

# **POOL OF DOMESTIC REFRIGERATING EQUIPMENT**

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*(Ship Department)*

With increased emphasis in recent years on improving the domestic amenities for sea-going personnel, the Ship Department of the MOD have assembled a range of approved units which are available for fitting in existing ships by A and A action and in ships building as initial fit.

These units are accounted for and supported differently from other fitted equipments in that they are not catalogued and complete units, or spares, cannot therefore be obtained through the Naval Stores organization or from the SPDC. In general, they are commercial units which have been proven by trial or experience to be suitable for use in H.M. ships. The design is, therefore, liable to minor changes (without reference to the MOD) as the new year's models are introduced. In a limited number of cases where the manufacturers have been willing to co-operate, the designs have been modified to suit MOD requirements, particularly in respect of electrical power supplies.

A Pool of complete units, primarily intended as a replacement service, and 'first outfits' of onboard spares is financed and maintained by the Ship Department, and the equipment is stored in the various Admiralty Machinery Depots for convenience of accounting and issuing. A small number of selected units are held also at Singapore ANZUC Naval Base.

The existence of this Pool, together with instructions on the procedure for obtaining replacement units, has been promulgated in DCI 1128/70. Contrary to the instructions contained in the DCI, a number of demands are still being forwarded to the SPDC and to SNSO.s in the Home bases. This indicates either that the DCI is ambiguous or that information contained therein, referring to demands for replacement units, is not being recorded by personnel responsible for raising demands. This article again draws attention to the existence of this DCI, to the service provided by the Ship Department and describes in more detail the equipment concerned. Spare gear for these units is provided on initial issue; replacement items should be demanded from the Ship Department, not Devonport Dockyard, contrary to the instructions in DCI 1128/70 which will be amended at reissue.

The majority of these units are powered by hermetically-sealed commercial refrigeration units connected to sealed evaporator systems, expansion taking place in a capillary tube. Ship's staff should not attempt to carry out repairs to this type of refrigerant system as special facilities are required to dehydrate, purge and re-charge to the required standard: a complete spare cabinet should be ordered. Spares kits for these units contain only minor electrical and cabinet spares.

A small number of cabinets are fitted with hermetically-sealed motor/compressor units connected by flanged or screwed connections to permit replacement of sub-assemblies, re-charging of dryers, and fitting of a dehydration/charging connection. These systems are generally not suitable for onboard replacement

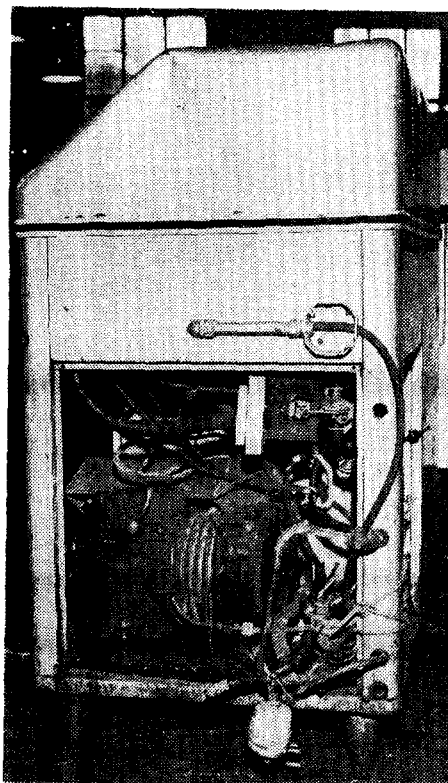


FIG. 1—CABINET AS RETURNED TO THE MANUFACTURER

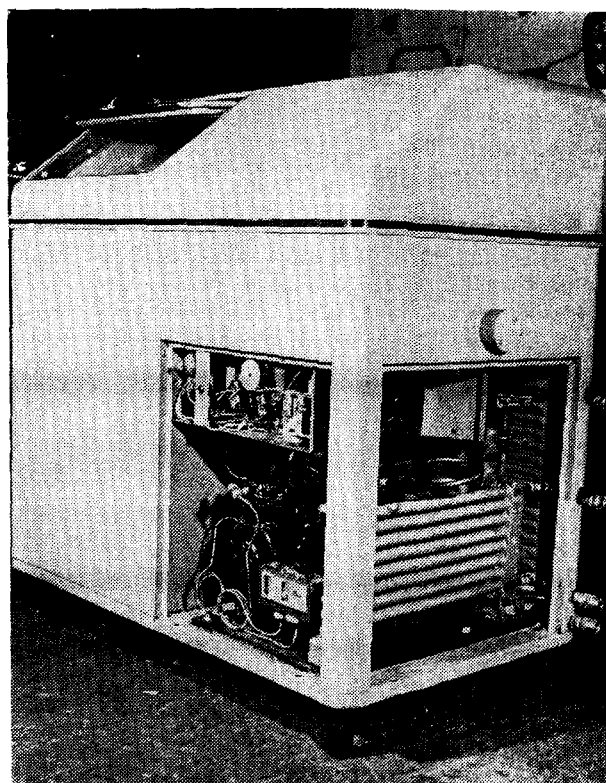


FIG. 2—THE CABINET SHOWN IN FIG. 1 AFTER REPAIR

of the motor/compressor as failure of this unit will distribute debris around the refrigerant circuit and meticulous flushing procedures, which can only be undertaken in suitable workshops ashore, are essential to restore the standard of system cleanliness required.

All d.c. and the larger a.c. cabinets are fitted with 'open-type' compressors driven by separate motors, expansion valves being fitted in lieu of capillary tubing. The onboard spare gear outfits for these cabinets contain compressor and circuit component spares (as well as the electrical spares) to permit repair by ship's staff of the complete refrigeration system including the compressor.

A repair organization has been set up through which defective units are returned to the manufacturer for restoration to 'As New' condition; the decision as to whether to repair or to 'dispose to the best advantage of the Crown' is taken individually depending upon the age, defect condition, and initial cost of the item. Removal from the ship and packaging for transport should be undertaken with the greatest care bearing in mind that any damage caused during this process will add substantially to the repair costs. An example, by no means an isolated case, of how not to return a cabinet is illustrated in FIG. 1. FIG. 2 illustrates the restored condition.

In the equipment descriptions which follow, the approximate current purchase price has been included to indicate the value involved; this, when multiplied by several hundred units issued each year, summates to a considerable amount of the taxpayer's money. Unnecessary and extensive damage which can result from inexperienced fault diagnosis and packing can necessitate writing off a cabinet which would otherwise have been suitable for repair. Domestic automatic refrigerators in general fleet usage have been patternized and are not therefore included in the Pool: details of these DARs have been promulgated in DCI T592/72.

The issue of domestic refrigeration units for first fitting in other than new construction vessels can only be made against an approved A and A initiated on a Class basis by the appropriate Warship Design Section of the Ship Department. This does not preclude individual ships raising A and A proposals through their administrative authorities if it is considered that substantial advantage would accrue from the fitting of such domestic 'goodies'.

### **Ice Cube Machines**

In the past, the bulk demand for ice has been met by slabs frozen in the ice tank of the main refrigeration plant supplemented by ice cubes from DARs for bar use and for individual drinks. The task of breaking up the ice slabs into a convenient size and the humping of heavy ice pails was accepted as a necessary inconvenience, as were the occasional wisps of sacking in the lime juice and contamination of the wardroom gin with brine.

At one time, it was considered necessary to provide a base load for the refrigeration plant to avoid rapid cycling when the required room temperatures had been achieved. This base load was provided by the ice tank. With the introduction of hot gas bypass techniques, continuous running plant became possible and it was no longer necessary to fit an ice tank.

Attention was directed towards identifying a suitable self-contained ice cube machine with storage facilities and preferably air cooled to avoid the hazards of sea-water cooling systems. During 1970-1, a number of different designs were purchased and despatched to sea for trial but it became apparent that the commercially designed air-cooled units were unsuitable for the high ambient and fresh water temperatures at sea. FIG. 3 illustrates the effect of ambient conditions on output from similar cabinets when water cooled and when air cooled. The water-cooled type of machine maintains its output better over a wide range of ambient temperatures and may be preferred in certain cases to an air-cooled unit.

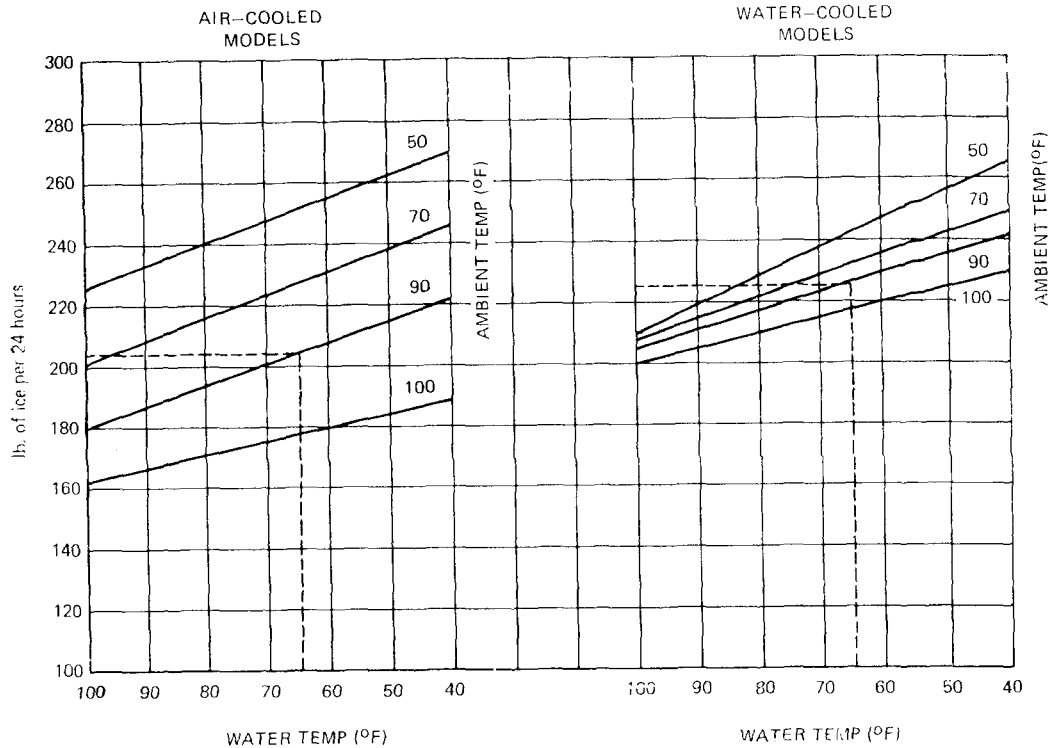


FIG. 3—ICE-MAKING CAPACITY—COMPARISON OF AIR COOLING AND WATER COOLING

The Scotsman 205 WJ machine, although water-cooled, was eventually selected as the standard unit on the grounds of reliability, satisfactory output at high ambient temperatures, and capacity to supply the daily requirements of large frigates and destroyers from a single machine. For smaller frigates where space is at a premium and the complement less, the Iceform Model K1 air-cooled machine was adopted in the absence of a competitive water-cooled unit and was modified to improve the output at high ambient temperatures.

With the introduction of senior rating's refreshment bars, a need arose for a small bar-type unit. The MK Refrigeration Ltd. model was selected as a result of a competitive tendering exercise to a MOD specification.

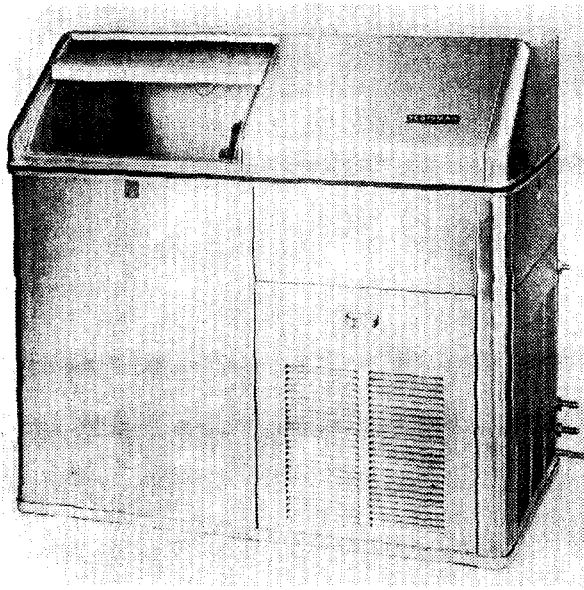


FIG. 4—SCOTMAN SUPER CUBER SM-205 WJ-SS

*Scotsman Super Cuber  
SM-205 WJ-SS (FIG. 4)*

This is a water-cooled unit with an output of approximately 220 lb. per 24 hours and has a storage facility of 150 lb. of compact ice cubes. It requires a 16-amp, 115-volt, single-phase, 60-cycle electrical supply and external services of sea-water supply and return and fresh water supply of not less than 20 p.s.i., and a drain.

The unit which is manufactured by King-Seeley Thermos Co. of Albert Lea, Minnesota, is shipped to Ernest West & Beynon Ltd. who fit a modified marine-type water-cooled condenser and sea-

water regulating valve, cupro-nickel piping and refrigerant circuit pressure gauges and charging facilities. The cost of the completed machine to the MOD is between £700 and £800.

Units currently in service, designated as SM-210 WJ-SS, were fitted with an open type of compressor, the type number being changed to 205 WJ with the introduction of a hermetically-sealed Copelaweld Refrigerant-12 compressor/motor. The cabinet which is free-standing on adjustable legs, weighs 385 lb. and has the following dimensions:

Height (with 6-in. legs)	45 $\frac{1}{4}$ in.
Width	44 $\frac{1}{4}$ in.
Depth	24 $\frac{1}{2}$ in.

Ice is formed by spraying water vertically upwards from a rotating spray-bar into 102 inverted refrigerated cups mounted in a rubber platen, thus building up a layer of ice in the cups and eventually a solid cube. Excess water from the cube cups gravitates back into a reservoir and is recirculated through the spray bar. The freezing cycle is thermostatically controlled for approximately 20 to 25 minutes until the cubes are 75 per cent formed at which point a timer motor is started. Freezing continues for a further nine minutes at which time the freezing cycle is terminated and the harvest cycle initiated. Harvesting is achieved by flooding for a period of three minutes the rubber platen, in which the freezing cups are embedded, with warm water heated by the hot compressor discharge line. At the end of this period harvesting is complete; the released ice cubes which fall under gravity into the now empty reservoir are mechanically swept into the storage bin by the rotating spray-bar, and the refrigeration cycle is restarted. This unit is now the standard ice-cube machine for frigates, destroyers and larger vessels where it can be accommodated. As and As have been raised to fit these units in all such vessels not so fitted and deliveries are expected to commence early in 1973 and complete in the autumn of 1973.

#### *Iceform Model K1 (FIG. 5)*

This is an air-cooled unit with an output of 110 to 120 lb. per 24 hours and a storage capacity of 45 lb. of ice cubes. It requires a 13-amp, 115-volt, single-phase, 60-cycle electrical supply and a supply of fresh water and a drain.

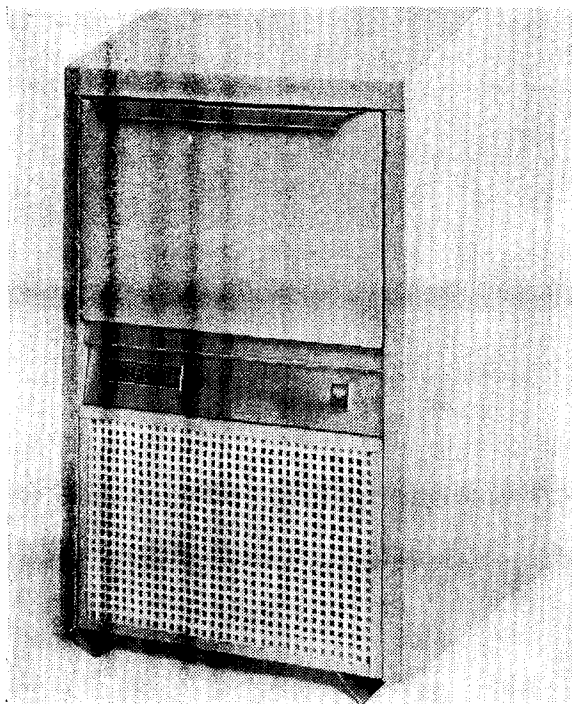


FIG. 5—ICEFORM LTD. MODEL K1

It is manufactured by Iceform Ltd. and modified by West and Beynon Ltd. to operate from a separate but associated transformer which converts the 115V a.c. ship's supply to 230V for which the cabinet was originally designed to suit the commercial market. The cost to the MOD for the modified cabinet is more than £600. During hot-box trials at the works of West and Beynon Ltd., it was observed that, as manufactured, the output decreased substantially at higher ambient temperatures necessitating the replacement of the  $\frac{1}{3}$  h.p. hermetically sealed compressor motor unit with one of  $\frac{1}{2}$  h.p.

The cabinet is free-standing on non-adjustable feet and is fitted

with bulkhead fixing brackets at the rear. The space required to install it is:

Height (including feet)	31½ in.
Width	18¼ in.
Depth (including brackets)	23¼ in.

and the cabinet weighs 105 lb.

The ice is formed in batches in a coaxial tubular coil, water circulating through the inner tube and Refrigerant 12 through the annulus. As ice builds up on the surface of the inner tube, the flow of water is progressively restricted until, at a predetermined flow, the refrigerant circuit is switched to pass hot refrigerant gas through the annulus thus releasing the ice in the tubular coil. The pressure of water passing through the ice tube is sufficient to expel the ice towards a deflector which snaps the ice into convenient lengths and deposits them into the storage bin. When the bin is full, a thermostat terminates the freezing and harvesting cycles, which are restarted automatically as the bin is depleted. The freezing cycle should extend over a period of seven to eight minutes producing some 13 ounces of ice. At present, these units are nominated for installation in the Type 21 frigates only.

#### *Bar-Type Ice Cube Machine Mk 9T (FIG. 6)*

This is an air-cooled unit with a capacity of 180 ice cubes every two hours. The unit operates on a 115-volt, single-phase, 60-cycle supply, no other services being required.

Manufactured by MK Refrigeration Limited, these machines cost over £60. The cabinet is suitable for mounting on a bar counter or on shelves behind or below the bar. The dimensions of the cabinet which weighs 70 lb. are:

Height	10 in.
Width	25½ in.
Depth	13¾ in.

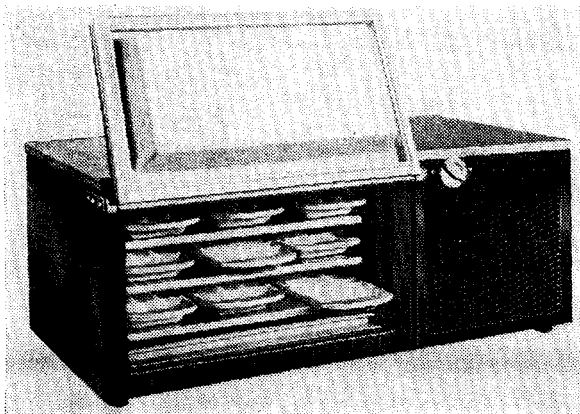


FIG. 6—MK REFRIGERATION LTD. BAR-TYPE ICE-CUBE MACHINE

In addition, an air space of at least two inches must be maintained at the rear of the unit to permit the required air flow both over the condenser and hermetically-sealed compressor/motor unit.

Ice is manufactured in nine ice cube trays (as used in domestic refrigerators) enclosed in a refrigerated compartment sealed by a top-hinged insulated door. Tray filling and harvesting is carried out manually.

#### **Dehumidifiers**

A small number of space dehumidifiers which operate on the principle of cooling the air to below the dew-point by means of a domestic refrigeration unit, resulting in condensation on the evaporator coil, are maintained in the Pool. The use of these units is limited to special areas such as bedding stores where these are not air-conditioned and for dehumidification of small vessels or small compartments of larger vessels in 'Reserve'. Where massive dehumidification is required, regenerative-type units of greater capacity are provided, but these latter units are not held in the Pool.

Two units both operating on 115-volt, single-phase, 60-cycle supply have been standardized and are currently available.

*Temperature Ltd. Temkon Dehumidifier Model DH2*

This is a 15½-in. wide × 30½-in. high × 16-in. deep free-standing cabinet (weighing 120 lb.) mounted on castors with a water removal capacity of one to five pints per hour depending upon ambient temperature and humidity.

*Westair Dynamics Ltd. Dehumidifier—Space No. Mk II/1*

This is a 12¾-in. wide × 11-in. high × 17-in. deep shelf-mounted cabinet weighing 65 lb. with a minimum water removal duty of 0.45 lb./hour.

At the request of DGST, this unit is being replaced by a Westair Dynamics Ltd. Type D50 KM of similar dimensions but with an improved minimum performance of 0.65 lb./hr for an 'all up' weight of 50 lb. The new unit will be patternized and available as a Naval Stores item.

### **Beer and Soft-drink Cooling Machines**

In 1967, when the privilege of purchasing beer on repayment through the NAAFI was extended to junior ratings, commanding officers were invited to submit forms S1182 containing proposals for beer-cooling stores (or cooling cupboards). Up to that time these units had been purchased by NAAFI, the units being of 20 to 150-cu. ft. capacity manufactured by the Lightfoot Refrigeration Co. Ltd. These units were subsequently purchased by the MOD, who accepted responsibility for meeting future requirements. Because of their reliability, it was decided to standardize on the Lightfoot 20-cu. ft. capacity cabinet.

In 1970, when the daily rum issue was abolished and, by way of compensation, the beer allowance to junior ratings was increased, in order to meet the need for greater storage capacity approval was given to issue Lightfoot cabinets to ships not already so fitted. It was discovered, however, that the 20-cu. ft. cabinet being too large to pass through the standard door frame required considerable dismantling before it could be embarked in the majority of frigates. In October 1970, a new specification was prepared and issued for competitive tender to a number of firms who were known to manufacture this type of equipment. The resulting product was the 14-cu. ft. West and Beynon Cool Drinks Refrigerator, Verikold Type BC-20.

In 1971 on introduction of senior ratings refreshment bars, a requirement arose for a can-cooling shelf. In the interests of standardization it was decided to specify a single-shelf design powered by a self-contained refrigeration unit, multiples of this unit to be fitted according to the ship's complement. Again, competitive tendering was applied and resulted in the adoption of the MK Refrigeration model. Although the carriage of beer in kegs is approved by the MOD and stowages are included in the official bar designs, the provision of any associated cooling machinery is the responsibility of individual ships and is not included in the Pool.

*Lightfoot 20-cu. ft. Beer Cooling Cabinet (FIG. 7)*

This unit, manufactured by The Lightfoot Refrigeration Co. Ltd., is basically a large size single-door domestic refrigerator with the machinery compartment below the refrigerated storage compartment and has a duty of cooling 48 dozen 12-oz. cans of beer to a temperature of 52°F. The cabinet, which weighs 942 lb. and is secured to the deck by four built-in securing lugs, has the following dimensions:

Height	74 $\frac{3}{4}$ in.
Width	42 $\frac{3}{8}$ in.
Depth	30 $\frac{3}{8}$ in.

The cost is between £500 and £600.

The R12 air-cooled refrigerating unit is of the open type belt-driven by a separate 115-volt, single-phase, 60-cycle motor suitable for *in situ* repair of minor defects.

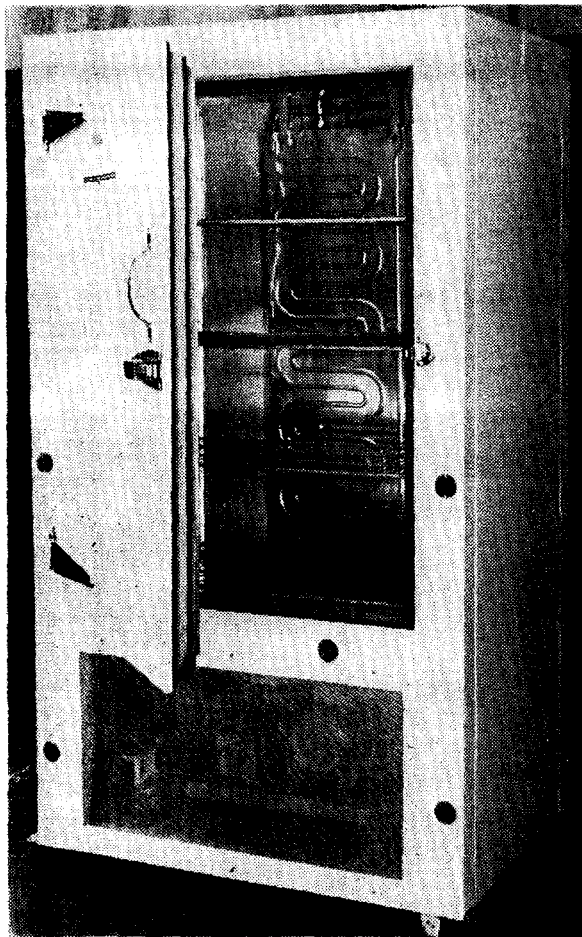


FIG. 7—LIGHTFOOT REFRIGERATION LTD.  
BEER-COOLING CABINET

A number of small Lightfoot cabinets originally supplied by the NAAFI were fitted in the early *Leander* Class; although described as of 20 cu. ft. capacity, they are in fact of nominal 10 cu. ft. capacity. As the West and Beynon units describe below provide a more economical use of the available space, the smaller Lightfoot cabinets will no longer be supplied from MOD resources.

As the average domestic automatic refrigerator will cool its contents to 40 to 42°F, beer should not be stored in DARs for extended periods; drinks cooled to this temperature can result in stomach chills, 50 to 55°F being considered the most suitable temperature.

*West and Beynon Verikold Type  
BC-20 (FIG. 8)*

This unit was specifically designed to meet naval requirements. The capacity is such as to provide cooling capacity for one day's issue of beer to the ship's company of a *Leander* Class frigate, and the overall dimensions were limited to enable the cabinet to be shipped through a standard watertight door. The refrigeration machinery

is housed in a removable housing which forms the top of the cabinet and includes two fans for circulating air through the cabinet. The air inlet and outlet grills are formed in this casing and are tilted at 45 degrees to the horizontal to avoid blockage by unauthorized stowage of items on top of the cabinet. This also enables the cabinet to be installed close to the bulkhead. Complete replacement machinery units will be available as spare items eliminating the need to remove the complete cabinet in the event of a cooling unit failure with possible consequential damage to the casing

To eliminate the need to provide an external condensate drain, an internal transparent tube is fitted which simply requires unclipping and draining when full.

The hermetically-sealed air-cooled refrigeration system is designed to cool 40 dozen 12-oz. cans from 70° to 52°F in six hours in an ambient temperature





FIG. 8—WEST AND BEYNON LTD. VERICOLD  
TYPE BC-20 BEER-COOLING CABINET



FIG. 9—MK REFRIGERATION LTD.  
MK/6 BOTTLE-COOLING SHELF

Various NAAFI canteens were already in business, providing and servicing their own machinery and selling their product to the general mess when the opportunity arose. 'Hand-held' ices were also available from the same source.

After surveying the field, the MOD decided to place a number of Guisti freezers and Lec hardening-cabinets in seagoing ships for trial; other rival contenders, privately entered by individual ships, were eventually eliminated on the grounds of size, capacity, ease of operation, and hygiene. In 1965, the 2-gallon horizontal Guisti Model 216A freezer, the 4-cu. ft. Lec Model F120, and the 14-cu. ft. Frigidaire LCR 145 hardening-cabinets emerged as standard

of 90°F, the cooling process being automatically terminated at the lower temperature. The cabinet which is free standing has four brackets for securing it to the bulkhead. The unit weighs 370 lb. and has the following dimensions:

Height	72 in.
Width	33 in.
Depth	24½ in.

The electrical power required is 35 amps of 115-volt, single-phase, 60-cycle current. The cost of the unit is in the region of £300.

#### *MK/6 Bottle-cooling shelf (FIG. 9)*

Provision is approved for fitting one cooling shelf for every thirty customers served by a refreshment bar. The unit which is manufactured by MK Refrigeration Ltd. consists of a single cooled tray with a hermetically-sealed air-cooled refrigeration unit mounted alongside.

The tray has a capacity of 6 dozen 12-oz. cans and the overall dimensions including the refrigeration unit are:

Height	8 in. (Over refrigeration unit)
Width	42 in.
Depth	17½ in.

The unit requires a power supply of 5 amps of 115-volt, single-phase, 60-cycle current. The cost is approximately £50.

#### **Ice-cream Machines**

The MOD responsibility for provision of ice-cream machinery dates back to 1964 when it was decided to supplement the general mess menu with this concoction.

equipment. In the event, the 14 cubic foot model was not fitted to any extent and was not included in the Pool.

Although it is MOD policy to provide hard ice-cream, submariners appear to prefer soft ice-cream of the 'Mr. Whippy' variety which, as the name implies, is similar to whipped cream and is mixed by a continuous process in freezers, manufactured by the Swiss firm of Cuper, which provide ice-cream literally on tap. Space was also a major consideration in the selection of this machinery for submarine use as no conservator is required. These Cuper units are not supported from the Pool.

In mid 1970, DG Ships was informed that the taste of ships' companies in NAAFI ice-cream had developed to 'choc-bars' and similar proprietary packages to the exclusion of cones and wafers; it was proposed that the MOD should supply sufficient conservators to enable NAAFI to stock up with such delicacies at each port of call. To meet the increased stowage requirements, the Lec F700 with a capacity of 24.2 cu. ft. was selected for addition to the standard range.

The problem of ships with d.c. systems remained unsolved as no such unit was available commercially.

However, before this policy could be implemented, NAAFI reported that the sale of ice-cream had dropped substantially and proposed terminating the sale of this commodity, a proposal which was resisted by DFSD. At the time of drafting this article, NAAFI are reconsidering their proposal with a view to maintaining small stocks of proprietary ice-creams provided that the conservators are supplied and maintained by MOD resources.

The provision of machinery to manufacture ice-cream for general mess requirements remains unaffected by these discussions.

*Guisti 2-gallon Creematic Ice-cream Freezer Model 216A (FIG. 10)*

This is a sea-water-cooled unit with a capacity of 2 gallons of ice-cream, each batch being frozen to a temperature of not less than 21°F for approximately 10 minutes. It requires external services of 440-volt, 3-phase, 60-cycle or 220-volt d.c. electrical supply and a sea-water supply of 4 gallons per minute at a maximum pressure of 40 p.s.i.

The unit, which is manufactured by T. Guisti and Son Ltd., incor-

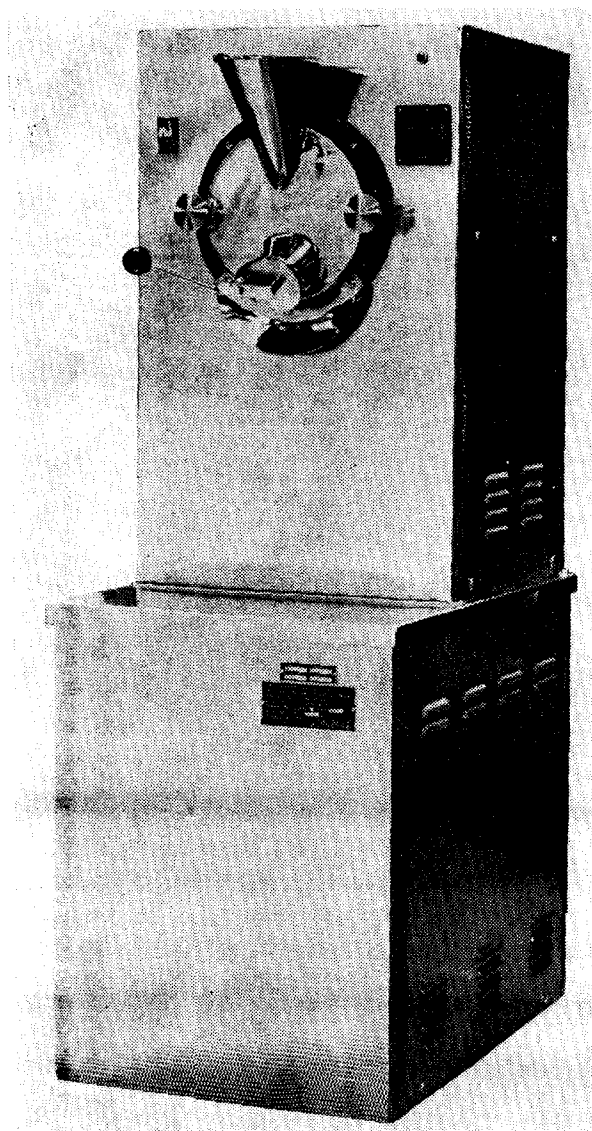


FIG. 10—GUISTI LTD. CREEMATIC ICE-CREAM COOLER MODEL 216A

porates a Lightfoot freezing unit and costs approximately £1500 for the a.c. model and £2200 for the d.c. model, thus illustrating the financial penalty of d.c. machinery.

The cabinet which is deck-mounted on non-adjustable feet weighs  $3\frac{1}{2}$  cwt. and is of the following dimensions:

	a.c. model	d.c. model
Height	$57\frac{1}{2}$ in.	$57\frac{1}{2}$ in.
Width	$19\frac{1}{4}$ in.	$21\frac{3}{4}$ in.
Depth	$28\frac{1}{4}$ in.	$34\frac{1}{4}$ in.

The ice-cream mix is charged through a filling funnel into the horizontal refrigerated drum where it is mixed by the belt-driven rotary beater for a period of approximately ten minutes under thermostatic control after which it is run off through the outlet gate into sterilized stainless-steel containers ready for hardening.

The refrigeration unit is powered by an open-type compressor and can if necessary be overhauled and repaired by local resources. A kit of spares is supplied for this purpose with each unit.

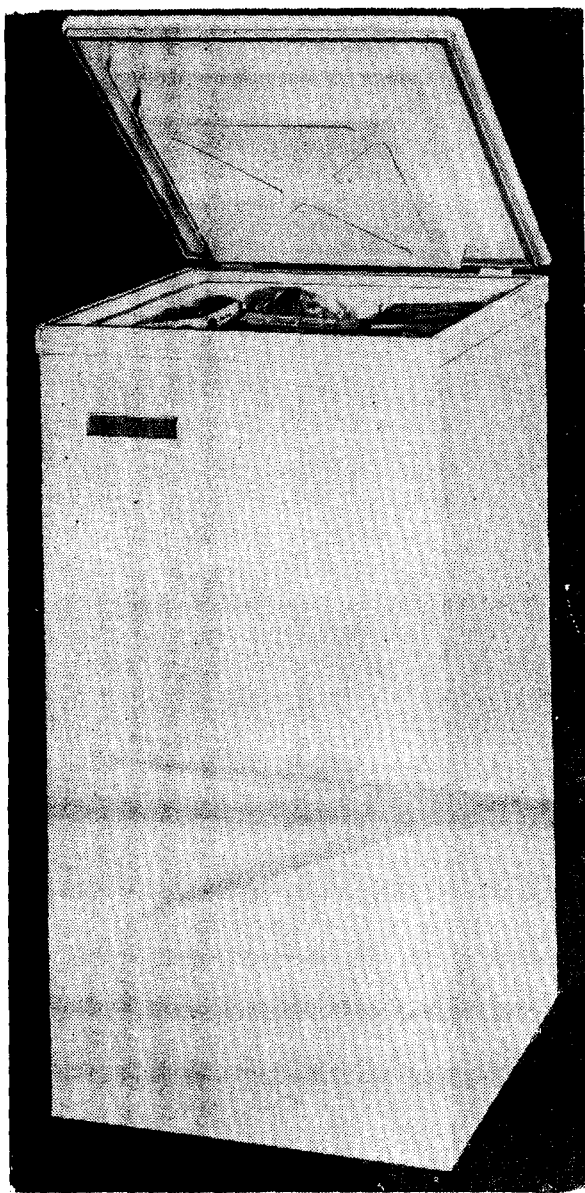


FIG. 11—LEC REFRIGERATION LTD.  
F120 CONSERVATOR

#### *Lec F120 Conservator (FIG. 11)*

Manufactured by Lec Refrigeration Ltd., the model has been updated to F128 with the introduction of the 1972 model. Both units are manufactured to the same specification but the latter is fitted with a small mains warning-light in the front of the cabinet and the interior tank is made of aluminium instead of galvanized sheet as previously.

It is an air-cooled unit of 3.75 cu. ft net capacity with a duty to harden at a temperature of  $0^{\circ}\text{F}$  the soft ice-cream produced by the Guisti machine. It requires a 115-volt, single-phase, 60-cycle electrical supply and costs approximately £60.

The unit is free-standing on non-adjustable frame, weighs 112 lb., and has the following dimensions:

Height	$39\frac{1}{4}$ in.
Width	$21\frac{1}{2}$ in.
Depth	$22\frac{1}{2}$ in.

On installation, a minimum of four inches must be allowed between the rear of the cabinet and the bulkhead to permit reasonable circulation of air over the hermetically-sealed motor/compressor unit and the refrigeration system.

*Lec F700 Conservator*

This unit was adopted into the standard range but was not provisioned to meet the NAAFI requirements for bulk stowage for proprietary ice-cream now under reconsideration. Since selection, the type designation for the 1972 model has been amended to F708 and subsequently Lec Refrigeration Ltd. have stated that they intend to discontinue this model in their 1973 manufacturing programme. If a unit of similar size is found to be necessary in the future, the most suitable unit will be the F673 with a net capacity of 23.7 cubic feet.

*Conservators for d.c. Electrical Supply*

Since few ships with only d.c. electrical systems now remain in the Fleet, it is not an economical proposition to maintain stocks of d.c. machines in the Pool. These units are not generally available commercially and requirements have to be met by special designs or by the provision of separate d.c. refrigeration units coupled to standard commercial cabinets accepting the size and cost penalties involved.

As examples of the magnitude of these penalties, West and Beynon Ltd. supply a special 3.5-cu. ft. d.c. cabinet at a cost of over £300 which occupies a space six feet high by two feet wide by two feet deep compared with a cost in the £50 to £100 region for the Lec F128. Hall Thermotank International supply a 16-cubic foot storage cabinet about  $3\frac{1}{4}$  feet high by 5 feet wide by  $2\frac{1}{2}$  feet deep which requires a separate air-cooled condensing unit about  $1\frac{7}{8}$  feet high by  $2\frac{3}{4}$  feet wide by 2 feet deep suitable for d.c. supply at a cost of between £600 and £700. The equivalent a.c. cabinet is the Lec F673 of 23.7 cubic feet capacity in the £150-£200 region which occupies a total space of about  $3\frac{1}{8}$  feet high by  $5\frac{1}{2}$  feet wide by  $2\frac{1}{2}$  feet deep.

**Self-contained Air-conditioning Units**

During 1962, the policy for air-conditioning H.M. ships was reviewed with the purpose of achieving as a first priority reasonable ambient conditions in operational spaces from an equipment serviceability aspect and as a second priority reasonable conditions of habitability in certain other compartments. Messdecks and other accommodation spaces, although at this time excluded from the list of nominated compartments, were added at a later date.

In new designs of ships, the policy was implemented by the provision of centralized air-conditioning plants but in existing ships it was decided to provide a variety of self-contained water-cooled air-conditioning units installed in the individual compartments to be conditioned. The space requirement for this additional equipment was accepted as a necessary penalty of improving conditions onboard. The original units selected for these duties imposed in service an unacceptable maintenance load on ships' staff due to chokage of refrigeration systems and failure of motor/compressor units. The range was replaced by commercial units marketed by Thermotank Ltd. which were almost identical to the current range manufactured by Temperature Ltd. Being a commercial range, the units were only available with a.c. motors and it was necessary to introduce a West and Beynon design to meet the needs of d.c. ships.

*Temperature Ltd. Type APW 100/24 (FIG. 12)*

This is a water-cooler self-contained hermetically-sealed Refrigerant-22 unit with a nominal duty of 20 600 B.T.U. per hour when the circulating-water inlet temperature is 75°F. At a sea-water temperature of 95°F the duty is reduced to 18 200 B.T.U. per hour. The design air-flow is 520 c.f.m. with air 'on' conditions of 80°F dry bulb and 67°F wet bulb. The cost of the unit is in the region of £350.

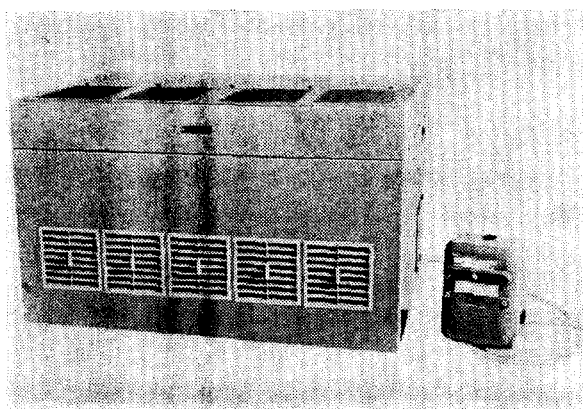


FIG. 12—TEMPERATURE LTD. TYPE APW 100/24  
24,000 B.T.U./HR AIR-CONDITIONING UNIT

A 15-amp electrical supply of 440-volt, three-phase, 60-cycle current is required together with a cooling-water supply and return of two gallons per minute and a  $\frac{3}{4}$ -in. gravity drain.

Air enters through the top of the cabinet, passes through the filter pads and is discharged through the directional discharge grills in the front. These filters must be cleaned at regular intervals if maximum cooling effect is to be maintained, and sufficient space (not less than six inches)

must be left above the units during installation to avoid restriction of the air flow.

A constaflo restrictor of the correct capacity is supplied with each unit to prevent excessive water-speeds and rapid erosion of the condenser pipes and fittings. A strainer and shut-off valves should be fitted in the circulating-water system to the unit.

The cabinet which is intended for bulkhead mounting occupies a space  $21\frac{1}{2}$  in. high by 30 in. wide by  $24\frac{1}{2}$  in. deep.

*Temperature Ltd. APW 100/12 | 9 | 7*

The details of these three units which are all similar in appearance and application are tabulated below for ease of reference. They are all water-cooled hermetically-sealed Refrigerant-22 systems fitted with air-filter screens at the back of the cabinet. As the ventilation air enters at the rear, it is essential to leave a minimum space of 4 in. between the back of the cabinet and the bulkhead, to ensure which special mounting brackets are provided. It is also necessary to provide a clearance of 14 in. at the side of the unit to permit filter withdrawal for periodical cleaning. Constaflo units of one gallon per minute are supplied with each unit and must be installed in the cooling-water supply line in conjunction with a strainer and shut-off valves.

External services required are similar to those for the APW100/24 but with reduced cooling-water requirements and a  $\frac{1}{2}$ -in. gravity drain connection. The APW100/12 and 9 models require a 10-amp electrical supply of 440-volt, three-phase, 60-cycle current; the APW100/7S model requires a 25-amp supply of 115-volt, single-phase, 60-cycle current; and the APW100/7A model requires a 25-amp supply of 230-volt, single-phase, 50-cycle current.

TABLE I—*Temperature Ltd. Air-conditioning units*

Model	Nominal Duty B.T.U./hr.		Air-flow c.f.m.	Height in.	Width in.	Depth to Bulkhead in.
	Sea-water Temp.					
	75°F	95°F				
APW 100/12	12,600	10,800	380	14	28	14
APW 100/9	10,500	9,500	340	14	28	14
APW 100/7	8,500	7,125	180	$13\frac{1}{2}$	27	$10\frac{1}{4}$

Depending upon their duty, these units cost between £150 and £200.

*West and Beynon 1¼-ton d.c. Unit (FIG. 13)*

At the time of promulgation of the revised policy on the air-conditioning of selected compartments, a considerable number of ships with d.c. electrical systems were still operational; even now there is still a substantial demand for d.c. equipment from minesweepers, minehunters, tugs, and boom defence vessels. The West and Beynon unit was selected to meet this demand.

The unit is available in two configurations to suit compartment geometry. It is a water-cooled open-cycle unit providing a duty of 15,000 B.T.U. per hour for air 'on' at 85°F dry bulb and air 'off' at 63°F dry bulb and 60°F wet bulb and costs approximately £600. The external services required are 46 amps of 220-Volt d.c. supply and 4 to 5 gallons per minute of cooling water at a minimum pressure

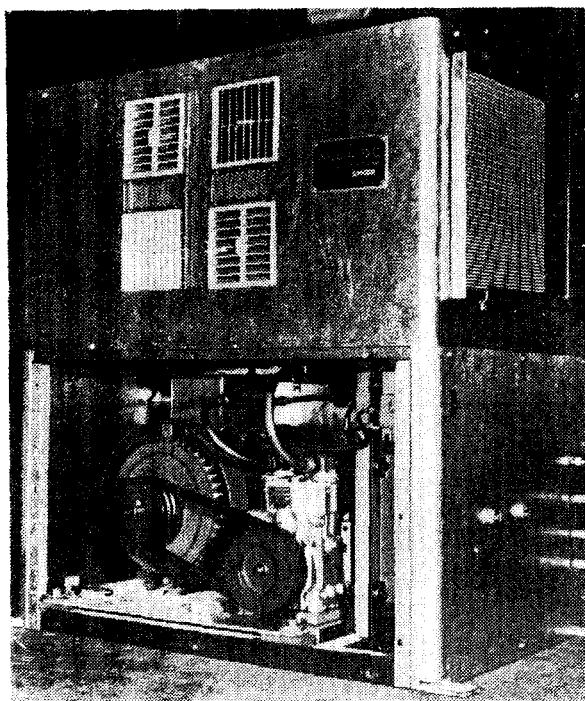


FIG. 13—WEST AND BEYNON LTD. STANDAZD W.B.U. 1¼ TON D.C. AIR-CONDITIONING UNIT

of 15 p.s.i. A constaflo unit, provided to limit the circulating-water flow, must be fitted in conjunction with a strainer and shut-off valves. A ¾-in. condensate gravity drain is also required.

The dimensions of the WB unit, which is intended for bulk-head mounting, are 24 in. high by 49½ in. wide by 24¼ in. deep (all dimensions are over the support frame) and the weight is 532 lb.

A clear 12-in. space must be left at each side of the unit to permit filter withdrawal, removal of the maintenance access panel, and to avoid restrictions to the air flow.

The WBU unit is intended for deck-mounting where bulkhead-mounting is undesirable. It is 37 in. high by 37 in. wide by 22 in. deep and weighs 400 lb. Again, a 12-in. clear space must be left on each side to permit removal of the air-filter panels.

### Drinking-water Coolers

Water for drinking purposes can be cooled by two different processes. The first is by the provision of a copper or aluminium cylinder containing a twin cast-in coil, one circulating chilled water from the ships chilled-water main which maintains the block at 45°F, and the other circulating water from the fresh-water main. This system, although containing no moving parts and therefore maintenance free, is only suitable in vessels such as nuclear submarines where chilled water is constantly available. The unit is not included in the Pool. The second method is to cool a drinking-water storage cylinder by an immersed coil connected to a small self-contained refrigeration unit, the whole mounted in a single cabinet. These units, although independent of other ships' services, do suffer from the disadvantage that, if a large quantity of water is drawn off in a short period, the machine requires a rest period to re-cool the storage tank to working temperature. This type of unit has been used with slight variations exclusively in H.M. ships for a number of years and is the approved equipment for the Pool in both a.c. and d.c. versions. A small number of alternative types of drinking water coolers (e.g. the 2-gallon per hour Aquonly Avon model in the

Naval Training Boats) have been fitted in ships built under design and build contracts, where the Ship Department has little or no control over the domestic equipment fitted. Every effort is made, however, to replace these with standard units, space permitting, when a replacement is required in service.

A design investigation is currently in hand for the manufacture of a water cooler which combines both the above principles with considerable reduction in size and, it is hoped, cost. A twin-coil aluminium-alloy block is cooled by refrigerant from a self-contained condensing unit, the latter being designed to maintain the correct water temperature at the maximum draw-off rate permitted by the bubbler valve. Although primarily intended for the MCMV, having been designed to a tight non-magnetic specification, its use could be extended with advantage to other vessels.

#### *Temperature Ltd. Model ACW 5000*

This is an air-cooled thermostatically-controlled unit with an output of 8 gallons per hour when cooling fresh water from 90°F to 60°F in an ambient temperature of 100°F. The insulated storage-tank has a capacity of 15 gallons. The Sterne hermetically-sealed refrigeration unit and fan motor are designed for 250-volt, single-phase, 60-cycle supply. An auto transformer is installed in the cabinet to enable it to operate on a 10-amp, 440-volt, single-phase, 60-cycle input via an auto switch, i.e. the cabinet can be connected across any two phases of the three-phase supply.

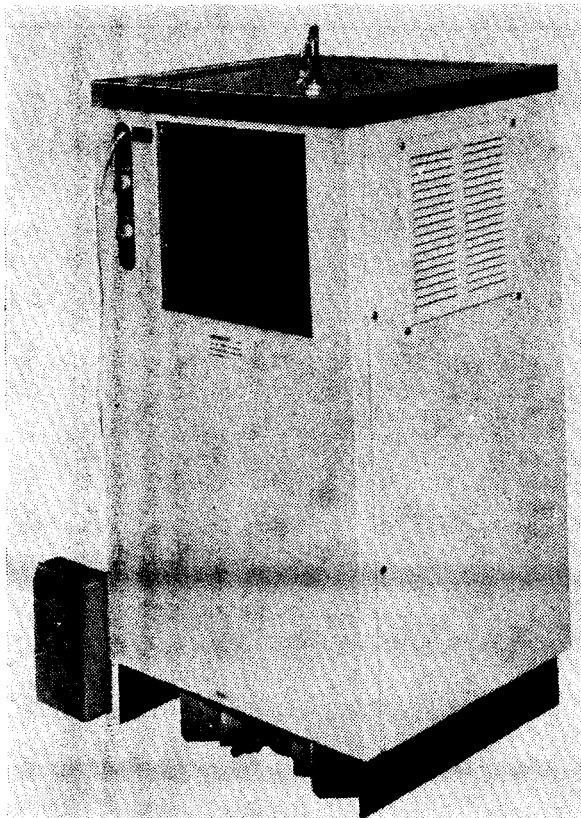


FIG. 14—TEMPERATURE LTD.  
DRINKING-WATER COOLER

The ACW 5000 model replaces the ACW 800 model which was fitted with a 440-volt three-phase, 60-cycle hermetically-sealed refrigeration unit and fan, modification being necessitated by the increasing difficulty of obtaining commercial hermetically-sealed units for the higher voltage. In all other respects the two units are interchangeable.

The cabinet is deck-mounted and, when siting, it is essential to leave a four-inch air space at the rear and both sides to ensure a free flow of air through the cooling unit. Draw off is through a 'bubbler' but a goose-neck jug-filler, supplied loose with each cabinet, can be fitted when a large quantity of cooled water is required to be drawn off at one time, e.g. in photographic rooms, or bakeries.

The cabinet which is 40 in. high by 21 in. wide by 20 in. deep weighs 270 lb. dry and costs about £350.

After complaints of choking of the sink drain, a small press-in type strainer has been introduced. This strainer will be fitted to new

coolers on assembly and will be supplied separately for ships' staff to fit to coolers currently in AMDs or issued to the Fleet recently.

*West and Beynon Verikold Type DAR/49*

This is an air-cooled thermostatically-controlled water cooler with an output of four gallons per hour when cooling fresh water to a temperature of 58°F. The principle of operation is similar to the Temperature ACW 5000 unit in that the direct expansion refrigerant coil is immersed in a storage tank and cools the water therein. The refrigeration unit is operated by a separate d.c. Admiralty standard Type 100A  $\frac{1}{2}$ -h.p. motor and open-type compressor connected to a 220-volt d.c. supply via a starter box.

The cabinet which weighs 450 lb. is 47 in. high by 18 in. wide by 18 in. deep and must be secured to the deck on a site which provides a clear 4-in. space at both sides and rear for circulation of the cooling air.

**Refrigerated Shelves and Counters**

Some difficulty is experienced by ships' staff in defining and identifying shelves and counters so causing confusion when replacements are demanded.

Refrigerated shelves come in two sizes, 3 ft. 3 in. and 4 ft. long and are sometimes referred to, probably more aptly, as 'counter tops', i.e. they are not free-standing but require bulkhead-mounted supporting brackets at each end. In some cases these units have been inserted into the top of 'built-in' furniture and the original cupboard doors retained; this results in overheating and failure of the hermetically-sealed motor/compressor by short-circuiting of the cooling air within the cupboard. When siting these units it should be borne in mind that for efficient and reliable operation they require a supply of 320 cu. ft. of free air per minute. Counters, of which only one design is currently fitted, are free-standing units combining separate refrigerated display and storage cabinets and working surfaces. Both are intended for the display and issue of cold foods in messes and dining-halls.

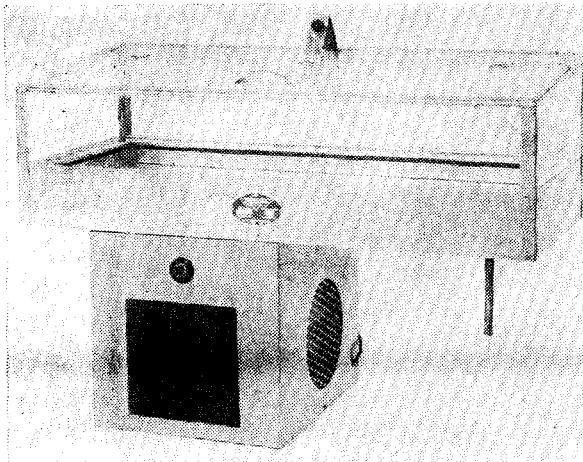


FIG. 15—WEST AND BEYNON LTD.  
VERICOLD REFRIGERATED SHELF

*3 ft. 3 in. and 4 ft Refrigerated Shelves (FIG. 15)*

Both units are of similar design and are manufactured by West and Beynon Ltd. They consist of a single thermostatically-controlled refrigerated shelf fitted with a perspex canopy closed with a perspex hinged cover, and are powered by an underslung air-cooled hermetically-sealed refrigeration unit operating on a 115-volt, single-phase, 60-cycle, 10-amp supply. A  $\frac{5}{8}$ -in. diameter condensate drain is provided. The 4 ft. shelf is fitted with a  $\frac{1}{5}$ -h.p. motor and the 3 ft. 3 in. shelf with a  $\frac{1}{8}$ -h.p. motor.

The physical dimensions of the shelves are:

Overall length	4 ft.	3 ft. 3 in.
Shelf height	2 ft. 4 in.	2 ft. 4 in.
Shelf width	1 ft. 9 in.	1 ft. 6 in.
Weight	158 lb.	123 lb.
Approximate cost	£150	£125



Both these shelves are also available to suit 220-volt d.c. supplies; for this, a slightly larger condensing unit compartment is provided to accommodate the  $\frac{1}{2}$ -h.p. separate motor and compressor unit. The original d.c. units were manufactured by J. Samuel White Ltd., but replacement units have been purchased from West and Beynon Ltd.

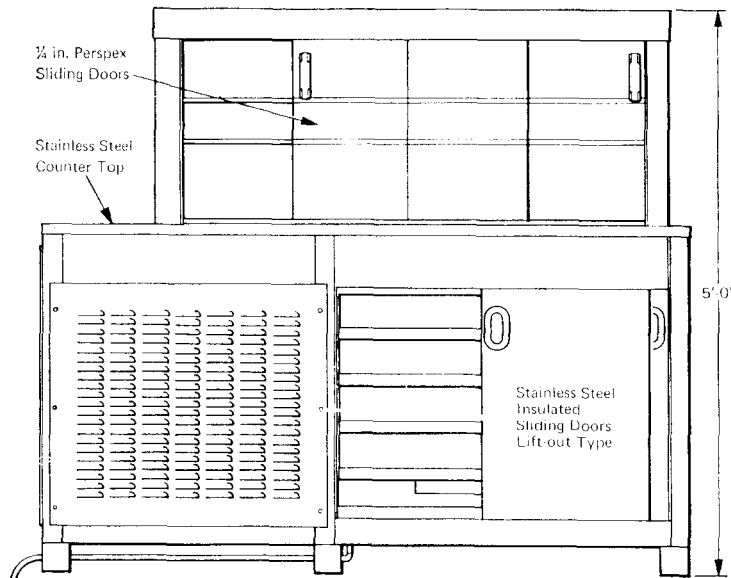


FIG. 16—GREENS LTD. REFRIGERATED COUNTER

#### 5 ft. 9 in. Counter (FIG. 16)

This unit, which is manufactured by Greens of Ecclesfield Ltd., provides a 3 ft. high refrigerated shelved cupboard storage with access from the rear surmounted by a twin-shelf refrigerated display cabinet with access from both front and rear and a slide for the customers trays along the front. A condensing unit, which is fitted with a separate motor and compressor, is mounted in the lower portion of the counter adjacent to the refrigerated cupboard and is connected to eutectic-filled evaporators in the cupboard and under the two shelves. The cupboard is maintained at a temperature of 40 to 50°F, and is fitted with a condensate drain. The air-cooled condensing unit is driven by a  $\frac{3}{4}$ -h.p. motor operating on a 440-volt, 3-phase, 60-cycle power supply.

Overall dimensions of the counter, which is deck mounted, are 5 ft. 9 in. long by 3 ft. wide and the height from shipbuilder's seating is 5 ft. The unit weighs approximately 13 cwt. and costs over £1100. Once installed, it is intended that maintenance and repair should be undertaken *in situ* unless the cabinet or machinery is extensively damaged by fire or explosion.

A redesign of this unit is currently in hand in consultation with DFSD who are specifying the customers requirements. The final design will be issued for competitive tendering and the resulting cabinet will replace, but be interchangeable with, the existing unit.