Cheese Making

Cheddar

Swiss

Brick

Edam

Limburger

Cottage, etc.

DECKER

SAMMIS

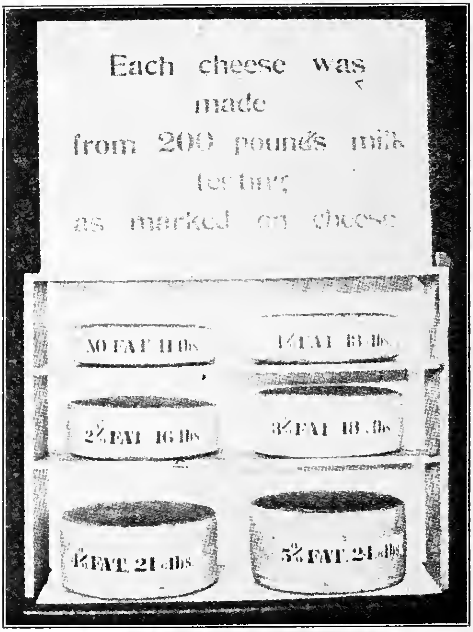

Fig. 1.—The yield of cheese is closely related to the fat test of the milk used.

CHEESE MAKING

A Book for Practical Cheesemakers, Factory Patrons, Agricultural Colleges and Dairy Schools

BY

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Sixth Edition of Decker's Cheesemaking, Entirely Rewritten

ILLUSTRATED

MADISON, WIS.

MENDOTA BOOK COMPANY

1918

CANTWELL PRINTING COMPANY
MADISON, WIS.

PREFACE.

Decker's "Cheesemaking" was published in 1893 for the use of students in the first American Dairy School, which had been established in 1891 at the Wisconsin College of Agriculture. The distinguished success of the book both in the English language and in a French translation by Emile Castele for French-Canadian cheesemakers, is a lasting tribute to the memory of its original author.

Covering only cheddar cheesemaking in the first edition, the work was revised and enlarged by Professor Decker for three later editions. After his death it was again revised by Dr. F. W. Woll, one of Professor Decker's colleagues at the University of Wisconsin.

The continued growth of the cheese industry in America, and the large number of foreign cheese varieties now being made here on account of decreased importations, have resulted in an increased demand for Decker's book among cheesemakers and dairy schools. The complete exhaustion of the past editions has afforded an opportunity for rewriting and enlarging the book to meet present day needs.

The new edition, as heretofore, is intended for use by cheesemakers and by Winter Dairy Students, who will study the general chapters in Part I, and the chapters in Part II, especially relating to the kinds of cheese which they intend to make. The numbering of sections in boldface type, and the index, provide means for ready reference to all topics discussed.

As a new feature of the present edition, the book has been enlarged in scope, and designed to form the basis for regular class work in agricultural schools and colleges. These students may begin with Part II, using chapters XX, XXI, VI (acidimeter), XXII, XXIII, VII (rennet) previous to the making of rennet cheese described in the later chapters. Before beginning American cheese (chaps. XXVII and XXIX) the rennet tests (chapter VI) should be studied, and while making American cheese and other varieties repeatedly in the work room, the class may study the remaining chapters of Parts I and II, thus utilizing the entire book, if time permits.

Acknowledgment is due for the loan of cuts by the Wisconsin Experiment Station; The Marschall Dairy Laboratory of Madison, Wis.; Stoelting Bros., Kiel, Wis.; Brillion Iron Works, Brillion, Wis.; Creamery Package Mfg. Co., Chicago, Ill.; Damrow Bros., Fond du Lac, Wis., and Louis F. Nafis, Chicago.

The book is designed to meet the needs of cheesemakers, dealers, factory patrons, students and others interested in the subject of cheesemaking.

J. L. Sammis.

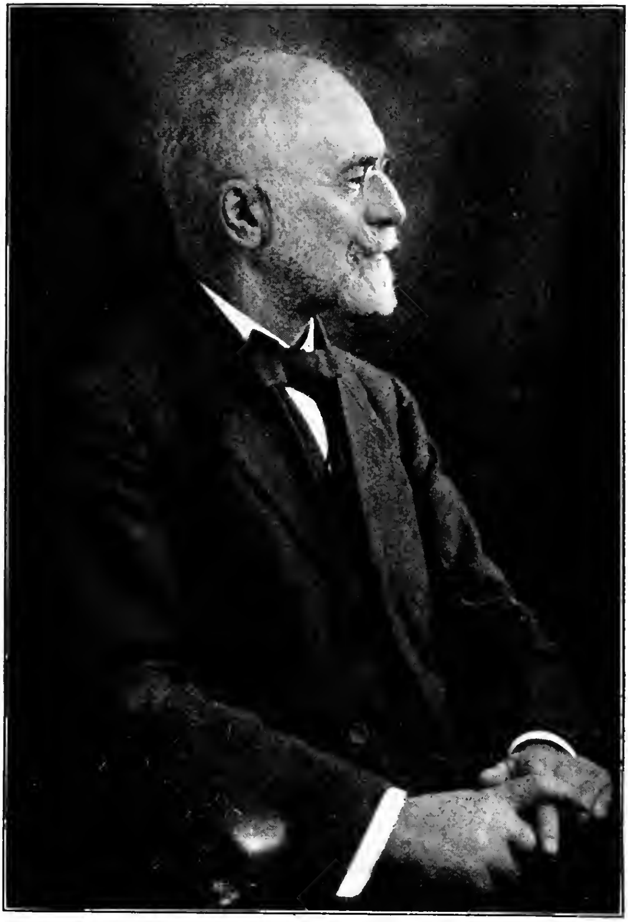
Madison, July 1, 1918.

To

STEPHEN MOULTON BABCOCK, Ph.D., Sc.D.,
Chief Chemist of The Wisconsin Experiment Station

Who, as a teacher, and later as a co-worker, by patient labor and wise counsel, inspired the author with a greater love for the profession of dairying,

THIS BOOK IS INSCRIBED



DR. STEPHEN MOULTON BABCOCK.

Medal presented to Dr. Babcock by Wisconsin legislature in 1899.

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PART I.

GENERAL FACTS FOR CHEESEMAKERS

CHAPTER I.

THE CHEESEMAKER'S EDUCATION.

(1) **Aims.** While working in the cheesefactory, or at the Dairy School, the young or old cheesemaker tries to learn (a) the best way to do each part of his work, (b) the reasons why, in every case, and (c) he will try to learn more than one way to do each operation, because different factories have different equipment, or emergencies may arise when the regular equipment can not be used, or special methods of handling curd may be advisable.

(2) **Sources of Information.** The Winter Dairy School student has already had six months' experience as a helper in a factory, and has learned much from his employer and from visits to neighboring factories. At the Dairy School are gathered people from all parts of the country, from large and small factories, where different methods of making are used. By getting well acquainted and talking often with each other, students may learn much.

Dairy papers, giving the cheese markets, factory and trade news, are published in New York, Chicago, Milwaukee, Michigan, Minnesota, Iowa, California, New Zealand, etc. Every student should examine these papers in the library, and subscribe to the one or more which he prefers.

In addition to the books on Milk Testing and on Cheesemaking which the student buys, there are in the agricultural library cheesemaking books in English, French, German, Danish, Spanish, Italian, etc.

Bulletins from the U. S. Department of Agriculture, at Washington, D. C., from the Experiment Stations at Madison, Wis., Ithaca, N. Y., Geneva, N. Y., Ames, Iowa, St. Paul, Minn., and from other dairy states and foreign countries give valuable information.

Instructors at the Dairy School will discuss every part of the work in class room and work rooms, and are glad to answer questions. A dairy society, meeting regularly, and holding weekly discussions on cheesemaking topics and other subjects is of great value to students, also affording practice in organizing and conducting meetings of factory patrons, in public speaking, etc.

(3) **The Student's Duty.** Be prompt at all classes. Pay close attention so as not to need to be told twice. Write down all that is new to you, because

(1) facts are presented too fast to be remembered,
(2) writing them down helps one to remember,
(3) written notes can be studied over and reviewed when needed.

Just as you have a daily schedule of class work, arrange for yourself a fixed plan for daily study. Take a short brisk walk out of doors daily and a long walk at least once a week, for your health Eat moderately. Sleep with windows open.

"Personal cleanliness* is of the first and highest importance with factory operators. Keep your body clean and your mind clear. Dirt and ignorance cost the dairy industry millions of dollars annually. Each student should take a thorough bath at least once a week. There is no excuse for lack of cleanliness. See that your underclothes as well as your overalls are always clean through frequent changes. Each morning before appearing in the class room, the student will give his hands and finger nails special attention and in all respects be in suitable form for creamery and cheese-factory inspection. In general, we hope in our Dairy School to teach not only how to make butter and cheese but to inculcate habits of great personal neatness, and an intense desire to have everything about the factory clean, tidy and in business form."

(4) **Experience in Many Lines.** In a commercial factory, the helper is sometimes kept busy upon a narrow line of work, as washing hoops or cans, and has little chance

*From "Advice to Students" by Prof. E. H. Farrington.

to learn other parts of the work. At the dairy school, instruction is given in all parts of the work.

The maker in a factory must do his own work, and also be prepared to give advice to his patrons on many subjects connected with dairy farming, factory business, etc. The dairy school student should therefore try to learn all he can about the following subjects, among others.

(1) How to keep factory and equipment clean and in good repair.
(2) How to erect and operate machinery, shafting, piping, etc.
(3) Best methods of producing clean milk on patrons' farms.
(4) How patrons may make their herds more profitable.
(5) How to inspect and test milk at the factory intake.
(6) How to make one or more kinds of cheese.
(7) How to take care of cheese in the curing room.
(8) Packing, wrapping, paraffining cheese for shipment.
(9) How to divide factory profits among patrons.
(10) The advantages of whey skimming to the patrons.
(11) The location, arrangement, and equipment of a new factory.
(12) The organization and business management of a factory.
(13) Should a factory be owned by patrons or maker?
(14) What by-products or side lines are profitable?
(15) Which pays better, butter or cheesemaking?
(16) How to judge the quality and faults of cheese, etc.
(17) How to make prize cheese for cheesemakers' convention, State Fair, etc.

Experienced factorymen, attending a Special Course in February for a week or two, have time to study one or two chosen subjects, such as milk testing, factory payments, whey skimming, starter making, fancy cheesemaking, or cheese moisture testing, etc.

Agricultural students in the four-year college course study cheese-making throughout the year, without previous factory experience, and learn how to make numerous kinds of cheese and related products which are of commercial importance in this country. These students may begin the study at Part II, and make the following from directions there given, while also covering Part I in the class room.

First Half Year

Classification of cheese varieties.
Casein with sulphuric acid
Casein from sour milk
Wet and dry casein
Casein from buttermilk
Cottage cheese from skim milk
Hand cheese, cooked cheese
Buttermilk cheese from raw or pasteurized cream
Rennet tests and acid tests
Neufchatel
Coulommier
Soft ripened rennet cheese
Lunch, isigny, camembert
Brie, liedertafel
Curd test, fermentation test

Second Half Year

Limburger cheese
Brick cheese, Edam
Swiss cheese, block,
American cheese, whole milk;
  soft or firm,
  granular or milled,
  skim or part skim
Club and mixed cheese
Testing cheese for fat
Testing cheese for moisture
Inspection of factories (trip)
Cheese lunch, many kinds, sampled
Cheese judging and scoring
Primost, whey butter
Italian skim and whey cheese

CHAPTER II.

PRODUCTION AND CARE OF MILK ON THE FARM.

(5) **Importance of Clean Milk Supply.** For the success of the factory it is necessary that the milk produced on each farm be kept clean by keeping dirt out of it, and that it be properly cooled, and delivered promptly and in good condition for cheesemaking. It is the cheesemaker's duty to see that these things are done and to show the patron how when necessary. The cheesemaker can give the farmer two reasons why milk should be clean and sweet when brought to the factory, (1) because with defective milk there is sure to be a loss either in the yield or quality of the cheese, and (2) because the laws of most states prohibit the sale or delivery of any insanitary milk at any factory, under penalty of fine and imprisonment.

The cheesemaker's success in his work depends, more than anything else, on his ability to keep his patrons interested in improving the milk supply of the factory.

(6) **Clean Milkers and Utensils.** The milkers' hands should be kept clean and dry while milking. Milking machines, if used, require intelligent and diligent inspection and

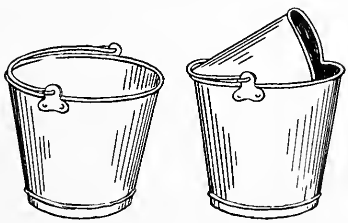

Fig. 3.—Closed top pails should be more generally used. They can be purchased from dealers, or the ordinary milk pail can be provided with a suitable top by any tinsmith.

cleaning daily, following the directions furnished with the machine. A closed top milk pail excludes three-fourths of the falling dirt, and is a great help in clean milk production.

A cloth or cotton batting strainer is the most effective kind if kept properly clean, but if not kept clean it becomes a source of infection and injury to the milk, and on farms where this occurs, an all metal strainer is preferable, because it is more easily kept clean than a cloth. Immediately after use, the milk pails, strainers and cans should be rinsed first with cool water, then washed with hot water, a brush, and a good washing powder, and rinsed, and finally scalded or steamed thoroughly, and kept in a milk house or other clean place until needed. It is not sufficient, as some patrons suppose, to rinse a milk can out with dish water, or to wipe it with a dirty cloth, for such methods leave great numbers of germs in the utensils, which will later make the milk sour or bad flavored, and injure the cheese. Probably dirty utensils spoil milk more frequently than any other one cause.

A simple device consisting of a covered pan of water and an oil or gasoline stove, etc., has been described in Farmers bulletin 748, from the U. S. Department of Agriculture, Washington, D. C., by which cans, pails, strainers, separators, bowls, etc., can be steamed in a few minutes on the farm. Large factories, and many condensaries and city milk buyers wash, steam, and dry all patrons' cans as soon as emptied, and require the use of a different set of cans for hauling back the whey, etc. Steaming whey in the factory whey tank helps greatly in keeping cans clean.

(7) **Clean Cows and Stables..** Barns and yards should be kept in such condition that the cows can keep themselves reasonably clean. In the stable where cows are milked, there should be neither dust falling from the ceiling, nor a wet, muddy floor underneath, nor a foul smell in the air. A well lighted and ventilated stable, whitewashed once or twice a year is essential.

Clean comfortable quarters and kind treatment are essential, if cows are to do their best. Some authorities believe that milk is secreted to a large extent at the time of milking, since the udder has room for only a small portion of the milk yielded by the cow at a milking; when a cow is excited or disturbed at that time, she may fail to produce as much milk of the same quality as usual.

Cows should not be obliged to wade through a muddy barnyard, or lie down in a filthy stable. If the cow's flanks and udder are not caked with mud or manure, a very little brushing or wiping before milking will remove loose hairs and dirt, so that these will not fall into the pail.

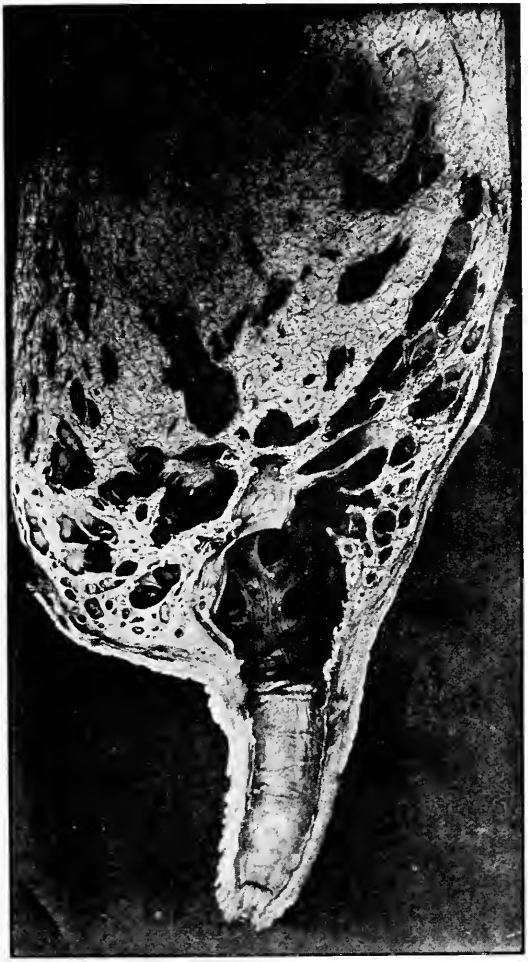

Fig. 4.—A section through a quarter of a cow's udder. From a photograph (Cornell Univ. Experiment Station).

All dusty feeds as hay and strong smelling or strong flavored feeds as silage should be fed just after milking, rather than just before.

(8) **Cooling and Holding Milk.** The pails of milk are carried immediately from the stalls to the milk room and strained into milk cans, which are set in the cold water tank. If stirred frequently with a dipper, the milk in the cans will be cooled to the temperature of the well water, within an hour's time after it was drawn from the cow. The tank is again filled with cold water before leaving for the night.

With a tin cooler filled with cold water, placed between the strainer and the milk can, milk can be cooled most rapidly. If it is to be hauled any great distance, the morning's milk should be cooled, but if the factory is near by, it is often delivered without cooling. Never mix warm morning's milk with cold night's milk at the farm.

Aeration can never cool milk sufficiently in warm weather, but is likely to cause milk to take up dust and bad odors. Under ordinary farm conditions, the aerator is likely to do more harm than good, and should not be used.

CHAPTER III.

INSPECTION AND TESTS OF MILK AT THE INTAKE.

(9) **Reasons for Inspection.** The reasons for careful daily inspection of milk at the factory are, (1) that any defective milk may be detected before it enters the cheese vat, and sent back to the farm, together with advice or instructions to the farmer as to how he may avoid such trouble next time. Proper attention to this is part of the maker's duty and protects careful patrons from having their good milk injured by mixing with defective milk from a careless patron. It also protects both maker and patrons from possible prosecution and fine by official inspectors visiting the factory at unexpected times, and finding that unfit milk is being offered and accepted.

(2) Another important reason for inspection is that it gives the maker, at the earliest possible moment, a knowledge as to what kind of milk he has today, so that he may handle it to the best advantage.

In addition, careful daily inspection of milk impresses the patrons with the importance of handling milk properly at the farm, and sets them a good example.

(10) **To Prepare for Milk Inspection.** Intakes should be built so that the maker can step up, examine, and smell every can of milk before it is poured into the weigh can, and make such other tests as he desires. A great many factories, especially the Swiss, brick and Limburger factories, are not so built. Intake inspection by the cheesemaker should include, first, his own equipment and outer clothing, to see that his overalls, weigh can, strainer, conductor and vat are in fit condition, before the patrons come.

(11) **Possible Defects to be Found in Milk.** Milk inspection is intended to show faulty conditions under which milk was produced, stored or delivered, as judged by

(1) the temperature, color, odor, taste, the presence of dirt in the milk, or in the bottom, sides, or shoulder of the can, or on the can, wagon, or hauler,

obtained, as a means of picking out those patrons who bring the unclean milk causing the trouble.

An outfit may be purchased of dealers, for holding 6 or 12 milk samples. Most factories have more than 12 patrons, and the need for using the curd test often arises suddenly, when there is no time to send for an outfit. In such cases, an iron wash tub and a set of two or three dozen pint fruit jars can be obtained at any country store, and will answer the purpose.

The tub, jars, and covers are cleaned, and scalded thoroughly with boiling water or by running steam into the tub-

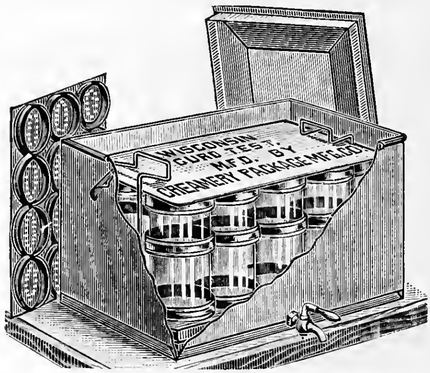

Fig. 5.—Wisconsin Curd Test Outfit of the form sold by dealers.

ful of water containing the jars and lids. The jars are then covered and set in a clean place near the intake ready for use. A portion of each patron's milk is caught in a pint jar held over the weigh can, and the jar is marked with the patron's number. This may be done on the metal cover, or the surface of the jar may be roughened at one spot by rubbing with a wet file, and the number written there with a black lead pencil. When all of the samples are taken, the jars are set in a tub of water at about 110 degrees for a short time, until the milk is raised to a temperature of 95–100 degrees, F. Ten drops of rennet extract are added to each jar in order, mixing it through the milk by stirring with a thermometer or case knife, which has been just previously scalded in hot water. After a few minutes standing quiet, the milk in each jar thickens, and the curd is then finely

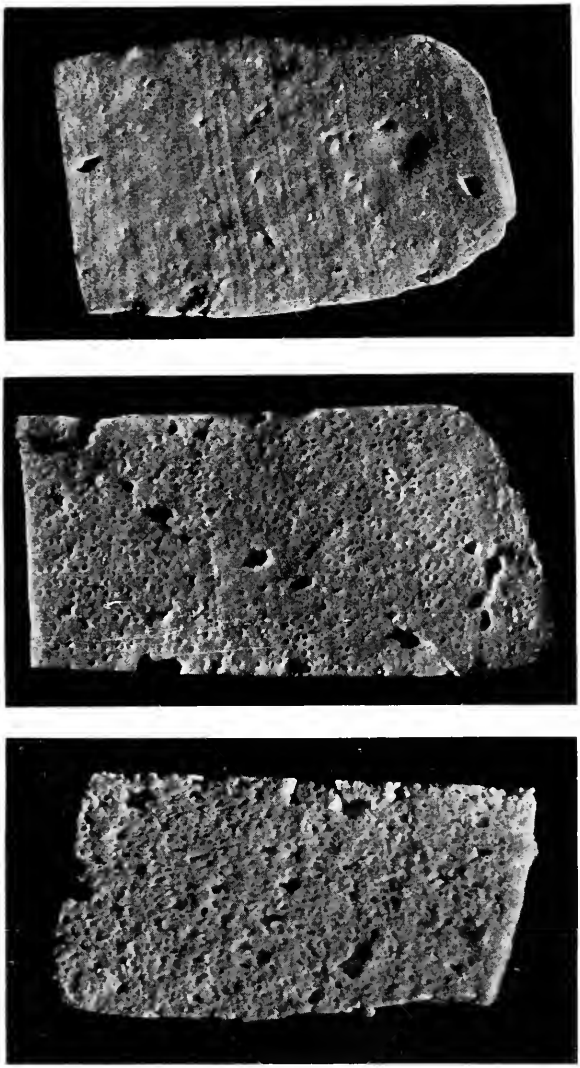

Fig. 6.—Curds from milk of different quality as produced in the Wisconsin Curd Test.

Upper figure, curd from a good milk. Large, irregular, mechanical holes.

Middle figure, curd from tainted milk. Numerous small "pin holes" due to gas formed by harmful germs in the milk.

Lower figure, curd from a foul mik. When received this milk showed no abnormal symptoms, but the foul odor and spongy texture appeared in six to eight hours due to the presence of filth germs.

By means of this test, the factory operator can determine which patron brings the gassy milk causing defective cheese.

test immediately so that he can see it, in comparison with those previously taken.

The sediment discs, showing the dirt collected from one pint of milk, are very effective and convincing, as well as surprising to the patrons. Where the test is repeated at irregular intervals, about once a week or oftener, an improvement in cleanliness is the result, as no one likes to have the dirtiest milk test more than once.

The sediment on the filter disc may consist mainly of fine grained black sand, where cows have access to a marsh, or

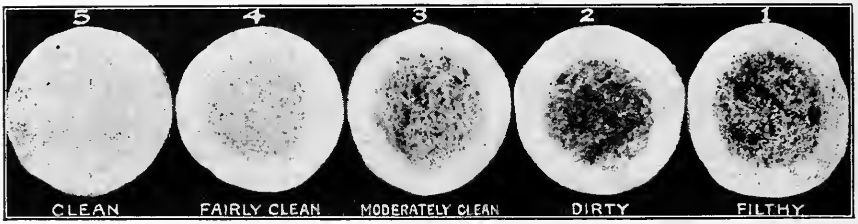

Fig. 9.—Sediment tests from different grades of milk.

may be yellow in color, indicating manure, or sometimes white and curdy due to a sick cow. A slight yellowish tint may be seen, due to the color of milk and butter fat.

In very dirty sediment tests, particles of straw, chaff, silage, manure, hair, sand, etc., can often be seen.

Dirty milk at the farm may be strained through cotton batting or flannel, removing all sediment, so as to give a clean sediment test, and yet contain the soluble material and the bacteria which can not be thus filtered out of milk.

The sediment test has been widely used with good success by inspectors, instructors, and factorymen.

CHAPTER IV.

CONDITIONS AFFECTING THE RIPENESS OF MILK IN THE CHEESE VAT.

(18) **The Growth of Germs in Milk.** Bacteria grow rapidly in warm milk. Thus at 68 degrees F. one germ in milk may produce over 6,000 germs in 24 hours, while at 50 degrees F. there may be only 4 or 5 produced. On this

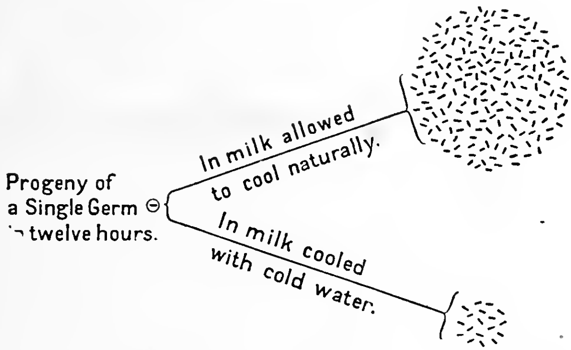

Fig. 10.—At temperatures above 55 degrees, the growth of bacteria in milk is rapid. From Wis. bul.

account, milk should either be used immediately after milking for cheesemaking, as at Swiss and Limburger cheese factories where milk is delivered and cheese made twice daily; or else the night's milk should be promptly cooled and kept cool until delivered in the morning (section 8). The lactic acid germs more or less rapidly change milk sugar into lactic acid, and thus sour the milk.

(19) **The Acidity of Fresh Milk.** Although perfectly fresh milk contains no lactic acid, yet it may show by the acidimeter about .12–.15% acidity if low in solids (as from 3 to 3.5% fat) and .16–.19% acidity if high in solids (as from 4 to 6% of fat), this acidity being due to the casein, mineral salts, etc., normally present in fresh milk.

(24) **Effect of Adding Starter.** Immediately after adding starter, and heating to 86 degrees, another acid test or rennet test may be made, and the milk will be found to be a little higher in percent of acid, or lower in time required to thicken with rennet, than before the starter was added, due to the lactic acid contained in the starter. The lactic germs in the starter will usually require an hour or more to begin producing acid after they are added to the vat. If repeated tests, made every few minutes after adding starter, show that the ripeness is steadily increasing, this is due to the lactic germs which were in the milk, before starter was added.

CHAPTER V.

A GOOD STARTER FOR CHEESEMAKING.

(25) **Qualities of a Good Starter.** A first class lactic starter for creamery use will usually be good also for cheese-making, although a poor starter is more likely to injure the quality of cheese than of butter.

A good starter should have a pleasant, mild, acid flavor and odor, as a sharp, sour flavor like vinegar is likely to show also in the cheese. The texture should be free from gas holes, and should not be wheyed off (at 72 degrees), but smooth and creamy in order that when stirred into the vat, the lactic germs may be easily distributed through the milk and not retained in lumps of curd. A starter contains the largest number of living, active lactic germs when its acidity is about .6–.7%, and it has just recently thickened at 72 degrees, F. It is then in the best condition either for adding to the cheese vat, or for transfer to another lot of milk for starter making. With proper handling, a good starter can be kept in daily use without deterioration for a long time, sometimes for months or years. For this purpose, the best rule is to transfer it every day into some freshly pasteurized milk.

(26) **Materials for Making Starter.** To prepare 1 percent of starter for use with 5,000 lbs. of milk, obtain (1) 55–60 lbs. of good, clean, fresh whole milk, and (2) a pint of first class sour milk, or starter, or a commercial culture of lactic acid germs.

(27) **Select Milk for Starter Making.** To get suitable milk for starter making, it is best to select the fresh, morning's milk from the best patron, and pour this directly into shot gun cans, or other cans used for starter making. Milk taken from the cheese vat after all patrons have come is not so good, because some gas or taint producing germs may have been present in the milk from one farm or another.

Whey from today's cheese is not good to make tomorrow's starter with, because it may carry over harmful germs

and to let it stand unopened and unshaken for several days, after which it is examined to see if it has developed gas bubbles, or a bad flavor, or has wheyed off.

(34) **Commercial Culture For Starter Making.** In addition to a supply of good starter milk (section 27) a good culture of lactic germs must also be provided. This may be a portion of yesterday's starter, or it may be obtained either (1) from a neighboring cheese factory, or by purchase from a dealer in factory supplies, or (2) as a "natural" starter.

Dealers supply commercial cultures in small bottles as "liquid" or as a "dry" powder. The liquid culture should have stood long enough to curdle in the bottle, but should be used for starter making while fresh as shown by the date on the bottle. A dry culture on the other hand will keep in good condition in the bottle for a somewhat longer time, but may be slower in growing when first used, as the drying of the culture may kill a part of the germs present. Full directions are printed on the bottle, for growing these cultures for one to three days in quart jars before using them in a large can of starter.

(35) **Natural Starter.** To obtain a "natural" starter, scald out several pint fruit jars with lids, carry these to a nearby farm selected for cleanliness. With clean hands and other precautions to exclude dirt (sections 6, 7) draw some milk from a clean cow. Throw away the first two or three streams of milk from the teat, and then milk directly into one of the jars. Repeat this with several jars and different cows. Cover each jar to exclude dust, and take all the jars to the factory. Keep them covered at about 95–100 degrees until the milk thickens, which may require 12 to 48 hours. Reject any curds which are gassy or wheyed off, and select the best flavored of the remaining curds, if satisfactory, to be transferred to some pasteurized milk for starter making. Sometimes all of the samples thus taken at a barn may turn out unsatisfactory, and another set may be taken from another source. The commercial culture is commonly preferred as quicker, and surer to be satisfactory.

CHAPTER VI.

TESTS FOR RIPENESS OF MILK, WHEY, STARTER, ETC.

(36) **Odor and Taste.** By the odor or taste of milk at the intake, or of milk or whey in the vat, or of starter, an experienced factoryman can judge whether it is fresh and sweet or how ripe it is. Cheesemakers and students should learn to judge the condition of milk, whey, etc., by its odor, tasting it also when necessary.

(37) **The Acidimeter or "Mann's Acid Test."** (a) This test is very generally used in Canadian cheese factories, and is taught at Dairy Schools along with other tests. It has been used with satisfaction by a number of leading cheese-makers in the United States.

The test is made in a variety of modified forms. The most practical method is probably the following, which is employed at the Wisconsin Dairy School and elsewhere:

(a) A 17.6 cc. pipette, the same as used for the Babcock test, is filled to the mark with the milk or whey, etc., to be tested, and is then emptied into a white porcelain cup, preferably wide and flat bottomed rather than narrow and deep. (b) Two drops of indicator solution are then added to the cup. The indicator solution contains 10 grams of phenol-phthalein powder dissolved in a quart of denatured alcohol. Sometimes the more expensive 95% grain alcohol is used for the purpose, dissolving the powder completely in one pint of the alcohol, and then adding slowly about two-thirds of a pint of distilled water or condensed steam, or even rain water, but not adding enough water to make the liquid turn milky white.

(c) From a burette holding 10 cubic centimeters, or more, and graduated in one-tenth cc. divisions (or sometimes in one-fifth cc. divisions), a solution of "neutralizer" or "tenth-normal alkali" is run in a rapid series of drops into the milk in the cup. As the first drops of "neutralizer" enter the milk a red color is produced, but this quickly disappears on shaking the cup held in the right hand, or stirring the milk with a rod or thermometer. The stirring and the addition of neutralizer rapidly by drops goes on until the last drop added produces a faint pink color which spreads through the milk and does not disappear on thorough mixing. A convenient color standard in a glass tube is on the market.

(d) The quantity of the neutralizer solution used is read from the burette, and (if 17.6 cc. milk was used) is divided by 20 to obtain the percentage of acidity in the milk. Thus fresh milk may require 2.8 cc., which divided by 20, gives 14/100% as the acidity. Milk for American cheesemaking should not take over 4.0 cc., equal to .20% acidity. Whey or curd drippings or overripe starter may use up to 16 to 20 cc., equal to .8 or 1.0% acidity.

(e) Sometimes, and especially with sour material, it is better to use a 9 cc. pipette, instead of 17.6 cc., thus saving

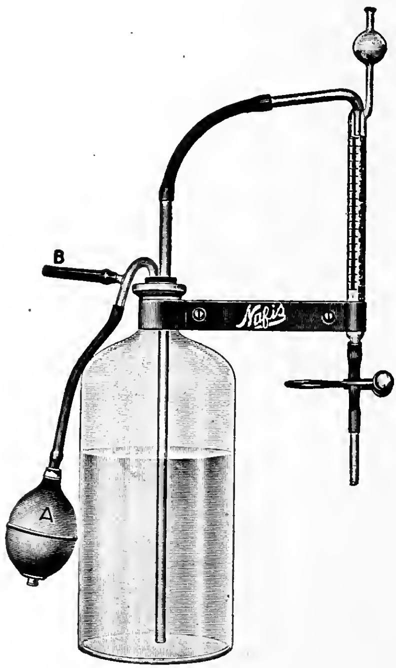

Fig. 11.—Nafis Acid Test.

half of the neutralizer; and the volume of neutralizer used is divided by 10 instead of 20 to get the percentage acidity.

The speed and convenience of the acid test is much greater if a modern form of the test, such as the Nafis, Marschall or similar form, is used in which the burette and neutralizer bottle are connected by a tube, through which the neutralizer runs, instead of being poured by hand into a separate burette.

(38) **Neutralizer.** The neutralizer is commonly a solution of lye of exactly the right strength, and can be bought from a dealer ready made at $1 per gallon or in powder form, to be dissolved in one gallon of soft water. The solution should be kept in a rubber stoppered bottle or jug to protect it from the air. A half pint rubber stoppered bottle may be filled from the gallon jug and kept on the table for filling the burette, thus protecting the main bulk of the solution from frequent exposure to the air.

To prepare large quantities of tenth-normal neutralizer, for use in a school, or to supply a number of factories, dissolve 1½ lbs. of pure stick caustic soda in 35 lbs. of distilled water in a large bottle and mix thoroughly. This solution is then compared with a *normal* strength solution of hydrochloric acid, purchased by the half gallon from a dealer in chemical supplies, and is then diluted exactly to normal strength, so that 10 cc. of the soda solution will exactly neutralize 10 cc. of the normal acid. 100 cc. of this normal alkali solution diluted with distilled water to 1000 cc. and thoroughly mixed gives a tenth-normal neutralizer, for use in testing milk.

(39) **Farrington's Alkaline Tablets.** One thousand alkaline tablets, costing $2.00, dissolved in soft water, make 3880 cc. of tenth-normal solution. (One gallon equals 3785 cc.) The "improved" tablets now being sold retain their strength both when dry and also in solution.

The cartridge shell test is made by dissolving one tablet in one ounce of soft water, and mixing a small measure full (as a No. 10 brass cartridge shell) of this solution with an equal volume of milk in a cup. If the mixture remains pink, the acidity of the milk is less than .20%. If it turns white, the milk is over .20% acidity and is not fit for cheesemaking.

This is a convenient intake test to show to patrons, when they bring overripe milk.

(40) **Alcohol Test.** When 2 cc. of 68% (by volume) alcohol are added to 2 cc. of milk in a test tube, and gently shaken, the appearance of curdling may be taken to indicate that the milk has ripened considerably or is abnormal in other respects, so that it should be returned to the farm. This test is used mainly in Europe.

(41) **Rennet Tests Measure Ripeness of Milk.** Sour or partly ripe milk thickens more quickly with rennet than does sweet milk. By mixing a measured quantity of milk at 86 degrees, with a measured amount of rennet extract, and noting on the watch the exact number of minutes or seconds required for thickening, the ripeness of the milk can be determined. The Marschall test, Monrad test, and Harris test are used by cheesemakers for this purpose. By testing a vat of milk every few minutes, the maker learns how fast it is ripening, and judges when he should add rennet to the vat.

In making rennet tests, as a measure of the ripeness of milk, it is necessary to use only normal cows' milk, and to work at the specified temperature, as with defective milk or at varying temperatures, the rennet test results will not be comparable with each other.

(42) **Milk Thickens Most Rapidly at About 106 Degrees.** The relative time required to thicken milk with rennet at different temperatures, all other conditions being the same, is shown in the table.

68F	77F	86F	95F	100F	102F	104F	105.8F	108F	113F	117F	118	120	122
555	225	141	116	107	104	102	100	102	112	128	144	167	200

For cheesemaking purposes, milk is always thickened between 68 F. and 118 F., and in most cases between 86 and and 95 F. For pasteurized milk, see (217).

(43) **Dissolved Substances in Milk Affect Coagulation.** The addition of almost any soluble substance to milk delays or hastens its coagulation with rennet.

The addition of water in moderate amounts to milk at the farm makes it necessary to use more extract at the factory.

The addition of formaldehyde to milk at first delays coagulation and later entirely prevents it.

Higher acidity of milk produced either by ripening or by addition of an acid causes it to coagulate more quickly with rennet. This fact is the basis of the use of rennet tests.

The addition of soluble lime salts as calcium chloride to milk hastens rennet coagulation, while common salt or alkalis delay it. Some makers add salt to milk supposing it possible thereby to avoid gassy cheese.

Pasteurization of milk, or boiling, followed by cooling, greatly delays coagulation, but the addition of an acid or a soluble lime salt restores the ability to thicken with rennet.

Milk from high testing cows, as Guernseys or Jerseys often thickens quicker than low testing milk.

Feeding cows feeds which are low or high in lime content does not affect the lime content of their milk, as a cow will put the proper amount of lime in her milk even if necessary to take the lime from her own body. Milk containing colostrum, and often the milk of sick cows will not curdle normally with rennet.

(44) **Marschall Rennet Test.** The Marschall test cup is filled above the zero mark with milk from the vat at 86 degrees, and is set on the corner of the vat. The milk runs slowly through the small hole in the bottom of the cup. A

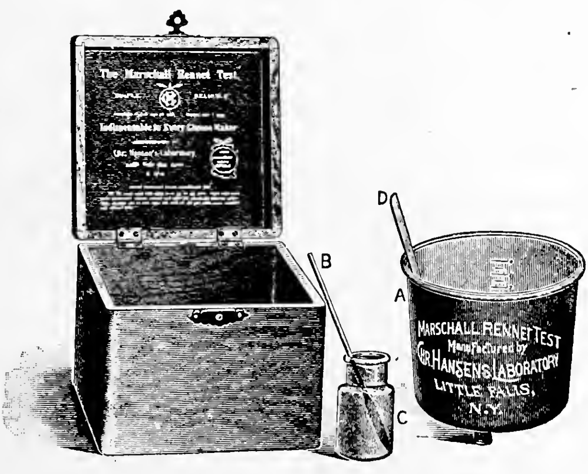

Fig. 12.—Marschall Rennet Test. The most convenient and widely used form of rennet test.

scale of figures on the inside of the cup shows, approximately in minutes, how long the milk has been running out.

A small bottle is filled to the mark with about 20 cc. of cool water, and 1 cc. of rennet extract is added, rinsing the pipette by drawing up the water once or twice.

When the milk in the test cup has run down until the zero mark at the top of the scale shows at the top of the milk, the diluted extract is quickly added and stirred in thoroughly for about half a minute with a thermometer or spoon. The thermometer may be left in the milk and read after the test to see whether the temperature has fallen.

As soon as the milk thickens in the cup, it closes the hole and stops running out. The reading on the scale at the top of the milk may be 1½ or 2 for ripe milk, 2½ to 3½ for moderately ripe milk, or 4 to 5 or more for sweet milk. Always clean the cup and the hole well before making a test. With very sweet milk at a Swiss cheese factory 2 cc. of rennet extract may be used instead of 1 cc.

(45) **The Monrad Rennet Test.** For this test, 5 cc. of rennet extract are measured with a pipette into a 50 cc. flask, containing some clean cool water. The pipette is rinsed by drawing up the water, and the flask is then filled to the 50 cc.

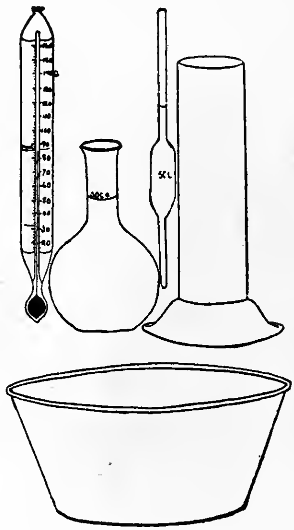

Fig. 13.—The Monrad Rennet Test.

mark on the neck with water. The contents are mixed thoroughly by shaking.

One hundred sixty cc. of milk from the vat, at 86 degrees, are measured by means of a tall, tin cylinder, and poured into a small pan, set in a larger pan containing water at about 88 degrees to keep the milk at 86 degrees. While stirring the milk with a thermometer, quickly add a 5 cc. pipette full of the diluted rennet to the milk in the pan, and note by the watch the exact second when the addition was made. Stir in the rennet quickly for half a minute or less, and at the same time add a few particles of charcoal dust. This dust shows when the milk thickens, by suddenly stopping its movement around the pan, appearing to move backward a trifle as it stops, when the time is again read by the watch. The exact number of seconds required for thickening may be 35 to 45 for quite ripe milk, or as much as 60 seconds for moderately ripe milk, or 85 seconds or more for sweet milk.

To deliver the diluted rennet quickly, the pipette should have a wide tip, or the liquid should be run out of its wide upper end turned downward for this purpose.

(46) **The Harris Rennet Test.** In this test, 8 (or in some cases 10) ounces of milk at 86 degrees are taken up

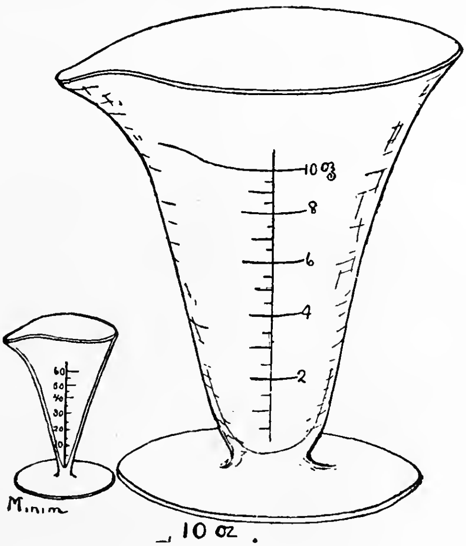

Fig. 14.—The Harris Rennet Test.

from the vat in a conical glass graduate, and ½ dram of extract is added at a time noted by the watch. The extract is stirred in well with a thermometer for 5 or 10 seconds, and the time is again noted on the watch when the milk first thickens.

(47) **To Obtain Accurate Rennet Tests.** Important precautions in making rennet tests: (1) To have the milk always at the same temperature, by the same thermometer, (2) to use the same lot of extract in a series of tests, as different extracts may vary in strength, (3) to use the same measuring vessels, as these may vary slightly in size or capacity, (4) to fill pipettes, etc., so that the bottom of the curved fluid surface is exactly on the mark.

Neglect of these precautions may cause irregular results. Tests made at different factories, even on the same milk, may vary somewhat, because the different sets of equipment may vary slightly in size. But at any one factory, tests made with the precautions listed above, will show clearly the ripeness of the milk, and its variations from day to day, due to differences in the way it has been handled by patrons, etc.

(48) **Experiments Using The Rennet Tests.*** In order to make a comparison of rennet tests with each other, and to study conditions affecting rennet curdling, a can of milk or skim milk should be provided, which should be fresh and cooled to the temperature of well water or below, in order to avoid ripening during the hour of work, so that comparable results can be obtained.

(a) Test duplicate portions of the same lot of milk with the acidimeter, the Marschall test, the Monrad test, and the Harris test. While performing this experiment with the Marschall test, observe the time in minutes and seconds on the watch, from the addition of rennet until the milk stream stops running. Does the scale of figures inside the Marschall test give the time in minutes or not? Are all Marschall tests alike in this?

After completing each test as directed above, find how much milk (or water) the measure used will hold, by means of a 100 cc. or a 500 cc. measuring cylinder.

*Note. All students in the class may work at the same time using milk taken from one large can, the students passing along from one table to another, on which the different test outfits are arranged. Be very careful not to pour any milk back into the large supply can, and thus avoid accidents, such as getting a little rennet into it.

In the Marschall test, how much larger is the volume of milk used than the volume of rennet? Answer this question also for the Monrad test and for the Harris test.

Which test uses the largest proportion of milk to rennet? Which test uses the smallest proportion of milk to rennet? How much larger is this proportion for one test than for the other?

How much longer time is required by the watch for thickening milk by the one test than by the other?

Does the time required for coagulation depend upon the proportion of rennet added to the milk? Every student should complete this experiment in good order, and write it up clearly in the note book.

The remaining experiments described below may be performed by advanced students, so far as time permits, or may be postponed, or omitted entirely, as directed by the instructor.

(b) Using the Monrad test, make several tests on milk from the can, at different temperatures, 65, 75, 85, 95, 105, 115, 125 degrees F., to determine at what temperature coagulation occurs most quickly.

(c) Heat some milk in a flask to about 180 degrees over a flame or by placing in boiling water, and then cool quickly in cold water to 86 degrees. Make a Monrad test. Does pasteurization interfere with rennet coagulation?

(d) To another portion of milk pasteurized as in (c) and cooled to 40–50 degrees F., add from a burette 1 cc. of N/1 hydrochloric acid per 100 cc. of milk, while shaking or stirring the milk vigorously to prevent curdling by the acid. Heat to 86 degrees and make a Monrad test. Does acid restore rennet action to pasteurized milk?

(e) To portions of milk from the can, measured out for the Monrad test, add different amounts of calcium chloride, ¼, ½, 1, 2, 5, 10 grams, and then complete the tests as usual. Try also different amounts of common salt, of borax, or of sodium carbonate in similar tests. At the end of a series of tests, repeat the first one a second time to make sure that gradual ripening of the milk while standing has not interfered with the results.

(f) Acidulate different portions of milk at 40–50 degrees with different amounts of N/1 hydrochloric acid, and after heating to 86 degrees, make Monrad tests, to show the effect of varying acidity on rennet action.

(g) Add 5% of starter to a pail of milk, mix well and heat to 100 F., to ripen. Cool immediately a small portion of the milk to 86 F., for a Monrad test, and test other portions at half hour intervals, at the same times making acidimeter tests. Which test detects small differences of acidity with greater certainty?

(h) Make several rennet tests, using different lots of rennet extract, fresh, or old, from different makers.

(i) Compare rennet extract and pepsin solution by making a Monrad test or Marschall test with each, using sweet milk for both, and afterward repeat the trials using milk at about .20–.22% acidity for each. Which is better for sweet milk, rennet or pepsin?

(k) Dilute some extract with water for the Monrad test, and let it stand for an hour or until next day. Then dilute a second flask of the same extract, and immediately make rennet tests, using first the freshly diluted extract, and afterward the other lot. Does diluted rennet extract lose strength on standing 24 hours?

(l) In a test tube, mix (1) 1 cc. of N/1 caustic soda solution, (2) 1 cc. of N/1 hydrochloric acid, and (3) 5 cc. of rennet extract, mixing well after each addition. Use 5 cc. of the mixture for a Monrad rennet test.

Now make a second mixture, placing in a test tube (1) 1 cc. N/1 alkali, (2) 5 cc. rennet extract, and after mixing well, add (3) 1 cc. N/1 hydrochloric acid. Make a rennet test, and explain why the results differ from the preceding.

(m) From a rennet test made on milk from a vat, figure in what time the milk should begin to thicken when the vat is set, and compare the figure thus obtained with the observed result. Explain any difference.

(n) Resistance of rennet to heat. Place 5 cc. of extract in a 50 cc. flask, by means of the pipette. Heat the flask in a pan of water at 100 degrees for 5 minutes. Then fill the flask to the mark with cold water, mix well and make a Monrad test.

Repeat with 5 cc. of extract, heated to 110, 120, or 130 degrees. At what temperature does the rennet lose about half its strength? All of its strength? In these tests the extract was heated before diluting.

Diluted rennet may be tested as to its resistance to heat, as follows: Dilute 5 cc. of extract to 50 cc. in the flask and mix well. Transfer about 10 cc. of diluted extract to another flask, heat to 100, 110, 120, or 130 degrees for 5 minutes, in hot water, then cool the flask in cold water, and make a Monrad test using 5 cc. of the liquid. At what temperature does diluted rennet extract lose about half of its strength? All of its strength?

(49) **Advantages of Rennet Tests, and Acidimeter Tests.** The advantage of the acidimeter for use in the cheese factory comes from the fact that it can be applied to the milk at the intake, and also to the whey or the drippings from the curd at every stage of the cheesemaking process. The test is made quickly, and can be applied at any temperature, as the result is not affected by temperature. Makers who have become thoroughly familiar with it recommend it highly.

The rennet tests do not require a special "neutralizer" or "indicator" solution, but are made with the same rennet extract which the maker buys in a jug for cheesemaking.

The Marschall test cup makes the use of a watch unnecessary, and the maker can read the test at any time. The Monrad and Harris tests require a watch, with second hand, but can be made with simple and inexpensive measures and utensils.

The rennet test, with the time measured in seconds, will detect small changes in the ripeness of milk more readily than the acidimeter.

(50A) **Comparison of Rennet Tests and Acidimeter Results.** In the Marschall test, about 800 cc. of milk and 1 cc. of rennet are used, so that the milk volume is 800 times larger than the rennet. In the Monrad test, the volume of milk is 320 times larger than that of the extract used, and in the Harris test 128 times larger.

The smaller the volume of milk used to 1 of rennet, the quicker the milk will thicken, so that the time of thickening is shorter in proportion for the Monrad test than for the Marschall test while the Harris test is yet shorter in time required. On this basis, a comparison of the different tests can be made, with a fair degree of accuracy, as shown in the table.

Name	Proportions	Time for		
		Ripe	Medium	Sweet Milk
Marschall test	800–1	2 min.	2½ min.	3½ min.
Monrad test	320–1	48 sec.	60 sec.	84 sec.
Harris test	128–1	19 sec.	24 sec.	33 sec.
Acidimeter, or Mann's Acid test		20% acid	18% acid	16% acid

(50B) Several Uses for the Rennet Test. Rennet tests are used most commonly to measure the ripeness of milk in the cheese vat, but may also be used to compare the strength of different lots of extract, as an old lot and a newly purchased lot. This is done by making a test on a given vat of milk using the old lot of rennet, and immediately making another test with the same milk and all conditions the same but using the new lot of rennet. It is well to make two or three such tests with each lot of rennet, as duplicate tests agreeing well with each other give the maker greater confidence in his results.

Another use is to occasionally test samples of each patron's milk, collected at the intake in separate jars, to determine whether any abnormal milk is being delivered, which will not curdle well with rennet.

(51) Hot Iron Test. The acidity of curd is measured also by the length of fine silky threads formed on contact with the hot iron. For this test a clean iron bar or piece of gas pipe, two or three feet long is heated at one end, under the boiler or in a flame, so that it is scorching hot, while the other end can be held in the hand.

A small block of curd with a smooth cut surface is taken in the right hand, and a suitable hot place on the iron is selected by touching a corner of the curd to the iron at spots between the middle and the hot end. The instant blackening of the curd indicates too high temperature for the test, and where the curd sticks but does not blacken at all the iron is too cold. Where the curd sticks and turns dark brown or black in about 5–10 seconds the temperature of the iron is about right. The flat surface of the curd block is applied to the iron at this point for two or three seconds, and then drawn steadily away, noting the length of the fine, not coarse, threads at the time when most of them have broken in two. By resting the iron and the hand on a brick, the curd can be moved steadily, and the maximum length of threads observed, depending on the acid in the curd. The whey is drawn when the threads are about 1/8 inch long or less, and the curd is salted when the threads are ¾ to 2 inches long, according to the cheesemaker's choice.

CHAPTER VII.

CALF STOMACHS, RENNET, PEPSIN, ETC.

(52) **Save Calf Stomachs.** The former supply of calf stomachs from Bavaria being cut off, cheesemakers, farmers and butchers should see that none is wasted, but all preserved for use in cheesemaking. Directions for preserving calf stomachs in suitable condition for shipment and use can be obtained on request from the Marschall Dairy Laboratory, Madison, Wis., or from The Chris. Hansen Laboratory, Little Falls, New York, or others who make rennet extract in large quantities, and are always ready to buy stomachs in good condition.

(53) **Preservation of Stomachs.** To obtain stomachs having the greatest strength for cheesemaking, the calves should be milk fed exclusively, 2 weeks or more of age, and hungry for about 10 hours when butchered. Calves shipped

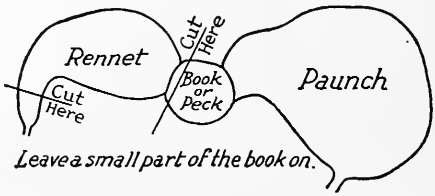

Fig. 15.—Calf Stomach. Cut off the fourth stomach from the third stomach, so as not to lose any of the upper end, which is most valuable.

a long distance by freight are inferior for this purpose. As soon as butchered, the rennet or fourth stomach is removed immediately, with care to retain all of its upper end, where the food enters, as this part is strongest in coagulating power. The stomach is squeezed to expel its contents, and any adhering fat or other tissue is taken off of the outer surface. The inside should not be washed. The ends may be tied with string, the stomach blown full of air, and hung up in a cool airy place, protected from flies, to dry for several days. When well dried, they are folded flat, packed in bundles, and shipped in boxes.

Instead of blowing full of air, the stomachs may be split open, stretched, sprinkled with plenty of dry salt, and left on an inclined board to drain and dry, with occasional stretching and salting. The well salted and drained stomachs may be shipped to the buyer when a sufficient number are collected.

(54) **The Making of Rennet Extract.** As American cheesemakers now generally prefer to buy commercial extract in kegs or jugs, the process of making will be described only briefly. The dried, salted stomachs are chopped up in a shredding machine, and put to soak in salt brine containing also some boric acid as a preservative. After soaking several days, more salt is added, and the liquid is filtered clear, and stored in a cool, dark place. After sufficient ageing, it is tested and brought to a definite strength for sale to the cheesemaker.

If rennet extract is made by the cheesemaker at the factory every few days, the different lots vary greatly in strength and there is more or less trouble and waste in using it, as well as in the making, while it is impossible to make satisfactory rennet tests with extract varying in strength from day to day. For these reasons most makers prefer to buy extract of good and uniform quality from a manufacturer or dealer, two or three times a year.

(55) **Keeping Quality of Rennet.** When first made, rennet extract loses strength slowly during the first month or two, but after that it keeps its strength with only very slight loss for a long period. On that account, extract makers store it at the factory for the first few months, and bring it to standard strength before it is sold.

Rennet extract keeps its strength better in the dark than in the light, and is therefore commonly sold in jugs, kegs, or brown bottles. It keeps better when cool, and is therefore stored in the coolest part of the factory. Heated for a time to 140 degrees, the extract loses its strength quickly, and less rapidly at 120 degrees. In neutral solution, it will stand heating better than in acid solution but it cannot be sterilized by heat without entire loss of strength. Therefore rennet extract is best sterilized, when necessary, by addition of formalin. Dry rennet powder can be sterilized by heat.

Diluted rennet extract loses strength rapidly, hence it is diluted only when needed for use. Never pour water into the jug or keg of extract.

The addition of alkali or alkaline substances of any kind to rennet almost instantly destroys its coagulating power. Hence vessels in which extract is handled should be free from soap or washing powder. The glass graduate used for measuring cheese color, which is a strongly alkaline liquid, should not be used also for extract without thorough washing. Separate graduates are preferable.

(56) **Other Rennet Products.** Beside rennet extract there are also in the market rennet powder put up in tin cans, and rennet tablets or junket tablets. The powder is dissolved in water and added to the milk. The tablets can be bought in small size suitable for a quart of milk, or in large size for 100 lbs. or more of milk. These products keep well and are especially useful where cheese is made only occasionally.

A dozen dried calf stomachs are often tied up in a roll, called a "wurst," or are sometimes chopped fine and packed in a pasteboard tube, for use by Swiss cheesemakers, who cut off an inch or more daily as required for making whey rennet (section 61).

(57) **Pepsin as a Rennet Substitute.** On account of the high price of stomachs and rennet extract, large quantities of pepsin made from hog stomachs from the packing houses have been sold as a substitute, either in the form of fine powder, or coarse powder, or in thin scales called "scale" pepsin, or in solution. The dry pepsin is weighed out by the cheesemaker at the rate of about ¼ ounce per thousand pounds of milk, or is sometimes measured as ¼ ounce by by weight of the different dry products will occupy ½ to ¾ ounce by volume in a glass graduate. The dry pepsin is dissolved in luke warm water, and the solution is added to the milk in place of rennet extract.

The solutions of pepsin more recently offered for sale are more convenient to handle at the cheese factory, as they can be measured out like rennet extract in a graduate, in place of weighing the powder and dissolving in water.

Before pepsin came into use as a milk coagulant, its principal use was as a medicine to aid digestion in the stomach, and its strength as a digestive agent marked on the bottle, 1-3000, meant that 1 gram of the pepsin was capable of digesting 3000 grams of boiled white of egg, under the conditions of the U. S. P. test. It was soon observed that different pepsin products, labeled 1-3000, differed widely among themselves in their power to coagulate milk, and that pepsin intended for cheesemakers' use should be tested for its action on milk instead of on egg white.

As a substitute for rennet, pepsin is not altogether satisfactory. If milk is ripened to about .20% acidity, ¼ ounce of good dry pepsin will thicken the milk about as soon as 3½ ounces of rennet extract, but where sweeter milk is used, as in the making of Swiss, Limburger, and at many factories making brick or American cheese, this quantity of pepsin does not thicken the milk so well as does the rennet extract. Swiss makers are therefore using pepsin little or not at all.

(58) **Rennet and Pepsin Mixtures.** If 1 gallon of rennet extract costing $5.00 will thicken 32,000 lbs. of milk, and 8 ounces of dry pepsin will do the same, at a cost of $2.50, it is clear that the pepsin is the cheaper, but for sweet milk it is not so satisfactory. On this account, mixtures of pepsin solution with rennet extract have been put on the market by manufacturers, as an improvement over pepsin alone, but costing less than rennet alone, and these are used with satisfaction by many cheesemakers.

(59) **Other Substitutes for Rennet.** In past centuries, cheesemakers have made use of the stomachs of lambs, hares, kids, for thickening milk, and also the juices of certain plants, as the thistle, and of the leaves of the fig tree and in more recent times a number of plant juices have been found to have milk curdling properties. None of these substitutes has found practical use in recent years.

(60) **Standard Strength of Rennet Extract.** The standard is difficult to state in exact terms, but 3 ounces of a full strength fresh extract has been known to thicken 1000 lbs. of perfectly fresh, sweet milk in 45 minutes, at 86 F., or 1000 lbs. of milk of .18% acidity in 15 minutes, at 86 degrees, F.

(61) **Making Whey Rennet.** Swiss cheese makers do not commonly use commercial rennet extract, but make whey

rennet daily, as needed for use. For this purpose, dried, blown rennets (53) are purchased by the thousand at the beginning of the season. Two dozen stomachs are examined carefully, and any dirty, or foul smelling parts, as well as the useless lower ends of the stomachs, are removed. The stomachs are rolled together in the form of a sausage or "wurst" 1½ to 3 inches in diameter, and 1 or 2 feet long. A piece of twine is wrapped spirally around them, binding them together tightly. If moistened with a little salt water, the stomachs pack more closely, but care must be used to dry out the moisture afterward in a well ventilated place. Each day, a half inch or more, as found necessary, is cut off from the end of the "wurst," and used for making whey rennet.

Fresh whey is dipped from the kettle into a well cleaned earthen jar, provided with a cover. As this whey may carry injurious bacteria with it, it is often safer to pasteurize it before use, as described for skim milk starter in (28), but the heated whey is finally cooled down to 98–100 degrees for use.

A common practice at European factories is to separate the albumen from the whey before using it. For this purpose, several gallons of whey are heated in a steam jacketed can to 180 degrees or higher, and a sufficient quantity of very sour whey, from a supply kept in a keg for this purpose, is stirred in so as to cause the precipitation of albumen. The material is then left to stand quiet for several hours, when the albumen will gather and float at the top and the clear, greenish yellow liquid below can be drawn out through a faucet. The value of this process probably lies in the pasteurization which the whey receives by the heating rather than by the removal of albumen.

About ½ gallon to 1 gallon of whey at 98–100 degrees, prepared by either of the methods described above, is placed in the earthen jar. The cut piece of wurst is added, and the mixture is set in a warm place, usually near or over the boiler, with occasional stirring, at about 98 F., for about 18 hours. The stomach infects the liquid with the necessary acid forming bacteria, and the whey rennet will test .60 to 1.0 or 1¼% acid, when ready for use.

For 2500 lbs of milk in one kettle, 1 pint to 4 quarts of whey rennet may be prepared, with the same amount of stomach, according as more or less acid or starter is required for the milk.

When ready for use, the liquid is poured through a piece of cloth to remove the pieces of stomach, before adding to the kettle.

CHAPTER VIII.

THE COMPOSITION OF MILK, WHEY AND CURD.

(62) **Percentage Composition of Milk.** Since milk was by nature intended for the nourishment of the calf, one might expect to find that it contains all the food elements necessary for the building up of the young animal's body. An analysis reveals the presence of *water*, which is absolutely necessary for the maintenance of life; *ash* is needed for the bones; *nitrogenous material* in the form of casein and albumen, etc., nourishes the muscles, hair, hoofs and horns; and *carbonaceous matter* in the form of sugar and fat maintains the heat of the body. Vitamines stimulate growth.

The milk given by a fresh cow during the first few days after calving is not fit for cheesemaking, as it will not curdle well with rennet, but it is needed by the calf, and is called colostrum. It contains a large proportion of albumen, and such milk will curdle on boiling.

The composition of a cow's milk, as well as the quantity produced, depends upon the individuality and breed of the cow, and upon the period of lactation, the milk becoming somewhat richer as the calf becomes older. Conditions as to health, feed, shelter, age, etc., are also of importance.

	Average.		Minimum.		Maximum.	
Water	87.4	per ct.	82.0	per ct.	90.0	per ct
Fat	3.7	"	2.3	"	7.8	"
Casein	2.5	"	1.9	"	3.8	"
Albumen	.7	"	.6	"	.8	"
Milk sugar	5.0	"	3.5	"	6.0	"
Ash	.7	"	.6	"	.9	"
Specific gravity (60° F.)	1.032	"	1.029	"	1.036	"

(63) **Constitution of Milk.** In milk, the milk sugar, albumen, and about half of the ash are dissolved in the water present. Milk sugar is white and crystalline, but not so sweet as cane sugar. It is used in medicine, in foods for infants and invalids, primost, etc. The fat is not dissolved in the water, but is distributed all through the milk in the

form of very small drops, called fat globules, which can be seen readily under the microscope.

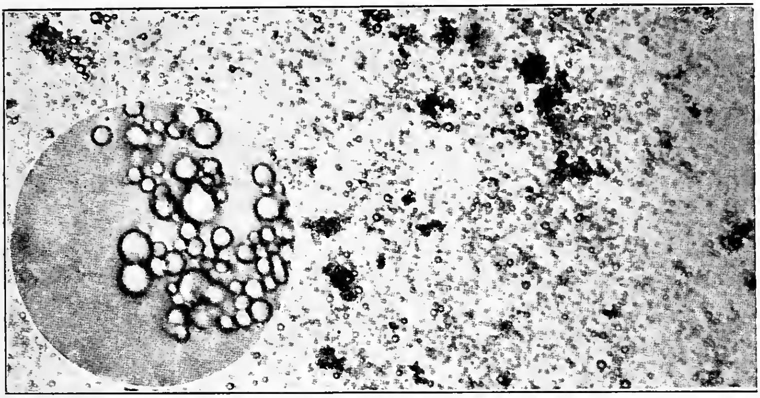

Fig. 16—The fat globules as seen through a microscope. The portion in the circle is more highly magnified. The globules vary from 1–2000 to 1–40,000 of an inch in diameter, and as many as 150,000,000 globules are present in one drop of milk.

(64) **Casein.** The casein is the part of the milk that is curdled by rennet or weak acids. It is classed as a protein.

The casein in milk is partly but not fully dissolved in the water present, but is distributed in very much smaller particles than the fat globules, so that the casein particles can not be seen under the ordinary microscope, neither do they settle to the bottom on standing, or rise to the top like fat globules. Yet it is certain that casein is not fully dissolved in milk, for if milk be filtered through a porcelain filter it will leave a gelatinous mass on the filter, which is the casein; or, if skim milk be revolved for a long time in a separator bowl, a layer of casein will be deposited on the walls of the bowl.

Casein in milk is like egg-white, glue, and blood, in that all four of these substances, while fluid at first, may be thickened to a jelly or clot. Thus egg white hardens on heating, gelatine or glue is fluid when hot, but hardens on cooling, while blood thickens or clots upon exposure to the air, and casein may be thickened, coagulated, or curdled by acids or by rennet.

(65) **Albumen.** The casein does not constitute all of the protein of milk. If slightly acid whey be heated to about 180 degrees F. another precipitate will be thrown down. This is the albumen. It is in solution like the white of an egg until the heat precipitates it. Albumen is not incorporated in Cheddar cheese in the ordinary method of manufacture, and apparently cannot be so incorporated without producing sour cheese.

In addition to the casein and albumen, small amounts of other nitrogenous components are always present in milk, but our knowledge of these substances is as yet incomplete.

(66) **Distribution in Curd and Whey.** When milk is mixed with rennet in the cheese vat, the casein thickens, and the thick curd surrounds and holds the fat globules. After cutting or breaking into small pieces, the curd gives up about 95% of the moisture present, which goes to form whey, carrying with it the same proportion of the water soluble materials, milk sugar, albumen, etc.

The distribution of milk constituents between curd and whey is about as shown in the diagram, for American cheese.

MILK
- Water 87.4%
- Total Solids 12.6%
  - Solids not Fat 8.9%
    - Milk sugar 5%
    - Albumen .7%
    - Ash, .7%
    - Casein 2.5%
  - Fat 3.7%

WHEY
- 95% of the water, dissolved milk sugar, albumen, etc.
- 5% of the casein
- 10% or less of the fat.
- About half of the ash.

CHEESE
- 90–95% of the fat.
- 95% of the casein.
- About half of the ash.
- About 5% of the water, dissolved milk-sugar, and albumen.

(67) **Composition of Whey and of Curd.** The average composition of whey and of curd from the whole milk American cheese vat may be represented about as follows:

	Whey	American Cheese
Fat, percent	.35%	34
Casein	.10	23
Albumen	.75	
Water	93.00	37
Milk sugar	5.00	6
Ash	.80	
	100%	100

CHAPTER IX.

THE COMPOSITION OF CHEESE.

(68) **Importance of Having Standards.** The cheesemaker is interested in the composition of cheese (1) with reference to the legal standards to which his products must conform, (2) as to the relation between composition and the flavor, texture, etc., which are factors in determining market quality, selling price, and profits, and (3) a knowledge of the variations in composition of cheese made from milks of different richness, which is of importance in selecting a fair method of paying for such milks.

(69) **Fat Standards.** Under the laws of many states, whole milk cheese must contain at least 50% fat in the dry matter. Thus, in Wisconsin, a cheese containing 40% moisture and 60% solids, must contain over 30% fat. Using whole milk, and normal methods of manufacture, there is no danger of any factory's product running below this fat standard, and the average fat content of American cheese in Wisconsin is between 30 and 35% fat. Whole milk cheese from either Holstein or Jersey milk sell equally well, and at the same price.

In Wisconsin the legal limit of fat in dry matter for Swiss cheese is 47 percent, being lower than for American cheese, because of the greater loss of fat in Swiss cheese whey, which may be .50 to .9%.

(70) **Moisture Standards.** The Canadian cheese supplied in enormous quantities to the English market contains about 34 to 36% of moisture, and shows a remarkably high quality and uniformity, because of the careful methods of manufacture used.

At the Wisconsin Experiment Station in 1916, 567 samples of American cheese collected from dealers in all parts of the state were tested for moisture, and on comparing the moisture tests with the dealers' judgment as to the quality of each sample, it was found that 40% before July 1st, and

39% after July 1st, is the limit for good, salable cheese suitable for the principal markets where Wisconsin cheese are sold. The Wisconsin legislature passed a law setting the limit at 40% for American cheese in this state. The great value of the Wisconsin law, efficiently enforced, has been shown clearly, effecting an improvement in about ⅓ of the output, according to an estimate. The New York legislature passed a somewhat similar law.

Wisconsin cheese manufactured for the southern markets contain about 37 to 39% moisture, and are somewhat quicker curing than the Canadian product, while yet firm enough to stand the warm climate where they are marketed. Cheese containing over 40% moisture made in Wisconsin previous to the passage of the law mentioned, were not able to stand up in the warm southern climates, and caused dealers a great deal of trouble and loss. They are fit only for immediate sale and consumption in the cooler, northern states.

(71) The consumption of cheese in the United States is increasing only about ⅓ as fast as the population increases and this notable falling off in the use of cheese is believed to be due in large measure to the modern tendency to manufacture soft, high moisture cheese, which are quick curing and are sold and eaten before they have developed a really attractive flavor. The passage of a moisture limit law is one step in the correction of this condition.

(72) **Composition, Yield, and Payments.** Studies at the New York (Geneva) Experiment Station over a period of years led to the view that in comparing the yield of cheese from high and low testing milk, mixed in the same vat, a uniform moisture content (as 37%) may be assumed, as the basis of the comparison. The New York view carries with it, necessarily, the assumption that casein carries relatively less moisture with it into cheese from low testing milk, than from high testing milk. These views are being made the subject of study at present by the author, using Jersey and Holstein milk in comparison, and it is possible that a fixed casein-moisture ratio and a variable moisture content may be found by experiment to be the correct basis for comparison and payments at whole milk cheese factories.

CHAPTER X.

CHEESE TESTS FOR MOISTURE AND FAT.

(73) **Cheese Testing by Makers.** In the making of cheese the control of the moisture content of the cheese is of great importance. Fresh meat, fruit, vegetables, milk, or wet bread may spoil quickly, while the same materials if dried will keep well for a long time. Similarly, cheese containing too much moisture is likely to spoil before it is eaten, and cause loss to the owner or maker.

Every cheesemaker should learn how to test cheese for moisture so as to be sure his daily product is within the legal limit.

The testing of cheese samples for fat by the Babcock test can now be done as quickly as cream testing.

(74) **Cheese Moisture Testing Equipment.** The equipment consists of a No. 1710 torsion scales or similar

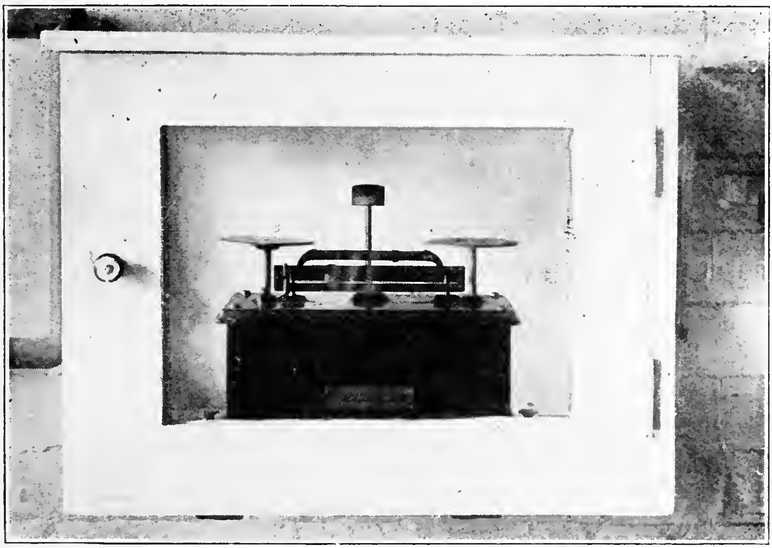

Fig. 17.—The moisture test scales may be protected from dirt and dampness as well as insects, by enclosing in a small box with glass door, attached to the wall at suitable height.

scales sensitive to .01 or .02 gram, a 10 gram weight, cheese sample bottles, trier, moisture test dishes either 3 or 2 inches in diameter, and a high pressure steam oven or equivalent device for drying the samples. The rapid methods by which butter samples may be dried directly over a flame in a few minutes are not applicable to cheese. Cheese samples can be dried over a kerosene lamp chimney as rapidly as in a steam oven. See Wis. circular 81.

(75A) **Sampling and Weighing Cheese for Moisture Test.** One or two trier plugs are taken, so as to be representative of the whole cheese, keeping well away from old trier holes, the cheese rind, a cut surface, or a damaged spot. Return the outer end (¾ inch) of the trier plug to close the trier hole, put the rest of the plug quickly into the cheese sample bottle and insert stopper. Do not wrap plugs in paper or cloth, or leave exposed to the air. See (254).

Instead of using one end of a plug in a moisture sample dish, it is better to split the entire plug lengthwise with a knife, as the long narrow strip is a better sample of the whole cheese.

A 10 gram sample should be well dried in 4 hours or more at 30 lbs. or higher steam pressure. A 5 gram sample should give the same percentage of moisture, but will dry

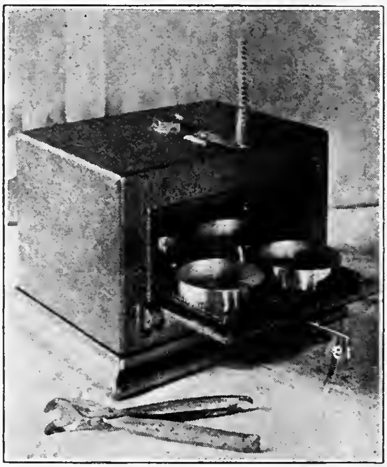

Fig. 18.—Steam ovens can be obtained of large or small size, holding 1 to 30 dishes, suitable for large warehouses or small factories.

in an hour less of time, and foams less in drying. To prevent all possibility of foaming or bubbling over, it is better to leave the steam oven door partly open during the first hour. It is advisable, for beginners at least, to make always two tests in two moisture dishes on the same cheese. One of these may be made with 10 grams and one with 5 grams if preferred, for comparison.

(75B) **Weighing Cheese Samples For Moisture Test.** From the set of moisture test dishes, select one of average weight and mark it plainly "B" and keep it carefully.

First, to balance the scales, put the "B" dish on the middle of the right pan, set the three small sliding weights each on the zero mark of its beam. Then move the fourth, and largest sliding weight until the pointer at the top swings the same distance on each side of the middle mark, showing that the scales are balanced. The leveling screws at the ends may also be used to balance the scales. Put away the "B" dish. Leave the fourth weight exactly where it is, until through work.

Second, put any empty, clean, numbered dish on the middle of the right scale pan, and balance the scales exactly by moving the top, smallest sliding weight to the right or left. If too light, put a tack or two in the pan; if too heavy, trim the edge of the pan with shears, When balanced exactly, record the dish number, and the tare weight in the first column below. The tare might be right 3.2, or left 4.6.

	First Test	**Second Test**
Dish number	--------------	--------------
Tare weight empty	--------------	--------------
Weight of sample	--------------	--------------
Per cent of moisture	--------------	--------------

Third, add a 10 gram weight to the left pan. Split a trier plug of your cheese into four quarters with a knife, lengthwise. Put one quarter and part of another into the dish until the scales are again balanced exactly. (Do not expose the unweighed cheese to the air very long, as it may dry out.)

Fourth, place the dish, with cover, and weighed sample in the steam oven. Record the steam pressure in lbs., and time of day when put in oven.

Fifth, with the scales empty, begin again at (2). Go through the directions a second time with a second dish, recording the figures in the second column. This gives you two tests on the same cheese.

Sixth, come back after about half a day, when the cheese will be dry, and finish the test. Balance the scales as in (1) using the "B" dish at the right as at first.

Put the first dish on the right pan, set the top slide at tare weight recorded for this dish. Put a 10 gram weight

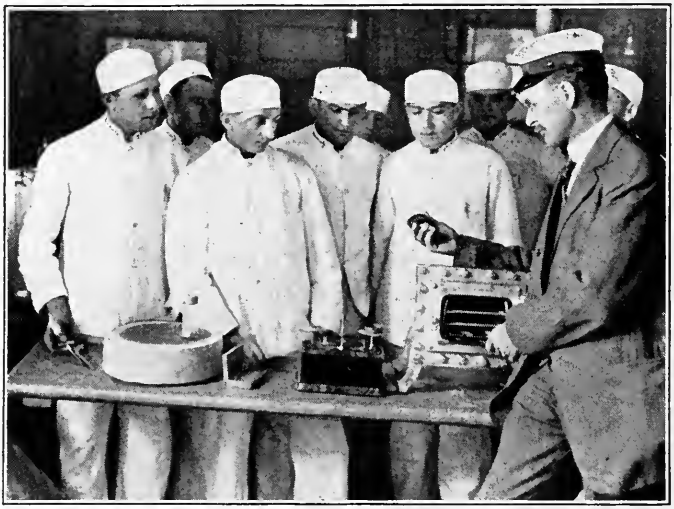

Fig. 18A.—Students Using Cheese Moisture Test.

on the left scale pan, and balance the scales exactly by moving the second and third sliding weights to the right. Read the position of these 2 weights, and record the sum as the per cent of moisture in the sample.

Remove the first sample dish from the scales, and put on the second, adjust the tare, balance and read in the same way.

Duplicate tests commonly agree within ¼ of a percent.

The method of weighing samples can be varied in several ways. Thus the dishes may be brought to a standard weight, as 17 grams, by adding fine, dry, quartz sand instead of using the upper tare beam. If a set of weights is at hand, instead of only a 10 gram weight, each dish may be weighed exactly, and the weight recorded.

Instead of a No. 1710 balance with moisture scale beams reading up to 50%, it is possible to use a No. 1700 balance, with beams reading up to 30%, by using also a 2 gram weight which is placed opposite the dried sample dish, and counts for 20% moisture.

(76) Testing Cheese for Fat by the Babcock Test. The Babcock test for determining the fat content of milk and its products was invented by Dr. S. M. Babcock of the Wisconsin Agricultural Experiment Station, and described in Bulletin No. 24, July, 1890; it is now not only in general use in this country, but in different countries of Europe, in India, New Zealand and Australia. It has literally "gone around the world."*

The older methods of dissolving cheese samples for the Babcock test consumed a great deal of time, but the following method devised by the author in 1909, and used without accident since that date, can be completed almost as quickly as an ordinary cream test.

The sample of cheese, amounting to from 8 to 10 or 12 grams is placed in the 30% Babcock test cream bottle, and weighed with the same scales used in the moisture test, or with the usual cream test scales.

If the bottles used for this purpose are permanently numbered by etching on the side, and are weighed clean and dry, the list of weights can be used thereafter, whenever the bottles are clean, dry, and filled with a cheese sample, making it necessary to weigh only the bottle with the sample, but not the empty bottle again.

The sample is dissolved rapidly in the following manner: Fill the acid measure to the mark with sulphuric acid as usual. From a dish of boiling water, by means of a wide tipped pipette, place 10 cc of the very hot water in the bottle with the cheese. At times it is necessary also to dip the bottle into the boiling water for a few seconds, as explained below, to aid in securing a sufficiently high final temperature.

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*The Babcock Test is described in detail in "Testing Milk and Its Products," by Professors Farrington and Woll (23rd edition, 1918; Mendota Book Co., Madison, Wis., publishers). Full directions for making tests of milk and other dairy products, and discussions of all phases of the subject will be found in the book.

Immediately after adding the hot water, and without any delay whatever, begin adding the acid from the measure in small portions, rapidly, about 1 cc at a time, shaking the bottle once quickly after each addition, to mix the acid and water. When about half of the acid has been added in this way in small portions, the remaining half may be added in larger portions, or all at once.

As soon as the acid is all in, the bottle is shaken continuously, and the heat developed by mixing the acid with the hot water is sufficient to soften the cheese quickly, melt it to a liquid, and dissolve all portions of it except the fat.

If the first bottle thus handled proves to be a little slow, in dissolving the sample, the next bottle may be heated a few seconds by dipping in the boiling water, before adding the 10 cc of water to the cheese.

While it may seem dangerous to suggest the addition of strong sulphuric acid to hot water, yet by adding small portions and mixing, as directed, the boiling point of the dilute acid in the bottle is always higher than the temperature attained, and in this way the work is done quickly without loss of material.

As in all Babcock tests, the neck of the bottle should be turned toward the wall while adding acid to avoid a possible accident from boiling over, but this seldom if every occurs. A burnt test is never obtained.

The bottle is whirled and filled with hot water for reading like any cream test, and red reader is used, or fat saturated alcohol, to permit accurate reading. Dividing the bottle reading by the weight of the cheese sample, and multiplying by 18 gives the correct fat test of the cheese. Duplicate tests agree remarkably well if set in water at 140°F., for five minutes before reading.

(77) **Fat in Dry Matter.** To calculate the percentage of fat in the dry matter, subtract the percentage of moisture from 100, and divide the percentage of fat by the remainder, which is the percentage of dry matter in the cheese. The quotient is the percentage of fat in the dry matter, and should be higher than 50% for all whole milk cheese, in Wisconsin, excepting Swiss for which the legal standard is 47%.

CHAPTER XI.

CHEESE JUDGING AND SCORING.

(78) **General Methods and Score Cards.** Cheese are intended to please the consumer, as to flavor, texture and general appearance or make up.

The texture of cheese is readily seen on cutting. A spongy cheese, full of holes, or one that is short and crumbly in texture so that it breaks readily and can not be cut neatly into regular sized portions, is not attractive to the consumer or housewife, and every such cheese put on the market serves to discourage consumers from buying again soon.

The flavor of cheese should be attractive, not sour or too acid, nor unclean, nor yet too mild and tasteless due to being sold too young. In the writer's opinion the modern tendency to sell cheese to consumers as young as possible (in order to get an early profit), is responsible, more than anything else, for the fact that cheese consumption in this country is increasing only one-third as fast as the population increases. If every cheese was made so as to keep in good condition for four to six months and none marketed earlier, the demand for cheese would be greatly increased.

The appearance of cheese, due to careful workmanship, has much to do with its attractiveness, as with any other line of merchandise.

Every consumer is a good judge as to whether a cheese pleases him or not. Cheese buyers, retail dealers, and many housewives have clearly in mind the qualities which make cheese attractive or the opposite. Every cheesemaker should learn to judge his own products.

Cheese scoring consists, in addition to judging, of setting a numerical value on the qualities which any given cheese possesses, thus affording an easy method of comparing and recording the excellence or poor qualities of different cheese. As a general rule, cheese scoring 90 to 92 are good cheese marketable at the ruling price, according to the supply and demand. Cheese scoring 95 or above are better than the average market product, and are the kind that win prizes and diplomas in contests, fairs, etc. Cheese scoring less than 90 are more or less defective in some respect, and are likely to be sold at a somewhat reduced price, unless the demand is unusually large and the buyers inclined to overlook defects.

The score card commonly used for American cheese is as follows:

Flavor 45, texture 30, color 15, make up 10, total 100.

For brick and Limburger, the following card is used:

Flavor 40, texture 40, color 10, salt 5, package 5.

For Swiss cheese, the Wisconsin score card is:

Flavor 35, holes 30, texture 20, salt 10, package 5.

The Canadian score card for Cheddar cheese is:

Flavor 40, body and texture 30, color 15, finish and boxing 15.

The English scale of points is:

Flavor 35, quality 25, texture 15, color 15, make 10.

(79) **Steps for the Beginner in Judging American Cheese.** Age and Temperature. See that the cheese is in fit condition for scoring as to temperature, age, etc. Thus cheese in cold storage at temperatures near freezing, or exposed for some time to very low winter temperatures or very warm summer heat, can be better judged if placed for 24 hours in a room of moderate temperature, as at about 60 to 70 degrees F., for the reason that very cold cheese are harder and very warm cheese are much softer than ordinary, and are difficult to compare under extremes of temperature. Very young cheese, only a few days old, are curdy and uneven in texture, and it is difficult to predict with certainty what their quality will be when fully cured. Especially with cheese which may possibly be too soft from excessive moisture, buyers have been mistaken at times in their judgment, and have sometimes put cheese into storage expecting them to come out several months later in good condition, but have found them of inferior quality after curing.

While a rough judgment may generally be passed on green cheese, yet for accurate scoring, they should be fully cured and American cheese should be at least one month old.

(80) **Taking a Trier Sample.** Drawing a trier plug should be done so as to get a representative sample of the cheese, not going too close to an old trier hole, a spoiled, moldy, or soft place in the cheese, a cut surface, or the rind. At times, as where several judges are at work, samples can easily be taken from different parts of the same cheese,

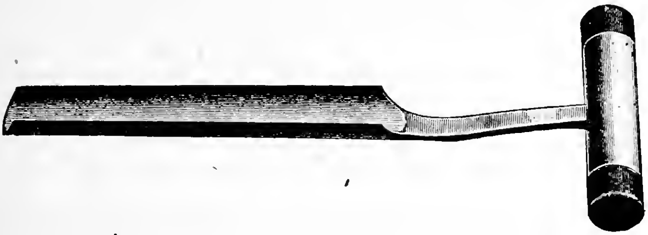

Fig. 19.—The cheese trier is made of steel, and often nickel-plated. Its use is illustrated in (254).

which is a distinct advantage since cases have been known where a Long Horn cheese, for example, bored at one end scored 5 points or more above a sample taken from the other end, due to mixing of curd or other causes.

(81) **A Full Trier.** A perfectly close, compact cheese will draw a solid or "candle" plug, while a cheese so open or loose as to draw only a half plug should be scored down on this account.

(82) **An Open Cheese.** The plug may be of full length, and yet show many small round holes, due to gas forming bacteria from unclean milk, or it may show many mechanical holes, large or small but irregular in shape, due to imperfect closing of the cheese in the press, or partly rounded holes indicating the presence of gas as well as mechanical faults. Mechanical holes may be seen filled with butter fat, due to pressing a greasy curd without first rinsing it. Insufficient pressure makes loose texture.

(83) **Is the Plug Elastic and of Good Color?** A trier plug taken from a well made cheese can be bent, sometimes into a half circle, without breaking. If the cheese breaks suddenly, and will not bend, showing it to be brittle and not elastic, this is due to too much acid developed while making the cheese, and the high acid quality is likely to be shown also by a dead white, or chalky white, or faded color, as well

as a strong acid, or sour taste. Besides bending well, a plug from a good cheese breaks gradually, showing a torn surface with a meaty or fibrous texture. The color should be slightly translucent, like amber, regardless of whether cheese color was used or not.

(84) **Working and Warming the Cheese in the Hand.** To judge how a cheese will please the eater, it is not necessary to chew and swallow it, and the cheese judge's sense of taste would soon weary and fail, if many samples were eaten. Instead of chewing, a portion of the plug perhaps an inch long is kneaded between the thumb and fingers for a few minutes, noting whether (1) it is firm enough, or weak and soft, or too hard, corky or woody, and if

(2) it works down to an even waxy mass or dough, or leaves some lumps which will not work down smooth, and if

(3) it is pasty, wet, sticking to the fingers, indicating a high moisture content, or is waxy, or is too dry, or is mealy.

(85) **Flavor Detected by Odor Or Taste.** Finally, the lump of warmed and kneaded curd is lifted to the nose, and the odor noted, also at times a small portion may be chewed and then rejected from the mouth, and the mouth rinsed after each trial or after a few trials. A bitter flavor usually can not be detected by the nose, but must be tasted; while almost any other defect in flavor can be observed as well by smelling as by tasting.

Faults in flavor due to too much acid, or due to unclean milk are readily detected. Too much salt or lack of it is occasionally noticed. Injury due to overheating cheese in the curing room or shipment may occur.

(86) **Examination for Careful Make-Up.** It is the maker's fault, when cheese show a wrinkled bandage, a checked or poorly closed rind, are crooked, that is higher on one side than on the other, or show a high edge due to loose followers, a dirty or torn bandage, etc., as these are entirely under his control.

(87) **Defects in American Cheese.*** A useful exercise for students in cheesemaking is to copy the following list of faults in the note book, inserting after each, one or more methods by which the fault can be remedied or prevented.

*See M. Michels in Wis. bulletin 182; also Publow, Cornell bulletin 257.

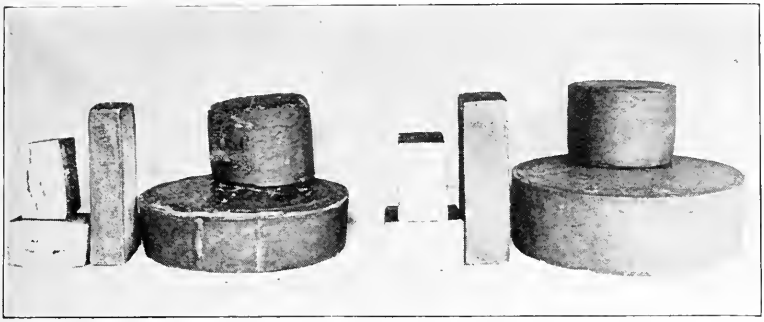

Fig. 19A.—Defective Workmanship Produces Cheese of Poor Appearance.

I. Defects in Flavor.

A. **Acid Flavors.** Indicated by a sour smell and taste.
Cause. (1) Ripening the milk too much before setting.
(2) Use of too much starter.
(3) Use of sharp and overripe starter.
(4) Insufficient cook at the time of drawing the whey.

B. **Lacking Flavor.** Lacking in taste and smell.
Cause. (1) Setting the milk underripe.
(2) Cooking a slow-working curd up too rapidly.
(3) Too much washing of the curd when placed on the racks or after milling.

C. **Fermented Fruit Flavors.** Indicated by a fermented whey or fermented fruit smell and somewhat sickening to the taste.
Cause. (1) Unclean cans in which milk is delivered.
(2) Unclean factory conditions, whey tanks, leaky vats, etc.
(3) Added with the starter.

D. **Bitter Flavors.** Indicated by a bitter taste.
Cause. (1) Aged milk.
(2) May develop in the starter.
(3) By bacteria brushed from the cow's udder while milking.
(4) Lack of salt.

E. **Weedy or Food Flavors.**
Cause. (1) Cows feeding on weeds.
(2) Feeding strong-scented feed just before or while milking.
(3) Exposing milk in an atmosphere laden with food flavors.

F. **Stable Flavors.** Bad taste and cow-stable smell.
Cause. (1) Uncleanliness in milking.
(2) Keeping the milk or cream in or near a dirty cow-stable.

G. **Unclean or Off Flavors.** Indicated by an unclean smell or taste.
Cause. (1) Often a combination of defects, as
(2) Unclean cans and other utensils coming in contact with the milk.
(3) Unclean milking.
(4) Exposing the milk to impure air.
(5) Using impure water in setting the milk or in rinsing the curd.
(6) Using a starter of unclean flavor.
(7) These terms are often used when the judges fail to find a suitable description.

II. Defects in Texture.

A. **Dry or Corky Textures.** Appear dry and hard and do not mould waxy.
Cause. (1) Lack of butter fat, due to skimming.
(2) Cooking too high or too long, losing moisture.
(3) Setting at too high temperature, losing fat.
(4) Handling curds roughly, losing fat.
(5) Cutting curds too fine.

B. **Acid Textures.** Appear short and mealy, look faded in color and sour to taste.
Cause. (1) Ripening the milk too much before setting.
(2) The use of too much starter.
(3) The development of too much acid before curd is properly firmed.
(4) Developing too much acid in the whey.
(5) Insufficient stirring when out of the whey.

C. **Weak Textures.** May be close boring, yet soggy. This fault usually appears with cold weather and with increased richness of the milk.

Cause. (1) Insufficient cook.
(2) Heating the curd too rapidly.
(3) Insufficient drainage.
(4) Cutting the curd too coarsely.
(5) Not enough salt.
(6) Matting the curd down too thin before milling.

D. **Open Textures.** Cheese very soft and full of holes.

Cause. (1) Insufficient development of acid, before salting.
(2) Insufficient pressure while in press.
(3) Too high a temperature of curing room.

E. **Gassy Textures.** Indicated by spongy texture and full of small openings throughout the cheese.

Cause. (1) Produced by bacteria brushed into the milk with dirt from cow's udder while milking.
(2) Use of unclean cans, or a dirty whey tank.
(3) Gassy starters.

F. **Greasy Textures.** Indicated by free butter fat between particles of curd which are not cemented together.

Cause. (1) Very rich milk, two days old.
(2) Setting the milk at too high a temperature.
(3) Piling and maturing the curd too much at high temperatures, and not rinsing.

III. Defects in Color.

A. **Dead or Faded in Color.** The cause and remedy the same as in acid texture.

B. **Mottled in Color.** Uneven color in the cheese, most noticeable in the case of colored cheese.

Cause. (1) Mixing curds of different colors.
(2) Uneven development of acid on curd.
(3) Allowing the curd to mat into large lumps while heating.
(4) Adding a curdy starter without straining.
(5) Adding starter after the milk has been colored.
(6) Making rennet tests before adding color.

IV. Defects in Make-up or Finish.

A. **High Edge.**

Cause. (1) Improperly fitting followers.
(2) Applying pressure too quickly.
(3) Dressing cheese before sufficient pressure has been applied.

B. **Crooked Cheese.**

Cause. (1) Improperly fitting followers.
(2) Hoops not filled evenly.
(3) Applying pressure too quickly.
(4) Head block crooked.

C. **Bandage.** Wrinkled, torn, dirty, too long or short at one end, loose from cheese.

Cause. (1) Carelessness in dressing, boxing, etc.

D. **Checked Rinds.**

Cause. (1) Greasy curds.
(2) Pressing when too cold.
(3) The use of hard and impervious press cloths.
(4) Lack of pressure while in the press.
(5) Too rapid drying when first taken from the press.
(6) Removing press cloths too long before paraffining.

(88) **A First Class American Cheese** should have—
Flavor, fine and nutty, with pleasing acid taste.
Texture, smooth, silky and close boring.
Color, even and slightly translucent.
Finish, a smooth rind covered with a closely fitting bandage and a square edge.

CHAPTER XII.

PLANNING FACTORIES, LARGE OR SMALL.

(89) **General Suggestions.** Before starting to build, remember (1) that at least 3,000 lbs. of milk daily should be obtained, with immediate prospects for more to secure economy in manufacture, (2) in most cases a large number of farmers should own shares in the factory building in order to retain their support and patronage. Cheesemakers owning factories are usually anxious to sell, sooner or later.

A new factory should be located centrally among the patrons, on a well built road, where good drainage is available, a good water supply can be had and if convenient on sloping land, so that milk, whey, etc., can run by gravity instead of being pumped.

To dispose of factory wastes, wash water, etc., these may be run into a stream carrying at least 30 times more water than the volume of the factory sewage, or through a septic tank into a filter bed (see Wisconsin bul. 245), or through a grease trap into a dry well in sandy soil. In case none of these are available, wash water and even whey may be collected in a tank, pumped into a tank wagon and sprinkled on the country roads, where it quickly dries up and causes no nuisance. Patrons should be required to haul away the whey daily, even if they dump part of it along the road. A surface ditch used to carry off whey alone is sure to have a foul odor, before hot weather is over.

All newly built factories should be provided with steam boilers, affording greater convenience and saving labor and making it possible to pasteurize whey before feeding it to live stock, as required by law in several states.

The plan should usually show the curing room on the north or coolest side, and if possible the intake on the east side, while the building for American cheese is commonly above ground but for Swiss, Limburger, brick or other cheese requiring long curing in a moist room of even temperature, the curing room usually extends underground, or into the side of a hill. Maker's living rooms are usually built above.

The whey should be skimmed, except at Limburger factories.

The necessary dimensions of a factory are readily figured when the number of vats and other equipment, and the amount of milk to be handled is known. The cheese business is now well established, and new factories should be built amply large, and of permanent construction.

The whey tank outlet should be in sight of the intake and high enough to run whey by gravity into cans on the patron's wagon. Concrete whey tanks do not last long. The wooden whey tank may be set on wooden or concrete posts out of doors, or over the coal bin, or even in the upper story of the building, but there is danger in this case of whey leaking down over the make vats, curing room, or living rooms and causing damage and insanitary conditions. A concrete block, 6 by 10 feet, with a slope toward the middle, and a bell drain and tile outlet should be placed under the whey outlet at every factory, so as to catch and remove all spilled whey, buttermilk, washings, etc., and thus entirely prevent the foul smelling mudhole which has been the worst nuisance at factories in the past.

Concrete floors, smooth walls and ceiling which can be washed or painted, thick walls especially around the curing room, plenty of light and ventilation and steam heat if possible are important details. The general aim should be to construct and arrange building and equipment so as to give the factory operator every facility for cleanliness and no excuse for lack of it. The factory in Wisconsin must be licensed, as well as the cheesemaker, and the requirements and suggestions for licensed factories as to construction and arrangements should be obtained before building from the Dairy and Food Commissioner, State Capitol, Madison, Wis.

Plans for organizing farmers and incorporating under state laws for the purpose of building and operating factories, which can be obtained from the Secretary of State, Madison, Wis., are discussed in Wis. Expt. Station bulletin 244.

Bulletins on factory planning and organization can be obtained from agricultural colleges in most of the dairy states.

(90) Large Factories Compared with Small Ones. The large factory has numerous advantages, so that it is preferable to have one large factory in a community rather than several small ones. In some localities, five factories could be replaced with one or two with increased profit to the patrons, while the makers thus released could find better paid employment elsewhere. The advantages of a large factory over small ones include (1) the ability to secure and hold the most skillful and experienced makers, who are able to carry responsibility and earn the best wages, (2) the purchase of up-to-date equipment and improvements of all sorts that may be needed, (3) in the purchase of supplies in large quantities, thus securing the most favorable prices and terms of payment, (4) in being able to afford large, roomy, well built, lighted and heated buildings and conveniences for the manufacture and storage of cheese and for storing supplies, etc., (5) in the sale of large quantities of the product, thus attracting the attention of buyers in the largest markets, filling large orders, with economy in handling and shipping and at good prices, (6) better economy in the employment of helpers and keeping them busy. (7) By means of a large factory, the community is united in its interest in the success of a single enterprise, instead of being divided against itself, as at many small neighboring factories. Where there are more than two factories within five miles of each other, the proposition of uniting two or more of them should receive consideration. The cost of cheesemaking may be over 3 cents a pound at small factories but only about $2\frac{1}{2}$ at large ones.

(91) Increasing the Milk Supply. The aim should be kept in mind to increase milk supplies from the near-by farms to the point where 10,000 pounds or more of milk can be obtained with short hauls.

The difficulty of increasing the number of cows kept per farm, has arisen mainly from the scarcity of help, especially milkers, but the increasing use of milking machines by careful operators has done much toward overcoming this objection to keeping more cows. With continued improvement in the machines on the market, and in the farm methods of handling them, further increase in size of dairy herds on small and medium sized farms becomes easier.

A yet more important matter for the average dairy farmer is the improvement of his herd whether the number of cows be increased or not. Cow Testing associations of which there are about 112 in Wisconsin and about 500 in the United States are a great help in this work. One competent man or woman, engaged by an association of about 25 farmers

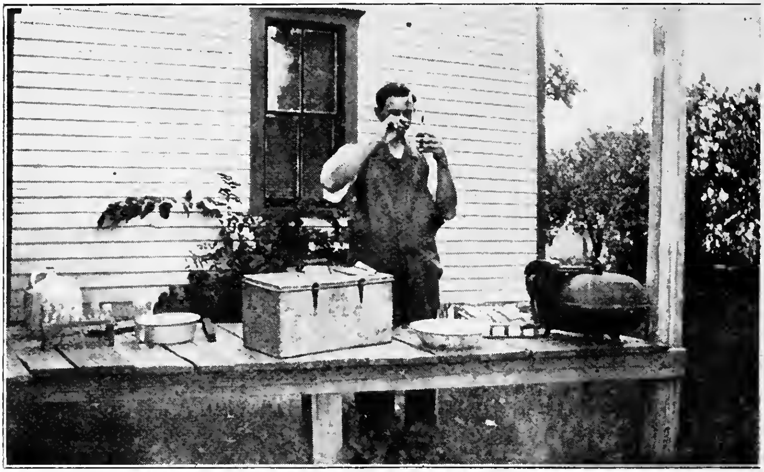

Fig. 19B.—Association Cow Tester at Work.

to spend one day per month at each farm, weigh and test the milk, and perhaps also weigh the feed used, enables the farmers to pick out with certainty the unprofitable cows to be disposed of, and to know precisely what each cow is doing to make the herd profitable. The best cows are bred to superior sires, preferably purebred and tested sires, and the calves are kept to replace the poorest cows in the herd. By proper attention to cow testing, cow selection, breeding and feeding, the milk produced by many herds has been more than doubled and the profits increased in yet larger proportion.

A good milk cow is one which has the ability to consume a large amount of feed, and transform it into milk. A less desirable animal might eat the same amount of feed, but transform it into body fat, giving little milk.

Having a good cow, the aim is to feed her all that she can consume, without producing any great increase in her weight.

Geo. C. Humphrey of the Wisconsin Agricultural Experiment Station advises that a cow weighing approximately 1000 lbs. may receive daily 1 pound of grain mixture for every three or four pounds of milk produced, in addition to either (1) 30 pounds of corn silage and 10 pounds of hay, clover or alfalfa preferred, or (2) 30 pounds of roots and 15 pounds of hay, or (3) 8 pounds of dried beet pulp soaked 12 to 24 hours before feeding, or (4) 20 pounds of hay with one or two pounds of oil meal added to her grain. Cows exceeding 1000 pounds in weight should receive relatively more hay and silage or roots. An important problem for the farmer is to select an economical grain mixture from those available in the market, and to grow alfalfa, put up silage, etc., on the farm. Valuable suggestions on cow testing, breeding, and feeding which the factory man is able to give the farmer will be returned to the factory in increased milk supply and profits.

CHAPTER XIII.

CHEESE FACTORY MANAGEMENT.

(92) **Division of Labor and Responsibility.** The important items in factory management, after the building is erected and equipped include the following:

(1) Hiring and paying the cheesemaker.

(2) Buying and paying for supplies.

(3) Weighing and testing milk.

(4) Making the cheese of standard quality so as to bring the ruling market price.

(5) Weighing and billing the correct weight of cheese to the buyer.

(6) Receiving the buyer's payment for cheese and distributing the money according to the plan adopted, figuring payments, statements, etc.

(7) Auditing the accounts, economizing in all helpful ways, etc.

The method of performing each part of the work should be such as will treat all parties fairly, and also satisfy them that they are being thus treated, so that they will continue to patronize the factory and bring in more business.

(93) **Systems of Factory Management. The Private Factory.** In a new dairy region, the coming of a cheesemaker who knows how to plan, build, equip and operate a factory is a great advantage to the farmers who thus are given an outlet for all the milk they can produce. The patrons are likely to recognize the maker's experience and to leave the entire factory operation to him, from the start. In a word, the patrons bring in their milk daily and receive a check once a month, while the cheesemaker does the rest. Under these conditions, the maker is paid not only for making cheese, but also for knowing more about the business than the patrons, who are only beginning to learn. The maker in this case may do, or neglect to do, several things which will serve to confirm the patrons' confidence in him. Among these are (1) explaining the cheese business so

far as the patrons are interested and not making a mystery out of it, (2) furnishing a statement with the pay check which meets the patron's ideas as what a statement should show, (3) providing for an audit of accounts, or in other ways to retain the patron's good will and confidence. As time passes, the patrons learn more and more about factory management and come to the point where they wish to pay the maker only for the work of making cheese, while the figuring of payments and other parts of the work is done by one of the patrons, elected for this purpose. Under these conditions, the maker cannot expect to earn as much as formerly, and often wishes that he no longer owned the factory, but was free to change his location. On this account, young cheesemakers are not advised to build factories at their own expense, but to invest their earnings in other ways, such as in approved farm mortgages, etc.

(94) **The Farmers' Factory.** At the other extreme of the scale is found the factory owned and managed entirely by farmers, where the cheesemaker is paid either by the month, for his labor only (items 3, 4, 5 above), or paid by the pound of cheese at a fixed rate ($2\frac{1}{4}$ to $2\frac{1}{2}$ cents) for which he furnishes both labor and supplies (items 2, 3, 4 5, above), while the patrons do the rest. (See also section 96.) Swiss cheesemakers receive about 13 cents on each dollar received from the sale of cheese.

(95) **Other Ways of Operating a Factory.** A variety of other ways are found among factories. Thus, for example, the factory building may be owned by a group of farmers, rented to a factory manager, who in some cases pays a rental of perhaps $100 a year, and in other cases charges the farmers $100 a year or more for his services as manager. The equipment may be owned by the farmers or may be owned and installed by the manager. The cheesemaking labor and supplies are paid for by the manager, who may also sell the cheese, and pay the patrons monthly by check, with or without a complete statement as to business details. Or, the farmers' secretary may receive the money and distribute it. Many variations of method are found.

(96) **Cooperative Factory Management in Wisconsin.** As indicated above, there are many ways in which

farmers may cooperate in owning and operating a factory. In the past, the term "cooperative" has been used loosely to apply to factories which were cooperative only as to ownership of the building but which were privately managed. In order to promote full cooperation among farmers, and secure certain other advantages, a law was passed in Wisconsin permitting only incorporated factories, using the prescribed plan of distributing their funds, to be called "cooperative" factories.

This plan requires that from the gross receipts from sale of cheese there shall be deducted and held in the treasury a charge, per pound of cheese, sufficient to cover the running expenses, and the funds, and dividends required by law.

In practice, it is found that factory supplies for several months are frequently purchased at one time, while other items as insurance, taxes, repairs, losses from bad debts, etc., occur at irregular intervals, but really apply to the entire year's work. Factory stockholders should be paid more than patrons, while those who support the factory throughout the year and keep it going are in a different class from those who leave the factory during the season. To meet these conditions in such a way as to promote unity and prosperity at the factory and secure the utmost loyalty from all patrons and employees, the following plan is recommended.

(97) Cooperative Profits. At such factories, incorporated under the Wisconsin cooperative plan, there is deducted from the sales each month a fixed charge as 2½, 3 or more cents per pound of cheese sold, which amount is held in the treasury and used for the payment of all running expenses, leaving a reasonable amount of money to be divided at the end of the year as net profits, in the following manner:

(1) An 8% dividend to holders of the capital stock.

(2) A reserve fund or sinking fund equal to 10% of the net profits.

(3) An educational fund equal to 5% of the net profits.

The balance is divided among the patrons and employees in the following manner:

(4) To the stockholders in proportion to the value of the milk delivered by them.

(5) To non-stockholders in proportion to ½ the value of milk delivered by them.

(6) A bonus to employees in proportion to wages received.

For example, if stockholders delivered milk worth	$30,000
and non-stockholders delivered milk worth	5,000
and employees received	1,200
Total	$36,200

and if the balance amounts to $2,085.50, it is found by dividing that a uniform dividend of 5.76% can be paid, as follows:

Stockholders receive 30,000x5.76% (uniform dividend)	$1,728	
Non-stockholders receive 10,000x2.88% (½ uniform dividend)	288	
Employees 1200x5.76% (uniform dividend)		69.12
Total		$2,085.12
Undivided balance carried forward to next year		.38
Total to be divided		$2,085.50

This plan has the advantage of encouraging employees to be economical and careful in their work, and to remain at the factory throughout the season, and gives the patrons also an inducement not to leave the factory during the season, while stockholders receive a fair additional return as interest on the money invested, and for their willingness to make the investment. The sinking fund provides for future repairs, as roofs, painting, machinery, etc., while the educational fund provides for meetings, or an instructor, to improve the milk supply, etc.

(98) **Figuring and Auditing.** At a small country factory, where the amount of figuring required is not large, it may be done by the secretary. Sometimes the figuring is done by one of the patrons, or a near-by school teacher, or other party who is paid 10 or 15 cents per patron per month for doing the work. In many cases, the figuring of payments is done, free of charge, at the bank where the factory deposits are kept.

Auditing is done to prevent mistakes. In any case, the person who does the figuring should go over it a second time to make sure that no errors have occurred. At some factories, the monthly figures are gone over by a second person, appointed as auditor, before the checks are sent to the patrons.

(99) **Test Committee.** A committee of patrons, frequently changed, whose duty it is to be present when the maker tests milk samples for fat, should be asked for, whenever there is any doubt of the correctness of tests. Patrons thus become acquainted with the fat test, and later may be led to take up cow testing.

(100) **Factory Statement.** The form of factory statement used upon the printed envelope should be such as to give the patrons all essential information from which they may figure their own payment if desired, or see how it was figured.

When a maker, disregarding the patron's wishes, hands each one a statement, containing only two or three items, such as the following,

Your weight of milk............	....5898 lbs.
Your test............	3.5 %
Amount due you............	.....$114.57

it is not surprising that the patrons become dissatisfied, and wish for a change. It is always to the maker's advantage, at a private or a cooperative factory, to keep the patrons satisfied, and since most factories give a more or less complete statement each month, every maker should expect to do so. The form on the following page, with some modifications, is used at a number of factories, with satisfaction.

STATEMENT OF NORTH MUSCODA ASSOCIATION CHEESE FACTORY

JOHN BROWN, Cheesemaker

Patron's name..

Month of.. 191 ......

Sales include following dates...to.................................

No. pounds of cheese sold...lbs.

Amount of money received..$ ....

Average price per pound...cts.

No. pounds of milk delivered...

No. pounds of fat delivered...

Average test...

Expense of making cheese...

Money to be divided among patrons...

Price per lb. of fat.. cts.

No. pounds of milk delivered by you...

Your average test..

Pounds of fat delivered by you..

Value at ....cents per pound, equals...............................$........................

Due you for whey cream sold...$........................

Total due you.. $........................

Deduct...................... pounds of cheese at.................. cts per pound............................

Check for balance $...

No. pounds of milk required for 1 pound cheese...

No pounds of cheese from 100 pounds milk...

Date of payment..

....Secretary

(101) **Economy at a Factory.** To avoid unnecessary wastes, and maintain the factory and equipment in good condition is a part of the work of the conscientious maker, but care should be used in planning and erecting a factory to see that the convenient and proper arrangement of rooms and equipment permits the maker to do his work without waste of time, or labor.

Waste of heat and fuel can be avoided by covering boiler and pipes with good insulation or pipe covering. Waste of lubricating oil, gasoline, soap, washing powder, tubs or boxes used as kindling wood, paper or bandages through storage in damp moldy places, waste of time in starting work because of lack of rules governing the time of milk delivery, unnecessary lifting of milk cans, carrying of cheese or hoops, pumping of whey, all of these can be avoided by giving attention to the matter at the proper time in building or in operating the factory.

On the other hand, it pays in the long run to provide all conveniences, a large enough milk supply, etc., so that a competent, experienced maker can be hired, and to pay him enough to retain his services and hearty cooperation. The low priced maker may be cheaper by the month, but cost more by the end of the year on account of waste, losses, etc.

To save washing powder, it is a help to provide a small tank or barrel in which a washing solution of suitable strength is prepared and heated for use by a steam jet, instead of sprinkling powder or soap on the floor for scrubbing purposes, etc.

The argument is often advanced that a private factory owner will be most likely to be careful and saving with supplies, but at a cooperative factory, where the maker is hoping to receive a bonus from the net profits at the end of the year (97) he too has reason to avoid waste.

CHAPTER XIV.

CHEESE SELLING, AND CHEESE BOARDS.

(102) **Early Methods.** In the early days, when farmers were entirely unacquainted with the cheese business, the management of the factory, and the selling of the cheese, and buyers visited the factories and bargained for the output, even the ownership of the factory was left to the cheesemaker.

In recent years, farmers in some localities have come to understand the details of the business, so that they have gradually taken over, with more or less success, the ownership of the factory, the management of the factory, and the selling of cheese. Combinations of cheese factories for cooperative selling of cheese are now being successfully managed in Quebec and in Wisconsin.

(103) **Quebec System.** In Montreal, Canada, the Quebec Cheesemakers' Cooperative association receives the shipments of cheese from many factories at the association warehouse, sorts the cheese into three grades, checks the weights, and sells the entire receipts in three lots at auction to buyers in that city. The cheese judging is done by two chief dairy instructors appointed by the Quebec government to manage the dairy schools, supervise the system of factory inspectors, and inspect the cheese at the cooperative warehouse. This system of inspecting Quebec cheese at the city of Montreal is possible for the reason that this city is the export point, to which the cheese intended for the British market must go for loading on board ship, so that no difficulty is experienced in collecting the cheese at one place.

(104) **Wisconsin Federation.** In Wisconsin, there is no one exclusive market or point of shipment, so that the Quebec system appears impossible of application here. Yet, in Sheboygan county, the Wisconsin Cheese Producers Federation was organized with about fifty incorporated factories as members and has erected its own cold storage warehouse,

where the entire output of its factories is shipped each week for sale. The federation has been in successful operation for several years, and claims two leading advantages which have made it successful, (1) that its cheese are offered for sale to the trade, with a charge of only ¼ cent added to the factory price per pound, to cover the warehouse expense including handling, paraffining, management, etc., and

(2) the details of factory business as to weights of cheese shipped and sold, quality of cheese, prices received, etc., are all in the hands of the farmers or their representative, the warehouse manager.

(105) **Cheese Boards.** At the great majority of American and Canadian factories, cheese is sold each week to a buyer who agrees to pay the ruling market price established on a specified "cheese board of trade." There are several cheese boards in Wisconsin, located at Plymouth, Sheboygan, Appleton, Muscoda, Spring Green, etc., in New York at Salamanca, Cuba, Watertown, Canton, Utica, etc., and in Canada at Brockville, Cornwall, Belleville, St. Hyacinthe, Que., etc. The cheese board is a great time saver for the buyers and makers. Formerly, buyers travelled around to each factory and bargained with the makers, who had no means of knowing what prices were offered at neighboring factories, thus causing uncertainty and delay.

At the cheese board meeting, the secretary writes on the blackboard the number of boxes offered of each size cheese opposite the factory's name. When all factorymen have thus posted their offerings, the buyers begin to bid. The secretary writes on the board the highest price offered for each factory's cheese and the bidder's initials, and when the bidding is completed, and everybody is satisfied, the meeting is over, taking less than a half hour of time in most cases. The makers go home and ship the cheese next day to the buyers, who receive and examine the cheese at the warehouse, and bring a check in payment at the next board meeting, or else send it before the meeting by mail.

In this way, without loss of time, the cheese from a number of near-by factories are sold, and the ruling price thus established is used by many outside factorymen and buyers as a basis for sales, especially at factories located too far from the board meeting to permit the maker's attendance.

At cheese boards in some localities in the eastern and northern cheese regions, the meeting is often adjourned after bidding, with all bids withdrawn and no sales made, after which the buyers and sellers make private sales, perhaps at prices differing from those bid during the meeting. In this case, the "board" prices do not represent actual sales. In Wisconsin, sales are generally completed at the board meeting, and the published board prices represent genuine sales and market values.

The cheese board serves the factory's interests better when the factories all sell on the board, so that buyers are forced to bid up and compete with each other in order to get cheese to fill their orders. If a buyer gets cheese from 20 factories at private sale, based on board prices, but buys only 2 or 3 factories' cheese on the board, it is to his interest not to bid too high, but to let the cheese on the board go at a reasonably low figure, even if a competitor gets them, thus keeping the price reasonably low on which the outside factories' sales are based. When properly managed, the cheese board is a great advantage to both buyers and sellers.

(106) Selling Undergrade Cheese. All bids made are for cheese of good marketable quality unless specified. Some buyers inspect all cheese bought at the factory before shipment is made or else agree to make no claim for inferior quality. Other buyers inspect cheese at the warehouse after shipment from the factory. Where sellers take care to mark every box of inferior cheese that may be produced and notify the buyer when shipped, there is little difficulty in coming to a settlement. Inexperienced makers who try to pass a poor lot of cheese along with a shipment of good cheese, without marking them or notifying the buyer, very properly lose money and reputation as a result of such dishonesty.

CHAPTER XV.

WHEY CREAM AND WHEY BUTTER.

(107) **Most Factories Skim Whey.** In the making of Swiss cheese the whey contains .5 to 1% of fat. It has long been the practice at Swiss factories, wherever located, to skim the whey, formerly by hand, later by milk separators and more recently by the use of the whey separator, and to churn the whey cream into whey butter.

As early as 1908, the manufacture of whey butter at Cheddar factories had made substantial progress in New York. In 1910, the report was published of a year's work in the skimming of whey and the making of whey butter at an American cheese factory near Plymouth, Wisconsin, showing that about $1,000 was paid to the farmers as their share of the profits. In 1911, there were three factories engaged in this industry in the same neighborhood. In 1912, other factories were reported in New York; and 24 or more factories were skimming whey in Sheboygan county, Wisconsin.

Since then, nearly every American cheese factory in Wisconsin has installed a whey separator, and found it profitable.

The following questions and answers from Wisconsin bulletin 246 will be found helpful in explaining to factory patrons the advantages of whey skimming:

(108) **What is Whey Fat?** When milk is made into American cheese, about nine-tenths of the fat in the milk is retained in the cheese; the rest goes into the whey and drippings from the curd. Whey fat is therefore good butter fat which can be either, (1) separated from the whey, churned and sold as whey butter, or (2) can be converted into pork.

(109) **How Much Fat is There in the Whey at American Cheese Factories?** Enough to make from about 10 to 20 pounds of butter a year for each good cow

contributing to the factory. The whey from 100 pounds of milk contains about 0.25 to 0.35 per cent or more of fat, or about 0.30 pounds of fat, which will make about 0.35 pounds of whey butter.

(110) **How Does Separated Whey Compare with Unskimmed Whey as Feed for Hogs?** Unskimmed whey contains about 7 per cent of solids, including 0.30 per cent of fat; 5 per cent milk sugar and 1.7 per cent of albumen, mineral matter, and other solids. The fat is thus about one twenty-third of the total solids in whey. The most careful feeding experiments have shown that a pound of fat in feed produces about two and one-fourth times as much gain in weight of hogs, as does a pound of milk sugar or albumen and therefore it is seen that the skimming of whey removes only about one-tenth of its feeding value.

(111) **Is It More Profitable to Sell Fat in Whey Cream Than to Feed It to Hogs?** It is. A pound of whey fat fed to a hog may produce a pound of pork worth about 17 cents, but a pound of whey fat in the form of whey cream sells at about the butter fat price, which is 40 or 50 cents.

To replace one pound of fat as hog feed, it is necessary to buy about three pounds of grain worth about 10 cents. There is left about 15 or 20 cents per pound of fat in whey cream, which will amply pay for the expense of skimming, and leave the farmer a good profit. At a good many private factories the farmer gets half the income from the sale of whey cream, or about 20 or 25 cents per pound of fat and after paying out 10 cents for grain to replace the fat as feed he has left 10 or 15 cents per pound of fat as profit. This amounts to 3 or 5 cents gain in price on each 100 pounds of milk delivered at the factory.

(112) **The Equipment for Whey Skimming.** At Swiss factories the curd is taken out first, leaving the whey in the kettle, but in American factories the whey is drawn first, leaving the curd in the vat. In either case the whey is raised by a pump or a steam jet through clean, sanitary pipes, arranged so as to be cleaned every time used, to a tin lined whey storage tank. In some factories the whey runs by gravity from the cheese vat to the tank.

The separator is started immediately and fed from the storage tank and the skimmed whey is caught in a large can and pumped to the farmers' whey tank. Whey separators run by steam turbine are most commonly used.

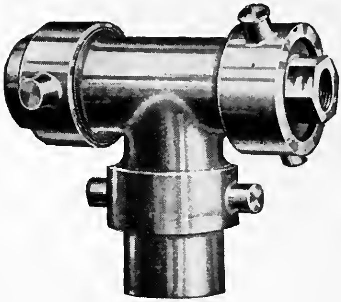

Fig. 19BB.—A Sanitary Steam Jet.

The whey cream is caught in a can, set in a tub of cold water, cooled as rapidly as possible, and kept in cold water until delivered to the buyer. In warm weather whey cream should be delivered every day, if possible, and certainly every second day. The curing room is not cool enough for the storage of whey cream. It should be kept at the temperature of fresh, cold, well water, best in a half barrel or covered wooden tank. Press drippings are not skimmed, as they are likely to injure the quality of whey cream.

(113) **Testing Whey and Skimmed Whey for Fat.** The Babcock test used for testing milk and cream is also used for whey as well as skim milk. For American cheese factory whey, the double necked skim milk test bottles reading up to 50% fat may be used. After placing 17.6 cc. of whey in the bottle, it should be stood in cold water for a time to cool the sample. It is best also to use about ¾ of a measure of acid and to add the acid in three or four portions shaking well after each addition. These precautions are taken to avoid a muddy fat column. The skimmed whey may also be tested in the same manner to determine how well the separator is working.

In testing whey it is necessary first to obtain a fair sample and this can be done by catching a dipperful of whey at the time when about half of the whey has run out of the vat. Without allowing time for the whey cream to rise, a pipetteful of whey is transferred to the test bottle.

(114) **Making Whey Butter.** For churning whey cream profitably it is necessary that a sufficient quantity be collected so as to keep the buttermaker employed. For this purpose a factory may purchase whey cream from a number of neighboring factories and sell whey butter in tubs or prints. The overrun in churning whey butter amounts to about one-sixth, on the average; that is, the butter weighs about one-sixth more than the fat in the whey cream, the same as with ordinary butter. In paying for the fat in whey cream at the same price per pound as the butter sells for, the profit comes only from the overrun. It is seen, then, that the value of whey fat is more than doubled by whey skimming but is increased only one-sixth by churning. For this reason the great majority of cheese factories prefer to sell whey cream, and buy whey butter for sale to the patrons.

A few factories churn whey cream two or three times a week, even in small quantities in order to supply whey butter to patrons at the lowest possible price.

For churning whey cream alone, it is preferable that the whey cream contain 50 or 60% fat, so that 60 to 100% of starter may be added, reducing the fat content to about 30% the day before churning.

As the whey fat is, if anything, a trifle softer than ordinary butter fat, the whey cream should be cooled to a somewhat lower temperature than ordinary cream, held cold for at least four hours, better over night, and churned a few degrees colder than with ordinary cream. The churn is stopped when the butter is in small granules, about the size of wheat grains. The butter is washed with water at about the same temperature, salted and worked and packed in the usual manner. Butter made wholly or partly from whey cream must be labeled "Whey Butter" to conform to Wisconsin law. Experience has shown that many consumers eat whey butter without prejudice, but others refuse to examine or buy a package labeled "whey butter," because they recall the old time whey butter of 20 years ago, which was inferior.

(115) **Other Uses for Whey Cream.** Whey cream is sold in large quantities for other purposes than buttermaking. It is used with entire success in ice cream mixtures for which no special label is required. To insure good quality in whey cream and its products, the same care and sanitary precautions should be used as with ordinary cream, that is the milk should be of good quality and the cream cooled promptly after skimming, kept cold and delivered before it becomes old and stale.

(116) **Distributing Whey Cream Money.** The money from the sale of whey cream is used partly to pay the expense of skimming which may amount to one-half or less and the patrons get the rest. All patrons should be paid at the same price per 100 pounds of milk delivered. The percentage of fat in whey from 4.5% milk is almost the same and only a very little higher than in whey from 3.5% milk. It would not be fair to add the whey cream money to the cheese money, and distribute it all at a fixed price per pound of fat in the milk; but the cheese money and the whey cream money should be figured separately and then added together.

At the Minnesota Experiment Station in 1892 cheese was made from normal milk of different fat contents. The following table shows the losses of fat from these different milks:

LOSSES OF FAT IN MILK OF DIFFERENT FAT CONTENTS

Per cent fat in milk	3.5 to 4	4 to 4.4	4.5 to 5	5 to 5.5
Average per cent fat in whey	.38	.36	.39	.32
Number of trials	28	31	14	4

Similar results have been obtained in Wisconsin and New York.

CHAPTER XVI.

PAYMENTS FOR CHEESE FACTORY MILK.

(117) **Aim.** In making payments for milk to patrons at a cheese factory, it is intended to pay each patron according to the cheese making value of his milk ; that is, according to the weight of cheese which his milk would yield if made into cheese by itself.

(118) **Pooling System.** From about 1850, when the first cooperative factories were started in this country, to 1890, when the Babcock test was invented, cheese factory profits were divided among patrons in proportion to the weight of milk delivered by each; that is, according to the pooling system. This system is now generally recognized to be very unfair, and is no longer used at the majority of factories.

(119) **Payment According to the Babcock Test.** After the Babcock test for fat in milk came into use it was found that 100 pounds of milk from one herd do not yield as much cheese as 100 pounds of milk from another herd but that the yield of cheese is more nearly proportioned to the weight of fat in the milk than to the weight of the milk itself. At the present time, the great majority of American cheese factories in Wisconsin use the Babcock test as the basis of milk payments and its use has also spread all over the United States and to many foreign countries.

(120) **Comparison of Payments by Different Methods.** For illustration, suppose that five patrons delivered each 100 pounds of milk at a factory. The milk yielded 53 pounds of cheese which sold at 22 cents a pound. After paying the maker 2 cents a pound for making, there was left $10.60 to be divided among the patrons. How much money should each man receive?

Under the pooling system, the money, $10.60, is divided by 5 which gives $2.12, the price to be paid per hundred pounds of milk. All patrons received the same price per hundred, as follows:

Patron No	1	2	3	4	5
Pooling system	$2.12	$2.12	$2.12	$2.12	$2.12

By the Babcock test, the milk was tested for fat, as follows:

Patron No	1	2	3	4	5
Fat test, %	3.0%	3.5%	4.0%	4.5%	5.0%
Wt. of fat in milk	3.0 lbs.	3.5 lbs.	4.0 lbs.	4.5 lbs.	5.0 lbs.

The total weight of fat in the 500 lbs. of milk was 20 lbs. Dividing the $10.60 by 20 gives 53 cents, the price per pound of fat to be paid to each patron. The patrons received amounts, as follows:

Fat test payments	$1.59	$1.855	$2.12	$2.385	$2.65

In comparison with the fat test payments, it is seen that the pooling system pays patron No. 1, 53 cents too much, and No. 5 gets 53 cents too little. Patrons 2 and 4 receive payments which are wrong by 26 cents on 100 lbs. of milk. Only patron 3 receives the same payment by both methods of figuring, and the reason is that patron 3 has a fat test equal to the average test of all the milk delivered at the factory.

By the pooling system, only those patrons receive correct payments whose fat test is the same as the factory average test. The farther a patron's test is from the factory average test, the farther his payments by the pooling system are from being correct. Pooling system payments are generally so unfair that this system should not be used at any whole milk cheese factory.

(121) The Yield of Cheese From Milk of Different Test. (a) Roughly, about 1 pound of cheese is obtained from 10 lbs. of milk, on the average, but this form of statement is not exactly correct, for it is well known that richer milk gives more cheese, while low testing milk gives less cheese, than 1 to 10.

(b) The yield of cheese is more or less closely related to the richness of the milk, and it has been found that the average yield of cheese from milk can be figured by multiplying the weight of fat in the milk by 2.7, or for cured cheese, the figure 2.6 is used.

The first rule is very inaccurate because it makes the cheese yield proportionate to the weight of the milk, the same as the pooling system of payment.

The second rule is slightly inaccurate because it makes the cheese yield proportionate to the weight of fat in the milk, as in payments according to the straight fat test method.

Payments by the Babcock test method are much nearer correct than payments by the pooling system. The question is often asked as to whether payments by the fat test are exactly correct. Is the yield of cheese exactly proportional to the fat test of the milk? Will 100 pounds of 6% milk yield twice as much cheese as 100 pounds of 3% milk?

(c) This question has been studied more extensively at the New York (Geneva) Agricultural Experiment Station than elsewhere, and the average yields of cheese (containing 37% of moisture) obtained from milk of different test have been tabulated by Van Slyke as follows, which figures may be used until further light is thrown on the subject by future investigations.

Fat test, %	3.0%	3.5%	4.0%	4.5%	5.0%	Total
Cheese yield, lbs	8.3	9.45	10.6	11.74	12.9	52.99

From these average yields, at 20 cents per pound, the value of the cheese from 100 lb. lots of milk may be figured.

Fat test, %	3.0	3.5	4.0	4.5	5.0	Total
Yield value	$1.66	$1.89	$2.12	$2.348	$2.58	$10.598

(122) **Comparison of Fat Test Payments and Yield Values.** Comparing the fat test payments and the yield values for the five lots of milk, as given above, the differences are found by subtraction, and the difference in each case, per dollar, are as shown below.

Fat test of milk	3.0%	3.5%	4.0%	4.5%	5.0%
Babcock payment	$1.59	$1.855	$2.12	$2.385	$2.65
Yield value	1.66	1.89	2.12	2.348	2.58
Difference per cwt	.07	.035	.00	.037	.07
Difference per $	.044	.019	.00	.011	.0264

Using the yield values as the standard, it is seen that the fat test payments agree with them within 2 cents on the dollar, in the cases of patrons 2, 3, and 4, whose fat tests are 3.5%, 4.0 and 4.5%. In general, it is true that when the highest patron's test at a factory is not more than 1% fat above the lowest test at that factory for the month, the fat test payments for that milk agree with the New York yield values within two cents on the dollar. At all such cheese factories, the fat test method of payment should be used, because it gives payments correct within two cents on the dollar, that is, almost exactly correct.

On the other hand, there is a second class of factories at which the highest patron's test is more than 1% and possibly even 2%, above the lowest patron's test, during the month. Here, where there are patrons like Nos. 1 and 5 above, the errors in payment per dollar are greater than 2 cents on the dollar, and may be over 4 cents per dollar, as shown. In all such cases, it may be desirable to use some modified method of figuring payments from the fat test, such as the *fat plus six-tenths* method described below, in order to make the payments equal the New York yield values, to all patrons.

(123) **The Highest and Lowest Fat Tests at Different Factories.** From a study of 15,000 payments to cheese factory patrons based on the Babcock test, reported to the Wisconsin Experiment Station from factories in many counties in this state, it was found that in 95% of all cases the highest patron's test at the factory was not more than 1% fat above the lowest patron's test. From this the conclusion was drawn that at the very large majority of cheese factories, payments should be based on the straight fat test, and at only a few factories is a modified method needed.

(124) **The Fat Plus Six-Tenths Method.** The simplest method of figuring which will give payments equal to the yield values (section 121 is called the *fat plus six-tenths* method. This consists in adding .6% fat to each patron's fat test, then multiplying the test plus .6% by the patron's weight of milk, to get the weight of "fat plus .6" in the milk. The method and its results are as follows:

Patron	1	2	3	4	5	Total
Fat test	3.0%	3.5%	4.0%	4.5%	5.0%	
Fat test plus six-tenths	3.6%	4.1%	4.6%	5.1%	5.6%	
Lbs. fat plus .6	3.6	4.1	4.6	5.1	5.6	23 lbs.

Dividing $10.60 by 23 gives 46.087 cents, the price per lb., and multiplying this figure by each patron's weight of "fat plus .6" gives the following values for the different lots of milk, which will be seen to agree closely with the yield values above:

$1.659	$1.889	$2.12	$2.35	$2.581	$10.599

This method is recommended for use at the few factories where patron's milk tests differ by more than 1% fat between the highest and the lowest during the month, and where the patrons become dissatisfied with payments by the straight fat test, for this reason.

(125) **The Fat Plus 2 Method.** This was proposed and used to some extent in Canada. To illustrate the method it is applied to the five patrons as follows:

Patron No.	1	2	3	4	5	Total
Fat test, %	3.0	3.5	4.0	4.5	5.0	
Fat test plus 2%	5.0	5.5	6.0	6.5	7.0	
Lbs. fat plus 2	5.0	5.5	6.0	6.5	7.0	30.0

Dividing $10.60 by 30 gives 35.33 cents, the price per lb. Multiplying this price by each patron's weight of "fat plus 2," gives the following values for the different lots of milk:

$1.766	$1.943	$2.12	$2.296	$2.473	$10.598

Comparing these values with the preceding, it is seen that while the payment to patron 1 by the straight fat method is 7 cents lower than the yield value, the fat plus 2 payment is 10.6 cents higher than the yield value. The figure 2 is too large to add to the fat tests, while the figure .6% is just right to make the payments equal the New York yield values.

(126) **The Fat Plus Calculated Casein Method.** As this method gives exactly the same milk values and payments to patrons as the fat plus six-tenths method, but is considerably more complicated to figure than the latter, it need not be illustrated here.

The method is based upon the view advanced by Van Slyke that the cheese yield of milk is proportional to the percent of fat plus the percent of casein, and that the casein percent can be calculated, with sufficient accuracy for the purpose, from the fat test, by the formula (Fat test—3.%)x .4 plus 2.1% equals calculated casein%. Some fat tests and the corresponding calculated casein tests are as follows:

Fat test	3.0	3.5	4.0	4.5	5.0
Casein per cent calculated	2.1	2.3	2.5	2.7	2.9

From these figures it will be seen that the casein in 3% milk is 7/10 of the fat, but in high testing, 4.5% milk, is 2.7% equal to 6/10 of the fat. The fact that high testing milk usually carries less casein per pound of fat, and yields less cheese per pound of fat than low testing milk is generally recognized.

(127) **Payments Based on Fat Test and Casein Test.** Instead of figuring the casein test of milk by the formula given above, according to Van Slyke, it was suggested by Hart that the casein should be determined directly by use of a casein test, since the observed casein test of milk often differs more or less from the calculated casein percent.

The only way to determine whether the casein test is required at a given factory is to use it at that factory for several months, and compare the payments figured, first, by the fat plus six-tenths method, and second, by the fat test plus casein test. If the payments differ as a rule more than 2 cents per dollar paid, the use of the casein test may appear justified. Very few factories now use the casein test. The correct handling of the Hart casein test is more difficult than with the Babcock fat test. When a fat test is improperly made, the appearance of the fat column gives an indication of the fact, and of the method by which the error can be avoided. Fat test duplicates should always agree within .1% fat. Casein tests may read larger or smaller according to the temperature of the milk and the reagents when mixed, or according to the time and speed of centrifuging, but there is nothing about the appearance of the finished casein test to indicate that any error in method has occurred. Duplicate casein tests frequently differ by .2% casein, when run with care by an experienced person.

(128) **Hart Casein Test.** For the casein test, samples preserved with potassium bichromate are used, although for the fat test the use of corrosive sublimate as a preservative is preferable. The casein test milk samples are best held in brown bottles to preserve them from the action of light.

With reagents, milk samples and workroom at about 70 degrees, the test bottles are filled with (1) 20 cc. of ¼% acetic acid, (2) 2 cc. of chloroform, (3) 5 cc. of the composite milk sample run into the middle of the acid, not down the side of the test bottle. After mixing by shaking not over 20 seconds, the samples are centrifuged in a special hand tester, for 7½ to 8 minutes, at 55–56 revolutions of the handle per minute, with the aid of a metronome or pendulum. After

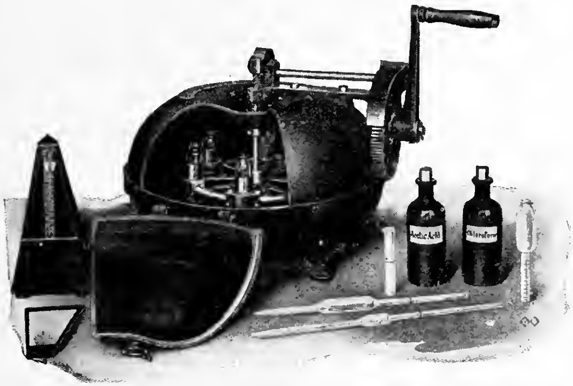

Fig. 19C.—The Hart Casein Test Outfit.

centrifuging, the test bottles are left to stand for 10 minutes before reading the figures on the graduated part containing the pellet of casein.

(129) "Correct Difference per Tenth" Method of Payment. Following the example of condensaries and city milk dealers, a few factories pay an average price for milk of average test, and add to the average price a certain number of cents, 3, 4, 5, or 6, for each tenth percent of fat test above the factory average test, making a similar subtraction from the price when milk is below the average in fat test.

This method gives correct payments, agreeing with the yield values of the milk, if the correct difference in price for .1% difference in fat test is figured out correctly each month, as this figure is likely to change every month, with the changing price of cheese. The use of a fixed difference per tenth, as 3 cents or 6 cents, is sure to produce payments differing from the yield values of the milk.

To get the correct difference per tenth each month, it is necessary to multiply the "average price per pound of fat" by the figure .0868. Thus, if the average price per pound of fat is 50 cents, the correct difference per tenth is 4.34 cents.

(130) **Pound For Ten Method of Payment.** In this method, the price of one pound of cheese is paid for each 10 lbs. of milk delivered at the factory. As this system is based entirely upon the weight of milk delivered, and pays the same price per hundred pounds of milk to all patrons, it is equally as unjust as the pooling system, and should not be used at any cheese factory, as a basis of payment to patrons.

(131) **Calculating Dividends by the Fat Test.** The Babcock Test is now quite generally used at American cheese factories where it has replaced the old and very unjust "pooling system" of paying for milk and cream. To calculate the amount of money to be paid each patron at a cooperative factory it is first necessary to add the receipts from all sales made during the month, and subtract from this sum the running expenses, including supplies, labor, etc., as for example:

Total sales, month of June, 1913	$2,101.23
Total expenses, month of June, 1913	175.00
Proceeds to be divided among patrons	$1,926.23

This amount of money, $1,926.23, is to be divided among the patrons in proportion to the weight of butter fat delivered by each. At most factories, composite samples of the milk delivered by each patron are tested twice a month. To calculate how much money each man should receive, it is necessary first to add up the columns on the factory milk sheet shown below to find out how many pounds of milk each patron delivered during the first and second halves of the month. From the record of weights and tests upon the milk sheet for patron No. 1, it is seen that between June 1 and 14 he delivered 3,123 pounds of milk, testing 4.2 per cent fat, which contained 131.2 pounds of fat. Between June 15 and 30 he delivered 3,010 pounds of milk testing 4.1 per cent fat or 123.4 pounds of fat, making a total of 254.6 pounds of fat during the month. In a similar way can be found the weight of fat delivered by each of the ten patrons during the month. Add these all together to find the total weight of butter fat delivered at the factory as follows:

Patron's number	Pounds fat delivered
1	254.6
2	567.5
3	....
4	....
5	....
6	....
7	....
8	....
9	....
10	....
Total pounds fat	8,175.4

(132) Factory Milk Sheet, Moneta Factory, June, 1910.

Patron's No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Date June, 1910.	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk
1.	215	420	130	557	698	986	1548	317	811	1400
2.	210	425	124	543	687	980	1537	324	820	1393
3.	216	419	139	569	700	975	1530	333	831	1380
4.	210	427	127	557	682	983	1559	325	815	1410
5.	213	410	120	550	674	989	1545	328	827	1390
6.	215	425	128	561	683	995	1560	329	809	1427
7.	221	435	137	569	690	1018	1572	330	819	1438
8.	232	430	130	574	698	992	1558	337	831	1395
9.	236	428	133	565	680	987	1568	330	837	1396
10.	223	420	137	563	703	985	1580	324	822	1358
11.	222	431	146	579	694	989	1589	338	814	1400
12.	245	435	140	570	687	996	1576	345	809	1430
13.	236	439	150	583	675	990	1589	350	828	1411
14.	229	447	143	580	684	1019	1580	337	835	1436
Total Milk	3123									
Test %	4.2	4.4	3.8	4.1	3.7	3.6	3.5	3.2	3.8	3.9
Lbs. Fat.	131.2									
15.	220	450	153	585	695	1007	1575	350	840	1470
16.	215	445	159	597	693	995	1587	347	851	1462
17.	206	453	152	580	704	990	1596	358	838	1497
18.	197	462	147	583	711	999	1584	363	847	1460
19.	190	465	158	590	725	1011	1598	355	859	1475
20.	180	460	150	599	698	1015	1580	347	850	1483
21.	180	455	141	587	700	992	1603	359	862	1479
22.	175	465	158	580	715	989	1592	363	852	1470
23.	180	469	162	593	704	996	1610	354	845	1465
24.	172	473	168	585	719	990	1619	359	858	1475
25.	181	462	158	579	711	998	1597	352	849	1480
26.	189	475	167	570	730	986	1618	348	851	1473
27.	182	467	154	578	725	979	1595	340	857	1481
28.	180	453	169	585	739	984	1589	346	846	1490
29.	178	478	153	592	747	996	1611	341	843	1470
30.	185	488	160	597	732	1010	1620	350	870	1486
Total Milk	3010									
Test %	4.1	4.1	3.7	4.3	3.9	3.8	3.6	3.3	3.5	3.6
Lbs. Fat.	123.4									
Total fat for month.	254.6									

The factory milk sheet at the end of the month, shows the total fat delivered by patron No. 1. The reader may complete the calculation for the other nine patrons.

Dividing the proceeds, $1,926.23, by the total number of pounds of fat delivered, 8,175.4 gives the price to be paid the patrons for each pound of butter fat delivered, which in this case is $.2356.

The amount of money due each patron is found by multiplying the number of pounds of fat delivered, by the price of butter fat, in this case $.2356, as shown below.

Patron's number.	Pounds fat delivered.	Price per pound for butter fat.	Amounts due the patrons.
1	254.6	Multiplied by $0.2356	$59.98
2	567.5	" " "	
3		" " "	
4		" " "	
5		" " "	
6		" " "	
7		" " "	
8		" " "	
9		" " "	
10		" " "	
Total	8,175.4	Total	$1,926.11

The patrons are entitled to the amounts given in the last column and there remain also 12 cents undivided, which amount is carried over to the following month, as cash on hand.

A valuable exercise for students is to figure out the amount of money due to each patron in the list above, according to the method there used.

In addition the payments for the same milk may be figured by the fat plus six-tenths method, and by the pooling system, for comparison, with the understanding that the pooling system is the most unjust method of payment which has ever been used at cheese factories.

CHAPTER XVII.

CONDITIONS AFFECTING CHEESE CURING.

(133A) **Curing Agents.** Cheese in curing becomes more soluble in water, waxy in texture instead of curdy, and acquires flavor. These changes are caused by various agents, including rennet enzymes, bacteria, bacterial enzymes, acid, and molds growing in or on cheese. Curing is delayed by salt and cold, and hastened by moisture and warmth.

(133B) **General Considerations.** Success in ripening cheese depends partly (1) on the way the cheese is made and partly on the conditions of (2) temperature and (3) humidity under which it is cured.

Very dry cheese, as Saanen, may require one to six years for curing to ripen fully. The English market prefers cheese ripened for several months. American cheese containing 36 to 40% of moisture often reaches the consumer at an age of one month, in accordance with the modern tendency to market such products as early as possible. Holding American cheese several hours at the temperature of the vat before putting it to press cures the cheese more than a much longer time at the lower temperature of the curing room. The use of more salt delays curing somewhat.

(134) **Curing Room Temperature.** The temperature in the curing room should be regulated. Curing goes on more rapidly at higher temperatures, but with injury to quality if too warm. On the other hand, cheese cures more slowly at lower temperatures, but without injury to the quality of American cheese which was first demonstrated at the Wisconsin station.

The curing room of the ordinary American cheese factory is really a storage and drying room in most cases, where cheese are kept for only a few days (3 to 10 days) until dry enough on the surface and until a suitable quantity is obtained for shipment to the buyer. In summer cheese are sold weekly, and shipped twice a week. Such factory curing room temperatures may go as high as 80–90 in summer and an accidental delay in shipping through lack of boxes or cars may cause serious injury to the quality of cheese and undue shrinkage in weight through continued storage at too high temperatures.

Such conditions are avoided in many well built curing rooms in Canada and elsewhere, having well insulated walls two feet thick, and provided with an adjacent ice house, from which cool air can be circulated through the cheese room, when necessary, to maintain a temperature of about 60–65 degrees for the best quality of American cheese.

Wisconsin storage warehouses, where cheese are kept for 6 months or more, are held at about 34 degrees by use of mechanical refrigeration, or at 40 to 50 degrees by use of ice or ice and salt. The Canadian cool-curing warehouses are kept at 55–60 degrees F.

Means employed to cool the factory curing room a few degrees include: (1) Running 1½-inch galvanized iron pipes several times along the curing room walls and connecting them to the pump, so that all water pumped at the factory is used first for cooling the curing room. (2) A rack at one side of the room into which a few cakes of ice can be placed when needed, is used at several factories. (3) A sub-earth duct, consisting of three to thirteen parallel lines of drain tile about 100 feet long buried six to twelve feet underground is connected to a stack provided with a revolving cowl, which always faces the wind. The air passing down the stack and through the tile, is delivered into the curing room, which is thus well cooled. A similar and rather more satisfactory arrangement consists in conducting the air from the stack down a pipe into a deep well, while the air issuing from the top of the well passes out into the curing room. (4) Factories located near a pond or stream can easily store ice in winter and a cheese storage room is frequently built in so as to be covered with ice as long as any is left in the ice house.

Swiss cheese are sometimes cured at 90° and hand cheese at 100° F., or above.

(135) **Curing Room Humidity.** The humidity of the curing room is of importance, since with too dry air the shrinkage in weight may be excessive and both yield and quality reduced, while with too moist air the cheese rapidly become moldy on the surface and do not dry properly or form a rind.

As the outside air in this country is usually much drier than necessary for cheese curing it is best to keep the cheese curing room closed most of the time. In summer this is an advantage also in keeping the room cooler than the outside air. When the nights are cooler than the days in summer the room may be ventilated by opening a window at night. If the cheese become moldy on the surface, due to too much dampness, daily ventilation will be found to correct the tendency.

After American cheese are well dried on the surface they are paraffined and returned to the cheese boxes in which they are kept during storage. The dry rind and the paraffine coating check the growth of mold, and storage in the box also checks further drying out.

The humidity of air in the curing room where soft cheese as Limburger, Brie, etc., are cured is higher than for American cheese in order to keep these soft cheese from drying out. For this purpose a spray of water may be kept flowing from a nozzle through the air or the floor may be kept wet, or wet cloths may be hung up. In France, where Brie and Camembert cheese are made in large quantities, the air is always naturally moister, due to easterly sea winds, than in the eastern part of this country. A curing room is more easily kept moist if it is nearly filled with cheese, and where only a few soft cheese are made, a small room or closet is best or the cheese may be kept covered with a wooden box to protect them from air currents. To destroy molds in the curing room fumigate with burning sulphur or formalin gas or scrub and then whitewash the walls and ceiling.

(136) **Measuring Humidity.** The humidity of air in the curing room can be measured by use of the hygrometer or by a pair of wet and dry bulb thermometers, which arrangement is called a psychrometer, the best form of which is the sling psychrometer which is whirled rapidly by

hand in the air. In a dry room the water on the wet thermometer bulb evaporates rapidly causing a cooling effect so that the wet bulb thermometer reads lower than the one with a dry bulb. The greater the difference in reading between the two thermometers the drier the air is in the room while if the air is saturated with moisture there will be no evaporation from the wet bulb and the two instruments

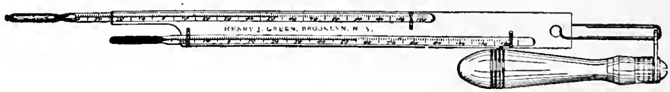

Fig. 19D.—The Sling psychrometer.

will read alike. The per cent of humidity may be read from the following table. Thus if the wet bulb reads 54 and the dry bulb reads 60, the humidity is 54%, meaning that the air then holds 54% or about half as much air as it could possibly hold if saturated. If the humidity is above 90%, cheese are likely to become moldy in a short time and require frequent washing.

(137) Table Showing the Relative Humidity in the Air of Curing Rooms.

Directions. Notice that the table is in three column sections. Find air temperature in first column, then find wet bulb temperature in second column, same division. In third column opposite this is relative humidity.

Example. Air temperature is 50°, in first column; wet bulb is 44°, in second column, same division. Opposite 44° is 61, which is the per cent of saturation, or the relative humidity of the air.

Dry Bulb.	Wet Bulb.	Rel. Hum.
40	32	37
	33	44
	34	52
	35	59
	36	68
	37	76
	38	84
	39	92
41	32	31
	33	38
	34	46
	35	53
	36	60
	37	68
	38	76
	39	84
	40	92
42	33	33
	34	40
	35	47
	36	54
	37	61
	38	69
	39	77
	40	84
	41	92
43	33	28
	34	34
	35	41

Dry Bulb.	Wet Bulb.	Rel. Hum.
43	36	48
	37	55
	38	62
	39	70
	40	77
	41	85
	42	92
44	34	29
	35	36
	36	43
	37	49
	38	56
	39	63
	40	70
	41	78
	42	85
	43	92
45	35	31
	36	37
	37	44
	38	50
	39	57
	40	64
	41	71
	42	78
	43	85
	44	92
46	35	26
	36	32

Dry Bulb.	Wet Bulb.	Rel. Hum.
46	37	38
	38	45
	39	51
	40	58
	41	65
	42	72
	43	79
	44	85
	45	93
47	36	28
	37	34
	38	40
	39	46
	40	52
	41	59
	42	66
	43	72
	44	79
	45	86
	46	93
48	37	29
	38	35
	39	41
	40	47
	41	53
	42	60
	43	66
	44	73
	45	79
	46	86

Dry Bulb.	Wet Bulb.	Rel. Hum.
48	47	93
49	38	30
	39	36
	40	42
	41	48
	42	54
	43	60
	44	67
	45	73
	46	80
	47	86
	48	93
50	39	32
	40	37
	41	43
	42	49
	43	55
	44	61
	45	67
	46	74
	47	80
	48	87
	49	93
51	40	33
	41	39
	42	45
	43	50
	44	56
	45	62

HUMIDITY IN THE AIR OF CURING ROOM—Continued

Dry Bulb.	Wet Bulb.	Rel. Hum.
51	46	68
	47	74
	48	81
	49	87
	50	93
52	41	35
	42	40
	43	46
	44	51
	45	57
	46	63
	47	69
	48	75
	49	81
	50	87
	51	94
53	41	31
	42	36
	43	41
	44	47
	45	52
	46	58
	47	63
	48	69
	49	75
	50	81
	51	87
	52	94
54	42	32
	43	37
	44	42
	45	48
	46	53
	47	59
	48	64
	49	70
	50	76
	51	82
	52	88
	53	94
55	43	33
	44	38
	45	43
	46	49
	47	54

Dry Bulb.	Wet Bulb.	Rel. Hum.
55	48	59
	49	65
	50	70
	51	76
	52	82
	53	88
	54	94
56	44	34
	45	39
	46	44
	47	50
	48	55
	49	60
	50	65
	51	71
	52	77
	53	82
	54	88
	55	94
57	45	36
	46	40
	47	45
	48	50
	49	55
	50	61
	51	66
	52	71
	53	77
	54	83
	55	88
	56	94
58	46	37
	47	42
	48	46
	49	51
	50	56
	51	61
	52	67
	53	72
	54	78
	55	83
	56	89
	57	94
59	47	38
	48	43

Dry Bulb.	Wet Bulb.	Rel. Hum.
59	49	47
	50	52
	51	57
	52	62
	53	67
	54	72
	55	78
	56	83
	57	89
	58	94
60	48	39
	49	44
	50	48
	51	53
	52	58
	53	63
	54	68
	55	73
	56	78
	57	84
	58	89
	59	94
61	49	40
	50	44
	51	49
	52	54
	53	58
	54	63
	55	68
	56	73
	57	78
	58	84
	59	89
	60	94
62	50	41
	51	45
	52	50
	53	54
	54	59
	55	64
	56	69
	57	74
	58	79
	59	84
	60	89
	61	95

Dry Bulb.	Wet Bulb.	Rel. Hum.
63	51	42
	52	46
	53	51
	54	55
	55	60
	56	64
	57	69
	58	74
	59	79
	60	84
	61	89
	62	95
64	52	43
	53	47
	54	51
	55	56
	56	60
	57	65
	58	70
	59	74
	60	79
	61	85
	62	90
	63	95
65	53	44
	54	48
	55	52
	56	56
	57	61
	58	65
	59	70
	60	75
	61	80
	62	85
	63	90
	64	95
66	53	40
	54	45
	55	49
	56	53
	57	57
	58	61
	59	66
	60	71
	61	75
	62	80

HUMIDITY IN THE AIR OF CURING ROOM—Continued.

Dry Bulb.	Wet Bulb.	Rel. Hum.
66	63	85
	64	90
	65	95
67	54	41
	55	45
	56	49
	57	53
	58	58
	59	62
	60	66
	61	71
	62	76
	63	80
	64	85
	65	90
	66	94
68	55	42
	56	46
	57	50
	58	54
	59	58
	60	63
	61	67
	62	71
	63	76
	64	81
	65	85
	66	90
	67	95
69	56	43
	57	47
	58	51
	59	55
	60	59
	61	63
	62	67
	63	72
	64	76
	65	81
	66	86
	67	90
	68	95
70	57	44
	58	48
	59	52
	60	55
70	61	60
	62	64
	63	68
	64	72
	65	77
	66	81
	67	86
	68	90
	69	95
71	58	45
	59	48
	60	52
	61	56
	62	60
	63	64
	64	68
	65	72
	66	77
	67	81
	68	86
	69	91
	70	95
72	59	45
	60	49
	61	53
	62	57
	63	61
	64	65
	65	69
	66	73
	67	77
	68	82
	69	86
	70	91
	71	95
73	60	46
	61	50
	62	53
	63	57
	64	61
	65	65
	66	69
	67	73
	68	78
	69	82
	70	86
	71	91
73	72	95
74	61	47
	62	50
	63	54
	64	58
	65	62
	66	66
	67	70
	68	74
	69	78
	70	82
	71	86
	72	91
	73	95
75	62	47
	63	51
	64	55
	65	58
	66	62
	67	66
	68	70
	69	74
	70	78
	71	82
	72	87
	73	91
	74	95
76	63	48
	64	52
	65	55
	66	59
	67	63
	68	66
	69	70
	70	74
	71	78
	72	82
	73	87
	74	91
	75	95
77	64	49
	65	52
	66	56
	67	60
	68	63
	69	67
77	70	71
	71	74
	72	78
	73	83
	74	87
	75	91
	76	95
78	65	49
	66	53
	67	56
	68	60
	69	63
	70	67
	71	71
	72	75
	73	79
	74	83
	75	87
	76	91
79	66	50
	67	53
	68	57
	69	60
	70	64
	71	68
	72	71
	73	75
	74	79
	75	83
	76	87
	77	91
80	66	47
	67	51
	68	54
	69	57
	70	61
	71	64
	72	68
	73	72
	74	75
	75	79
	76	83
	77	87
	78	92
	79	96

CHAPTER XVIII.

CLEANLINESS IN THE CHEESE FACTORY.

(138) **Suggestions.** Keeping the cheese factory clean is the duty of the maker. In order to get ahead with any important piece of work, it is necessary not only to do the daily work in good shape and on time, but also to devote a little time each day to planning or putting into effect some improvements. Each day there is either a little more dirt collected in the factory, or the factory is cleaner than before, depending largely on the maker's attitude toward his work. No maker need have a dirty factory unless he is willing to do so. On the other hand, a well planned and built factory is more likely to be well kept, also.

Dirt is material in the wrong place. Thus, milk in the vat is milk, but milk on the floor or walls is dirt. It is important to have the factory and equipment so planned, constructed, and arranged that the work of making cheese can be carried on without waste of material, as milk, coal, lubricating oil, and without waste of supplies, labor, or time.

A good rule in a cheese factory is to clean every utensil, immediately after using it, before it has time to get dry, because it is easier to clean, and dirt does not accumulate when this is done.

(139) **Steam Heat.** Steam heat in the factory permits pasteurization of starter milk, insures a plentiful supply of scalding water for cleaning purposes, and enables the maker to comply with the law as to pasteurization of factory by-products fed to farm animals. It is of the utmost importance as an aid in keeping the factory and curing room free from yeasts, or other infections, such as those causing red spots on cheese, or bloated cheese, since these germs can generally be exterminated by steaming and scalding utensils and equipment.

As an influence in favor of cleanliness, a fresh coat of paint on the outside of the factory building is perhaps more powerful than any other one factor. With the building looking fresh and attractive, the appearance of the surrounding yard demands attention, and a weedy lawn, muddy drive, or pile of old tinware and vats begins to look offensive and out of place.

In a bright and freshly painted intake, what maker can work in a dirty pair of overalls, or fail to wash up spattered milk?

The overalls can readily be scrubbed every night in a few minutes, rinsed and hung up on the line, thus always having a clean pair ready for the next day. If there is no better way at hand, soak them in hot soapsuds in a pail for a few minutes, spread them out on the floor, and brush thoroughly with the scrub brush.

A pair of gloves or mitts, kept at the boiler room door and put on when shoveling coal will save much time and keep the hands clean. An outer apron, put on when shoveling coal, loading cheese, or doing any work outside of the make room, will help to keep the dirt where it belongs.

(140) **Odors.** Probably the most discouraging thing about some cheese factories in the past has been the foul odor from the decomposition of spilled whey. A cement block below the whey delivery pipe (89) will correct this, and enable the maker to admit a visitor to the factory with out a feeling of shame at the odor.

A shower bath of the simplest kind can be provided by enclosing a small corner, and erecting a shelf about six feet high on which to place a pail of warm water with a spigot or both warm and cold water can be piped to a sprinkler placed over head for daily use by the cheesemaker.

Cheese hoops can be quickly cleaned and freed from "milk stone" by dipping first in hot water, and then rubbing while hot with a brush dipped in a strong lye solution, which will quickly loosen and remove the adhering material from the inside of the cheese hoop. Cheese hoops which are well tinned can also be left to soak in sour whey, over night, and then scrubbed.

Press cloths which become hard and stiff from dried whey, etc., absorbed with repeated use, are made soft and pliable again by soaking in sour whey, or as some prefer, in a pail of water containing a little sulphuric acid, after which they are washed and dried. Press cloths should be washed daily, and kept clean, the same as hoops, followers, or the cheese press, or strainer cloth.

The floor, the outside as well as the inside of the vats, the intake walls, curing shelves, the whey tank, and the windows require regular attention and care, the same as all other parts of the factory and equipment, to keep them clean.

(141) **Paint, etc.** It is often found easier to put a new coat of paint on the ceiling and walls of the make room than to scrub them.

The accumulation of junk in corners should not be permitted. A place for everything, and everything in its place, is a good rule.

The use of disinfectants can never fully take the place of hot water, washing powder, and the scrubbing brush for removing particles of milk, curd, grease and dirt which otherwise may accumulate, adhere, and decay in the corners and on the surface of dairy utensils, pipes, etc.

Many other suggestions on cleanliness will occur to the wideawake cheesemaker or helper, and are given in publications of the Dairy and Food Commissioner relative to licenses for factories and makers.

CHAPTER XIX.

THE FOOD VALUE OF CHEESE.

(142) **"Eat More Cheese."** This should be the housewife's motto, when she understands the facts. The ordinary "store" cheese, or American cheese, is well known for its attractive flavor, and it remains to make equally well known the facts (1) a pound of cheese has practically twice the food value of a pound of meat, and (2) that it is easily and completely digestible, without causing indigestion or constipation, when eaten with other foods, as bread and fruits or vegetables.

(143) **Cheese Costs Less.** Cheese contains about 37% moisture, and no waste, while round steak contains about 8% bone, and other waste, and about 62% moisture, or altogether 70% of non-nutrient material. Cheese therefore contains about 63% of nutriment, and steak only 30%. In addition, the cheese nutrients consist of a little over one half of fat and the rest mainly protein, while the meat nutrients are about ⅓ fat and ⅔ protein. From this, it is seen that a pound of steak contains about 9% fat and 19% protein, while the cheese contains about 34% fat and 26% protein, together with some mineral matter, etc.

(144) **Easily Digested.** In many households, where cheese is eaten freely as a substitute for meat, it is found that no ill effects follow its use. The Swiss nation are great cheese eaters. Few American mechanics or workman of any sort do a harder day's work than a Swiss cheesemaker, whose meals of cheese, bread, and vegetables are abundant, satisfying and wholesome in every respect. Large slices of cheese eaten at every meal furnish the energy required for hard work, and satisfy the appetite fully as well as meat. Experiments made in this country, in which large numbers of students were fed ⅓ pound of cheese with bread and bananas daily for three days, showed no indigestion or harmful effects in any case. One man who ate cheese as the chief source of protein and energy, eating an average of 9.27

ounces daily with bread and fruit for more than two years, did a fair amount of muscular work, and kept in good health.

Cheese is so completely digestible as to leave little waste material in the system. Just as a horse or cow requires some bulky feed as hay along with the concentrated grain feed, so the human animal requires some vegetables, fruits, or other bulky food, in addition to the more highly concentrated and digestible meat or cheese.

(145) **Cheese "Too Good."** The principal complaint made by the housewife about cheese is that it is so good as to be all eaten up too soon, thus appearing to cost more than meat, but when it is considered that the food value of cheese is twice as great per pound as of meat, and that the appetite of a normal person commonly indicates what the system needs, the importance of a daily supply of cheese on the table becomes evident. The flavor, the economy and the digestibility are all in its favor.

(146) **Human Food Standards.** A man who does more or less work in lifting, and who walks about a good deal, such as a salesman, would be likely to get the food which his body needs if supplied daily with such a combination of foods as the following:

1¼ pounds of bread or other similar food made grains.

2 ounces or ¼ cup of butter, oil, meat drippings, etc.

1¼ lbs. of fresh fruits, and green vegetables or roots.

2 ounces of sugar, or ⅓ cup of syrup, honey, etc.

12 ounces of protein-foods, as cheese, meat, fish, eggs, dried beans, or in place of these, about three pints of milk.

A man at hard work would probably require more food than this, and a desk worker somewhat less. The ordinary full cream cheese contains both the required protein and the required fat, as shown above. A pound of cottage cheese supplies all the protein needed by a man in a day, but contains little or no fat.

A quart of milk contains as much protein as 6 ounces of round steak or 4⅓ eggs, and as much energy as 12 ounces of steak or 8½ eggs. With milk at 10 cents a quart it is cheaper than steak at 23 cents a pound, or eggs at 25 cents a dozen. Cheese contains butterfat which carries vitamines.

PART II.

CHEESE VARIETIES, THEIR CLASSIFICATION AND MANUFACTURE.

CHAPTER XX.

METHOD OF CLASSIFYING CHEESE VARIETIES.

(**150**) Anyone visiting a large city market for the first time is surprised at the great number of different kinds, flavors, qualities, shapes, and sizes of cheese which are made from milk.

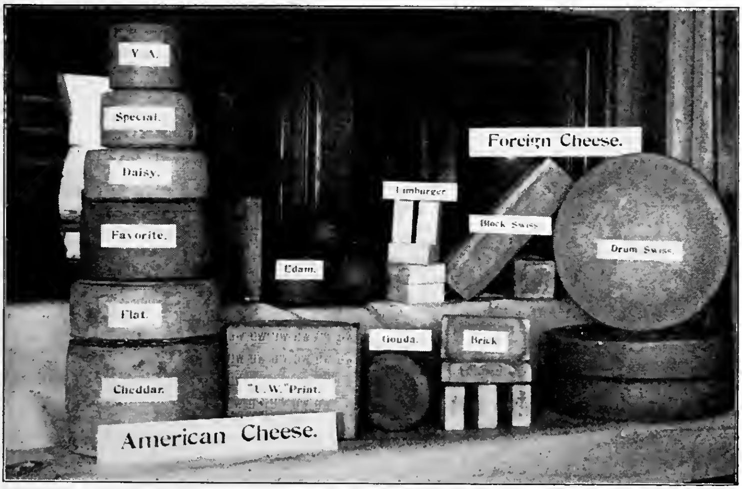

Fig. 20.—Over 30 varieties and styles of cheese are manufactured in Wisconsin.

The student should take every opportunity to learn to recognize different kinds of cheese by name, flavor and appearance, to learn where each kind of cheese originated and where it is now manufactured. A helpful method, with a large class of students at the close of the course of study, is to purchase as large an assortment of cheese varieties, in small samples, as can be obtained with the aid of dealers price lists, and to hold a "cheese party." This will afford each student sufficient time to inspect, compare, and taste the samples in a leisurely manner, to weigh and measure the packages, and write notes upon each variety.

For reading and study, students may obtain from Washington, D. C., a copy of Farmers Bulletin 608, Bureau of Animal Industry, containing names and brief descriptions of nearly 250 varieties from different parts of the world. A useful exercise with this bulletin may consist of dividing these varieties in groups and classes so far as possible, somewhat as follows, and finally counting the number of kinds of cheese in each group. Other sources may also be consulted.

(1) Hard cheese (contain less than 40% moisture when made from whole milk), Swiss, American, Edam, Gouda, etc.
(2) Soft cheese (contain 45 to 85% moisture and are soft to the touch), Limburger, Cottage, Neufchatel, etc.
(3) Rennet cheese (milk curdled with rennet), many kinds.
(4) Sour milk cheese (milk curdled by souring), Cottage, hand cheese, etc.
(5) Fresh, when eaten, Cottage, Neufchatel, Coulommier, etc.
(6) Cured for eating, Swiss, American and many others.
(7) Cured by molds inside, Roquefort, Stilton, Gorgonzola
(8) Cured by surface molds, Camembert, Brie, etc.
(9) Whole milk cheese, Swiss, Cheddar, Wisconsin-made American, and others.
(10) Skim milk cheese, Parmesan, Reggiano, cottage, some Edam, etc.
(11) Cream cheese, a few varieties.
(12) Cow's milk, most kinds.
(13) Sheep milk, Roquefort, and a few others.
(14) Goat, or other animals' milk, a few kinds.

In this way, Limburger, for example, may be classed as cow's whole milk, cured, soft, rennet cheese.

(151) **Similarity of Different Cheese.** Frequently, the same kind of cheese as to method of manufacture, is put

up in a variety of different sized packages, called by different names. Thus American Cheddar cheese is called according to the size and shape of the package, Young America, Daisy, Flat, Long Horn, square, mammoth, Cheddar, midget, etc. Swiss cheese is made either as "block," an oblong shape and weighing about 20 lbs., or as "drum," a round cartwheel shape and weighing 100 to 200 lbs. each.

It frequently occurs that different names are given to cheese made in different localities or by different firms, although made by exactly the same process, and alike in size and in all essential respects.

(152) **Similarity of Different Cheese Making Processes.** To give an idea as to the complexity of the cheese making process, and of the different steps in the general process by which the many varieties of cheese are produced, the following list of operations and conditions has been prepared in tabular form. In making any specific kind of cheese, one part or another of the general process as here outlined may be entirely omitted while other parts receive special attention in order to produce the desired kind of product.

A. (1) Material Used. Milk of the cow, or sometimes the sheep, goat, or rarely of other animals.

(2) Richness. Whole milk, part skim, full skim milk, or rarely enriched milk or cream.

(3) Ripeness. Sweet, fresh and warm from the animal; night's and morning's milk mixed together; ripened to .18%; to .25%; to .30% or above.

(4) Cleanliness. In general milk should be clean and free from putrefactive germs; but with ripened milk great care is not so necessary as with certain cheese varieties made exclusively from fresh, sweet milk, such as Limburger or Swiss. Milk is always strained at the factory when received.

B. Inspection. This should never be omitted in order that the maker may know what he has to work with. Defective milk is thus stopped at the intake.

C. Testing in the Vat. With cheese made from ripened milk, the ripeness or acidity of mixed milk in the vat is usually tested as early as possible.

D. Heating up the Vat. Milk is heated to a suitable temperature which may be 72, 86, 90 or 96 degrees, for different sorts of cheese.

E. Ripening. The warmed milk, either with or without the addition of starter may be held in the vat for a period of 1 or more hours to attain the required degree of acidity or ripeness, recognized by suitable tests.

F. Thickening. In most cases thickening is produced by the addition of rennet extract, or pepsin, or very rarely by certain plant juices, and in a number of cases by souring the milk, as with cottage cheese.

G. Cutting tbe Curd. This is done with a variety of tools, such as knives, wire strung harps or in the case of skim milk by stirring with a rake.

H. Stirring the Curd. To prevent the cut or broken particles of curd from uniting to form lumps or large masses, stirring may be done by hand, by mechanical agitators or various tools.

I. Firming the Curd. The separation of the thickened milk into curd and whey begins rapidly (after cutting), making the curd firmer as it proceeds.

J. Heating the Curd. To hasten the separation of whey from curd, the vat may be heated, if necessary, to a higher temperature, as 96, 100, 110, 120 or 130 degrees or thereabouts, or heating may be omitted here. A slight pressure on the curd may also aid in whey separation.

K. Draining the Whey Off. The curd is freed from the separated whey, either by dipping up the curd in a cloth bag, through which the whey drains, or by drawing or siphoning the whey out of the vat, leaving the curd behind. The firmness or acidity of curd, or acidity of whey may be tested here.

L. Matting and Milling Curd. If the drained curd is allowed to lie quiet in the vat, to mat or unite into a single large mass, it is afterward cut up or milled into small pieces again. Both matting and milling may be omitted and the granular process used.

M. Salting Curd. The addition of salt, and sometimes other flavors, by stirring them well with the curd particles after either (K) or (L) is sometimes included and with some cheese varieties is omitted at this point.

N. Forming Cheese. Curd may be placed in hoops of the proper shape and size after (K), or (M) or directly after (G) or (F).

O. Ripening Mould germs are sprinkled on the surface or inside of curd in the hoops, in the case of a few cheese varieties, to aid in the curing process.

R. Pressing Cheese. Pressing expels a little remaining whey and compacts the curd particles into a solid mass, usually of the required shape for market.

S. Salting Cheese. Some cheese are salted at this point by placing in strong salt brine, or by rubbing dry salt on the surface.

T. Curing. Placed in curing rooms of proper humidity and temperature, cheese undergo changes in flavor and texture necessary for marketing.

U. Care. While in the curing room, cheese require more or less attention and care as washing, cleaning, turning, together with salting and paraffining when required, and finally packing for sale. Some kinds of cheese require wrapping, grating, drying, staining, varnishing, etc.

(153) **Different Ways of Making a Product.** In reading and studying the following descriptions of cheesemaking processes it is to be recognized that the methods of manufacture are often modified to suit local conditions, or according to the customs of cheesemakers in different localities, or in making smaller or larger quantities, without changing the essential characteristics or market quality of the product. Unforeseen emergencies arising in commercial factories often make it desirable for the maker to understand several methods or devices which may be used to attain the same result.

For example, cottage cheese made in small quantities on the farm by souring or with rennet may be drained in a cloth bag, but when made in a creamery in large quantities draining on a flat cloth covered rack is much less laborious, while draining the curd on the bottom of the vat saves both labor and floor space. Casein is made in large quantities from skim milk either by curdling with sulphuric acid, or more cheaply by souring until thick and the maker should understand the different methods. Many similar examples might be mentioned.

(154) **Small Scale Experiments for Classroom Practice.** In order that all students in a class may have the advantage of doing the work, each with his own hands, it will be found helpful and satisfactory in many cases to have each student carry on the entire process with 10 or 20 pounds of whole milk, skim milk, etc., carefully weighed in a pail. With such small quantities, heat can be applied by placing the pail for a few minutes in a tank of warm water and the final products thus obtained should be exactly weighed to determine the yield and examined and compared to determine the quality, and especially to notice the effect of intentional or accidental variations of the method.

For example, with a class in cottage cheese making, different students may follow the same methods in all respects, except that each may heat the material to a different final temperature, as 90, 105 or 120 degrees and the effect upon the product will be seen by all present. Many such experiments can be devised, in which all members of a class take part with benefit to all.

From the records as to materials used and yields obtained, students should usually make calculations as to the costs of manufacture and the profits to be obtained by each method. It is usually advisable to allow or require students to repeat the manufacture of a given product, on different days if necessary, to ensure that a reasonable degree of familiarity and certainty is attained in handling the process and to fix the details firmly in the mind.

The student's notebook should be written up at the time of doing the work, giving complete details, so that by reading the record after several months have passed the student may have no difficulty in making the same product with success.

The making of casein is especially well suited to serve as an introduction to the making of cheese, since it affords experience in the handling of skim milk in the simplest possible way and there is no danger of spoiling the product so that it can not be sold, which might easily happen to the beginner undertaking to study first a more complicated process.

CHAPTER XXI.

THE MAKING OF CASEIN.

(155) **Cooked Curd by Sulphuric Acid.** Run skim milk from the separator into a wooden or tin lined vat (or weigh 10 pounds into a pail). Run steam into the milk to heat it to 130 degrees, or set the pail in hot water, stirring with a thermometer.

For each 1,000 pounds of milk, measure 1 pint of sulphuric acid from the carboy and dilute the acid by pouring it slowly, stirring, into 3 or 4 pounds of cold water in a wooden pail. (Or dilute 5 cc. of the strong acid by pouring into 50 cc. of water in a beaker, and after pouring this into a 100 cc. cylinder, fill with water to make 100 cc. of solution. Mix well.) Hydrochloric acid may be used instead of sulphuric.

With the milk at 130 degrees, stirring vigorously with a wooden rake (in the vat), add the acid slowly, using no more than is necessary to produce clear whey, of a yellowish green color and not milky in appearance. (Note the volume of dilute acid used for 10 pounds milk; figure the volume and the weight of strong acid, specific gravity 1.82, required and its value at 2 cents a pound, for 100 pounds milk.)

Drain the whey from the curd, catching any particles which might escape in a cloth covered strainer. Rinse the curd in the vat with several pails of cold water. (In the pail rinse the curd with water at 130 degrees.) Grinding curd under water is effective in thoroughly freeing it from acid.

Cover the curd with water (hot water in the pail) and run steam into the water to heat the curd to 170 degrees. Stir the curd over in the hot water, raising the temperature to 180 or 190 if necessary, until it melts together into a mass, like dough. Drain off the water. Turn the curd over and work it back and forth on the vat bottom with an iron shovel or rake, until well drained and thoroughly matted together into one mass.

Transfer the soft, hot curd to weighed barrels and leave to cool. (Leave some of the curd from the pail in a ball and roll some of it out into a thin sheet while hot, and leave it to cool and harden until the next exercise.)

Weigh the product, which is called "cooked curd" and calculate the yield per 100 pounds of skim milk. It is shipped to the near-by buyer in this form.

(156) **Making "Dry Casein" from "Cooked Curd."** The wet "cooked curd" shipped in barrels from the creamery reaches the buyer in a solid lump, the surface of which is dry and tough, and free from openings, so that no mould can grow into the mass during shipment. If the casein is to be shipped a long distance, or stored for any length of time, it is dried by the buyer or maker, forming "dry casein" which weighs less and keeps indefinitely without becoming putrid or mouldy.

For this purpose the wet casein as received is taken from the barrels and run through a power mill, or "green curd shredder" which cuts it up fine. The ground curd is spread in thin layers on trays 30 or 36 inches square. These trays consist of a frame made of wooden strips 1 inch square, to which is tacked a square of ¼ inch or finer wire netting of galvanized iron. The curd is spread about ¼ to ½ inch thick on the trays, which are then piled 4 or 5 feet high, on

Fig. 21.—Drying trays on a wheeled truck permit the rapid drying of casein in large quantities, in a current of warm air.

a square truck having four castors at the corners. The truck loads of curd are wheeled into the cool end of a long drying kiln or closet, built of matched lumber about 4 feet high and 5 feet wide inside to hold two rows of trucks and 10 or 20 feet long. A slow moving fan draws a stream of hot air through a steam radiator and forces it across the casein on the trucks. After partial drying the trucks are pushed forward toward the warmer end of the closet and after 6 to 12 hours when the casein is bone dry they are taken out and emptied.

The student can dry the wet casein made from 10-pound lots of milk (155) or (158), on 18-inch square tin or wire netting shelves in a small oven with open bottom, set over a steam coil, after grinding the casein in a food chopper. Any creamery wishing to make either wet or dry casein for sale can usually obtain from the buyer full directions for making and drying the product and for the drying equipment.

(157) **Making "Pressed Casein" for Drying Before Shipment.** Where it is intended to dry the wet casein at

Fig. 22.—A vertical press is used to remove the loose moisture from casein before drying in the kiln.

the creamery before shipment it is made somewhat differently in the vat. For this purpose, the final heating to 170 degrees is omitted, so that the curd remains in a somewhat loose, granular mass, sticking together only slightly to avoid loss of small particles. After washing at about 130 degrees the curd is drained well and packed in press cloths or bags, such as grain sacks.

The bags of curd are tied shut and packed in layers in a vertical press, with 30-inch square wooden slat frames between the layers. The screw press is then tightened gradually to keep the whey running, until the dripping stops. The curd is then emptied out of the bags, and is easily ground up and afterward spread on the drying frames and dried in the closet as described in (156). The student can follow this process with 10 or 20 lbs. of skim milk in a pail.

(158) **Making Casein from Sour Skim Milk.** While skim milk can be made into casein with sulphuric acid as soon as it comes from the separator, yet the press of work in the creamery often makes it necessary to leave the skim milk in the vat until late in the afternoon or next morning early, before making the casein.

During this period it is apt to become sour and thick or may be intentionally soured by stirring in some starter as soon as in the vat and leaving it to stand covered at about 100 degrees. For souring by next morning, about 2 per cent of starter is usually plenty, but to sour and thicken the same afternoon 10 per cent or more of starter may be needed. Starter should be smooth and creamy when added and should be poured through a metal strainer to break up all lumps, so as to distribute the bacteria throughout the milk.

After the milk is thick it is stirred with a wooden rake and while stirring is heated to 130 degrees, after which it is washed and finished for shipment, either at 130 degrees for immediate drying as in (157) or at 170 degrees for shipment as wet casein, as in (155). Students can practice this method with 10-pound portions of skim milk set in pails to sour.

(159A) **Making Sizeing Out of Dry Casein.** Grind some dry casein so as to pass through a sieve having

30 meshes to the inch. Weigh out 18 grams into a wide mouthed jar, add 3 grams of powdered borax and add 65 cc. of hot water. Set the jar in hot water and stir frequently, until the casein dissolves to form a thick glue.

This, mixed with resin soap and some minerals, is used for glazing paper. Spread some of it evenly in a thin layer on the surface of some unglazed paper and leave to dry.

Casein ground to 60 mesh size, and mixed with a little slaked lime and water forms a glue.

Casein dissolves readily in any alkali and has many commercial uses. Rennet made casein finds little demand in this country.

(159B) **Milk Sugar from Whey.** In a few localities where 20,0C0 pounds or more of whey are available daily, the manufacture of milk sugar has been undertaken. Vacuum pans and other special machinery, as filter presses, are used. The uses and demand for milk sugar are limited to medicines, special foods, etc. Its food value is equal to that of cane sugar, but its sweetness is much less.

(160) **Buttermilk for Casein Making.** Casein made from buttermilk is inferior in glue-making qualities, so that if more than 10% of buttermilk is mixed with skim milk, the resulting casein is likely to sell at a reduced price. The yield of dry casein from 100 lbs. of buttermilk is about 2¼ lbs. as compared with 3 to 3½ lbs. or more obtained from 100 pounds of skim milk. Buttermilk, if used, must not be coagulated previous to mixing with the skim milk. Some buyers refuse buttermilk casein at any price. To make casein from raw cream buttermilk, or from sweet-pasteurized cream buttermilk, where the cream was soured after pasteurizing, the buttermilk is heated in a vat by running steam into the vat jacket, stirring the buttermilk a very little at intervals until the temperature reaches 130–140 degrees. Then let the material stand quiet without stirring for about an hour, during which time the curd separates, and rises to the top of the whey in a compact layer, or may settle to the bottom. In either case, after an hour, the whey can be drawn off quite completely leaving the curd in the vat, by carefully opening the gate part way at first, so as not to disturb the curd by the whey currents. The curd rack and cloth below the gate

catch any curd which escapes, and the whey, flowing out, passes through the cloth into the drain. Finally, the curd in the vat runs or is scooped out upon the cloth, and left to drain for about 24 hours. It is not possible to get buttermilk curd to unite into a plastic doughy mass, as does skim milk curd at 170 degrees, but the granular buttermilk curd after draining fully is packed into barrels for shipment, or may be dried at once, in the drying closet.

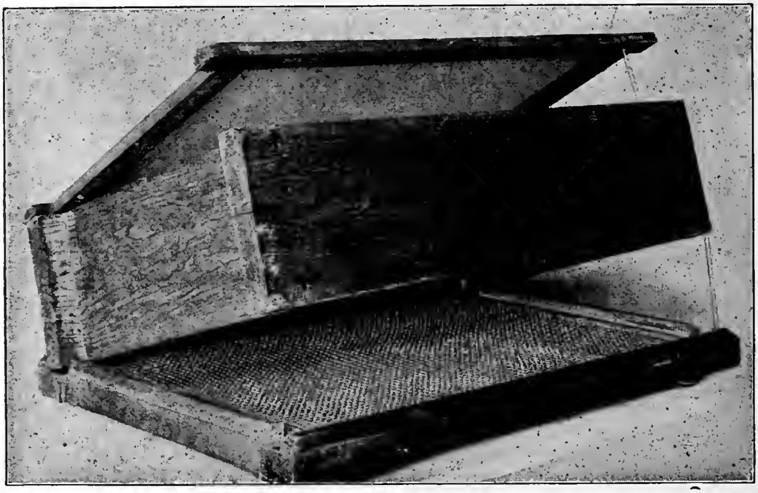

Fig. 23.—The flat draining rack with bottom of wire netting can be made large or small, as required, but is always about one foot deep, and is covered with cheese cloth for draining cottage cheese and similar materials.

(161) **Making Casein From Sour Pasteurized Cream Buttermilk.** With this kind of buttermilk it is almost impossible to get a curd which can be collected on a cloth, or drained in a reasonable time, as the curd obtained by heating is very fine grained, like chalk dust. If a mixture of 1 part skim milk and 4 parts or less of this buttermilk is heated to 130 degrees, the skim milk curd collects and encloses the buttermilk curd, and the mass can be caught and drained on a cloth without loss. A mixture containing a larger proportion of skim milk gives a curd which resembles yet more closely a skim milk curd in the ease of collecting and draining on cloth.

CHAPTER XXII.

COTTAGE CHEESE.

(162) **Cottage Cheese From Sour Skim Milk.** The ordinary farm method of making cottage cheese is too well known to need description here. For use in a busy creamery, the method must be modified so as to permit the cheese to be made with the least labor and time, at a time of day convenient for the operator, and so as to get the vat empty in time to receive the next day's milk.

In the factory, skim milk is run from the separator into a vat or any receptacle which can be heated. A regular cheese vat is preferable, and a tall, cylindrical strainer to fit inside the vat next to the outlet should be purchased with the vat.

Although not so convenient, it is possible to use a vat without a jacket, heating the curdled milk by adding hot water, while stirring with a wooden rake. The older method of souring skim milk in milk cans, heating each can by placing it in a tub of hot water, is yet more inconvenient where a large quantity is handled.

For students' exercises, 10 pound portions of skim milk may be weighed into tin pails, and left to sour.

Starter is added as described in (158), and (168).

(163) **Finishing the Cheese**. When the milk is thick and the maker is ready, the curd may be cut into cubes with ordinary cheesemakers' curd knives. Many makers prefer instead to use a wooden rake, which is moved slowly back and forth through the curd to break it into rather coarse flakes, but not beat it to a smooth pulp or into fine grains. (Students may stir curd in a pail with a thermometer, as the hand or a dipper will break it up too fine.)

While stirring (after cutting with knives, if used) the steam is turned into the jacket, and the material heated to about 105 degrees, or if preferred (168) using higher temperatures. When at this temperature the curd is stirred occasionally until judged to be firm enough for the next step. During the heating, and stirring, the whey comes out of the curd, which shrinks and becomes firmer.

(164) **Tests for a Well Firmed Curd.** The end of this part of the process is reached when the curd, if not gassy so as to float, will settle down two-thirds of the way toward the bottom, under the surface of the whey.

A better way to judge the firmness is to take up a handful of curd without squeezing it, and notice whether the small pieces stick together in a jelly like mass, in which case it is too soft. When firm enough, the curd in the hand remains open and porous, allowing the whey to run out freely, so as to drain fully in a short time. The softer and more mushy a curd is when the whey is drawn, the more the curd will collect around the strainer and stop it up, and the more time and labor is required to drain and finish it. A little experience will demonstrate this.

A firm curd will stick to the hand held vertically, but soft curd will fall off at once. Use about half a teaspoonful of curd for this test.

(165) **Draining the Whey From the Curd.** The older method of dipping curds into bags to drain is too slow for factory use. If there is plenty of floor space, a flat draining rack may be used, as illustrated in (160), and the curd is drained and salted in the rack and then packed in tubs.

A better way, described in a Wisconsin bulletin, is to drain the curd and salt it in the vat in which it is made, thus saving floor space which a draining rack would require, and also shortening the time and labor required. This method is described below.

With a rake, the curd is gently pushed away from the gate end of the vat. The tall, cylindrical strainer is then put into the vat, with the outlet fitting into gate. An ordinary metal strainer below the gate will catch any curd that escapes. Next allow the vat to stand quiet for a few minutes, to settle the curd fully. In this way, a deep layer of clear whey is obtained, which will run rapidly through the strainer when the gate is opened. If the curd is stirred or disturbed by too rapid whey currents, it will clog the strainer, and delay the work. The last whey will run more rapidly, if a gutter is made in the curd with the rake, down the middle of the vat, as in (167).

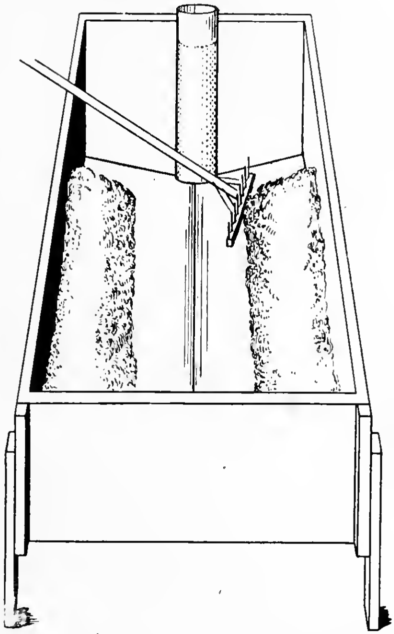

Fig. 24.—Draining in the vat. A curd heated to about 130 degrees after cutting, cooled thoroughly with cold water, and drained in the vat, can be salted in one-half hour to one hour after cutting the curd.

(166) Cooling the Curd is Advantageous. As soon as the whey has run out as completely as is convenient, so that the curd is wholly or partly uncovered, the gate is closed, and cold well water is run into the vat quickly, in sufficient quantity to cover the curd and to reduce the temperature of the mixture to 70 degrees, or lower. It is best to have the water ready in cans, before it is needed. The water should be added very promptly, even while there is yet some whey in the vat if the last whey runs out slowly. Stir up the curd in the water to break up any lumps, and cool all parts of it. Washing a curd once with cold water in this way does not injure its flavor. Cooling the curd thus has two advantages, (1) the curd is not in danger of becoming tough and rubbery or sandy as may easily happen if drained while warm, and (2) the cooled curd remains open and porous and drains more rapidly, so as to be finished more quickly.

Cottage cheese, when well made and cooled, should not give up loose whey, after packing, but should be dry enough to permit addition of cream, etc., by the consumer, if desired, at the table.

(167) **Draining, Salting, and Packing the Cheese.** The curd is allowed to settle again, and the water is drawn off through the strainer, When most of the water is out, a ditch is made down the middle of the vat with the wooden rake, as shown in the figure. Push the curd a little towards each side of vat and away from the strainer. This will allow the remaining water to drain away more rapidly. The curd is left on the bottom of the vat for a short time to finish draining until dry enough to suit the trade. The use of cold water in this way makes the final draining of the curd more rapid than if no water was used. The cooling also avoids danger of getting the curd tough and rubbery, which is likely to occur when the curd is drained and left at a high temperature. Probably the early cooling and the washing out of the whey also improve the keeping quality of the cheese.

When satisfactorily drained and not before, the curd is salted, adding 1¼ to 1½ lbs. of salt to 100 lbs. of curd, and stirring it in evenly. All of this salt should remain in the cheese, which is now ready to pack. About 16 lbs. of cheese are obtained from 100 lbs. of skim milk.

From 2½ to 5% of finely ground canned pimento may be stirred into the cheese after salting, but this is done only on special orders.

The cheese can be packed in 60-lb. tubs, or in tin cans for shipment, and in moisture proof single service containers for the retail trade, or more cheaply in thin wooden plates or common paper ice cream or oyster pails, if the retailer has time to weigh it out at the counter.

The product should be kept cold, until it reaches the consumer. During long shipment in warm weather, it may spoil in flavor. Some buyers keep it for several months, frozen solid in cold storage, and mix in a little fresh cheese to imrpove the flavor when sold.

(168) **The Effect of Varying Temperatures.** The temperature and amount of starter used in souring milk may be varied by the maker to suit the case. It is desirable to have the milk sour and thick only a short time before it is used for cheesemaking, as with very old, sour material, a disagreeable, rank flavor in the curd is likely to result. With very high acidity, the curd breaks into a slow draining, fine grained mass during the cutting or stirring, and tends to produce a cheese of tough, sandy consistency.

Curd ripened at 72 degrees, like starter, has a more creamy consistency, and tends to break up fine during the stirring.

The effect of heating the vat finally to a higher temperature than 105 degrees (163) is to hasten the firming process, and quicker work in cooling with water then becomes necessary to avoid a tough, sandy product.

(169) **Pasteurization of Skim Milk For Cottage Cheese.** Skim milk for cheesemaking should be pasteurized at 145 degrees for 30 minutes, because it is more sanitary. Where whole milk is pasteurized before separating, both the butter and the cheese are benefited. Most cottage cheese is made from raw skim milk, as many creameries have no means for pasteurizing. The method of manufacture with milk so pasteurized is the same as with raw milk, although more starter may be required for ripening the milk.

(170) **Making Very Soft Cottage Cheese—Bakers' Cheese.** Cottage cheese sold to bakers should be much softer than when made for table use. For this purpose, the milk is left to sour at such a temperature that it will cool down to about 75 degrees, After cutting, and stirring at this temperature, the curd may be dipped from the vat to a flat, cloth covered, draining rack, and left to drain half a day or over night. While yet quite soft, like quaking mortar, it is packed in cans without salt, and shipped to the buyer. The yield is about 20 lbs. cheese per 100 lbs. skim milk.

See also (184).

(171) **Pasteurization of Cottage Cheese During Manufacture.** It is possible to modify the method, keeping the curd in large flakes by stirring very little, and heating slowly up to 145 degrees for 20 minutes, and finally drawing

the whey and cooling the curd with cold water before salting, and in this way to give the cheese a practical pasteurization during the making. This may consume more time, but there is no chance of contaminating the product through use of a poor starter added to the skim milk, which has been previously pasteurized. If the curd is stirred too much, it will break up into small pieces, and become tough or sandy.

(172) **Cottage Cheese from Buttermilk—Buttermilk Cheese.** Buttermilk from old, gathered cream is likely to yield curd having a disagreeable, old flavor, in comparison with cheese made from freshly soured skim milk. On this account, probably, cheese from skim milk is preferred in some markets, since it is more likely to be uniformly good in flavor.

If a skim milk curd is heated too long, or to too high a temperature in the whey, the cheese is sure to become tough, rubbery, or sandy, and unattractive for table use. But curd from buttermilk is different, in that it may be heated to 140, or 160, or even higher for an hour or more, without the slightest danger of obtaining a tough or sandy curd.

By no known method is it possible to start with skim milk, and get from it a curd which can be heated to 140–160 degrees for an hour without becoming sandy, while all curds made from buttermilk can be so heated and yet yield a typical "buttermilk curd," which is very smooth and fine grained, and can be instantly rubbed out to a smooth paste with a little water in the hand. Starting with buttermilk it is impossible to make by any known means a curd which is tough or sandy, or which will not quickly absorb water applied to it.

The difference between skim milk and buttermilk originates in the centrifugal cream separator where apparently the cream proteins and the skim milk proteins are separated from each other. Further investigation must explain this difference more fully.

The differences mentioned between skim milk and buttermilk curds make it necessary to use different methods for making cheese from these two materials, but it has been found that buttermilk cheese can be sold and eaten with equal relish in place of cottage cheese. In several large towns and cities, buttermilk cheese has found ready sale, but in the largest cities, the demand for buttermilk for drinking purposes makes it impossible to supply buttermilk cheese except from outside creameries by shipment.

The method of making cheese from raw cream buttermilk is as described in (160), but after the curd has drained on the rack for about half a day it is dry enough for table use and should be salted with 1¼–1½% of salt, well stirred in and packed for sale. Water stirred in to moisten the salted curd, if too dry, is quickly absorbed.

When sour cream is pasteurized the temperature and the high acidity cause the casein in the cream to curdle in very fine grains. These grains pass through the churn with the buttermilk, but when such buttermilk is heated to make cheese the curd separates as a slimy mass like chalk and water, but can not be drained rapidly, or made into a satisfactory product for table use. The curd from such buttermilk can be recovered in good condition, if to the cold buttermilk there is added (1) a lye solution evenly stirred in until the mixture is alkaline to phenolphthalein, and (2) hydrochloric acid evenly stirred in to neutralize the lye, in such quantity as required until a test portion of the well stirred mixture, on heating to 140 degrees, wheys off clear and gives a curd in all respects like a raw cream buttermilk curd. The lye dissolves the fine grains of curd formed in the pasteurizer and the acid precipitates the curd again at a moderately low temperature, as occurs in handling raw buttermilk. Sweet pasteurized cream buttermilk must be ripened with starter until it will curdle at 130 degrees, like raw cream buttermilk.

Wisconsin bulletin 239 describes buttermilk cheese.

(173) **Other Products Made from Cottage Cheese.** A surplus of cottage cheese, if not salted, can always be dried further and sold as casein. From skim milk cottage cheese are made a number of other kinds of cheese, as hand cheese, sap sago (krauterkase or schabziger), gammelost, cooked cheese (kochkase), appetitost, and many others containing a variety of herbs, spices, and other flavoring materials, some of which are occasionally seen in this country, and a few of which are described below.

CHAPTER XXIII.

CURED CHEESE MADE FROM SOUR MILK CURD.

Cottage cheese is made as described above and used for immediate consumption while fresh, but the use of sour milk curd for making cured cheese has been widespread in Europe and is practiced to a slight extent in America.

The best known, cured, sour milk cheese in this country are hand cheese, sap sago (krauterkase or schabziger), cooked cheese (kochkase), gammelost, etc.

(174) **Hand Cheese Manufacture.** This cheese, so-called because originally moulded into balls or cakes by hand, is made in Europe in a variety of shapes and small sizes and flavored with a great variety of herbs, as caraway, thyme, majoram, hops, pimento, mace, cayenne and often with beer, wine, etc. In different localities, different names, often geographical, are applied to what is practically the same product in all essential qualities, differing only in the kind of flavoring and in the proportion of salt used, which is from 3 to 5% of the weight of the curd. Descriptions are given by Stohmann, p. 950; in Milchzeitung, 1891, pp. 142, 189, 273; 1887, p. 981; 1889, 175; 1894, p. 367; Polytechnic Journal, vol. 263, p. 569; Fleischmann, Lehrbuch der Milchwirtschaft, p. 441, 5th ed.

Skim milk from the separator is mixed in a tin vat with some buttermilk and left at about 90 degrees to stand quiet over night, during which time it becomes thick and cools somewhat. Stir gently next morning so that the floating curd shall not settle and be overheated on the bottom, during 1–1½ hours while heating up to 113–122° F. Allow it to stand 2 hours in the kettle undisturbed and then draw off the whey with a siphon and strainer. Transfer the curd to a draining rack until completely cooled so that it is no longer sticky. The curd is now ready to mill. All dried, tough grains formed on the sides of the vat must be kept out. Curd is ground twice, if necessary, to make it very fine grained.

The two smooth rolls of the mill move at unequal rates. They are of wood, iron or granite and are adjustable as to distance for the first and second milling of curd. A hopper delivers the curd just between the rolls and a conveyor below takes the curd to the press.

During the milling the necessary salt, etc., is mixed in, using in summer 4½–5 pounds, and in winter 4 pounds of salt, and $^1/_5$ to ½ pound of caraway seed, etc., to 100 pounds curd. The curd is then put in a screw press for 24 hours to remove whey, but should yet be moist enough to remain coherent when squeezed in the hand, and not fall apart The press is lined with a coarse cloth and has holes in the sides for escape of whey.

The pressed curd is formed by hand or machine into cakes. The simple, two-part hinged mold is filled with a ball of curd, pressed together, and the cake of curd remaining in it is set on a board to dry. Or, a round zinc mold of the same diameter and height as the cheese, is filled with curd, set on a board and the ring lifted off, leaving the cheese on the board to dry. This gives the round flat handkase. For the long round kummelkase, the curd is rolled on a board under the hand, and laid in round grooves in a board and turned frequently. The rectangular Berlin kühkase is packed into a large form of the right depth and afterward cut into strips of the required length and width, when it has dried somewhat.

After forming, the cheese is dried. In warm seasons this is done in the open air or in two warmed rooms in winter. In the open air use simple, open sheds, roofed with roofing paper, built across the wind. The width is not greater than the length of the boards on which the cheese rest. The height may be 6 to 8 feet and the length 30 feet if necessary. The shed consists, besides the roof, only of posts with horizontal strips placed 4 to 5 inches apart, down to 2 feet above the ground to carry the cheese boards. The strips also have grooves into which sliding boards can be put when necessary as protection against the weather and during the night.

During the cold weather two rooms are needed which are provided with ventilating flues and well heated. The ventilation must be excellent to remove moisture rapidly to keep cheese from remaining sticky and becoming moldy. In the drying room similar shelving is placed as in the sheds, but not against the walls, to secure free movement of air.

The formed cheese remain 6–12 hours in the forming room at 55–60° F., in winter to begin drying, then 6–12 hours in a room at 86–90° F., and then at 108–110° F., with one or two turnings, until on breaking they appear brittle, but not so dry as to be hard, glassy or nearly transparent, the time depending on the dryness of the material used and the size of the cheese.

The dried cheese are then taken to the curing rooms kept at 55–60° F. As soon as they begin to show a moist surface with a brownish color they should be washed to maintain a golden yellow color and secure the best quality. Place in water for 10–15 minutes and stir well with the hand or put the cheese through a brushing machine, then return them to the curing room or to a moderately warmed drying room. Small cheese may be packed in cases of 10 or 20 pounds to ripen, after ripening to a depth of a few millimeters, but larger cheese should be kept on the shelf longer.

In the curing room, either wet or dry molds may grow. Wet mold grows on the slime and is easily removed by rubbing when packing, but dry mold attacks the surface deeply, causing loss of weight in cleaning. If washing does not prevent this, fumigate the room several days by burning several pounds of sulphur, then whitewash the walls and scrub the woodwork and cheese boards with hot water. In packing, handle cheese carefully to avoid breaking.

One hundred pounds of skim milk and buttermilk give about 11 pounds of pressed fresh curd and 5 to 8.5 pounds of fully ripened cheese. The small hand cheese lose 30% in weight in ripening and 35–50% when fully ripened.

(175A) **Sap Sago Cheese from Sour Skim Milk Curd.** This cheese, called in Europe schabziger or green krauterkase, has been made for 4 centuries in canton Glarus in Switzerland and is imported to America in cone shaped pieces about 4 inches high, 3 inches in diameter at the bottom and 2 inches at the top. The color is gray-green, the texture is compact and hard and the odor aromatic. Small quantities have been made here with good success. When eaten, it is grated and spread on buttered bread.

The skim milk should not be sour enough to curdle on boiling, as such curd will be too dry and hard for this cheese. The skim milk is heated to boiling in a copper bottomed kettle or pail to avoid burning. Cold buttermilk is added to raise the acidity to about .20%, but in small quantities at a time to avoid curdling and the kettle is heated again. A portion of very sour whey is spread with a wide scoop over the surface of the milk, the kettle is drawn from the fire and left quiet. Soon the surface layer thickens and this curd is taken off with the scoop. The remaining liquid is stirred and enough sour whey added to thicken it all and separate clear whey. Too much sour whey used here makes the curd hard and crumbly and gives the cheese a sour taste, which is its greatest fault. Too little sour whey leaves the whey milky and the curd is soft and sticky and retains too much whey which cannot be easily pressed out.

The whey is drawn and the curd is laid in wooden troughs in a thin layer to drain and cool. The cool curd is placed in wooden forms having draining holes in bottom and sides, covered with a board and pressed moderately by adding weights. It is left thus for 3 to 6 weeks protected from flies to ferment, best at 60–65 degrees F. If kept too cold, or pressed too hard, it remains too tough, becomes bluish in color and defective in flavor. If kept too warm or pressed too lightly, it ferments too strongly and liquefies. Well made curd will keep longer than 6 weeks if necessary. This "fermented white curd" is sold in 150-lb. sacks to the cheesemakers. Eleven to twelve pounds of curd are obtained from 100 lbs. of whole milk, besides the butter churned.

The maker runs the curd several times through the curd mill to a smooth paste, with 4–5 lbs. salt and 2.5 lbs. dried clover leaves for each 100 lbs. curd, until the mass is fully uniform. A wooden mold is lined with cloth and the curd is packed in tightly and the maker's stamp imprinted on the bottom. The cheese is then tipped out of the mold and dried in a room protected from extremes of temperature which cause cracking and from direct sunlight which bleaches the color, but with good ventilation for 2 to 6 months before it is packed for shipment. The cheese is grated fine and spread on rye bread and butter.

Six or seven pounds of ripened cheese are obtained, besides butter, from 100 lbs. of milk. One hundred pounds of fermented curd yields 66 lbs. of dry cheese. The clover *Melilotus* (*Trigonella*) *coerulea*, is grown for the purpose and dried, before it blossoms or goes to seed, in a cool shady, place for 2 or 3 weeks, after which it is brought for short periods of time into the direct sunlight on a cloth or may be dried a short time in a steam oven. When dried enough, it is rubbed fine, sifted free from stems and is ready for use as a very fine green powder.

(175B) **Cooked Cheese from Sour Milk Curd.** Cottage cheese curd, freed from whey, is rubbed fine, flavored with salt, caraway and a little bicarbonate of soda and placed in a jar and left in a warm place for 3–5 days at 60° F. It is then heated carefully in a greased pan over the fire, adding milk if necessary, until melted to a syrupy mass. It is poured into small containers to cool until it solidifies, and is then ready to be sold and eaten at once, as it does not keep long before becoming moldy.

(175C) **Gammelost.** This Norwegian cheese is made from pressed sour skim milk curd, dipped for ¾ to 1 hour in boiling hot whey, then pressed in a form, taken from the form, left in a warm place and turned daily. After a few weeks it is packed in moist straw, in jars. After 2 or 3 months it is ready to eat. It is imported in tin cans, and has a golden brown color, and a strong flavor.

(175D) **Pultost.** Another Norwegian cheese called pultost or knaost, is made from pressed and finely ground cottage cheese, which is then left at a warm temperature to ferment. After mixing with caraway and salt, the mass is rubbed fine again, and packed in wooden containers, and either eaten fresh, or after one or two months.

(176) **The Curdling Temperature of Milk.** While fresh milk can be heated to boiling without curdling, milk ripened to .3% acidity or more will curdle at temperatures

below boiling, and at .5% acidity or more will curdle at room temperatures.

Not only the proportion of acid in milk, but also the proportion of almost any other substance added to milk affects more or less the temperature at which it will curdle.

The temperature at which milk curdles can be observed without difficulty by placing a thermometer and 1 or 2 cc. of the milk (enough to cover a thermometer bulb) in a test tube, inserting and holding the tube in a 200 cc. beaker half full of water, which is slowly heated over a bunsen burner. By moving the test tube most of the time, the water is well stirred, and the instant that visible coagulation occurs in the milk, the temperature can be read on the thermometer. Duplicate tests on the same milk usually agree within two degrees, Fahrenheit.

(a) With a pail full of sweet skim milk, at about 40 or 50 degrees, Fahrenheit, 1 pint portions can be quickly brought to different higher acidities by shaking the milk while running in from a burette, 1, 2, or 3 cc. of N/1 strength hydrochloric acid. If the milk is cold and well shaken, curdling should not occur during the addition of the acid.

(b) Each lot of acidulated milk may then be tested with the acidimeter for its acidity, and finally tested as described above to determine the temperature at which it will curdle.

(c) Different pint portions of skim milk can be brought to different degrees of ripeness by holding them for a few hours at warm temperatures, from 85 to 105 degrees, and the milk at different acidities may be tested for its coagulation temperature.

(d) If instead of hydrochloric acid in (a) there be used a N/1 solution of lactic, or acetic, or phosphoric acid, quite a different set of coagulation temperatures will be observed.

(e) Other substances beside acids strongly affect the coagulation temperature. Starting with a lot of milk which because of ripening, or the addition of an acid, will curdle at about 150 to 170 degrees, and adding 1, 3, or 5% of calcium chloride, of common salt, or almost any other soluble salt, it is found that the curdling temperature is raised or lowered many degrees. See Wis. Expt. Sta., Ann. Rept. for 1907, page 176ff.

(177) Rennet Action Lowers the Coagulation Temperature. The experiments in (176) show that in any sample of sour milk, the casein will curdle, that is, let go of the other constituents, at a definite temperature, which was there called the coagulation temperature.

When rennet extract is added to milk, a change begins at once in the casein itself, changing it into another substance "paracasein." Paracasein in milk has a lower coagulation temperature than casein, so that as the rennet action progresses, in a given sample of milk, the temperature at which the milk will curdle is lowered. When the coagulation temperature of the milk finally becomes as low as the temperature of the room, the entire mass of milk curdles.

(a) The progressive lowering of the coagulation temperature of milk, as rennet action proceeds, can be shown as follows: To a gallon of milk in a pail, at about 80 degrees, add enough rennet extract to cause the first visible thickening in about 20 or 25 minutes. Note exactly the time when rennet was added, and keep the milk at a uniform temperature. After about 4½ minutes measure out a pint of this milk into a quart bottle, and add to the milk from a pipette 10 cc. of N/1 caustic soda, mixing it in quickly and thoroughly. The alkali used should be sufficient in quantity to make the milk alkaline to phenolphthalein, and thus instantly destroy the rennet present, and stop its action on the milk.

At five minute intervals, take out other equal portions of the milk from the pail, and treat exactly in the same way with alkali.

Finally, set all of these bottles in ice water, so as to cool the milk down to about 40–50 degrees, and then add to each while shaking, exactly the same volume of N/1 hydrochloric acid as was used of the alkali. The acid and alkali neutralize each other, forming some common salt. After all of the bottles have been thus treated, the milk in each is tested for its coagulation temperature, which will be found to be lower in that milk on which the rennet acted longest.

CHAPTER XXIV.

FRESH, SOFT RENNET CHEESE.

(178) **Junket.** For these unacquainted with this dish, an exercise in the preparation of junket is interesting and instructive, as an example of the simplest possible form of the process of making cheese with rennet.

Fresh milk is sweetened, and flavored with vanilla, artificial peach flavor, or any other preferred flavoring, in about the following proportions:

3 quarts of sweet milk
1 pound of sugar
½ ounce of vanilla extract

This mixture is heated to about 90–95 degrees, and junket tablet solution is added, or rennet extract at the rate of 2 cc. extract for the quantity given above. Immediately after stirring in the coagulant, pour the milk quickly into cups, and allow to stand undisturbed until well thickened. Carry the tray of cups to the refrigerator, and leave for half an hour or more, until the material is well chilled, when the junket is ready to be eaten.

Junket tablets may be purchased at almost any grocery or drug store in two sizes for different quantities of milk. The tablet is dissolved in a little water and used instead of rennet extract. The tablets keep well for a long time in the dry form and are preferable to extract for occasional use in the household.

(179) **The Neufchatel Process.** Neufchatel cheese is commonly sold in small 10-cent packages, wrapped in tin foil under a variety of names. It is made from either whole milk or skim milk and sometimes from cream or milk to which some cream has been added. It is often called cream cheese.

It was formerly made in France from milk or cream thickened by souring, and then wrapped in a cloth, which was hung up to drain. The cloth had to be frequently changed or at least the contents must be stirred and scraped down before the draining was complete. This process has been improved in America, so as greatly to lessen the labor required and systematize the manufacture.

An early form of the process in this country consisted in thickening sweet milk with rennet extract in milk cans and pouring the curd thus obtained into a yard square of cloth stretched over an oblong wooden frame and fastened to the four corner posts by slipping an iron ring over the cloth at the top of each post. This process required labor to handle and wash a great many cans and wooden frames and has been generally abandoned.

The modern process for making Neufchatel cheese begins by thickening the milk in a vat and drawing the curd through the gate into muslin bags. After draining the whey out, with occasional shaking of the bags, they are put in a press for a short time. When sufficiently dry the curd is emptied into a trough, where it is mixed with salt and other flavoring material, if used, and is then run through a machine, moulding it into cakes, which are wrapped by hand in paper and tin foil and packed in flat wooden boxes for sale. The cheese is easy to make but like other fancy products, requires much advertising to secure the ready sale of a large quantity before it has time to spoil. The retailer should receive fresh stock at least twice a month or oftener, and any spoiled, unsold stock is usually replaced by the manufacturer.

(180) **Cream Cheese or Whole Milk Neufchatel.** Made from whole milk or with milk enriched to contain 5 or 6 per cent fat, the product is usually labeled "cream cheese," and put up in 3- or 6-ounce packages, of square or oblong form.

The whole milk, with or without added cream, is run into a vat and heated to about 72 degrees. Sometimes a little starter is also added, if found necessary, and about 1 to 2 ounces of rennet extract per 1,000 lbs. of milk is then thoroughly mixed in. The vat is left undisturbed until the next morning. With whole milk, this quantity of rennet is necessary to secure thickening before too much cream has risen. During the night, the milk ripens slightly and thickens. The next morning the curd is cut in the usual way with American curd knives, into cubes, but no heat is applied. Immediately after cutting, a test of the whey should show at least .30% acidity. If the milk had not ripened, the whey would test only .12 or .15% and the curd from such sweet milk tends strongly to retain whey, so that it cannot be readily drained, or pressed dry enough for salting.

If the factory milk supply does not ripen at 72 degrees, without starter, the milk may be set at 75 or 77 degrees and about 1/10 of 1% of starter may be added before the rennet is stirred in. In cold weather the milk may be set warmer so as to thicken and cool down about 70–72 over night.

(181) **Draining the Curd in Bags.** After cutting the curd, a muslin bag, about thirty inches long and eighteen or twenty inches wide, made of pillow case tubing, is put under the gate and filled nearly full of curd. The neck of the bag is then tied shut and the bag is hung up by the tie string on a hook to drain for 24 hours. It may be necessary to shake each bag vigorously once in two or three hours to mix the contents, as the curd next the cloth drains dry quickest and may form a layer which delays the draining of the curd in the center.

(182) **Cooling the Curd.** The curd is cooled when partly drained in order to reduce the loss of fat in subsequent pressing and is kept cold until packed and shipped, in order to preserve the good flavor as long as possible.

The draining hooks may be attached permanently overhead in the make room, and in this case the bags of partly drained curd are taken down and loosely packed with cracked ice in a draining trough and left over night.

If the draining hooks are attached to a movable frame which can be wheeled about on castors, the frame carrying the bags on the hooks is pushed into the refrigerator where it is left to drain over night.

It is possible to omit this cooling process entirely, if the curd is to be eaten soon without shipment to a distance.

(183) **Pressing the Curd, Salting and Packing.** The next morning the bags of curd are shaken so as to collect the contents at the bottom, and the bag above the

curd is twisted up to prevent loss of curd while pressing. The bags are placed in a vertical press in layers, alternating with wooden slat frames, about 30 inches square, which keep the pile from falling over. The screw press is tightened so as to keep the whey running for about 20 minutes or until the curd is dry enough. The bags are then turned inside out, emptying the curd into a tin trough, 1 foot deep and 2 by 2 feet or larger and set like a table on legs with castors, so as to be wheeled about. To make the curd perfectly smooth, it is sometimes run through a power food chopper. The curd is mixed in the trough and salt at the rate of 1¼ to 1½ lbs. per 100 lbs. of curd is stirred in evenly. Two and one-half to 5% of pimento may also be added or other flavoring matter, as chopped olives, nuts or a mixture of these.

The curd is then put into the hopper of a soft cheese packing machine, which, by the action of a conical screw, forces the curd through a nozzle of the desired shape, and delivers the cheese in cakes ready for wrapping. The tin foil has a lining of thin parchment paper. The cakes of cheese are wrapped by hand and packed in wooden flats holding one or two dozen.

The cheese is also packed and sold in 3-ounce or larger jars of glass, either white or transparent and sometimes is put up in 1- or 5-pound cartons for hotel use, or for cutting on the retail counter.

(184) **Neufchatel Cheese from Skim Milk.** The process with skim milk is the same as described above for whole milk, excepting that as the curd contains no fat which might be lost by rough handling, the curd is not hung on hooks but the bags are piled on a wooden slat draining rack placed on the floor. The bags are repiled about once an hour and at times may drain so rapidly that they can be pressed the same day.

The pressing, salting and packing is done as described above, excepting that the shape of the 3-ounce cheese is not oblong, but cylindrical, when made from skim milk. When packed in tubs, it is often called baker's cheese (170).

(185) **Neufchatel Cheese in Loaves.** Skim milk Neufchatel is also put up in 5- or 10-pound loaves, wrapped

in parchment paper, ready to be cut with a string on the retail counter into pound slices or larger, as called for by the consumer. By this method the expense of hand wrapping and tin foil wrappers is avoided and the product can be sold at a lower price with profit.

For this purpose, the skim milk in large vats is heated to about 72 degrees and set with 1/10 ounce rennet extract per 1,000 lbs. of milk, well stirred in, at about 3 p. m. The temperature may be somewhat higher, up to 80 degrees, if necessary, to get the desired acidity as indicated below.

About 4 a. m. next morning, the milk should be found well curdled, and the whey acidity at about .30 or .35%, but not lower than this. The curd is now cut with ordinary curd knives, preferably with blades. After cutting, some makers heat up the surface of the curd next the tin vat, by running steam into the jacket, with no stirring. This may allow the curd to drain more freely next the tin, later, or it may be omitted if thought useless.

About ½ to 1 hour after cutting the curd has settled somewhat under the whey and a vat strainer is put in above the gate and the whey allowed to drain out slowly. When down to the level of the curd, the curd is dipped out with large scoops in thin layers into a cloth covered draining vat, made of smooth boards with a wooden slat bottom. After dipping the curd the vat is washed and filled with fresh skim milk. The curd drains in the rack, and a ditch is made around the edge with an opening through the bottom in each corner to carry off whey from the top. After draining an hour or two, until the top whey is all off, salt is sprinkled all over the top of the curd, but not stirred in. The curd is then scooped up in thin slices in a tin scoop into tin molds holding 7 or 8 lbs. of cheese, 4½ inches square at the end, and 9 inches long, slightly larger at the top than at the bottom. The form is lined with cheese cloth before filling, and the filled forms are piled three or more deep, for slight pressing, and may be placed in the refrigerator for chilling. The molds are perforated with ¼-inch holes and 1 inch apart, so that the draining is readily completed on the same day. The loaves of curd hold their shape well, and are turned out of the molds, and wrapped in parchment paper and packed 12 in a tin shipping case. The cheese may also be made in molds 6 inches deep and 12½ inches in diameter.

Like all Neufchatel cheese, the product is eaten while fresh.

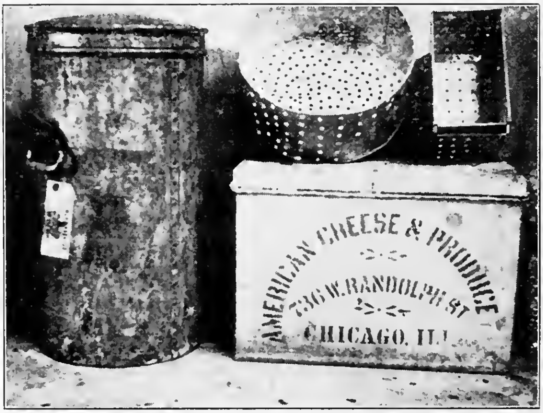

Fig. 25.—Loaf Neufchatel Cheese. Perforated molds for draining the curd, and shipping cans are used for this product.

(186) **Coulommier Cheese, Made in Hoops.** Neufchatel cheese in tin foil is stirred up with salt and then moulded into shape *after* draining and pressing, while the Neufchatel curd in loaves is molded into form *during* the draining process.

It is possible also to put the curd into molds *at the beginning* of the draining process, so that when fully drained the cheese have their final shape, which they retain during the salting process and until eaten. The Coulommier is made in this way.

The cheese of this class are made by dipping the rennet curd with a ladle into small tin hoops, in which the draining takes place. The cheese take their shape from the hoop and are salted on the outside. Coulommier cheese and a few other kinds are eaten fresh without curing and for this reason are easier for the student to make, as an introduction to the subject.

Mixed night's and morning's milk of good quality and not over .20–.21% acidity may be used. With very sweet milk, ½–1% of starter may be added, in order to avoid gassy cheese. The milk, at about 86 to 90 degrees, is thickened with 3 to 5 ounces of rennet extract, so as to be smooth, firm and ready to cut in about 1 to 1½ hours. It may be top stirred to keep down cream, at 10 minute intervals, before visible thickening begins.

The curd is transferred with a round bottomed, sharp edged ladle to tin hoops, which stand on straw matting or on coarse cloth, as burlaps, spread on grooved draining boards, usually made of wood. The ladle should be small enough to reach down into the hoop, so that the curd can be gently laid on the bottom, without breaking. Four hoops, 5½ or 6 inches deep, and 3 to 5½ inches in diameter, and open at both top and bottom, stand on one board which is about 12 by 14 inches. The sides of the hoops may be perforated with holes ⅛ inch in diameter and about 1 inch apart. The hoop is best made in two halves, the upper half fitting into the lower half about half an inch.

After filling the hoops, any remaining curd may be added to the top of the first hoops filled, after the curd has settled somewhat.

In about 20 hours, or sooner, the curd has shrunk into the lower half of the hoop, so that the top half may be taken off. The rate at which the whey is expelled depends on several factors. With quite sweet milk, the curd drains more slowly, so that it is better to have the whey acidity at about .18–.20% when the curd is dipped into the hoops. The make room should be at about 60 to 75 degrees, best at 68 degrees, and not too dry. If dipped in thin slices, the curd will drain more rapidly than if in thick slices.

When the top half of the hoop is removed, a square of matting or coarse cloth is put on, and another draining board and the hoops together with the boards are turned over. The curd begins to drain again more rapidly from the side now underneath. The upper board and cloth are removed and the top rind of the cheese, showing the pattern of the cloth or matting is sprinkled with about ⅛ ounce of salt. The next morning the cheese are turned again and the other end and edge are salted. After 24 hours further draining, the cheese are ready to be wrapped in parchment paper or tin foil, packed in individual boxes, sold and eaten. They may be kept a few days, if cool and well covered to prevent drying out. In handling the cheese care is used at all times not to break the rind or surface.

Cheese of this kind, if not sold promptly, may be kept cool for several days or weeks, during which time they undergo more or less curing, develop more flavor and may get moldy on the surface; but for proper curing, curing room conditions must be carefully controlled, as for Camembert and similar cheese. Read Bulletin 172, Ontario Agricultural College.

CHAPTER XXV.

SOFT, RIPENED RENNET CHEESE.

(187) **Camembert Cheese.** This variety of cheese, originally made in France about 1800, is now made in a few factories in this country with more or less success. The very moist curing room conditions, occurring naturally in France, are hard to supply in this country, because of the drier climate except on the west coast.

The methods and equipment in French factories are described in bulletin 58 and others from the Storrs Expt. Station, Connecticut, and in Farmers' Bulletin 384.

The make room should be at 60–70 F., as below 60 F. the separation of whey from curd is delayed, or even entirely interrupted. Night's and morning's milk in good condition, at 85 degrees, F., is set with about 3% starter, and ripened to .20–.23% acidity, but if at .24–.25% acidity a mealy curd is likely to result. A starter tasting quite sour but not yet curdled is preferred. Rennet at the rate of 3–5 ounces per 1,000 lbs. milk is used, and the curd cut in 1¼–1½ hours. If the draining room is too cold, the curd may be cut before dipping, but with the room at 68 F., the curd is dipped directly into the hoops without cutting and in 18 hours the curd should have shrunk to less than 2 inches in thickness and can be turned over without breaking. Hoops with small holes and smooth inside surface facilitate settling and turning. The hoops stand on mats on a draining board and table.

When first turned, the cheese may be inoculated, if this is to be done, and are then salted on one side. Twelve hours later they may be turned again and salted on the other side. Use dry salt and avoid too much. They are then placed on salting boards, 24 by 30 inches, holding 30 cheese, and set on an upper shelf in the make room, leaving the draining table empty. By the third afternoon the cheese may be taken to the curing room. Here they are placed upon open frames containing cane or wooden strips about

1–1¼ inches apart, so as to expose the cheese to the air both at top and bottom.

During salting, the cheese contain about 60% of moisture, and when fully cured, about 50%. In the curing room, at 52–58 degrees F., and with high humidity, the cheese gradually dry during 2 or 3 weeks and then lose very little afterward. If too moist, the cheese grow white mold quickly and are apt to decay or liquefy. If too dry, the edges become hard and knife-like. If the cheese in 10–12 days develop sufficient red slime and gray-green mold, they are then put in a drier room, and the drying is finished quickly down to the proper point. The mold colonies should be well established when the cheese are one week in the curing room. Lack of mold tends to make high flavored cheese, and to decomposition, while too much mold gives a creamy texture with but little flavor.

During the first two weeks in the curing room, the cheese become sticky and smell yeasty in about 3–4 days. In 5–6 days the white threads of mold appear, with perhaps some colored spores. The mold should cover only part of the surface and the rest is reddish and slimy. If the room is too moist, the cheese are sticky and yeasty with little mold, or other kinds of molds. If too dry, the mold covers the cheese with a dark felt, colored by spores. Between these two extremes, the best conditions are found.

In two weeks' time the rind should be well formed and softening begun underneath it. When softening begins the cheese are removed to solid curing boards to avoid cutting the rind by the cane strips. They are turned frequently avoid sticking to the boards.

At 60 F., in three weeks' time, cheese may be almost fully softened, but at 50–54 degrees may be only half ripe in that time. Ripened quickly, they must be used at once or will decay and smell ammoniacal. Ripened in four weeks or more they keep longer but are generally wrapped in parchment, or tin foil and boxed when three weeks old or less. The soft, ripened curd is alkaline to litmus, but the fresh curd is acid.

(188) **Brie Cheese.** Fromage de Brie, or Brie cheese is made in about the same manner as Camembert cheese,

but in hoops 10 or 12 inches in diameter. The finished cheese is of a soft, almost creamy texture. A very fine example of this class of cheese is the Fromage de la Trappe, made at Oka, Province of Quebec, Canada, and sold by many dealers in the United States.

(189) **Soft, Ripened Rennet Cheese Heated After Cutting. Heating Cut Curds.** While the preceding rennet cheese are dipped into the hoops, without previous cutting, at the temperature of the vat, the Limburger cheese process introduces a further modification, in that the curd is cut into cubes with knives and the cut curd is held in the vat for some time, stirring and slowly raising the temperature, so as to expel a large part of the whey before the curd is dipped into the hoops.

(190) **Limburger Cheese Process.** This important variety, which originated in Belgium, is made at about 60 factories in southern Wisconsin and in a few other states. The partly cured cheese is wrapped in parchment paper and tin foil before packing it for market and the tin foil retains odors in the rind, which many persons do not care for. If a well cured Limburger cheese is unwrapped out of doors and a thin layer of rind, about ⅛ inch thick is cut off from the entire surface with a sharp knife the clean soft interior of the cheese taken to the table exhibits far less disagreeable odor and the cheese thus prepared is spread on bread and is relished by many.

(191) **The Milk Supply.** For making Limburger, only the best and cleanest milk should be used, as gassy or tainted or overripe milk is sure to produce an inferior product. For sweet milk cheese such as Limburger and Swiss cheese a much better quality of milk is essential than for American cheese since the development of acid in milk for American cheese does much toward checking the production of gas and tainted flavors in the cheese.

In warm weather milk for Limburger cheese is brought twice a day to the factory, while fresh and warm from the cow, and is made into cheese as soon as received, both night and morning. If quickly cooled at night and properly cared for on the farm, night's and morning's milk may be mixed together with good results.

(192A) The Process of Making. The milk in the vat at about 86–90 degrees, is set usually without starter and with enough rennet ($3\frac{1}{2}$ to 5 ounces per thousand lbs.) so as to cut in about 25 to 30 minutes. After cutting with curd knives into cubes, the curd is stirred and after 10–15 minutes it is slowly heated to about 95 degrees. About three-quarters of an hour after cutting, the whey should not test over .15% acid. The curd is now ready to dip, while quite soft. The whey is drawn down until the curd begins to show above the whey surface, and the curd and remaining whey are dipped with a flat sided curd pail into wooden molds, placed on an inclined draining table which is covered with coarse cloth or burlaps. The molds are filled to the top, and after 15–20 minutes when the curd has settled, the molds are turned over on the cloth and left to drain, with 3 or 4 additional turnings during the day. No boards or weights are placed on the curd.

The wooden or tinned, sheet iron molds or hoops are 5 inches wide, and 8 inches deep, and may be 10 or 30 inches long. They are perforated with $\frac{1}{8}$-inch holes about 2 or 3 inches apart, or wooden molds may have the inner surface scored about $\frac{1}{4}$ inch deep, with a saw blade, forming vertical grooves about $1\frac{1}{2}$ inches apart. The holes or grooves aid in the draining.

(192B) Salting and Curing. The next morning the hoops are removed and the block of curd is cut into 2-lb. square blocks, or oblong 1-pound blocks. These are rolled lightly in coarse, dry salt, and piled one deep on the salting table. The second morning they are salted again and piled two deep. The third morning they are salted again lightly and piled three deep and on the following morning they are taken to the curing room and placed on the flat side, close together on shelves.

The curing room is kept at about 60–65 degrees and at about 95% humidity. The cheese are turned over and rubbed by hand every other day and if the surface becomes at all dry, they are washed with water containing a little salt. After 10 days they may be placed on edge, close together. Curing requires about 6 weeks, but the cheese may be wrapped in paper and tin foil when three weeks old, and packed for shipment. After a few weeks in the curing room, the surface is smooth from rubbing and turns a brownish color, while the interior begins to soften just below the rind. The curing proceeds toward the center until the kernel of white, crumbly curd is entirely softened and disappears when the cheese is fully ripe and ready to eat. Curing may be delayed somewhat in cold storage.

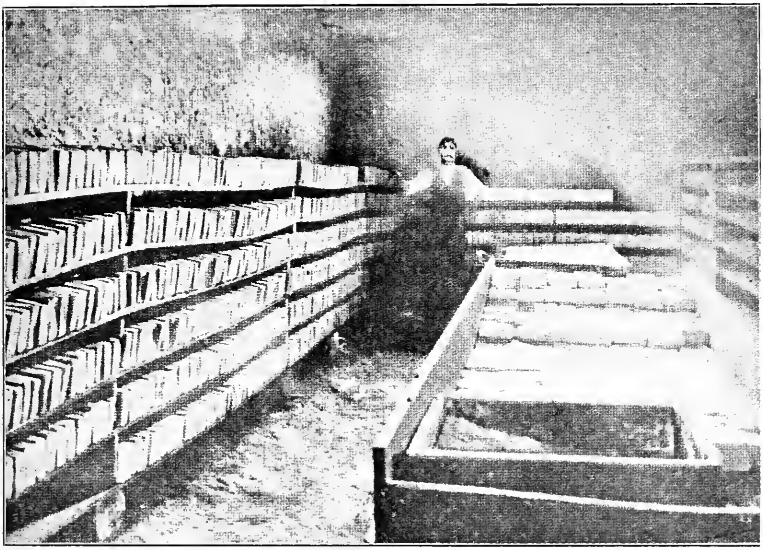

Fig. 26.—Limburger Curing Cellar. The cheese are shown on the salting table and on the curing shelves.

Limburger cheese is made as described above in oblong tin cheese vats, using American curd knives and having the draining table placed along side of the vat. It is also made in round copper kettles by the same general process, using the scoop, wooden sword, and Swiss harp commonly employed with a round kettle.

Limburger cheese is quite compact, showing few if any holes on the cut surface. It contains about 45% of moisture. The surface is never paraffined.

(193A) **Brick Cheese Making.** This variety of cheese, said to have originated in America, is made much like Limburger, but is a little drier and slower curing and does not become liquid or creamy in consistence when fully cured. The milk used need not be so sweet as for Limburger, and mixed night's and morning's milk is commonly used.

If the milk is very sweet, or tends to be gassy, the addition of about ½ per cent of starter is desirable. Without waiting for ripening, the milk at about .16–.17% acidity is set at 86–90 degrees with 3½–4½ ounces of rennet extract per thousand pounds, so as to cut in about 30 minutes.

After cutting with American curd knives, the curd is stirred for about 10–15 minutes and then heated slowly (in about 30 minutes) to 110–120 degrees, according to the maker's judgment.

The curd is not allowed to become as firm as for American cheese and the whey acidity should not go over .15%, but the maker watches the firmness and seldom uses an acid test. When firm enough a handful of the curd no longer appears like a mass of quaking jelly or wet mortar, when gently shaken, but the curd pieces are firm enough so that the whey runs out freely from among them, leaving some air spaces visible among the cubes in the handful.

The whey is drawn until the curd begins to show above the surface, and about one hour after cutting, the curd and remaining whey are dipped out of the vat with a flat sided curd pail into wooden molds (192A) of the same dimensions

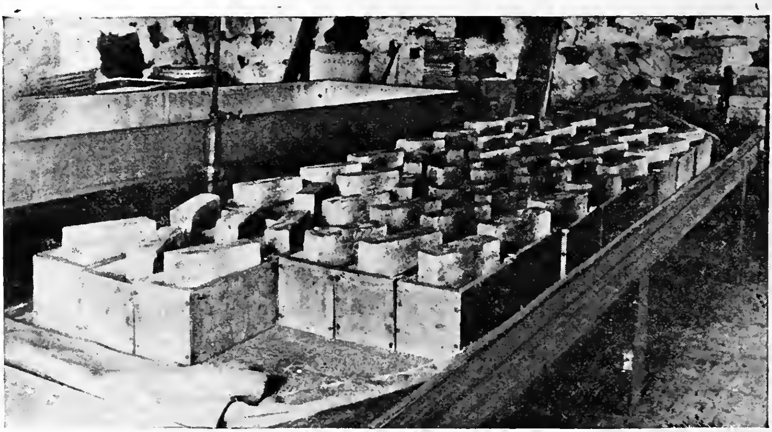

Fig. 26A.—Brick Cheese In the Forms, under Pressure.

as for Limburger cheese and arranged on the draining table in like manner. Factories making brick cheese throughout the season, commonly use the 10-inch molds, which are placed close together on the table so that the curd from the pail runs into two molds at once. Each mold makes one brick cheese.

Factories making Swiss cheese during most of the season make brick cheese usually at the beginning and end of the season, when the milk is delivered in small quantity once a day.

The cheese are turned with the mold about 10–15 minutes after dipping, and a wooden follower is dropped into each mold, and a 10-inch mold is weighed with one ordinary building brick, preferably with a glazed surface to prevent absorption of moisture. For a 30-inch mold, two bricks are used. Each time the hoops are turned the board and weight are replaced.

(193B) **Salting and Curing.** The cheese are salted on three successive mornings, the same as with Limburger cheese and are then scraped on the edge with a dull knife blade to fill up and smooth the surface, and placed on the curing room shelves.

The tendency of a beginner is to salt the cheese too heavily, which causes them afterward to become very sticky and slimy on the surface and later very hard on the rind. The rind should be just firm enough after curing to hold the cheese in regular shape, so that it can be handled and packed without damage. With too little salt the rind is soft and thin and the cheese will bulge and lose their shape and the flavor will be affected.

The curing room is kept at about 60–65 degrees, and the floor may be sprinkled with a jet of water, if necessary, to keep the air moist.

In the curing room they are washed every other day, turned and replaced on the shelf. They slowly become brownish on the surface and waxy and translucent inside, but not creamy as curing proceeds. For complete curing about 8 weeks is required.

When half cured the cheese may be allowed to dry for a day or two, after which they may be dipped in paraffin to prevent further drying out and wrapped in parchment and manilla paper, and packed in cases about 22 inches wide, 31 inches long, and 5½ inches deep, or sometimes in half boxes 15 inches long, inside measurement.

Brick cheese are rarely wrapped in tin foil, except for shipment to a warm climate, where there is danger of excessive shrinkage through drying out, unless wrapped.

Brick cheese show on the cut surface a few small holes either of irregular outline, or somewhat rounded.

The cheese contains 40% of moisture or a little more, or less and is thus just on the border line between soft cheese and hard cheese.

(194) **Muenster Cheese.** The curd is made in the same way as for brick, but the cheese forms are round, made of sheet metal and perforated. The cheese after draining in the hoops are salted like brick cheese, but must be kept on one of the flat ends and wooden blocks are often used between the cheese on the salting table to keep them in the proper shape, while developing a rind.

Fig. 26B.—Muenster Cheese In Hoops On The Press Table.

CHAPTER XXVI.

HARD, RIPENED RENNET CHEESE.

(195) **Swiss Cheese.** In making this and all other kinds of hard cheese, the curd is heated and well firmed in the whey before the curd is put into hoops.

(196) **The Milk Supply for Swiss Cheese.** Milk for Swiss cheese is regularly brought to the factory both night and morning, fresh and warm from the cow, and is made into cheese without delay, twice a day, in several hundred factories in Wisconsin. It is often made once a day, from mixed milk in Europe.

Milk inspection should be carefully done daily (10). The sediment test, fermentation test, and Wisconsin curd test may frequently be used in detecting the source of defective milk. Abnormal milk is especially harmful in making Swiss cheese.

(197) **The Swiss Making Process and Tools.** A copper kettle holding 2,500 or 3,000 lbs. is used. In the past it was hung on a crane, and heated over an open fire, but the building soon became blackened by the smoke. The kettle and fire are now therefore usually surrounded by a movable jacket, connected to a chimney, and provided with a cover to retain smoke when the kettle is swung away. Or, the kettle is often set permanently in brick work, and heated from below by a movable fire wagon on a little track below the floor. The latest method is to heat the kettle by steam in a jacket, or underneath the bottom.

(a) The milk, strained into the kettle, is heated to 90–95 degrees, and is ready to set with rennet. Commonly, home made whey rennet is used, but sometimes ¼ to ½% of lactic starter and some commercial extract may be used, if necessary. The whey rennet acts both as starter and as extract (61).

While stirring the milk with the scoop, from the bottom of the kettle upward, the whey rennet diluted with water is added, in quantity sufficient to thicken the milk ready for cutting in 25–35 minutes. The milk must become fully quiet before thickening begins.

On account of the tendency of the top layer of milk to cool and curdle less rapidly, the vat is covered as soon as set and soon after thickening the scoop is used to take up and turn over a thin layer of curd from the top surface, to warm it again in this way.

Afterward, the curd is cut with the harp, or with a wooden sword, into vertical columns, about 1½–2½ inches square. The tops of these are then cut off by drawing the scoop across the kettle, until the curd is all cut into cubes and well mixed.

(b) The harp is then put in, and kept going steadily, cutting the curd finer, until it is of the size of wheat grains. The wire basket stirrer is then used, in place of the harp, to stir without cutting, and this stirrer is often run by machinery instead of by hand.

Too finely cut curd checks the formation of eyes, while too coarsely cut curd will ferment too freely, probably carrying too much moisture.

Cutting evenly to the right size is more difficult if the curd is too hard, due to too much rennet used; but if curd is too soft, due to too little rennet used, much fine curd-dust is formed. With uneven cutting, the large pieces later may cause soft spots on the surface or interior, and irregular distribution of eyes of different sizes.

(c) When of sufficient fineness and firmness, the curd is allowed to settle for 10–15 minutes, during which it gains a certain elasticity, and part (about one-fifth) of the whey is drawn out, to permit more rapid stirring afterward. It is then stirred with the wire basket stirrer until evenly divided, when the heat is turned on and with continual stirring, the temperature is raised in 25–35 minutes to 125–140 degrees, according to the maker's judgment.

The heating is done more slowly when the curd is softer, and more rapidly when the curd is already quite firm. A higher temperature is used when large cheese are made, or when the curd particles are larger, or the milk thickened more slowly. A lower temperature is used if the curd is cut very fine, or the curd was very thick because of strong rennet, etc.

When heated up, some makers add a small quantity (half a pail) of cold water, lowering the temperature about one degree, believing that this makes the curd softer and more elastic.

(d) The final stirring, "to dry the curd" need not be so rapid, since the heat is turned off, and there is no danger of overheating the curd. It is continued, until a handful of curd, firmly pressed together, breaks off short when bent, and is easily rubbed to pieces in the hands. As a rule the warming and the final stirring require together about 50-60 minutes.

When the test is satisfactory, the stirring is stopped, and some cold water or cool whey is added, but the temperature should not be reduced below 125 degrees. If cheese sets (forms eyes) freely, water is used; if not freely, whey is used. After this addition, the curd is stirred briskly, and the stirrer is then held vertically in the middle of the kettle, so that the curd settles quickly, to prevent large curd pieces from collecting at the outside of the pile, where they would cause large holes or rindholes. The curd is dipped immediately.

(e) For this purpose, the square cloth is moistened along one edge, which is wrapped two or three times around the "boegli," a long thin flexible strip of steel, by means of which the cloth is slipped between the curd and the kettle, without much disturbing the curd. The opposite corners of the cloth are then tied together, and the bag of curd hoisted with rope and pulleys hanging on a conveyor track. After draining the whey for an instant, the curd is run over to the press table, and lowered into a form, which is round for "drum" Swiss, or oblong for "block" Swiss cheese. The curd is pressed down to fit the form, with the flat hands, thus also freeing any large whey masses that may be contained. Immediately, a second dip into the kettle is made with another cloth to collect any remaining curd, and this small mass (strebel) is either rubbed up fine and distributed over the top of the main lot, or in a mass is pressed into a hole made with the hand, at one side, next the form. Rapid cooling of the curd mass should be avoided and the cloth is folded over smoothly, and a heavy (2 inch), round, iron edged, wooden cover is put on the cheese, and a weight applied. A 100 lb. stone, or a keg of bricks may be used, for this purpose. The hoop should touch neither the table nor the cover, but the weight should rest entirely on the cheese itself. The hoop is drawn tighter if necessary, to leave a finger width above and below it. With too heavy pressure

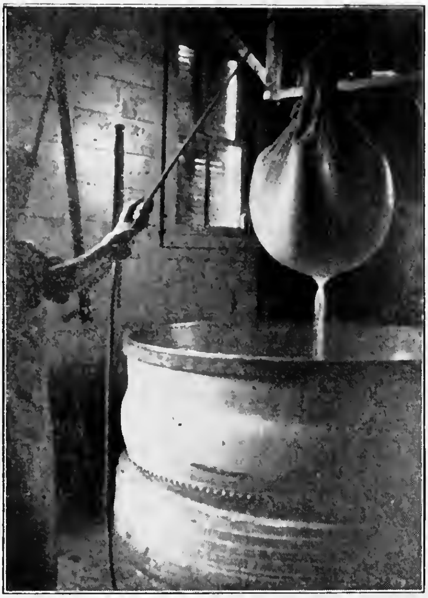

Fig. 27.—Swiss Cheese Dipping. The cloth bag of curd hoisted from the kettle is drained for a few seconds as shown, before transferring to the press table and hoop.

at first, the whey is milky, the cheese becomes too hard, and the cloth sticks to the surface, causing damage in removing, later.

(f) The cheese is turned frequently at first, and dry cloths applied, avoiding wrinkles, which cause marks in the rind, which may later cause splits. The press drippings are more or less impure and are not used for starter, whey rennet, or sour whey, but may be skimmed while fresh, for making whey cream. A softer cheese must be more often turned, which gradually tends to correct inequalities in curd texture. After 24 hours, the cheese are turned no more, but left in the press for 12 hours finally, either with no cloth, or with cloth only on the bottom, to form a smoother rind. The pressure is gradually increased up to 18–20 lbs. per lb. of cheese, and is applied with a heavy log, or iron bar with sliding weight, hinged to the wall, near the ceiling.

After 12 hours pressing, block Swiss curds are cut into 20-lb. strips, about 5x6x20 inches in size, and each strip is placed in a separate mold, with a wooden cover, and cloth, and pressed to form a rind on the cut surfaces.

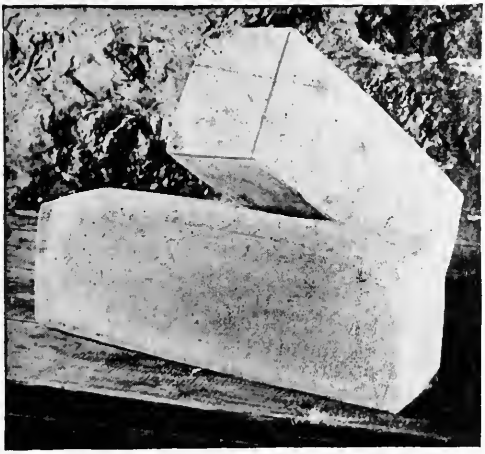

Fig. 28.—Block Swiss Cheese.

The appearance of the rind after 24 hours pressing should be yellowish, with small, whitish spots on the surface, and elastic under the fingers. The cheese is taken after 24 or 36 hours to the salting room. Each cheese is dated, with soot and water paste, on the surface.

(g) The cheese may be salted "in the hoop", or "in the brine." Frequently, it is salted one or two days in the hoop to harden the rind, and retain its shape better, and then is placed in the brine tank. This method also avoids heating the brine tank, by adding slightly warm cheese. The inside of the wet hoop is strewed thickly with salt, and the hoop applied to the cheese after which the top surface is strewn evenly with salt from a sieve. Next day, the cheese is turned over, and again salted as before. This dry salting may be continued for four to six days, in the hoop, or the cheese may be put in brine after the first or second day. In the brine, the cheese are turned over daily, and salt sprinkled freely and evenly on the upper surface, which floats just at or above the brine surface. The brine contains about 26% salt, and as each cheese absorbs salt, and gives up some moisture, more salt must be added to the tank from time to time. The tank may be of wood or of concrete. Too weak brine soon becomes foul and injures the cheese. Fine salt on the cheese surface more quickly extracts moisture. More salt in the cheese checks fermentation, and less salt promotes fermentation (eye formation). Not more than two cheese should lie below each other in the tank. The cheese is left in the brine 2 or 3 days, and then taken to the first curing room.

(h) Here it is turned, washed, rubbed, and salted every other day. If left longer without turning, on the "lead," or circular board, the rind is injured. The next day, after each salting, the salt is found to be fully dissolved, and the cheese wet with brine. The second day, the brine is again fully absorbed, and the cheese ready for turning. The turned cheese is left on a dry board, on the shelf, each day, to prevent becoming moldy or foul. Toward the end of the ripening, the turning and salting need not be done more than every third day, and less salt is used. A large flat brush is often used for rubbing cheese. The rind must be kept clean.

(i) During 10–12 weeks, the eyes gradually grow. Each cheese is tested by tapping with the finger, and if the sound indicates too rapid fermentation (eye formation) it is taken to a cooler room, or if too slow, to a warmer room. To prevent bulging at the edge, a hoop may be put on.

Besides temperature, the humidity should also be regulated. With a dry cheese, the salting is lighter, and the room damper. The temperature and humidity should be kept as uniform as possible in each room, for which purpose, Swiss cheese are usually cured in underground cellars, lighted only by a few narrow windows, near the ceiling.

When properly open (eyes large enough) the cheese are taken to the storage cellar, at a lower temperature, where the turning and salting are continued, until "salt ripe," that is until salt is no more absorbed freely, but the surface remains wet and sticky, showing that the interior has sufficient salt.

In ventilating a cellar, direct drafts on the cheese must be avoided, as likely to cause drying and cracking of the surface. A bursted cheese is sure to become foul inside, and cause loss. To prevent slight cracking, cloth strips are sometimes stuck tightly to the rind around the edge, when thought necessary. Temperatures used in the curing cellars may be as follows, according to European practise.

	Temperature	Humidity
For fresh cheese	52-59 degrees F.	90-95%
For the first curing room	60-65	85-90%
For the warm curing room	65-70	80-85%
For the storage room	50-55	80-85%

American warm rooms are often heated to 90, F.

(k) At many small factories in Wisconsin, having only limited curing room space, the cheese are kept for one to three months, and then sold to the buyer, who has large curing rooms, in which the best No. 1 cheese are further opened, and finished.

(198) Swiss Cheese Quality. Serious faults in Swiss cheese may be: (1) "Blind" cheese develop no eyes, due to too ripe milk, or too dry cheese, or too low curing temperatures, etc. (2) "Niszler" cheese show too many and too small holes, due to dirty milk, which often produces gassy texture in all kinds of cheese. The use of a small amount of extra "sour whey" or of whey rennet (without increasing the amount of calf stomach used), may often prevent such gassy cheese. (3) "Glaesler" or glass cheese show horizontal cracks or splits instead of eyes, all through the interior, which may be due to too sweet or too ripe milk, or too much added sour whey, to too dry cheese, to variable temperatures in the curing room, or to too rich milk with 3.75 to 4.5% fat. One of our students reports that with the Marschall rennet test used in his factory, a milk that tests five or six will be sure to give a glaesler cheese, while milk at 3½ will not do so. (4) "Blown" cheese develop too large eyes, which may run together, forming large cavities, and splitting the rind, causing great loss, due to too moist cheese, too warm curing temperature, too little salting, etc.

At some factories, "blowing" of the cheese has been observed to begin when 1 to 2 weeks old, and to continue rapidly, until the cheese become spongy and crack open when less than a month old. Total loss of such cheese may be avoided by placing them very early in cold storage at 34 degrees or a lower temperature. The cause in several such cases has been traced to a foul, yeasty condition in the whey

Fig. 29.—Bloated Swiss Cheese. A yeasty fermentation in the whey tank caused this bloating. As soon as the maker began steaming the whey in the tank no more trouble of this kind occurred.

tank, so that the patron's cans used for carrying home whey, become infected, and if not thoroughly washed, infect the milk, and the next day's cheese. Pasteurization of the whey tank, by running in steam, up to 155 degrees, has been found to stop such loss immediately, at several factories.

Blown cheese are sometimes thought to be due to feeding corn silage to cows, but at numerous factories where no such trouble occurred, it was found that silage was freely and regularly fed, without bad effects.

At the Wisconsin dairy school, during 1915 and 1916, block Swiss cheese, made on 50 days from the milk of cows fed silage daily with hay, but no pasture, showed no tendency to bloat.

The imported Swiss cheese which reach this country are hard, whitish, and short, and not at all elastic, but well salted and cured. The domestic make of Swiss cheese is often sold and eaten in an uncured condition, very elastic and rubbery, yellow in color, with no salty taste, and little or no flavor. This is an injury to the industry.

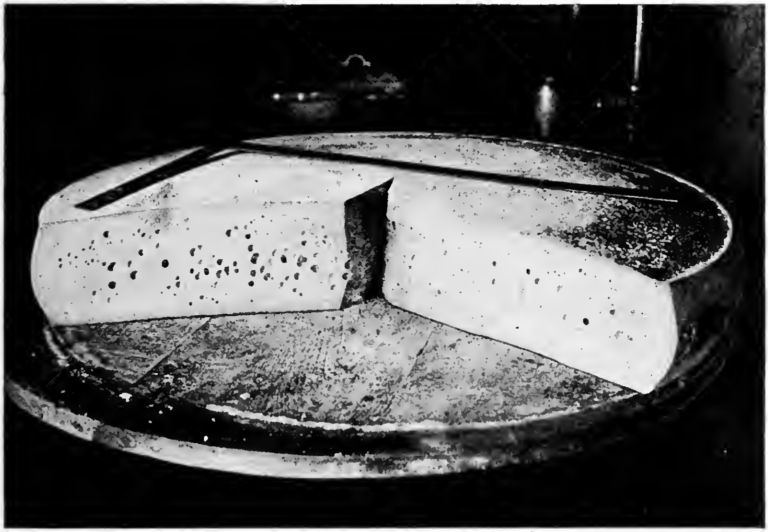

Fig. 30.—Fine Quality Swiss Cheese. The uniform size and even distribution of the eyes seen here is characteristic of the best Swiss Cheese.

No. 1 cheese in the market have good flavor and salt, eyes of the right size, evenly distributed, and doughy texture, neither sticky nor too dry; but if the eyes are right, the rest is likely to be satisfactory.

No. 2 cheese in the market include glass, niszler, blind, or those with uneven, or abnormal eyes, if not split open.

No. 3 cheese include any with surface openings, caused by rats, mice, flies, bloated cheese, or having decayed spots.

While the price of No. 1 Swiss cheese is always high, yet many factories are unable to produce always No. 1 cheese, so that the full price is not always obtained. On account of the large amount of curing room work, and the necessity for making cheese twice daily, morning and night, Swiss factories are operated almost exclusively by native Swiss makers who have come to this country after learning the process.

Because of the fine quality and the high prices always obtained for the best Swiss cheese of domestic make, it appears desirable that its manufacture should be undertaken more widely, and by native American workmen, in this country.

(199A) **Edam Cheese.** In northern Holland, Edam cheese are made in round kettles and tubs. The method used for making Edam cheese in the United States resembles closely the method of making American cheese by the gran-

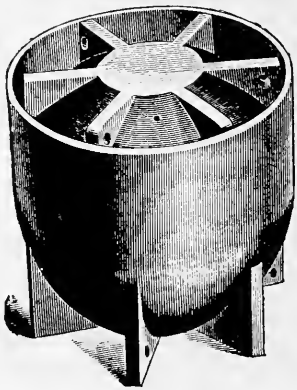

Fig. 31.—Edam Cheese Mould made of cast iron.

ular process (205), excepting that the cheese is well colored by adding 1–1½ ounces of cheese color to the milk, and the method of hooping and subsequent treatment is different.

The curd is well firmed in the whey, and well stirred in the vat, after drawing the whey, and salted in the granular form. The cast iron Edam cheese molds are lined with strips of cheese cloth and well filled with curd, so that after pressing, the cheese will yet fill the hoop, and not allow the base and the cover to rest on each other. After pressing for a half hour or more in the gang press used for Young America cheese, the cheese are taken from the hoops, any rough places trimmed off, and dipped for about two minutes in hot whey at about 125 degrees. They are then wrapped again completely in the cheese cloth strips, and returned to the hoops and left in the press over night.

The next day, the cheese are examined, and if the rind is perfectly closed, they are ready for salting. This is done by rubbing dry salt over the entire surface, and after placing the cheese in the salting hoop, dropping a small handful of dry salt on the upper surface, and leaving uncovered until

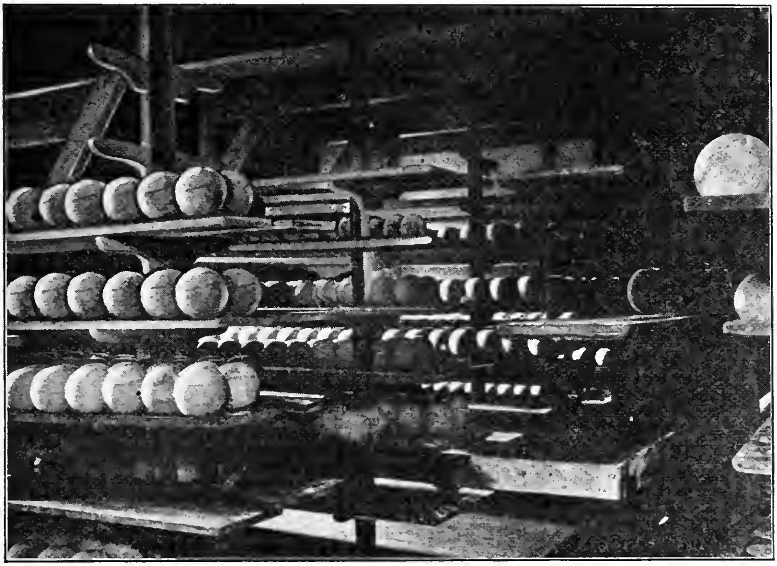

Fig. 32.—Edam Cheese on the Curing Room Shelves in Holland.

next day. The cheese are then turned over in the mold and the other side salted, and this is repeated for 4 or 5 days. Finally, the cheese are washed with whey, wiped dry, and placed on the curing room shelf. The air should be quite moist to prevent the rind from drying out and cracking, and the temperature at about 60–65 degrees, F. The cheese are turned daily, may be washed to keep the surface clean and prevent cracking. Later, when the surface is well dried, they are colored a dark red by dipping in a red dye, which can be bought in the market. After standing again on the shelf until the surface is well dried, they may be dipped in hot paraffine, and packed for shipment.

Using half-skimmed milk, a rather dry, and well salted cheese is produced. Instead of paraffine, the cheese may be rubbed with boiled linseed oil, which is applied to the salted and partly cured cheese to prevent cracking of the rind, and the red color may be applied later by dipping in an alcoholic solution of carmine or Berlin red. After a final rubbing with oil, they are packed for shipment.

(199B) **Gouda Cheese.** These are made in south Holland, and have the shape of a flattened ball or sphere. The

Fig. 33.—Gouda Cheese Hoop, Used In Holland.

cheese is made from sweet milk, cutting the curd very fine, and firming well in the whey. The whey is then drawn, and the curd pushed to the upper end of the vat with a strainer board, and left to mat. The matted curd is later cut into square blocks, one of which nearly fills the Gouda hoop. After pressing, the cheese are salted in brine. They are made in several sizes.

CHAPTER XXVII.

AMERICAN CHEESE FOR THREE MARKETS.

(200) **The Quality Should Suit the Trade.** In North America, enormous quantities of whole milk American cheese are made for three markets. Canadian cheese made throughout Ontario and Quebec are sold mainly for export to Great Britain, or to residents of Canada, and nearly all of this cheese is made firm, close, slow curing, and containing about 34 to 36 percent of moisture.

In the United States, over half of the American cheese manufactured, is made in Wisconsin, a smaller amount in New York, and several other states have made a beginning in the cheese industry. Although more or less cheese is made for export in these states, yet the greater part is intended for sale throughout the western and southern states. The quality for this purpose need not be quite so firm, or close, or slow curing as for export while the moisture content is about 37 to 40 percent in Wisconsin, the upper limit being established by state law.

In some other states, having as yet no cheese moisture laws, cheese made in local factories are sold and eaten almost entirely within the state, and for this purpose the standards of quality are often much lower, the cheese being frequently quite open or full of holes, quick curing, soft, and containing 39 to 43 percent of moisture. Such cheese are entirely unsuitable for either the export trade or the great southern trade, and are fit neither for shipment to any distance nor for storage through the winter, as in either case they are likely to deteriorate greatly. These are sometimes called "home trade" cheese, or "Michigan soft" cheese, etc.

These three classes of cheese differ so greatly in their quality and method of manufacture, that it is necessary for a maker to decide definitely which kind of cheese his trade demands, and what market he is intending to supply, before beginning work. Sometimes a maker offers cheese, for example, for the southern trade, which are made with so high a moisture content that they are not really fit for this trade. Such abuses have led to the establishment of legal cheese moisture limits in the leading cheese producing states.

(201) **Moisture in Cheese.** In 1916, 567 samples of cheese, collected from factories and dealers in all parts of Wisconsin, were tested* for moisture at the University of Wisconsin Dairy School, under the writer's direction, and it was found that the dividing line between good southern trade quality of cheese and "too moist" cheese lay at about 40% before July 1st, and at about 39% during the later months of the season (96).

The general principles underlying the manufacture of a cheese containing a larger percentage of moisture are (1) the shortening of time between the cutting and hooping the curd, and (2) the use of sweeter milk with little or no starter. With sweet milk, as at .16%, the curd gives up moisture more slowly than at a higher acidity up to .20% and by also shortening the time allowed, the increased moisture content is obtained, and a higher yield but an inferior quality, if the milk is at all defective.

The importance of a cheese moisture test outfit in the cheese factory is coming to be realized by leading makers and managers.

(202) **Method of Making Canadian Export Cheese.** The milk in the vat is commonly treated with about 1% of starter, and is set at 86 degrees, at about .175% acidity by the acidimeter, using 3 or 3½ ounces of rennet extract per thousand pounds. The curd is cut in about 40 minutes when showing clear whey in the break, but while yet rather softer than is customary in Wisconsin, using ⅜ inch horizontal wire knives and ¼ inch vertical wire knives, and lapping the vertical cuts so as to almost double the cutting effect upon the fineness of the curd cubes. The agitators are started slowly, immediately after cutting, and the steam is turned on slowly, so that the vat is heated to about 100 degrees in about 45 minutes. After heating, the whey is drawn down about 8 inches in the vat, and the agitators are run faster, at about 12 revolutions per minute.

*From thesis of L. J. Schenkenberg, M. S., 1916, University of Wisconsin.

The whey is tested for acidity with the acidimeter at intervals, and the curd is allowed to become quite firm and elastic, much more so than in Wisconsin. The whey is drawn 2½ to 3 hours after setting the vat, at a whey acidity of about .17%. Three hours time is preferred rather than 2¼ hours. As much whey as possible is drawn out through a siphon, as the vats have no gates attached to the pans. The remaining whey together with the curd is then dipped out of

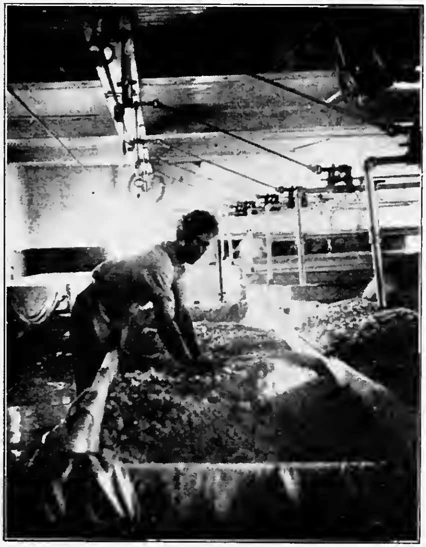

Fig. 34.—Curd Sink in Use in a Large Canadian Factory.

the vat, by two men with flat sided curd pails, into a curd sink covered with a heavy cotton curd cloth like sheeting. In the sink, the curd is stirred by two men, during a full half hour, so as to keep the cubes from matting, and to allow complete drainage of whey from the curd. In this way, all danger of soft, whey soaked cheese, containing excessive moisture, is avoided. Sometimes with milk riper, the whey is drawn at acidity as high as .20%, but preferably as described above.

The curd is allowed to mat in a pile about 8 inches deep; and ½ an hour later the matted curd is cut across into long strips, which are turned up on the cut surface in the curd sink. In half an hour more the curd is piled two deep, and repiled at regular intervals to keep the temperature even, etc. About 2 hours after matting, the curd is milled. One hour later it is salted, and ½ an hour later, it is hooped. This makes a total of 6 to 7 hours from setting to hooping.

The curd is so firm and free from excessive moisture that just before salting, to obtain 10 cc. of curd drippings with which to make an acid test, it may be necessary to wring the corner of the curd cloth in the hand.

Fig. 35.—Canadian Cheese Factory with Ten Vats in Use.

The cheese thus made are shipped without delay to the buyers' warehouses, and cured by the cool curing system at about 60 degrees, and the product thus made is surprisingly uniform in flavor, texture, body, and keeping quality.

The method described above was observed by the writer in 1914 and 1915, at a number of the largest factories in Ontario, some of which have 8 or 10 large vats full of milk daily.

Under the close supervision of government inspectors, in Ontario and Quebec, a high degree of excellence and uniformity is attained both in factory construction and maintenance, and in quality of cheese produced. The whey from the vats is run through gutters in the cement floors, and is not run through a whey separator in most cases. In some of the model factories, every piece of equipment is kept clean, scrubbed, painted, varnished, polished, and in the finest condition, including the boiler room and curing room as well as make room.

The cooperative method of selling cheese from the province of Quebec, which are shipped to Montreal for export, is successful, and gives satisfaction both to buyers and sellers.

The cheese are commonly paraffined at the buyer's warehouse, at the age of a week or more.

(203) **Method of Making American Cheese in Wisconsin.** In making cheese in Wisconsin for the southern market or for export, the method is of course the same in a general way but with some important differences as to details.

There is perhaps more variation in method among factories in Wisconsin than among those observed in Canada. The milk acidity when received is from .16 to .20, and if of .18% or less is set with about 1% of starter, 3 to 4½ ounces of rennet extract or pepsin solution is used or about ¼ of an ounce by weight of dry pepsin (dissolved in luke warm water) per thousand pounds. The curd is cut in 25 to 45 minutes, when it should be fairly firm and showing clear whey when broken with the finger.

Stirring is begun with the arms, or agitator, immediately after cutting and is continued with little or no stop until the curd has been heated up to the desired temperature. The heating is begun about 15 or 20 minutes after cutting (or sooner with overripe milk), and the temperature is raised slowly and steadily up to about 100 or 102 degrees, or some times a little higher. The agitator or a wooden rake is used to stir while heating.

With a "normally working" vat of milk, the acidity of the whey increases to about .17 or .19% in about two hours after the rennet is added and the whey is drawn at about this acidity. Some makers incline to the lowest possible acidity of milk and of whey and others prefer to develop acidity equal to the larger figures given above so that the curd shows about $\frac{1}{16}$ or $\frac{1}{4}$ of an inch of fine strings by the hot iron test, when the whey is drawn.

The vats in Wisconsin have gates, and the whey is allowed to drain out completely, the curd being retained in the vat by a tall, round strainer, having a tip which fits into the vat outlet, just above the gate. No curd sink is used in Wisconsin factories with one or two exceptions.

If the curd is a little too soft when the acid has reached the desired point, the curd may be stirred over with the hands while the last of the whey is running out, to keep the curd from matting for a few minutes longer, and during this stirring, while out of the whey, the curd gives up moisture very rapidly. By leaving about an inch of whey in the vat and closing the gate, the curd may be stirred with the rake, teeth down, for five minutes or more if it is very soft, but with plenty of acid. It is planned to have the curd as firm as desired, at the same time that it shows the required acid test, and in this case no stirring of the curd is necessary after drawing the whey, but a gutter is made with a rake down the middle of the curd, piled about 3 to 6 inches thick and covering the bottom of the vat evenly. The gutter permits the last whey to escape freely, and the curd is allowed to mat, on the bottom of the vat, into a solid mass. In about five minutes, when well matted on the bottom, so that the escape of whey is slowed up, the curd is cut across the vat into blocks about 1 foot wide, and the blocks are immediately turned over. The curd is turned again after 20 minutes, when well matted on the bottom, and is piled two or more blocks deep and repiled at 10 minutes intervals to keep the curd at uniform temperature throughout.

The curd is milled, preferably when it will string $\frac{1}{2}$ inch or more on the hot iron, and is well matted so as not to fall into cubes when milled. In many cases, an hour and a half after matting will find the curd in good condition to mill. Some makers will mill a curd much earlier, when it is matted only half an hour but before it has the acid, in their effort to retain moisture and gain yield.

After milling, the curd is left at least half an hour, and if it appears very greasy, may be rinsed with water at 90 degrees to remove the grease. It is salted with 2–2¼ lbs. salt per 1,000 lbs. milk, or per hundred pounds of curd, and is left in the vat at least 30 minutes with frequent stirring until the salt is fully dissolved, and the curd is once more soft and velvety. It is packed in the hoops at about 80–85 degrees temperature and pressed over night. It is placed on the curing room shelves for a few days to dry the surface and is boxed and shipped when 3 to 8 days old.

(204) **Method of Making "Soft" American Cheese for Northern Home Trade.** In this process, the purpose is to finish the work at the vat as soon as possible, to retain a larger proportion of moisture in the cheese and thus to increase the yield, and hasten the curing of the cheese.

The general method employed to retain moisture is (1) to use sweet milk, ripened little or not at all, and little or no starter, and (2) to shorten the time for all parts of the work.

The result of applying such methods to unclean, gassy milk is to produce a cheese with a very spongy texture, and which acquires a strong, sharp, tainted flavor in a very few weeks' curing. Local consumers, living near such factories in Michigan and to some extent in other states, have learned by custom to prefer cheese with a "right stout" flavor, which would be entirely unsalable either for export or in the large city markets.

An example of the process will be given for illustration. The milk in the vat, more or less tainted, usually not sour but rather unripened, is set without starter, with 3½ or 4 ounces of rennet per thousand pounds, at about 86 to 90 degrees, F., and is cut in about half an hour into ½-inch cubes. It is stirred and heated slowly to 98 or 100 degrees. The whey is drawn while the curd is quite soft, and without waiting for acid to develop sufficiently to show strings on the hot iron. The curd is not stirred while drawing whey, but is ditched in the middle to aid in draining. The curd mats quickly, and is milled about half an hour later, salted immediately after milling, and hooped in 15–20 minutes after salting, as soon as the salt has dissolved.

No acid tests or rennet tests need be made at any time during the process. With overripe milk the product is a sour cheese, and the yield is lower than with sweeter milk. This class of cheese is cured at ordinary temperature at the factory and sold to near-by consumers, or shipped to near-by town trade. They deteriorate rapidly and must be eaten young.

Previous to the passage of cheese moisture laws in Wisconsin considerable quantities of this class of cheese were made in the state and caused great dissatisfaction and often loss to dealers who received them but who intended to buy cheese suitable for export or the southern trade.

CHAPTER XXVIII.

MINOR SORTS OF AMERICAN CHEESE.

As stated previously there is a very general tendency in many localities to vary the cheese making process slightly in some minor respect, such as in size or shape of package, or as to length of time it is held in the vat, or in using a home made press instead of the more convenient gang presses commonly used in American cheese factories, and to call the products by a different name, either a geographical name, as Monterey cheese, or a fanciful name as Jack cheese. A business of considerable extent may be built up in the manufacture and sale of such products under these special trade names. It is of interest to compare these processes and products with the standard varieties, and note their resemblances and differences.

(205) **Granular Curds.** The granular process of making American cheese was widely used in the early days of the American cheese industry. It is yet used occasionally when a maker wishes to finish his work earlier than usual for any reason, and by a very few makers who employ the process in every day work.

The granular process differs from the ordinary American cheese process employed in Wisconsin, in that (1) the curd is made a little firmer by holding it longer and perhaps developing a little more acid before drawing the whey; and (2) after drawing the whey, the curd is stirred steadily to keep it from matting, while spreading it out to cool as rapidly as possible on the vat bottom. After stirring more or less steadily for about 20–30 minutes, the curd has become firmer and cooler and has little tendency to mat. It is now mixed with salt at the usual rate and as soon as the salt has dissolved, the curd is filled into the hoops and pressed.

The granular made American cheese can usually be distinguished from the ordinary matted curd in the market by the texture. The granular curd shows distinctly the separate cubes which were put into the hoop. Especially in the neighborhood of any small openings in the cheese, the separate cubes show plainly. The granular cheese is more apt to crumble in cutting thin slices. If pressed a little too cold or too lightly, so that the rind is not perfectly closed, the same appearance of small distinct curd particles can often be seen on the outer surface.

The matting process which has largely displaced the granular process has advantages (1) in allowing the curd to be held longer in the vat before pressing, to develop more acid, and to work out any gas or pinholes, thus greatly reducing the danger of gassy cheese, which may happen frequently where the granular process is used regularly. (2) The granular process usually makes a cheese of less close and uniform texture. For these reasons the matting process is very generally considered a decided improvement over the granular process, in the making of American cheese.

(206) **Monterey Cheese: Jack Cheese.** The first name is derived from Monterey county, California, where its manufacture was first taken up on a large commercial scale about 1916. Previous to that time, it had been made by Portuguese farmers in California, often from the milk of a single cow or small herd on the farm. It is made either from whole milk, or sometimes from half skim milk, and in the latter case becomes quite dry, so that it is grated for use in cooking, like Parmesan, Sap Sago, and other very dry skim milk cheese.

The process employed with whole milk is practically the same as the granular process described above, but the curd is salted while yet warm, being stirred only a short time after drawing the whey. It is finally pressed in a cloth bag, giving it a peculiar shape.

(207) **Method of Making Jack Cheese.*** The cheese is made every morning from night's and morning's milk. The mixed milk should not test higher than .16% acidity and should have a clean flavor. Standardize the milk to 3.1 or 3.2% fat. Heat the milk to 86° F. and add ½ to 1% commercial starter (clabbered milk). Add sufficient rennet

* Private communication to the author from Prof. H. J. Baird, University of California.

(about 6 oz. per 1,000 lbs. milk) to curdle the milk ready for cutting in 25 minutes. (Dilute the rennet about forty times its volume with cold water before adding.) The time for cutting is determined by the same method as for Cheddar, testing the curd for firmness. The curd is also cut in the same manner as for Cheddar. After cutting, the curd should be allowed to stand a few minutes before stirring, then stir gently with the hands. Stir the curd sufficiently during the cooking process to prevent matting. The heat should be applied ten minutes after cutting and the temperature raised to about 110 to 112° F. in 35 minutes or at the rate of about 3½ degrees in five minutes. It will take about 35 to 40 minutes to firm the curd after it reaches the maximum temperature, but the only method for determining the time for dipping should be the firmness of the curd. The curd should be slightly rubbery but not so firm as curd for Cheddar cheese. The whey is removed and the curd stirred sufficiently to remove the excess whey. (Too much stirring injures the curd; *do not* handle it roughly.) Salt is added while the curd is warm at the rate of 3 lbs. per 1,000 lbs. milk and after it is thoroughly mixed and dissolved the curd is ready to press.

The press cloths used for molding these cheese are made of heavy sheeting and are about 34 inches square. The cloths are laid out evenly, one over the other, and are spread over the top of a large open pail. Push the center down to the bottom of the pail leaving the edges hanging over the sides. Sufficient curd (about 7 lbs.) to make a six pound cheese is weighed out and poured into the top press cloth. The four corners of the cloth are caught up with the left hand, while with the right hand the curd is formed round and the cloth straightened. The cloth is now taken up tightly over the curd with the left hand, while the cheese is given a rolling motion on the table, with the right hand pressing at the same time to expel the whey. This twists the press cloth tightly over the curd, where it is tied with a string. The excess cloth is spread out evenly over the top of the cheese and it is then ready for the press.

The cheese are pressed between two wooden planks, 12″x1½″ surfaced; the length will depend upon the number of cheese pressed or the size of the room. The first board should be laid with a slight slant to permit the whey to drain off readily. The cheese are then placed in the center of the board about one inch apart after which another board is placed on top. If necessary the cheese can be placed four or five layers deep if a board is placed between layers. Best results can be gotten by placing the boards and cheese in an ordinary upright cheese press. Another method is to brace the first board, near a wall, about three feet from the floor; then level with the top board a lever (2x4, 5 feet long) is fastened to the wall with a hinge which will allow it to be raised or lowered. These levers, one every four feet, are laid over the top board and a weight (about 100 lbs.) is fastened to the other end. This acts as an automatic press. The cheese are left in the press about fifteen hours after which they are removed, the press cloths taken off, and the cheese laid on the shelves. If the press cloth sticks to the cheese, pulling out pieces of cheese when removed, this is a sign that the surface gets too dry while in the press. Water thrown on the cheese occasionally or the room kept moist will prevent this. In about two days after removing from the press the cheese should be dipped in hot (200 to 220 degrees F.) paraffine and held there for 10 seconds. This will prevent shrinkage and give the cheese a neater appearance.

(208) **Half Skim Jack Cheese.** Milk used for half skim Jack Cheese should test 1.8 to 2% fat. The night's milk may be skimmed and the skim milk mixed with an equal amount of morning's whole milk. The rate of rennet extract should be decreased sufficiently to curdle the milk ready for cutting in about 45 minutes. The cooking temperature

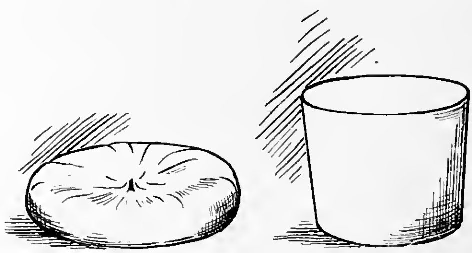

Fig. 36.—Jack Cheese Pressed in Cloth (at left). Home Made Cheese Pressed in a Lard Pail (at right).

should be lower; about 104 to 106 degrees F., and the whey should be removed when the curd is about the same firmness as for full cream Jack. The cheese should not be paraffined as they are usually dried for grating purposes.

(209A) **Home-made American Cheese.** In the early days of the cheese industry in this country, cheese was made at home on the farms, from the milk of a few cows, by the farmer or some member of his family. The question is frequently asked as to whether cheese of the American type can not be made successfully for home use, or for sale to neighbors, in localities where there are no cheese factories, but where a small quantity of milk is available.

A family cheesemaking outfit can be rigged up at home, if the process is well understood, but a complete outfit together with brief directions for making cheese at home can be purchased from dealers. The outfit includes a 20 gallon tank and stand for holding milk, a small lamp-stove for heating the milk, a thermometer, press and hoop, supply of rennet tablets, cheese color, curd knife, bandages, hot iron test, directions, etc. It makes cheese of 10 pound size, and costs $25.00 or more, complete.

Where cheese is made at home, provision for curing in a moderately cool place must be made. The cheese may be rubbed with grease on the rind to prevent cracking, and kept in a cool cellar, cave, or well, for curing until used. It is even possible to cure cheese at summer temperatures out of doors, but there is much loss of weight from loss of moisure and of fat, and loss of quality from drying out and development of strong flavors, so that such curing is not advisable.

Very heavily salted cheese will keep better in warm climates, and while too tough to eat, may be grated and used in cooking.

For use at farms or small factories, having no steam, self-heating vats can be obtained, having a small stove under the milk pan, which holds 200 lbs. of milk or more.

A simple method of making cheese at home on the farm is as follows: Use at least two pails of fresh, sweet milk, or of morning's milk and night's milk mixed together, provided that the night's milk was promptly cooled when fresh and kept cool, about 50 degrees F., until morning. This quantity of milk, about 50 lbs, will make about 5 lbs. of cheese.

Heat the milk to about 90 degrees, using a thermometer, and immediately add a rennet tablet dissolved in half a glass of cold water. Stir the solution thoroughly through the milk, at 90 degrees, and cover the pan so as to keep the milk from cooling. Notice by the clock the time when the rennet was added, and watch closely to see when the milk first thickens, which may take 5 to 15 minutes. Then cover and leave the milk about 2½ or 3 times as long, that is 20 to 45 minutes, until firmly thickened. Cut the curd with a long bladed knife back and forth making a checkered pattern with half inch squares. Then cut the curd cross ways, using a bent piece of tin or a wire frame, such as is used for toasting bread. See that the curd is all cut up into pieces no larger than ½ inch cubes. Stir the curd gently by hand, or with a large spoon, being careful to keep it in as even sized pieces as possible. After stirring about 15 minutes, begin to heat again, stirring all the time to prevent scorching the bottom. In half an hour, raise the temperature to about 100 degrees, but no higher. Stir frequently after heating, to keep the curd from sticking together to form large lumps. After half an hour, when the curd is firmer, it may be heated to 110 or 105 degrees. When quite firm, about 1½ or 2 hours after cutting the curd, pour it on a cloth to drain. After draining has about stopped, break up the curd by hand or cut it into nut sized pieces with a knife. Stir about 3 ounces of salt into the curd, adding it in three portions, and mixing thoroughly. About 15 to 30 minutes later, when the salt is well dissolved, the curd may be filled into a flaring lard pail, or similar metal can, from which the bottom has been removed, or with a number of holes punched in the bottom for drainage, to serve as a cheese hoop. The hoop is set on a piece of burlap cloth in place in the press before filling with curd, and afterward another cloth and a wooden cover are put in the hoop on top of the curd, and pressure is applied. The object in pressing is to close up the curd into a solid mass, and especially to close the rind or surface perfectly, so that no openings are visible. Without a perfectly closed rind, the cheese is apt to become moldy inside during the curing process. The pressure may be applied by means of a screw fruit press, or cider press, or by means of a plank and weight. For this sort of home made press, set the hoop on the floor near a wall, nail a cleat to the wall about 3 inches above the top of the hoop. Put the end of a six foot plank under the cleat, and over the wooden block covering the curd. Hang a pail of stones on the outer end of the plank, and leave until morning, well covered to protect the cheese from flies, rats, dogs, rain, etc. After pressing for an hour or two, take out the cheese, wrap it in a piece of cheese cloth, and put back in the hoop, and leave it over night. After the cheese is taken from the press next day, place it in a cool, well ventilated cellar, and in a few days when the rind is dry but before it begins to crack, grease the rind well, wrap it in a cloth bandage, and hang it in a basket in a cool cellar, cave, or well, to cure. The cheese may be rubbed and greased again every few days to keep it from becoming moldy on the surface, and in four weeks' time at about 60 degrees it should be ready to eat but is better if older.

In cutting cheese, keep the cut surface flat and smooth, and turn it down on a clean plate to prevent drying out, or cover it with cloth wet with salt brine, or simply grease the cut surface with butter, each time it is cut. If it gets moldy, this is due to being kept in too damp a place.

Home made cheese may also be made and pressed like Jack cheese (207).

(209B) Pineapple Cheese. This is a rather firm make of American cheese, put up in pineapple form, and made for many years by one or two eastern factories. The curd after pressing is hung up in a net bag, so that the cord of the net make an imprint on the surface of the cheese. A neater appearance can be made with a corrugated metal mold instead of a net bag.

(210) Skim Milk American Cheese. Cheese prices must go unusually high, in order that the income from the making of skim milk cheese at a creamery may exceed the feeding value of the skim milk for live stock. The cost for equipment, supplies and labor is about the same as for making whole milk American cheese; the market is limited, very few dealers handling skim cheese; and the demand from consumers is small.

Small factories can not keep both a cheesemaker and a buttermaker busy, and large creameries are likely to undertake the manufacture of skim cheese only under exceptional conditions.

Viewed from the standpoint of the dairy industry, the making of skim milk cheese is likely to be a detriment, unless safeguards are provided to avoid the suspicion that unscrupulous dealers substitute skim cheese for whole milk cheese in the markets.

(211) Laws Relating to Skim Milk Cheese. Tabular statements of the standards for dairy products established by law in different states are published by the Bureau of Animal Husbandry, U. S. Dept. of Agr., Washington, D. C. In the majority of cases cheese containing less than 50 per cent of fat in the dry matter are classed as skim milk cheese.

While some states require skim cheese to be so labeled on the bandage, yet such labels are readily removed by unscrupulous dealers, and consumers are always liable to suspect that any cheese from such states are made in part or wholly from skim milk, and have been fraudulently substituted for whole milk cheese in the market.

Since 1898, in the state of Wisconsin, the law has required that all skim or part skim cheese shall be made 10 inches in diameter and 9 inches in height, so as to be readily recognized and distinguished in the markets from whole milk cheese, which are never made in this size and shape. As a result, no skim milk cheese have been made at either American, brick, Limburger or Swiss cheese factories in Wisconsin for many years, and the state's industry is fully protected by this law both from fraud and suspicion of fraud. No more effective method of distinguishing and labeling skim milk cheese could be devised than the one just described.

Another equally effective method of unmistakably marketing skim milk cheese, devised at the Wisconsin station in 1918, consists of adding 1 ounce of cheese color per thousand pounds of milk in the vat, to about 1/10 of the vat content, just after adding rennet, and before the milk has begun to thicken. For this purpose, a movable partition is temporarily placed in the milk near one end of the vat after adding rennet, and the regular cheese color is stirred into the small portion of the milk behind the partition. After all the milk has thickened, the partition is carefully lifted out. Thus without extra cost or trouble the cheese is effectively labeled with a speckled pattern through the interior which is striking, attractive, not at all repulsive in appearance, and which can never be removed from the cheese. The colored curd can also be made in a separate vat.

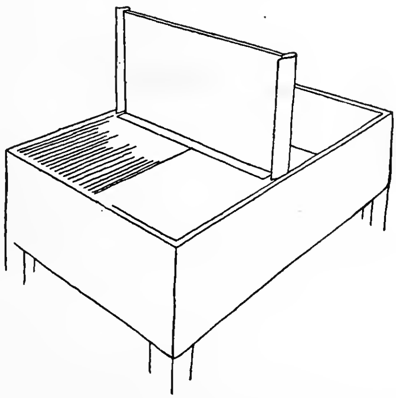

Fig. 37.—Movable Partition For Dividing Cheese Vat. The sheet metal flanges on the sides and bottom of the partition are bent to fit the vat snugly. The partition remains firmly in place while the color is being stirred in, and can be lifted out with ease after the milk has thickened.

It is possible that skim milk cheese thus marked might be made in any convenient size and shape used for whole milk cheese, if permitted by law, without danger of fraudulent substitution. The laws relating to whole milk cheese, limiting the moisture content to 40% or less, do not apply to skim milk cheese, as these regularly contain over 40% moisture.

(212) **Methods of Making Skim Milk American Cheese.** In making whole milk cheese, the whey is drawn when the curd is firm and when the whey acidity is about .18%, corresponding to milk acidity of .24%. In making skim milk cheese, the curd becomes firm much faster, so

that it is necessary to set the milk at a higher acidity, in order to draw under the same conditions of acidity and firmness as with whole milk cheese.

With separator skim milk to start with, this may be ripened to .24% with 5 to 8 lbs. of starter, and set at 84–86 degrees with 3½ ounces of rennet extract, so as to cut in 30 minutes. After cutting, the curd is stirred by hand for a time, without raising the temperature, and a part of the whey is drawn out. When the curd has become firm enough, as judged by the feeling of handful, so that it can be piled up on the bottom of the vat, and not run down like wet mortar, and so that the curd will drain and mat well without collecting around the strainer and clogging it, the remainder of the whey is drawn, and the curd is piled up to mat.

If the milk is sweeter than directed above, a longer time will be required to get the curd firm before drawing the whey.

The piled curd mats rapidly, and is soon cut into blocks and turned. Half an hour after drawing whey, the curd can be milled without danger of shattering, and a few minutes later it is salted, and as soon as the salt has dissolved, the curd is hooped.

Just after milling, and before salting, the curd may be rinsed with cold water to cool it and prevent it from becoming too dry. One to 1½ lbs. of salt per 100 of curd is used, and the pressed cheese should be paraffined as soon as the surface is dry. They may be ripened for 30 days at about 70 degrees.

With half skimmed milk, containing about 2 per cent fat, the process is intermediate between that for whole milk and for separator skim milk. With 2 or 3 lbs. of starter per 100 of milk, it is ripened to about .22% and set to cut in 20–30 minutes, at 84–86 degrees.

After cutting, the vat is gradually heated to about 92 F., and as soon as the curd is elastic and drains well, which may take 30 minutes or longer, the whey is drawn at about .18% acidity, and the curd is matted. It is cut into strips and turned as usual. When well matted and meaty in texture, as with whole milk cheese, it is milled, salted with 1½–2% of salt, and hooped as usual.

As already stated, there is at present no way by which skim milk cheese can be made or kept in exactly the shape and size required by law in Wisconsin, on account of shrinkage, etc.

(213) **New York Soaked Curd Cheese.** Soaked curd cheese are made in New York state, often from partly skimmed milk, by the methods described above, with this difference that after milling, the curd is covered with cool water at 65–70 degrees, and allowed to soak for 5–10 minutes or longer, during which time they absorb some of the water and retain it, so as to produce a larger yield, but an inferior quality of product. After soaking, the water is run out, the cheese are salted and pressed as usual.

(214) **Sage Cheese.** Sage cheese is a favorite cheese with some people and is manufactured to a limited extent in certain localities in this country. It is made in exactly the same way as common American Cheddar cheese, with the exception that a sage flavor is imparted to it, preferably by adding sage leaves to the curd, three ounces being sufficient for the curd from 1,000 lbs. of milk. The sage should be weighed, all stems picked out and the leaves finely powdered and added to the curd just before salting.*

(215) **Pimiento Cheese.** In a similar way, canned pimiento is sometimes added to American cheese curd after salting, so that the red color is distributed unevenly throughout the cheese and the flavor is noticeable in all parts after curing. The pimiento is a sweet pepper, with a fleshy pod, grown in Spain, California, Ohio, and in a few other localities It is canned like other fruit for the market.

(216A) **Club Cheese and Similar Preparations.** Club cheese is made by running well cured American cheese through a grinder or mill, reducing it to a smooth paste, and mixing in a certain amount of butter with or without other flavoring materials. About 1 ounce of butter to a pound of cheese is a fair proportion, but somewhat more or less can be used.

The stronger flavored and older cheese are preferred for making club cheese. An old cheese partly damaged by mold in the interior and bought at a reduced price can be cleaned

* Michigan Spec. Bull. 21; Farmer's Bull. No. 202.

by cutting out the moldy portions and the remainder is often very satisfactory for club cheese. The product is put up in small jars.

Club cheese containing more or less butter is often flavored with pepper, either black pepper or a red pepper as cayenne, pimiento, or paprika. If colored green and with a peppery flavor, it is known as chili cheese, and by a variety of trade names.

(216B) **Canned Cheese.** During the recent years, at least one American cheese factory has put up fresh curd as taken from the press, in cans which were then sealed air tight. As no preservative or heating was used, the cans frequently swelled from an accumulation of gas, which, however, did not indicate that the cheese had spoiled.

Other methods have also been devised commercially by which cheese are sealed in cans, in a thoroughly sterilized condition, so as to keep without swelling, and in good condition for a long period. These products, put up under various proprietary names are well suited for use by travellers, and for table use, as they come in individual portions as well as larger packages and there is no rind, or other waste.

(217) **Cheese from Pasteurized Milk.** The importance of pasteurizing milk for drinking purposes, as a protection against the spread of typhoid fever, tuberculosis, and other diseases is well recognized. In the leading dairy states, the pasteurization of the by-products of cheese factories and creameries is required by law, before these materials may be used as feed for farm stock, to prevent the spread of tuberculosis, etc. It has been demonstrated that when milk in the cheese vat was intentionally infected with tuberculosis germs and then made into cheese, the cheese so made was capable of infecting guinea pigs to which it was fed seven months later. In view of these and other facts, authorities have recommended that milk for cheese making should be pasteurized.

On account of the extra expense for buying pasteurizing machinery and extra labor for operating it, it does not seem likely that any pasteurization process is likely to be adopted by small, one-man cheese factories, unless required by law.

While experimental trials of methods of making cheese from pasteurized milk have been made at several Experiment Stations, the most extensive experiments and commercial trials have been made by the Wisconsin Station.

As the pasteurization of milk renders it incapable of coagulating like raw milk with rennet extract, some special treatment is necessary to correct this fault. For this purpose at the New York (Ithaca) College of Agriculture, milk was heated to 165 and cooled to 90 degrees, and then treated with 2 cc. of 25% calcium chloride solution and 2 to 3 pounds of lactic starter per 100 lbs. of milk. Rennet extract at the rate of 3 ounces per 1,000 lbs. of milk was then added and the milk thickened first in about 5 minutes and was ready to cut in 40 minutes.

At the Wisconsin Experiment Station, the following method was developed. The milk pasteurized at 165 and cooled to about 75 or lower, was treated with enough N/1 strength hydrochloric acid to raise its acidity to .25%, calculated as lactic acid. Three-fourths per cent of starter was then added and after heating to 85 rennet extract is added at the rate of 2 ounces per thousand pounds. The particular feature of this process is that the acidity required is gained instantly by the addition of hydrochloric acid, and as a result the rest of the process can be carried on according to a fixed time schedule, which has been found very helpful in a large factory where one cheesemaker and half a dozen helpers did the work.

The time schedule for making cheese by the Wisconsin Method, after pasteurizing and acidulating, is as follows:

Operation	Time intervals between operations		Total time after adding rennet	
	Hrs.	min.	Hrs.	min.
Adding rennet	0	0	0	0
Cutting the curd	0	25	0	25
Beginning to heat	0	15	0	40
Turning off steam	0	20	0	60
Placing rack, after drawing whey	1	25	2	25
Milling the curd	1	30	3	55
Salting the curd	1	00	4	55
Hooping the curd	0	20	5	15

The Wisconsin method of making pasteurized milk cheese was given practical trials by the Station, making 14,394 lbs. of cheese on 142 days during 1912 and 1913, at four commercial Wisconsin factories in four counties. In addition, during 1914 and 1915, a firm of Chicago milk dealers manufactured 1,113,000 lbs. of pasteurized milk cheese by this process at three of their plants, as a means of utilizing surplus milk, with good success.

CHAPTER XXIX.

DETAILS OF AMERICAN CHEESEMAKING PROCESS.

Intake Work. The inspection and testing of milk at the cheese factory intake, has been described in Chapter III.

(218) **Ripening the Milk.** As soon as the milk is all in, it is tested for ripeness and heated to the cheesemaking temperature, usually 86 degrees. With the necessary amount of starter added, it is ripened to the desired acidity, if not already ripe enough.

The best acidity at which to add rennet to milk is a matter on which makers do not always agree, but after working at a factory for a few days, the maker will choose what seems best to him. With ordinary Holstein milk, he may prefer to add rennet at a milk acidity of .165%, and thus allow a longer time for cooking and firming the curd, than if set at a higher acidity. Other makers may prefer to ripen milk to .175% and a few will ripen to .19% or .20%, thus spending more time in ripening and shortening the time for getting the curd firm in the whey before drawing the whey.

It may often happen also that the milk may come in at a higher acidity than desired, so that the maker must do the best he can with it, add rennet as soon as possible and work rapidly.

In starting work at a new factory at the beginning of the season, the milk may be ripened to about .175% before adding rennet, and its behavior watched closely afterward, from which the maker may decide to ripen differently on the following day.

(219) **Keeping a Make Room Record.** Cheesemakers, especially young makers, are strongly urged to get a blank book about 5 by 8 inches, and keep a daily record of the methods used with each vat of milk. The notes should

contain the amount of milk in the vat, and the weight of green cheese taken from the hoops or the weight of cheese when boxed for shipment, thus giving some knowledge of the yield obtained for comparison with the milk fat test, etc., and other days' yields.

The amount of starter and the time of adding it; the ripeness test of the milk when all in and when set with rennet; the proportions of color and of rennet used and the time when adding rennet, cutting curd, beginning to heat, turning off steam and final temperature of vat may all be jotted down with a pencil as the work is being done. The different tests for acid in whey or curd and time when the whey is drawn, whether the curd was stirred, or rinsed before matting, the time of milling and of salting and the proportion of salt used.

The advantages of keeping a record are that if the cheese do not turn out well, it is possible for the maker to figure out what should have been done differently and to get advice from another party as to changes in method. The notes may well include any unusual occurrences, such as "warm night," "patrons later than usual at the intake," "milk riper than usual," "milk bad flavored," "defect in equipment delayed work," etc.

(220) **Adding Color.** Cheese color is commonly added to the milk at the rate of about ¼ ounce per thousand pounds in summer, or 1 ounce per thousand in winter. When cows are on grass, the milk has nearly enough color naturally. White or uncolored cheese are made only when the factory has received an order for such cheese in advance and when not specified as white, it is assumed that cheese will be colored.

Where the rennet test is used at a factory, the color should be added to the milk before the first rennet test is made, to avoid having lumps of white curd from the rennet test mixed through the colored cheese.

Where the acidimeter is used in testing the ripeness of milk, it is better not to add color to the vat until the milk is fully ripened and ready to add rennet, because the cheese color in milk gives it a slight reddish tinge, so that the end point of the acidimeter test is not so readily seen.

Color may be added directly to the milk in the vat without first diluting with water. In stirring in color, it is well to note in some way how much stirring is necessary to distribute the color evenly, by observing how many minutes are spent in stirring, or how many times the rake is pushed across the vat, or how many times the maker walks the length of the vat before the color appears to be evenly mixed. This gives a clear indication as to how long the milk should be stirred after adding rennet extract, which is the next step.

(221) **Adding Rennet.** Rennet extract at the rate of 3 or 4 ounces per thousand pounds of milk is measured in a graduate. Small amounts of rennet may be measured, when needed, in cubic centimeters, remembering that 1 ounce equals about 30 cc. A pipette, burette, or 100 cc. cylinder may be employed.

The measured rennet extract or pepsin solution or a mixture is poured first into some clean cool water. The quantity of water for 5,000 lbs. of milk may be one or two pails, equal to ½ or 1% of the milk. After mixing the extract through the water, set the pail down near the vat. Set the milk in motion either with the agitators, or by stirring crossways with the rake. (Stirring lengthways is likely to cause high waves, and throw the milk over the end of the vat.) While the milk is in motion, pour from the pail into the middle of the vat, while walking briskly along the side, so as distribute the extract evenly from one end to the other. Quickly take up the rake, if used, and stir again across the vat, while walking 2 or 3 times along the length of the vat, so that the rennet is evenly distributed in the milk as quickly as possible and within 2 or 3 minutes after the addition was made. The agitator may be run while adding rennet, instead of using the rake, if preferred.

Rapid work is needful, because the milk is likely to begin to thicken in 8 minutes after adding rennet, and if three minutes is required to complete the stirring, there will be only five minutes left during which the milk must become perfectly quiet, before the first visible thickening occurs. If milk is moving or is stirred after it has begun to thicken, there is likely to be loss of fat in the whey, dry texture and loss of yield.

During the thickening, for the same reason, the milk should not be jarred by anyone leaning against the vat, by heavy walking across the floor, or by moving machinery, etc. Cover the vat to keep the milk surface warm.

(222) **Top Stirring.** If milk will require more than 8 minutes before first visible thickening, it may be top stirred by running lightly over the surface of the milk with a rake or dipper about 3 or 4 minutes before it is expected to thicken, to stir down cream, but so as to allow the milk to become quiet again, before thickening occurs. Before top stirring, make sure that thickening has not already begun.

(223) **First Visible Thickening.** It is an advantage, in many cases, to note by the watch the exact time when rennet was added, and again the time when the milk shows the first sign of becoming thick. The first sign of thickening can be detected either (1) by lowering a horizontally held thermometer or finger below the surface of the milk, which will cause a permanent depression in the surface, as soon as thickening occurs, or (2) by dipping a glass tube or glass plate into the milk at short intervals, lifting it out quickly and looking to see whether the film of milk adhering to the glass contains small granular particles, which will be visible as soon as coagulation begins.

If a vat of milk requires, for example, 10 minutes after adding rennet before the first visible thickening occurs, the maker can expect that the curd will be ready to cut in about 2½ or 3 times 10 minutes, that is, in 25 or 30 minutes after rennet was added. By knowing this rule, he can go ahead with other work, and return to the vat at just about the right time for cutting.

(224) **When Curd is Thick Enough to Cut.** If a curd is cut when very soft, the whey which separates is likely to be somewhat white and milky, showing an unnecessary loss of fat and perhaps of casein. Also a very soft curd is more likely to be broken and mashed during the stirring after cutting, causing further loss.

Before cutting, cheesemakers split the curd with a finger or a thermometer, and look to see if the whey in the break is clear or milky, also whether the break shows a lot of finely broken curd which sticks to the finger, or not. If well thickened, the whey is clear, and no small broken pieces of curd stick to the finger.

Other tests may be used just before cutting the curd. Some makers lay the back of the hand on the curd close to one side of the vat, and by a sideward motion try to pull the curd away from the tin. If the curd stretches, but does not separate from the tin, it is too soft to cut. If it splits away from the tin readily, it is firm enough to cut.

By laying the back of the hand on the curd in the middle of the vat, and pressing down, the firmness of the curd can be judged. On moving the hand up and down, so as to shake the curd and cause ripples to move across its surface, it will be noticed that when the curd is quite soft, the ripples will travel several feet across the curd surface, but when quite firm and ready to cut, the ripples will not move farther than one foot from the hand. Each maker prefers one of these tests or another, and the student should try *all* of them.

(225) **Cutting Curd With the Horizontal Knife.** Rest the upper end of the horizontal blade or wire curd knife against the inside upper edge of the vat end; with the knife held nearly horizontal, swing the knife downward into the curd, with a motion like that of a pendulum falling from a nearly horizontal to a perpendicular position, the knife stopping against the end of the vat, and just touching the vat bottom. In this way the knife is inserted with a cutting motion and without breaking or mashing the curd. The second movement of this knife carries it along the length of the vat, close to the side, to the opposite end. The third movement swings the knife around (like a door) in the curd, ready to move next down the length of the vat again toward the first end. Each lengthwise cut is made as close as possible to the edge of the preceding cut, so that no uncut curd is left between them.

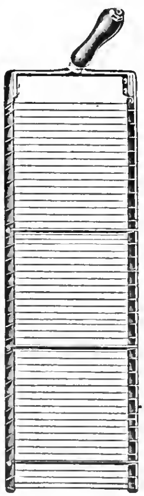

Fig. 38A—Horizontal Wire Curd Knife.

In this way, turning the knife at the ends of the vat, and cutting forward and backward the long way of the vat, the curd is all cut into horizontal layers, like blankets on a bed, and the knife is finally taken out by a pendulum-like motion the reverse of that with which it entered the vat.

When making the last cut lengthwise of the vat, it may happen that the curd mass is slightly wider than the curd knife. In such case, cut next to the side of the vat, leaving a narrow strip of uncut curd between this last cut and the preceding one.

(226) **Cutting Curd With Vertical Knife.** Next insert the vertical knife into the vat at one corner without mashing the curd and cut across the width of the vat. The knife is taken out at the end of each cut, moved along its width toward the right and put into the curd again. The position of the knife while moving across the vat is straight up, but while going in or out of the curd, the knife is tipped away from the side of the vat, so that the cross bar at the bottom end of the knife does not mash curd while moving up or down.

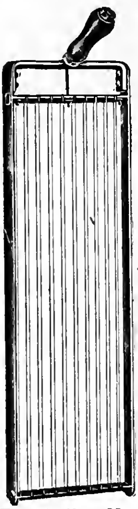

Fig. 38B.—Vertical Wire Curd Knife.

After cutting crossways of the vat with the vertical knife, the curd is next cut lengthways with the same knife and in the same manner. Three-eighths inch wire knives have largely replaced the ½ inch blade knives in recent years, being much lighter in weight, and with proper care the wires seldom break. The object of cutting is to divide the curd into small uniform cubes.

(227) **Stirring Curd After Cutting.** Very soon after cutting, test the whey for acidity. If the cubes are left quiet, in contact with each other, after cutting, they will begin to stick together again, forming lumps of larger size, and when stirred later these lumps will break up into irregular pieces of all shapes and sizes. It is necessary therefore to stir the vat enough, beginning very soon after cutting, to retain the curd in cubes of uniform shape and size. The stirring should be begun with a slow motion of the maker's washed arms and hands, reaching down through the curd to the bottom of the vat, fingers together, starting at one end of the vat and moving in long strokes across the width of the vat,

toward the other end. The object at first is to move each cube slightly away from its neighbors, so that they will not stick together. This stirring should be continued steadily, as long as necessary, but at the same time it must be done gently, not violently, to avoid mashing the curd cubes, and to prevent a high loss of fat in the whey. With care, the fat loss can be kept low.

During the first 15 minutes of stirring, before heating begins, the curd should be loosened from the tin surface of the vat at all points, especially at the bottom, corners, and upper edge of the milk, to prevent the curd from sticking fast and being overheated, after heating begins.

After stirring by hand for the first few minutes, the rake may be put in, or the agitator started, just before beginning to heat. With a well thickened curd, some makers start the

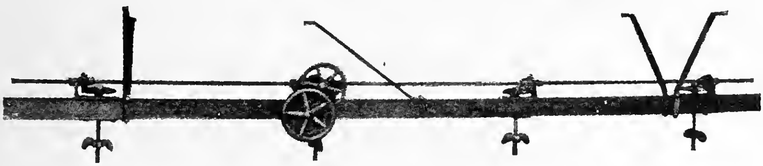

Fig. 39.—Mechanical Curd Agitators Save Much Time and Labor. Revolving paddles hang in the vat and stir the contents.

agitator immediately after cutting, especially in factories where the agitator is provided with a slow speed (6 or 8 R. P. M.) for use at first, and a higher speed (10–12 R. P. M.) for use during and after heating.

The cleanly cheesemaker will not forget to dip a rake or other utensils in scalding water just before putting it into the milk, and to wash his hands and arms before using them for stirring.

(228) **Heating Up the Vat.** After the curd has shrunk and settled somewhat below the level of the whey (which may take 15–20 minutes if slow working, or 5–10 minutes if fast working), the heating is begun, raising the temperature 5 or 6 degrees during the first 10 minutes, and 9 or 10 degrees during the next 10 minutes, until the desired temperature, usually 100–102, is reached.

The stirring must continue without stopping during the heating, to prevent part of the curd from remaining on the vat bottom, thus being heated too high.

After the vat is heated up, the stirring must be continued for 15–30 minutes to keep the curd cubes from uniting to form lumps. Any lumps formed should be broken in two by hand. After the curd becomes firmer, it is not so likely to become lumpy, and stirring may be stopped for a few minutes at a time, if desired. To stir a large vat of curd with a rake, and keep it free from lumps, requires considerable strength and skill. Where the agitator is used, it may be run continuously, if desired, until the whey is drawn.

(229) **Uniformity in a Vat of Curd.** The cheesemaker's aim should be to keep all parts of the curd in the vat in uniform condition in all respects, so far as possible, that is, to keep the cubes of uniform size, avoid irregular cutting, or the production of a lot of very small or very large sized curd pieces or lumps, also to keep the temperature uniform in all parts of the vat. If the closed steam valve leaks slightly, a little steam entering the jacket will heat some parts of the milk or curd hotter than desired, which should be avoided.

If the steam pipe, between the valve and the vat, contains a short length of steam hose, or a hose coupling, or a lever union, by which the connection with the vat can be quickly broken without trouble, all danger from steam leaking into the jacket is avoided.

(230) **Conditions Affecting the Separation of Whey from Curd.** In milk containing 87% of moisture and 2½% of casein, there are about 35 lbs. of water to 1 lb. of casein. In whole milk American cheese of average composition, there are about 1½ to 1¾ lbs. of moisture per pound of casein.

The separation of whey from curd, by which the moisture content of the curd is reduced, begins at the time the curd is cut and goes on very rapidly at first, but more slowly as time passes. For example, in one case, 100 lbs. of curd lost 32 lbs. of whey during the first half hour after cutting, 20 lbs. during the next hour, and 10 lbs. during the next hour, before the curd was matted.

Immediately after the whey was drawn from the vat and the curd piled to mat, the curd gave up whey again more rapidly, losing 10 lbs. in 15 minutes, 3 lbs. the next

15 minutes, and 4 lbs. during the next hour, before the curd was milled.

The curd after milling continued to lose whey slowly, the amount being about 4 lbs. in 2 hours, before the curd was salted.

After salting, the separation of whey from curd was again hastened slightly by the action of the salt, and of course there were further losses in pressing and curing.

(231) **Proportion of Rennet Used.** It is well known that milk thickens more quickly when a large proportion of rennet extract is used, but after the milk has thickened and the curd is cut, the curd gives up moisture at the same rate whether more or less rennet was added to the milk.

Where milk is overripe, enough rennet should be used to secure rapid coagulation, so that the curd can be cut without loss of time, but the rate of whey separation after cutting is independent of the proportion of rennet used.

Size of Curd Cubes. The smaller the cubes or pieces into which the curd is cut, the faster the whey will separate after cutting. For example, four vats of the same lot of milk were thickened alike with rennet, but cut with different knives into cubes ¼, ⅜, ½ and ¾ inch, respectively, on the edge. The four vats were handled alike, and in 2½ hours the curds contained 49%, 53%, 58%, and 70% of moisture. These differences in moisture content were due only to the different sizes of the cubes in the four vats.

(232) **Effect of Temperature on Separation of Whey.** A curd set at 86 degrees and kept at 86 after cutting contained 73% of moisture 2½ hours after cutting, but another vat of curd from the same lot of milk, heated to 104 degrees after cutting, contained only 64% of moisture 2½ hours after cutting. The heating of the vat, properly done after cutting, helps to expel moisture and make the curd firm.

(233) **Effect of Acidity on Rate of Whey Separation.** In general, the separation of whey from curd goes on faster if there is a moderate amount of acid in the milk and curd, than if they are perfectly sweet. This fact is made use of in cheesemaking. If a cheesemaker wishes to retain more moisture than usual in American cheese, he can do so by

setting the milk somewhat sweeter than usual, with less ripening, and with less starter or no starter.

If milk is quite ripe, or slightly overripe, in the American cheese vat, the curd will give up whey faster and become firm faster for this reason, thus helping the maker to get his curd firm before the acidity has become too high. The cheesemaker may be obliged also to use some other special means to hasten the separation of whey, such as cutting the curd finer, heating it higher, stirring it on the vat bottom after drawing whey, before matting, etc., to avoid sour cheese.

The effect of acidity in hastening whey separation from curd is seen in making other kinds of cheese also, as for example, in making Neufchatel cheese, where with unripened milk it is a long and tedious process to get the curd sufficiently dry, but with ripened milk, handled alike in all other respects, the curd drains rapidly and freely, and is finally pressed dry in a half an hour or less. Many other examples and proofs could be cited to show the importance of proper ripeness or acidity of milk as a factor in hastening separation of whey.

(234) **Effect of Stirring a Curd in the Whey on Moisture Content.** The purpose of stirring a curd in the whey was stated in section 227. A curd which is not stirred enough soon becomes lumpy and the lumps retain more moisture than the small cubes. A curd which is stirred too roughly is apt to be broken into small pieces or fine grains, and in so far as this occurs, it must be expected that the small pieces will give up moisture faster than the regular sized cubes, and thus make the cheese drier and firmer.

If a curd is properly stirred, so as to permit neither the formation of curd lumps, nor of small broken particles, the curd gives up moisture at the normal rate. After the curd is sufficiently firm so that danger of becoming lumpy or broken is past, the moisture content is not reduced more rapidly by either (a) continued stirring as with an agitator, or (b) intermittent stirring done with a rake or by hand. While it seems possible that there might be some difference in the moisture content of curds, due to the method of stirring, as by hand, by a rake, or by an agitator, yet a number of carefully conducted experiments at Wisconsin showed that there is no noticeable difference.

(235) **Effect of Pressure on Separation of Whey from Curd.** When 500 lbs. of curd is piled 5 inches deep on the bottom of the vat, after drawing the whey, the layer of curd 1 inch thick at the bottom of the pile is under a pressure of 400 lbs. due to the curd above it. This pressure greatly hastens the separation of whey from the curd for a short time.

This action does not occur until after the whey has been drawn from the vat, and the curd is piled in the air. As long as the whey in the vat surrounds the curd cubes, the whey buoys up the curd, so that it presses very lightly on the bottom of the vat when it settles. A cube of curd which weighs 1 gram in air, weighs only about 1/43 of a gram when surrounded by whey. If the 500 lbs. of curd in the vat is allowed to settle to the bottom, before the whey is drawn, it exerts a pressure of about 1/43 of 500 lbs., or 11 to 12 lbs. on the bottom of the vat. When the whey is drawn, the lifting effect of the whey is lost, and the curd in the air now exerts its full pressure of 500 lbs. on the vat bottom, and on the lowest layer of curd. Drawing the whey and piling the curd for matting is thus one way to apply a certain amount of pressure, which greatly aids in expelling moisture from the curd.

(236) **Effect of Stirring a Curd in the Air Before Matting.** If we remember that a curd gives up very little or no whey while in a large mass before cutting, but gives up whey very rapidly after cutting, it is easy to understand that curd in small cubes on the vat bottom, after drawing whey and just before matting, gives up moisture more readily than it does when in a single large mass just after matting. The effect of stirring the curd to prevent matting has the effect of keeping the curd in the form of small cubes longer, and in this manner permits more complete separation of moisture, producing a dryer curd and cheese. Stirring the curd to delay matting, after drawing the whey, is an effective means of rapidly firming any curd, which is too moist when the whey is drawn. Possibly the slight pressure exerted on curd in stirring may help a little.

(237) **Proportions of Fat in Milk.** Careful experiments at the Wisconsin Station, not yet published, have shown clearly that with two vats of whole milk, containing different percentages of fat, as from Jersey and Holstein cows, and handled exactly alike in making cheese, the ratio of moisture to casein is the same, and independent of the fat content of the milk. Other experiments in which whole milk and part skim milk were compared appeared to indicate that the casein in a skim milk curd gives up moisture more rapidly than in a whole milk curd. This difference is being studied further.

As fat is not soluble in water, it is clear that the water in cheese is carried by the casein, and the casein, more than the fat in normal milk, affects the rate of separation of whey from curd and the final moisture content of the cheese.

(238) **Watching the Development of Firmness and of Acid in Curd.** Two important changes go on in the curd, after cutting, both of which should be watched closely by the cheesemaker. These are (1) the separation of whey from curd, by which the curd becomes dryer and firmer as time passes, and (2) the development of acid by the bacteria in the curd, shown by the hot iron test on the curd, and by the acidimeter applied to the whey immediately after cutting and again at intervals.

(a) Under the best conditions these two, *acid* and *firmness*, develop in the curd at the same time, and the cheesemaker tries to have them do so, in order that at the time the whey is drawn, the curd may have the right acidity and the right firmness.

(b) If the milk is overripe when received, or is ripened too long before adding rennet, or if too much starter is added, the acidity will develop faster than the firmness, and when the acidity is at .17 or .19% the curd will yet be softer than is desirable at the time of drawing whey. The whey should be drawn, and the curd firmed rapidly by special methods.

(c) If the milk is sweeter than usual, or too little starter is used, the curd may become firm before it shows as much acid as desired by the maker. In this case, the whey should be drawn and the curd matted, and kept warm in the vat for several hours, in order to develop the proper acidity before milling or salting.

(239) **Special Methods For Rapidly Firming Curd from Overripe Milk.** When it is known in advance that the milk is riper than usual, the process may be varied in one or more of the following ways, to avoid an acid or sour cheese:

(1) Use little or no starter.

(2) Set the vat as soon as possible, after receiving and heating.

(3) Set the vat to cut in a short time, 20 to 30 minutes.

(4) Cut the curd finer than usual, either by using finer knives, or by lapping the cuts, or by cutting the whole vat of curd once or twice over, in addition to the usual 3 cuts. The extra cutting is usually done lengthwise of the vat with the perpendicular knife.

(5) Begin heating soon after cutting and perhaps heat a few degrees higher than usual. At the time of drawing the whey, the firmness of the curd may be increased more or less by treatment as follows:

(6) Stir the curd over with the hands on the bottom of the vat, one, two, three or more times before allowing it to mat.

(7) If it is quite soft, so that it is difficult to keep it from matting by hand, stir with a wooden rake, teeth downward, while the whey is running out, but shut the gate while there is yet an inch or two of whey on the bottom of the vat, with most of the curd standing above the whey level. Continue stirring with the rake, as long as desired, until the curd appears firm enough, which will take only a few minutes. The whey left in the vat aids in keeping the curd from matting. When firm enough, the curd is drained fully by opening the gate again, and is piled as usual to mat.

(8) An overripe curd is often rinsed with water of the same temperature immediately after drawing whey and before the curd mats. This removes the whey from between the curd cubes, carrying some lactic acid, milk sugar and bacteria which would otherwise go into the cheese. Using four pails of water to rinse a large vat of curd will slightly reduce its acidity, and check a slight tendency toward an acid cheese.

Many factory men make it a practice always to rinse every vat of curd in this manner, believing that they thus improve the flavor, and they do this daily, whether the milk is overripe or not.

This method of using water is sometimes carried further with overripe milk by drawing out half or nearly all the whey from the vat, as soon as the acidity of the whey reaches the selected point and immediately running water at the same temperature into the vat to dilute the remaining whey. The curd may thus be "firmed in water" for the purpose of avoiding a sour cheese. The difficulty with this method is that few factories have at hand a sufficient quantity of clean water (1,000–2,000 lbs.) at the right temperature for the purpose.

Curds thus rinsed or firmed or washed in warm water should not be confused with "soaked curds" described in section 213, where the purpose and effect of using cold water is to cause the curd to soak up water which it would not otherwise hold, to the great injury of its quality.

(240) **Drawing the Whey.** After deciding from the firmness and acidity (.17 to .19% as preferred) of the curd that it is time to draw the whey, the maker should see if the vat has cooled off and if so heat it up to the cooking temperature, about 100 degrees, because the curd will mat more rapidly when warm than if cooler.

The curd is given a final stirring to make sure that it is free from lumps and is then allowed to settle for a minute or two. With a wooden rake, or two rakes, or in New York with a board about six inches wide, as long as the width of the bottom of the vat, and bored with a number of $\frac{3}{8}$- or $\frac{1}{2}$-inch holes, the curd is pushed away from the gate end of the vat moving it forward very slowly to prevent the curd cubes from floating over the rake or board. A space of two feet or more, free from curd, next to the gate is thus obtained. The vat strainer is put inside the vat next to the gate, and another strainer is placed below the gate to catch any escaping curd. The whey is now drawn off rapidly through the gate, or by means of a siphon, if the vat has no gate. Vats with gates are universally used in Wisconsin, instead of the siphon.

To allow the last of the whey to drain out rapidly, the gate end of the vat may be lowered slowly when the whey is nearly all out, but in recent years many vats are made having the bottom inclined downward toward the gate end, so that the curd drains well without tipping the vat.

As soon as the level of the whey goes below the top of the curd, the final draining is made easier if a ditch is made in the curd down the middle of the vat, with the rake, beginning at the gate end. If this is not done, a good deal of curd is likely to be carried along by the whey currents, stopping up the strainer and delaying the draining. The edge of this ditch may be trimmed straight with a large knife and the trimmings spread over the curd in a thin layer.

When the whey is out or nearly so, any necessary stirring or rinsing (239) of the curd is done immediately before the curd begins to mat.

Stray particles of curd on the sides of the vat or in the strainer are brushed down and spread on the curd pile.

(241) **Matting the Curd.** Curd is commonly matted on the bottom of the vat, in Wisconsin, but sometimes on draining racks placed on the vat bottom. The curd is usually stirred little or none, before matting in this State, so that curd sinks are really unnecessary under these circumstances.

To keep the curd warm while matting, the vat should be covered soon after making the ditch. Cold drafts blowing directly on the curd may be avoided by closing doors and windows, when necessary, while the curd is uncovered.

If the room is cold, the curd may be kept warm by running a little steam under the cover of the vat. The practice of running steam into the jacket for this purpose is not recommended, as it is likely to overheat the curd in spots.

The curd is left undisturbed for perhaps 5 or 10 minutes, or until the bottom layer next the tin is well matted, so as to check the draining of whey through the mass. When this occurs, some whey will begin to collect on the top of the curd, or by pressing down with the hand on the upper curd surface, a quantity of whey is pressed out and collects around the hand. The curd is now matted well enough so that it can be cut immediately into large blocks, perhaps 12 by 18 inches, across the vat, and turned over without breaking the blocks. The turning is begun at the gate end where there is some vacant space.

These blocks may be left, after the first turning, for 10 or 20 minutes, or until their under surface is seen to be matted as well or better than their upper surface. The blocks of curd may then be turned over and piled two deep. They are repiled every 10 or 15 minutes, turning them over each time, turning the cold outer surfaces to the inside of the pile, and changing the lower blocks to the top of the pile.

If curds appear to be as firm and dry as they should be, they are piled 4, 8 or more blocks deep. This reduces the exposed surface from which moisture can evaporate, and also puts the curd under more pressure, which causes the firm curd to mat well and close up rapidly. A soft, moist curd on the other hand may be left in piles two blocks deep, as it will mat readily without much pressure, and being spread out will allow moisture to evaporate more freely.

During the matting process, it is desirable to keep all parts of the curd at the same temperature, and this is accomplished by turning the blocks of curd over and repiling them every 10–15 minutes, keeping the vat covered, etc.

(242) **Reasons for Matting Curd.** When the curd is first matted, its acidity is low, as shown by the hot iron test or acidimeter. During the next few hours the curd is to be kept warm, in order to develop more acid, so that it may finally string ½ to 1 inch or more on the hot iron, or test .7 to 1% acidity or more in the curd drippings, by the acidimeter. The curd is allowed to mat during this period (1) because it would be very difficult to keep it in the granular form for so long a time while yet warm, as a great deal of laborious stirring would be required; (2) curd held so long in granular form would become much drier than intended.

The development of acid in the curd as described improves the flavor and texture of the finished cheese, and also greatly reduces the danger of getting a spongy, gassy cheese, which were more common in earlier years when curds were made granular, without matting. Even when there appears to be no danger of gas, it is much safer always to mat the curd.

A granular curd can usually be recognized quickly when a trier plug or a cut surface is examined (205). The attempt to press a granular curd into a solid mass, free from mechanical holes, is not usually successful. In order to get a well closed cheese, it is much safer to begin closing up the curd cubes by matting 1 or more hours before pressing, while the curd is yet warm. Although the matted curd must be milled later to permit of salting, yet it is milled into larger pieces than the original cubes, and there is much less chance for leaving mechanical openings in cheese, if these larger pieces, instead of the smaller cubes, are packed in the hoop for pressing.

All the time that curd is held warm in the vat, it is curing much faster than is possible in the curing room at a lower temperature. Holding the cheese longer in the vat makes it ready to eat sooner.

(243) **Milling Curd.** Before a curd can be considered fit to mill, it should be at least well enough matted so that the original cubes will not shatter apart when going through the mill, so that the milled curd will consist of uniform, large sized pieces, free from fine particles. This uniform mechanical condition is desirable because with large and small pieces in the milled curd, the distribution of salt will be uneven, as the small pieces have the greater surface area and take up more salt, per pound of curd, than the larger pieces.

An acid test should also be made before milling, either with the hot iron, or the acidimeter. Also cut the curd in several places with a sharp knife and examine the cut surface for gas holes or for pin holes. If the curd is seen to be gassy, it should be kept in the vat until frequent examination shows clearly that the gas holes have stopped increasing in size and in number. Sometimes a curd has to be held thus two or three hours longer than usual before the gas holes stop growing and begin to flatten out and close up. It is usually better to hold the curd in the large blocks, rather than to mill it first and hold it in small pieces, when gas is present.

When the curd is in satisfactory condition as to closeness of texture, acidity, and freedom from gas, it may be milled.

In addition, the best makers prefer to hold a curd before milling, until the cubes are so well united that the color on a cut surface appears uniform or nearly so, the texture is meaty or fibrous, and the acid test shows .7 to 1¼% acid, or the hot iron shows ¾- to 1½-inch fine strings.

(244) **Styles of Curd Mill.** The earliest style of mill consisted of one or two wooden rollers, armed with pegs or spikes, sometimes forked at the end. As the two rollers revolved at unequal rates, the curd was torn into irregular fragments in a violent manner.

Later styles of mill had knife blades instead of spikes, and cut the curd instead of tearing it. The knives revolved with the roller, and the cutting was intermittent, occurring whenever a knife blade came against a piece of curd. A number of different mills were built on this principle.

In the Harris mill, and similar kinds, the curd was pushed against a stationary knife or set of knives, the pieces of curd passing between the knives. The Harris mill was operated by hand, while some other forms as the Barnard and the Fuller could be run by power.

The Kasper mill is a later form in which the knives are arranged in the form of a cylinder, and the curd could be fed in continuously while the mill turned.

The more modern forms of mill, as the Junker, Globe, etc., can be run by power, and the curd fed in without

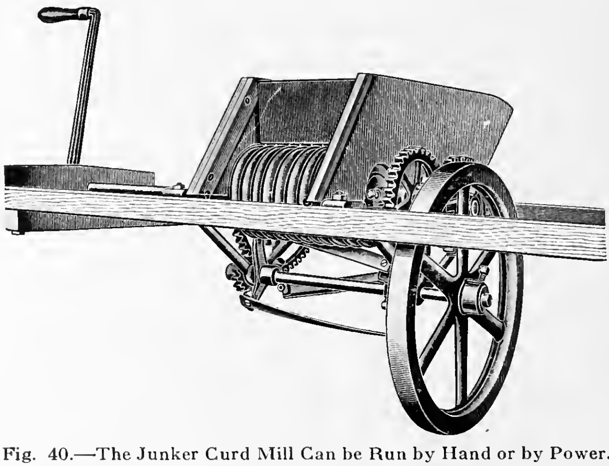

Fig. 40.—The Junker Curd Mill Can be Run by Hand or by Power.

stopping. The curd passes first between rollers which carry it forward steadily. Cutting disks of sheet metal, spaced about ½ inch apart on an axle, cut the blocks of curd into long strips like the fingers of the hand. These strips are next cut off into short pieces like the joints of the fingers, by a set of knives like those in a lawn mower. The mills can be run at high speed, and cut rapidly. The Victor mill forces the curd through a stationary set of knives by means of a large revolving screw.

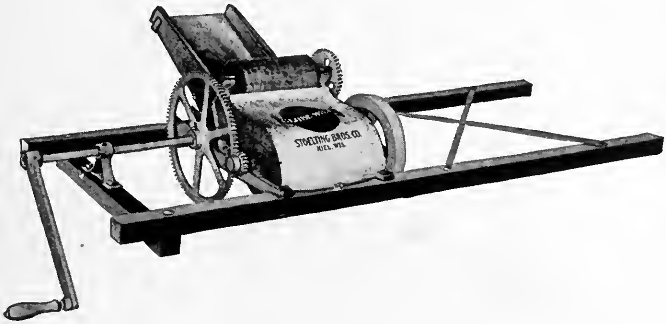

Fig. 41.—The Globe Mill is One of the Newer Forms.

(245) **Draining the Curd After Milling.** After milling, the warm pieces of curd begin to mat together again very quickly, and to prevent this the curd is stirred by hand or with a curd fork having tines with rounded ends, so as not to make holes in the vat bottom.

With the curd at about 90 degrees, it is observed either that (1) only a little clear, watery drippings run from the milled curd, or (2) that a little whitish, milky drippings escape, or (3) that a good deal of a thick white whey or drippings escape which in extreme cases may test as high as 30% fat. The amount and character of the drippings after milling depend largely on the moisture and acid content of the curd. If it is well firmed and reasonably dry, the drippings are small in quantity and almost water clear in appearance, containing little or no fat. If the curd is moderately well firmed, as in Wisconsin, the quantity of drippings will be larger and its color more or less white and milky, due to a small amount of escaping fat. With a very moist, soft curd, the quantity of drippings after milling may amount to one or more pails full, and its fat test may be high. To save the greatest amount of food in the cheese, the curd should be made reasonably firm, thus reducing the fat loss after milling.

If the curd becomes quite greasy after milling, due to escaping fat, it should be rinsed with water at about 80–85 degrees, shortly before salting, to rinse off the fat, which if left on the curd will make it more difficult to close up uniformly when pressed. Four pails of rinse water are usually enough for a large vat of curd, and the water is allowed to drain out of the vat immediately.

(246) **Salting the Curd.** The main object in milling the curd was to permit salt to be mixed all through the cheese. If a curd is too moist, a considerable amount of moisture can be removed by holding it in the vat for an hour or more after milling, with frequent stirring. But otherwise, the curd may be salted in a short time after milling, as soon as the drippings or rinsings have stopped running.

The purpose of salting curd is (1) to improve the flavor. (2) It acts as a preservative, covering the curd surface with brine, checking the growth of molds on the surface, etc. (3) The curing process is made slower by the presence of salt so that the cheese is longer lived, and remains in a condition fit for food for a longer time. (4) A small amount of moisture is extracted from the curd by salt, but only a very little.

Just before salting, the curd should have a smooth, silky surface and should be somewhat more mellow, or soft when squeezed, than when first milled. It should string an inch or more on the hot iron, and the drippings, before rinsing, may show about 1% of acid by the acidimeter.

The proportion of salt weighed out is about 2¼–2½ lbs. to 100 lbs. of curd. After stirring the salt all through the curd the presence of the salt grains gives the mixture a rough, harsh feeling in the hand. After a few minutes the salt dissolves in moisture extracted from the surface of the curd pieces. This leaves the curd surfaces somewhat drier and rougher feeling than before salting.

It is left in the vat with frequent stirring until the salt is fully dissolved and the curd again feels mellow and silky to the hand. It is then filled into the hoops with a scoop.

The curd is stirred up every 10 minutes after salting, and is spread out to cool, usually with the vat uncovered. Some of the salt brine runs off of the curd, and in this way from

¼ to ½ of the salt added may be lost. At the same time, the salt brine begins to soak into the curd, and the longer the curd is left in the vat after salting, the more salt is retained in the cheese. The reason for this is that if curd is pressed in 15–20 minutes after salting, most of the brine is on the curd surface, and is driven off when the curd is pressed. But when the salted curd is left for an hour longer in the vat, the salt brine soaks in farther and less of it is squeezed out in the press.

(247) **Styles of Cheese Hoops.** The simplest form of hoop is a plain cylinder of wood or metal open at both ends, which was widely used with the old fashioned vertical press. A wooden follower, inside the upper end of the hoop, rests on the curd. In the early days, the hoops were removed after pressing the cheese, and a cloth bandage was wound around and fastened to the cheese.

Instead of being cylindrical, hoops are now made a little larger at the top to permit easier removal of the cheese. Hoops are also made with closed bottoms in most cases, though sometimes these are loose and can be removed. The bandages are now applied to the hoop before filling it with curd, requiring less work than to bandage the cheese after pressing.

The Canadian Cheddar cheese hoops are provided with a large tin funnel, fitting closely inside, and carrying the bandage, which is cut of the right length from a bolt of the tubular cotton cloth. In filling this hoop, the curd is packed and pounded down with a wooden packer, shaped like a bowling pin, or a base ball bat, and weighing about 5 lbs. After filling the hoop with curd, the bandager funnel is lifted out, leaving the bandage in place on the cheese. Large square cap cloths are used.

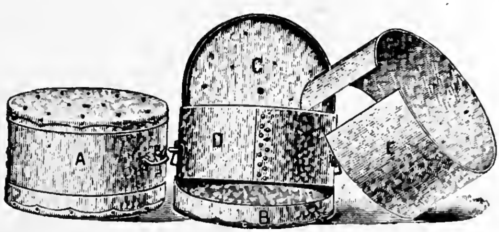

Fig. 42.—Wilson Hoops Are Used in the Eastern States.

In the United States, where smaller cheese are more commonly made, much time is saved by bandaging the hoops earlier in the day, before they are needed, since many are used. The Wilson hoop is widely used in the eastern states, and the Fraser hoop in Wisconsin.

(248) **Directions for Using the Wilson Hoops.** Each hoop consists of four pieces, as follows:

B. The bottom cover, with the widest flange or rim.

E. The open wide hoop.

D. The closed or tight wide hoop.

C. The top cover with narrow flange or rim.

First—Place the cover with the widest rim (B) on the ways in the bottom of the press.

Second—Place the Cap Cloth on the bottom of the cover (B). Said Cap Cloth should be as large as the bottom of the cover.

Third—Place within the bottom of cover (B) the open hoop or bandager (E).

Fourth—Wet one edge of the bandage, adjust with the open hoop and turn the wet edge over the top of the hoop.

Fifth—Put the closed wide hoop (D) on top of the open one, letting it lap over about one inch, and fasten the hooks which are provided to keep same from slipping down.

Sixth—Put in the cheese curd as may be desired, for any thickness the cheese are to be made, but always put in enough so that the outer or tight hoop in slipping over the open one when pressing shall not quite be forced down to meet the edge of the lower cover.

Seventh—Put on the top cover (C), then unfasten the hooks under the handles, then turn the cheese over, placing the top cover up snug against the head of the press. Proceed in the same manner with the balance of the hoops until all are filled, placing the top cover against the bottom of the previous one, etc. Then proceed to pressing.

Eighth—After pressing as usual, for a time, the bandage is to be turned in or lapped over the edge of the cheese in order to press the bandage down. It is well also to remove the cheese from the hoop, turn it over, and put it back in the hoop with the other face up, and then put to press again. This will give opportunity to remove any wrinkles that may have formed in the bandage.

(249) **Sizes of Hoops and Cheese.** Some supply houses list as many as 50 different sizes of cheese hoops, either in Fraser or Wilson style, but only a few sizes are in common use.

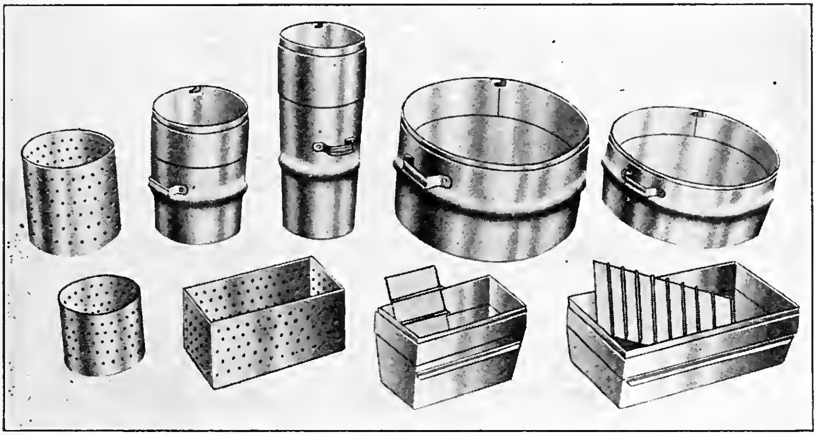

Fig. 42A.—Sizes and styles of metal hoops for American, brick, and Muenster cheese.

The usual market sizes of whole milk American cheese are about as follows:

Name	Weight	Diameter	Height
Young America	8–10 lbs.	6½ inches	7 inches
Long Horn	12 lbs.	5½	11½
Daisy	19–21	13–13½	3½–4
Flat	30	14–15	5½–6
Cheddar	60	14–15	10½–11

Square prints weighing 5 and 10 lbs. each are made 9x4x4 inches, and 14x6½x3½ inches in size, respectively.

Canadian Cheddars usually weigh about 85 lbs. and are sometimes cut in two, making 43 lbs. flats or twins. The Canadian stilton shape is about the same as the Young America. Prints have marks impressed on the rind to show where they may be cut into 1-pound slices.

(250) **Cutting Cheese in Two.** When this is necessary, it is done the next morning, after taking the cheese from the press. By means of a pair of dividers, or a pencil

put through one end of a stick a mark is made around the cheese exactly at the middle and a sharp knife is then used to cut through the bandage along this line. A piece of copper wire, with short sticks at each end for handles is wrapped around the cheese, and drawn up tight, thus cutting the cheese smoothly in two. Each cut end is then covered with a cap cloth, and both halves are returned to the press for a few hours, to close and smooth the cut ends by pressing them against the bottom of the hoop and the follower.

(251) **The Fraser Hoop and Its Use.** The hoops are cleaned (140) and made ready for use during the day at odd moments, while thickening the milk, firming the curd, etc. The cap cloth of muslin or, better, of canvas, is placed in the bottom of the hoop. Sometimes on top of the cap cloth there is placed also a starched circle of bleached and starched cheese cloth.

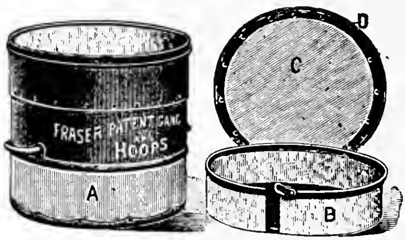

Fig. 43.—Fraser Hoops Are Generally Used in Wisconsin.

The bandage if woven tubular, is cut the right length from a bolt and is applied to the bandager, which is the loose, upper split ring belonging to the Fraser hoop. If the bandages used are "ready made," that is, cut from cheese cloth and sewed up by machine, the bandage must first be turned inside out, to get the "wings" inside; and the wide end, if the bandage is tapered, is then applied to the bandager.

Pushing the bandager down into the hoop until it fits against the shoulder, the bottom of the bandage should be long enough to turn up about three-quarters of an inch on the bottom of the hoop. The hoop is now ready to receive curd, which should be weighed in, so as to get all the cheese of uniform size, and packed down tightly by hand.

Another cloth or pair of cloths is put on top of the curd, the same as at the bottom of the hoop, the follower is added and the hoops are piled up two or three deep, until all are ready for the press.

After pressing for about an hour, the cheese in the Fraser hoops require to be dressed, which consists of removing all wrinkles or other faults in the appearance of the cheese and turning down the bandage over the upper end of the cheese. To do this, the hoop is taken from the press; and the follower is taken out with the hook. The bandager is then removed, releasing the upper end of the bandage. The hoop is then turned upside down, dropping the cheese on the table, or on a plank laid on top of the press. The cap cloths are removed, all wrinkles are pulled out of the bandage and the cheese with cloths returned to the hoop, this time turning down the upper end of the bandage under the follower. If high edges occur, due to loosely fitting followers, these are corrected and the cheese are returned to the press. If the cheese are crooked, that is, higher on one side than on the other, this is corrected by turning all such high sides to the bottom of the press. The cheese are then put under pressure and left until next morning. The press should be tightened either automatically or by hand, so as to keep the cheese under full pressure throughout the night.

The Fraser hoops are made slightly wider at the top than at the bottom, so that they fit together in the press.

When dressing the cheese, if it is seen that the top of the cheese stands above the shoulder of the hoop, the bandager should be put back in the hoop, to avoid a mark on the cheese due to the shoulder.

(252) **Weighing Curd Into Hoops.** In order to have cheese of uniform size, as preferred by the buyer, it is customary to place a dial scales on the vat bottom, weigh each hoop, and scoop a uniform weight of curd into each hoop. Especially when metal followers are used, without flexible fibre rings, it is necessary to place the correct weight of curd in each hoop which it is made to hold, in order that the follower may fit just right in pressing.

(253) **Pressing the Cheese.** The salted pieces of curd are finally placed in hoops and pressed according to methods

described below, in order to close up the curd into a solid mass of the proper shape for the market. In pressing cheese it is best to apply a light pressure at first, just sufficient to start the drippings and later to increase the pressure as fast as necessary to keep them running, until the full pressure is on.

After dressing the cheese in the hoops, the pressure should be maintained during the night, either tightening up the press by hand, when the cheesemaker goes to bed, or making use of an automatic pressure device, which does the work without attention.

The aims in view in pressing are to close up the interior of the cheese into a solid mass, with as few mechanical holes left as possible, to close up the rind perfectly leaving no openings through which air may enter and permit the growth of molds inside of the cheese, to give the cheese a regular, workmanlike appearance, in size and shape, with a smooth and tightly adhering bandage.

(254) **Sampling Cheese for Moisture Test After Pressing One Hour.** If cheese are thoroughly pressed for one hour before dressing, the moisture test samples may be taken while the cheese are out of the hoop, and the moisture tests thus obtained will agree closely with those obtained from samples taken next day. For this purpose the bandage may be turned down somewhat from the side of the cheese, and the trier inserted in the side, placing the trier plugs in sample bottles (75A). During the rest of the night's pressing, the trier holes will close up entirely leaving the cheese perfectly solid and compact. This is often preferred instead of boring a new cheese after taking it from the press on the day after making.

(255) **Cheese Presses and Continuous Devices.** The primitive forms of cheese press working by means of a weight or weighted lever (209A) were first replaced in American cheese factories by vertical screw presses, which are yet used in a few eastern state factories. In recent years, horizontal gang presses have come into more general use, by which a long row of cheese are pressed by means of one screw, or by a hand lever.

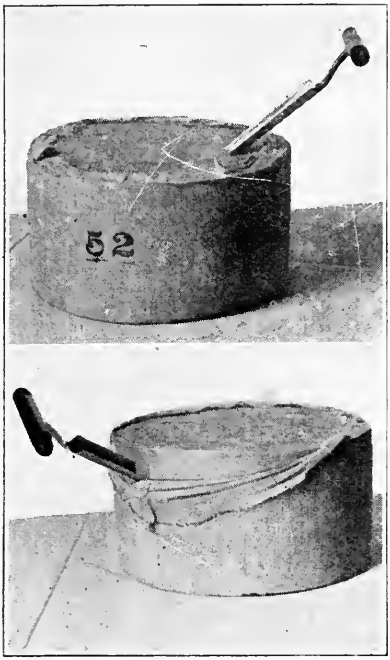

Fig. 44.—Cheese Sampling. Old cheese are sampled as shown in the upper figure. Cheese are sampled after dressing as shown below.

It is possible for remote factories to purchase the iron screw, nut and lever, and build a press from this by means of wooden rails or timbers. The same press can be bought already made or built with steel rails. These come in two sizes, wide for holding either daisies, flats or Cheddars, and and narrow for either long horns or young Americas.

On account of the shrinkage in size which cheese undergo while in the press over night, several devices have been contrived for automatically taking up the shrinkage and keeping the cheese under pressure. The simplest of these "continuous pressure" devices consisted of a set of one to four coil springs, enclosed in an iron box, which was put in the press along with the cheese. The springs were closed by the pressure applied at first, but later they expanded as the cheese shrunk. The Sprague device consists of a weight on a long lever arm, which in moving downward opens a toggle joint, and offsets the cheese shrinkage. These devices have now been largely replaced by presses in which a

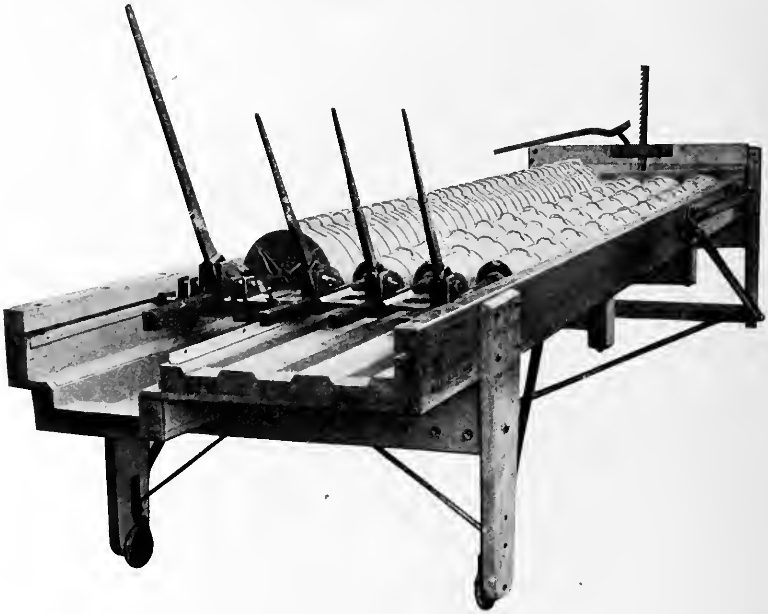

Fig. 45.—The McKinnon Cheese Press. Several styles of cheese can be pressed at once. The pressure is automatically maintained over night.

part of the press moves downward under the weight of the cheese, tightening up the head block in so doing. Among presses built on this plan are the Helmer, the McKinnon, and the Victor.

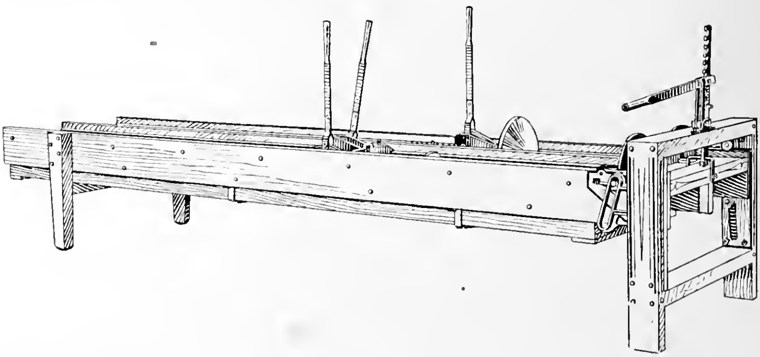

Fig. 45A.—The Victor Press, built in several styles, with continuous pressure.

(256) **Taking Cheese From Hoops.** After building a fire under the boiler, the maker's first work in the morning is to take the cheese out of the press, so as to get the hoops empty and ready for use again. To empty the hoops, the follower is removed by means of a hook, and the cheese is loosened from the sides of the hoop by running the flexible blade of a steel spatula or table knife all around the inside of the hoop. The hoop is turned over, and tapped lightly on the table, and the cheese falls out. It should be quickly inspected and if satisfactory in appearance, is placed on the curing room shelves. If faults in workmanship are seen, these are corrected so far as possible, and the cheese thus treated may be returned to the press and left until noon, when they are placed on the shelf. Each cheese on the shelf should be numbered to show when and in which vat it was made.

(257) **Faults Seen in Green Cheese.** If some of the cheese, when taken from the press, are crooked, that is higher on one side than on the other, they should be returned to the hoop and the press, with all the high sides at the bottom of the press so that after repressing, this fault will be corrected.

If bandages are wrinkled, they should be loosened from the cheese surface, and pulled smooth, and pressed again to make the bandage stick to the cheese as it should. If the bandage was not placed correctly in the hoop at first, it may lap too far or not far enough over one end of the cheese. This may be corrected by loosening the entire bandage, and moving it into place, or if too long, by cutting off part of the bandage with a sharp knife, and repressing.

If the rind is not well closed, showing too light pressure or too large a follower, or that the curd was too cold when pressed, hot water may be poured over the outside of the hoop, in the press, and the follower may be trimmed or dipped in hot water, and the cheese repressed.

Faults due to careless workmanship mark the maker as inattentive,. and cheese buyers as well as factory patrons soon learn which makers can be depended on to always make a neat appearing product. Too much acid causes cheese to close poorly, and the cap cloth when pulled off may tear away some of the rind.

(258) **Cheese on the Curing Room Shelves.** In most American factories cheese are kept only a few days on the shelves before shipment to the buyer's warehouse. On the shelf, they should be turned daily in order that both ends of the cheese may dry evenly, and not become moldy. The cheese should be well dried on the surface when boxed and shipped, so that they are fit to be paraffined as soon as received at the warehouse. Very few factories paraffine cheese before shipment. The curing room should be sufficiently well ventilated to allow the escape of moisture in the air, so that the cheese do not become moldy. The shrinkage in weight during this period before paraffining may be about 5%, but if the room is cool may be somewhat lower. In warm weather, ventilation during the cool nights is preferable. Moldy cheese are cleaned with a dry brush, by scraping, washing and drying, or by applying a clean bandage and pressing. Rusty spots are due to a bacterial infection, in the curing room.

(259) **Boxing Cheese For Shipment to Buyer.** A piece of thin wood veneer, called "scale board" is placed in the bottom of each box, and another on top of the cheese in the box, and two scale boards between the cheese if two or three cheese are placed in the same box. These scale boards prevent cheese from sticking to each other or to the box.

Heavy press cloths or heavy cap cloths, if used, are taken off of the cheese just before boxing. Thin starched circles, if used, may be left on until the cheese are ready to be dipped in paraffine. If cloths are removed long before paraffining, the cheese rinds are likely to check or crack open, and admit mold to the interior of the cheese.

The boxes, if taller than the cheese, should be cut down so that the cover rests on the cheese as well as on the sides of the box, to prevent the boxes from splitting when piled high.

This extra work can be avoided by ordering the boxes of the right size to fit the cheese. The box lids should fit snugly, otherwise it will be necessary to wedge each lid on, after filling the box with cheese, to prevent falling off, and because railroads usually will not accept shipments with loose box lids.

The boxes should be stored at the factory so as to keep dry and clean.

Each cheese is weighed just before it goes into the box, and where two or more cheese are put in one box it is possible to make a selection so that all in a box will be of the same size or that the total weight of cheese in the box shall be at the desired figure.

On the outside of each box, at one side of the nailed lap, should be placed the "marked weight" which is from ¼ to ½ pound less than the actual weight of cheese when boxed. This allows for shrinkage and ensures that the buyer will receive the weight of cheese marked on the box and billed to him. The buyer's stamp or stencil is used in marking each box for shipment.

On the other side of the nailed lap should be placed the number showing when the cheese was made. This enables the buyer to sort the cheese into piles by vats when received, so that by boring one cheese from each pile, he can test the quality of all.

(260) **Shipping Cheese.** In packing boxed cheese in a railroad car, they should be piled evenly and arranged so as not to fall down or be broken in transit. Refrigerator cars pass through principal cheese shipping points twice a week or oftener and serve in summer to protect cheese from overheating and from freezing in winter. In very cold weather, cars of cheese may be provided with oil heaters to prevent freezing. Frozen cheese should be slowly thawed at 34–50 degrees.

Cheese are sometimes damaged by being hauled to the station and left standing in the sun for several hours before being placed in the car, or by being kept in the uncooled factory curing room longer than necessary in summer, because of failure to receive cheese boxes when needed, or other causes.

Where cheese box lids do not fit snugly, or cheese are to be shipped a long distance, or to a special market, especially to various export markets, the box lids may require to be wedged on tight, or the boxes may be placed in sacks or fastened together in 100-lb. packages with strap iron, to meet the demands of railroads or ship owners.

(261) **Cheese at the Receiving Warehouse.** The buyer of cheese from a factory receives the shipment in his warehouse, counts the boxes, sorts them in piles according to the marks on the boxes, tests one cheese from each vat by drawing a trier plug, and then starts opening the boxes. At least 5 or 10%, or all of the cheese in a shipment, are weighed on a dial scales, as they come from the boxes to see if the weights billed and marked on the boxes are correct. The cheese are dipped in paraffine and replaced in the boxes and may be either shipped out again immediately to purchasers, or may be placed in cold storage rooms, carefully arranged in piles, so that the contents of every pile is known exactly and can be given proper attention and finally shipped to a suitable market.

If the cheese buyer finds either the quality or the marked weights of the cheese to be below the standard, the deficiency is noted, and notification is sent to the shipper at the factory, who may then accept the buyer's offer as to weights and reduced price, or may dispose of the cheese in any other way.

Upon the buyer's judgment as to whether a given lot of cheese is of fit quality to be put into storage or not, so as to be taken out several months later without loss of quality and value, depends his profit or loss.

(262) **Paraffining Cheese.** Cheese to be paraffined should be well dried on the surface and should have a small amount of dried cheese at the surface, forming a rind. The purpose of the paraffine is to protect the rind, prevent the growth of molds and minimize the shrinkage or loss of weight, by checking the evaporation of moisture from the cheese.

The paraffine melting at 123–125 degrees is heated in a steam tank to about 220 degrees and the cheese are immersed for about two seconds. Under these conditions, the paraffine coating on the cheese is thin and flexible, and is less likely to crack off than if a thicker coating is applied at a lower temperature.

(263) **Rind Rot.** Where a thick coating of paraffine is applied to cheese having a poorly dried surface, or too thin a rind due to insufficient drying, it will probably be

found after a few days, weeks or months, that the paraffine is not adhering to the surface, but cracks off readily and that underneath the paraffine, the surface of the cheese is wet and smeary. This condition is called "rind rot," and is so objectionable as to require that the cheese should be cleaned by washing, drying in the air, and paraffining again before they are sold. This extra trouble and expense is avoided by not making cheese too moist, and by seeing that they are in proper condition before first dipping in paraffine.

(264) **Paraffining Equipment.** Paraffine can be heated to 220° F., or above in a sheet metal tank by means

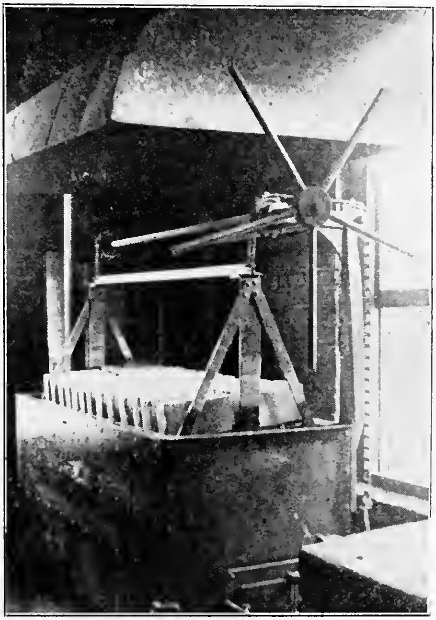

Fig. 46.—A Paraffining Outfit Used in a large Wisconsin Warehouse.

of coil of steam pipes placed in the bottom of the tank. The entrance and exit pipes for steam should come up over the top edge of the tank, as it is difficult to make a tight joint and avoid leakage of paraffine, if a hole is cut in the side of the tank near the bottom.

With a paraffine tank made of boiler iron with a double wall, steam is admitted to the jacket, direct from the boiler, and the condensed water from the jacket may run back into the boiler by gravity. A small steam trap can be used to allow water but not steam to escape.

In some Canadian warehouses, where all cheese received are of the low moisture, well firmed kind, the paraffine tank in use consists of a boiler iron tank, heated by a row of gas jets underneath, and in order to keep the paraffine from becoming too hot and boiling over and thus taking fire, a small amount of water is poured into the tank, making a thin layer below the paraffine. In this way, the paraffine is never heated higher than the boiling point of water, about 212 degrees F. This appears to give satisfaction, but a higher temperature for the paraffine is recommended and used in many Wisconsin warehouses.

A water jacketed paraffine tank with a gasoline lamp underneath does not heat the paraffine quite to 212 F., and for this reason steam heat is preferred.

Where only a few cheese are dipped this can be done with tongs, one at a time, but in large warehouses, dipping frames carrying several hundred pounds of cheese, balanced by a weight on a rope and pulley, are suspended over the hot paraffine and immersed with the least loss of time.

(265) **The Cold Curing of Cheese.** The supposition that cheese are injured, becoming bitter, etc., by curing in cold storage was overthrown by the experiments of Babcock and Russell at the Wisconsin Experiment Station, beginning about 1895. At present, cold storage warehouses having mechanical refrigeration maintain American cheese rooms at 34 degrees. Other houses cooled by ice hold cheese at 40 to 50 degrees. The Canadian cheese warehouses are commonly kept at temperatures above 50 degrees which practice is called "cool curing."

(266) **The Cold Storage of Cheese.** Cold storage is used as a means of preserving cheese in good condition from the fall months, September and October, until the winter and early spring months, when little is made.

Privately owned cold storage warehouses in leading cheese centers rent rooms or space at fixed rates to cheese owners, charging in some cases ¼ of a cent per pound of cheese for the first month and ⅛ cent for the second month, or a certain maximum price for storage until the following February 1st or March 1st. The cheese owner must recover the expense of the storage and the interest on his money invested in cheese during the winter, from the increased price at which the cheese may sell in the spring before the new cheese come into the market. In case the market price of cheese does not increase during the winter the cheese owner is a loser. Market prices are often unforeseen and uncontrollable.

In case the cheese placed in storage deteriorate in quality during the winter, the owner is likely to suffer loss, and great skill and care must be used in selecting for storage only well made cheese of good quality and suitably low moisture to avoid loss from this cause.

(267) **Injuries to the Cheese Industry and Their Prevention.** (1) A buyer who attends a cheese board meeting and buys 1,200 boxes of cheese, intending to store 800 boxes and use 400 boxes at once for filling current orders for fine goods, may find when the cheese arrive from the factories that half or all of them are not fine goods and are unfit for storage, because of certain defects as high moisture, acidity, etc., but are fit only for immediate sale but not to the best trade. Because of these conditions, he may be tempted to store some cheese of doubtful quality, which may ultimately cause a loss. Also, he may be tempted to ship to his trade cheese of doubtful quality, which may not be found suitable on arrival, and cause him to lose money and future business. Where such conditions occur generally among factories and buyers in a county, a region, or a state, the cheese from that district lose their good reputation and the whole industry suffers injury, including farmers, makers and dealers. The enactment of cheese moisture limit laws in cheese producing states is an essential step in correcting and preventing such injury.

(2) insanitary conditions in and about cheese factories, such as foul-smelling whey tanks or whey puddles on the ground, dirty buildings or utensils, when allowed to continue, contribute directly to the production of defective quality in the products, encourage patrons to be careless and arouse in tourists and all passers-by feelings of disgust

for cheese made among such unwholesome surroundings, which are always recalled to mind by the sight of cheese on the table and which tend strongly to decrease the consumption of cheese. The establishment of Factory License Systems in the several states, by which insanitary factories are closed and careless makers refused licenses to make cheese, is an essential step in the prevention and correction of such evils where they occur.

(3) In states where skim and part skim American cheese are made in the same sizes and shapes as whole milk cheese, there is always the possibility of a suspicion in the minds of consumers that any cheese coming from that state may be more or less skimmed, and of inferior quality as food. This condition where it exists is a source of injury to the industry. The Wisconsin law permitting skim milk cheese to be made only in a specified size, 10 inches in diameter and 9 inches high, which size is not used for whole milk cheese, effectively protects consumers from such fraud and establishes confidence in the consumer's mind on this point.

(4) The very general sale to consumers of cheese while in a partly cured condition and very young in age, having little or none of the attractive flavor of well cured cheese, is a serious cause of injury to the industry. A return to the older custom of making firm, slow curing cheese, which will keep well in storage and to the custom of selling and eating only well aged, fine flavored cheese would do much to increase the popular demand for cheese among American consumers.

CHAPTER XXX.

ITALIAN CHEESE IN AMERICA.

(268) **Skim and Whey Cheese.** These cheese are mostly made from skimmed or partly skimmed milk, and in some cases from whey. They are heavily salted, and have more or less acid flavor. The cheese are not used by the average American trade, and few dealers handle them. While there is a certain small demand for them in this

Fig. 47.—Italian Cheese, Hoops, Baskets, and Containers.

country, especially since importation stopped, yet the business is in the hands of a very few firms, and factories should first make sure of an outlet before beginning to make these products.

(269) **Caccio Cavallo** or "horse cheese" is so named from a trade mark or from the supposed resemblance of the cheese to the shape of a horse's head. The cheese is sometimes molded into a long cylindrical shape, and hung up by a string to cure. The portion above the string settles over toward one side, giving an appearance suggesting the name by which it is known. The same cheese is also frequently made in round hoops, looking somewhat like a "daisy" American cheese.

The process varies somewhat. One third skim milk is often used. With 2% starter, the rennet curd is cooked up to 105 or 110, and the whey drawn immediately. The curd is matted, cut, turned, and piled, and left in the vat until next morning, or until a small test portion dropped in boiling water, will form a thread reaching to the floor. It is then ready to mold. The curd is sliced thin and a small portion sufficient for one cheese, about 5 lbs., may be placed in a wicker basket, dipped in hot water, and kneaded while hot into a doughy mass, and molded into the desired shape. Or, the entire quantity of sliced curd may be placed in a tub of boiling hot water, stirred with a paddle, covered again with water at 180 degrees, and after four or five minutes stirring, it is in one doughy mass. It is then dipped out with the paddle, five pound portions are weighed off and molded into the desired shape while hot, dipping into hot water again if necessary.

The doughy curd may be worked first into a smooth ball, then elongated somewhat, squeezing a neck below, flattening the head, and putting the piece into cold well water for an hour to harden, turning it over at short intervals on all four sides. The cheese is then put into salt brine for three days, and hung up to cure for about 90 days. After 30 days, it is very hard, and may be packed in barrels for shipment.

Instead of molding by hand into various shapes, the hot, doughy curd is often placed in round metal hoops, about 12 or 13 inches in diameter and 1¾ inches deep. These cheese are later salted with dry salt on the shelf, and may be oiled on the surface. They are called by various names as Kaseri, Asiago, etc., and the process is variously modified.

(270) **Romano.** This is usually made from skim milk, The rennet curd is matted, milled and packed into molds open at both ends, about 8 inches in diameter and 6 inches high. It is salted on the outside, after draining 24 hours.

(271) **Romanello.** This is made like Romano, excepting that the curd is placed in a wicker basket to drain, and after draining, the mass of cheese retains the imprint of the woven basket on its surface. The cheese are about 9 inches in diameter and 5 inches high, and weigh 9–12 pounds. Baskets of different sizes are used.

(272) **Feta.** The skim milk is thickened with rennet, stirred or cut with knives, and then dipped into large wooden molds about 48 by 30 inches or any convenient size, and 8 inches deep, standing on a draining cloth and table. A little later it is cut into large blocks, salted on the surface, and later turned over and salted again. The next morning, the curd is cut into slices about an inch thick, and packed in paraffined wooden kegs holding about 125 lbs, with some salt. The spaces between the curd pieces are soon filled with salt brine from the curd. The cheese is ready to eat in thirty days.

(273) **Ricotta, or ricorta.** This is composed mainly of whey albumen. The whey with perhaps 5 to 10 percent of skim milk added, is mixed with some sour whey from a barrel and is heated to about 190 degrees, F., which curdles it. It is allowed to stand quiet for 5–10 minutes. The curd rises and is dipped off with a fine meshed wire strainer, and poured into cloth bags to drain, or else placed in metal hoops 9 inches high and 5 inches in diameter, with strainer sides and bottom. The curd settles to a height of 7 inches, and is salted dry on the outside next morning, by rolling in salt. The cheese are then returned to the hoops for two hours to drain further, after which they are put to dry, which may be done on a rack of lath, in a room at 110 degrees, over the boiler, or the drying may be done in the open air. The dried cheese are wrapped in greased paper, placed in cartons and packed 40 in a box, and are ready for use at once.

By adding whole milk instead of skim milk, *ricotta gras* is obtained by this process.

A similar cheese made from whey with the addition of 8–10% of milk, is dipped into molds 10 inches high and 8 inches in diameter with strainer sides and bottom. It settles to a height of 7 inches, and is salted on the surface and dried out of doors, and is called Maroni.

Where whey alone, without any milk added, is curdled by heat and sour whey, and the albumen put to drain in cloth bags, the product is salted with dry salt on the surface and called Mejette.

(274) **Parmesan and Reggiano.** These are skim milk cheese made in copper kettles somewhat like Swiss cheese, but smaller in size. They are hard, and are grated for cooking.

CHAPTER XXXI.

PRIMOST.

(275) **Manufacture and Use.** In Norway and some other countries, whey left from cheesemaking is boiled down, like maple sap, until on cooling it will solidify, like maple sugar into a crumbly mass, consisting mainly of milk sugar. This is good food, but rather lacking in attractive flavor, and is called primost.

By adding some buttermilk or whole milk to the whey the product is more pasty, and is called soft mysost. From sour milk cheese whey, the product is called sur-prim; and mysmer from sweet curd whey. Mysost means literally whey cheese.

To meet the demand in this country from former residents of Norway, for this product, a few factories in the northern states, including Wisconsin, Michigan and northern Illinois make primost.

The whey from the cheese vat, after making rennet cheese, is run immediately into a large iron pan, 8 or 10 feet in diameter, and about 2 feet deep, and flat bottomed. The

Fig. 48.—A Primost Pan Used in Wisconsin.

pan is made of smooth iron about ¼ to ⅜ inch thick, and has a hollow bottom about six inches deep, into which steam is run for heating the pan contents. The whey soon boils, and the escaping steam passes up through a wooden flue through the roof. A large wooden hood over the pan connects with the flue. A cloth apron tacked to the edge of the hood hangs down around the pan, and can be raised when the workman is stirring the pan contents, etc.

Five thousand pounds of whey will require from 5 to 10 hours to boil down. About 20 lbs. of steam pressure in the jacket is required, and toward the end a higher pressure to give the required temperatures.

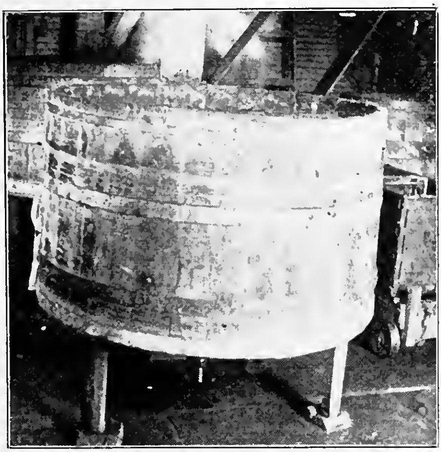

Fig. 49.—Stirring Tub for Primost While Cooling.

During the boiling, especially toward the end of the process when the material begins to thicken, the pan contents are stirred frequently to prevent sticking to the bottom, using a long handled iron hoe or scraper. When of the consistency of thin mortar, the steam is turned off, and the hot, mushy product is dipped with flat sided curd pails into a stirring tub, where the product is stirred as it cools, thus producing a fine grained, smooth mass of the consistency of thick mortar. The cooled mass is packed into well greased wooden cubes, such as are used for packing butter which is to be cut into pound prints. After standing for several days, until the product is fully cooled and hardened, it is cut up with a wire, and the blocks, weighing one or two pounds, are wrapped in tin foil or dipped in paraffine, and placed in cartons for the retail trade.

The acid developed in milk and whey during the making of American or similar cheese is of course present after the whey is boiled down and may impart more or less bitter or sour flavor, which is partly overcome by adding small proportions of brown sugar to the primost in the boiling pan, just before dipping it into the stirring tub. Primost requires no curing, but sometimes becomes moldy on long standing.

In the middle of the tub stands a hollow box, through which a shaft extends upward, carrying a cross beam at the top, from which four paddles extend downward into the tub. The paddles move around the inside of the tub about 80 times per minute, scraping down the primost from the walls, and keeping it moving while cooling.

(276) **Primost and Cottage Cheese.** To make both primost and cottage cheese from skim milk, add 1 or 2% of starter to the sweet skim milk, heat to 90 degrees, set with rennet so as to cut into cubes in one-half hour. Stir the curd in the whey (or it may be broken with a rake) for half an hour, allow to settle, and draw off the sweet whey into the primost pan. Before the curd in the vat has a chance to mat, pour in several cans of cold water, enough to cover the curd. Leave the curd thus under a little water, at 70 degrees or lower, until early next morning, when the curd will have a good sour flavor. Drain the water off, add salt and pack the cottage cheese as usual.

This method gets very sweet whey for primost and sour curd for cottage cheese out of the same milk.

CHAPTER XXXII.

BLUE VEINED CHEESE RIPENED WITH MOLD INSIDE.

The principal cheese varieties in this group are the French Roquefort, the English Stilton, aud the Italian Gorgonzola. In France, Roquefort is made from sheep's milk, containing from 7 to 12% of fat, and 17 to 23% of other solids. The milk is thickened in 1½–2 hours at about 80–90 degrees. The curd is cut and stirred, and after dipping out some whey, the curd is poured on a cloth to drain. The curd after draining is stirred well by hand, and finally filled into perforated forms, adding small portions of mouldy bread crumbs in the centre of each form. The curd in the hoops drains three days longer in a warm room, and is then taken from the hoops to a cooler, dry room to dry the surface, turning daily for two or three days. It is then taken to the curing cellar, salted twice on the surface, and after three days more the slimy surface is cleaned with a brush, and the end is punctured many times with needles, making openings through which air reaches the interior of the cheese, to permit the growth of molds within. It is then taken to the curing shelves, in a cave at 60% humidity and 40–46 degrees F. About 6 weeks of curing are required, and they are then wrapped in tin foil. In America, small quantities of fairly good Roquefort cheese have been made from cow's milk. The cut surface is veined with blue mold, and the cheese has a characteristic, somewhat peppery taste.

Stilton cheese are made by somewhat similar methods, and English stilton is packed in stone jars for export.

Gorgonzola is a blue veined cheese made in Italy.

The Roquefort mold is a variety which is able to grow in an atmosphere containing much carbon dioxide and little oxygen, more freely than most other varieties, according to Thom, an American investigator.

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