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55TH ANNUAL MEETING
August 19, 20, 21, 22, 1968
Chase-Park Plaza Hotel
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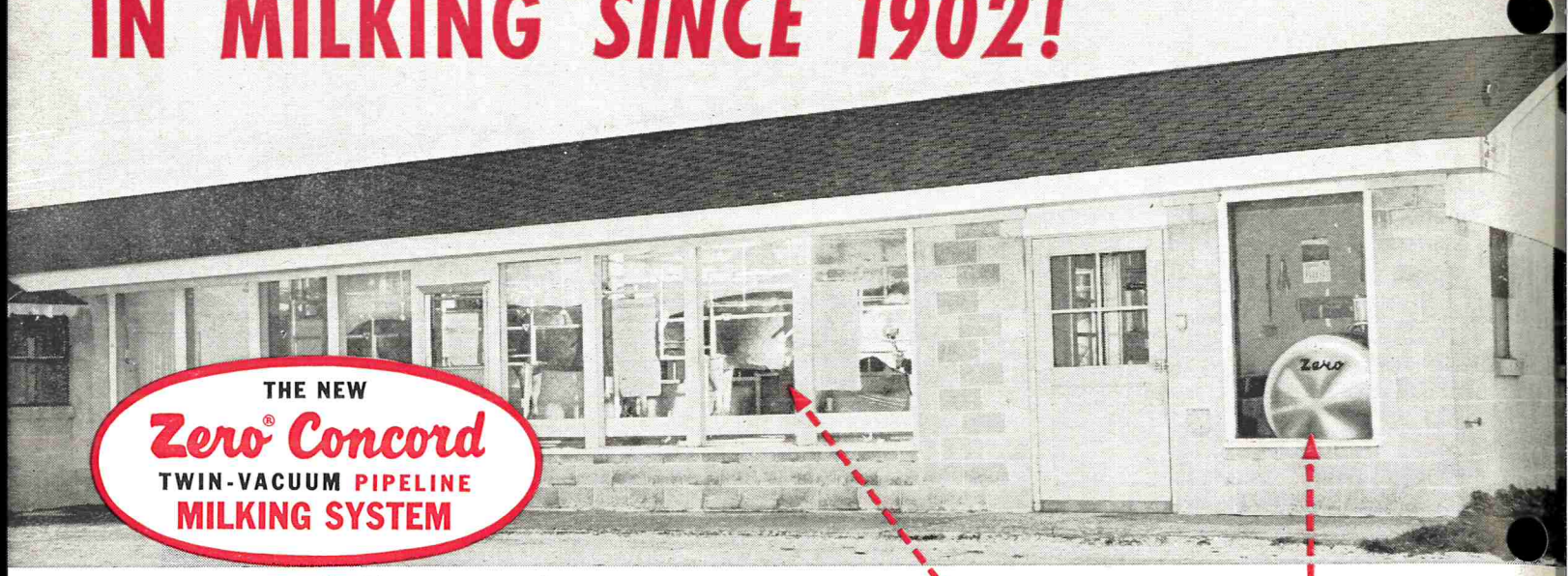

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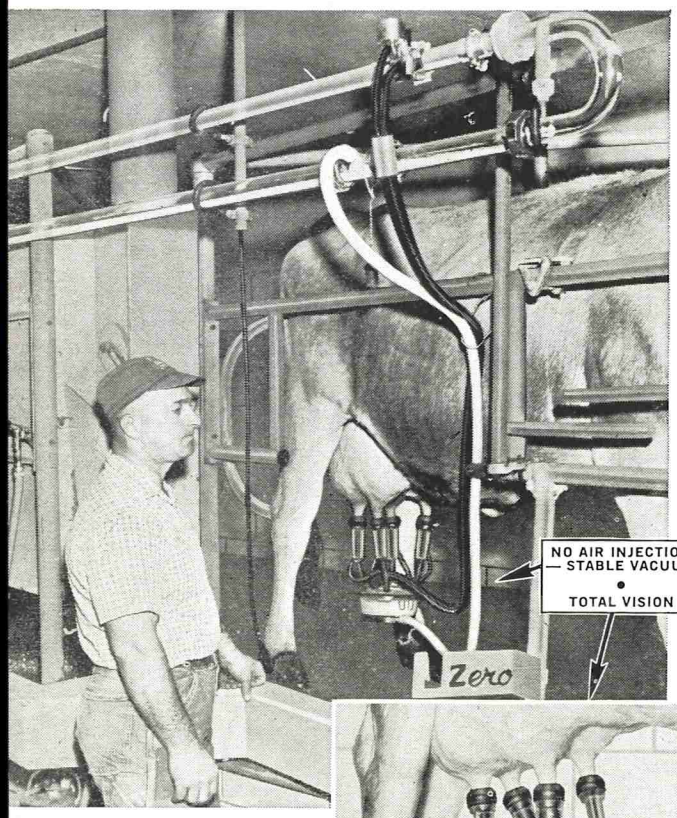

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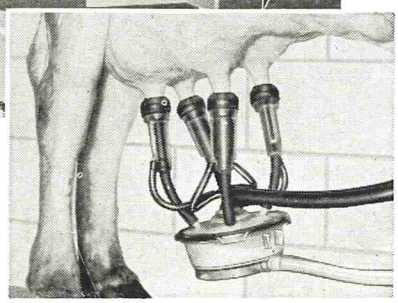

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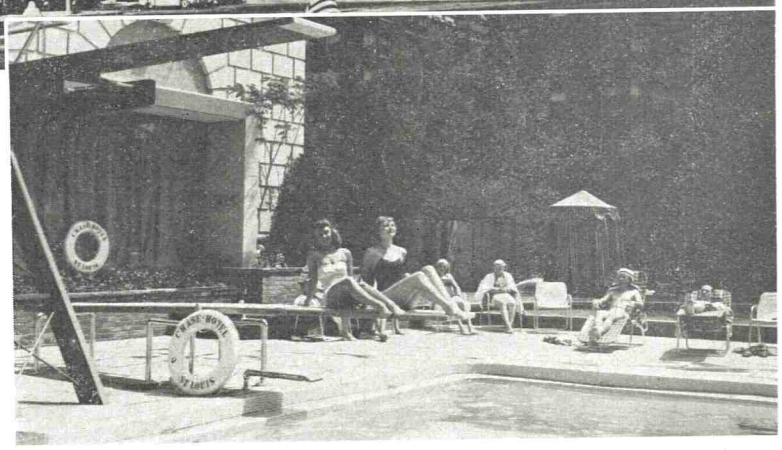

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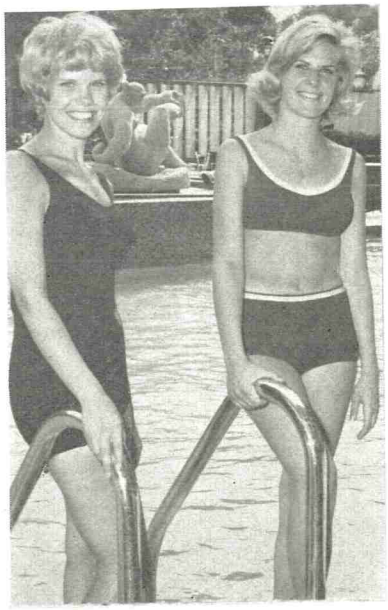

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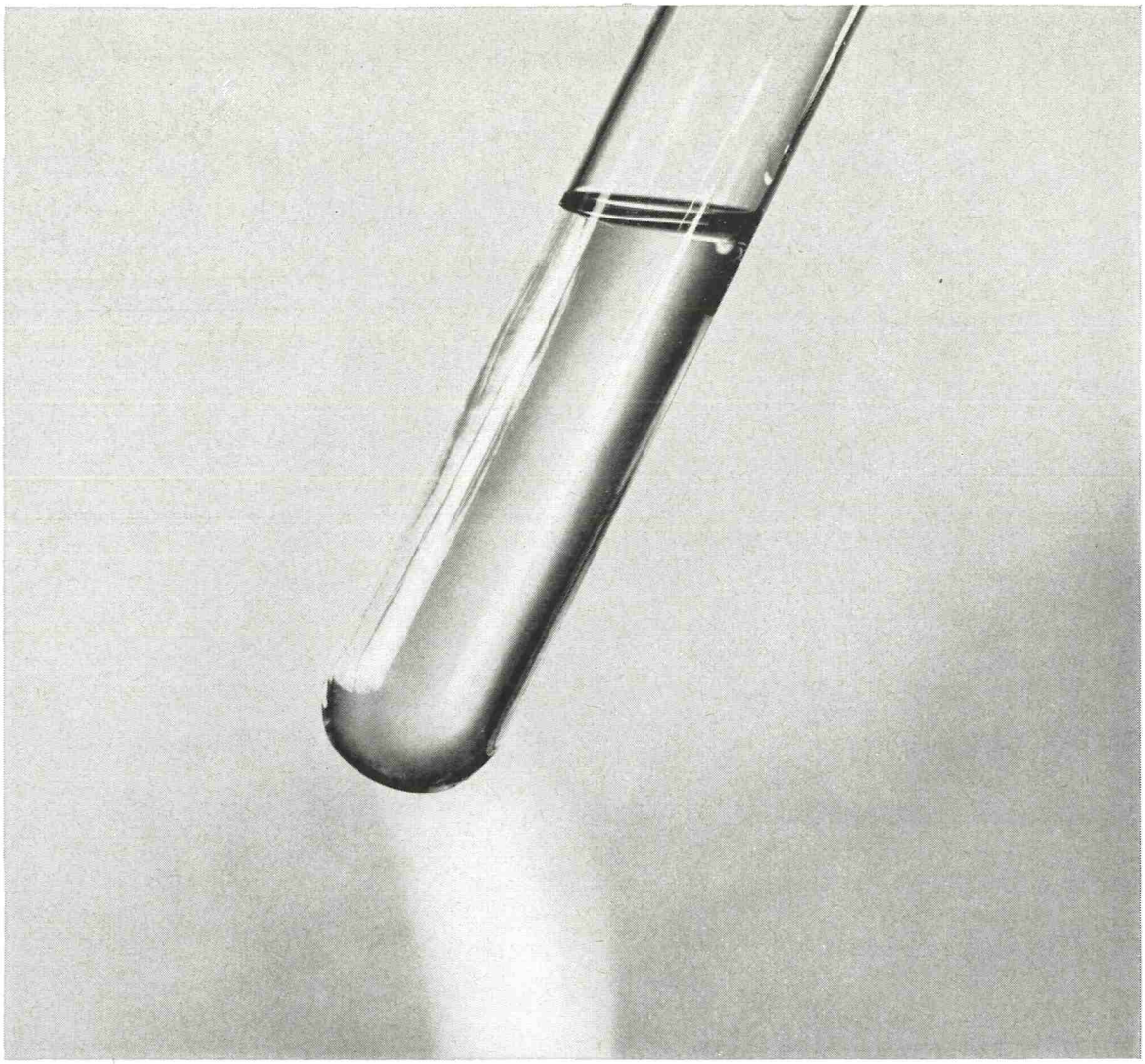

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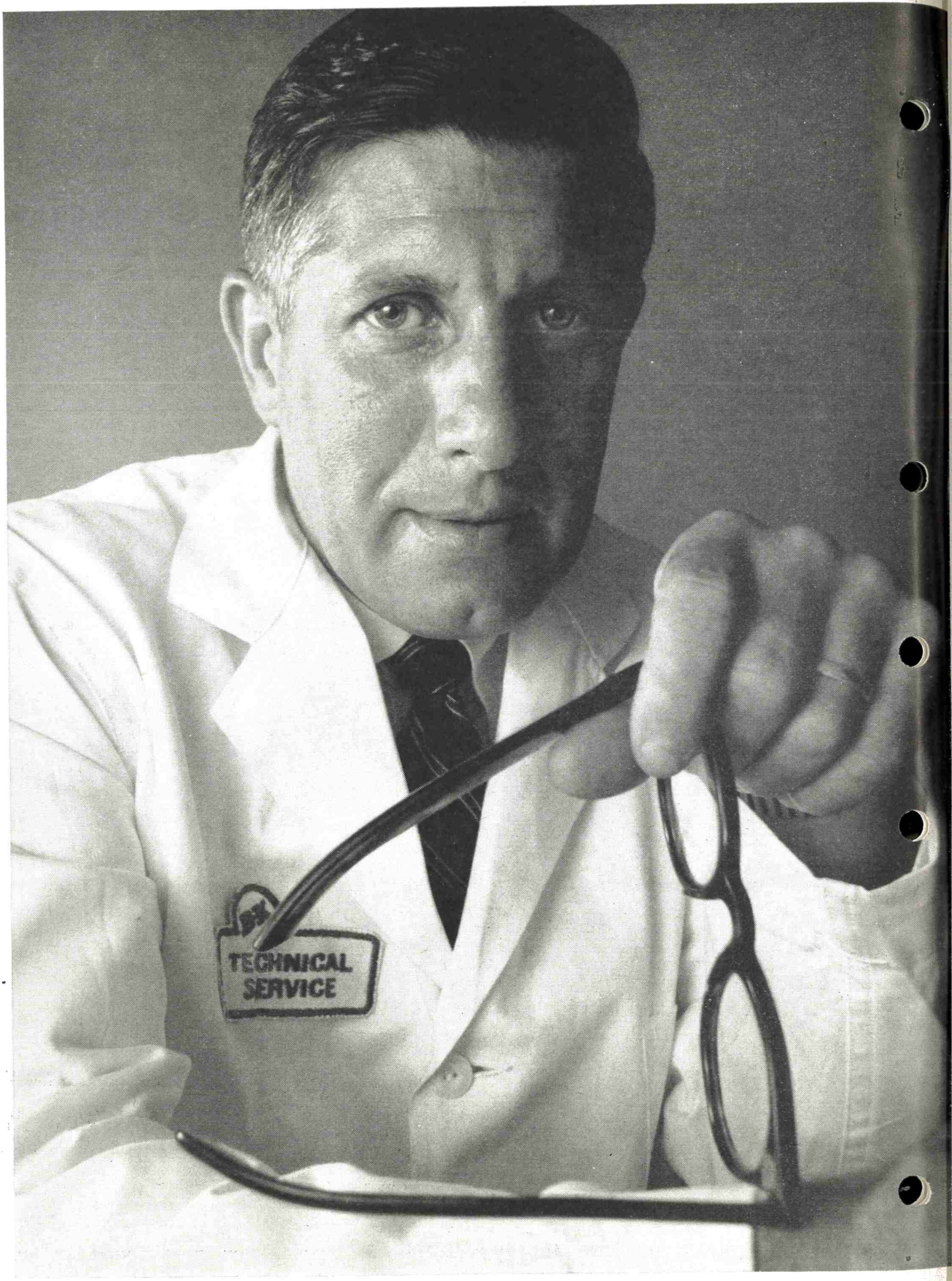
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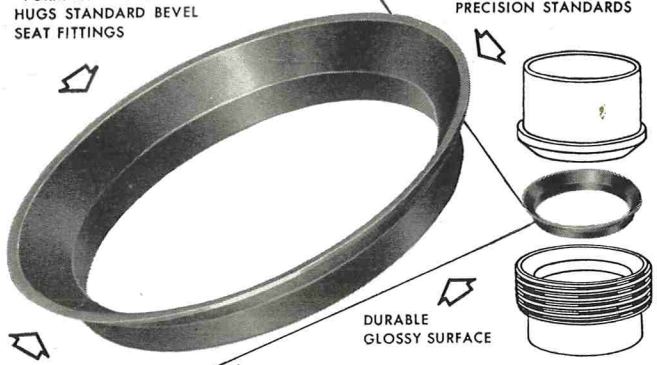

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EFFECT OF CERTAIN VARIATIONS IN DILUENT AND DILUTION PROCEDURE ON SURVIVAL OF *PSEUDOMONAS* SPECIES GROWN IN VARIOUS MEDIA[1]

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(Received for publication October 20, 1967)

ABSTRACT

Studies on the effect of various diluents on the level of population of pseudomonads grown in skimmilk, nutrient broth, and on agar slants indicate that with skimmilk cultures usually minor increases or decreases in viable counts occurred. With cultures grown in nutrient broth at 25 C, reductions in numbers after holding in phosphate buffered water or distilled water became more prevalent. The viable population of cell suspensions from agar-slant cultures held in either Standard Methods buffer or distilled water decreased rapidly in most instances. The temperature of the diluent did not have a significant effect on the survival of test cultures in various diluents. Studies on the effect of cell concentration on survival of test cultures in various diluents indicate that in general only minor changes in viable count could be attributed to differences in cell concentration. With respect to pH of the diluting fluid, a diluent at pH 7.0 seemed preferable. Experiments with distilled waters from difference sources indicate that the type of water used as diluent can have a great effect on the viable count.

One of the major quality characteristics of many foods is the number of viable microorganisms present in them. The agar plate method of estimating microbial populations is used on all types of foods including dairy products. The conditions for carrying out this procedure for dairy foods are described in detail in *Standard Methods for the Examination of Dairy Products (1).* In recent years numerous papers have been published on enumeration of the viable population of foods which contain a significant proportion of psychrotrophic bacteria. In most of these studies, emphasis is placed on the effect of time and temperature of plate incubation on the viable count. Detailed information on this subject is presented in a recent review by Baumann and Reinbold *(3).* Recently, Vanderzant and Matthys *(24)* reported on effect of temperature of plating medium on the viable count of psychrotrophic bacteria.

With respect to diluents used in enumeration procedures, *Standard Methods (1)* provides specific recommendations regarding the composition of the diluent (phosphate buffer) and the suitability of distilled waters used in the preparation of the diluent. Various studies have reported that some species of bacteria die during holding in diluents such as water, saline, or phosphate buffer solutions. Wagenaar and Jezeski *(26)* noted that less than 1% of a population of *Pseudomonas putrefaciens* was viable after holding in distilled water for 1 hr. Straka and Stokes *(22)* showed that as much as 40 to 60% of the bacterial population of poultry pies was killed in distilled water in 20 min and over 90% in 1 hr. Various methods have been proposed to reduce the destructive effect of water, for example, the use of phosphate buffer *(1, 5);* 0.1M potassium phosphate and 0.002M magnesium sulfate *(9);* gelatin-sodium phosphate buffer *(26);* 0.1% sodium thiosulfate *(13);* peptone water *(12, 13, 16, 22);* yeast extract, casein hydrolyzate, glutamic acid or glycine *(22).* Phosphate buffered or saline diluents, however, do not always provide good protection for certain bacteria *(5, 13, 21, 22).* Although little is known about the optimum pH value for diluents, some reports *(22, 23)* indicate that the survival rates at the low and high pH values were lower than near pH 7.0. In addition to the composition and pH of the diluent and length of holding the sample in the diluent, other factors such as the density of the initial viable population *(2, 6, 9, 20, 22, 27)* and the temperature of the diluent *(8, 11, 17)* can influence the survival rate of bacteria. The extent of the reduction in viable population by cold shock in the diluent was influenced by the medium in which the organisms were grown *(7)* or on which they were subsequently plated *(14).* The present study was prompted by the need for more information on the influence of various characteristics of diluents on the survival of various pseudomonads.

EXPERIMENTAL METHODS

The routine tests for the cultural, morphological, and physiological characteristics of the test cultures were carried out as described in the *Manual of Microbiological Methods (19).*

[1]Technical paper No. 4931 of the Texas Agricultural Experiment Station, College Station.

Other tests, including sugar utilization by the Hugh-Leifson procedure, oxidase reaction, production of NH_3 from arginine under anaerobic conditions, fluorescin production, and sensitivity to various antibiotics were described previously *(25)*. Selection of the test cultures was limited to species of *Pseudomonas* types I and II. Previous studies *(25)* have shown that these species frequently make up an important part of the flora of refrigerated milk and meat products. Test cultures 1, 13, 17, 20, 47 and 64 were selected from a major group (82%) of 51 cultures isolated at 5 C from milk and milk products. All cultures of this group were Gram-negative rods with a polar flagellum. They were oxidase-positive, produced NH_3 from arginine under anaerobic conditions, utilized carbohydrates oxidatively, and were resistant to 2.5 I. U. of penicillin. On the basis of these tests they were tentatively identified as species of *Pseudomonas*. Sources of the individual cultures were given in another paper *(24)*. Cultures P-10, F-01, and F-11 had similar characteristics. They were from the stock culture collection of the Department of Animal Science. No specific species designation was made because many of the cultures did not fit the characteristics of the species described by Breed et al. *(4)*.

Cultures 1, F-11, 13, and 64 produced fluorescin and were identified as *Pseudomonas* type I, cultures F-01, P-10, 17, 20, and 47 (without fluorescin) as *Pseudomonas* type II. All test cultures grew at 5 and 32 C in common media such as milk, nutrient broth, and plate count agar. Cultures 13, 17, 20, and 64 grew at 37 C. Only culture 13 showed growth at 42 C. All cultures except P-10 and F-01 hydrolyzed casein and liquefied gelatin. Cultures F-11, 17 and 64 produced nitrites from nitrates.

The cultures were maintained on slants of plate count agar *(1)*. They were transferred daily for 2 transfers prior to each trial in the growth medium employed in the experiment. For individual experiments, cultures were grown in sterile skimmilk, nutrient broth, or on slants of plate count agar at either 25 or 7 C. For experiments using an incubation temperature of 25 C, 0.1 ml of an 18 hr culture was inoculated into 100 ml of either skimmilk or nutrient broth. With cultures incubated at 7 C, a 3 day old culture was used as the inoculum.

At certain intervals, samples (usually 1 ml) from the skimmilk or nutrient broth cultures were transferred into 99 ml of sterile diluent. With the cultures grown on slants of plate count agar, a loopful of surface growth was transferred into 5 ml of sterile Standard Methods buffer. The cell suspension was stirred with a sterile loop for 5 min. One milliliter of this suspension then was transferred into 99 ml of diluent as described for the skimmilk and nutrient broth cultures.

Modifications in the characteristics of the diluent with respect to composition, temperature, and pH will be described in the individual experiments. At the end of the desired contact time between sample and diluent, appropriate dilutions were made. With the exception of variations in the diluent, the viable count was determined according to the procedure outlined in *Standard Methods (1)* with incubation of duplicate plates at 32 C for 48 $\pm$ 3 hr. Skimmilk was prepared by reconstitution of low-heat nonfat dry milk solids (9.0%) with distilled water. Peptone water contained 0.1% Bacto-peptone. These solutions were autoclaved for 15 min at 15 psi (121 C). Unless stated otherwise, deionized glass-distilled water, prepared with a Glenco automatic glass water still (Continental Water Conditioning Co., Houston, Texas) was used as distilled water. Distilled water A was from another laboratory on the Texas A & M University campus and was not deionized. Standard Methods buffer was prepared as described in *Standard Methods (1)*. Only distilled water suitable for the preparation of Standard Methods buffer *(1)* was used in the preparation of the various diluents, culture and plating media. Analysis of variance, assuming a fixed model, was employed in the statistical treatment of the data. The individual plate counts were transformed to logarithms before analysis of variance was applied.

RESULTS AND DISCUSSION

Effect of type of diluent and time of holding. The viable counts of skimmilk and nutrient broth cultures of P-10, F-11, and F-01 grown at 25 and 7 C were determined with Standard Methods buffer, distilled water, and peptone water as diluents. After incubating a culture for 0, 4, 8, 24, and 48 hr at 25 C, 1 ml of the culture was transferred to each of 4 dilution blanks of each type of diluent. Each bottle contained 99 ml of the sterile diluent. One dilution blank was used for the experiment with a 0 min contact time, the others for those with a 15, 30, and 60 min contact time. A similar technique was used for the cultures incubated at 7 C, except that they were tested after 3, 5, 7, and 10 days. The plates were incubated at 32 C. Increases or decreases in viable count after holding in a diluent were expressed in per cent of the viable count obtained with a 0 min

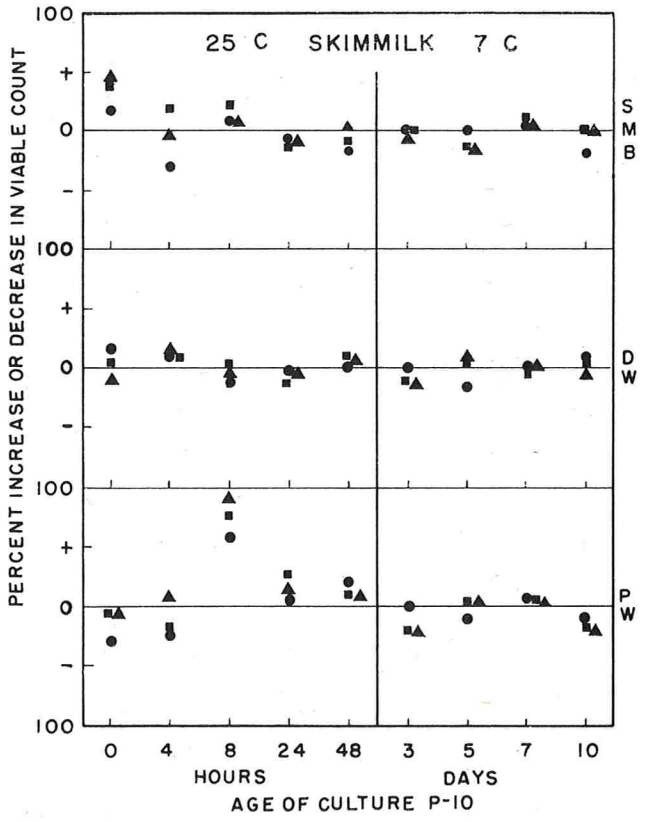

Figure 1. Effect of length of contact (● 15, ■ 30, ▲ 60 min) between culture P-10 and various diluents (SMB, Standard Methods buffer; DW, Distilled water; PW, Peptone water) on the viable count at 32 C.

TABLE 1. EFFECT OF DIFFERENT DILUENTS AND TIME OF HOLDING IN THE DILUENT ON THE VIABLE COUNT (32 C, 2 DAYS) OF VARIOUS CULTURES OF *Pseudomonas* GROWN IN SKIMMILK AT 25 C FOR 8 HR

Type of diluent	Time in diluent (min)	Viable count per ml of culture no. 1	13	17	20	47	64
Standard Methods buffer	0	36 X 10^5	35 X 10^5	33 X 10^5	130 X 10^4	120 X 10^3	27 X 10^4
	60	51 X 10^5 (42)[a]	45 X 10^5 (29)	76 X 10^5 (130)	130 X 10^4 (0)	190 X 10^3 (58)	36 X 10^4 (33)
Distilled water	0	39 X 10^5	36 X 10^5	57 X 10^5	140 X 10^4	100 X 10^3	33 X 10^4
	60	54 X 10^5 (40)	41 X 10^5 (14)	79 X 10^5 (39)	100 X 10^4 (−29)	270 X 10^3 (170)	36 X 10^4 (9)
Distilled water A	0	33 X 10^5	32 X 10^5	43 X 10^5	130 X 10^4	92 X 10^3	26 X 10^4
	60	44 X 10^5 (33)	37 X 10^5 (16)	99 X 10^5 (130)	130 X 10^4 (0)	260 X 10^3 (183)	31 X 10^4 (19)

[a]Per cent change in viable count.

contact time. Increases were recorded above the horizontal line drawn through the zero mark, decreases below this line. With skimmilk cultures (Fig. 1) usually only minor increases or decreases in viable counts occurred during contact time with the diluents. The extent of these changes depended upon the type of diluent, length of holding in the diluent, and age of the culture. In most instances these changes were less than 25% of the initial viable count. In a few instances, increases in viable count of 50% or more after holding in a diluent were observed with the cultures grown in milk for 8 hr at 25 C. Results with cultures F-11 and F-01 were similar to those of P-10.

When 6 other cultures, grown in skimmilk for 8 hr at 25 C, were tested with various diluents (Table 1) the level of population after holding in the diluent usually remained the same or increased slightly. Analysis of variance (Table 2) based on these data indicated that differences in viable count attributable to the effect of the diluent were not statistically significant. Highly significant differences in viable counts, however, resulted from type of culture used and from time in diluent. The cultures generally responded the same to the 3 diluents. A significant culture X time in diluent interaction was observed. Consistently higher viable counts were found after holding for all cultures except for culture 20. It is possible that entrance of the growth phase by cultures was responsible for this behavior. After incubation in skimmilk for 8 hr at 25 C the cultures were in the logarithmic growth phase. It is probable that growth took place during holding of the milk in the diluent for 60 min. Results with the other cultures grown in skimmilk at 7 C were similar to those of cultures P-10 at 7 C (Fig. 1).

When culture P-10 was grown in nutrient broth at 25 C (Fig. 2), the number of times reduction in viable count was noted after holding in buffer or distilled water increased sharply as compared with the culture grown in skimmilk. However, with cultures grown at 7 C, results were similar to those of cultures grown in skimmilk (Fig. 1). Results with cultures F-11 and F-01 were similar to those of P-10. When 6 other cultures were grown in nutrient broth at 25 C (Table 3), reductions in viable count in distilled water were observed in 4 cultures and in 2 cultures with Standard Methods buffer.

Statistically significant differences (Table 2) resulted from the influences of diluents, type of culture, and time in diluent. All main effect means differed significantly from each other when subjected to Duncan's *(18)* multiple range test. All first and second order interactions were highly significant statistically. Cultures 17 and 47 responded differently from the other cultures with respect to time of holding in diluent. With respect to time, distilled waters reacted similarly. Several factors may be responsible for the differences in reaction to the diluent (phosphate buffer, distilled water) between cultures grown at 25 C in skimmilk and in nutrient broth. The

TABLE 2. ANALYSIS OF VARIANCE RESULTING FROM EFFECTS OF DILUENTS, CULTURES, AND TIME IN DILUENT ON THE VIABLE COUNT OF *Pseudomonas* CULTURES GROWN AT 25 C

Sources of variation	d.f.	Mean squares: Skimmilk	Nutrient broth
Diluent (D)	2	0.00978	0.08072**
Culture (C)	5	5.11864**	8.02923**
Time (T)	1	0.39352**	0.01453*
D X C	10	0.00620	0.04851**
D X T	2	0.00749	0.02849**
C X T	5	0.06278**	0.21696**
D X C X T	10	0.00649	0.02081**
Residual	36	0.00378	0.00288
Total	71		

* <.05 level of probability.
** <.01 level of probability.

TABLE 3. EFFECT OF DIFFERENT DILUENTS AND TIME OF HOLDING IN THE DILUENT ON THE VIABLE COUNT (32 C, 2 DAYS) OF VARIOUS CULTURES OF *Pseudomonas* GROWN IN NUTRIENT BROTH AT 25 C FOR 8 HR

Type of diluent	Time in diluent (min)	Viable count per ml of culture no.					
		1	13	17	20	47	64
Standard Methods buffer	0	180 X 10^5	180 X 10^5	74 X10^5	43 X 10^5	66 X 10^3	180 X 10^4
	60	75 X 10^5 (−58)[a]	120 X 10^5 (−33)	130 X 10^5 (76)	43 X 10^5 (0)	260 X 10^3 (294)	180 X 10^4 (0)
Distilled water	0	160 X 10^5	180 X 10^5	59 X 10^5	35 X 10^5	60 X 10^3	150 X 10^4
	60	80 X 10^5 (−50)	120 X 10^5 (−33)	92 X 10^5 (56)	12 X 10^5 (−66)	170 X 10^3 (183)	140 X 10^4 (−7)
Distilled water A	0	160 X 10^5	260 X 10^5	49 X 10^5	55 X 10^5	59 X 10^3	190 X 10^4
	60	100 X 10^5 (−37)	150 X 10^5 (−42)	66 X 10^5 (35)	37 X 10^5 (−33)	79 X 10^3 (34)	150 X 10^4 (−21)

[a]Per cent change in viable count.

possibility exists that: *(a)* the skimmilk added to the diluent afforded more effective protection than the nutrient broth, or *(b)* that the cells grown in skimmilk had acquired greater resistance to the detrimental effect of diluting fluids. For culture P-10 grown at 25 C, peptone water seemed to be the superior diluent. For the cultures grown at 7 C, none of the diluents seemed superior.

When cell suspensions of *Pseudomonas* cultures grown at 25 C (Table 4) for 12, 24, and 48 hr on slants of plate count agar were held for 60 min in Standard Methods buffer or distilled water, reductions in viable count occurred in most instances. Mean differences in viable count resulting from type of culture, age of culture, and time of holding in diluent were highly significant (Table 5). The influence of time in diluent usually was greatest when the culture was incubated for 12 hr. There was less decrease in viable count with the longer incubation time. Reductions in viable counts were also observed for the other 6 test cultures when examined after 5 and 10 days of incubation at 7 C. In this series of experiments the reduction in viable count after holding in Standard Methods buffer ranged from 5 to 100%. These results show that the cultures varied greatly in their ability to withstand the detrimental effect of the diluting fluid. The more extensive reduction in viable count in diluting fluids of the cultures grown on agar slants as compared with those grown in nutrient broth or skimmilk probably resulted from the absence of skimmilk or nutrient broth in the diluent. These additions most likely reduce the destructive effect of the diluent.

TABLE 4. EFFECT OF DIFFERENT DILUENTS AND TIME OF HOLDING IN THE DILUENT ON THE VIABLE COUNT (32 C, 2 DAYS) OF CELL SUSPENSIONS OF VARIOUS CULTURES OF *Pseudomonas* GROWN ON PLATE COUNT AGAR SLANTS AT 25 C

Type of diluent	Age of culture (hr at 25 C)	Time in diluent (min)	Viable count per ml of culture no.		
			P-10	F-11	F-01
Standard Methods buffer	12	0	81 X 10^6	96 X 10^6	210 X 10^5
		60	32 X 10^6 (−60)[a]	100 X 10^6 (4)	100 X 10^5 (−52)
	24	0	290 X 10^6	33 X 10^7	200 X 10^6
		60	220 X 10^6 (−24)	27 X 10^7 (−18)	100 X 10^6 (−50)
	48	0	280 X 10^6	45 X 10^7	120 X 10^6
		60	280 X 10^6 (0)	37 X 10^7 (−18)	75 X 10^6 (−37)
Distilled water	12	0	110 X 10^6	120 X 10^6	180 X 10^5
		60	43 X 10^6 (−61)	91 X 10^6 (−24)	97 X 10^5 (−46)
	24	0	270 X 10^6	260 X 10^6	200 X 10^6
		60	190 X 10^6 (−30)	230 X 10^6 (−12)	150 X 10^6 (−25)
	48	0	290 X 10^6	52 X 10^7	120 X 10^6
		60	280 X 10^6 (−3)	47 X 10^7 (−10)	100 X 10^6 (−17)

[a]Per cent change in viable count.

Effect of growth medium. Cultures were grown in nutrient broth at 25 and 7 C. The diluents were kept at 25 C with contact times of 0 and 60 min. After incubation of cultures for various lengths of time, cells were separated from broth by centrifugation. The supernatant fluid was poured off and replaced with an equal amount of diluent to be used in the experiment. This procedure was repeated once. One milliliter of the cell suspension then was transferred to each of 2 dilution blanks (99 ml). One was used for the trial with a 0 min contact time, the other for that with a 60 min contact time. A comparison of the data on the changes in viable count in diluents of washed and non-washed cells of culture 1, 13, 17, 20, 47 and 64 (grown in nutrient broth at 25 C for 8 hr) revealed that in most instances the rate of destruction was higher with washed cells than with non-washed cells. This may have resulted from *(a)* a decrease in the protective action because no nutrient broth was added to the diluent,

TABLE 5. ANALYSIS OF VARIANCE RESULTING FROM EFFECTS OF DILUENTS, CULTURES, AGE OF CULTURE, AND TIME OF HOLDING IN DILUENT ON THE VIABLE COUNT OF *Pseudomonas* CULTURES GROWN ON PLATE COUNT AGAR SLANTS

Sources of variation	d.f.	Mean squares	F-ratio
Diluent (D)	1	0.01037	6.10*
Culture (C)	2	2.15652	1268.17**
Age (A)	2	4.19931	2416.52**
Time of holding (T)	1	0.41656	244.97**
D X C	2	0.00146	0.86
D X A	2	0.00723	4.25*
D X T	1	0.00214	1.26
C X A	4	0.21986	129.29**
C X T	2	0.04108	24.16**
A X T	2	0.04651	27.35**
Pooled interactions	16	0.01202	7.07**
Residual	36	0.00170	
Total	71		

* <.05 level of probability.
** <.01 level of probability.

or *(b)* washing of cells which increased their susceptibility to destruction during holding in the diluent.

The results reported in this section are in agreement with observations of Wagenaar and Jezeski *(26)*. In their study, less than 1% of a population of *P. putrefaciens* (grown on agar slants) was viable after a 1 hr contact with sterile distilled water. With skimmilk as diluent they observed little if any reduction in viable count during a 90 min contact period. With cultures P-10, F-11, and F-01 grown in skimmilk at 7 or 25 C (Fig. 1), and in nutrient broth at 7 C (Fig. 2), peptone water was not superior to either distilled water or Standard Methods buffer. For nutrient broth cultures grown at 25 C, peptone water was, in most instances, superior to Standard Methods buffer and distilled water. Other workers *(12, 13, 22)* have shown that peptone water can minimize losses in viable population during dilution. The data also substantiate earlier findings that the type of distilled water can have a great effect on the change in viable population during dilution.

Effect of temperature of diluent. Cultures P-10, F-11, and F-01 were grown in skimmilk at 7 C. After incubation for 3, 5, and 7 days, 1 ml was transferred into each of 4 bottles (99 ml) of each diluent. Two bottles were kept at 25 C, and 2 at 3 C. One of the bottles at each temperature was used for the trial with a 0 min contact time, the other for the one with a 60 min contact time. When culture P-10 was plated immediately (0 min contact), a reduction of the temperature of the diluent from 25 to 3 C, caused only minor increases or decreases in viable count. With few exceptions similar results were observed with cultures F-11 and F-01. Mean differences resulting from the influence of diluents, age of cells, and time of holding were highly significant (Table 6). Among diluents, Standard Methods buffer and peptone water gave similar results and generally produced higher viable counts than distilled water. The effect of temperature of diluent on viable count did not produce significant differences. However, when some of the cultures were held in the diluent for 60 min, a reduction in temperature of diluent caused, in some instances, more extensive changes (both increases and decreases) in viable count. This reaction may be the result of a combination of temperature of the diluent and length of holding in the diluent.

Other workers have reported that the temperature of the diluent can affect the per cent survival of bacteria. Gorrill and McNeil *(8)* showed that young dividing cells of *Pseudomonas aeruginosa* were killed rapidly in certain cold diluents. The differences in the results of the present studies and those experiments may have been caused by differences in: *(a)* the bacterial species involved, *(b)* type of growth medium employed, *(c)* composition of the medium used for enumeration of cells, and *(d)* composition of

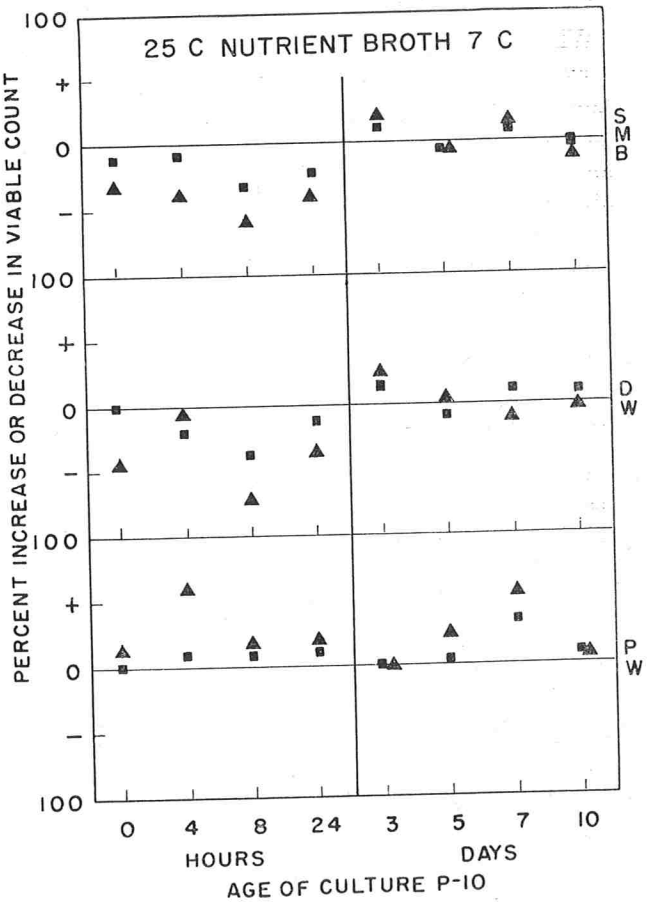

Figure 2. Effect of length of contact (■ 30 min, ▲ 60 min) between culture P-10 and various diluents (SMB, Standard Methods buffer; DW, Distilled water; PW, Peptone water) on the viable count at 32 C.

TABLE 6. ANALYSIS OF VARIANCE RESULTING FROM EFFECTS OF DILUENTS, TEMPERATURE OF DILUENT, AGE OF CULTURE, AND TIME OF HOLDING IN DILUENT ON THE VIABLE COUNT OF *Pseudomonas* CULTURES GROWN IN SKIMMILK AT 7 C

Sources of variation	d.f.	Mean squares	F-ratio
Diluent (D)	2	0.01300	7.14**
Temperature (Te)	1	0.00067	0.37
Age (A)	2	5.76792	3168.59**
Time (Ti)	1	0.01715	9.42**
D X Te	2	0.00082	0.45
D X A	4	0.01207	6.63**
D X Ti	2	0.00836	4.59*
Te X A	2	0.00009	0.05
Te X Ti	1	0.00146	0.80
A X Ti	2	0.00906	4.98*
Pooled interactions	16	0.00448	2.46
Residual	36	0.00182	
Total	71		

* <.05 level of probability.
** <.01 level of probability.

the diluent. In this respect, Farley et al. *(7)* reported that the cold-shock effect is influenced by media in which the organisms are grown. Furthermore, Meynell *(14)* showed that the numbers killed by cold-shock depended upon the plating medium which was subsequently used. The possible effect of temperature and time of plate incubation on the viable count should also be taken in consideration *(10, 15)*.

Effect of cell concentration. Milk cultures of P-10, F-11, and F-01 were incubated at 25 and 7 C. After incubation of cultures for 12, 24, and 36 hr at 25 C, or 3, 5, 7, and 10 days at 7 C, variations in the cell concentrations were made by adding 1, 0.1, and 0.01 ml of each milk culture to 2 bottles (99 ml) of each diluent. The highest level of cell concentration ranged from 57 X 10^5 to 78 X 10^6 per ml, the lowest from 60 X 10^3 to 63 X 10^4 per ml. Dilutions were made at 25 C with a contact time of 0 and 60 min. Six dilution blanks were used for each culture at each sampling period. One bottle was used for the trial with a 0 min contact time, the other for that with a 60 min contact time. In general, the changes in viable count during holding in the diluent within the 3 levels of cell concentration were similar when evaluated by the non-significant time X volume interaction mean square. Results were similar with the cultures grown in skimmilk at 7 C.

With respect to these findings, Straka and Stokes, *(22)* reported smaller losses in viable count in certain diluents with food containing low numbers of bacteria than in foods with a high bacterial content. Ballantyne *(2)*, DeMello et al. *(6)*, Spangler and Winslow *(20)*, and Winslow and Brooke *(27)* reported that a high viable population favored survival. It might be argued that with less milk (0.1 or 0.01 ml, instead of 1 ml) added to the dilution blank, less protective action would be available to the cells. For this reason, experiments were conducted in which sterile milk was added (0.9 and 0.99 ml, respectively) to dilution blanks which received only 0.1 or 0.01 ml of culture. Results of these trials, though preliminary in nature, did not bear out the hypothesis that a difference in the amount of milk added to the dilution blanks was responsible for this phenomenon.

Effect of pH of diluent. Cultures P-10, F-11, and F-01 were grown in skimmilk at 7 C. After incubation for 3, 5, and 7 days, 1 ml of culture was transferred to each of 2 bottles (99 ml) of diluent. The diluents (Standard Methods buffer and peptone water) were kept at 25 C. One bottle was used for the trial with a 0 min contact time, the other for that with a 60 min contact time. Diluents were adjusted to pH 5, 6, 7, and 8 with either HCl or NaOH. Analysis of variance based on the data indicated that the viable count of culture P-10 was not significantly influenced by pH of the diluent; however, a careful study of the data suggested that a pH of 7.0 may have been somewhat more preferable than pH values of 5.0, 6.0, and 8.0. Similar observations were noted when cultures F-11 and F-01 were used. It should be recognized that the diluents were at pH values of 5, 6, 7, and 8 initially and that addition of 1 ml of culture changed their pH values. In one series of experiments, the addition of 1 ml of milk changed the initial pH of the phosphate buffer of 5, 6, 7, and 8 to 6.4, 6.5, 7.25, and 7.5, respectively. With peptone water the changes from pH 5, 6, 7, and 8 were 6.0, 6.35, 7.10, and 7.4, respectively. It is recognized in the literature *(12)* that the optimal pH value for most species of bacteria is not known. In general, it is accepted that the survival rates of cells in diluents at the low and high pH values are lower than at pH values near 7.0. The results of the present study generally agree with this observation. Although the extent of its influence is difficult to measure, it should be recognized that the addition of acids and bases to adjust the pH value of a diluent may have some additional effect on the change in population characteristics during holding in the diluent.

CONCLUSIONS

Milk and various other milk products are usually stored under refrigeration, sometimes for extended periods of time. Hence the results of the present studies conducted with cultures incubated at the lower temperatures are of greater practical significance to the dairy and food industry than those carried out at 25 C. The following observations then pertain only to the results obtained with milk cultures held at 7 C. The type of diluent (Standard Methods buffer, distilled water, or peptone water) had little effect on the change in the viable population during holding in the diluent. Within the

time limits of the experiments (3 to 10 days), variation in the age of the culture did not show a specific pattern with respect to the rate of survival in the various diluents. Changes in viable count during holding in the diluent were less extensive with cultures grown at 7 C than at 25 C. Either growth temperature or age of the cells may have been a factor in the greater resistance of the cells grown at 7 C. In general, the data also indicate that the extent of reduction in viable count in distilled water of test cultures grown in nutrient broth or skimmilk was not as extensive as reported by Straka and Stokes (22). It is possible that differences in the type of food product and the species of bacteria present may account for this variation. Some foods may afford better protection to the cells. The data also indicate that holding of certain cultures in either Standard Methods buffer, peptone water, or in certain distilled waters caused an increase in viable population. The possibility of growth, particularly when held in the diluent for extensive periods should not be ignored. With respect to effect of the temperature of the diluent, a decrease in temperature from 25 to 3 C usually caused only minor increases or decreases in the viable count of the cultures which were plated without extended contact time with the diluent. It is recognized that these observations were made with a limited number of cultures. The data also indicate that the kind of distilled water used as diluent can have a great influence on viable count. It is therefore stressed that recommendations given by *Standard Methods* for the quality characteristics of distilled water in the preparation of the buffered diluent be followed closely.

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TIME-TEMPERATURE STANDARDS FOR THE ULTRA-HIGH TEMPERATURE PASTEURIZATION OF GRADE A MILK AND MILK PRODUCTS BY PLATE HEAT EXCHANGE

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Abstract

Time-temperature standards for ultra-high temperature pasteurization of milk and milk products have been identified by the U. S. Public Health Service as equally efficient and supplemental to those processes described in the 1965 Grade A Pasteurized Milk Ordinance. These standards are applicable to all milk products normally pasteurized in plate-type heat exchangers and consist of holding times of 1, 0.5, 0.1, 0.05, and 0.01 sec for respective temperatures of 191, 194, 201, 204, and 212 F. The tests described in the Grade A Pasteurized Milk Ordinance for high-temperature, short-time pasteurizers are applicable to ultra-high temperature equipment except for modification of the procedures used for timing the holding tube and determining the speed of response of the recorder-controller flow-diversion valve system.

The Public Health Service has received several requests for milk and milk product pasteurization standards for processes that would involve shorter holding times and higher holding temperatures than are now being used for high-temperature short-time (HTST) pasteurization. These processes have been given the general label of ultra-high temperature (UHT) pasteurization. For purposes of identification, UHT pasteurization for milk and milk products can be defined as a group of thermal processes for dairy products that have holding times of 2 sec or less with holding temperatures of from 190 to 270 F. The upper limit of 270 F was selected because most heating processes for milk and milk products that use holding temperatures above 270 F are designed to sterilize rather than pasteurize.

Before standards could be set for UHT pasteurization by plate heat exchange, data were needed that could be used to answer several questions about the public health aspects of the proposed processes. The types of data needed were summarized in a paper published in 1964 *(2)*. Since that time, additional research has enabled identification of procedures and standards for UHT pasteurization by plate heat exchange that appear satisfactory for the protection of the public health. In general, the provisions of the Grade "A" Pasteurized Milk Ordinance *(3)* for HTST pasteurization, with the following modifications, can be applied to UHT pasteurization by plate heat exchange.

Time-temperature Standards for UHT Pasteurization

From a public health standpoint, pasteurization has a single function; to inactivate any viable pathogenic microorganisms present in the raw product so that these microorganisms cannot impair the health of the consumer. Accordingly, when new processing conditions are proposed, the first consideration must be the lethality of the proposed processes for pathogenic microorganisms. Data on the inactivation of viruses, rickettsiae, and bacteria, in milk and milk products have supported the approach to new standards suggested previously *(2)*, wherein standards for UHT processes would be obtained from the semi-logarithmic extrapolation of the existing time-temperature combinations for ice cream mix (155 F, 30 min; 175 F, 25 sec). By this method, virtually an infinite number of time-temperature standards could be obtained with holding times of 2 sec or less and holding temperatures of 190 to 270 F. Since application of an infinite series of standards would cause confusion, 5 time-temperature combinations were selected as standards for UHT pasteurization by plate heat exchange. These are *(a)* 1 sec hold at 191 F, *(b)* 0.5 sec hold at 194 F, *(c)* 0.1 sec hold at 201 F, *(d)* 0.05 sec hold at 204 F, and *(e)* 0.01 sec hold at 212 F. These combinations of time and temperature are minimum standards and actual processing conditions could exceed these standards in either time or temperature if the processor should so elect. The standards are applicable to all milk and milk products (whole milk including Vitamin D and fortified, skim milk, low fat milk, chocolate milk and drink, cream, ice cream mix, eggnog and concentrated milk) normally pasteurized in plate-type heat exchangers.

Control Response Time

The term "control response time" is defined as the elapsed time between passage of the first portion of underheated milk over the temperature sensing unit of the control system and closure of the forward-flow port of the flow-diversion valve. Two general approaches are applicable to the problem of control

response times for UHT pasteurization; in one, the control response time is the same or less than the holding time, and in the other, the control response time exceeds the holding time.

As an example of the first approach, for a process with a 1 sec holding time and the temperature sensing unit of the control system at the beginning of the holding tube, the control response time must be 1 sec or less to prevent, in the case of process failure, underheated milk from getting through the flow-diversion valve before it is in diverted flow. Controls with a response time of 1 sec or less, including controls with negative response times (controllers with rate mode) *(1)*, are feasible with modern instrumentation and would be satisfactory for the control of UHT processes provided that *(a)* the response time was equal to or less than the holding time, *(b)* the temperature sensing unit was at the beginning of the holding tube, *(c)* the holding tube was protected so that liquids such as water used for rinsing the outside of the press during operation could not come into direct contact with the holding tube, and *(d)* the controls were suitably adjusted so that the time required to go from diverted to forward flow would exceed the holding time.

When provision *(a)* cannot be met and the control response time exceeds the holding time, the diversion temperature of the recorder-controller must be increased above that of the applicable UHT pasteurization standard so that diversion is completed before the product temperature falls below standard. The proper diversion temperature is obtained by determining the maximum number of degrees F the temperature of the product would fall during the control response time and adding this to the pasteurization standard. In practice, the number of degrees F to add to the pasteurization standard is determined by taking the number of degrees increase in product temperature that occurs in the heater section during normal operation of the pasteurizer and dividing this by the number of sec required for product to pass through the heater. This will give the average rate of temperature increase in degrees F per sec and hence the average decrease upon failure of the steam supply to the pasteurizer, and for hot water systems, simultaneous failure of the hot water pump. This value multiplied by the control response time less the holding time in sec (the temperature sensing unit is at the beginning of the holding tube), will yield the number of degrees F to add to the appropriate pasteurization standard to obtain the proper diversion setting of the recorder-controller. The increase in product temperature can be determined by temporarily installing thermometers at the inlet and exit of the heater section of the UHT pasteurizer and reading the temperatures indicated while the pasteurizer is running at desired capacity and temperature with water as product. The time required for product to go through the heater is measured by the salt injection technique with the injection point at the inlet to the heater and the conductivity sensing element at the exit from the heater. Determinations of heating rate and residence time in the heater for a given process need to be made only at initial start-up and whenever flow rate and/or plating arrangement is changed.

TIMING THE HOLDING TUBE

The holding time for UHT pasteurization processes must be calculated rather than measured, since gross inaccuracies could occur in the field without more sophisticated and expensive timing devices than in current use. Since the standards for UHT pasteurization are all-product standards, holding tube length must be such that the fastest flowing particle of any product will not traverse the holding tube in less than the calculated holding time. Under some conditions of pasteurization of dairy products, laminar flow occurs in the holding tube. In laminar flow, with Newtonian fluids, the fastest flowing particle flows twice as fast as does the average. Because of this, holding-tube lengths are calculated as twice the length required to hold the average flow rate for the desired holding time.

In practice, proper holding-tube length can be calculated by determining the time required for the pasteurizer to fill a vessel of known volume, converting these data by division to obtain flow rate in gallons per sec, and multiplying this value by a number in a table (provided by the U. S. Public Health Service) to obtain the required length of holding tube for the process. Although better sealing characteristics (at the metering pump) and hence faster pumping rates are obtained with product, the pasteurizer can be operated with water to obtain the data needed to make a calculation of holding-tube length, because the increased flow rate with product is compensated by the deviations from fully developed laminar flow found in all pasteurizers. The effect of laminar flow is reflected in the tabular values mentioned above and need not be considered in field calculations.

Based on the data obtained to date, the time-temperature relationships described herein for UHT pasteurization, when used in conjunction with approved and properly operated equipment, are acceptable for the pasteurization of milk and milk products under that portion of definition S of the Grade "A" Pasteurized Milk Ordinance *(3)*, which provides for other pasteurization processes that have been recognized by the U. S. Public Health Service to be equally ef-

ficient. More detailed information on methods for the inspection of equipment used for UHT pasteurization, together with examples of the necessary calculations, will be provided upon request.

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EFFECTS OF MILKING MACHINES ON THE QUALITY OF MILK[1]

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Advisory officers and milking machine manufacturers have, in the past, criticised scientists on the ground, it is claimed, that no attempt is made to describe developments associated with farming in terms which can be understood by intelligent laymen.

This article deals with the specific problem of the effects of the milking machine on milk quality. It suggests one approach to the problem of machine design. There may well be other solutions which have not yet been explored.

It is realised that the requirements for high quality milk production may contradict the needs of the farmer with a large herd who is short of labour. There is also the problem of mastitis.

These aspects will be examined in later articles in the series, with the thought that, out of an up-to-date consideration of all the problems involved, a working solution will emerge which will be economical, efficient and available to New Zealand farmers.

With the tremendous advances in recent years in dairy factory technology, the factory as a source of contamination of our dairy products has diminished in significance. This means that the limiting factor in the quality of the final article is set by the standards applied by the farmer in the cowshed.

It is convenient to divide quality problems into two groups—those related to the bacteriology of the milk and chemical and related contaminations. Bacteriological quality is controlled by the effectiveness of the cleaning and sanitising applied by the farmer. It is not proposed to discuss these in this article. They have been covered by Mr. A. Twomey in articles previously published in the Journal. In what follows, it is hoped that the reader will see the significance of different aspects of milking machine construction and action in relation to the chemical quality of the product as it leaves the farm.

Chemical and physical contamination of the milk is conveniently dealt with under three headings. First there is the plain question of dirt getting into the milk from dirty udders. The elimination of this sort of trouble is most effectively achieved by the use of a hose and running water, combined with the vigorous massage of the teats and lower portions of the udder. The efficiency of this operation can be greatly improved by the use of an udder soap, preferably containing an antiseptic or a detergent-sanitiser. The sediment level of milk can be very substantially reduced by this procedure.

A second type of contamination, over which the farmer has no control, but which he must consider seriously when buying a new milking plant or having his old one reconditioned, is copper contamination.

Milk passing over brass, copper or cupro-nickel alloy surfaces will pick up copper. Copper has the effect of inducing oxidation of the fat in milk, particularly in the presence of light, and so gives rise to rancid flavours. If its level is at all high, a substantial increase in churning losses is incurred as a result of attempting to correct for the influence of copper in the butter-making process. Copper-induced rancidity can have a most unfortunate effect on the flavour of butter, whole milk powder and whole milk.

It will be evident that exposed brass or copper in the machine or the cooler is detrimental from every point of view and steps should be taken immediately to eliminate such exposed metal.

It is not so obvious to a farmer that a cupro-nickel alloy (dairy metal) can have a similar effect. Further, it is now clearly established that, when in-place cleaning is practised, if there are any cupro-nickel alloys within the circulation system, such as the air line, copper is taken up by the circulating detergent

[1]Reprinted from New Zealand Journal of Agriculture, August, 1967.

and deposited on stainless steel surfaces elsewhere. When the milk comes through the plant at the next milking it will lift this deposited copper.

It is, therefore, quite essential in the construction of a milking machine, particularly when in-place cleaning is used, that no components containing copper exist anywhere in the cleaning cycle; not only in the milk pipe but in the air line, the dropper tubes or any other component likely to be in the cleaning circuit.

Furthermore, if in-place cleaning using a third line is practised, no copper or copper alloy should be used for any part of the system. Several examples have come to the attention of the writer of the evil effects of copper used in a third line cleaning system. The copper concentration was so high in one case that it had an effect on the life of inflations.

It is absolutely essential in the design of a machine or a cleaning system to avoid copper at any point whatever, whether the copper be in the form of a cupro-nickel alloy, such as brass or dairy metal, or pure copper.

An indirect effect of using cupro-nickel alloys is to cause the precipitation of milkstone at or near junctions between the alloy and stainless steel. Such deposits tend to be higher than usual in copper and present not only a bacteriological problem but also a chemical one.

A second type of chemical contamination of milk which greatly reduces the quality, particularly of whole milk and butter, is what is called hydrolytic rancidity. Milk contains an enzyme called lipase. This enzyme splits fats and produces what are called free fatty acids, which have a rancid flavour. The fat in the fat globules in milk is protected against this enzyme by an envelope surrounding the globule.

When fat globules come into an interface between air and milk, the surface tension, as it is called, along the surface will cause the fat globule envelopes to split. The greater the area of interface, the greater the number of globules damaged.

An enormous area of interface is created when a foam is generated in milk by bubbling air through it. Thus, any situation in which foaming is caused will give rise to the damaging of the fat globule surface and so makes possible the action of lipase on the fat, producing free fatty acids. This enzymatic action occurs most vigorously when the milk is held at a low temperature and there is quite a long period of time before the free fatty acid development becomes evident to taste or smell.

With the development of tanker pickup using chilled vats and "skip a day" collection of milk, the problem of rancidity rapidly develops.

Because of the world-wide stress on the importance of high quality in dairy products, a tremendous amount of work has been done and is being done overseas on factors which influence the flavour of milk. In particular, a lot of attention has been given to this problem of rancidity or lipolysis. It is useful, therefore, to look at some of the salient facts related to this problem and then to examine possible ways of solving it.

A study by Johnson and von Gunten shows how the amount of free fatty acid decreases as the production of milk per day increases. Low producing cows tend to have milk of a higher fatty acid degree value.

The same study shows the influence of stage of lactation on the percentage of cows which produce rancid milk. It is evident that with advancing lactation there is a tendency for more free fatty acid to occur in the milk.

Table 1 shows the influence of cooling under vacuum on the amount of free fatty acid in milk, compared with cooling under normal atmospheric conditions. It is apparent that the level of free fatty acid can be reduced by cooling under vacuum.

In a study carried out by the writer and Professor Lascelles, in Australia, the results shown in Table II were obtained. Milk collected by hand, by gently milking into a bucket, was compared with that col-

TABLE 1. FATTY ACID DEGREE VALUES OF MILK COOLED AT ATMOSPHERIC PRESSURE AND MILK COOLED UNDER VACUUM

	Temperature deg F.	Fatty acid value
Control (cooled immediately		1.75
to 32 deg F.)		1.75
Atmospheric pressure		
After cooling 30 min	40	1.63
After cooling 60 min	33	1.32
Vacuum (20 in of mercury)		
After cooling 30 min	44	1.55
After cooling 60 min	33	1.18

TABLE II

Machine action and hydrolytic rancidity.

Air admission and lipolysis (Whittlestone and Lascelles)

(The milk was held at 4 deg C. for 18 hours after withdrawal to permit spontaneous hydrolysis to occur. Results are expressed as mg per cent stearic acid)

Cow	No air admission		1/32 in air hole		2 x 1/32 in hole	
	0	18	0	18	0	18 hrs at 4 deg
152	5.2	6.0	5.7	7.5	8.0	13.0
02	3.5	5.9	3.9	6.6	6.2	10.1
148	5.8	9.2	6.7	12.4	17.4	27.5
144	4.7	6.9	6.3	10.2	15.8	23.4
85	5.7	9.3	8.6	27.1	13.8	55.0

lected at the top of a dropper, when the claw had a standard 1/32 of an inch air-hole, and under similar conditions when two air admission holes were used.

The table shows clearly that, as air admission is increased, the amount of free fatty acid increases.

It will be noted that there is a big difference among the cows. Cow number 85 was well advanced in lactation and so shows the end-of-lactation effect.

Table III sets out the results of a low-line versus a high-line milking system as tested by Professor Gholson and his colleagues in the United States. It is clear from this that the low-line milking system induced less rancidity than did the high-line system, in spite of the fact that both had similar milk pumps and milk lines, so that the dropper therefore was contributing only a portion of the total agitation.

TABLE III

Pipeline height and lipolysis (Gholson et al)
(Rancidity expressed as ml N KoH/100g fat) Lowline
Initial 0.71 After 48 hrs storage 1.29 Diff. 0.59 Highline
Initial 0.77 After 48 hrs storage 1.63 Diff. 0.86
Generally air admission and agitation particularly in the droppers causes an increase in the degree of hydrolytic rancidity. Milk pipe length and air leakage also increase rancidity.

In the study by Johnson and von Gunten the figures shown in Table IV were obtained. These show clearly that milk flowing along a pipeline is so agitated that quite a substantial increase in lipolysis can occur. This confirms earlier studies by other American workers who showed particularly that small leakages in milk pipe joints can have a marked effect on the degree of hydrolysis produced.

TABLE IV

Fatty acid degree values of milk samples taken from the weighing can of a recorder milking machine and after discharge from the end of a milk pipeline.

	Fatty acid degree value	
	Weight can	End of milk-pipe
Average for first period—7 samples	1.45	2.09
Second period—2 samples	1.11	1.39
Third period—4 samples	1.20	1.59
Fourth period—4 samples	1.00	1.26
Over-all averages	1.25	1.69

In general it will be clear that any situation in a milking system which produces agitation and foaming will tend to induce rancidity. Thus, in the design of a milking system, such characteristics must be avoided.

The following suggestions are offered to the designers of milking machines as a way in which the undesirable effects of agitation and foaming can be minimised:

Vertical dropper tubes should be eliminated. This means placing the milk pipe beneath the cow. In order to minimise agitation at the point of entry, it may be shown that by bringing the inlet in at a tangent and obliquely so that the milk spirals in the direction of flow, a substantial reduction in turbulence may be obtained.

Reduce air admission to a minimum. This is difficult with a high-line system. Some reduction may be achieved with a low-line milker. However, in this case, as the milk-air mixture is of short duration because of the decreased distance between the cups and the milk pipe, a lowline milker produces less lipolysis with the same air admission.

Use a milk line of such dimensions that at no stage plugging can occur, giving rise to high velocity turbulent flow. The milk should flow along the bottom of the line with no agitation.

Eliminate all air leakages into the milk line system.

Minimise the length of the milk line. The releasing system should be fitted as near to the last set of cups as possible.

Use a pump-releaser system in which the pump operates only when there is milk flowing. This will eliminate "starved" pumping conditions which can contribute substantially to agitation.

Pump the milk into the bottom of the milk vat when this is used and not into the top. By using a flow-controlled pump the main objection to bottom entry of the vat is eliminated, in that the pump will only run when there is milk to be pumped and thus air will not be blasted through the milk during periods of low flow. A tremendous amount of damage is done to milk when it falls into the vat from a substantial height. This causes a high degree of turbulence on the surface of the milk and may give rise to churning.

With the equipment now available in New Zealand it is quite practical to design a machine milking system in which the foregoing points are incorporated. Such a system may well include a plate type of heat exchanger designed to permit cooling under vacuum. Thus it is possible to have an in-place cleaning system which includes the milk cooler and, by the use of cross flow circulation cleaning, a high velocity can be achieved particularly if a centrifugal pump is used to boost the flow.

A system with short milk pipes and no droppers is capable of a much higher velocity of flow during cleaning than the orthodox machine. Furthermore, by a small modification in design, the pump which is used for the in-place cleaning of a machine may be used also to clean the farm vat automatically.

The introduction of these concepts into the design of the milking machine will greatly improve the chemical quality of the product and, further, by

combining it with modern methods of in-place cleaning, a marked improvement in bacteriological quality also will be obtained.

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PHS TO STUDY INCIDENCE OF CLOSTRIDIUM PERFRINGENS

A national study to determine the frequency of a mild food poisoning seldom recognized in this country until seven years ago is being conducted by the Public Health Service in cooperation with state and local health departments. This was announced by Jerome H. Svore, Director of the Service's new National Center for Urban and Industrial Health in Cincinnati, Ohio. The Service's National Communicable Disease Center in Atlanta also is cooperating in the study.

This food-borne illness — caused by a bacterium called *Clostridium perfringens* — is characterized by acute abdominal pain and diarrhea. Symptoms of this type of food-borne disease usually begin eight to twenty-two hours after eating the contaminated food with complete recovery within 24 hours. "The ailment", Mr. Svore said, "usually is caused by eating food that has been cooked and allowed to cool slowly. The combination of cooking and lack of immediate refrigeration allows the growth of enough bacteria to cause illness. The contaminated food is usually a meat, meat dish, or gravy."

The illness was first studied in Great Britain as early as 1945. It was not until 1960 that researchers, in what is now the National Center for Urban and Industrial Health in Cincinnati, began developing a simplified method to isolate and identify the bacteria in food-borne disease outbreaks in this country.

Robert C. Novick, Chief of the Center's Environmental Sanitation Program said: "We still have no idea of the extent of this illness in the United States, but British experience reveals this type food poisoning to be more prevalent than available American statistics indicate."

Mr. Novick said the way to prevent this type of food poisoning is as follows: Food should be cooked at a temperature above 140 F and, unless eaten immediately, cooled quickly to below 40 F, and kept cold. If the meat or meat dishes are reheated for subsequent use, they should be reheated rapidly to boiling, where possible, before they are served or placed in steam tables.

Many strains of *Clostridium perfringens* have heat resistant spores that will withstand boiling or survive roasting. These spores grow rapidly at relatively high temperatures (optimum growth temperature 113 F). Uncovered foods can become recontaminated by strains of the bacterium in dust. Chilling adversely affects the survival and growth of the organism.

According to Dr. Keith H. Lewis, Chief, Food Protection Activity, the national study of *Clostridium perfringens* food poisoning has been developed through interest and collaboration of two experienced microbiologists, Dr. H. E. Hall, Food Protection Research Section, NCUIH, and Dr. V. R. Dowell, Jr., Bacteriology Section, NCDC. These two scientists will not only coordinate the work of the participating state and local health departments, but also conduct research on the bacterial cultures provided by these departments.

FOOD PROTECTION RESEARCH IN THE PUBLIC HEALTH SERVICE[1]

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The Environmental Sanitation Program of the National Center for Urban and Industrial Health encompasses activities related to interstate carriers, recreation, and urban sanitation, but its research component is associated with food protection. Although the main thrust of the research is directed toward prevention and control of food-borne disease, a variety of projects have been undertaken that are of mutual interest not only to other components of the Program and of the Center, but to other Federal agencies that have, in part, supported this research effort.

The Public Health Service has been actively engaged for more than 50 years in assisting agencies of Federal, State, and local governments, and industry to improve the safety and quality of food supplies. Its efforts are based on the knowledge that proper diet is essential for the physical development of every individual and that food can be a major source of human exposure to hazardous contaminants from the environment, including microbial agents of disease and toxic chemical residues. The past contributions of the Service to improved sanitary practices in the dairy industry and in food service operations (through development of recommended ordinances, codes, manuals, and guides to safe practices) are well known and detailed recitation is not necessary. Over the years, the recommendations of the Public Health Service have been incorporated into many State laws, local ordinances, and Federal regulations. They now constitute the invisible framework within the structure of public health protection that is used by enforcement agencies and industry to prevent foodborne illness in the United States.

Modifications of these recommendations repeatedly have been necessary, especially in recent years, to cope with the rapid technological changes that have occurred throughout the food producing, processing, distribution, and serving industries. As the technology of feeding the increasing urban population has become more and more complex, the need has increased for research to investigate potential hazards to health and to devise appropriate new measures for the prevention and control of foodborne illnesses. Since the close of World War II, the Public Health Service has maintained a modest research effort in Cincinnati and a substantial grants program in the field of food protection. The intramural studies were conducted under the auspices of the Robert A. Taft Sanitary Engineering Center from 1954 through 1966, when they were transferred to the National Center for Urban and Industrial Health.

Substantial contributions have been made by this group to the detection, identification, and reduction of such potential health hazards as radionuclides in milk, pesticide residues in drinking water and foods, and several types of microbial food illnesses including staphylococcal food poisoning, botulism, and salmonellosis. Extensive research on time-temperature relationships of bacteria and their toxins, as well as of viruses, has resulted in improved refrigeration, pasteurization, and other heat treatments of foods. Pilot plant studies have revealed sanitary deficiencies in commercial equipment and processes that have been overcome through experimental engineering.

The findings of these studies have been presented in more than 250 technical publications and have been used extensively in the development of model ordinances, codes, and industry sanitation guides. They have also been incorporated in specialized training courses for professional personnel employed in the food industry and governmental agencies. Requests for consultation and specialized technical assistance related to the research activities are estimated to exceed 700 per year. The senior staff also receives invitations at least once a week to speak about the public health aspects of food protection, and by selective acceptance reaches an audience of 3,000 to 5,000 persons per year. Individual staff members are frequently asked to serve on national or international committees concerned with the control of food hazards and currently hold about 30 such appointments.

In recent years, requests from other Federal agencies for research by this group have resulted in the negotiation of direct-reimbursement or interagency agreements within the National Aeronautics and Space Administration, Department of the Army, National Cancer Institute, and National Center for Radiological Health.

A limited number of research contracts have also been negotiated to obtain the help of selected State, municipal, and private laboratories. These studies

[1]Presented at the 95th Annual Meeting, American Public Health Association, October 22-27, 1967, Miami Beach, Florida.

have been mainly related to the detection and prevention of food contamination with *Clostridium botulinum*, because funds were allocated specifically for this purpose. A much broader contract program would be desirable to foster the application of laboratory and pilot-plant studies to actual field problems.

For convenience, the remainder of this discussion is presented in 3 sections that correspond to the organizational pattern of Food Protection Research; i.e., Milk Sanitation, Food Chemistry, and Food Microbiology. In addition to conducting the types of studies illustrated, the Food Protection Research staff devotes much effort to the technical assistance and training functions already mentioned.

CONTRIBUTIONS OF MILK SANITATION RESEARCH

Research is being conducted in several areas, with major emphasis on pathogenic microorganisms in dairy products and on engineering problems of public health significance associated with the processing of these products. In addition to research, the group conducts a nationwide program on the evaluation of milk laboratories, and this effort is supported by a program on the development of improved methods for the examination of dairy products. To illustrate the scope of this research, 3 examples follow together with a brief description of the laboratory evaluation program.

The first example relates to studies on the most common group of food poisoning toxins, staphylococcal enterotoxins. At the inception of this program, enterotoxins could be assayed only in cats, monkeys, or human volunteers. In concert with other laboratories, however, reliable, inexpensive, and rapid *in vitro* techniques were developed to assay these toxins by means of gel-diffusion procedures. These techniques have been used to demonstrate that some strains of the coagulase-positive staphylococci, which occurred in 20% of the market samples of Cheddar and Colby cheese, are capable of producing enterotoxins *(11, 13)*. These strains will grow rapidly in raw milk that meets the standards of Grade "A" milk, and detectable levels of enterotoxin can be produced in as little as 6 hr at 35 C *(10)*. Enterotoxin has been demonstrated in milk and cheese by extraction and concentration procedures followed by assay using gel-diffusion procedures *(40, 41)*. Although prophage is necessary for the production of toxin by some bacteria, demonstrable prophage is not essential for enterotoxin production by *Staphylococcus aureus (39)*. Once enterotoxin is formed in milk, the heat resistance of this toxin is such that it will not be completely inactivated by either pasteurization or sterilization processes *(38)*. Similarly, enterotoxin will withstand the processes used for the sterilization of foods by gamma irradiation *(37)*.

The second example relates to recent reports that milk may contain C-type particles similar in morphology to known leukemic viruses. This observation reopened the question of the efficacy for virus destruction of processes recommended by the Public Health Service for the pasteurization of dairy products. With financial support from the National Cancer Institute, tissue culture procedures have been developed for the isolation and enumeration of viruses from both raw and pasteurized milk and milk products. These procedures are being used to establish the times and temperatures required for the thermal inactivation of viruses. Fortunately, the results to date indicate that the present processes used for pasteurization of dairy products are adequate to inactivate the several types of viruses under study *(44)*. On the other hand, the radiation resistance of viruses has been found to exceed that of bacterial spores.

The third example is concerned with engineering studies of pasteurization processes. In the most common process used today, the length of time required for the product to traverse the holding tube and the efficacy of the controls used to prevent its forward flow when underheated are of prime public health concern, because they determine to a large degree whether the process will be effective for the inactivation of pathogenic microorganisms *(36)*. Studies done in the research pilot plant have shown that present methods of measuring or calculating holding times for viscous products, such as ice cream mix and egg yolk, are inaccurate. The actual holding time for the fastest flowing component in the holding tube may be 45% less than indicated. These studies have precipitated a reevaluation of these processes and, in egg pasteurization, adjustment of the operating conditions so that proper holding times are obtained.

Laboratory evaluation is an important feature of the cooperative State-Public Health Service program on interstate shipment of milk. The laboratories that test the milk are regularly surveyed to determine whether they are uniformly applying prescribed methods *(3)*. A representative of the Milk Sanitation Research staff visits each State central milk laboratory every 3 years. Laboratory Survey Officers are certified after they have demonstrated the ability to survey local milk laboratories. This program has been instrumental in standardizing and improving the procedures used to examine milk in over 500 laboratories in the United States *(2)*. In addition to the surveys made of laboratories, split samples of milk are sent to each State and local laboratory, and the results are analyzed for accuracy. The uniformity of the split sample results has indicated rapid and pro-

gressive improvement over the 10 years this program has been in operation. The laboratory evaluation activity is supported by research on methods *(4, 12)*, and by the participation of the research staff in Regional seminars, training courses, and conferences with State and local laboratory personnel.

CONTRIBUTIONS FROM FOOD CHEMISTRY

The Food Chemistry Unit conducts research and provides technical assistance on a variety of health-related problems associated with foods. Characteristically, the unit carries out intensive investigations in specific areas of concern rather than attempting to cover the entire field of food chemistry at any one time. Also, an attempt is made to balance the work between problems requiring immediate solution and those of a more basic nature concerning the potential hazards relating to changes in man's environment. The areas of research that have been emphasized in the Food Chemistry Unit include public health problems associated with paralytic shellfish poison and other marine toxins *(26, 29, 45)*, the presence and significance of radionuclides and pesticides in foods *(5, 7, 43)*, research and technical services concerning the development and evaluation of standard methods of analysis *(30)*, and the exploration of instrumental methods of analysis for application in the field of food protection *(31, 42)*.

Current activities of the Food Chemistry Unit include the exploration of gas chromatographic procedures for the determination of toxic or otherwise undesirable substances in food, the development of chemical methods for the direct measurement of fecal pollution and for the identification and enumeration of bacteria, and the development of an indicator test for measurement of heat treatment applied to commercial egg products.

Instead of simply listing projects, 2 projects are discussed below that illustrate the scope and philosophy of food chemistry activities.

In recognition of the potentially harmful effects of radioactive fission products to man and the importance of food, particularly milk, as a major vector of exposure, the Food Chemistry Unit was requested in the early months of 1957 to develop a program of research in this area, which has been continued over the past 10 years. The high points of the work include (*a*) the development of rapid methods of analysis for specific radionuclides *(34)*, which are suitable for surveillance of milk and other foods; (*b*) the establishment of a pilot surveillance network that demonstrated the feasibility of a nationwide monitoring program to assess the levels of exposure to man from his foods *(6)*; and (*c*) the development of commercially feasible methods for the selective removal of fission products of biological significance from milk by use of properly charged ion-exchange resins, without appreciable change in the flavor or nutritional quality of the product (32, 33).

Another problem of current interest in Food Chemistry is the concentration and distribution of trace elements in food. Although the biological significance of certain trace elements has long been known, exploration in this area has traditionally been slow and laborious. The recent availability of atomic absorbance spectrophotometers has, however, provided a basis for the greatly simplified methods of analysis and, in turn, given rise to a resurgence of interest in the field. Fortunately an instrument was obtained quite early and a study of the application of atomic absorbance to problems concerning the presence of trace elements in food and water *(31)* was undertaken. The studies have already been extended to include the determination of concentrations of rubidium, lead *(35)*, cadmium, and silver in milk as influenced by seasonal variation and area of production. Our findings indicate that cadmium and rubidium vary markedly with season and geographical location. The observed concentrations of these elements usually are between 0.017 and 0.030 ppm for cadmium and 0.57 to 3.39 ppm for rubidium. With silver and lead, no significant geographical differences were noted and seasonal variations seemed to be restricted to the southeastern states. The concentration of silver varied between 0.027 and 0.054 ppm, whereas that for cadmium ranged from 0.023 to 0.079 ppm. A further extension of these studies is underway to determine other trace elements in milk and to investigate the levels of trace elements in whole diets.

Reasons for investigating the concentration and distribution of trace elements in foods came from the recognition that although many are hazardous at certain concentrations, these same elements at other concentrations are often absolute nutritional requirements of man and most living things. Also, the level of uncontrolled intake through food frequently represents a major source of exposure, as with lead, where this level and the tolerance level are quite close *(27)*. For these reasons, it was believed that consideration of man's exposure to trace metals without knowing how much he received from his food would be meaningless. In this connection, Goal No. 6 of Task Committee on Environmental Health and Related Problems in the report entitled "A Strategy for a Livable Environment," is quoted as follows: "A materials, trace metals, and chemical control effort to establish, by 1970, human safety levels for synthetic materials, trace metals, and chemicals currently in use, and prohibit after 1970 general use of any new synthetic material, trace metal, or chemical until approved by the Department of Health, Education, and Welfare." (Chapter II, page 20.)

CONTRIBUTION FROM FOOD MICROBIOLOGY

The Food Microbiology Unit conducts research on the incidence, occurrence, isolation, identification, and quantification of pathogenic and indicator organisms and their toxins in foods *(17, 18)*. The research is designed to provide technical information that can be used by regulatory agencies and quality-control laboratories of industry to improve the public-health safety of foods.

During recent years, this research has resulted in the development of several media and procedures that have found application in the field of food microbiology. For example, a medium (TPEY) *(8)* has been developed that selectively isolates staphylococci from foods. Its composition is such that most micrococci and other Gram-positive organisms are severely inhibited, whereas S. *aureus* grows well and produces typical enzymatic reactions that aid in its recognition. Another medium (SPS agar) *(1)* that will quantitatively recover the vegetative cells of *Clostridium perfringens* from foods has been developed and field tested. This medium has been evaluated by other workers both in this country and abroad and has been found to be well adapted to the examination of foods involved in food-borne disease outbreaks. Methodology using this medium for the examination of foods is being evaluated for the Association of Official Analytical Chemists.

Other studies on media and methods have included the development of an enrichment medium for *Clostridium botulinum (9)* that selectively enhances growth and toxin production without the use of meat particles.

Over the years, the Food Microbiology Unit has had a keen interest in the incidence and occurrence of microorganisms of public health significance in foods and related sources. This interest has led to the determination of the incidence of salmonellae in market meats *(46)* and grade A dry-milk powder *(21)*, of *C. perfringens* in raw and prepared meat products *(15)* and in the feces of foodhandlers, and of coliform organisms and *Escherichia coli* in market foods. These studies have been extended to determine the characteristics of the *C. perfringens* strains associated with foods and food-borne diseases *(22)*, and to establish that enteropathogenic *E. coli* may occur occasionally in foods, and in the feces of 6% of the food handlers *(14, 16)*.

Research related to the toxins associated with food-borne illness has included the development of *in vitro* tests for the detection of paralytic shellfish poison *(23, 25)*, and hemagglutination and hemagglutination-inhibition tests for the detection and identification of the botulinal toxins and the enterotoxins produced by S. *aureus (20, 24)*. Additional work on the enterotoxins has resulted in the development of a method for their detection in foods, other than dairy products, by means of extraction procedures and gel-diffusion techniques *(19, 28)*.

The results of the above research activities have been applied to the development of a series of methods for the examination of foods for purposes of surveillance and quality control, as well as for investigation of foods implicated in disease outbreaks. These methods have been incorporated into the training course manual used for food protection training and into the PHS publication No. 1142 on Examination of Foods for Enteropathogenic and Indicator Bacteria.

Another highly gratifying aspect of the work of the Food Microbiology Unit is the cooperative activities with others in this country and abroad who have similar interests and problems. These activities include correspondence and sharing of ideas as well as actual laboratory studies. For example, during the past year more than 200 cultures of S. *aureus* have been received for enterotoxin determinations from State Health Departments and from foreign countries such as the Netherlands, Italy, Israel, and Greece. Contributions to methodology have also been used extensively by the American Public Health Association, the Association of Food and Drug Officials of the United States, the Association of Official Analytical Chemists, the International Committee on Microbiological Specifications for Foods, and the International Atomic Energy Agency in selecting procedures for microbiological examination of foods. It is, therefore, encouraging to think that Food Protection Research has served and will continue to serve the immediate interests of both the Public Health Service and of the scientific community at large.

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PESTICIDES AND THE MILK SUPPLY[1]

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Pesticide residues in foods are nothing new, but interest in the problem by scientific investigators and the public in general has developed only during the past 20 years. The main contributing factor for this increased attention is the great number of new organic compounds that have come into general use since 1940. Accompanying this use, a demand has arisen for adequate controls to protect the consumer.

Residues in milk and dairy animals are particularly troublesome. Presently (December, 1967) the tolerance for any pesticide, other than DDT and its metabolities, in milk is technically zero. A zero residue level simply means that a particular product contains less residue than the analytical chemist is able to detect with available techniques. However, the more capable the chemist and the better his technique, the lower the residue level that can be detected.

In October 1966 the Advisory Committee to the Food and Drug Administration (FDA) recommended that a tolerance level be established with a limit of 0.05 parts per million (ppm) of DDT, DDD, or DDE, individually or in combination, for whole milk. FDA accepted this recommendation and established the tolerance indicated above.

A difficult situation for the dairy industry exists because of the very widespread use of pesticides on farms, drift problems, the pooling of milk from many dairy farms in a milkshed, and the rapidity with which milk has to be processed and distributed. In addition, analytical techniques which can detect parts per billion (ppb) and even less of a particular residue are becoming increasingly available.

The persistence of chlorinated hydrocarbon pesticides in tissues of dairy animals has been well established. Once an animal is contaminated with a chlorinated hydrocarbon pesticide, residues are found in the milk long after intake of the chemical has ceased. However, relatively few data are available concerning the body storage and elimination of chlorinated hydrocarbon pesticides fed prepartum; or of their subsequent appearance and duration in milk following parturition. An area of additional interest, which has profound implications for human health and medicine, is placental transfer of these compounds to the fetus and the time required for dissipation of residues from young contaminated *in utero*.

Since milk is the primary excretory route of chlorinated hydrocarbon pesticides in dairy cattle, non-lactating dairy heifers may have little opportunity of eliminating these compound from their bodies and could possibly produce milk containing detectable residues at 24 months of age without ever having received contaminated feeds.

Studies have recently been completed at Michigan State University in which the placental transfer of dieldrin in dairy calves born to dams contaminated during three stages of gestation was investigated. Pregnant heifers were fed dieldrin in grain equivalent to 5.4 ppm in the total diet. This level was higher than one would normally experience in routine feeding of contaminated feedstuffs. Contamination began at 60, 120, or 180 days before calving and continued for 60 days.

Placental transfer of dieldrin occurred in each of 33 dams, resulting in contamination of all newborn calves. Female calves had about 9 ppm of dieldrin in their internal (omental fat) at birth, but these levels had decreased to one-half (4.5 ppm) at 16 weeks of age. By one year of age negligible residues were detectable in only one of five calves. Thus, fortunately for the dairy industry, these data would indicate that at the dieldrin levels used in these studies, female calves contaminated *in utero* will not contain sufficient dieldrin at parturition for detection in their milk.

Dairymen and others in the milk industry must always be on guard against using unapproved pesticides in dairy barns or on forage crops which could result in the appearance of the chemicals in the milk supply.

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[1]From the Kentucky Association of Milk, Food and Environmental Sanitarians Newsletter, January, 1968.

HOLDERS OF 3-A SYMBOL COUNCIL AUTHORIZATIONS ON FEBRUARY 20, 1968

0101 Storage Tanks for Milk and Milk Products, as Amended

97 Beseler Steel Products, Inc. (3/24/58)
417 East 29th, Marshfield, Wisconsin 54449

116 Jacob Brenner Company, Inc. (10/ 8/59)
450 Arlington, Fond du Lac, Wisconsin 54935

28 Cherry-Burrell Corporation (10/ 3/56)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

102 Chester-Jensen Company, Inc. (6/ 6/58)
5th & Tilgham Streets, Chester, Pennsylvania 19013

1 Chicago Stainless Equipment Corp. (5/ 1/56)
5001 No. Elston Avenue, Chicago, Illinois 60630

2 CP Division, St. Regis (5/ 1/56)
1243 W. Washington Blvd., Chicago, Illinois 60607

117 Dairy Craft, Inc. (10/28/59)
Holdingford, Minnesota 56340

76 Damrow Brothers Company (10/31/57)
196 Western Avenue, Fond du Lac, Wisconsin 54935

115 DeLaval Company, Ltd. (9/28/59)
113 Park Street, So., Peterborough, Ont., Canada

109 Girton Manufacturing Company (9/30/58)
Millville, Pennsylvania 17846

21 The J. A. Gosselin Co., Ltd. (9/20/56)
P. O. Box 280, Drummondville, Quebec, Canada

44 The Heil Company (10/26/56)
3000 W. Montana Street, Milwaukee, Wisconsin 53235

114 C. E. Howard Corporation (9/21/59)
9001 Rayo Avenue, South Gate, California 90280

127 Paul Mueller Company (6/29/60)
1616 W. Phelps Street, Springfield, Missouri 65801

197 Mueller/Richardson Ltd. (9/ 9/67)
84 Wellington St., South, St. Marys, Ont.

143 Portersville Stainless Equipment Div., (5/16/63)
Gibson Industries, Inc.
Portersville (Butler County), Pennsylvania 16051

39 Stainless & Steel Products Co. (10/20/56)
1600 Barry Avenue, St. Paul, Minnesota 55114

31 Walker Stainless Equipment Co. (10/ 4/56)
Elroy, Wisconsin 53929

0201 Pumps for Milk and Milk Products, Revised, as Amended

23R Cherry-Burrell Corporation (10/ 3/56)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

63R CP Division, St. Regis (4/29/57)
1243 W. Washington Blvd., Chicago, Illinois 60607

183R The DeLaval Separater Co. (5/ 5/66)
Poughkeepsie, N. Y. 12602

65R G & H Products Corporation (5/22/57)
5718 52nd Street, Kenosha, Wisconsin 53140

145R ITT Jabsco, Incorporated (11/20/63)
1485 Dale Way, Costa Mesa, Calif. 92626

26R Ladish Co., Tri-Clover Division (9/29/56)
2809 60th Street, Kenosha, Wisconsin 53140

148R Robbins & Myers, Inc. (4/22/64)
Moyno Pump Division
1895 Jefferson Street, Springfield, Missouri 65803

163R Sta-Rite Products, Inc. (5/ 5/65)
234 South 8th Street, Delavan, Wisconsin 53115

72R L. C. Thomsen & Sons, Inc. (8/15/57)
1303 53rd Street, Kenosha, Wisconsin 53140

175R Universal Milking Machine Div., (10/26/65)
National Cooperatives, Inc.
First Avenue at College, Albert Lea, Minn. 56007

52R Viking Pump Company (12/31/56)
406 State Street, Cedar Falls, Iowa 50613

5R Waukesha Foundry Company (7/ 6/56)
Waukesha, Wisconsin 53186

0400 Homoyenizers and Hivh Pressure Pumps of the Plunger Type, As Amended

87 Cherry-Burrell Corporation (12/20/57)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

37 CP Division, St. Regis (10/19/56)
1243 W. Washington Blvd., Chicago, Illinois 60607

75 Manton-Gaulin Mfg. Co., Inc. (9/26/57)
44 Garden Street, Everett, Massachusetts 02149

0501 Stainless Steel Automotive Milk Transportation Tanks for Bulk Delivery and/or Farm Pick-up Service, As Amended

131 Almont Welding Works, Inc. (9/ 3/60)
4091 Van Dyke Road, Almont, Michigan 48003

98 Beseler Steel Products, Inc. (3/24/58)
417 East 29th, Marshfield, Wisconsin 54449

73 Jacob Brenner Company (8/ 5/57)
450 Arlington, Fond du Lac, Wisconsin 54935

40 Butler Manufacuring Co. (10/20/56)
1000 Berry Avenue, St. Paul, Minnesota 55114

118 Dairy Craft, Inc. (10/28/59)
Holdingford, Minnesota 56340

66 Dairy Equipment Company (5/29/57)
1919 So. Stoughton Road, Madison, Wisconsin 53716

123 DeLaval Company, Ltd. (12/31/59)
113 Park Street, South, Peterborough, Ont., Canada

190 Eastern Industries, Limited (11/18/66)
830 Blvd., Lemire, Drummondville, Quebec, Canada

121 The J. A. Gosselin Co., Ltd. (12/ 9/59)
P. O. Box 280, Drummondville, Quebec, Canada

45 The Heil Company (10/26/56)
3000 W. Montana Street, Milwaukee, Wisconsin 53235

93 Pennsylvania Furnace & Iron Co. (2/ 6/58)
316 Pine Street, Warren, Pennsylvania 16365

85 Polar Manufacturing Company (12/20/57)
Holdingford, Minnesota 56340

144 Portersville Stainless Equipment Div., (5/16/63)
Gibson Industries, Inc.
Portersville (Butler County), Pennsylvania 16051

71 Progress Industries, Inc. (8/ 8/57)
400 E. Progress Street, Arthur, Illinois 61911

80 Mueller/Richardson, Ltd. (11/24/57)
84 Wellington Street, So., St. Marys, Ont., Canada

47 Trailmobile Div. of Pullman, Inc. (11/ 2/56)
16th & Howell Streets, North Kansas City, Mo. 64116

189 A. & L. Tougas, Ltée (10/ 3/66)
1 Tougas St., Iberville, Quebec, Canada

25 Walker Stainless Equipment Co. (9/28/56)
New Lisbon, Wisconsin 53950

0800 Fittings Used on Milk and Milk Products Equipment, and Used on Sanitary Lines Conducting Milk and Milk Products and Supplements 2, 3, 4, 5, and 6, As Amended

79 Alloy Products Corporation (11/23/57)
1045 Perkins Avenue, Waukesha, Wisconsin 53186

138 A.P.V. (Canada) Equipment, Ltd. (12/17/62)
103 Rivalda Rd., Weston, Ont., Canada

82 Cherry-Burrell Corporation (12/11/57)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

124 DeLaval Company, Ltd. (2/18/60)
113 Park Street, South, Peterborough, Ont., Canada

184 The DeLaval Separator Co. (8/ 9/66)
Poughkeepsie, New York 12602

67 G & H Products Corporation (6/10/57)
5718 52nd Street, Kenosha, Wisconsin 53140

105 Girton Manufacturing Company (7/25/58)
Millville, Pennsylvania 17846

199 Gray Company, Inc. (12/ 8/67)
60 Eleventh Ave., N.E., Minneapolis, Minn. 55413

89 Burton Klemp Corporation (3/24/60)
6613 28th Avenue, Kenosha, Wisconsin 53140

34 Ladish Co., Tri-Clover Division (10/15/56)
2809 60th St., Kenosha, Wisconsin 53140

149 Q Controls (5/18/64)
Occidental, California 95465

73 L. C. Thomsen & Sons, Inc. (8/31/57)
1303 43rd Street, Kenosha, Wisconsin 53140

191 Tri-Canada Fittings & Equipment Ltd. (11/23/66)
21 Newbridge Road, Toronto 18, Ontario

151 Tubular Components, Inc. (11/18/64)
Butternut Drive, East Syracuse, New York 13057

86 Waukesha Specialty Company (12/20/57)
Walworth, Wisconsin 53184

0900 Thermometer Fittings and Connections Used on Milk and Milk Products Equipment and Supplement 1, As Amended

32 Taylor Instrument Companies (10/ 4/56)
95 Ames Street, Rochester, New York 14611

1000 Milk and Milk Products Filters Using Disposable Filter Media, As Amended

35 Ladish Co., Tri-Clover Division (10/15/56)
2809 60th Street, Kenosha, Wisconsin 53140

1100 Plate-Type Heat Exchangers for Milk and Milk Products, As Amended

20 A.P.V. Company, Inc. (9/ 4/56)
137 Arthur Street, Buffalo, New York 14207

30 Cherry-Burrell Corporation (10/ 1/56)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

14 Chester-Jensen Co., Inc. (8/15/56)
5th & Tilgham Streets, Chester, Pennsylvania 19013

38 CP Division, St. Regis (10/19/56)
1243 W. Washington Blvd., Chicago, Illinois 60607

120 DeLaval Company, Ltd. (12/ 3/59)
113 Park Street, South, Peterborough, Ont., Can.

17 The DeLaval Separator Company (8/30/56)
Poughkeepsie, New York 12602

15 Kusel Dairy Equipment Company (8/15/56)
100 W. Milwaukee Street, Watertown, Wisconsin 53094

1200 Internal Return Tubular Heat Exchangers, for Milk and Milk Products, As Amended

103 Chester-Jensen Company, Inc. (6/ 6/58)
5th & Tilgham Street, Chester, Pennsylvania 19013

96 C. E. Rogers Company (3/31/64)
8731 Witt Street, Detroit, Michigan 48209

152 Sanitary Processing Equipment Corp. (11/18/64)
Butternut Drive, East Syracuse, New York 13057

1301 Farm Milk Cooling and Holding Tanks — Revised, As Amended

19R Dairy King Sales and Service Corp. (9/ 1/56)
Kearns Bldg., Salt Lake City, Utah 84101

11R CP Division, St. Regis (7/25/56)
1243 W. Washington Street, Chicago, Illinois 60607

119R Dairy Craft, Inc. (10/28/59)
Holdingford, Minnesota 56340

4R Dairy Equipment Company (6/15/56)
1919 S. Stoughton Road, Madison, Wisconsin 53716

92R Delaval Company, Ltd. (12/27/57)
113 Park Street, South
Peterborough, Ontario, Canada

49R The Delaval Separator Company (12/ 5/56)
Poughkeepsie, New York 12602

94R Esco Cabinet Company (2/ 6/58)
West Chester, Pennsylvania 19380

10R Girton Manufacturing Company (7/25/56)
Millville, Pennsylvania 17846

95R Globe Fabricators, Inc. (3/14/58)
7744 Madison Street, Paramont, California 90723

179R Heavy Duty Products (Preston), Ltd. (3/ 8/66)
635 Laurel St., Preston, Ont., Canada

61R James Mfg. Co., Sani-Kool Division (4/ 2/57)
104 W. Milwaukee Avenue, Fort Atkinson, Wis. 53538

12R Paul Mueller Company (7/31/56)
1616 W. Phelps Street, Springfield, Missouri 65801

58R Schweitzer's Metal Fabricators, Inc. (2/25/57)
806 No. Todd Avenue, Azusa, California 91702

50R Emil Steinhorst & Sons, Inc. (12/20/56)
612-616 South Street, Utica, New York 13503

134R Universal Milking Machine Division (5/19/61)
National Co-operatives, Inc.
First Avenue at College, Albert Lea, Minn. 56007

182R Vacooler Co. (5/20/66)
700 Gaylord Ave., Elyria, Ohio 44035

42R VanVetter, Inc. (10/22/56)
2130 Harbor Avenue S.W., Seattle, Washington 98126

18R Whirlpool Corporation, St. Paul Division (9/20/56)
850 Arcade Street, St. Paul, Minnesota 55106

55R John Wood Company, (1/23/57)
Superior Metalware Division
509 Front Avenue, St. Paul, Minnesota 55117

170R The W. C. Wood Co., Ltd. (8/ 9/65)
5 Arthur Street, South, Guelph, Ont., Canada

16R Zero Manufacturing Company (8/27/56)
Washington, Missouri 63090

1400 Inlet and Outlet Leak Protector Plug Valves for Batch Pasteurizers

122 Cherry-Burrell Corporation (12/11/59)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

69 G & H Products Corporation (6/10/57)
5718 52nd Street, Kenosha, Wisconsin 53140

27 Ladish Co. - Tri-Clover Division (9/29/56)
2809 60th Street, Kenosha, Wisconsin 53140
78 L. C. Thomson & Sons, Inc. (11/20/57)
1303 43rd Street, Kenosha, Wisconsin 53140

1600 Evaporators and Vacuum Pans for Milk and Milk Products, As Amended

132 A.P.V. Company, Inc. (10/26/60)
137 Arthur Street, Buffalo, New York 14207
111 Blaw-Knox Company, (2/12/59)
Dairy Equipment Division
750 E. Perry, Buffalo, N. Y. 14210
110 Arthur Harris & Company (11/10/58)
210-218 North Aberdeen Street, Chicago, Illinois 60607
128 Mojonnier Bros. Co. (7/ 6/60)
4601 W. Ohio Street, Chicago, Illinois 60644
164 Mora Industries, Inc. (4/25/65)
112 South Park Street, Mora, Minnesota 55051
107 C. E. Rogers Company (8/ 1/58)
8731 Witt Street, Detroit, Michigan 48209
186 Marriott Walker Corporation (9/ 6/66)
925 East Maple Road, Birmingham, Mich. 48008

1700 Fillers and Sealers of Single Service Containers, For Milk and Milk Products, As Amended

192 Cherry-Burrell Corporation (1/ 3/67)
2400 Sixth St., S.W., Cedar Rapids, Iowa 52404
139 Exact Weight Scale Company (4/15/68)
538 East Town Street, Columbus, Ohio 43215
137 Ex-Cell-O Corporation (10/17/62)
P. O. Box 386, Detroit, Michigan 48232
140 General Films, Inc. (4/23/63)
Covington, Ohio 55318
153 Mantes Scale Co. (1/ 6/65)
489 Sixth Street, San Francisco, California 94103
142 Polygal Company (4/15/63)
Div. of Inland Container Corp.
P. O. Box 68074, Indianapolis, Indiana 46268

1900 Batch and Continuous Freezers, For Ice Cream, Ices and Similarly Frozen Dairy Foods, As Amended

141 CP Division, St. Regis (4/15/63)
1243 W. Washington Blvd., Chicago, Illinois 60607
146 Cherry-Burrell Corporation (12/10/63)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404

2200 Silo-Type Storage Tanks for Milk and Milk Products

168 Cherry-Burrell Corporation (6/16/65)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404
154 CP Division, St. Regis (2/10/65)
1243 W. Washington Blvd., Chicago, Illinois 60607
160 Dairy Craft, Inc. (4/ 5/65)
Holdingford, Minnesota 56340
181 Damrow Brothers Company (5/18/66)
196 Western Ave., Fond du Lac, Wisconsin 54935
156 C. E. Howard Corporation (3/ 9/65)
9001 Rayo Avenue, South Gate, California 90280
155 Paul Mueller Co. (2/10/65)
1616 W. Phelps Street, Springfield, Missouri 65801
195 Mueller/Richardson, Ltd. (7/ 6/67)
84 Wellington St., So., St. Marys, Ont. Canada
165 Walker Stainless Equipment Co. (4/26/65)
New Lisbon, Wisconsin 53950

2300 Equipment for Packaging Frozen Desserts, Cottage Cheese and Milk Products Similar to Cottage Cheese in Single Service Containers

174 Anderson Bros. Mfg. Co. (9/28/65)
1303 Samuelson Road, Rockford, Illinois 61109
178 John A. Carrier Corporation (2/18/66)
Middlesex Turnpike, Burlington, Mass. 01804
193 Triangle Package Machinery Co. (1/31/67)
6655 West Diversey Ave., Chicago, Illinois 60635

2400 Non-Coil Type Batch Pasteurizers

161 Cherry-Burrell Corporation (4/ 5/65)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404
158 CP Division, St. Regis (3/24/65)
1243 W. Washington Blvd., Chicago, Illinois 60607
187 Dairy Craft, Inc. (9/26/66)
Holdingford, Minnesota 56340
177 Girton Manufacturing Co. (2/18/66)
Millville, Pennsylvania 17846
166 Paul Mueller Co. (4/26/65)
1616 W. Phelps Street, Springfield, Missouri 65802
198 Mueller/Richardson, Ltd. (9/ 9/67)
84 Wellington St., South, St. Marys, Ont.

2500 Non-Coil Type Batch Processors for Milk and Milk Products

162 Cherry-Burrell Corporation (4/ 5/65)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404
159 CP Division, St. Regis (3/24/65)
1243 W. Washington Blvd., Chicago, Illinois 60607
188 Dairy Craft, Inc. (9/26/66)
Holdingford, Minnesota 56340
167 Paul Mueller Co. (4/26/65)
1616 W. Phelps Street, Springfield, Missouri 64801
196 Mueller/Richardson, Ltd. (7/ 6/67)
84 Wellington St., So., St. Marys, Ont., Canada

2600 Sifters for Dry Milk and Dry Milk Products

171 Entoleter, Inc. (9/ 1/65)
Subsidiary of American Mfg. Co.
1187 Dixwell Avenue, Hamden, Connecticut 06514
173 Food & Chemical Equipment Div., (9/20/65)
Blaw-Knox Company
1325 S. Cicero Avenue, Chicago, Illinois 60650
185 The Orville-Simpson Co. (8/10/66)
1230 Knowlton St., Cincinnati, Ohio 45223
172 Southwestern Engineering Co. (9/ 1/65)
6111 E. Bandini Blvd., Los Angeles, California 90022
176 Sprout, Waldron & Co., Inc. (1/ 4/66)
Munsy, Pennsylvania 17756

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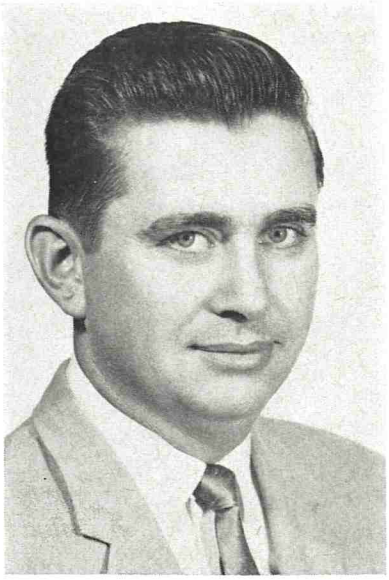
NOMINATIONS FOR OFFICES OF IAMFES, INC.–1968-1969

FOR SECOND VICE-PRESIDENT AND SECRETARY-TREASURER



MELVIN WALKER "JEFF" JEFFERSON

Melvin Walker "Jeff" Jefferson was born September 9, 1923, and raised on a farm in Southside Virginia at Red House. His college education was interrupted during World War II when he served for three years as an Air Force pilot in Italy and South America, but he returned to Virginia Polytechnic Institute and received a B.S. degree in Dairy Science in 1948. He majored in manufacturing and minored in production.

From 1948 until 1952, Jefferson was employed as Quality Control Supervisor and Plant Manager with the dairy industry. In 1952, he was employed by the State of Virginia as a dairy inspector in charge of enforcing all state laws pertaining to processing and distribution of Grade A fluid milk, ice cream and manufactured products. In 1953 he became supervisor of all dairy plant inspections and was promoted to Chief of Dairy Products Inspection in 1957. At the present time he supervises Virginia's statewide inspection program of the State Department of Agriculture and Commerce.

Jefferson is a member and past president of the Virginia Association of Sanitarians; a member of the International Association of Milk, Food and Environmental Sanitarians; he has served on the Farm Methods Committee for the past ten years and also served on the Sanitarians Awards Committee.

He is also a member of the Virginia Dairy Fieldmen's Association, member and past president of the Southern States Dairy Division of the National Association of State Departments of Agriculture, and member of the Dairy Division of NASDA where he has served on the National Labeling Committee since 1961. Since 1962 he has been chairman of that Committee and was instrumental in preparing and recommending the National Uniform Coding System for package identification of milk and milk products processing plants. He has actively participated on the Virginia Mastitis Prevention and Control Committee as well as the National Mastitis Council.

M. W. Jefferson has been active in local community work. He is a member of the Bon Air Civics Association, Bon Air Swimming Pool Association and is a past member of the James River Lions Club and the Chesterfield Ruritan Club.

He, his wife Lorena and two children—Sharon Sue, 17, and Kevin, 14, live in Bon Air, Virginia, just outside Richmond. The family attend the Bon Air Methodist Church where Mr. Jefferson is a member of the Board.

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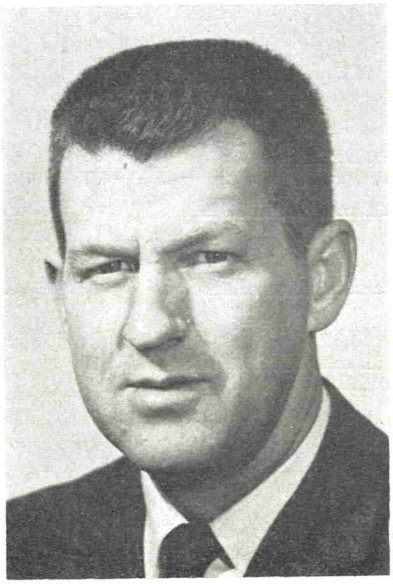


ORLOWE M. OSTEN

A native of Minnesota, Orlowe M. Osten is employed by the Minnesota Department of Agriculture. As Assistant Director and Chief Inspector of the Food

Inspection Division, he supervises inspection sections dealing with Dairy, Meat and Fish, and Food products.

He is a veteran of World War II, serving with the U. S. Army Combat Engineers in Europe. Prior to entering the service, Mr. Osten had completed three years at Mankato State College. He returned to Minnesota and obtained his bachelor's degree in Dairy Technology from the University of Minnesota in 1947.

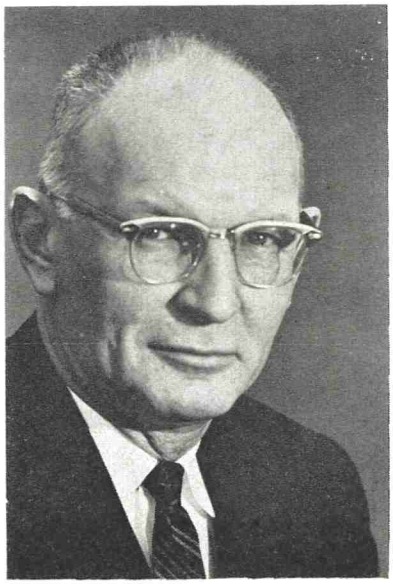
Following graduation he served as an Industry Laboratory Technician and Inspector with the Minnesota Department of Agriculture. In 1949 he accepted the position of Interstate Milk Certification Officer with the Minnesota Department of Health and served in that capacity until 1954. He then returned to the State Department of Agriculture and served as Supervisor of the State Grade A Milk Inspection program until 1964 when he was promoted to his present position.

He is Past President and has served as Secretary-Treasurer of the Minnesota Sanitarians Association for the past eight years. He is Secretary-Treasurer of the Minnesota Mastitis Council; is a member of the Executive Board of the National Conference on Interstate Milk Shipments; and serves as a member of the Committee on Sanitary Procedures (IAMFES) 3-A Committee.

Mr. Osten holds a commission in the Inactive Reserve Corps of the U. S. Public Health Service and in 1965 was awarded a Certificate of Merit by the Minnesota Sanitarians Association.

He is a member of the Immanuel Lutheran Church Council. He and his wife Nilla have been married for 26 years and have four children and one grandchild.

SECRETARY-TREASURER



ROY B. FAIRBANKS

Roy B. Fairbanks is Milk Sanitation Survey Officer for the Division of Milk Control, Illinois Department of Public Health. Mr. Fairbanks attended public schools in Illinois and after one year in the University of Illinois, he began his first task with the dairy industry as a tester for the Dairy Herd Improvement Association.

He spent a number of years in the fluid milk and cheese industry in Illinois and Missouri. He has been in public health work on local and state level for the past 20 years. In 1948, he became Chief Milk Sanitarian for the City of Aurora, Illinois, until accepting a position as Milk Sanitarian for the Illinois Department of Public Health in 1956. Since 1963, he has devoted full time to milk sanitation survey activities.

Mr. Fairbanks has been a member of the International since 1950 and is a past president of the Illinois affiliate, member of the Illinois Public Health Association and is a Registered Sanitarian with the Illinois Department of Registration and Education.

Mr. and Mrs. Fairbanks live at 21 Salmon Court, Springfield, Illinois. They have a married daughter, Carol, at Aurora, Illinois, and a son, Ronald, in his first year of graduate work at Berkley, California.

REPORT OF COMMITTEE ON DAIRY FARM METHODS, 1966-1967

THIRD SECTION

(Editors Note: This is the third and last part of the 1966-67 report of the Dairy Farm Methods Committee, consisting of the remaining Task Committee reports and the full Committee membership.)

Relation of Farm Water Supplies to the Quality of Milk

Henry Atherton, *Chairman*

This subcommittee accepts responsibility in two areas of interest as defined in our 1965 report to the Association: To serve as a central committee to receive information relating to farm water supplies and attempt to evaluate these findings in the general area of milk quality for the Farm Methods Committee and members of the Association and to encourage further study of farm water supplies as they affect the cleaning chemicals which are used in dairy farm sanitation programs.

There are a number of items which should be brought to the member's attention. While some of these are problems of long-standing importance, they continue to create difficulties in providing a top-quality product for our consumers.

The rapid increase of recirculation cleaning programs in dairy farm sanitation systems has placed a heavy burden on our hot water heaters. Some producers have increased the hot water temperature in the tanks to overcome the limited quantity available. This can be particularly dangerous in areas where temporary hardness is a factor in the water supply. In one instance brought to our attention, a dairy unit that was newly constructed had a water heater "short-out" two months later. Investigation showed the lower coil split by caked limestone and workers removed over three pounds of stone from the bottom of the heater. The thermostat of the heater had been set at 180 F to deliver enough hot water. While the water supply had only 26 grains hardness, nearly all temporary, the volume of water used in this two month period was enough to ruin the heater coil (and could have produced a dangerous fire if the "short" had occurred at night). Members should be cautioned that the precipitation rate in a water heater proceeds at markedly increasing rates as the temperature increases above 150 F. The 10 from 150-160 F produces roughly the same precipitation as the 30 from 120-150 F.

A second continuing problem this subcommittee wishes to mention is the large number of instances where the milk supply has been adulterated with water. We are well aware of the legal implications of adulteration whether such addition is intentional or accidental. In some instances milk plants have had trouble meeting total solid requirements for a city milk supply through repeated cases of small amounts of added water resulting from carelessness in dairy sanitation operations.

Of major importance, but less well understood, is the problem of psychrophilic bacteria in the contaminating water. This may be a problem even when the water meets the requirements for a potable supply. Such adulteration may cause the milk supply to fail to meet bacteriological standards and/or result in marked shortening of storage life of the raw supply.

The subcommittee wishes to note the interest which has developed in the past year or two in the possibilities of controlling bacteriological contaminants in water with ultraviolet treatment. There seems to be mounting dissatisfaction with many aspects of chlorination of farm water supplies because of design errors and the frequency of human failure to maintain the equipment and chlorine charge properly. An additional problem is the observation that some organisms, known to be psychrophilic and capable of adversely affecting the quality of milk, cheese and butter, resist high concentrations of chlorine for extended contact periods. While there is much to be learned about this new system, the following comments may be of value to the members of the Association:

(1) USPHS has described acceptable use criteria for UV treatment of water supplies. Acceptance of this type of treatment in a given State or community is dependent upon acceptance by the State milk control authority (See Dept. of HEW, USPHS Policy Statement on Use of Ultraviolet Process for Disinfection of Water, dated April 1, 1966.)

(2) It should be noted that "all other requirements of the Drinking Water Standards relating to Source and Protection, Chemical and Physical Characteristics and Radioactivity are met."

(3) UV treatment does not provide residual bactericidal action. Thus periodic flushing and disinfection of the water distribution system must be provided. In some cases, new piping may be required. Recontamination of the treated water in storage or piping systems must be avoided.

(4) Acceptable criteria for installation of UV systems require the unit to shut off automatically if the water is too turbid. An outlet prior to the treatment site must be provided for fire protection. Some underwriters are cancelling contracts where these UV systems have been installed.

Another method of water treatment is the water pasteurizer. The Agricultural Engineering Department at Pennsylvania State University has completed research on this method and has found it acceptable for farm water supplies. Allegheny County in Pennsylvania has accepted this procedure and the water pasteurizer is recognized in several areas of Pennsylvania.

Problems with oxidized flavor in the milk supply continue to be traced to copper and iron in the water. While mention of this was made in an earlier report, the continuation of the problem suggests research is needed to determine the effect of copper pipes used under varying water conditions. The whole area of mineral contaminants in water supplies should be studied in relation to their effect on dairy sanitation procedures.

A recent activity of major importance to the dairy and other food industries is the appointment of a National Technical Advisory Committee on Water Quality Criteria for Agricultural Use. This is one of five committees appointed by Secretary Udall to assist the Department of Interior's Federal Water Pollution Control Administration to determine the acceptability of individual state proposals for control of water quality in interstate, international, and coastal waters. Your subcommittee chairman was asked to serve on this agricultural committee in the area of water supply criteria for farmstead use (to include cleaning, cooling, human and animal needs, etc.) While it is not possible at this time to report any results of the activities of this group, it is important to acknowledge that the Farm Methods Committee is represented in these discussions.

This subcommittee would like to encourage anyone with information pertaining to the responsibilities of our group to submit same to us so that we can inform the total membership. Particularly, we would encourage anyone having research funds and facilities, to devote at least a portion of these to resolving our problems with farm water supplies and milk quality.

DAIRY FARM MILKING MANAGEMENT
T. A. Evans, *Chairman*

Recently the term "managed milking" has become popular. One definition is—"Using properly functioning equipment to remove, without irritation to the mammary system, a maximum amount of top quality milk from cows compatible with good breeding, feeding and cow comfort.

The job of milking should be planned for individual cow attention and requires complete concentration to the job at hand at all times. High quality milk is essential and can be produced only from clean, healthy cows, properly prepared for the milking operation.

So much has been published on milking management that this committee feels that we can be of more service to the industry by listing these publications than to try and make a new publication.

The following references on milking management are available:

1. Recommended Milking Procedures. What-How-Why. V. L. Baldwin and Associates, Cooperative Extension Service, V.P.I., Blacksburg, Va.

2. Managed Milking Demonstration Survey Form. Cooperative Extension Service, V.P.I., Blacksburg, Va.

3. How Milking Machines Work. L. E. Stewart, Cooperative Extension Service, University of Maryland, College Park, Md.

4. Organizing a County Mastitis Program. M. F. Ellmore, Agricultural Extension Service, V.P.I., Blacksburg, Va.

5. Guidelines for Milk Equipment Installation on Maryland Dairy Farms. C. M. Chance, Department of Dairy Science, University of Maryland, College Park, Md.

6. The Pennsylvania Abnormal Milk Program. Agricultural and Home Economics Extension Service, The Pennsylvania State University, University Park, Pa.

7. Hydrolytic Rancidity—Some Causes and Control. S. B. Spencer, The Pennsylvania State University, University Park, Pa.

8. Milking and Management Supplement for Mastitis Problem Herds (Supplement to VSE-6-24). The use of a Milking Machine Test Gauge. S. B. Spencer and S. B. Guss, DVM, The Pennsylvania State University, University Park, Pa.

9. Environment, Milking and Management Survey for Mastitis Problem Herds (VSE-6-24). Plant Fieldman's Section, Agriculture and Home Economics Extension Service, The Pennsylvania State University, University Park, Pa.

10. An Outline for Managed Milking. S. B. Spencer and S. E. Barnard, Agriculture and Home Economics Extension Service, The Pennsylvania State University, University Park, Pa.

11. The Milking Machine System. R. W. Guest and S. B. Spencer, Agriculture and Home Economics Extension Service, The Pennsylvania State University, University Park, Pa.

12. Vermont Mastitis Survey Project in Franklin County, 1965. Agricultural Extension Service, University of Vermont, Burlington, Vt.

13. You Can Control Mastitis. W. A. Dodge, Agricultural Extension Service, University of Vermont, Burlington, Vt.

14. Master Milker Award Contest. Vermont Mastitis Committee, Agricultural Building, Montpelier, Vt.

15. Irritation of Udder Costs Money. W. A. Dodge, Agricultural Extension Service, University of Vermont, Burlington, Vt.

16. Comments on "Standards for Northeastern Dairy Farms". W. D. Schultze and J. W. Smith, Animal Husbandry Research Division, ARS, USDA, Beltsville, Md.

17. Development of Milking Systems. Dr. R. D. Plowman, Genetus and Management Investigation, Dairy Cattle Research Branch, USDA, Beltsville, Md.

18. Vacuum Pump Ratings. American Society of Mechanical Engineers, Method Prepared by W. A. Dodge, Agricultural Extension Service, University of Vermont, Burlington, Vt.

19. The Relationship of Milking Machines to Mastitis. L. E. Stewart, Cooperative Extension Service, University of Maryland, College Park, Md.

20. Recommended Management Practices. Cooperation Extension Service, V.P.I., Blacksburg, Va.

21. Current Information Relative to the Prevention and Control of Mastitis. Cooperative Extension Service, V.P.I., Blacksburg, Va.

22. The Way Cows Will be Milked on Your Dairy Tomorrow. Babson Brothers Dairy Research Service, 2100 South York Road, Oak Brook, Ill. 60521.

23. Harvesting Your Milk Crop. Dr. C. W. Turner, Dept. of Dairy Husbandry, University of Missouri, Columbia, Mo.

24. Standards for Installation, Cleaning and Sanitizing of Pipeline Milking Systems. Sedgwick County Department of Public Health, 1900 East Ninth, Wichita, Kan.

25. The Southwest Milk Producers Association Milkers Clinic Passouts. Sedgwick County Department of Public Health, 1900 East Ninth, Wichita, Kan.

26. Milking Machine Care. Special Circular 97. Agricultural Extension Service, University of Wisconsin, Madison, Wis.

27. Mastitis—Questions and Answers. Agricultural Extension Service, University of Wisconsin, Madison, Wis.

28. Control Mastitis. C. W. Burch, Spec. Circular 68, University of Wisconsin, Madison, Wis.

29. The Role of Milking Machine Dealers in Mastitis Programs. S. B. Guss, V.M.D., Veterinary Science Extension, The Pennsylvania State University, University Park, Pa.

30. Sample Calculations of Pipe Friction Losses. S. B. Spencer, The Pennsylvania State University, University Park, Pa.

31. Milking Study Farm. Verne Cavanaugh, Indiana State Board of Health, Northwestern Branch, La Porte, Ind.

32. The De Laval Handbook of Milking. The De Laval Separator Co., Poughkeepsie, N. Y.

33. Rules for Good Milking, Milkbarn Card, Babson Brothers Co., Oak Brook, Ill.

34. The Modern Way to Efficient Milking. Milking Machine Manufacturer's Council, Farm and Industrial Equipment, 410 N. Michigan Avenue, Chicago, Ill. 60611.

35. The Use of a Milking Machine Test Gauge. (Mimeo.) S. B. Spencer, The Pennsylvania State University, University Park, Pa.

36. Personal Communication. W. A. Dodge, Extension Dairyman, University of Vermont, Burlington, Vt.

We, the members of the Farm Methods Committee of the International Association of Milk, Food and Environmental Sanitarians sincerely hope that this report will be beneficial to the membership of our International organization.

DAIRY FARM METHOD COMMITTEE MEMBERS

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Toronto, Ont., Can.

H. E. Hansen,
Iowa Assn.,
State Health Dept.,
Des Moines, Ia.

BOTULISM STUDIES AT UNIVERSITY OF WISCONSIN

University of Wisconsin bacteriologist H. Sugiyama is looking for a new way to detect the poison which causes botulism. Botulism is a type of food poisoning caused by a species of bacteria, *Clostridium botulinum.*

No one knows why these bacteria make the chemical, and scientists have not been able to determine its importance to the organism. They do know that the toxin does not get out of the cells into the surrounding environment until the cells die.

Six types of *C. botulinum* have been discovered, and each one produces a slightly different toxin. The antitoxin for one type of toxin will not protect against the other types of toxin. Type E botulism is usually caused by eating fish or marine animals in which the organism has had a chance to multiply. Type E organism is found in the digestive tract of fish, but the fish are healthy. Research in Sugiyama's laboratory indicates that fish pick up the bacteria in their food. It passes through their digestive tract without multiplication and is eliminated in four to five days.

C. botulinum, like many bacteria, can live in a dormant form called a spore. Spores can survive treatments which would kill the active or vegetative forms. Fish experimentally injected with type E spores and smoked by a procedure which should destroy all of these spores still contain living spores. Research shows that the body fat liquifies during the smoking process and traps some of the spores. The liquified fat then protects the spores against the killing effects of the heat.

For some reason, there is high concentration of *C. botulinum* in Green Bay, Wisconsin. Slightly over half its fish carry the organism. And almost all of the mud samples from the bottom of the bay also contain the type E botulism organism. One to 9 percent of the fish in the Great Lakes carry type E botulism. For a long time, scientists have felt that *C. botulinum* lives in the soil and then is washed into lakes and streams. But Sugiyama's data suggest the bacteria reproduce in Green Bay itself.

The antitoxins work by combining with a harmless part of the protein. The toxin-antioxin reaction can occur in a test tube even though the toxin is not able to cause poisoning symptoms. This makes it impossible to be sure whether a particular sample contains the active toxin without doing animal tests.

Sugiyama is developing an immunizing agent which produces antitoxins to neutralize the toxin by reacting with the structural part of the toxin which causes the symptoms of food poisoning. If the anti-toxin reacts specifically with the toxic site, the reaction can only occur if the harmful region is intact. This will enable medical personnel and researchers to detect the presence of the toxin in a sample of food without using laboratory animals. It would cut down the expense of botulism research too.

Recently, a group of organisms have been found in the Great Lakes which seem to be identical with type E, but they do not produce a toxin. Some of these organisms inhibit the growth of toxic Type E. Sugiyama is looking for clues to the genetic differences between these two bacteria.

NEWS AND EVENTS

GEORGE SHADWICK HONORED FOR 4-H WORK IN ILLINOIS

Dr. G. W. Shadwick, Director of Technical Services for Beatrice Foods Co., Chicago, recently was named recipient of the 1967 Illinois 4-H Alumni Recognition Award. Congratulating him in the accompanying photo are T. W. Thompson, left, Director of Program Services for the National 4-H Service Committee, and Merlyn C. Heyen, right, Associate Extension Advisor, Agriculture, University of Illinois Extension Service. The award is made annually to a former 4-Her in the state in recognition of outstanding accomplishment in his field of endeavor.

THE LITTERBUG—AN ANCIENT SPECIES

The litterbug is one of the oldest living species on earth, according to historical information compiled by Keep America Beautiful, Inc.

The national litter-prevention organization reports that litterbugs were active in the days of ancient Rome. Archaeologists excavating Herculaneum, a Roman city buried under lava from Mt. Vesuvius in the first century of the Christian era, found a sign at a crossroads warning that litterers would be fined or subjected to corporal punishment.

Visitors to William Shakespeare's birthplace in Stratford, England may see a sign on the wall of one of the rooms reporting that "John Shakespeare, the poet's father, was fined for depositing rubbish in Henley Street in 1552."

One of the first recorded actions against litter in the U. S. was an editorial in a Boston newspaper in 1784 condemning the litter left behind after an Independence Day celebration. The city fathers were urged to prevent a recurrence.

"The major difference between ancient and modern littering is that there is a lot more of it in present-day civilization," said Allen H. Seed, Jr., KAB's executive vice president. "Litter today takes a half-billion-dollar-a-year tax bite out of the national pocketbook. That is the amount of the annual litter cleanup bill. The species could be eliminated, however, if each person would assume responsibility for the proper disposal of his own litter and trash. It is the individual who creates litter, and only the individual can prevent it. This means you and me."

FIVE NATIONAL CONFERENCES SCHEDULED FOR MAY AND JUNE

Five annual meetings of interest to milk, food and environmental sanitarians will be held during the months of May and June, 1968. The conferences in the order of occurance are sponsored by the American Society for Microbiology, the Institute of Food Technology, the American Dairy Science Association, the Association of Food and Drug Officials of the U. S. and the National Association of Sanitarians.

The first annual meeting will be held May 5-10 in Cobo Hall in Detroit by the American Society for Microbiology. Information regarding the program can be obtained from R. W. Sarber, Executive Secretary, 115 Huron View Blvd., Ann Arbor, Mich. 48103.

On May 19-24, the Institute of Food Technologists will hold its 28th Annual Meeting and Technical and Industrial Exhibit at the Philadelphia Civic Center, Philadelphia. An attendance of some 4,000 members and non-members is expected. C. L. Willey is Executive Director with offices at Suite 2120, 221 N. LaSalle St., Chicago, Ill. 60601.

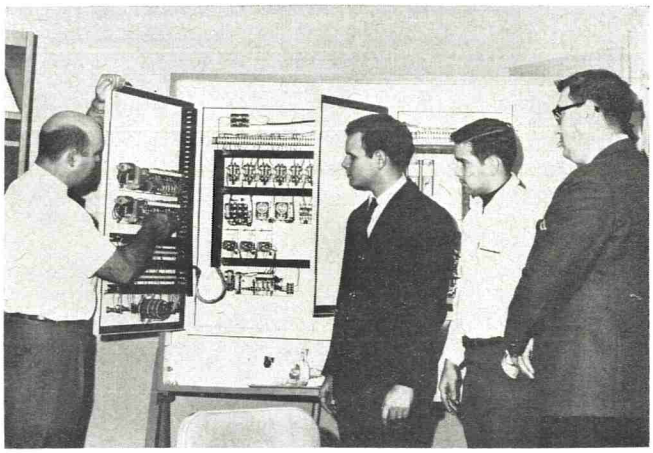
The 72nd Annual Conference of the Association of Food and Drug Officials of the U. S. will take place at the Hartford Hilton at Hartford, Conn., June 16-20. Information about the program can be obtained from Eaton E. Smith, Vice President and Program Chairman. Address him at the Connecticut Department of Consumer Protection, State Office Bldg., Hartford 06115.

The American Dairy Science Association meets at Ohio State University, Columbus, June 16-19. Program Chairman is T. I. Hedrick, Michigan State University, E. Lansing and the Executive Secretary is Claude Cruse, 903 Fairview Ave., Urbana, Ill. who

can furnish details about the program.

The 32nd Annual Educational Conference of the National Association of Sanitarians will take place June 23-28 at the Sheraton-Park Hotel, Washington, D. C. Program information is obtainable from Nicholas Pohlit, Executive Director, 1550 Lincoln St., Denver, Colo. 80203.

PROGRAM ON AUTOMATION AT TEXAS A&M



Dale A. Seiberling, Manager, Equipment-Engineering Dept., Klenzade Products, Beloit, Wisconsin, presented a special program on "Process Control and CIP Automation" to the Food Plant Management class at Texas A&M on January 9, 1968. Mr. Seiberling explained and demonstrated to the class how a well-designed process CIP automation system can help (1) reduce labor costs through higher productivity per man-hour, (2) reduce product loss through elimination of leaks, overflows, spillage, (3) obtain better and more consistent product quality, and (4) achieve future growth at minimal capital cost and with minimal added man-power.

The accompanying photograph shows Mr. Seiberling demonstrating the functions of the automated CIP control panel to two of the students in the class, while Dr. H. E. Randolph looks on. Identified left to right: Mr. Dale A. Seiberling, Jose Pomentta, Alex Fondeur, and Dr. H. E. Randolph, Associate Professor, Department of Animal Science.

FIVE-DAY COURSE ON ENVIRONMENTAL CONTROL OF COMMUNICABLE DISEASES

The Training Program of the National Communicable Disease Center announces a Headquarters Course, No. 3230-G, "Environmental Control of Communicable Diseases," to be held in Atlanta, Georgia, May 20-24, 1968. The course is for all Public Health workers with particular orientation toward Sanitarians, Public Health Engineers, Administrators, and Nurses.

The purposes of the course are to provide information and afford the opportunity to develop proficiency in the solution of communicable disease problems existing in the community and amenable to environmental controls. Emphasis will be given to increasing the capabilities of Public Health personnel for participation in the overall disease control activities of the health agency.

A substantial portion of this five-day course is presented by use of teaching problems. For interest and realism these teaching problems are laid in a thoroughly documented teaching reference community – Dixon, Tiller County. The teaching staff will be drawn from the National Communicable Disease Center, universities, health departments, and similar organizations.

Anyone who wishes to attend or would like more information about this course should write Dr. Donald M. Martin, Chief, Training Program, National Communicable Disease Center, 1600 Clifton Road N.E., Atlanta, Georgia 30333.

WHAT DOES THE PUBLIC KNOW ABOUT THE SANITARIAN?[1]

To be truthfully honest—a high majority of the general public does no thinking whatsoever about "the sanitarian" because it does not know what a sanitarian is or what he does in the work-a-day world, nor that he even exists.

A number of sanitarians, in Ohio, are qualified for their positions by education and by experience and are able to meet their responsibilities with faithfulness. This is fine and as it should be. But it is not enough. The average man—and he is numerous—never hears of this, nor is he likely to if the sanitarian as an individual, or a group, continues silent.

It seems timely and logical to step forward and bring the fact of the sanitarian and his work to the attention of the general public. The news media—papers, press and tube—carry a variety of news stories—on murder, robbery, rape and assault—how to sew—how to diagnose your ills—the remedies—how to mend broken hearts and homes—how to do it yourself, etc., etc. Why is the "sanitarian and his unique contribution" in the health professions, a well-kept secret? Our guess is that few, very few professions have given any thought to "Public Relations." It's time that all of those who care should start.

[1]From the *Ohio Sanitarian,* a publication of the Ohio Association of Sanitarians, Inc.

NEW USES FOR ALUMINUM PACKAGING

The all-aluminum can is expected to pace a second consecutive five-year doubling of aluminum's use in the dynamic and fast-growing packaging field, according to Cliff Sands, chairman, Containers and Packaging Committee of The Aluminum Association. "We look for the all-aluminum can for beer, beverages and processed meats and a broadening of the easy-opening end market into processed foods to lead the growth of aluminum in packaging that has doubled in the past five years and should double again in the next five," Sands said in a year-end report to the industrywide trade group during its annual meeting in New York Nov. 29-Dec. 1.

Snack foods, volume feeding systems, unit containers or "portion packs," smooth wall containers and foil-laminated pouches—so-called "flexible cans" for processed convenience foods that can be boiled before opening—all are additional areas of expected dramatic growth for aluminum foil in 1968 and the five years ahead. Aluminum's versatility is the key to this increase in a burgeoning market whose byword is "convenience," Sands noted. Citing some of the light metal's advantages, he pointed to strength with light weight, resistance to rust and corrosion, formability, natural eye-appeal, decorability, barrier qualities against moisture and gas transmission, and its ability to be rolled into very thin foils for a wide variety of applications, both alone and in conjunction with other materials.

Disposable unit containers, both flexible and semi-rigid, offer a real convenience to the user whether in products like the cocktail mix or in pre-measured food portions or dosages of ethical and proprietary drugs in institutions such as schools and hospitals. The smooth wall containers provide an esthetically-pleasing appearance coupled with the use of less metal than the familiar wrinkled-wall foil.

Laminated foil pouches are being used for processed vegetables such as peas, beans and corn with butter or other sauces, for sauerkraut and a whole variety of drugs, and toiletries.

Technological developments during the past few years have been responsible for much of aluminum's growth in packaging—such as the smooth-wall process for foil containers and the ironing of all-metal cans permitting both draw-and-iron and impact-and-iron processes for the all-aluminum cans.

Both the packaging and aluminum industries are constantly at work on new ways to improve packaging. Developmental work going on right now or already scheduled on new alloys, new designs and fabricating techniques will contribute substantially to the packaging versatility of aluminum and the great growth of the light, modern, convenience metal in the next half-decade. This, together with a growing acceptance of the innate advantages of aluminum for packaging, should help aluminum to maintain its "skyrocketing" growth in packaging, according to Sands.

UNIQUE STUDIES AT MICHIGAN STATE ON AIRBORNE CONTAMINATION OF FOODS

To keep processed foods free from contamination by airborne bacteria, a Michigan State University scientist is borrowing ideas from the space program, the drug industry and some of the nation's most modern hospitals. "These modern air filtration techniques are necessary to extend the shelf life and improve the quality of many food products," contends Dr. Dennis R. Heldman, assistant professor of agricultural engineering and food science.

Heldman says he is testing air filter concepts used in other industries to insure food safety. Among those being tested are the "clean room" techniques used in the space program. "These filters are used in the assembly of components for space ships," he explains. "In these applications, one particle of contamination could cause an electrical short or some other malfunction. We're also looking at the techniques used in the drug industry to insure that drugs are kept pure from the time they are made until after they have been sealed in their final containers. And we're looking at the techniques used in hospitals to prevent infections from airborne bacteria."

As food processing becomes more sophisticated, says Heldman, there is a greater need for purified air surrounding the product to prevent bacterial contamination. A case in point was the recent incidence of dry milk contamination with *salmonella*, a type of bacteria which can cause serious stomach disorders, sometimes fatal. Extensive investigation showed one source of this contamination was air that came in contact with the product after it was dried. To insure food safety, dry milk processors are now putting air filters on the spray drier to keep the air "clean" around the product.

In his attempt to control airborne contamination, Heldman has determined the major sources of contamination. He has also developed mathematical formulas for predicting the numbers, types, and life span of bacteria in a room and how many of the bacteria can be transported from one room to another through a given opening.

"One of the major sources of air contamination is the human," says Heldman. "In our experiments, we had someone place a sanitized arm (cleaned with soap and skin sanitizer) and an unsanitized arm (washed only with soap) in a chamber, and we measured the bacteria that were shed from the two arms.

At first, the number of bacteria shed from the sanitized arm was rather low. But in a short time the rate of shedding from this arm was as high as that from the unsanitized arm."

Other sources of contamination are floor drains and ventilation systems. When the floor drains are flooded with water, bacteria collect on the walls of the drains and are blown back into the room when water going into the drain forces air out. In ventilation systems, dust particles gather within the system when it is shut off. As soon as it is turned on, the particles are carried throughout the room.

"We also think that another source of contamination is any flat horizontal surface within a room," says Heldman. "Dust can settle on these surfaces when it is not being used, and then particles can be carried into the air as activity resumes."

Currently, Heldman is trying to eliminate some of these sources of bacterial contamination and, where he can, in trying to prevent dispersion from these sources into the surrounding atmosphere. To do this, he will experiment with different air filtration techniques which will take contaminated air out of a food processing room and recirculate clean air, under very low velocity, back into the room.

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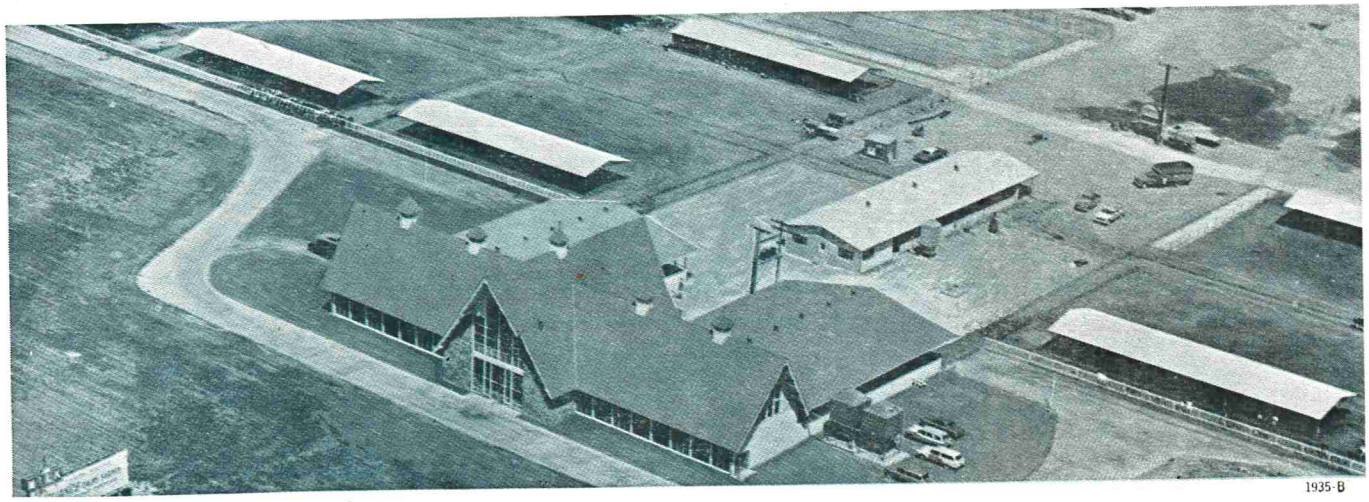

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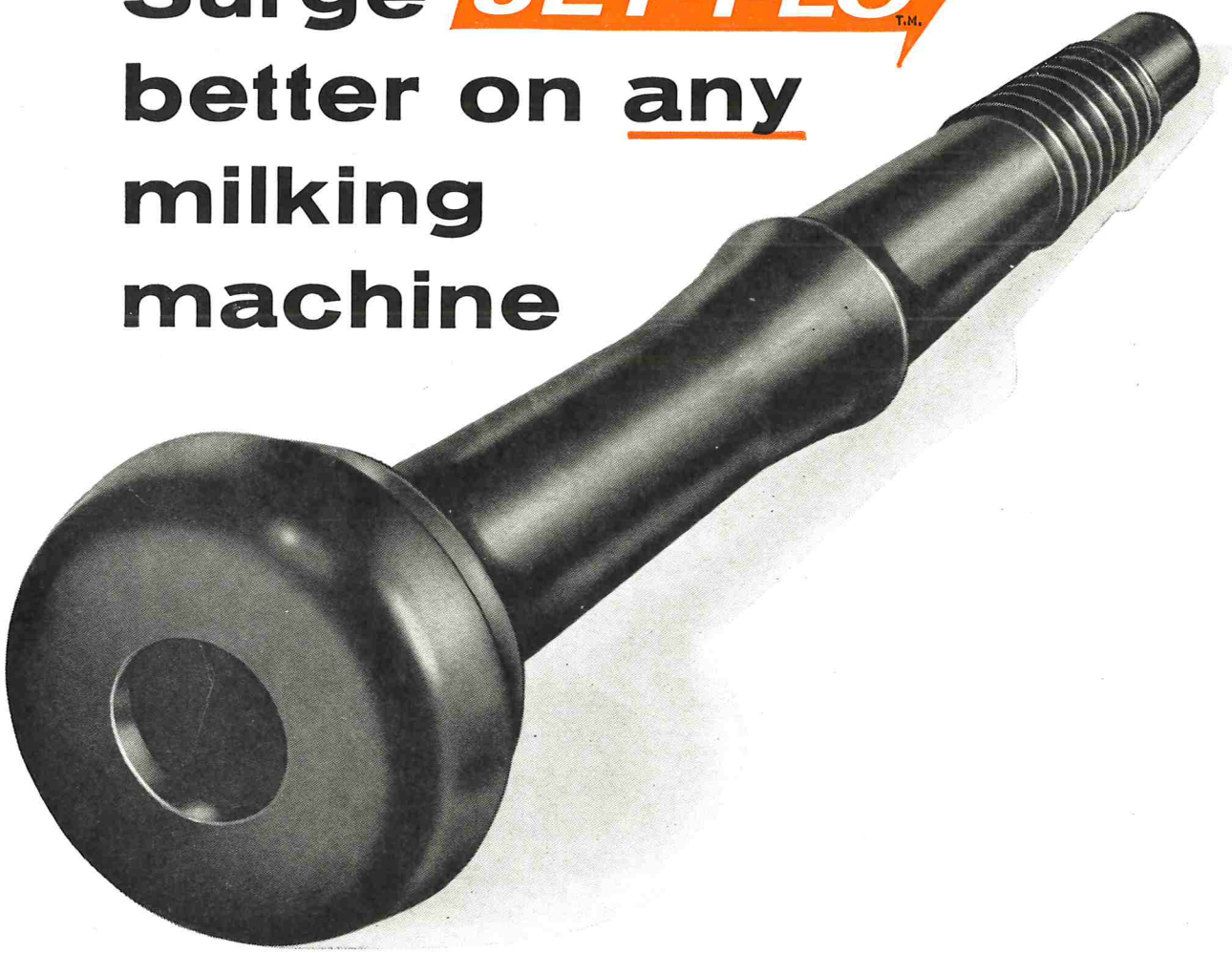

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