MILKING MACHINES:

V. THE PRODUCTION OF HIGH GRADE MILK WITH MILKING MACHINES UNDER FARM CONDITIONS.

JOHN W. BRIGHT.

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THE PRODUCTION OF HIGH GRADE MILK WITH MILKING MACHINES UNDER FARM CONDITIONS.

JOHN W. BRIGHT.

SUMMARY.

1. In order to determine whether the cleaning methods for milking machines found successful at the Station were practical for the average dairyman, and applicable to types of machines other than the one in use at the Station, these methods have been tested at two dairies sending milk into Geneva. Conditions have also been observed at a third dairy where the dairyman had used methods of cleaning which produced good results.

2. The quality of the milk produced by the dairies previous to, and later than, the work described here was determined from the records of the bacteriological examinations made by the persons in charge of the milk inspection work for Geneva. These records were based upon a determination of the approximate numbers of bacteria present in the milk as brought to the city.

3. Trouble had been experienced at Farm A in continuously producing a milk with a low germ content. A ten-day visit was therefore made to this farm during which time the author observed conditions, and introduced cleaning methods similar to those used at the Station. Numerous tests of the milk showed that at this farm, at this time, the chief trouble arose from a failure to scald and dry metal utensils properly. The milking machine tubes were reasonably clean, and were kept in a solution of brine and chloride of lime which was in satisfactory condition, tho various details in the care given the tubes could have been improved. Improved methods were introduced with the result that, so long as the care of the machines remained under observation, all cans of milk sent to Geneva were found to have a low germ content. During the seven months that have elapsed since the visit was made, the
quality of the milk from this farm, tho variable, has been better than it was previous to the visit. Observations lead the author to believe that the fluctuations in quality were due to a failure on the part of the dairyman to attend to all of the essential details of the cleaning process.

4. Trouble had also been experienced at Farm B in producing a high grade milk, and an eight day visit was made to study conditions. Investigation showed that there were many possible sources of trouble at this place, beginning with poor cleaning of the teat-cups and tubes, pails and other utensils. In addition, the sterilizing solution used for the rubber tubes was weak both in salt and in chloride of lime, while the milk was not cooled satisfactorily before shipping. The introduction of better methods of cleaning and caring for the utensils largely removed the difficulty, tho this was not cleared up entirely until the milk was cooled more efficiently. So long as these things were under control, the milk reached the city with a low germ content even tho it was shipped 27 miles without icing and was never cooler than 62° F.

5. A description of conditions at Farm C is also included because at this farm the dairyman himself had adapted the Station methods of cleaning machines to his own conditions so successfully that he had maintained an almost perfect record for producing milk with a low germ content. This record corresponded with the excellent record maintained by the same man during periods when his herd was milked by hand. Some difficulty which he experienced during the spring of 1919 disappeared following the use of a sterilizing solution for the teat-cups and tubes which contained salt as well as a strong solution of chloride of lime. Great care was maintained at this farm at all times to keep the machines as well as all other milk utensils in a cleanly condition.

6. The chief conclusions to be drawn from the observations are: that the methods of cleaning are more important than the type of the milker in determining the germ content of the milk, and that high grade milk can be produced with the milkers under observation provided they are cleaned and cared for twice a day for 365 days in the year by methods known to give good results. Success cannot be attained, however, by doing the work in a half-hearted way. The neglect of any one of several important details in the cleaning process may make all the difference between success and failure.
INTRODUCTION.

The extensive use of the mechanical milker during the past four or five years has greatly complicated the problem of producing high grade milk. The milking machine with its rubber tubes, pail lid with milk spigots and valves, and, generally, a more or less complicated pulsator, and heavy pail requires much greater care than do the simple milk pails used in hand milking. While these parts entirely enclose the milk in its passage from the teat to the pail, and so protect it from contact with human hands and from sediment and dust, they may at the same time seed the milk with excessive numbers of bacteria.

Thus, while machine-drawn milk is, in one sense of the word, cleaner than the average hand-drawn milk, yet in another sense (if we regard the accumulation of bacteria in the milky material left in poorly cleaned tubes as dirt) the average machine-drawn milk is not as clean as hand-drawn milk.

As it is a relatively simple matter to protect machine-drawn milk from extraneous dirt and sediment, little attention is given this phase of the matter in the present bulletin, and the discussions are largely confined to the difficulties actually encountered by farmers in keeping the milk drawn thru the milking machine free from excessive numbers of bacteria.

If market milk is to reach the consumer as it should reach him, clean and pure and of good keeping quality, it must be carefully handled from the time it leaves the udder of the cow until it is delivered into the hands of the consumer. One of the most essential points in the handling is to see that all utensils into which the milk is poured or thru which it passes are thoroly clean.

The requisites for the successful care of the milking machine are: Plenty of hot water, a good washing compound, a rack for drying, a good sterilizing solution in a large crock, and a willingness to use care twice a day for 365 days in the year.

As a result of the ease with which machines become seeded with bacteria, the following method for the care of the machine has been developed at the Station. A rapid but careful washing of the machines by drawing successive pails of cold water, hot alkali water, and clear hot water thru them immediately after every milking; immersion of the teat-cups and all rubber parts in a good steril-
izing solution between milkings, supplemented by a very thorough weekly overhauling of the teat-cups and tubes; and the daily scalding and thorough drying of all the metal parts that come in contact with the milk except those parts kept in the sterilizing solution.\(^1\)

This method seems rather complicated to many milking machine users and prospective buyers, principally because of the difficulty experienced in obtaining a good supply of hot water. In view of our experience with machines, however, it seems necessary to use an abundance of hot water, i.e., more than a tea kettle full, if the utensils are to be kept in a cleanly and essentially sterile condition. Inasmuch as the cleaning of the machines must be done at the barn or in the milk house, the hot water supply should be available at the same places. Where the barn is equipped with running water, a hot water tank and heating coil can be installed, and the coil heated by means of a wood or coal stove, a gas burner, or a kerosene burner. If there is no running water supply in the barn, then the water may be heated in a large boiler on a wood, gas, or kerosene stove placed in the milk room or some other safe place where the danger of fire is reduced to a minimum. Suitable outfits are shown in the illustrations. (See Figs. 1, 2, and 3.)

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These bulletins are also issued in a popular edition. Circular No. 54 gives methods of preparing sterilizing solutions, and the like.
Coupled with the use of plenty of hot water is the equally important process of proper drying of all pails and pulsators. To accomplish this, one should either erect a good drying rack out in the open air, where the utensils may be inverted and exposed to a maximum of sunlight and fresh air with a minimum of dust; or racks may be so arranged as to expose the utensils to the heat of the fire.

While the methods outlined have given good results as practiced at the Station for more than ten years, yet the farmers of the region about Geneva, who have introduced apparently similar methods of cleaning and caring for their machines, have generally failed to secure equally good results. As inspection of these dairies usually gave evidence that directions were not being followed in all details, a conviction gradually developed that this lack of attention to detail was the reason for the failure to produce milk free from excessive numbers of bacteria.

THE GENEVA MARKET MILK SUPPLY AS INFLUENCED BY THE USE OF MILKING MACHINES.

Since 1915 the Station has been in charge of the milk control work for the city of Geneva. During this time practically all the milk sent into the city has been distributed as Grade B pasteurized. The milk is delivered by about sixty-five dairymen at two central receiving plants, and is there pasteurized and bottled for distribution. Samples for bacteriological analysis and sediment tests are collected on the platform from the individual cans before the milk is emptied into the receiving vats.

In the four and one-half years extending from February, 1915, until the first of July, 1919, 22,134 cans of milk have been examined for the purpose of exercising a control over the quality of the milk supply. Of this number, 5,351 cans were produced with the aid of milking machines, and 16,231 by hand milking, leaving 552 cans which can not be taken into account because of uncertainty as to the method of their production. During this time the percentage

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3 See the Sanitary Code established by the Public Health Council of the State of New York. Chapter III. Milk and Cream. 1914.
of machine-drawn milk has varied from a minimum of 19.1 percent in 1917 to a maximum of 30.1 percent in 1918.

It is in the production of high grade milk, however, rather than in the production of milk in general that we are particularly interested, and an examination of the records shows that of the total number of samples graded during the four and one-half years, 18,758 (86.5 percent) were graded as excellent or good, 2,478 (11.4 percent) were graded as medium, and 536 (2.5 percent) were graded as poor. Sixteen thousand two hundred and thirty-one of these samples were of hand-drawn milk, and of this number, 14,608 (90 percent) graded as excellent or good, 1,396 (8.6 percent) graded as medium, and 227 (1.4 percent) graded as poor. Five thousand three hundred and fifty-one of them were machine-drawn samples, and of these, 3,955 (73.9 percent) graded as excellent or good, 1,153 (21.5 percent) graded as medium, and 243 (4.6 percent) graded as poor. These percentages are graphically represented in Chart I.

It is evident from this chart that the bacterial quality of milk brought to the city would have been materially improved by the elimination of that brought from the farms where machines were used.

The detailed inspection records indicate that the amount of poor quality milk brought from the group of farms using machines was less than it would have been had no pressure been brought to bear upon these farmers. This pressure was very real in that one man was forbidden to bring milk into the city because of continued failure to keep his machine in a sanitary condition, while the premium which was paid for bringing in high grade milk was frequently withheld from men using milking machines because of the poor quality of their product.

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4 All grading has been done by direct microscopic examination of dried milk smears.

Excellent — Contained less than 300,000 individual bacteria per cc. Would meet the bacteriological requirements for a Grade A raw milk.

Good — Contained more than 300,000 and less than 1,000,000 individual bacteria per cc. Would meet the requirements for a Grade A pasteurized milk.

Medium — Contained more than 1,000,000 and less than 10,000,000 individual bacteria per cc.

Poor — Contained more than 10,000,000 individual bacteria per cc. Would not even meet the requirements for a milk satisfactory for pasteurization as Grade B.

While the exact relation between these counts and the ordinary agar plate counts cannot be given, it should be stated that counts of individual bacteria usually average about five times the size of ordinary agar plate counts. See Tech. Bul. No. 49 for a description of the technique used.
Yet in spite of this pressure, the resulting conditions can scarcely be called satisfactory. Unless the men using milking machines can get as good quality milk as those men who practice hand milking, the hand milker will remain a severe competitor of the milking machine.

While it is the tendency of control officials to regard the chief problems presented by the present day milking machines as sanitary ones, the average dairymen who is operating the machine is inclined to think that mechanical defects constitute the principal difficulties. Not so much mechanical defects of the machine itself, perhaps, but rather of the gas engine that is generally used to furnish the power to operate the machine. Wherever gas engines are used there is frequently more or less trouble, particularly if the operator is not mechanically inclined. But so far as machines themselves are

**Chart I. — Quality of Geneva Milk Supply, 1915-1919.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>22,134 Samples.</td>
<td>16,231 Samples.</td>
<td>5,361 Samples.</td>
</tr>
</tbody>
</table>

- Excellent and good.
- Medium.
- Poor.
concerned, experience shows that they are reasonably successful from the mechanical standpoint.

However, it can scarcely be claimed from the sanitary standpoint that the manufacturers of machines have even yet given sufficient attention to proper construction. They have not realized the importance of eliminating all possible seams or crevices that gather dirt. Likewise, not all manufacturers have given sufficient attention to the construction of leak-proof valves at the point which guards possible leakage into the milk from the main vacuum line. This line cannot be cleaned satisfactorily with methods ordinarily available, and may become foul with milky vapor, condensation water, and like material. Even a drop of this material in a single pail of milk produces a detectable contamination.

Further study could profitably be given by many of the manufacturers to the selection of suitable metal alloys for use in the teat-cups and pulsators. These should be such as are not corroded by the commonly used washing compounds and sterilizing solutions. It would also be very desirable if a standard grade of rubber were used for tubes and inflations; one which would withstand the action of the animal fats, a generous use of hot water, and which would have fairly uniform wearing qualities.

PRACTICAL EXPERIENCES ON FARMS USING MILKING MACHINES.

As a result of the failure of some nearby dairies to produce high grade milk, the writer visited two farms to watch operations closely, and then to operate and clean the machines in order to introduce such procedures as were necessary in order continuously to produce good milk.

FARM A.

Considerable trouble in producing a low count milk had been experienced at this farm. Two Empire units had been in use there for some time. Since the milk had started to come into Geneva from Farm A in August, 1918, 175 cans of milk had been examined up to May 17, 1919, at which time the investigation began. Of this number, 94 (53.6 percent) were graded as excellent, 26 (14.8 percent) were graded as good, 38 (21.7 percent) were graded as medium, and 17 (9.9 percent) were graded as poor.

5 See footnote 4.
The average of all the milk (3,153 cans) examined at the Station during the same period was as follows: 79.7 percent were graded as excellent, 6.9 percent as good, 10.3 percent as medium, and 3.1 percent as poor. Of the 3,153 cans, 1,942 were hand-milked, and 90.5 percent of these were graded as excellent, 4.4 percent as good, 4.5 percent as medium, and 0.6 percent as poor. The total number of machine-milked samples tested was 1,211, of which only 62.2 percent were graded as excellent, 11.2 percent as good, 19.4 percent as medium, and 7.2 percent as poor. These percentages are graphically shown in Chart II.

The chart shows very clearly that the milk coming from Farm A was far below the average in quality for milk coming from all the farms regardless of the method of production, and that it was also considerably poorer in quality than the average machine-produced milk.

At the time the investigation started at Farm A, everything about the dairy barn was in fairly clean condition. The barn itself was
large, light, and well ventilated. (See Fig. 4.) The handling of the milk was done directly behind the cows, because there was no milk room. Any hot water that was needed had to be brought from the house which stood about one hundred and fifty yards away from the barn, but there was a good supply of running cold water available at the barn. Cooling of the milk was accomplished by submerging the cans up to their necks in a vat of cold running water. The cows themselves were kept in very good condition, and altho washing of the udders was not practiced, the udders were generally clean.

All parts of the machine appeared to be in fairly good shape, tho the rubber milk tubes had a bad odor. Two teat-cup inflations were leaky; but the insertion of an observation glass into the stanchion hose leading from the pail to the vacuum pipe line failed to show that any milk was being drawn into the vacuum line. When the machines were washed at the end of the milking, however, it was observed that a small amount of water was drawn into the air lines. The vacuum lines themselves were satisfactory as they were dry, and there was no accumulation of milk or foul material in the vacuum tank.

The tubes and cups were kept in a twenty-five gallon crock (see Fig. 5) filled with a saturated brine solution plus a stock solution of chloride of lime. This solution was in very good condition, and care was taken during our work there to keep it so by the further addition of chloride of lime. As the tubes were being dropped into the solution carelessly, however, air was imprisoned in the tubes with the result that the solution did not come in contact with all the tube surface over which the milk had passed. Therefore, the bacteria which cause sour or tainted milk were probably multiplying and producing the bad odor in the tubes. Undoubtedly this was a prolific source of contamination.

The care given the machines after each milking was not good, and this was, apparently, the chief source of trouble. Immediately after the morning milking, the tubes and pails were rinsed out by sucking a pail of cold water thru them. This one pail of water had to do double duty as it was used for both double units. The tubes and cups were then put into the solution jar without further treatment. After breakfast the dairyman took the machine pails, pail lids, and stripping pails up to the house to be washed. They
were washed during the morning in water that was sometimes nearly cold. After this they were put outside to dry. Shortly before the afternoon milking these things were carried to the barn. At milking time the tubes were removed from the solution, rinsed with cold water, and attached to the machines.

### Table I.—Quality of Individual Cans of Milk from Farm A During the Latter Part of May, 1919.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Date</th>
<th>Time of milking</th>
<th>Grade of milk after four hours</th>
<th>Age of milk when examined the second time†</th>
<th>Grade of milk.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1919 May 19 P. M.</td>
<td>G-E-E-E†</td>
<td>16 hrs.</td>
<td>G-M-E-E-F†</td>
<td>Milk utensils cleaned and cared for as usual except that screw cap was removed from each claw before immersing the tubes in the solution. Conditions as above.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>May 20 A. M.</td>
<td>E-E-E-E</td>
<td>28 hrs.</td>
<td>M-M-E</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>May 20 P. M.</td>
<td>E-E-E-E</td>
<td>16 hrs.</td>
<td>G-E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>May 21 A. M.</td>
<td>M-M-G-G</td>
<td>16 hrs.</td>
<td>M-M-M-M</td>
<td>As above except that two pails of hot water were sucked thru the machines just before starting to milk. As in No. 1, except that milk was cooled immediately to 45° F., by passing over an aerator. Cooled as above; but temperature had increased to 51° F. when milk was examined. Machines taken apart and washed, but pails not scalded and dried. Tubes in solution for short time only.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>May 21 P. M.</td>
<td>E-E-E-E†</td>
<td>16 hrs.</td>
<td>E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>May 22 A. M.</td>
<td>G-E-E</td>
<td>28 hrs.</td>
<td>M-G-E</td>
<td>Machines cleaned as at Station. Conditions as above.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>May 23 A. M.</td>
<td></td>
<td>16 hrs.</td>
<td></td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>May 24 P. M.</td>
<td>M-G-G</td>
<td>16 hrs.</td>
<td>M-G-G*</td>
<td>Machines taken apart and washed, but pails not scalded and dried. Tubes in solution for short time only.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>May 25 A. M.</td>
<td>E-E-E-E</td>
<td>16 hrs.</td>
<td>E-E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>May 25 P. M.</td>
<td>E-E-E-E</td>
<td>16 hrs.</td>
<td>E-E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>May 26 A. M.</td>
<td>E-E-E-E</td>
<td>16 hrs.</td>
<td>E-E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>May 27 P. M.</td>
<td>E-E-E-E</td>
<td>16 hrs.</td>
<td>E-E-E-E</td>
<td>As above.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>May 28 A. M.</td>
<td>E-E-E-E†</td>
<td>16 hrs.</td>
<td>E-E-E-E†</td>
<td>As above.</td>
<td></td>
</tr>
</tbody>
</table>

† Each letter indicates the quality of the milk in a single 40-quart can. E—excellent, G—good, M—medium, P—poor. See footnote 4 on page 8.

* Samples for the tests indicated by an asterisk were taken from the cans as the milk left the farm for the pasteurizing plant. Order of letters after May 19 corresponds with the order in which the cans were filled.

† Cooling at this farm was accomplished by well water which had a temperature less than 45° F., at this time. Milk held on the farm longer than four hours was kept in the cooling vat, and usually had a temperature between 45° and 52° F.

Note.—Total number of cans examined—53. The grades when they were sent to the city were as follows: 33—excellent, 12—good, 8—medium. Thirty-three cans were examined before the Station methods of cleaning were used. The grades were 13—excellent, 12—good, 8—medium. Twenty cans were examined after Station methods of cleaning were used, all of which graded excellent in quality.

As soon as the milking was completed, a pail of cold water was drawn thru the machines and this was generally followed by half a pail of fairly hot soda water and half a pail of clear warm water.
This water also had to do double duty, and by the time it had finished its task of washing out two double units, and a couple of stripping pails it was cold and greasy. After this treatment, the cups and tubes were again put into the solution, and the pails and lids were turned upside down on a bench in the barn until milking time the following morning. Examination the next morning showed them still to be wet and greasy. Twice a week the machines were taken in their entirety to the house for a thoro cleaning, and at this time they were taken entirely apart and washed.

For the first four or five days that the investigation was being carried on at Farm A, no definite or detailed system of caring for the machines was carried out. As noted in the remarks in Table I, one procedure was tried at one milking, and another at the next. This system, or rather lack of system, was used to determine whether any particular step in the care of machines and utensils was the one absolutely necessary step upon which depended the production of high grade milk. As shown in column four of the table, the quality of the milk as delivered at the milk receiving stations varied greatly under these conditions. It was not until the detailed methods recommended by the Station were put into practice on May 25 that a consistently good product was obtained.

Duplicate samples were taken from every can of milk after each milking. Preparations for microscopic examination were made immediately from one set of samples and the other set was put into the cooling tank to stand for twelve or twenty-four hours as the case might be. By this method we were able to determine the grade of A. M. milk as it was received at the milk plants, and as it was after standing for some hours; and also the grade of the P. M. milk after milking, and then again sixteen hours later, or as it was when delivered to the receiving plant.

The first corrective step taken was the removal of the screw cap at the end of the claw of the teat-cups before putting the cups into the solution after each milking. This was done in order to allow the escape of air from the milk tubes and to insure free passage of the solution thru the tubes in order that the sterilizing function of the solution could be fully utilized.

In other respects the procedures for caring for the machines and utensils were allowed to remain the same as usual. Care was taken, however, to see that no leaky inflations were used, that plenty of
Fig. 4.—Farm A. Interior Dairy Barn.

Fig. 5.—Farm A. Solution Jar.
Fig. 8.—Farm C. Interior Dairy Barn. Solution Jar may be seen in background.

Fig. 9.—Farm C. Solution Jar.
cold water was used in rinsing out the tubes and milker pails after each milking, and that the udders of the cows were clean before the teat-cups were attached. Table I shows that the milk quality under these conditions varied considerably, and during this time seven cans graded as excellent, five as good, and two as medium when received at the milk plant in Geneva.

Just before the fifth milking, two pails full of very hot water were drawn thru the milker tubes into the machine pails. This procedure thoroly scalded both the tubes and the pails. The results were gratifying as the four cans of milk produced under these conditions all graded as excellent.

No more hot water was used for a time, but efforts were made to keep the quality "excellent" by the use of a combined cooler and aerator. This aerator was of the open, tubular type, and, with its use, the milk could be cooled to about 45° F. The first time that the cooler was used the results were satisfactory as the first can graded as good, and the other two as excellent. The next time one can graded as medium, one as good, and one as excellent. The third time two cans graded as medium and two as good. This gradual lowering in the quality of the milk was probably due to the fact that the cooler was being inefficiently cleaned, and it illustrates very strikingly a common source of milk contamination.

Evidently cooling alone was not sufficient to produce first-class results. In order to get good quality milk, it is evident that it must first be handled in clean utensils so that it does not contain large numbers of bacteria. Cooling merely stops the growth of bacteria and does not reduce their numbers.

For the next two milkings, the procedure that had been in use before our work started was again used, but no real improvement was shown, as three cans graded medium and four good.

At this time it was decided to follow the methods that have been successfully used at the Station in exact detail. Immediately after milking, the tubes and pails were washed by drawing a pail of cold water thru the tubes into each milker pail. This was followed by a pail of hot soda water and a pail of clear hot water. The tubes and cups were then put into the sterilizing solution with the caps removed from the claws. The pails and pail covers (with the exception of the pulsators proper) were thoroly scalded and dried. This treatment also included the forty quart milk cans and the aerator.
A glance at the results from the last five milkings given in Table I shows that they were all that could be desired. Out of the twenty cans of milk produced under these conditions, the entire number graded as excellent.

From tests made during the course of the work it is evident that the chief source of trouble at this particular time was probably the metal utensils. The milker pails were clearly in bad shape for a liter of sterile water used for rinsing them gave agar plate counts of 1,500,000 and 240,000 per cc. The strippings pails under the same conditions gave counts of 70,000 and 340,000 per cc. Pails containing numbers of organisms as large as indicated from these counts would add enough bacteria to five quarts of milk to cause it to be rated below the excellent class even if no bacteria were present from any other sources.

Proof that scalding and drying these utensils did cause the disappearance of excessive numbers of bacteria is furnished from the fact that after this procedure was adopted (May 25) every can of the twenty examined was found to grade in the excellent class. Of the thirty-three cans examined immediately previous to this date only thirteen had graded in the excellent class.

It has been noted in the examination of milk from the dairies where milking machines were in use that there is often a higher bacterial count in the milk of one out of a number of cans containing milk from the same milking. Frequent repetition of this fact led to the thought that the can with the highest count was probably the first can filled and that the milk in this can had been contaminated by the first rinsings from the tubes and pails of improperly cleaned milking machines.

In order to verify this theory a record of the order in which the cans were filled was kept for several days at Farm A. The milk in these cans was sampled and graded.

Table I shows that in eight cases where this was done (May 20 to May 24) the first one or two cans filled had a higher bacterial count than did the rest of the cans of the same milking.

Altho the cases observed were few in number, yet they serve to justify the theory that the presence of a higher bacterial count in one of a number of cans containing milk from the same milking is
due to the fact that it contains the first rinsings from poorly cleaned milking machines or other utensils.

During the course of the work at Farm A the dairymen asked why it was that, despite the fact that the milking machines were really receiving less care previous to the morning milking than they did for the afternoon milking, yet the morning milk as received at the milk plant was almost invariably in the better condition. It was pointed out to him that this was probably due to the fact that the night’s milk was not sent in to the receiving station immediately, and was not examined and graded until it was about sixteen hours old. The morning’s milk, on the other hand, was received and graded when about four hours old. The twelve hours difference in the age made a great difference in the bacterial content as the milk was not held at a temperature low enough to prevent the growth of bacteria.

To illustrate this point, samples of morning milk were held for sixteen hours, and at the end of that time the grades were determined.

Chart III shows that of twenty-three samples of morning’s milk examined and graded when four hours old, or as delivered at the receiving plant, sixty-one percent were excellent, and the rest good or medium. Sixteen hours later, however, duplicate samples of the same milk graded only forty-five percent excellent. Of nineteen samples of night’s milk examined and graded when four hours old, seventy-nine percent were excellent, but after holding duplicate samples for sixteen hours, or the age at which the milk was delivered at the receiving station, this percentage had decreased to sixty-three. Evidently, when compared with night milk of the same age, the morning milk was in poorer condition.

The records of the milk inspection work for this farm during the remaining months of the year do not indicate that even this demonstration caused sufficient care to be used in cleaning the machines. During the seven months that followed, 104 cans of milk were examined. Of this number only seventy-five (72.2 percent) graded as excellent, twelve (11.5 percent) as good, fifteen (14.4 percent) as medium, and two (1.9 percent) as poor. In November a visit was made to the farm, and at this time it was evident that several
essential procedures in the care of the tubes were being neglected; for example, the tubes in the solution were again found to be largely filled

**Chart III.**—Comparative Quality of A. M. and P. M. Milk Held 4 and 16 Hours Respectively at 55° F.

|--------|--------------|--------------|---------------|---------------|

- **Excellent.**
- **Good.**
- **Medium.**

with air, the caps on the ends of the claws were not being removed, and the solution itself contained very little chloride of lime.
On the average this record was an improvement on the record maintained before the demonstration of proper methods was made at the farm. However, when plotted by the individual months as shown in Chart IV, it is seen to be characterized by a great irregularity evidently not correlated with temperature.

Chart IV.—Quality of Machine-Drawn Milk from Farm A During Latter Part of 1919.

Thus the poorest quality milk was delivered in July and November, while these bad months were in each case followed by records which were excellent.

Investigations made by enquiry at the farm makes it probable that the bad records were correlated with failure to carry out the
cleaning procedure with care; and that the good records, immediately following the bad ones, were brought about by increased attention given after notice that the milk was being received in poor condition.

FARM B.

Three units of a Sharples machine had been in use at this farm for some time before the investigation began. Since the milk had started coming into Geneva in November, 1918, 113 cans had been examined up to June 1, 1919. Of this number, forty-five (39.8 percent) graded as excellent, eighteen (16 percent) as good, thirty-seven (32.7 percent) as medium, and thirteen (11.5 percent) as poor.

As shown in Chart V these percentages compare very poorly with the averages showing the quality of the entire milk supply during the same time, or even with the quality of the average machine-produced milk.
A general inspection of the dairy barn and equipment at the beginning of the work showed that, while they were up to a good standard in construction (see Fig. 7), they were being poorly kept. Manure had been allowed to accumulate on the cement platform behind the stanchions, and this made it difficult to keep the milker pails and other utensils clean.

There was a good supply of running cold water in the barn and in the milk room, but no provision was made for hot water, except that it could always be procured at the house which was not very far away.

The cooling tank was a large concrete vat in the milk room. This was filled with cold water at each milking time, and the cans set in it up to their necks. This was later fitted with a drain so that a stream of cold water was constantly supplied.

The cows were kept fairly clean, but little attention was being paid to the condition of the udders when the teat-cups were put on, and oftentimes they were dirty.

The solution used for the teat-cups and tubes was in a twenty-five gallon crock and was mechanically clean. (See Fig. 6.) Altho the weather was very hot, the solution contained no hypochlorite and insufficient salt, so that it was not effective as a sterilizer.

The vacuum pipe line contained a few drops of moisture after each milking, and a milky spray drained out of the vacuum tank trap and the compressed air tank when the stop cocks were opened after milking.

The machines themselves were dirty. Altho the dairyman had supposedly cleaned them the day before the investigation started, a casual examination showed them still to be dirty. When questioned as to his methods for cleaning, it was found that he practically never removed the nipples from the bottom of the teat-cups nor even took off the short milk tubes from the cups. The cups and tubes were simply put into warm water, and a brush was run thru them a few times, they were then rinsed in hot water, and the cleaning was finished. This procedure was insufficient, and a coating of fat and dried milk was left on the inclusions and in the tubes. The check valve and milk spiggots on the pail lids fared no better, and much dried milk was found on the strainers in the check valve, on the valve seats, and on the valve plugs.
Each morning after milking, the machine pails (three in number) and the large milk cans (generally three or four) were rinsed out with about a kettle full of hot water, and turned upside down to dry. The cans were put on a rack outside the milk house, and the pails in the milk house on a rack built over the cooling vat. After the evening milking the pails and tubes were simply rinsed out by sucking a pail of cold water thru them. The pails were then put on the racks to dry, and the tubes were put into the sterilizing solution. No hot water was used. Also the caps were left on the milk claws when the cups and tubes were put into the solution, a good deal of air being imprisoned in the tubes, with the result that the solution was not able to act upon all the inside surface of the tubes.

In order to determine the germ content of the three milker pails under the methods of washing that had prevailed on the farm before the system of scalding and drying the utensils had been introduced the pails were rinsed out with a liter of sterile water on June 3. This water when plated out and incubated gave counts of 20,000 to 53,000 per c.c. If five quarts of milk were drawn into pail number two, which contained the greatest number of organisms, it would result in an initial contamination of about 10,000 organisms per c.c. of milk. This does not indicate satisfactory conditions tho the result is much better than that secured at Farm A where the rinse water gave counts up to 1,500,000 per c.c.

Before the next milking, all metal and rubber parts of the machines were thoroly cleaned with hot alkali water and rinsed with clear hot water. The machine pails, strippings pails, and large milk cans were scalded and dried. The rubber inflations in the teat-cups were in bad condition, and three of them had to be replaced with new ones. A strong hypochlorite solution was made up by mixing a can of chloride of lime with a gallon of water, and pouring off the clear greenish liquid. The rubber parts were all soaked in this for about an hour before assembling them again. A pint of the stock solution of hypochlorite was also added to the brine solution in the crock.

After the evening milking, the tubes and pails were washed out by drawing thru them: First, a pail of cold water; second, a pail of hot soda water; and third, a pail of clear hot water. The cups and tubes were then put into the brine solution. The screw caps
on the milk claws were removed and kept in a box beside the solution jar. The milk and pail lids were turned upside down on the rack out in the open air to dry.

At every milking care was taken to be sure that the udders of the cows were clean before the cups were attached, and efforts were made to prevent any dirt from getting into the milk pails and cans.

**Table II.—Quality of Individual Cans of Milk from Farm B during the Early Part of June, 1919.**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Date</th>
<th>Time of milking</th>
<th>Grade of milk after four hours</th>
<th>Age of milk when examined the second time.†</th>
<th>Grade of milk.</th>
<th>Remarks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June 2</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>P-P-M†*</td>
<td>Cleaning as usual. Temperature of milk as shipped—62° F.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>June 3</td>
<td>A. M.</td>
<td>16 hrs.</td>
<td>P-M-G</td>
<td>As above. Milk not cooled before shipping.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>June 3</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>M-E-E*</td>
<td>Machines thoroly cleaned. Pails scalded and dried. Cooled in vat to 62° F.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>June 4</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>E-E-E*</td>
<td>Machines cleaned as at Station. Cooled as in No. 3.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>June 5</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>G-G-E*</td>
<td>As above. Aerator used for first time. Cooled to 64° F.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>June 6</td>
<td>A. M.</td>
<td>28 hrs.</td>
<td>G-G-M-M</td>
<td>As above. Well water used in aerator. Cooled to 60° F.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>June 6</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>E-E-E*</td>
<td>As above. Well water used in aerator. Cooled to 60° F.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>June 7</td>
<td>A. M.</td>
<td></td>
<td></td>
<td>As above. Well water used in aerator. Cooled to 60° F.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>June 7</td>
<td>P. M.</td>
<td>16 hrs.</td>
<td>E-E-E*</td>
<td>As above. Well water used in aerator. Cooled to 60° F.</td>
<td></td>
</tr>
</tbody>
</table>

† Each letter indicates the quality of the milk in a single 40-quart can. E—excellent, G—good, M—medium, P—poor. See footnote 4 on p. S.

‡ Samples for the tests indicated by an asterisk were taken from the cans as the milk left the farm for the pasteurizing plant.

Cooling at this farm was accomplished by running spring water which was never colder than 60° F. during this period. Milk held on the farm longer than four hours was kept in the cooling vat, and usually had a temperature of from 62 to 65° F.

Note.—Total number of cans examined—30. The grades when they were sent to the city were as follows: 24—excellent, 2—good, 2—medium, 2—poor. Twenty-one cans were produced after Station methods of cleaning were used. Nineteen of the latter graded excellent and two good.

The results under these conditions were excellent until the third milking, at which time one can graded as excellent, and two as good.

The usual precautions had been taken previous to this milking, and an aerator had been added to the equipment already in use. It was found, however, that the milk was being cooled to only 64° F., so that, after standing for about sixteen hours (as the night milk did before being delivered to the receiving plant), whatever organisms were present had ample opportunity to multiply rapidly. For the bacterial count to remain low for so long a time at this tempera-
ture, all utensils would need to be in very excellent condition, and
great care would need to be taken continually during milking.

It was a significant fact that the samples graded as good showed a
high count of lactic acid organisms, and very few of the type
commonly regarded as "utensil" organisms.

By the next milking, the cooling conditions were changed so that
the milk was cooled below 60° F., and from then on until the end
of the work no further trouble was experienced, and all cans graded
as excellent.

In order to determine the content of the milker pails under the
conditions to which they were being subjected: i.e., being scalded
and dried after every milking, they were each rinsed out with a liter
of sterile water. This water, when plated out and incubated, gave
counts of 20,000 to 53,000 per cc. If five quarts of milk were
drawn into pail number two, which contained the greatest number
of organisms, it would result in an initial contamination of about
10,000 organisms per cc. of milk. Although this does not indicate
entirely satisfactory conditions, yet this result was much better
than those secured at Farm A where the rinse water gave counts up
to 1,500,000.

It was very disappointing to us to find at the conclusion of our
work at Farm B that the milk from this farm was to be sent to a
nearby creamery in order that the skim milk might be available for
stock feeding. As a consequence, inspection of the quality of this
milk was discontinued until the following November, when the milk
was again sent to Geneva.

The record for November was not satisfactory as only six (50
percent) of the samples of milk examined were graded as excellent,
while three were graded as good, and three as medium. December's
record, however, was good, as all samples examined, fourteen in
number, were graded as excellent.

FARM C.

As a contrast to the farms under discussion, let us briefly review
the history of Farm C. The dairy barn on this farm is not a strictly
modern building, but it is kept reasonably clean, and there is a
plentiful supply of light and air. (See Fig. 8.) Due to the fact
that the cows must frequently come thru a muddy yard to get into
the barn, their udders are sometimes dirty so that Farmer C washes
them carefully with warm water. A double unit Empire machine has been used on this farm since May, 1917, and the quality of the milk produced has been good up to the present time. From May, 1917, until January 1, 1920, 274 cans of milk from this farm have been examined, and of this number 266 (97.1 percent) have been graded as excellent or good, seven (2.5 percent) as medium, and one (0.4 percent) as poor. The record at this farm since the machines have been in use compares very favorably with the record of the same farm when the cows were milked by hand. In Bulletin No. 450 of this Station, the statement is made that "On six farms where direct comparisons between hand-drawn and machine-drawn milk were possible, only two of them produced milk by machine with as few germs as were contained in the milk produced by them by hand." Dairyman C is one of the latter.

In general, the cleaning methods recommended by the Station have been in use on this farm with the exception that, after each milking, the tubes and cups are washed out only by sucking cold water thru them. At Farm C, however, they are very careful to scald all utensils out thoroly after every milking. Everything that in any way comes in contact with the milk is kept scrupulously clean. Until very recently, the cups and tubes have been kept in a strong chloride of lime solution, except in the winter when brine was added to keep the solution from freezing. (See Fig. 9.) Great care has always been taken, however, to keep the chloride of lime up to strength, and in June, 1918, at one test the solution showed 888 parts per million of available chloride. This indicates a very active sterilizing solution.

During this last summer trouble was encountered in maintaining the excellent record made up to that time. In April the records showed eight cans excellent, one can good, and three cans medium; in May, four were excellent, two good, and two medium; and the first test in June showed two excellent and two medium cans. An examination of the microscopic preparations showed that a yeast was commonly present, a condition which is in itself somewhat unusual. Following the examination of the milk on June 4 the dairyman was instructed to add brine to his chloride of lime solution and, tho it may be a coincidence, it is a fact that since that time every can examined has graded as excellent or good (thirty-two excellent and two good).
The important points to note in regard to this record are the following: In the first place all of the utensils with which the milk comes in contact are being kept very clean. This important rule is being faithfully observed. As a general rule, the producer and his wife attend to the care of the dairy themselves, so that this work is not left to hired help, which is often either incompetent or indifferent. In the second place, the solution in which the cups and tubes are kept is always sweet and clean. In this connection it might be well to point out that it does not matter so much where the solution is kept as how it is kept. In this particular case the solution crock is kept in the barn with the cows. (See Fig. 8.) In the third place the cows are always kept clean. Fourthly, the milker himself is clean. Finally, the barn is kept in good condition. This combination of affairs has resulted in the establishment of an excellent record, and is proof that, with proper care and attention, good milk can be produced with a milking machine under practical farm conditions.

CONCLUSIONS.

An examination of the methods applied at Farms A, B, and C, together with the results secured, show that, while machines are quite complicated, yet clean milk can be secured with them if proper precautions are taken. It also shows that these precautions are such that they come within the limits of the ability of every dairyman. The all-important principle which must be kept in mind is strict attention to detail. No matter if two essential rules are always carried out to the letter, if a third is occasionally neglected the results are sure to be irregular. If every detail is carried out every time, however, the results will always be satisfactory.

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Thanks are also given to the owners of the farms where the investigations were made for courtesies extended during the work.