

MILK DISTRIBUTION

E. CAPSTICK, M.Sc.*

Milk and milk products are extremely valuable foods for people all over the world, but they are exceedingly perishable and if contaminated during distribution could become carriers of disease. Therefore it is very important to ensure that distribution is effected in the most hygienic and rapid way possible. The cost of doing this should also be considered, as the consumption of these foods will not go up unless the price is kept down to an economic level in every country.

It is only during the last fifty years or so that various methods of distribution (see Fig. 1) have been studied and controlled. Before then milk distribution was a completely haphazard business and the condition of the milk when it arrived at the consumer was not regulated in any way. Until Pasteur demonstrated that heat would destroy bacteria in a liquid, no processing of any kind was carried out. Once efficient methods of heat treatment had been established in some countries, people began to investigate methods of distribution. Now it is fully accepted that distribution must be carefully supervised and controlled so that high-quality milk reaches the consumer.

Raw milk

In some places milk is still distributed raw, but this cannot be recommended except in temperate areas where production is carefully supervised and where a comparatively short time elapses between production and consumption. The milk should be distributed in sealed containers, and where possible the temperature should not rise above 10°C at delivery. The consumers should also be educated to boil all raw milk before use, unless it is from cows that have passed the tuberculin test. Raw milk consumption will probably continue in rural areas in most countries, but strict hygienic control is necessary to ensure that it is of good quality.

* Director, United Dairies, Ltd., London, England.

FIG. 1
DISTRIBUTION OF RAW MILK BY OLD-STYLE HAND-PRAM OR PUSH-CART



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Pasteurized milk

The widespread use of pasteurized milk is now generally accepted; in some countries it is very difficult to buy raw milk. Various methods of pasteurization may be used; it does not appear that the keeping quality is much affected by varying time and temperature combinations, provided that they are included in the Dahlberg curve.¹ The deterioration of pasteurized milk is caused mainly by post-pasteurization contamination and the use of poor-quality raw milk, and is accelerated by exposure to ambient temperatures in excess of 10°C.

Containers²

The most hygienic method so far developed for the distribution of pasteurized milk is in a sealed bottle or carton. Bottles have been in use for many years and are best sealed with aluminium foil which covers the pouring lip. Waxed paper cartons are a comparatively recent innovation and are gaining popularity in countries where paper pulp is easily obtained at an economic price. More recently, paper coated with polyethylene has been successfully used for cartons, which are made and filled by one machine.

¹ Khurody, D.N. (1953) In: *Proc. XIII Int. Dairy Congr.*, The Hague, 2, 212.

² See also chapters by Casalis & van de Putte, page 569, and by Ekman, page 557.

Bottles

The chief advantages of the bottle are transparency—so that the cream line can be appreciated—and low cost. Provided satisfactory systems of bottle-recovery are organized, between 40 and 50 trips per bottle are normally attained under widely differing conditions. In ideal conditions, up to 80 trips have been achieved. With trippage figures of 50 per bottle, the cost of using them as containers for milk generally works out at about one-third of the cost of cartons which, of course, are single-trip containers.

TABLE 1
COMPARATIVE CAPACITIES OF CRATES FOR MILK
CONTAINERS OF VARIOUS SIZES

Bottle size	Number of bottles per crate	Weight of crate of full bottles (pounds)	External dimensions of crate (inches)			Percentage weight of milk (gross weight)
			Length	Width	Height	
Quart	12	64.0	18.5	14.375	11.25	48.0
Pint	20	59.0	18.5	14.375	10.25	43.4
Half-pint	30	53.5	18.5	14.375	7.5	35.1
Third-pint	30	43.0	18.5	14.375	7.5	30.0

The disadvantages of bottles are weight, breakage and misuse. With 0.5-litre bottles held in a suitable crate, the weight of milk amounts to only 43 % of the total. With 0.2-litre bottles used for school milk, the milk constitutes only 30 % of the total weight (see Table 1). There is the ever-present risk of breakage, with the attendant risk of splinters getting into filled milk bottles. The number of occasions when this actually happens is very small, but if the breakage takes the form of chipping of the lip of the bottle when under the filling valve or capping head of a modern bottle filler, it is very difficult to detect. Bottles when in the hands of the public may be misused so as to render it impossible to cleanse them satisfactorily in the most powerful bottle washers available. Bottles may be used for containing paraffin or other strong smelling liquids and may pass through the bottle washer without detection and still have traces of the foreign odour which is rapidly absorbed by the milk.

Bottles used are generally colourless, but trials have shown that the use of coloured glass partially prevents the development of light-induced oxidization with its particular flavour. Coloured glass bottles were introduced in Sweden in 1957, and now 60 % of the milk there is distributed in brown glass bottles and 40 % in Tetrapak cartons.

Cartons

The chief advantages are lightness and their being single-purpose containers. Cartons thus increase the payload on transport vehicles, or,

alternatively, reduce the strength of the vehicle required for a comparable payload. Owing to their non-returnable nature, no breakage or misuse of cartons occurs. Leakage of milk from cartons during delivery is a hazard which seldom occurs with bottles.

The principal disadvantages are high cost and slower filling rate, while in some countries opacity may be so considered. Cartons are about three times more expensive than bottles if trippage of 40-50 per bottle is obtainable, but the cost of collection, transport and washing of bottles is of course eliminated if cartons are used. The filling rate for cartons is generally much slower than for bottles, and two or three fillers would be required to replace the capacity of the modern bottle filler. Cartons are opaque, so that the cream line cannot be seen. It is perhaps significant that since most milk sold in the USA is homogenized and thus has no cream line, no consumer resistance was encountered when cartons were introduced into that country. Originally most cartons were straight-sided, but a four-cornered Tetrapak introduced in Sweden is slowly becoming more popular. The newer Zupack of rectangular shape may not encounter much material consumer resistance.

Distribution

Bulk distribution

Distribution of pasteurized milk in bulk was widely practised in Europe up to the Second World War, but is now rapidly decreasing. However, in countries where there is a need to provide pasteurized milk at low cost this method is in use—for instance, in some urban areas in India.

It must be pointed out that there are disadvantages and dangers when this method is used. Unless it is tightly controlled the door is wide open for malpractices and adulteration. If adulteration takes place, or the vessels are not scrupulously cleaned and sterilized before being filled, outbreaks of milk-borne diseases such as gastro-enteritis are likely to occur.

The importance, therefore, of the need for strict hygienic control cannot be over-emphasized. It is strongly recommended that, when bulk distribution of pasteurized milk is carried out, the cans be sealed at the dairy and distribution be permitted only from authorized and supervised distribution points.

Finally, every effort should be made to persuade consumers purchasing this milk to boil it immediately before use.

Other distribution methods

Milk may be distributed either through delivery by roundsmen, or from milk shops that sell other dairy produce (and, in some countries, a considerable range of foodstuffs), or from booths to which milk is delivered at

set times twice a day. The method used in any country or district depends in part on the way in which the industry has developed, and on local factors such as the building density in the area, the quality of the roads, and the cost of distribution to the home compared with distribution through either shops or booths.

In cities and towns where milk consumption is high and the trade is well organized, household distribution has generally become established, but in some areas, notably the larger cities on the eastern seaboard of the USA, household distribution has become so expensive that many consumers now choose to collect their milk from big departmental stores or milk shops.

Factors influencing the pattern of distribution in urban areas

Building density. Where the building density is high, the rate of delivery per unit of time is greater than where it is low.

Topography of the area. The rate of delivery is slowed down in hilly areas and the vehicles used may not be able to carry as large a load as in flatter districts. Topography also influences the type of vehicle that may be used for the delivery service. Hand-push trucks are useless in hilly areas, and electric vehicles not so efficient, as the heavier demand on their batteries when climbing hills reduces the mileage they can do without recharging (see Table 2).

TABLE 2
COMPARISON OF PAYLOADS OF VARIOUS VEHICLES

Type of vehicle	Miles per charge	Maximum load (tons)	Number of crates	Equivalent gallonage		
				Quarts	Pints	Half-pints
Small electric (pedestrian controlled)	6	0.5	24	72	60	45
Medium electric (pedestrian-controlled)	9	1.0	36	108	97.5	93.75
			39			
			50			
Large electric (driven)	45	1.5	50	150	120	123.75
			60			
			66			
Horse-drawn	—	1.0*	35	105	100	93.75
			40			
			50			

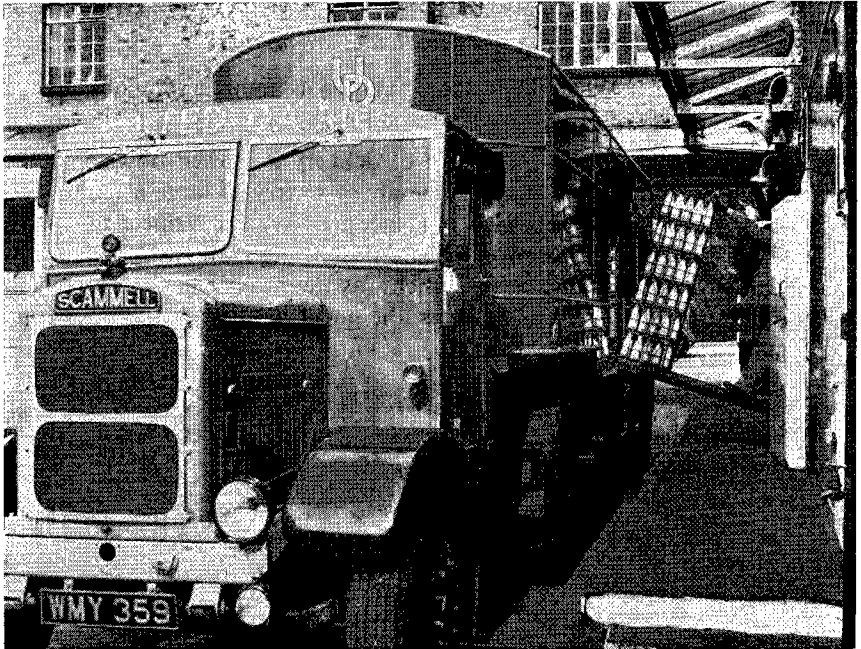
* Very elastic; this figure is approximate.

Factors within the control of the distributor

Number of customers served per round. When competition exists between a number of dairymen, the quantity of milk that can be delivered is lower than when the distribution areas have been zoned and only one man delivers in an area.

Distance of the delivery area from the dairy. This obviously materially affects the time that can be spent on actual distribution, and limits the overall quantity of milk that can be distributed from a central processing dairy. In larger towns the practice has grown up of establishing distribution depots with adequate cold-storage accommodation in areas remote from the processing plants. The bottled milk is taken to these depots in large delivery vans (see Fig. 2) and placed in cold store during the afternoon or night

FIG. 2
THE DELIVERY OF PASTEURIZED BOTTLED MILK FROM THE PROCESSING DEPOT
TO THE DISTRIBUTION DEPOT



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before the milk is required for distribution. Distribution vehicles are kept at and operate from these depots. Their size varies widely—the largest may operate up to 50 rounds and the smallest, on the fringe of a big town, as few as 6. All distribution depots must have sufficient cold storage accommodation to hold one day's delivery of milk at a temperature not exceeding 8°C.

A minor variation of this system is the use of an insulated or refrigerated vehicle to act as a cold store in an area where new trade is developing. When sufficient trade has been secured, the normal practice is to build a permanent depot, and the insulated vehicle is used to operate in another developing area.

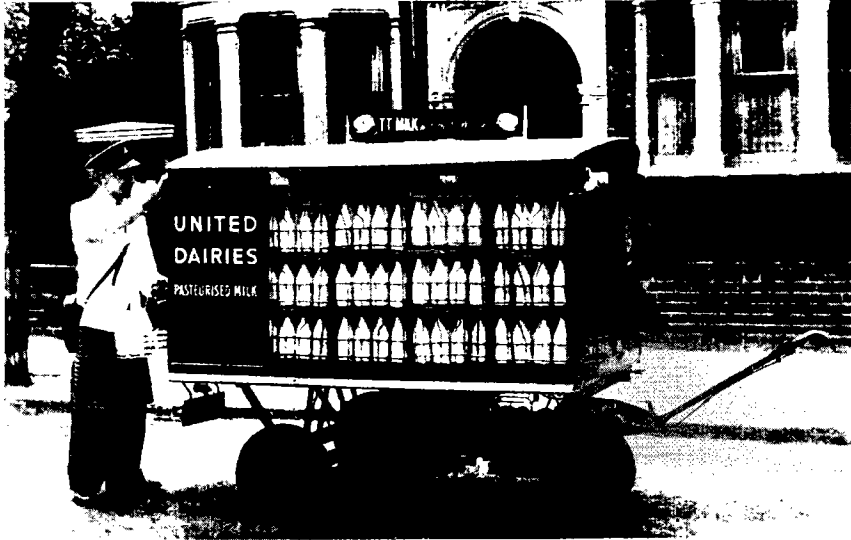
Types of delivery vehicle

Delivery vehicles at present in use (see Table 2) include:

(a) Hand- or push-prams which can be used only in the immediate neighbourhood of the processing dairy or distribution depot.

(b) Pedestrian-controlled electric vehicles which have a carrying capacity of up to 1 metric ton (see Fig. 3).

FIG. 3
PEDESTRIAN-CONTROLLED ELECTRIC VEHICLE



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(c) For rounds with greater mileage, electric or horse-drawn vehicles driven by the roundsman (see Fig. 4, 5). Capacities in this class of vehicle vary between payloads of 1 and 1.5 metric tons.

(d) For rural distribution, petrol or diesel engine vehicles are the only suitable types available.

In temperate climates the vehicles used both for transport of the bottled milk from the bottling depot to distribution depots and for retail distribution need not be insulated. In marginal climates, where the day temperatures can be high, the necessity of insulating delivery vehicles is avoided by carrying out distribution during the cooler hours of the night. In hot climates, e.g., the southern states of the USA, insulated vehicles have gradually become more and more popular. They are, however, both expensive in capital outlay and somewhat more costly to operate.

FIG. 4
LATEST-STYLE ELECTRIC DELIVERY VEHICLE
WITH FIBRE-GLASS BODY-WORK



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The type of body on distribution vehicles is very important. It should be as large as possible, so that the crates containing the bottles or cartons need not be stacked unduly high. Some dairies operate horse-drawn vehicles with a body of sufficient size so that it is unnecessary to stack more than two tiers high. With electrically driven vehicles three tiers are usual. The body of the vehicle should be capable of being opened on two sides and at the rear, so that the roundsman can easily get to any particular crate.

Types of crate

Whether the retail containers in use are bottles or cartons, they must be packed in crates for ease of handling. For bottles, because of the weight, the crates must be of stout construction; they are usually made of either wire or angle iron and expanded metal. It is very important that the design of crates should be such as to permit interlocking for stacking, and if more than one size of bottle or carton is filled, crates should be designed to be of uniform size and permit interlocking irrespective of the size of

FIG. 5
HORSE-DRAWN RETAIL DELIVERY VEHICLE



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bottle held in them. A typical standard range to carry four different sizes of bottle but be capable of interlocking is shown in Table 1 (see page 597).

The design of crates, which appears to have remained stationary for many years, is now changing, and straight wire divisions are disappearing in favour of partitions made of loops of wire fixed to the base of the crate. This greatly facilitates automatic crating and decrating at the bottling plant. Pallets or platforms may be used for wholesale distribution to decrease the labour of loading and unloading. Their use, however, depends on adequate space being available for the operation of mechanical trucks at both the bottling and the distribution depots. Such space should be provided for in all new buildings, even when labour saving is not immediately contemplated, as conditions may change.

Types of milk

In countries with a long tradition of milk processing, many types of milk are sold, which again further complicates the problems of both processing and distribution. It is therefore always advisable to endeavour to restrict the types of milk, which might with advantage be limited to pasteurized and sterilized, possibly of two qualities. The Bombay Milk Scheme, for example,¹ distributes only two qualities of milk—straight

¹ Khurody, D.N. (1953) In: *Proc. XIII Int. Dairy Congr.*, The Hague, 2, 212.

pasteurized milk from native Indian cows containing 5%-6% butterfat on testing, and toned pasteurized milk, which is a mixture of buffalo milk and reconstituted skim-milk powder, giving a final composition of 3.5% fat and 9% solids-not-fat. (See the chapter by Khurody, page 695.)

Organization of rounds

Where distribution areas have been rationalized and one operator supplies all the needs of the householders in a particular block, it is practicable to make approximately 350 calls per day. Under British conditions the quantity of milk so delivered would be between 400 and 500 litres. At each call the roundsman leaves the milk ordered for the day and collects the empty bottles. (Where cartons are used, no problem of returns arises.) It is important to educate the customer to rinse the bottle as soon as it has been emptied. This will greatly reduce the number of complaints that may arise from bottles which cannot be perfectly cleansed after passing through the normal bottle-washing machinery.

In many countries where household delivery is established, the roundsman also carries other dairy products such as butter, cream and cheese. In other areas, where it is difficult to build up rounds of sufficient size to make them profitable, a further range of goods such as eggs, canned fruits, etc., are also sold to improve the profitability of the round.

Shop distribution

In many countries distribution to customers' homes has never become widespread and milk is normally obtained from the local dairy shop which also sells cream and other dairy products. In some countries such shops are survivals from the old practice of town cowkeeping. In others, they have been specially built as milk distributing points and sell dairy products in addition to milk. Very often they are linked to the local processing depot, and in the case of farmer/co-operative enterprises may be owned by the producers supplying milk to the processing plant. Such shops must have adequate cold-storage accommodation to hold a complete day's supply of milk and must be flexibly staffed to cope with the big demand for milk that usually occurs early in the morning and during the luncheon break.

The Bombay System

Although some delivery to homes by private milkmen and dairies may still persist, the system of distribution of milk pasteurized and bottled at Aarey Colony achieved real economies in distribution costs. Khurody¹ has described the setting-up of several hundred milk distribution booths at strategic points throughout the city. Milk is delivered to these points

¹ Khurody, D.N. (1953) In: *Proc. XIII Int. Dairy Congr.*, The Hague, 3, 1514.

at advertised times. About 200 consumers fetch the milk during one hour in the morning and one hour in the afternoon from each distribution point, and at the same time return rinsed empty bottles. The customers pay for the bottles on their first purchase and are responsible for their replacement if they are broken whilst in their possession. Milk obtained in this way is quickly transported back to the consumer's home and kept in a cool place until required. In many homes the long-established custom of keeping the milk simmering in a pan on the fire is still practised.

This system has advantages in tropical climates, as the milk passes from the processing cold store into the consumers' hands within 2-3 hours, when the responsibility for the keeping quality of the milk can be taken over in the home by keeping it either cool or hot. Further, it is very much cheaper than either household delivery or distribution from milk shops.

In many countries where government or municipal plants have been established, with or without UNICEF support, distribution from approved shops with adequate refrigeration cabinets is well established. This is a good system, but inevitably it is more costly than distribution from booths which are staffed for only 2-3 hours a day and have no refrigeration expense.

Sterilized Milk

The cost of distributing sterilized milk can be less than for pasteurized milk because of its superior keeping quality, as a twice-weekly delivery would be satisfactory in most climates. Further, it can be carried over much greater distances involving longer periods of time without the provision of insulated or refrigerated vehicles. It therefore appears to have very real value under tropical conditions, where processing centres are likely to be far apart. In such circumstances the area to be supplied with milk from these centres is greater than can safely be served with pasteurized milk of lesser keeping quality. Its only disadvantage is that the cost of the sterilization process, together with the more expensive cap necessary to seal the bottle, does necessitate the imposition of a higher price on the consumer.

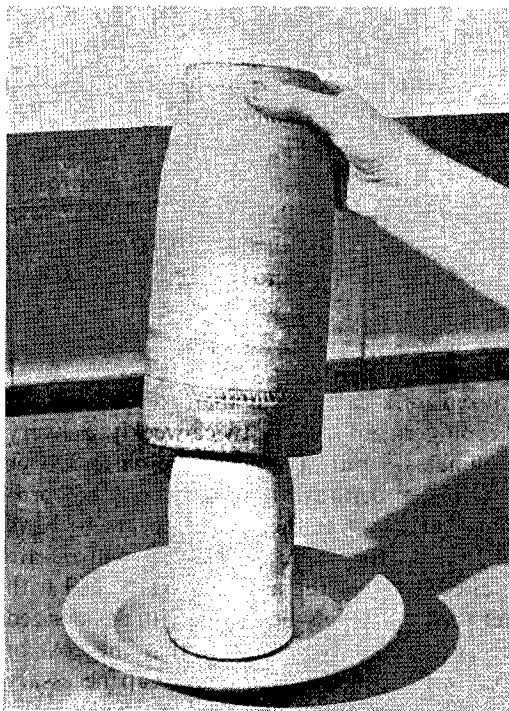
Care of Milk in the Home

Properly pasteurized milk in sealed containers is safe—that is, free from pathogenic organisms when it arrives in the home. If kept too long at atmospheric temperatures it will go sour or putrid. If souring occurs it will still be consumable, but if it putrefies it is not likely to be acceptable for human consumption.

The care of milk in the home, therefore, has two aspects: suitable storage to delay souring or putrefaction and to provide a reasonable period within which it can be consumed; and the prevention of contamination in the

home. Suitable storage is simple if domestic refrigerators are available. Except in North America, the great majority of homes are not equipped with refrigerators. The milk must, therefore, be kept in the coolest place and preferably in the dark. If this is not practicable, it should at least be sheltered from direct sunlight to avoid loss of riboflavin and ascorbic acid.

FIG. 6
EARTHENWARE COOLER



This covers milk bottle and stands in water on a plate. The water rises through the porous earthenware and evaporates from the external surface. This evaporation produces colder air conditions inside the container.

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Exposure to direct sunlight under tropical conditions is liable to induce "sunlight flavour" in as short a time as 30 minutes, and a very great loss of these two vitamins. Earthenware coolers (see Fig. 6) covering one or more bottles of milk, or small cabinets to hold up to four bottles, both depending on the cooling effect produced by the evaporation of water, are available where refrigeration is not. Where used they should be kept in a draughty place to increase the quantity of water evaporated and thus maximize the cooling effect. With such aids, properly pasteurized milk kept in its original container should keep for at least 24 hours at 18°C. In temperate zones a keeping quality of up to 2 days without mechanical refrigeration is frequently attained.

In very hot climates the practice of raising the milk to the boil on receipt or before use has much to commend it. This practice, however, has two disadvantages: (a) the milk is exposed to the risk of contamination after the heating process is over, and (b) if cooling is attempted in order to hold the milk for some hours after the boiling process, any contamination that may occur will have an opportunity to develop and might on occasions

prove serious. However, if there is any doubt as to the hygienic quality of milk, either raw or pasteurized, which has been distributed loose, the milk should be boiled immediately before consumption. To avoid contamination in the home it is always advisable to leave pasteurized or sterilized milk in the bottle until it is required. If the whole contents of the bottle are not required at once, it is better to replace the cap on the portion remaining in the bottle rather than to decant the whole into a jug or household vessel. Any household vessel into which milk is decanted should be washed and scalded with boiling water and allowed to drain and cool before the milk is poured into it. On no account should the jug be dried internally by the use of a dish cloth or tea towel. As soon as a bottle has been completely emptied of milk it should immediately be rinsed in clean water to remove all traces of milk solids. This is enough, as the milk bottle will be washed and sterilized on its return to the processing dairy. Most of the troubles with imperfectly washed bottles arise through failure of consumers to carry out this simple treatment before returning them to the dairyman.

Milk is so valuable and yet so perishable a foodstuff that consumers, even in countries in which a safe milk supply has long been established, require constant reminders and education on the sensible and safe keeping of milk in the home. The best results in such educational campaigns are obtained when the dairy, the distributor and the local health authorities all combine in regular concerted efforts.

Milk Legislation

In countries where milk is delivered in sealed containers the legislation and regulations made thereunder governing distribution need not be so elaborate as where milk is sold loose. It is desirable, however, that such legislation should provide for: (a) the registration of the distributors; (b) the registration and approval of the premises; (c) the approval of the types of vehicle used for transporting the milk, either from processing plant to distribution points, or for household delivery; and (d) the medical examination of staff employed in distribution.

Registration of distributors

The virtue of this is obvious in that it can be used to control or prevent the operation of an excessive number of distributors in any town or area.

Registration and approval of premises

This is important in that any premises should be provided with adequate cold storage and proper washing and toilet facilities for the staff. It is equally applicable where the premises are also used as a shop, and in such circumstances, if the state of development justifies it, it is possible to insist

on the installation of refrigerated display cabinets as a condition of registration.

Approval of types of vehicle used

In warm climates the type of vehicles employed must offer reasonable protection from the ambient temperatures and also from intense sunlight. Refrigerated vehicles for bulk distribution from processing to shops or distribution points are ideal, although their costs may be high. Under such circumstances, insulated vehicles are often adequate to overcome reasonably high ambient temperatures. For household distribution, refrigerated vehicles are generally completely uneconomic, but it is important that milk being distributed under conditions of intense sunlight should be shielded, otherwise the risk of an oxidized flavour is considerable.

Medical examination of staff

The medical examination of staff is particularly important where milk is sold loose. In such cases no person who suffers from any infectious or contagious disease should be employed. It is, in fact, undesirable for any person suffering from cuts, wounds, etc., to be employed in the handling of such a valuable foodstuff as milk, which is so important in the nutrition of infants and young children.

Where milk is sold loose, the risk of spreading disease through failure adequately to cleanse and sterilize all the utensils used is very great indeed. All premises, therefore, that are licensed for loose milk distribution must have adequate facilities for the washing and sterilizing of vessels and utensils used. For sterilizing, boiling water is usually adequate, although a steam chest in which the temperature of the utensils can be raised to 98°C is better. In the absence of either, the use of hypochlorite sterilizing agents can be satisfactory, but considerable skill is required to ensure their proper use.
