

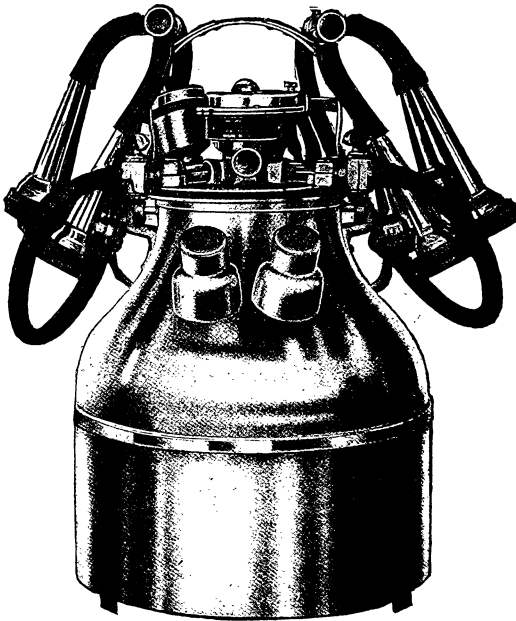
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MILKING MACHINES AND CLEAN MILK.

SUMMARIZED BY

F. H. HALL

FROM BULLETIN BY

H. A. HARDING, J. K. WILSON AND G. A. SMITH

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POPULAR EDITION\*

OF

BULLETIN No. 317.

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## MILKING MACHINES AND CLEAN MILK.

F. H. HALL

**Many factors involved in milking-machine success.** A successful milking machine, satisfactory in all points, should mean much to the dairy industry. At present the small quantity and poor quality of farm labor available in many sections make dairying there impracticable on a large scale; for with uncertain help the farmer can keep only so many cows as he can handle alone when need arises. If a machine be perfected that will take the place of any considerable part of the necessary hand labor in caring for dairy stables, it will mark a long step in advance for dairying. The production of milk on many farms could then be raised from an incident to a business, and it is only as a business, carefully studied and properly managed, that dairying can be an economic success.

Machines are on the market that are at least mechanically successful, that is, *they do milk cows*; but before they can be recommended without many qualifications, much more than this must be known. The work must not only be done, but to be considered successful it must be done as well or better than it

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\* This is a brief review of Bulletin No. 317 of this Station, on Milking Machines: Effect of Method of Handling on the Germ Content of the Milk, by H. A. Harding, J. K. Wilson and G. A. Smith. Anyone interested in the detailed account of the investigations will be furnished, on application, with a copy of the original bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete, as desired. Bulletins are issued at irregular intervals, as investigations are completed; not monthly.

can be done by hand and more cheaply, without decrease in quantity or lowering of quality of the milk and without immediate or remote ill effect upon the animals. The advent of these machines has placed on dairy investigators the duty of determining their good and bad points, and this Station is, therefore, seeking facts to aid in the solution of some of the problems.

Early in 1906 two Globe milking machines were placed in the Station stables and work with them was carried on intermittently during the spring and summer of that year. Mechanical defects repeatedly put the machines out of commission, and when working at their best they were not satisfactory. On a few cows they could not be used at all and stripping by hand was necessary with most of the others.

The parts of the machines coming in contact with the milk were carefully washed, cleansed with sal soda or steamed between milkings, but it was found impossible to keep them even reasonably free from bacterial contamination. Examinations of samples of milk from these machines, drawn at many different times, always showed more germs than were found in milk drawn by hand from the same cows at corresponding times and under similar conditions. More than thirty typical comparisons showed an average of 40 times as many bacteria in the machine-drawn milk as in that secured in the usual way by milking into an open pail. In the dairy it was found almost impossible to keep the machine-drawn milk from premature souring. It often curdled so soon that it could not be run through the separator 48 hours after milking.

The Globe machine was withdrawn from market in the fall of 1906, and the two outfits in the Station stable were removed.

These Globe machines were followed in the spring of 1907 by two Burrell-Lawrence-Kennedy "cow milkers;" and the successors of these machines, "cow milkers" of the same make and same general type but with important modifications and improvements, are still in use. These machines have been in operation quite regularly for two years and, in the

latest form, appear to be well designed, mechanically, and well made; they work when called upon to do so, they milk the cows as clean as would most hand milkers, they seem to promise some economy in labor and they have produced no immediate or evident ill effects upon the animals. Whether their continued use will affect the cows favorably or unfavorably, will permanently increase or diminish the milk flow and, if either, how much, whether any economy will attend the use of the machines with herds of different sizes under different conditions, are problems that can not be solved without several years of careful study. The Station investigators are not prepared to offer conclusions upon these points, but hope, in the future, to secure satisfactory data upon them.

Upon one phase of milking machine use, however, careful investigations have been in progress for three years. This is the problem of cleanliness, perhaps the most important in present day dairying; for one of the most vigorous current demands is that for pure milk,—a demand voiced alike by milk drinker, buttermaker and cheesemaker. It is a demand to which the producer would gladly respond if he could, for he knows that only a sweet, pleasant-tasting, pure-smelling product will find a ready market at profitable prices. To impurities accidentally present, not to inherent defects in the milk itself, are due the buttermaker's and cheesemaker's chief troubles; and, beside the disgust occasioned the consumer by thoughts of dirty milk, the impurities cause actual loss to him through premature souring of his table supply or may endanger his life by introducing the germs of some dreaded disease.

Impurity in milk may come from one or many of a multitude of sources; but, whatever its source, the unclean material bears with it a load of bacteria. These flourish in milk though they are not numerous in the udder of the clean, healthy cow. The number of these minute organisms found in it is taken, therefore, as a measure of the cleanness of milk. If the germs are few the milk must be clean and, prob-

**Problem of cleanliness important.**

**Measuring the purity of milk.**

ably, wholesome, while if bacteria are numerous in fresh milk, the milk is dirty and may be injurious to health. The bacteria may not always, perhaps not usually, be dangerous;—for only at a very small percentage of the examinations are disease germs found;—but the presence of large numbers of common innocuous bacteria indicates that the milk has been drawn or kept in dirty surroundings and so condemns it for human food.

**Counting** Bacteria are practically invisible, singly, except  
**bacteria.** with a powerful microscope; but under favorable conditions each multiplies so rapidly that it soon produces a colony easy to see with a low power lens or even with the unaided eye. The bacteriologist who wishes to know how many germs milk contains, takes a small sample of it—a cubic centimeter, about one-sixth of a teaspoonful. This sample, small as it is, may contain many millions of bacteria. The milk is diluted many times, which scatters the bacteria widely. A small, measured portion of the diluted milk is united with a quantity of “culture medium,” a material that is food for bacteria and promotes their growth. When this warm liquid is poured in a thin layer upon a glass plate, the individual germs are widely separated. The colony formed by each one after a sufficient time in a warm place is visible as a point or dot or spot in the transparent “culture medium,” which hardens on cooling to a jelly like consistency and so keeps the colonies from running together. The spots on a definite portion of the plate are then counted, and their number, multiplied by a factor corresponding to the amount of dilution, gives the number of germs in the sample. Thus Science measures the cleanliness of milk. Comparison of samples taken under different conditions shows whether those conditions have favored or hindered the entrance into the milk of dirt, dust, filth and similar bacteria-carriers. In this way it was found, as already stated, that 40 times as many bacteria got into milk drawn by the Globe machines as into milk from the same cows drawn by hand.

**Some points  
in milking-  
machine  
construction.**

is maintained. The intermediate connecting parts are one large and four small rubber tubes, which are united by a metal teat-cup connector, and a metal and glass tube attached to the pail.

**One way  
the machines  
may collect  
bacteria.**

Milk, of course, penetrates the connections between rubber and metal, enters all cracks, wrinkles or air holes inside the rubber tubes and adheres to any rough places; so unless great care is used in cleansing or sterilizing all these connecting parts the milk left offers a very favorable place for bacteria to grow. This was the trouble with the Globe machine; for in spite of supposedly ample precautions in steaming the metal parts and cleansing the rubber hose with hot water and sal soda, the tubes were still thoroughly seeded with bacteria when each milking began. These readily passed into the can with the current of milk. That this was the case rather than that the bacteria gained entrance in other ways was shown by a decrease in numbers of bacteria from 47,000 in the milk of the first pair of cows milked to 30,000 in the next pair and to 23,000 in the third pair, these figures being averages from about a dozen separate trials. The passing of the milk gradually washed the bacteria out of the tubes.

**Keeping  
tubes  
in brine.**

The makers of the Burrell machine recognized the difficulty in keeping the detachable rubber parts of the milker free from living bacteria, therefore directed that such parts, after cleansing, be kept until needed again in brine containing one-tenth its weight of salt. Such a solution greatly restricts bacterial growth, is harmless and is not noticeable in the milk if the tubes are rinsed in cold water.

The marked beneficial effect of this treatment was shown in comparative tests. When the parts were kept in brine between

milking the average germ content of the milk samples for six milkings of two cows was 17,000 bacteria per cubic centimeter, while the average for nine milkings of the same cows when the parts were not kept in brine was 174,000, a more than ten-fold increase. This use of brine for keeping the tubes free from bacteria is a most important step in milking-machine hygiene. It should never be omitted and great care should always be taken to have all the air forced out of the tubes when they are immersed in the brine. If this is not done, some portions of the tubes may be protected from the brine by an air cushion, leaving good conditions for germ growth. Carelessness in this regard, before the importance of the step was fully recognized, resulted in notable fluctuations in the bacterial content of the milk, the numbers being high one day and low the next.

Bacteria may also enter milk during machine drawing in two other ways; but both may be so well guarded that milk of low bacterial content could be readily secured in the Station stable, where conditions were no better than they can quite easily be made in any good stable.

**Use of filters.**

After each stroke of the "pulsator" allowing the full force of the vacuum to be exerted air must be admitted to the teat-cups so that milk from the udder may again enter the teats. Provision is made for air to enter through small orifices in each teat-cup connector, so a stream of stable air, with its dust, is constantly flowing into the machine. This air, as it enters, however, is made to pass through a layer of cotton, which strains out or filters out the dust just in proportion to the thickness of the layer and the care with which it is made to fill the space about the opening. In the first B-L-K machines used, the disks of cotton in these relief filters were too thin, but in later forms provision is made for an ample supply of cotton which can easily be placed in position.

Air also enters the machine at the close of milking, as the vacuum must be released before the pail can be opened. Release is most quickly made by drawing the connecting rubber hose from the nipple near the stanchion on the main pipe leading



to the pump. This, however, causes a sudden rush of the stable air into the pail,—a current so violent that, in the old styles of machines, iron rust from the pipes was carried by it in sufficient quantity to discolor the surface of the milk. As the air always contains dust and larger floating particles, especially when disturbed by the motions of the attendants, and each grain of dust carries many bacteria, this release of the vacuum at the stanchion cock is a fruitful source of bacterial contamination unless proper precautionary measures are taken. This is particularly true on one side of the divided milk pail used with the B-L-K machine. The suction opening is not in the center of the pail cover but at one side so that the rush of air affects principally the milk of one cow. In tests with three cows at eight milkings, more than 50,000 bacteria were found, on the average, in the milk samples taken from the side of the pail beneath the opening and 13,000 in samples from the opposite side. Provision was made in the old style machines for a thin, filtering layer of cotton, the suction filter, which protects this opening as the relief filters protect the opening in the teat-cup connectors. These first, thin filters kept out many of the bacteria, even when carried by such a strong current of air. When the cotton was in place and the vacuum was broken at the stanchion cock, the numbers of germs in the milk were reduced to 20,000 and 8,000 respectively, in the two sides of the pail.

The vacuum can be broken, also, by allowing the air to enter gradually through the relief filters. This method of releasing the teat cups takes longer but reduces the bacteria, for without the filters in, the average numbers of germs when the vacuum was broken through the teat cups were 11,000 with one machine milking four cows sixteen times and 7,000 with the other machine.

The thin filters were evidently not fitted to  
**Better** resist such a strong inrush of air, so in the newer  
**filters.** machines provision was made for larger and  
 thicker disks of cotton. The relief filters in  
 the machines of the latest model are nine times as large as those  
 first used and the suction filters eleven times as large. To compare these two types of filters an old machine with small filters

and a new machine with large filters were used on the same cows. The small filters allowed nearly three times as many germs to enter, the figures being 8,000 for the old machine and 3,000 for the new one.

Of the two filters on each machine,—suction filter on the pail and relief filters in the teat-cup connectors, the suction filter is by far the more important. In tests without cotton in either filter 16,000 germs were found in the milk, but when the suction filter only was filled the number was reduced to 4,500. If time is too short at any milking to fill all the filters properly, the suction filter should be given preference as this is the larger and more easily filled and, as shown above, is much more important.

**Excellent results secured.** Using the new machines with large filters, both properly provided with cotton, and keeping the rubber parts in brine between milkings, the machines drew the milk in very clean condition.

In 40 milkings, including trials of two machines and both ways of releasing the vacuum, the average germ content was less than 4,000 and in one-fourth of the samples it was less than 1,000. This last figure indicates exceptionally clean milk for a product secured under ordinary stable conditions and proves that the machines, properly managed, may be very efficient aids in producing clean milk. A germ content lower than this is not common even where certified milk is made; and no attempt was made in the Station stable to secure the conditions demanded for producing certified milk.

**Some minor factors.** Incidental to the investigation of the two important factors, storage of rubber parts in brine to keep them clean and the use of large, well-packed filters to exclude the germs in the air, other interesting facts were brought out.

Absorbent cotton was found no better than ordinary cotton, if as good, for use in the filters; as it matted down more easily through its greater readiness to take up moisture. It was not superior in filtering power, as the bacteria were practically equal in number in tests comparing the absorbent cotton and the ordinary cotton. Since the latter is cheaper its use is preferable.

Several times during the tests, teat-cups were accidentally dropped or were kicked off by the cow before or during the milking. The effect was, in every case, a most marked increase in bacteria in the milk of that cow. The number of germs was sometimes so great after such an accident that the colonies crowded the culture plate too closely to allow counting.

Since teat-cups of different sizes must be used with cows having large and small teats, it is often necessary to disconnect one set of cups and put on another during the milking. If this is done in the stable, there is some danger of introducing bacteria, but in tests where this change was purposely made and samples taken, only a few decided increases were noticed and the average effect was but slight. This is fortunate, for in practical work it would be impossible to make all the changes immediately before putting the cups into the brine, as was done in all the other Station tests.

It was also found that there was an occasional marked increase in bacteria from carrying the pail into the barn with the cover off, a practice of some milkers, who distribute the weight of the apparatus by carrying the cover in one hand and the pail in the other. This is, however, a careless practice, and an unnecessary one, since the pail, with the cover on, is not cumbersome.

The marked increases in bacteria from any  
**Conclusions.** } carelessness in keeping the rubber parts well  
 } protected by brine, from improper filling of the  
 filter cups and from accidental entrance of dirt or dust into the  
 teat-cups, with the occasional increases from changing the teat-  
 cups or from carrying the pail into the stable open, all emphasize  
 the fact "that the quality of the milk obtained from a milking  
 machine depends primarily upon the intelligent care which is  
 exercised in the manipulation of the machine."

The most important steps are to keep the rubber parts immersed in brine or similar solution between milkings and to use a type of machine having large filter cups which are kept well filled with good, dry cotton. If the men handling the machines are careful to observe these precautions at all times, and to

avoid other careless practices in their work with the machines "they can be reasonably expected to deliver milk of a germ content comparable with good hand milking when given proper attention."