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## * Care of Cargo at Sea—II. Interim Report on Dehumidification in Ships.


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### PART 1.

#### Introduction.

This paper is an interim report describing the practical application of principles set forth in the authors' paper, "Care of Cargo at Sea", published in Volume 46, page 109, of the TRANSACTIONS of this Society for 1938. It analyzes the commercial operation of dehumidification systems on cargo ships under ordinary service and wartime conditions and explains certain developments in design and construction that proved desirable when the apparatus was taken to sea.

Information and data contained herein have been gathered from observation of many commercial vessels in regular service with dehumidification equipment operating during the last two years. In this test period these ships have carried representative types of general cargo susceptible to moisture damage, have followed trade routes and have encountered weather conditions which notoriously produce condensation (sweat) on the ship and the cargo in damaging quantities.

The results may be summarized as follows:

(*a*) The theories expounded in Section I of this paper, presented before this Society in 1938, have been proved correct.

(*b*) The magnitude of the capacity required to cope with the problem was known to be great but was found to be even greater than anticipated.

(*c*) Equipment that has been installed has demonstrated that moisture in loaded cargo holds can be entirely controlled; consequently, moisture damage and depreciation of basic commodities and finished products, such as military stores, can be prevented.

(*d*) Dehumidification can be successfully applied to prevent corrosion and deterioration in decommissioned naval vessels and in closed compartments of commissioned vessels.

Dehumidification has had a gratifying success, but with the maintenance of research and the continued co-operation of the shipping industry further progress is to be expected.

#### Résumé of the Moisture Problem.

A brief summary of the basic principles involved in the moisture problem in cargo holds will bridge the gap of the three years between Sections I and II of this paper.

It will be remembered that together with damage by handling, theft, fire and sea perils, damage by moisture in many forms is a major cause of cargo loss. Until recently, a considerable confusion regarding responsibilities existed and the loss by moisture damage was classified either as a "peril of the sea", an "inherent vice of the cargo" or "negligence in the management of the ship". Such moisture losses were accepted as largely inevitable. The scientific analysis outlined in Section I pointed out the several physical conditions responsible for such damage, and further indicated that they could be controlled and thereby eliminate the damage by removing the cause.

The fundamental aerological principles underlying this system are few and simple, but the multiplicity of variables involved in a cargo hold make their application difficult. The following definitions will recall the principles set out in Section I.

*Dew Point.*—The temperature below which air begins to deposit its moisture is called the dew point and is the most important single factor to remember in preventing damage by condensation (sweat).

*Ship Sweat.*—Just as soon as a ship's hull cools below the dew point of the contacting air in the holds, condensation of moisture from that air will form on the structure, which it corrodes and whence it may drip onto the cargo as ship sweat. Such moisture gets into the air of the hold principally by way of evaporation from the internal free or hygroscopic moisture of the cargo.

*Cargo Sweat.*—The other common form of condensation is called cargo sweat. This is moisture deposited from high dew-point air coming in contact with cold cargo. The cargo is cold when loaded and, as the ship sails into warm tropical weather, high dew-point air is often erroneously forced into the ship's holds by natural or mechanical ventilation. Moisture may also have had time to evaporate from damp cargo or the bilges in the same hold.

*Hygroscopic Moisture.*—Internal moisture in cargo is generally carried aboard as hygroscopic moisture; that is, in air-dry grain, lumber, hides, cartons, textiles, coffee, dunnage, etc., all of which will absorb moisture from or evaporate moisture into the contacting air, depending on relative vapour pressures. If this type of cargo warms up during the voyage, some of this moisture may be released into the cargo space where it will come in contact with the cold structure of the ship or with cold cargo with damaging results. While this hygroscopic condition is, indeed, an "inherent vice" of the cargo it need not cause damage if the released moisture is removed rapidly enough.

*Free Moisture.*—Much other moisture is carried aboard by cargo previously wetted by rain, snow, fresh or salt water.

*Proposed System.*—Based on the conclusions drawn at the time Section I was presented, a practical solution for those postulates was suggested and a system for dehumidifying cargo holds was described which was believed to be capable of coping with such a large and hitherto unsuccessfully attacked problem.

This system consisted essentially of three independent parts (Section I, Figs. 13 and 14, pages 140 and 141, Volume 46, TRANSACTIONS of The Society of Naval Architects and Marine Engineers):

(1) The air-drying unit, centrally located.

(2) A fan and duct system complete and independent within each cargo hold.

(3) The supervising instruments for the cargo holds and the atmosphere.

The operation of the system was to be in the following manner:

(1) Ventilate with outside air when the atmospheric dew point is lower than the dew point in the hold, and weather permits.

(2) Recirculate the air in the holds and inject dry air from the air-drying unit at all other times.

The air from the drying unit displaces an equal amount of wetter air from the hold, reducing the moisture content and consequently the dew point.

The proposed system was expected to make possible the protection of cargo independently of weather conditions.

#### Application of Dehumidification System to American Vessels.

During the last three years, through the help and forward vision of the shipping industry, it has been possible to make a number of full-scale installations of the new dehumidification system in transoceanic freighters. Based on the performance of eleven different ships in four different services, it is gratifying to state that it has been possible to demonstrate and prove the soundness and practicability of the original proposal.

Considerable experience has been gathered bearing on the general arrangement and technical details of the new system. Also, much additional evidence has been gathered on the extent and importance of marine moisture damage with specific cargoes and on various ocean routes. The theoretical basis on which this system operates has been further elaborated and solidified. This work is being continued.

* Paper presented at the Annual Meeting of the Society of Naval Architects and Marine Engineers, New York, November 13th and 14th, 1941, and reproduced by kind permission of the Council of the Society.

Due to the newness of dehumidification considerable effort must be spent in learning all the facts involved and all information and complaints on the system are carefully gathered. An observer is sent on a round trip with the first ship of each new group for the purpose of studying the performance of that particular type of installation, the climatic conditions during the voyage, the type of cargo carried both ways, the personnel entrusted with its operation, and other factors that bear upon this intricate problem. Later, whenever the ships return to the United States, they are systematically examined and pertinent data compiled concerning the voyage. In this manner the performance is checked and consideration is given to further improvements in fundamental or detailed design.

The European war has had a profound influence on this subject as well as on its basic design. During the early stage of development of this work in Seattle, Wash., seven years ago, the United States merchant marine was in a pitiful condition. Hence, though a great deal of information on the subject was obtained from American intercoastal steamers, the greatest encouragement and demand for relief from sweat damage came from the many foreign ships calling at Seattle.

Then came the determined will for a reconstruction of the American merchant marine, out of which grew the United States Maritime Commission. When our activity shifted from Seattle to New York early in 1938 the construction of the first group of ships of the shipbuilding programme had advanced to such a degree that the new idea of dehumidification of cargo holds could not be incorporated in the plans. However, the Commission immediately sensed its future possibilities and encouraged the first installation by approving the request of the American Export Lines. The four original installations were designed for the comparatively moderate conditions of weather and cargo occurring on the Mediterranean run to the Near East. A number of successful voyages were made before Italy entered the war. Then the ships were sent to India by way of the Cape of Good Hope. The climatic conditions on this latter route are much more severe than on the former and the condition of many products is more conducive to moisture damage.

Obviously, the different conditions led to several changes in subsequent designs of the air-drying unit and the air-distributing system. Due to unsettled conditions in world shipping, each installation is now designed to satisfy average severe conditions in world-wide routes rather than specific conditions occurring on a certain given trade route.

With the successful performance of the new system on the first round trip, the Maritime Commission and other marine interests became interested in incorporating this system into many of the later ships, totalling at the time of this writing nearly two hundred built or building. One very important new application is the prevention of corrosion on the internal hull structure of sealed or remote compartments of decommissioned or seagoing naval vessels.

## PART 2.

### First Installation on s.s. "Exporter" and Observations on Maiden Voyage.

The first contract calling for the installation of a dehumidification system was awarded by the Fore River Yard of the Bethlehem Steel Company, Shipbuilding Division, in the latter part of 1938. At that time the keel was being laid for the "Exporter", first of eight fast freighters ordered by the American Export Lines, Inc., for the Mediterranean trade. This company was well aware of the risk involved in transporting Turkish tobacco, one of its most important cargoes, and was anxious to improve its record.

The installation design as finally approved retained the basic features of that illustrated in Fig. 13, page 140 volume 46 (1938), TRANSACTIONS of The Society of Naval Architects and Marine Engineers. However, due to the novelty of the system extreme economy of first cost, space and power requirements was requested. Also, the ship was already partially constructed when it was decided to incorporate the system, and hence rather drastic compromises were necessarily imposed on the design. The following is a brief description of the system as installed on the "Exporter" and her seven sister ships (see Fig. 1).

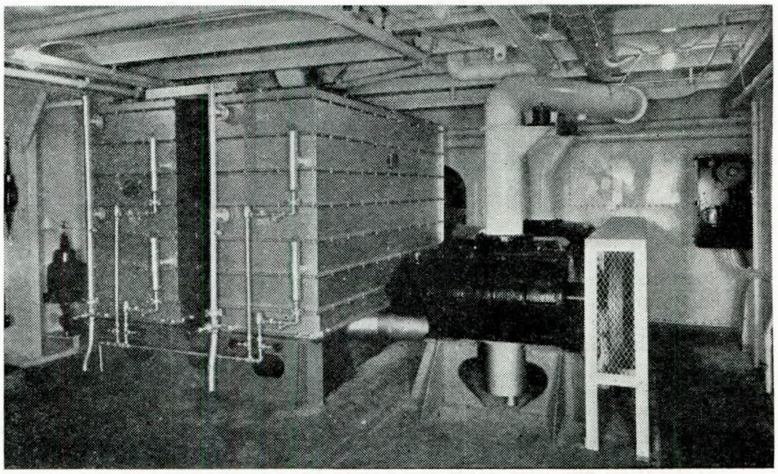


FIG. 2.—*Dehumidifying unit installed on the "Exporter" class of ships.*

### The Dehumidifying Unit (Fig. 2).

The air-drying machine is located on the port side of the third-deck flat in the engine room. It consists of two silica gel adsorption towers, the necessary piping and two positive volume blowers connected by V-belts to one 15-horsepower motor. The adsorption towers, which are identical, are built up of filters, cooling coils, heating coils and adsorber beds, to give two-stage adsorption. While one tower is drying air for two hours, the other is being reactivated; that is, having its own moisture driven off. During the succeeding two hours the process is reversed.

The cycle of four hours is designed to coincide

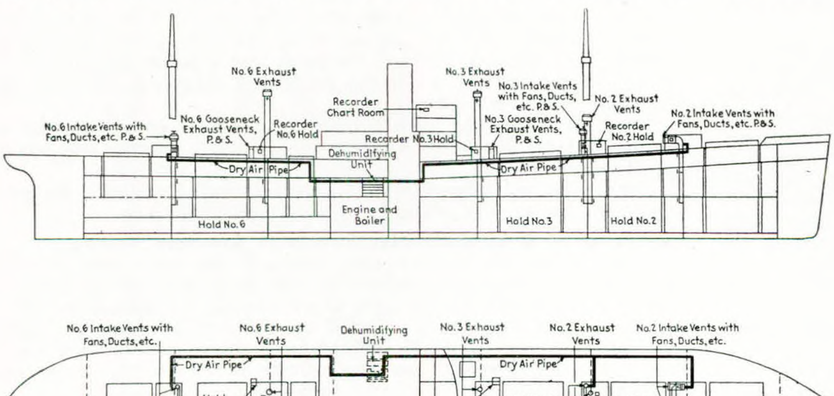



FIG. 1.—*General arrangement of dehumidification system on the "Exporter" class of ships, holds Nos. 2, 3 and 6.*

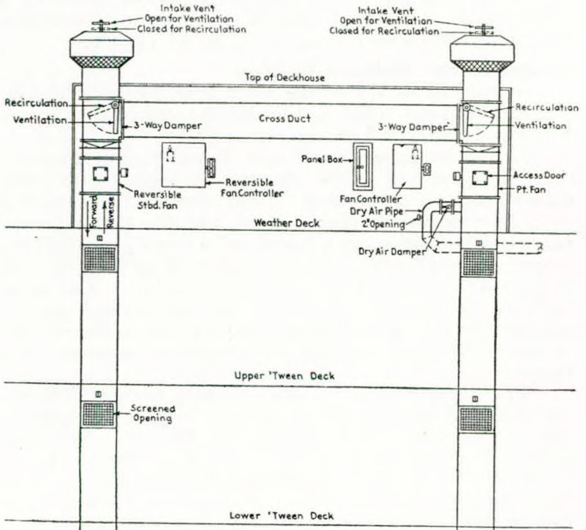



FIG. 3.—*Fan and duct systems on the "Exporter" and "Exemplar" classes of ships.*

with the engineers' watches. This necessitates a change-over only twice each watch and consists of the following operations:—

(1) On the tower which has been drying the air—shut off the salt water to the cooling coils and open the steam to the heating coils.

(2) On the tower which has been reactivating—shut off the steam and open the salt water.

(3) Shift the 4-way damper.

**The Fan and Duct Systems (Fig. 3).**

The duct systems, because of cost, had to be greatly simplified from those originally proposed. Distributing ducts were eliminated entirely, leaving only vertical supply and exhaust trunks on the hold bulkheads with openings to each deck (Fig. 4). For ventilation, each of two axial-flow fans supplies outside air to one end of the hold which escapes through two natural exhausts at the opposite end. For recirculation, one fan is reversed, thus withdrawing air from one side of the hold and returning it via a cross-duct to the other side where it is injected back into the hold (Figs. 3 and 5). In order to ensure proper air distribution without distributing ducts, it was hoped that ample circulation space on top of the cargo would be available for this purpose.

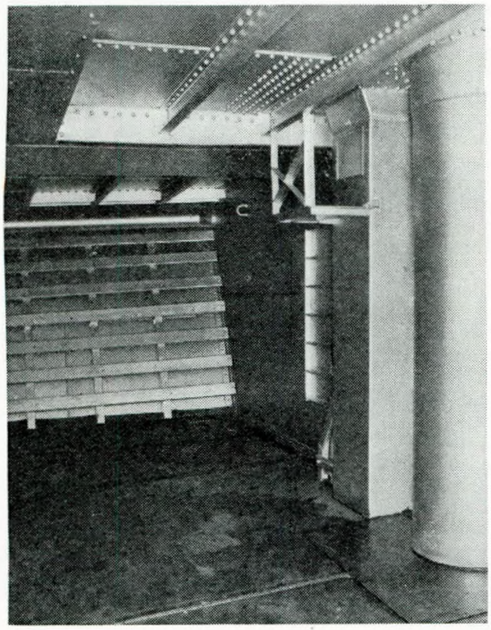


FIG. 4.—*A corner of an upper 'tween deck on the s.s. "Exemplar" showing a trunk opening, guard and dry air pipe (outboard, close to overhead).*

The actual steps necessary to operate the fan and duct system are as follows:—

For ventilation with outside air:—
(1) Open dampers in intake ventilators.
(2) Open dampers in exhaust ventilators.
(3) Set 3-way dampers on "Ventilation".
(4) Start fans, both running "Forward".

For recirculation with dry air:—
(1) Close dampers in intake ventilators.
(2) Close dampers in exhaust ventilators.
(3) Set 3-way dampers on "Recirculation".
(4) Start fans, starboard fan in "Reverse".
(5) Open dry air damper.
(6) Notify chief engineer to start unit.

**Instrumentation.**

For determination of dew point and temperature it was originally proposed to have an electric recorder in the pilot house connected through a selective switch to temperature and humidity elements in each hold as well as at a suitable location in the outside air. Due to the cost budget and lack of marine experience with this instrument it was decided to limit the recorder to sampling the atmosphere only and to use local insertion-type indicating thermometers and hygrometers in the exhaust ventilator trunks to sample the air in the holds. In addition, the ship was provided with hand-aspirated psychrometers by which dew points could be checked at any location on the ship, below or on deck, and in the cargo itself.

**Maiden Voyage of the "Exporter".**

The "Exporter" sailed from New York on October 5th, 1939, with one of the authors on board, bound for Mediterranean and Black Sea ports. The cargo consisted of bulk grain, baled cotton, machinery, automobiles and steel products. The cargo was moderately warm and no sweat-producing conditions were expected or encountered.

It may be recalled that the "Exporter" was equipped with the dehumidifying system in Nos. 2, 3 and 6 holds only. Nos. 1, 5 and 7 had mechanical ventilation and No. 4 cowl ventilation. It was most fortunate to be able to compare three types of ventilation in adjacent holds on the same ship.

Homeward bound the ship loaded first at Constanza, Rumania. This cargo consisted principally of baled cellulose, with smaller consignments of tinned Polish hams and various seeds in bags. The next port of call was Istanbul, to pick up a small amount of general cargo and tobacco, then on to Izmir (Smyrna) where the first large shipment of tobacco was received. In addition, a sizable consignment of liquorice root was loaded here. Then followed Kavalla and Piraeus across the Aegean Sea in Greece, where more tobacco was waiting. Starting westward from Piraeus the "Exporter" called at Palermo, Sicily, for a small amount of ground sumac and finally topped off at Lisbon with chestnuts, wine, sardines, sea moss, olive oil, wool, beeswax and a 15-foot deck load of cork. The large parcels were divided more or less equally among the seven holds with the exception of the tobacco, which was stowed entirely in the protected holds Nos. 2, 3 and 6.

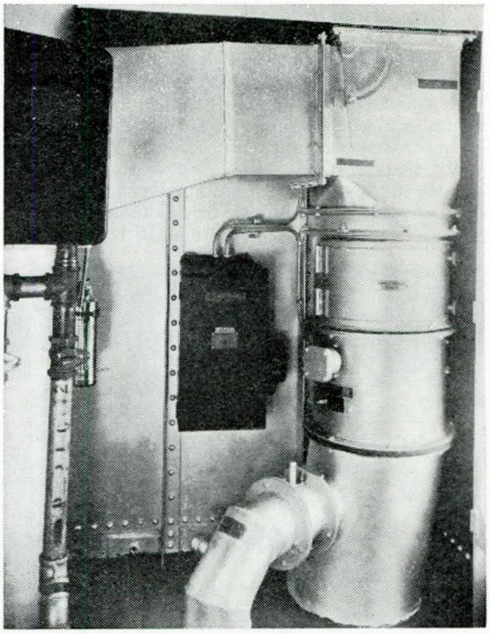


FIG. 5.—*A corner of a resistor house on s.s. "Exemplar" showing fan housing, access door to fan, dry air pipe, section of cross duct, fan controller, recirculation damper and recorder cabinet.*

The dehumidifying unit was started immediately upon leaving Lisbon and kept running the entire eight days of the voyage home. The cargo hold fans were also used continuously during this period. They were used on ventilation whenever the atmospheric dew point and the weather permitted. Recirculation was used about 75 per cent. of the time. The non-protected holds were ventilated continuously by natural draught or by mechanical ventilation where fitted. Typical North Atlantic winter weather was encountered which included the usual westerly gales, rain passing the Azores and the sudden transition from comparatively warm to cold air and sea water when approaching the coast. This temperature change amounted to a 20-degree drop in the atmosphere and 15 degrees in the sea water. While this is not as severe a change as normally would have been encountered later in the winter, it was definitely sweat producing. Upon arrival in New York on December 1st, 1939, it was found that the protected holds, Nos. 2, 3 and 6, showed no sign of sweat while all the others had considerable.

The first practical test of the new system under actual service conditions in direct comparison with other types of ventilation on the same ship showed that the theory is sound and that sweat formation can be eliminated with certainty.

## PART 3.

**Improvements on s.s. "Exemplar".**

It was anticipated from the beginning that changes in design would appear desirable after the first seagoing test of the new system.

Under the terms of the contracts with the shipbuilders for a total of eight ships, it was difficult to make major changes in the general arrangement of the second group but the builders generously conceded such changes as were thought absolutely necessary.

Unfortunately the most important difficulty encountered was the uneven distribution of air through the cargo holds. The arrangement described worked very well for ventilating with outside air, due to an end-to-end sweep through the hold, but when recirculating it was impossible to avoid some air short-circuiting at one end of the hold. In view of the impossibility of modifying the duct system greatly so as to follow the original recommendation more closely, the only structural addition made was to provide guards in front of the air grilles for the purpose of keeping cargo away from them (Fig. 4). Also, instructions were given and posted for the proper stowage of cargo in order to ensure better air distribution through the holds. By stowing the cargo high between the two air grilles in each deck the air would be forced to sweep through a larger part of the hold and reduce short-circuiting. Later on, however, it was found difficult always to enforce such special stowage, with the result that the ships' officers must be particularly well trained and alert, and outside air ventilation whenever possible must be relied on heavily. The dry-air unit is operated to advantage together with outside air ventilation.

The second important necessary change that became apparent was the arrangement of the cooling and heating coils in the dry-air unit. The two-stage adsorption was thought possibly necessary before seagoing results were available. This was found not to be needed and single-stage adsorption was adopted. By separating the heating and cooling coils and placing them externally to the adsorber beds, the size and number of coils were both reduced and the area of the beds could be increased with consequent reduction in air resistance and saving in horsepower. The external location of the coils prevents the coolers being heated and the heaters cooled each cycle. The most important operating result was to reduce the duty

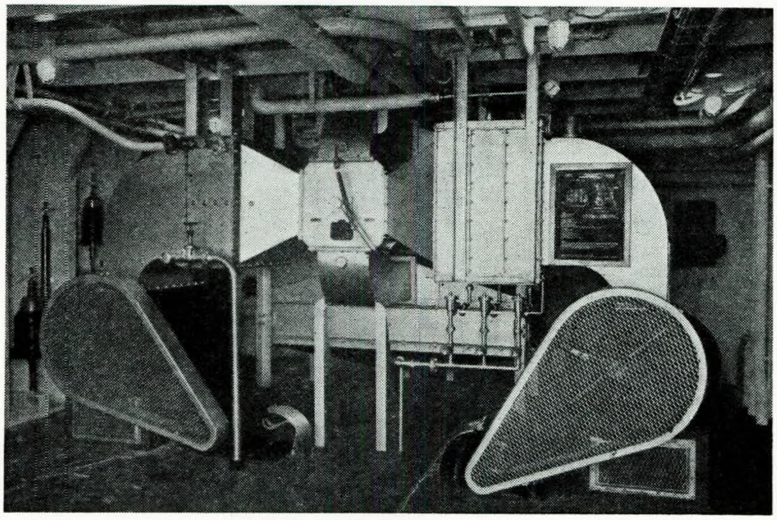


Fig. 6.—*Dehumidifying unit on the "Exemplar" class of ships.*

of the engineer to one throw of the four-way damper with no valve change once the unit is started. All parts were made accessible.

The single-stage unit adopted for the "Exemplar" type of ships is illustrated in Fig. 6.

This type of unit was therefore retained for the third group of American Export Line ships, the s.s. "Exceller" type. To eliminate

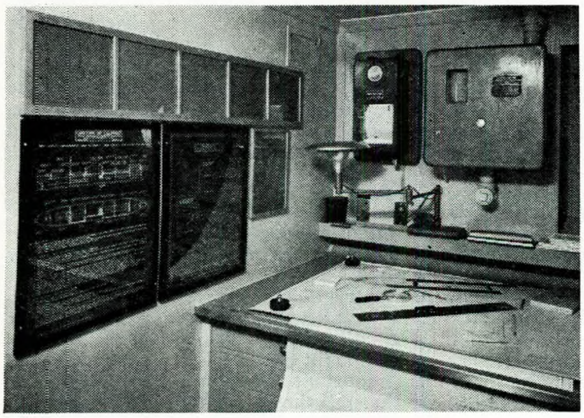


Fig. 7.—*Chart room of the s.s. "Robin Locksley" showing temperature and humidity recorder for outside air, instruction diagram, and dew-point chart.*

the sometimes very wet engine-room air, which puts a great load on the adsorber beds, the dry-air blower on these and subsequent ships gets its supply from the outside atmosphere through the engine-room ventilation system.

Regarding the instruments required for obtaining the condition of the atmosphere and the air in the holds, changes were necessary due to the fact that the regular commercial remote electric-type temperature and humidity recorders used on the first four ships did not stand up to seagoing conditions and the local insertion type instruments did not have sufficient air circulation. Consequently, the remote-reading recorders were replaced with specially designed local recorders both for atmosphere (Fig. 7) and for each cargo hold. A continuous sample of air is drawn through the recorder by means of 2-inch pipes from the desired space, giving a continuous inked record of the condition of the air at each location (Figs. 8 and 18).

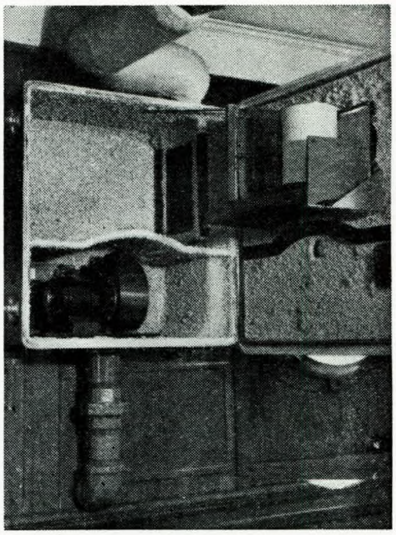


Fig. 8.—*Interior of a recorder cabinet showing recorder, filter and fan.*

Of the eight ships in this group, three have been turned over to the United States Navy or the British. The others are operating on the East Indian run where conditions leading to moisture damage are much more severe than in the Mediterranean trade. In spite of the fact that the installations for these ships were not designed for this trade, the system appears to work satisfactorily and the outturn of the cargo has been found to be good.

## PART 4.

### Installation on s.s. "Mormacmoon" and Maiden Voyage.

When the American Export Lines decided to acquire the four C-3 type Maritime Commission cargo ships building at the Ingalls Yard, Pascagoula, Miss., they called for the air-drying system in three holds out of five. A novel installation problem arose as two of these ships were already partly completed and all materials were fabricated. The original design called for mechanical hold ventilation, which at that time had become standard for the Commission ships. Careful studies with the naval architect showed that many of the present trunks could be utilized (Figs. 9 and 10). Some had to be blanked off, others cut into and connected to the fans.

The unit built for these ships was larger, due to the greater size of the holds. A good location was found in the engine-room

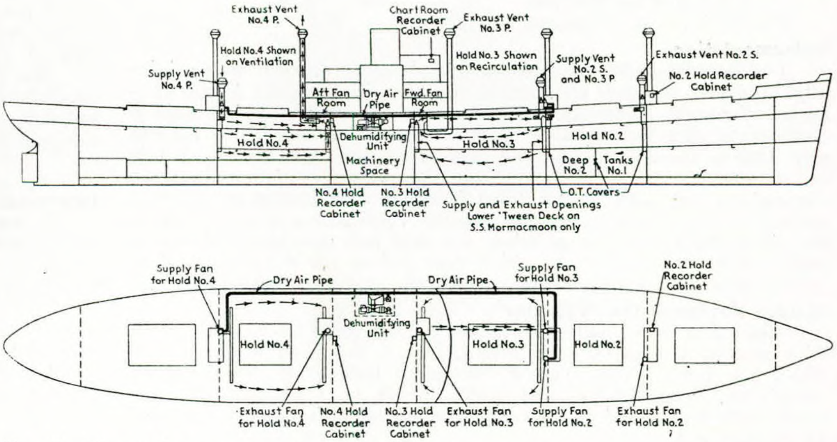



Fig. 9.—*General arrangement of dehumidification system on the "Mormacmoon" class of ships, holds Nos. 2, 3 and 4.*

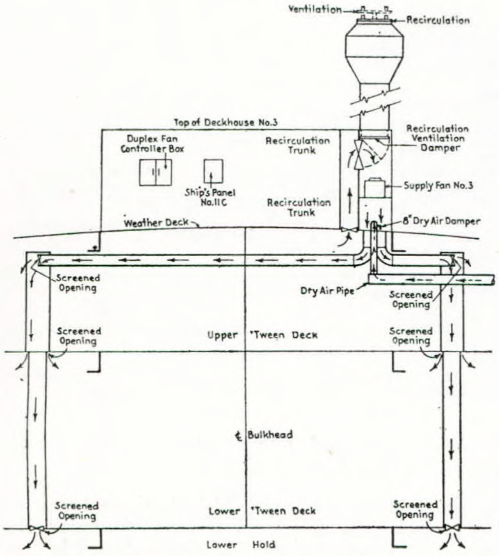



FIG. 10.—*A fan and duct system typical of the "Mormacmoon" class of ships, showing old-fashioned duct system adapted to dehumidification.*

flat on the second deck, port side. A larger dry-air pipe was permitted for the purpose of reducing the power consumption of the dry-air blower. It was possible to substitute a centrifugal fan for the reactivation blower at some saving in weight and cost, because the static resistance of the reactivation system is relatively constant and does not need the "meter effect" of a constant-volume blower (Fig. 11). A thermodynamic study of this larger unit showed that for a few minutes after changing the cycle the dry air coming out of the freshly reactivated and heated adsorber bed was at high temperature. To prevent undue rise in the temperature of the dry-air pipe in the hold, where cargo might rest against it, an aftercooler was installed using the same sea water as the precooler (see Figs. 11 and 21).

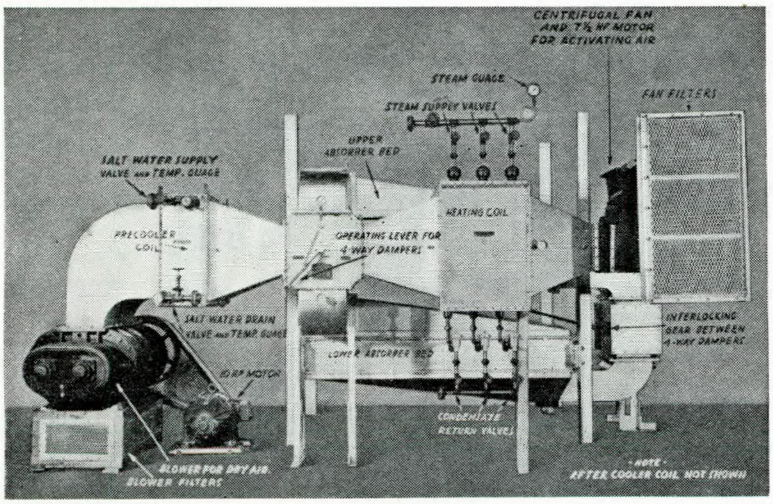



FIG. 11.—*Dehumidifying unit on "Mormacmoon" and "Robin Locksley" class of ships.*

The local-type temperature and humidity recorders, which had been adopted for the "Exemplar" group of ships had proved satisfactory and were retained. Before construction was completed the first and fourth ships were taken over by the United States Navy. The other two were finally reassigned to Moore-McCormack Lines, Inc. They retained the dehumidification system, as they had already adopted it for their four Diesel cargo-passenger ships under construction in the yard of the Sun Shipbuilding and Dry Dock Company, Chester, Pa.

In spite of these construction difficulties, it was found possible to attain the ideal positive air flow in the cargo holds desired in Section I, Figs. 13 and 14, pages 140 and 141, Volume 46 (1938), but with a change to fore-and-aft flow instead of thwartship flow which was found to save a very great deal in both cost and weight with no diminution in effectiveness. Instead of both a supply and an exhaust fan at one end of the hold with natural exhaust at the opposite end, the fans were placed at opposite ends of the holds. No other vents were provided. Fig. 9 shows the resulting improved air distribution when recirculating. In addition, the capacity of the fans was increased to the maximum attainable on 2 horse-power motors under the static resistance encountered.

**Maiden Voyage of the "Mormacmoon".**

The "Mormacmoon" sailed the first of this year from Mobile, Ala., in ballast to Rio de Janeiro, taking fuel and cargo oil in Curacao. In Rio manganese ore consigned to Baltimore was loaded in lower holds Nos. 3 and 4. This ore appeared reasonably dry and warm to the touch. In Buenos Aires and Montevideo the ship loaded to capacity, mainly with wool, but also with fair quantities of bagged and cased goods such as Quebracho extract, wines, meat and dry hides. Moisture samples taken after loading indicated that the wool was excessively damp due to local wet weather. Wet salted hides were stowed in the deep tanks and over-stowed with other wool. All ventilation was cut off from these tanks and they were sealed so that they had no effect on the rest of the cargo.

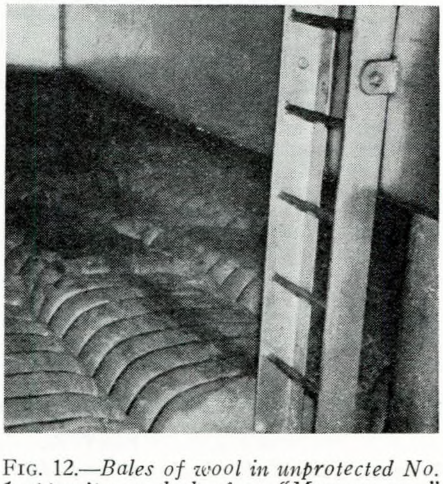


FIG. 12.—*Bales of wool in unprotected No. 1 upper 'tween deck of s.s. "Mormacmoon" on maiden voyage. Note condensation dripping from hatch coaming, leaving streak on bales and pool at corner of hatch.*

Due to the fact that the relative humidity and dew point in the atmosphere are generally high in the belt from 35 degrees south to 27 degrees north latitude, the holds were battened down after leaving Montevideo for Trinidad. The air was recirculated and dry air injected into all holds. In this manner excessive moisture was removed from the cargo. The weather remained unchanged; clear, with a temperature of 80 degrees and a relative humidity of 80 per cent. until Bermuda was approached. At this point, a strong north wind developed which became colder steadily over the next three days until, when the ship entered Boston harbour, the temperature was below freezing. The sea water remained warm until it dropped precipitously about 35 degrees shortly before reaching Boston. As soon as the dew point of the outside air fell below that in the holds, ventilation was started. In spite of the increasingly rougher seas, ventilation was continued because of the fact that the weather was clear and the dew point of the atmosphere desirably low. It was observed that the ventilator heads provided on these ships eliminated the sea water spray rather well as long as no solid water was being taken over.

Upon arrival in Boston it was found that while the cargo in the treated holds was in good condition considerable condensation had occurred in the holds ventilated in the customary manner (Fig. 12), upon further un- (Fig. 13). In fact,

FIG. 13.—*Protected No. 2 hatch of s.s. "Mormacmoon" immediately after opening at Boston. No sign of sweat on steel structure and bales in perfect condition.*

loading of the untreated hold No. 1 fresh water was discovered lying in the after end of the shelter deck space, the cause of which was concluded to be accumulated condensation. No such condition was present in the treated holds.

With the exception of the very surface layer of the cargo, the wool bales were nearly as warm as at the time of loading. Further tests also showed that this thin layer of the exposed bales was dried only moderately while the inside was hardly affected at all. Due to the fact that the bales continued to evaporate large quantities of water vapour in the lower decks while the shelter deck space was already empty, ventilation had to be continued not only while the hatches were open, but also on the coastwise trip to New York and Philadelphia, as long as the sweat-producing conditions continued.

The fact that the ventilating system is often needed when the ship is in port and even when the hatches are open is a potent reason for not permitting the ventilation fans to be used for any other purpose, such as ventilating resistor houses. Wool is a useful cargo with which to work and experiment because it is highly hygroscopic, generally loaded excessively moist, and stowed sufficiently loosely so that the ventilating air can come into contact with nearly every bale. The moisture load on this trip during the winter time is very considerable and it is estimated that the dehumidifying system displaced a quantity of about six tons of excessive and harmful water from the three holds, without drying the bales beyond a thin surface layer. Final tests after unloading indicated that the surface layers of the bales had returned to their normal moisture content.

## PART 5.

### System on s.s. "Robin Locksley" and Maiden Voyage.

Immediately after the return of the "Exporter" from her maiden voyage the Seas Shipping Company was convinced of the desirability of providing dew-point control in the cargo holds of their new fleet of six ships to be built at the Sparrow's Point Yard of the Bethlehem Steel Company, Shipbuilding Division. These ships are of the open shelter deck type with five holds, all protected by dehumidification, excepting the refrigerated spaces. These were the first ships to be completely protected with dehumidification, which is the case with all subsequent designs to date.

The air-drying unit is located in a closed compartment immediately forward of the engine room on the third deck. This space is insulated and connected with the engine room by an access door only. The air to be dried is supplied from topside by the engine-room ventilation system. The air for reactivation is taken directly from the engine room, as moisture is not harmful in this portion of the cycle. The unit installed on the "Mormacmoon" was specifically developed for these ships, though a larger unit was originally proposed because of the greater cargo space to be treated. However, the shipowners felt that the smaller unit would suffice, inasmuch as the lower holds would always be filled with ore on the west-bound voyage and would not require treatment. The fan and duct systems in the cargo holds are the first that have been designed to suit the performance of the dehumidification system rather than existing hull designs. In spite of the fact that the shelter deck spaces are interconnected, with the exception of hold No. 1, the fans and recorders are arranged as if the holds were separated by bulkheads. Each hold has a supply fan at one end and an exhaust fan at the opposite end.

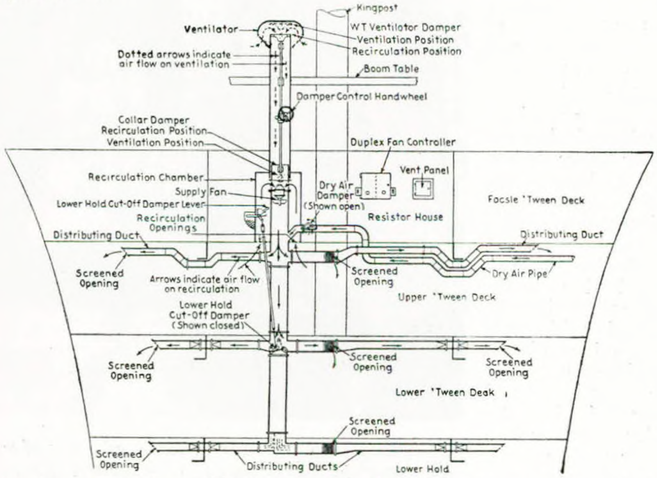



FIG. 14.—*Typical supply fan and duct system on the "Robin Locksley" class of ships, holds Nos. 1, 2, 3, 4 and 5.*

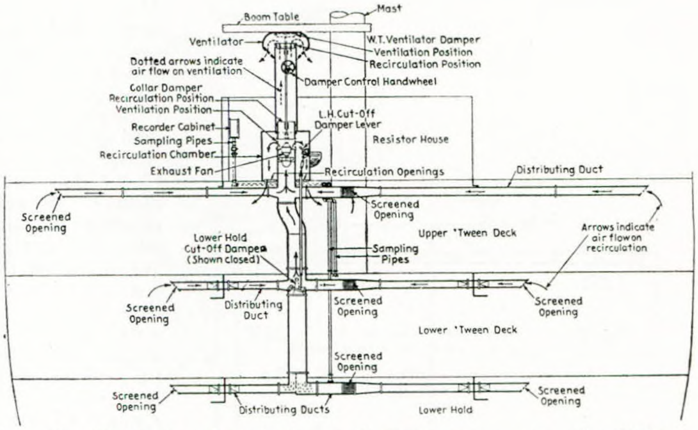



FIG. 15.—*Typical exhaust fan and duct system on the "Robin Locksley" class of ships, holds Nos. 1, 2, 3, 4 and 5.*

The distributing ducts were made of 14-inch diameter heavy tubing where headroom would permit, and were rectangular elsewhere. Each transverse distribution duct has three air grilles well guarded against interference from cargo. The resulting air distribution system is illustrated in Figs. 14 and 15. A damper is provided in each vertical trunk for the purpose of cutting off the air supply either to the lower hold or to the lower 'tween decks.

The operation of the system has been greatly simplified by interlocking the watertight covers in the ventilator heads with the recirculating dampers (Figs. 16 and 17). The time required for one man to shift all ten dampers for the five holds from outside air ventilation to recirculation is less than 15 minutes. This is about the same as that required for trimming the cowl ventilators on an older type ship, except that when once changed this new system remains set for days at a time. Moreover, much more time is required for opening and closing hatches for additional ventilation with cowl ventilators when damageable cargo is being carried.

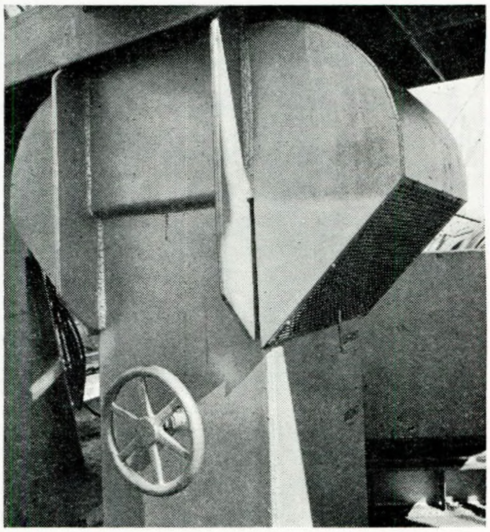


FIG. 16.—*Ventilator head on s.s. "Robin Locksley". Handwheel controls ventilator damper interlocked with collar damper shown in Fig. 17.*

The local type temperature and humidity recorders are installed for all holds and one for the atmosphere in the chartroom (Fig. 7).

### Observations on Maiden Voyage of the "Robin Locksley".

The s.s. "Robin Locksley" of the Seas Shipping Company was the first vessel with a dehumidifying system to enter the South and East African trade. She sailed for Capetown on April 11th, 1941, after loading at Baltimore and New York. Her cargo consisted of steel, tin plate, machinery, boxed automobiles and trucks, automobile parts, canned goods and various other items. Some of this cargo was considerably wet from rain and snow before loading.

Of particular interest from a dehumidification standpoint were the canned goods and tin plate. These parcels had acquired a low temperature through being exposed to cold weather (25 to 40 degrees) while waiting on the dock to be loaded. They were stowed deep in the holds where their temperature rise would be slow. If high dewpoint air were to come in contact with them, cargo sweat would form on their cold surfaces. Therefore, the dehumidifying unit was started upon departure and used throughout the entire passage with

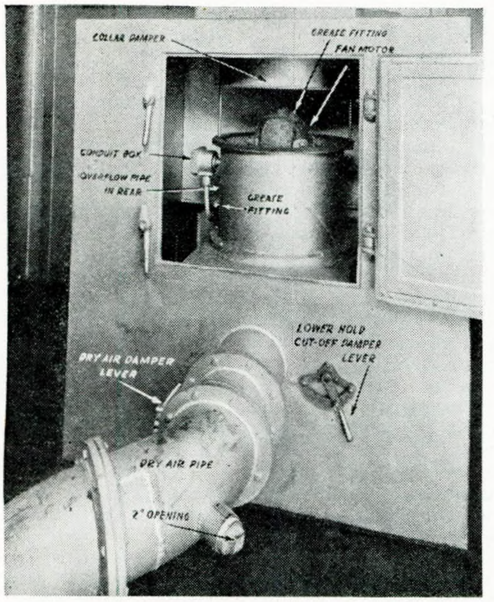



FIG. 17.—*Recirculation chamber on s.s. "Robin Locksley" showing collar damper.*

the dry air concentrated on the vulnerable compartments. This dry air together with the air of the hold recirculating along the warm decks and underwater body of the ship produced a double effect; it kept the dew point of the hold air low, and at the same time accelerated the temperature rise of the cargo.

For the eleven-day period between leaving New York and reaching mid-tropical waters, the average dew-point rise in the three holds not receiving dry air was 37 degrees. In the two holds being treated the average rise was only 25 degrees, indicating the large quantity of rain water which was being released as the cargo warmed up. In the remaining seven-day period as the weather gradually cooled, the dew point in the untreated holds dropped 13 degrees and in the treated hold 21 degrees. The dew points in all holds were low enough to leave a safe margin under the 15-degree temperature drop between the tropics and Capetown. No sign of ship sweat was found upon arrival. The canned goods and tin plate, consigned to Durban and Mombasa, did not leave the ship till nearly two months after departure from New York. As far as could be ascertained no cargo sweat occurred, in spite of particularly adverse conditions.

Homeward bound, the "Robin Locksley" loaded coffee and baled pyrethrum flowers at Mombasa, cloves at Zanzibar, mangrove at Dar es Salaam, sisal and bulk chrome ore in lower holds Nos. 3, 4 and 5 at Beira, bagged asbestos at Durban and Capetown, and dry hides in Nos. 1 and 3 holds at every port. With minor exception the cargo appeared air-dry. Of these commodities none was particularly susceptible to moisture damage except the consignment of coffee, stowed in Nos. 4 and 5 upper 'tween decks. The shipping industry is well aware of the damage this delicate cargo can sustain from dripping condensation or excessive moisture from any source.

Sweat-producing conditions were encountered coming down from tropical East Africa into the South African winter (the latter part of June). The temperature dropped gradually from an 80-degree average to a minimum of 50 degrees. All hatches except No. 1 were being opened almost daily at ports of call and did not require attention. Therefore the entire output of the dehumidifying unit could be concentrated on No. 1 hold, which had been finished and battened for sea at Beira on June 13th. Upon arrival at Capetown fifteen days later, without having had to resort to any outside ventilation, the dew point in this hold had been reduced from 70 degrees to 41 degrees as shown on the chart (Fig. 18), leaving an ample margin of safety under the lowest atmospheric temperature of 50 degrees.

While loading at Capetown frequent rain squalls occurred. In spite of the usual precautions considerable rain entered Nos. 3 and 4 hatches, wetting the dunnage in the upper 'tween decks, collecting in puddles on the deck. Forty-eight hours of recirculation with dry air sufficed to dry this water completely and to the eye, at least, the dunnage as well.

After leaving Capetown the air in all holds was recirculated and the dry air was concentrated on Nos. 4 and 5 hatches. Tropical conditions were encountered after about five days out and continued until the night before arriving at Boston. At that time, when the cold current was entered immediately after leaving the Gulf Stream, the sea water temperature dropped from 82 degrees to 52 degrees in sixteen hours. In the same period the atmospheric temperature took a plunge from 78 degrees to 56 degrees and a dense fog shut in. When the dew point was low enough all holds were ventilated with outside air. When the hatches were opened the cargo was found to be in good condition. Holds Nos. 4 and 5 had a sufficient safety margin to prevent the formation of ship sweat even without ventilation.

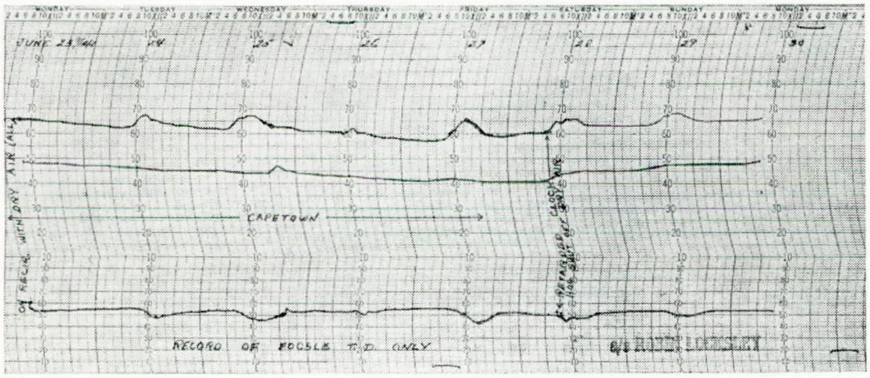



FIG. 18.—*Recorder chart from No. 1 hold on s.s. "Robin Locksley" showing 41-degree dew-point after fifteen days of recirculation with dry air. Note dew-point rise when dry air was shut off June 28th.*

Two apparent paradoxes were emphasized on the voyage:—

(1) Sweat-producing conditions may be present on the course to Boston from the tropics, even in mid-summer.

(2) Ventilation of a warm cargo with low dew-point outside air, even though fog is present, will prevent condensation forming inside.

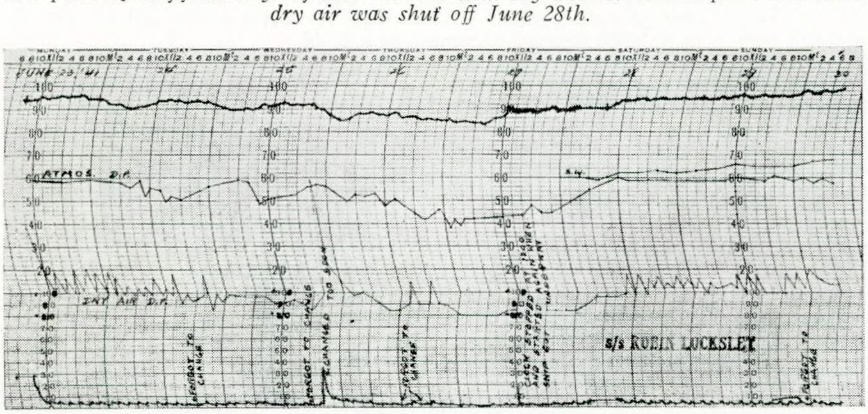



FIG. 19.—*Typical dry air recorder chart (dew-point and sea water temperature curves plotted).*

## PART 6.

### System of s.s. "African Comet" and Latest C-2 and C-3 Ships.

The system being installed in the three ships for the American South African Line is essentially the same as in the ships of the "Robin Locksley" type. All four general cargo holds are to be provided with moisture control. The schematic layout of the entire system as it will be installed in the "African Comet" is shown in Fig. 20. It is similar to many of the later C-2 and C-3 ships.

The duct system became somewhat involved due to the fact that the cargo spaces and deep trunked hatches had to be protected against moisture damage, and because of passenger accommodations. The capacity of the dehumidifying unit, which is 50 per cent. larger than any previous unit, was determined by experience and research. The space assigned to the unit is immediately above the group of generators on the engine-room flat on the starboard side. Consequently, the unit had to be greatly compressed in height as illustrated in Fig. 21.

The air to be dried is supplied from topside by the engine-room ventilation system and the air for activation is taken from the space in which the unit is located. This serves to ventilate that space, because it is anticipated that the ambient temperature there

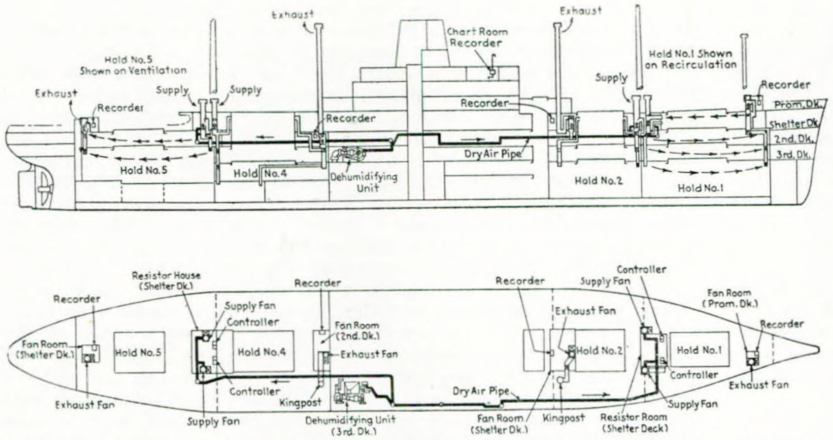



FIG. 20.—*General arrangement of dehumidification system on s.s. "African Comet" C-2 and C-3 ships, holds Nos. 1, 2, 4 and 5.*

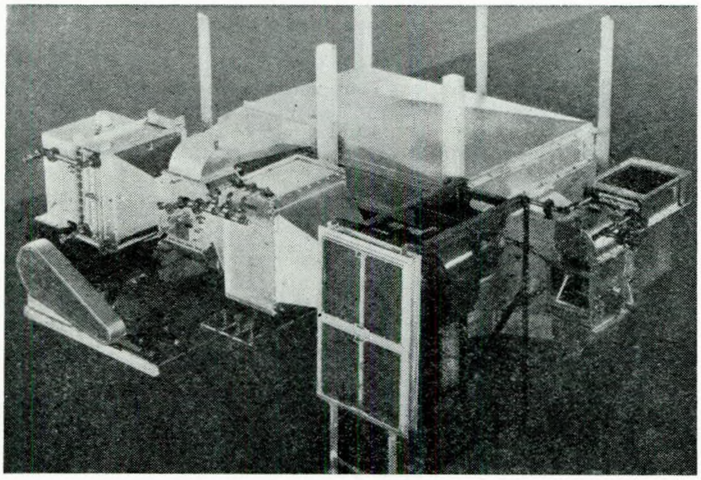


FIG. 21.—*Dehumidifying unit installed on s.s. "African Comet", C-2 and C-3 ships.*

will be high.

Based on a successful trial installation on the "Robin Locksley" (Fig. 19), a standard dry-air recorder has been designed and will be installed near the unit using the same instruments as shown in Fig. 8 but without a filter or a suction fan as there is sufficient air pressure in the dry-air pipe.

## PART 7.

**Portable Dehumidifying Units.**

When Section I of this paper was read three years ago, there were some comments by the Navy Department which were partially answered by the authors at the time the paper was discussed. The authors spent some time with the Navy Department analyzing and discussing its reasons for questioning the practical use of silica gel. We were able to furnish newer information with the result that silica gel dehumidifiers have been tested and placed on "Approved Lists".

While undertaking this investigation, one of the authors was requested by the Department to visit the Navy Yard at Philadelphia where experiments were being undertaken to prevent moisture damage to the interiors of decommissioned submarines and destroyers.

The experiments that had been run at the Philadelphia Navy Yard with calcium chloride had reached a natural limit due to the fact that calcium chloride deliquesces as it absorbs water and drains away in the shape of brine which it is impractical to regenerate. This brine must be carried out of the ship in buckets by labourers and the hoppers refilled with new chloride. This means that closed decommissioned submarines, for instance, must be entered fairly often. Water vapour gets into the air from the natural exudations of this personnel and also enters through the necessarily frequent openings of hatches, doors, etc., which are sometimes accidentally left open.

However, very good results were accomplished, indicative of the possibilities of dehumidification for preserving ships laid up out of commission.

Some large-scale experiments were then made by hanging muslin bags of silica gel in certain remote spaces in naval ships. These bags could be reactivated by placing them in the galley ovens or, if the ovens were in use, in special heaters aboard the ship. Moisture adsorption is necessarily slow as there is no blower to circulate the air in the space. Time for reactivation is indeterminate. The use of the muslin bags is an improvement over early attempts with lime trays and the subsequent development of the calcium chloride hoppers. There is no slacked lime or corrosive calcium chloride brine to remove and replace. The gel bags can be used over and over as the silica gel is completely usable again.

With the approval of the Bureau of Ships, three different designs of silica gel adsorbers were then developed for different problems and actually tried out on naval vessels. Other designs are in preparation.

The first approach to the problem was made by adapting a commercial air-drying unit for the preservation of several destroyers. It was desired to make the unit completely self-contained and portable so that it could be placed on the dock alongside one or more destroyers or be lifted by a crane to the deck of a destroyer or submarine. Hence, it was made heavy and sturdy and fitted with skids and lifting pads. The first machine was fitted with steam coils for reactivation. The second two of the same design were fitted with electric heaters.

The scope of this design was to furnish sufficient dry air to dehumidify six laid-up destroyers at the same time. About the time one destroyer was made air-tight and ready for test, the recommissioning programme of the Navy began to make headway and this first vessel was put into service. Several other destroyers were prepared but also were taken away before a test could be run.

It was then decided to put the dehumidifying unit on a decommissioned submarine. A very fine result was obtained with an ultimate dew point of minus 35 degrees F. This is, of course, a very "bone dry" condition, and resulted in satisfactory dielectric tests on the electric wiring and total absence of moisture in the interior.

While the second and third units of this first design were under manufacture the submarine "Squalus" was lost off Portsmouth. It was thought possible to make use of one of these units to arrest corrosion and damage to special equipment by quick drying when the vessel was brought to the surface. Two of the units were rushed to Portsmouth as soon as they were operable and placed on the hull when it was put in dry dock. However, the interior of the hull was foul with mud and oil. It was decided, therefore, to remove the engines entirely and send them to the factory for overhaul as quickly as possible. As the whole submarine was opened up to remove the engines no conclusive tests could be made of its use in dehumidifying though the personnel kept the unit running for ventilation and warmth.

**Decommissioning and Recommissioning Procedures.**

The operation of the first steam model and the two subsequent electric models, while not perfected, paved the way for development. The obvious disadvantage of reactivation by the use of steam in portable models was the piping required and the excessive use of steam in cold weather. It was effective but not practical for servicing a large fleet of decommissioned ships.

The electric model, while operating very successfully, used amounts of current which would be out of the question for a large number of decommissioned destroyers.

It then was realized that large capacity (in other words, quick drying) was not a desideratum. Decommissioned ships are to be laid up for years until called upon in a national emergency.

Then, as we have just experienced, the ships must be ready to put to sea at the shortest notice and be in fighting condition, rather than requiring extra maintenance for some months after commissioning.

Present decommissioning procedure has been to remove from the ship all portable tools, all instruments, gauges and other valuable equipment. A liberal use of heavy oils and greases, even in turbines and boilers, makes recommissioning a stunning task. Partial dehumidification of decommissioned ships has been standard Navy practice for years by the use of trays of dehydrated lime in boilers. This is a step in the right direction but should not be considered completely satisfactory. If the whole boiler room can be kept dry, the boiler will be preserved, likewise.

The mission for dehumidification as laid down by the Bureau of Ships will change this procedure radically. Instead of removing tools, instruments, etc., from the ship and putting them in storehouses ashore, where they are sometimes lost or issued to the wrong ships; instead of the use of heavy petroleum products, which in general render the interior of the ship messy, to say the least, without always preventing corrosion; and instead of replacing much deteriorated wiring, machinery and hull structure; the new doctrine is expected to remove the cause of damage, namely, moisture, and keep it out of the ship.

If this can be accomplished, the electric wiring will always be in good condition, all machined surfaces will be protected only with thin polar compounds, and all instruments, tools and certain stores will be in place. This will mean that the ship should be ready for habitation at any moment and by the time her crew is assembled can be ready for sea. This saving of literally months of time and large maintenance and repair funds is obviously of great military advantage and should be worth the time to investigate and develop fully.

**Automatic Portable Units.**

Consequently, it was determined to proceed on a special design for decommissioned ships which primarily would be economical of power consumption because of the many ships contemplated to require treatment at any one yard after the present emergency. In accordance with the Navy Department it was felt that the optimum result would be obtained with a machine that could produce air of a very low dew point with a very low power consumption, and which should be totally automatic so as to eliminate as far as possible the cost of any supervision. It was further desired to make the unit sufficiently small in size so that it could be readily handled and could pass through a standard watertight door of a destroyer. The result is seen in Figs. 22 and 23.

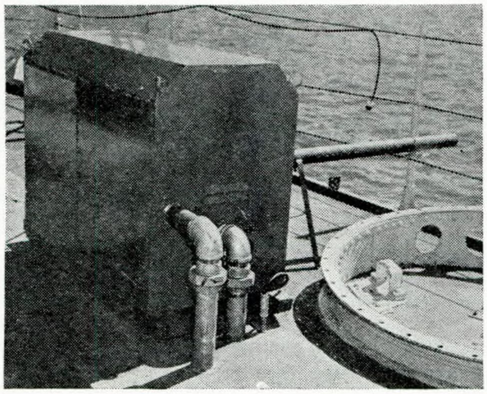


FIG. 22.—*Portable automatic dehumidifier on deck of decommissioned destroyer showing (left to right) dry air supply pipe, wet air return pipe, and electric connection to humidistats in after boiler room.*

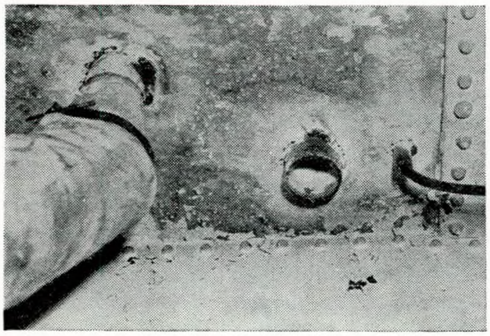


FIG. 23.—*View of deck overhead in boiler room, showing air pipes and electrical connection to humidistats. Note sweat under deck plating—this disappeared within two days.*

Low dew point was desired not only to prevent formation of sweat but to prevent surface corrosion. It has been determined that, if the relative humidity can be kept below about 30 per cent., surface corrosion is inhibited. Consequently, silica gel was selected as the most practical material to use for getting this low dew point and relative humidity.

An interesting detail of this design was the "two-timing" feature. When a ship is finally dried out after initial treatment and is being maintained in a dry condition by merely eliminating what little moisture may filter into the ship through seams and gaskets, very little moisture is adsorbed during the adsorbing half-cycle. Consequently, on the reactivating half-cycle very little heat is required to drive off the small amount of water adsorbed. As the maintenance period will be many score times the drying-out period, it followed that the capacity of the electric heater should be designed for this condition.

When a ship is being dried out initially from the wet condition specified (namely, an 80-degree dew point and 90-degree temperature), the amount of moisture which the gel beds will adsorb in a one hour half-cycle will take three times as long to be dried. A timer is provided which increases the time of the half-cycle to three hours, rather than the normal one hour half-cycle when the machine is on maintenance duty. In this way the power requirements can be kept low and still have a machine which can get very low dew points with very low power use.

Specifications called for one unit to take care of the largest compartment of a four-stack destroyer, which would have one unit for each of the following main spaces:—

(1) Living spaces forward of the No. 1 boiler room bulkhead.
(2) No. 1 boiler room.
(3) No. 2 boiler room.
(4) Both engine room spaces.
(5) After living space.

Being divided in this way, all machines would not be operating at the same time once the ship was dried down. This should result in a great reduction in the power demand required at the yard, as the machines would operate only occasionally to take care of infiltration of moisture.

To accomplish this, electric humidistats are required for each main compartment. They will keep the machine running while the relative humidity is above 30 per cent.

Actually, two humidistats are used in each compartment—one close to the ship's hull near the highest point of the compartment, and one within an inch of the ship's hull near the lowest point of the compartment, which would be below the waterline. The coldest spot is the one which would be first to deposit sweat and at all times would have a higher "relative humidity" than air touching warmer parts of the shell. In the summer time the coldest portion of the compartment is usually that below the waterline, as the water is colder than the air. In the winter time, particularly around Philadelphia, the air is usually colder than the water and the humidistat above the water line would be the controlling instrument. These humidistats are connected in parallel with the starter of the unit. In case either humidistat shows a rise in relative humidity, the dehumidifier will start up and continue dehydration until the truant moisture is removed.

Should something happen to the machine so that it fails to function, an electric bell would ring to call the attention of the shipkeeper to the failure. In this way there is no extra cost for supervision or watchmen to handle a whole fleet of decommissioned ships.

**Hand Portable Dehumidifying Unit.**

When this stage of the development was reached, it was thought desirable to have a still smaller unit for ships in commission, particularly combatant ships. It was not felt that a built-in system, using perhaps the damage-control piping, would be desirable for the fighting ships at this time.

It was, however, felt that a portable unit should be designed which would be small enough to pass through a 13-inch by 18-inch manhole and still have enough capacity to reduce the moisture in various spaces and maintain it in that condition with the minimum amount of manual effort.

A regenerative unit was out of the question for use in double-bottom spaces and storerooms well below deck, as no air piping was to be provided through the bounding surfaces for the intake of new air to be dried or for the exhaust of damp air from the regenerating process. Consequently, units of the construction shown in Fig. 24 were finally designed. The lower section houses a motor and blower. Its load is small enough so that it can be plugged into any ordinary lamp socket or outlet. A cartridge of silica gel with threaded openings at top and bottom fits onto the blower unit. When the cartridge is placed on the blower unit

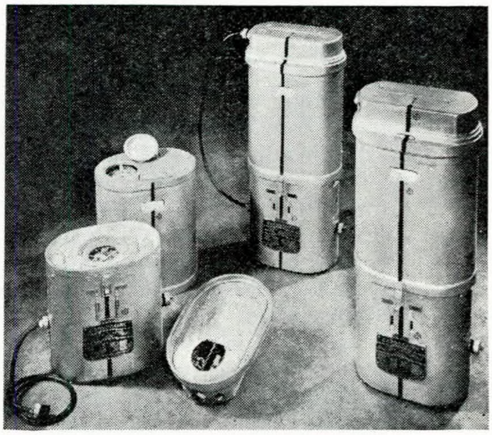


FIG. 24.—*Portable Obround dehumidifier showing blower assembly, silica gel adsorber, and heater section.*

and the blower is started, air is pulled down through the cartridge, leaving its moisture in the silica gel crystals. This can continue for over four hours under the heavy design load and under milder conditions will continue to take out the moisture for many hours. Pyrex tubes of silica gel impregnated with cobalt chloride serve as tell-tales to determine whether or not a cartridge taken from the shelf is dry. If the main body of gel is dry, the telltale gel will be a bright cobalt blue. As it approaches saturation, it turns to a pink colour.

When the cartridge becomes saturated, another one can be placed on the same blower unit without removing it from its location in a compartment, double-bottom or void space. This cartridge can then be taken up above and placed on another blower unit for reactivation. A heater unit, shown in Fig. 24, is placed on top of the silica gel cartridge. Air is then pulled through both heater and cartridge by the blower. The hot air heats the silica gel, which gives off its moisture. When the cartridge has been reactivated, which will not take more than four hours if completely saturated, the cartridge is removed and the closures screwed in position. It is then ready for use again.

Three of these units are being used at a naval air station for keeping flying boats dry when they are hauled out onto ramps overnight. In the tropics, sweating occurs frequently in the interior of the flying boats during the cool hours of the night.

Forty units are now in production for use on battleships and cruisers. It is believed that the use of these small units will save many hours of painting, chipping and cleaning of double-bottoms and enclosed spaces with a more certain preservation of the hull structure.

**Watertight Integrity.**

A particularly desirable use for such units is in some storeroom spaces of warships. Many such rooms, other than cold storage spaces which are beyond the scope of this application, contain dry stores, such as flour, biscuits, clothing, etc., which can be severely damaged by mould due to high humidity conditions. Some authorities state that relative humidity must be at about 80 per cent. before mould can form readily. Consequently, if the relative humidity is kept below 70 per cent., the problem of mould formation is solved.

There is a military reason for using dehumidifying units in these locations. At present it is customary to provide ventilation to these spaces to prevent mould formation. This requires a supply duct and an exhaust duct where the space is desired to be watertight. Most storerooms are watertight spaces and part of the cellular system of the ship, because these storerooms are placed in spaces not used for the propulsion equipment, magazines or crew accommodation. Storerooms are generally tucked away in spaces left over from the main functions of the ship. Consequently, these compartments are below armoured decks, and behind watertight bulkheads and decks, all of which complicates the ventilation problem.

Dehumidification thus has a distinct military value because, although valves, automatic float cut-offs and other devices can be installed in ventilating trunks, there is no positive surety that they will be properly operated when needed. In action, personnel assigned to this duty may be killed or wounded. The heavy force of modern underwater explosions or bombings from the air may warp bulkheads sufficiently to prevent cut-off of this piping, which then becomes a watercourse at the expense of watertight integrity. It will also be unnecessary to run the risk of taking off watertight manhole covers of explosion spaces to air out or dry out these important protection compartments. These spaces will be kept dry and will not sweat.

### PART 8.

**Summary and Outlook.**

It may appear premature to present at this time an interim report on dehumidification in ships, instead of withholding it until sufficient observational data are accumulated for a final paper, and the machinery devised for this purpose is more nearly perfect. The authors felt, however, that such a report is due this Society and the American shipping industry in view of their continued and active interest in this work after the presentation of Section I of this paper. So much is happening these days so rapidly that the industry is entitled to know what is going into modern ships. This report discussed the following facts:—

(1) The theories developed in Section I have in general been borne out.

(2) The dew point of the air is most important. Its control in the cargo hold is necessary to prevent moisture damage to cargo.

(3) Actual seagoing use has stressed the importance of certain details, such as danger from free moisture in the cargo regardless of the season. It has minimized other details, as two-stage adsorption in the air-drying unit. Some new ideas, too, have come forth; e.g., in the concept of "the dry air blanket" over the top of the cargo.

(4) Experience in adapting dehumidification to ships which had been already designed or practically built showed that completed vessels can have the system without undue delay or serious changes in existing structure.

(5) Repeated voyages show that holds treated with dehumidification fare far better than adjacent unprotected holds.

(6) Dehumidification is found of military use in saving thousands of defence man-hours by getting war supplies to destination without damage.

(7) Trials of small portable units in combatant ships show promise of better preservation of the ships' underwater compartments with surer maintenance of watertight integrity. Full-scale tests with larger portable units have shown that decommissioned ships can be successfully preserved against moisture damage, so that they will be ready for active duty without costly delay and overhaul.

Special designs are in the making for grain ships and cement carriers. Barges of the inland waterways may soon join the fleets of protected ships.

We hope that the results described in this paper will provoke further thought in the minds of marine men, both naval and merchant, to consider the use of dehumidification for other applications in their own particular fields or specialties.

# JUNIOR SECTION.

## Naval Architecture and Ship Construction (Appendix).

*By* R. S. HOGG, M.I.N.A.

Erratum.

The author regrets that a misstatement occurred in Chapter XVI on the subject of air resistance referred to under the heading of "The Determination of Horse Power from Model Experiments". Paragraph 9 (page 35, April, 1942 TRANSACTIONS) should be deleted and the following substituted:—

"No mention has been made in these discussions of *air resistance*. It is of little importance, and in the absence of precise experimental data it is usual for the designer to add a small percentage to the water resistance to cover this effect. About 5 per cent. would be enough.

The experimental work of W. Froude and Zahm (in America) on plane surfaces and the more recent work of G. S. Baker on models of superstructures support the view that air resistance is comparatively small. It becomes of less account (relatively) as speed increases, and there appears to be little advantage in streamlining the superstructures."

Waves.

The pressure at any point on the surface of a wave must be that due to the weight of the atmosphere, or in other words the surface is one of equipressure. If for a moment the water be considered stationary, it would seem, according to the principles of hydrostatics, that the pressure in the trough must be much greater than on the crest, owing to the head of water produced by the difference in level at trough and crest (see Fig. 194).

It is necessary therefore to provide a theory which will account for the motion of the wave particles in such a way as to produce a series of equipressure tubes which

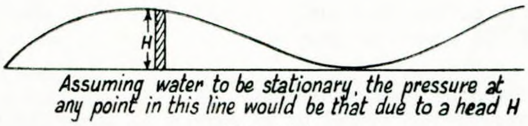



FIG. 194.

follow the wave profile.

In what follows an attempt will be made to show that the trochoidal wave theory will satisfy these conditions in certain circumstances.

*Trochoidal Wave Theory.*

This theory supposes every particle in any equipressure tube to trace out a circular path as the wave passes (in point of fact the path is slightly elliptical). It is common knowledge that a cork thrown on to the surface of a wave will rise and fall as the wave passes; it will move forward on the crest and backwards in the trough. Adding these motions together, it is clear that the cork moves in a circular, or nearly circular path.

A trochoid is the curve traced out by a point within a circle which is rolling along the underside of a straight line. The easiest way of drawing a trochoid is to take a penny with a hole in it, place a pencil point in the hole, and roll the penny along the lower edge of a ruler. The curve traced out by the pencil point is a trochoid.

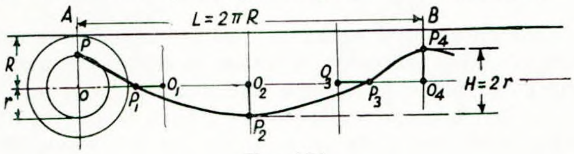



FIG. 195.

Fig. 195 depicts a trochoidal wave surface.

The radius of the rolling circle $=R$

Hence length of wave $L=2\pi R$

Radius of tracing circle $=r$

$\therefore$ Height of wave $H=2r$

For each quarter length travel of the rolling circle the tracing point P moves anti-clockwise through 90° Thus the points $P_1$, $P_2$, $P_3$, $P_4$ are obtained. A curve through these points is the surface trochoid of the wave.

The wave structure is assumed to be made up of a series of equipressure tubes each one of which is trochoidal in form. The subsurface trochoids have the same longitudinal travel (*i.e.* they are each generated from a rolling circle of radius $R$), but are of diminishing heights as the distance below the surface trochoid increases. The general appearance will be seen from Fig. 196.

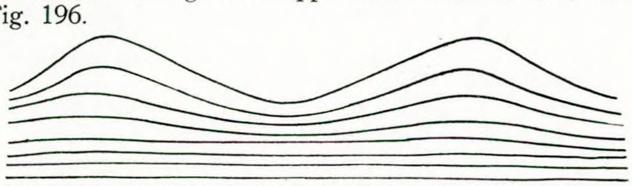


FIG. 196.

In Fig. 197 $P_1$ is a point on the trochoid, then $O_1P_1=r$, $O_1N=R$.

The motion of $P$ consists of a rotation around $O$ added vectorially to the motion of translation along $AB$.

$N$ is the instantaneous centre for the position $P_1$ as shown. Hence $P_1O_1N$ is the vector diagram of velocities, *i.e.* $\overline{NO_1}+\overline{O_1P_1}=\overline{NP_1}$

and $NP_1$ must be $\perp^r$ to the trochoid at $P_1$.

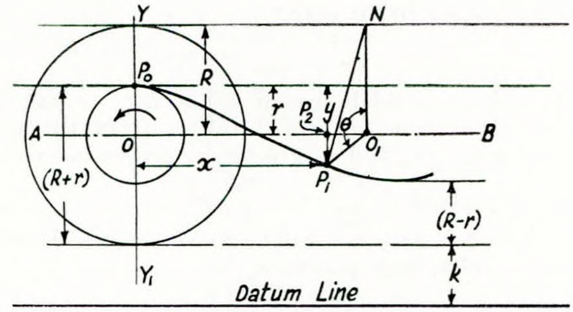



FIG. 197.

If $\omega$ be the angular velocity of $P$ about $O$, the linear velocity of $P$ due to its rotation around $O$ is $r\omega$. Let $P_1N=\rho$. Then on the scale for which $O_1P_1=r\omega$ it follows $P_1N$ represents a velocity of $\rho\omega$ about $N$, *i.e.*, the resultant linear velocity of $P_1=v=\rho\omega$ ... ... ... ... (1)

This result can also be obtained by pure mathematical reasoning as follows :—

When the rolling circle turns through an angle $\theta$, $O$ has travelled $R\theta$ along $AB$, and $P_o$ has now rotated anti-clockwise through an angle $\theta$, thus occupying the position $P_1$.

$$\therefore \quad O_1P_2=r\cos(\theta-90)=r\sin\theta.$$

[Note the sine curve and cosine curve are always 90° out of phase.]

And taking the $\perp$' axes through $P_0$,

$$x=R\theta-r\sin\theta=\frac{L\theta}{2\pi}-\frac{H\sin\theta}{2}$$

Also $y=r+r\sin(\theta-90)=r-r\cos\theta=\dfrac{H}{2}(1-\cos\theta)$.

$$\therefore \text{ Equation of trochoid is } \left\{\begin{array}{l} x=\dfrac{L\theta}{2\pi}-\dfrac{H\sin\theta}{2} \\ y=\dfrac{H}{2}(1-\cos\theta) \end{array}\right\}$$

Suppose the point $P_1$ to move to an adjacent position $Q$ such that $P_1Q=ds$.

then $ds^2=dx^2+dy^2$, and

$$v=\frac{ds}{dt}=\frac{\sqrt{dx^2+dy^2}}{dt}$$

or $v^2=\left(\dfrac{dx}{dt}\right)^2+\left(\dfrac{dy}{dt}\right)^2$

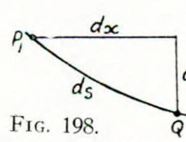



FIG. 198.

$$\text{But}\frac{dx}{dt}=\frac{dx}{d\theta}\times\frac{d\theta}{dt} \quad i.e. \quad \left(\frac{dx}{dt}\right)^2=\left(\frac{dx}{d\theta}\right)^2\times\left(\frac{d\theta}{dt}\right)^2$$

$$\text{Similarly,} \quad \left(\frac{dy}{dt}\right)^2=\left(\frac{dy}{d\theta}\right)^2\times\left(\frac{d\theta}{dt}\right)^2$$

$$\therefore \quad v^2=\left[\left(\frac{dx}{d\theta}\right)^2+\left(\frac{dy}{d\theta}\right)^2\right]\left(\frac{d\theta}{dt}\right)^2$$

However, if $x=R\theta-r\sin\theta$

$$\frac{dx}{d\theta}=R-r\cos\theta,\ \left(\frac{dx}{d\theta}\right)^2=(R-r\cos\theta)^2,$$

and if $y=r-r\cos\theta$

$$\frac{dy}{d\theta}=r\sin\theta,\ \left(\frac{dy}{d\theta}\right)^2=r^2\sin^2\theta$$

$$\text{also} \quad \frac{d\theta}{dt}=\omega, \quad \left(\frac{d\theta}{dt}\right)^2=\omega^2$$

$$\begin{aligned} \therefore\ v^2 &= [(R-r\cos\theta)^2+r^2\sin^2\theta]\omega^2 \\ &= [R^2-2Rr\cos\theta+r^2\cos^2\theta+r^2\sin^2\theta]\omega^2 \\ &= [R^2-2Rr\cos\theta+r^2]\omega^2 \end{aligned}$$

From the vector diagram (Fig. 197) and using the cosine rule

$$(P_1N)^2=\rho^2=R^2+r^2-2Rr\cos\theta.$$

Substituting in the above,

$$v^2 = \rho^2\omega^2$$
$$\text{or } v = \rho\omega.$$

If the trochoidal stream tubes are of the same pressure throughout, it would follow from Bernouillis' theorem that if $v_1$ and $v_2$ are the velocities at crest and trough respectively, $\frac{v_1^2}{2g} + h_1 = \frac{v_2^2}{2g} + h_2$
where $h_1$ and $h_2$ are the heights above a given datum for the crest and trough positions, *i.e.*,

$$h_1 = k + R + r$$
$$h_2 = k + R - r.$$

Hence, $\rho_1^2\frac{\omega^2}{2g} + k + R + r = \rho_2^2\frac{\omega^2}{2g} + k + R - r$

or $\frac{\omega^2}{2g}(\rho_1^2 - \rho_2^2) = -2r.$

Now $\rho_1 = R - r,\ \rho_2 = R + r.$

$$(\rho_1^2 - \rho_2^2) = (\rho_1 - \rho_2)(\rho_1 + \rho_2)$$
$$= (R - r - R - r)(R - r + R + r)$$
$$= -4Rr.$$

Hence $\frac{\omega^2}{2g} \times -4Rr = -2r$

or $R = \frac{g}{\omega^2}$

This gives the condition for the trochoidal tubes to be equipressure tubes, *viz.*:—

For the trochoidal tubes to be equipressure, and therefore for the trochoidal theory to be valid, *the radius of the rolling circle R must be constant and must equal* $\frac{g}{\omega^2}$ where $\omega$ is the angular or orbital velocity of the particles.

The velocity of propagation of a wave is obtained by dividing its length by the time for two successive crests to pass a fixed point.

The value of $T$, the time for two successive crests to pass a fixed point, is of course the *period* of the wave. If the trochoidal theory holds,
then $T$ = time for one complete revolution of the rolling circle
$\omega$ = angular velocity of the particles
$L = 2\pi R$

whence $T = \frac{2\pi}{\omega}$

and since $R = \frac{g}{\omega^2}$

$$\omega = \sqrt{\frac{g}{R}}$$

$$\therefore\ T = 2\pi\sqrt{\frac{R}{g}} = 2\pi\sqrt{\frac{L}{2\pi g}} = \sqrt{\frac{2\pi L}{g}}$$

Also the linear speed of propagation $= v$

where $v = \frac{L}{T} = \frac{L}{\sqrt{\frac{2\pi L}{g}}} = \sqrt{\frac{gL}{2\pi}}$

*Example 78.*

Find the period of a N.A. storm wave 400ft. long. What is its linear speed of propagation?

$$T = \sqrt{\frac{2\pi L}{g}} = \sqrt{\frac{400\pi}{16}} = 5\sqrt{\pi} = 8{\cdot}87 \text{ secs.}$$

$$v = \sqrt{\frac{gL}{2\pi}} = \sqrt{\frac{16 \times 400}{\pi}} = 45{\cdot}1 \text{ft. per second.}$$

= 30 statute miles per hr. (appr.).
= 26 knots (approximately).

This means that only a very fast ship could run away from waves of this size.

*The Period of Roll of a Ship.*

Suppose the vessel to be heeled to some position $\theta$ where the restoring couple $= W \times GZ = W \times GM \times \theta$ (if $\theta$ is small). The effect of this couple is to produce an acceleration towards the mean position which may be written $\frac{d^2\theta}{dt^2}$. If the mass of the ship $= \frac{W}{g}$ and the radius of gyration $= k$, then since twisting moment = rotational inertia × angular acceleration.


Fig. 199.

$$W.GM.\theta = -\frac{Wk^2}{g} \times \frac{d^2\theta}{dt^2} \quad (k \text{ is the radius of gyration})$$

$$\therefore\ \frac{d^2\theta}{dt^2} + \frac{GM.g}{k^2} \times \theta = 0$$

$\frac{GM.g}{k^2}$ is a constant which may be represented therefore by $n^2$,

then $\frac{d^2\theta}{dt^2} + n^2\theta = 0.$

This differential equation may be solved in a variety of ways. The following solution is not necessarily the shortest, in fact it is not the one usually given in works on naval architecture. It has the merit, however, of not starting with the general solution as an assumption—a subterfuge often employed in solving this class of equation.

Multiply through by $2d\theta$

then $2d\theta \times \frac{d}{dt} \times \frac{d\theta}{dt} + 2n^2\theta d\theta = 0$

$$2\frac{d\theta}{dt} \times d\left(\frac{d\theta}{dt}\right) + 2n^2\theta d\theta = 0$$

Integrating $\left(\frac{d\theta}{dt}\right)^2 + n^2\theta^2 = C_1$

When $\theta = \alpha$ (extremity of roll) $\frac{d\theta}{dt} = 0.$

$$\therefore\ n^2\alpha^2 = C_1$$

and $\left(\frac{d\theta}{dt}\right)^2 = n^2(\alpha^2 - \theta^2)$

or $\frac{d\theta}{dt} = n\sqrt{\alpha^2 - \theta^2}$

$$\frac{d\theta}{\sqrt{\alpha^2 - \theta^2}} = ndt.$$

Integrating, $\sin^{-1}\frac{\theta}{\alpha} = nt + C_2$

or $\frac{\theta}{\alpha} = \sin\,(nt + C_2).$

When $\theta = -\alpha$ $t = 0$ [commencement of roll from port, say]

$$\therefore\ -1 = \sin C_2$$

*i.e.*, $C_2 = \frac{-\pi}{2}$

$\therefore$ When $\theta = 0$ [upright position]

$$\sin\left(nt - \frac{\pi}{2}\right) = 0$$

$$nt - \frac{\pi}{2} = 0$$

$$t=\frac{\pi}{2n}=\frac{\pi}{2}\sqrt{\frac{k^2}{GM.g}}$$

This is the time to move from say port to the mid position.

∴ The time of roll from port to starboard and back to port equals $T=4\times\frac{\pi}{2}\sqrt{\frac{k^2}{GM\times g}}=2\pi\sqrt{\frac{k^2}{GM\times g}}$

*N.B.*—The result is true only when the motion is strictly simple harmonic. In practice the formula gives reliable values when $\theta$ is less than about 15° and when $GM$ is not too small.

To indicate one case in which it fails, let the metacentric height ($GM$) be zero :—

$$\text{then } T=2\pi\sqrt{\frac{k^2}{0\times g}}=\infty,$$

which is obviously absurd. Actually, of course, the formula can only hold within the limits for which it is reasonably true to say that the righting lever $GZ=GM\times\theta$, and this is clearly not true when $GM=0$.

For a more rigid and comprehensive treatment of the subject see a paper by Professor Scribanti (I.N.A., 1904) and "Studies in Naval Architecture" by Dr. A. M. Robb.

*Example 79.*

Find the still water period of roll for a vessel whose radius of gyration ($k$) equals 18ft. and whose metacentric height is 1·5ft.

$$T=2\pi\sqrt{\frac{18^2}{1{\cdot}5\times32}}=16\tfrac{1}{4}\text{ secs. (approx.).}$$

*The Law of Dynamic Similarity.*

This was first enunciated by Newton, although the generalised mathematical treatment probably originated in France. Both Lord Rayleigh and W. Froude recognized its value in relation to practical problems, and it is to the latter that its application to the wave resistance of a ship is attributed.

A rigid proof demands some considerable acquaintanceship with the mathematical theory of dynamics, but the following treatment should prove adequate for the purposes of the general reader.

It is well known that force=mass × acceleration.

If $w$=weight per unit volume of a body

$L$=a linear dimension of the body

then mass $\propto wL^3$.

Now acceleration is rate of change of velocity, and can be written $\frac{v}{T}$ where $v$=velocity acquired in time $T$. Further, velocity is rate of change of position, and can be written $\frac{L}{T}$ where $L$ is the distance moved in time $T$.

$$\text{Whence acceleration}=\frac{L}{T}\times\frac{1}{T}=\frac{L}{T^2}$$

$$\therefore \text{ Force}\propto wL^3\times\frac{L}{T^2}$$

Write $\frac{L}{v}$ for $T$,

$$\text{then force}\propto wL^3\times\frac{L}{L^2/v^2}\propto wL^3\times\frac{v^2}{L}$$

*i.e.*, Force varies as $L^3$ if $\frac{v^2}{L}$ or $\frac{v}{\sqrt{L}}$ is constant.

This is the law of dynamic similarity.

In the case of the wave resistance of a ship it can be shown that $\frac{v}{\sqrt{L}}$ is constant; for it has been proved already in this appendix that the speed of a wave is given by

$$v=\sqrt{\frac{gL}{2\pi}}$$

$$\text{Whence }\frac{v}{\sqrt{L}}=\sqrt{\frac{g}{2\pi}}=\text{a constant.}$$

Further, it can be shown both theoretically and experimentally that the length of the waves produced by similar ships will vary directly as the length of the ships when the latter are running at their corresponding speeds,

$$\text{i.e., when }\frac{\text{ship speed}}{\sqrt{\text{length of ship}}}=\text{a constant.}$$

The law of dynamic similarity therefore holds, and *Froude's law of comparison* may be stated as follows :—

*The wave resistances of similar ships will vary as the cube of their linear dimensions, if the speeds are in the ratio of the square root of their linear dimensions.*

*Stability at Large Angles.*

In the text stability has been considered from the point of view of small angles of inclination only. The equation $GZ=GM\sin\theta$ does not hold, however, for angles beyond about 15°, and the following procedure becomes necessary. The moment of statical stability

$=W\times GZ$ tons feet

$=W\ \{BR-BT\}$

But from the principle of moments :—

$$\frac{v\times hh_1}{V}=BR$$

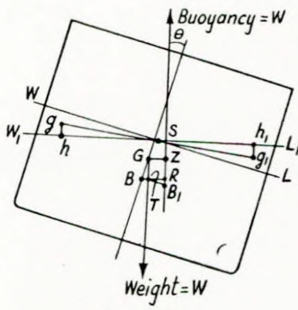



FIG. 200.

where $v$= volume of the wedge of transference

$hh_1$= horizontal travel of the c.g. of this wedge

$V$= underwater volume of the ship

$BR$= horizontal travel of the centre of buoyancy as the ship inclines.

Also $BT=BG\sin\theta$.

Whence the *moment of statical stability*

$$=W\left\{\frac{v\times hh_1}{V}-BG\sin\theta\right\}$$

This is known as *Attwood's formula.*

The work involved in evaluating $v\times hh_1$ is very tedious and the formula is only employed to get a few check spots on the *cross curves of stability.*

*Cross curves of stability* are curves of $GZ$ plotted on a base of displacement for constant angles of heel. That is to say, the vessel is assumed to be inclined at some angle $\theta$, and the values of $GZ$ are estimated at this

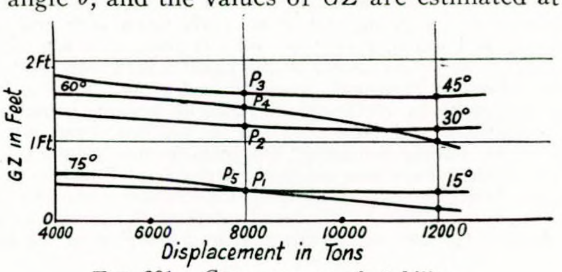



FIG. 201.—*Cross curves of stability.*

angle for a number of displacements between the light and load condition. The process is repeated for a series of angles selected usually at intervals of $7\frac{1}{2}°$ or $10°$. When completed the results can be portrayed graphically as in Fig. 201.

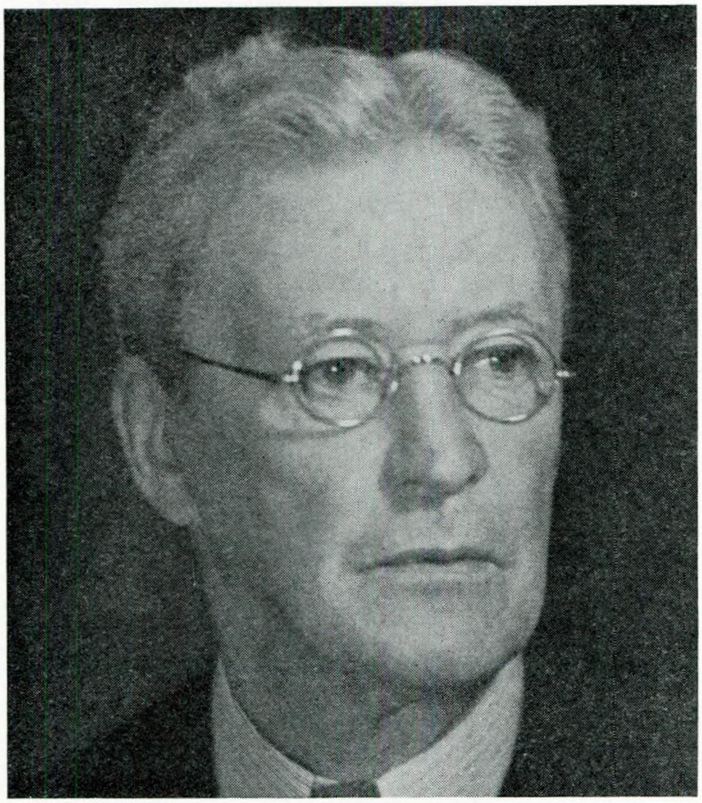
*(To be continued).*

# OBITUARY.

## MR. A. C. HERON.

It is with deep regret that we record the death of Mr. A. C. Heron, which occurred on Tuesday, 20th January, 1942, at his home at Cremorne, Sydney, in his 77th year.

Mr. Heron served his apprenticeship with Messrs. Thompsons of Clydebank and Messrs. Caird & Co. of Greenock. He supplemented his general education by technical studies which resulted in his obtaining from the City and Guilds of London Institute a 2nd Class Honours Pass in Mechanical Engineering. He then commenced his sea career and at the age of 25 was holding the position of second engineer in the Portuguese Mail Steamers. Later he



The late Mr. A. C. Heron.

became chief engineer of passenger steamers on the Brazilian and Australian coasts. Mr. Heron was then appointed an engineer officer in the Royal Indian Navy, in which he served for three years. He then entered the shipyard of Messrs. A. Rodger & Co. of Glasgow, where he obtained further experience of shipbuilding and naval architecture.

In 1894 Mr. Heron was appointed a surveyor on the staff of Lloyd's Register of Shipping and in his early years with the Society was stationed at London, Liverpool and Glasgow. He was the first Lloyd's surveyor to be appointed in the Great Lakes area, and subsequently he served at Nagasaki, Shanghai and Seoul. Finally, he was appointed to Sydney in 1912 and in 1924 he became principal surveyor for Australia and New Zealand, a position from which he retired in 1934, having completed 40 years in the Society's service.

In 1909 Mr. Heron was elected a Member of The Institute and twelve years later he was appointed Vice-President for the Sydney area, in which capacity he rendered particularly effective service until his death. He was also for many years a Member of the Institution of Naval Architects. Since his retirement from business he was a keen member of the Mosman Bowling Club. The death of Mr. Heron, who leaves a widow, a daughter and three sons, will be keenly regretted by his many friends in this country and Australia.

# ELECTION OF MEMBERS.

List of those elected by the Council during the period 27th February to 30th March, 1942.

**Members.**
George Boag Baird.
James Charles Herriot.
Eng. Rear-Admiral John Kingcome.
William Arthur Trevor Taylor.
Captain William Ramsay Halley, I.A.O.C.
Harold Edward Pinches.

**Associates.**
Thomas William Burt.
James Henry Clarke.
John Pollock Crawford.
Walter Ronald Guerin.

**Student.**
Leslie Archibald Goodyear.

**Transfer from Associate Member to Member.**
Arthur Douglas Timpson.

**Transfer from Associate to Member.**
Allan Hubert Abraham.

# ADDITIONS TO THE LIBRARY.

Presented by the Publishers.

**The following British Standard Specifications:—**

| | |
|---|---|
| No. 24: Part 6: 1942. | Steel Plates, Sections, Bars and Rivets (Railway Rolling Stock Material). |
| No. 24: Part 2: 1942. | Tyres (Railway Rolling Stock Material). |
| No. 24: Part 3: 1942. | Springs and Spring Steel (Railway Rolling Stock Material). |
| No. 995-1942. | Gas Producers. |
| No. 996-1942. | Performance of Drying Ovens and Commercial Acceptance Tests of Fuel-fired Bakers' Ovens. |
| No. 991-1941. | Data on Cast Iron. |
| No. 997-1941. | Crude Sperm Oil. |
| No. 1003, 1004-1941. | High Purity Zinc and Zinc Alloys for Die Casting. |
| No. 1001, 1002-1941. | High Tensile Brass Bars and Sections and Forgings. |

**Memorandum to Consumers and Producers Regarding the Standardisation of Special and Alloy Steels. (British Standard 970A).**

On the instructions of the Iron and Steel Control a Memorandum of the utmost importance to all users and producers of wrought and alloy steels has just been issued by the British Standards Institution. (Reference No. 970A).

In August last year B.S. 970 was issued. It included 58 steels in what is called the En. series and it was stated that it was considered that this range would be adequate to cover all the essential needs of the general engineering industry. This work of co-ordinating the steel production of the country has now been taken a stage further and has been given practical effect by a Direction which has been issued by the Iron and Steel Control to all steel producers stating that in future all wrought and special alloy steels supplied shall be made to a selected list of 44 of the 58 steels given in B.S. 970.

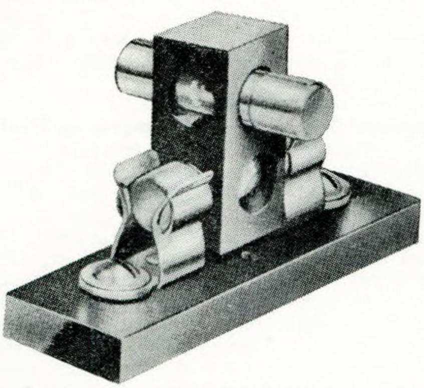
This decision, which represents a very important step in rationalisation in the steel industry, has been taken in full consultation with all the Services. The memorandum now issued explains the direction and sets out the steels actually available.

Any user, producer or contractor who has not so far received a copy of the memorandum which is being circulated to contractors by Government Departments is advised to communicate with the British Standards Institution, from whom copies are obtainable price 6d. nett (9d. post free).

# Abstracts of the Technical Press

**New Method of Changing Fuses.**

A Chicago firm have introduced an improved form of fuse holder designed for use in confined spaces. This unit also serves as a combined spare fuse holder and puller. As may be seen in the accompanying illustration, the fuse in circuit goes through one end of the soft, rubber, rectangular holder between the clips, whilst above it is an opening for the spare fuse. The caps of the spare fuse project beyond the holder, thereby providing an easy grip for two fingers. When the fuse in circuit blows, all that need be done is to pull out and reverse the rubber holder, thus putting the spare fuse in circuit and bringing the blown fuse into the position previously occupied by the spare one. One end of the holder is painted red, so that when the fuse is changed the red end is brought into full view. If the black end is uppermost, both the fuse in circuit and the spare are still serviceable. —*"The Nautical Gazette", Vol. 132, No. 1, January, 1942, p. 46.*



**Naval Constructors for Royal Canadian Navy.**

A Department of Naval Construction, which will deal with all matters appertaining to new naval construction in Canada, is being established for the Royal Canadian Navy. The new department will be under the direction of an engineer captain, on loan for a period of four years from the British Admiralty. This officer will have a technical staff of both British and Canadian experts to assist him, and will work under the authority of the Chief of Naval Staff. One of the most important responsibilities of the department will be the supervision of the construction of the "Tribal" class destroyers in an East Coast shipyard.—*"Canadian Shipping and Marine Engineering News", Vol. 13, No. 6, January, 1942, p. 34.*

**"Bits and Pieces" for Shipbuilding.**

One of the main difficulties of the Canadian shipbuilding and marine engineering industries was the shortage of machine tools and skilled operators, and in order to overcome this bottleneck situation the Canadian Pulp and Paper Association has formed a Wartime Machine Shop Board for the purpose of utilising the idle hours of machine tools in the 83 mills of the Dominion. The Board's scheme includes the training of new operatives to man the machines over a 24-hour day, and a dilution of the skilled personnel to make as many men as possible available for war work. The ordinary working hours of a machine shop in a pulp and paper mill amounted to 48 per week, and allowing for meal-hours, this meant that the machines were normally idle for 114 hours in a seven-day week. These machine shops are mostly large and well equipped, their plant including case-hardening furnaces, welding equipment, hydraulic forging presses and hobbing machines, in addition to lathes and machine tools of every kind. Some of the larger mills also possess pattern shops and foundries. With an average of about 30 machines in the 83 mills, this meant that a maximum of 283,860 idle machine-hours could be utilised per week. The problem of manning the machines, as well as the fitting and erecting shops, has been solved by the adoption of a 24-hr. day and a seven-day week, with the men working an 11- or 12-hr. shift until such time as they can be relieved by newly-trained operatives. The training of new men and boys is taking place by means of theoretical home-study courses supplemented by practical shop instruction. The home-study course is a special one of 12 months' duration conducted by one of the leading Canadian correspondence schools. The students are examined at regular intervals, and their weekly tuition fees of $1.25 are paid by their employers and charged against their earnings. The practical instruction is given at evening classes in the shops and, when possible, the trainees specialise on some particular machine. The courses include machine-shop practice, blacksmithing, pipe-fitting, welding, millwrights' work, tinsmithing, steam-engine maintenance and electrical work. The production system adopted is somewhat similar to the sub-contracting programmes carried out in the U.K., and the "farming out" system employed in the U.S.A. The co-ordinating department of the Board compiled a detailed census of the machines and skilled labour available at each mill, leaving the problem of manning the machines and training of the new workers to the respective companies concerned. The allocation of sub-contracts to these mills is done by the co-ordinator in accordance with the facilities available at each, the geographical location of the various mills having no bearing on the placing of the sub-contracts. The reason for this is that the parts made are comparatively small and can be readily shipped by rail to their destination. Among the "bits and pieces" made for the shipbuilding and marine engineering industries are the following (mostly complete units):—Winches and turning engines; tunnel and tailshaft bearings; eccentric rods, sheaves and straps for reciprocating engines; large bearing bolts and holding-down bolts; valve chests and fittings; reversing engines; relief, change-over, stop and throttle valves; evaporators and distillers; feed-water regulators and feed-check valves; filters and strainers; air vessels; drilling jigs; and miscellaneous fittings of various descriptions.—*A. C. MacNeish, "Canadian Shipping and Marine Engineering News", Vol. 13, No. 6, January, 1942, pp. 26 and 28.*

**Improved Water-pump Seal.**

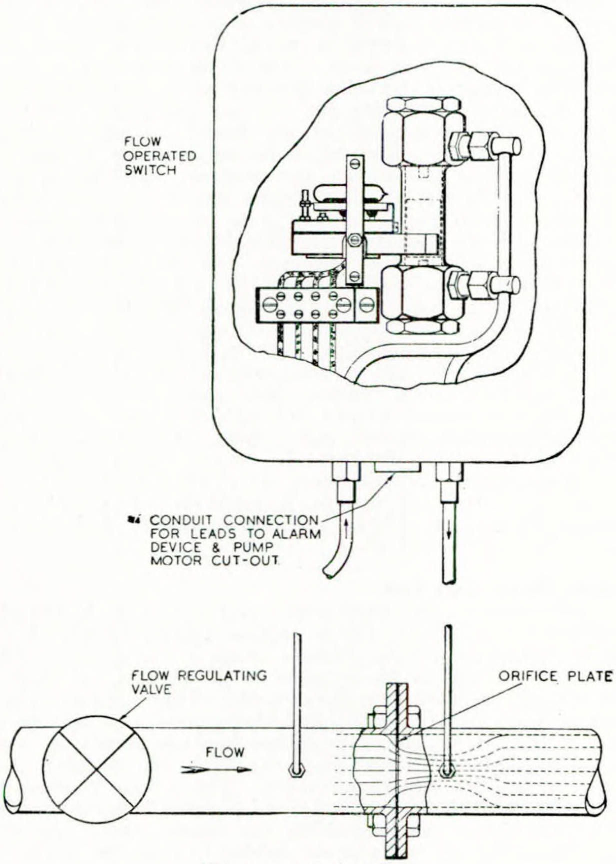
A new bellows-type water-pump seal has been developed by a Hamilton (Ont.) firm of engine packing manufacturers. It comprises a corrugated tubular bellows made of a synthetic rubber composition, claimed to be resistant to all greases, oils and salt water, etc., and enclosed by a spiral spring. Other features claimed for the seal are that the enclosing spring causes it to operate as a driving coupling, and that as the design does not permit the seal to touch or have sliding contact with the shaft, its efficiency cannot be impaired by dirt, rust or corrosion. The bellows connects two flanged ends, with the spring in a fixed position between the inside shoulders of these, thereby holding the contact faces against the sealing washer on one end and the driving base on the other. The seal flexes as a single unit, so that variations of pressure, misalignment, thrust, torque or vibration set up by an unbalanced impeller can, it is claimed, be easily compensated for. The serrated concentric-grooved contact faces, with flat-faced ribs, are said to effect a position seal by suction action, and as both ends of the seal are identical, it cannot be fitted the wrong way round.—*"Canadian Shipping and Marine Engineering News", Vol. 13, No. 6, January, 1942, p. 48.*

**Lubricating-oil Conditioner.**

An appliance known as a "Milwaukee Vacuum Oil Re-refiner" is being fitted in several motor vessels by a New York firm. The diluted or contaminated Diesel-engine lubricating oil is heated in a vacuum to get rid of the water and volatile products, after which it is filtered through Fuller's earth. No odour or dangerous fumes can escape into the engine room during the process of re-refining. It is claimed that the effect of the process is such that the oil is fully restored to the characteristics of new oil, and in most cases the colour is restored. It is further claimed that in addition to the removal of water and other diluents effected by the treatment, the oil is rendered more stable and durable, and in many instances the film strength is doubled, the viscosity increased, and the resistance to emulsion improved. The apparatus is made in a variety of capacities, ranging from 1 to 50 gall./hr.—*"Motorship and Diesel Boating", Vol. XXVII, No. 1, January, 1942, p. 77.*

**Flow-operated Switch to Guard Water-cooled Plant.**

One of the latest devices for safeguarding water-cooled engines, air compressors and other plant and equipment from damage due to failure of the cooling-water supply, is a flow-operated switch, the construction of which is shown in the accompanying diagrams. The switch is housed in a rectangular casing, $1\frac{5}{8}$in. by $9\frac{3}{8}$in. by $4\frac{9}{16}$in. depth, suitable for bulkhead mounting, and is connected in series with the water supply. The flow is slightly restricted by an orifice consisting of an adjustable gate valve, and the difference of pressure on either side of this orifice causes a flow of water through a vertical tube containing a piston or plunger. The gate valve or orifice is adjusted by a removable key so that the minimum flow for safety causes the piston to ascend to the top of the vertical tube, any reduction in flow causing it to fall to the bottom. The piston lifts when the head across the by-pass valve is approximately




*Flow-operated switch.*

8in. w.g., and falls when this is reduced to 6in. The movement of the piston is transmitted to a pivoted magnet surrounding the vertical tube, and on this magnet a mercury tube switch is fitted which makes or breaks the electric circuit as the magnet is tilted. This method of operating avoids any glands which might cause friction or leakage of water. The mercury tube switch has a current-carrying capacity of 2 amp. at 250 volts a.c. or d.c., and is thus suitable for operating alarm bells, lights, relays, etc.—*"Industrial Power", Vol. XVIII, No. 196, January, 1942, p. 11.*

**Diesel Propulsion in the U.S. Navy.**

Although the larger warships now under construction for the U.S. Navy are propelled by steam machinery, a considerable number of the auxiliary vessels and small craft which are being built under the great naval expansion programme will be driven by Diesel engines. Among the 1,032 Diesel-driven craft building or ordered during the past year are 79 submarines, 115 submarine chasers, 265 minesweepers of various sizes, 32 boom defence vessels, 316 landing boats, 10 fleet tugs, 25 harbour service tugs, 81 motor launches and one destroyer of a special type. The engines of these various craft vary in size from 15 h.p. to 10,000 h.p., whilst the total number of propulsion units involved is about 1,900. This figure does not include the large number of auxiliary engines required for installation in the Diesel-driven vessels, nor the Diesel-powered generating sets intended for service on board numerous steam-propelled ships.—*"Motorship and Diesel Boating", Vol. XXVII, No. 1, January, 1942, p. 56.*

**U.S. Cadet Training Time Halved.**

The U.S. Maritime Commission have announced that for the duration of the war emergency the period of training to be undergone by mercantile marine cadets is being reduced to about half the time ordinarily required. Furthermore, cadets will not be required to take competitive examinations for appointments. The U.S. Bureau of Marine Inspection and Navigation has agreed to accept 22 months' cadet training as qualifying service for candidates for the third assistant engineer's certificate examination. Of this time, two months are now to be devoted to preliminary training and basic naval science in a training establishment ashore, followed by 10 months' sea service in merchant ships and the last 10 months at a cadet school on advanced work. On completing these courses, engineer cadets will be eligible to be examined for certificates as engineer officers in both steam and motor vessels. The cadets are paid \$65 a month, with board and lodging, during their 22 months' training. A third assistant engineer is eligible for pay at the rate of \$180 to \$300 a month and all found.—*"Canadian Shipping and Marine Engineering News", Vol. 13, No. 6, January, 1942, p. 40.*

**Marine Activities of the American General Electric Company in 1941.**

The General Electric Company manufacture geared-turbine, turbo-electric and Diesel-electric propelling machinery for ships of every type, as well as switchboards, cable, motors, and other auxiliary equipment, in addition to which the company produce all kinds of apparatus and instruments for warships. During 1941, the company had an order from the U.S. Navy Department alone, turbine machinery for more than 400 propeller shafts, aggregating about 9,500,000 h.p., and reduction gears for 168 propeller shafts, totalling 4,700,000 h.p. At the same time, propelling machinery installations for over 150 cargo vessels for the U.S. Maritime Commission were in hand. The largest single order for merchant ship machinery ever placed with one firm of manufacturers was received from the Sun Shipbuilding and Dry Dock Company. It amounted to 18 million dollars and involved main propelling and auxiliary power-generating equipment, together with all the control and protective devices, for 52 oil tankers for the U.S. Maritime Commission. These vessels will be single-screw ships with turbo-electric propelling machinery of 6,600 h.p. Expansion of the company's turbine and gear manufacturing facilities, initiated during 1941, will add over a million square feet of floor space to the shops, and will cost more than 50 million dollars when completed. The three main works of the company now in process of extension are those at Schenectady, Erie and Lynn. All marine gears and some main turbines are made at Lynn, whilst the Schenectady and Erie works concentrate on the manufacture of turbines. The combined output capacity of these works is being doubled. Two of the new factories in process of construction will be solely devoted to the production of propelling machinery for C-2 and C-3 type cargo vessels, the works at Erie being due to turn out 100 turbines per annum, whilst those at Lynn will have an annual output of 50 sets of gears. Both works are scheduled to be in production by August, 1942. The company supplied the main turbines and gears, turbo-generators, Diesel-generators and switchboard equipment of the 35,000-ton battleships "South Dakota" and "Massachusettes", launched during the year considerably ahead of schedule. They also supplied similar machinery and equipment for the "North Carolina" and "Washington" of this class which were commissioned during the year well ahead of schedule. Several of the 1,630-ton destroyers commissioned in 1941 were likewise equipped with propulsion turbines and turbo-generators supplied by the company. The standardisation of propelling machinery in the U.S. Navy has played an important part in accelerating production, steam conditions of approximately 550lb./in.$^2$ pressure and 825° F. temperature having now been adopted for the main turbines of warships. Over 100,000 induction motors with motor starters were supplied during the year for battleships, cruisers, destroyers and auxiliary vessels, all of which, except certain ships of the latter type, now use a.c. equipment. The extent of the progress made in the production of the propelling machinery and equipment for 55 submarines is indicated by the fact that some have been delivered five to six months earlier than originally planned. During the year the company received orders for Diesel-electric propelling machinery (excluding submarine propelling machinery) aggregating approximately three times the horse-power of all the Diesel-electric propulsion equipment made in the U.S.A. during the previous 20 years. At the present time such machinery for 67 vessels is in process of completion, the total output involved being over 300,000 h.p.—*D. W. Niven, "Marine Journal" Vol. 69, No. 1, January, 1942, pp. 21 and 28.*

**Metropolitan-Vickers Research Work in 1941.**

The activities of the Research Department of the Metropolitan-Vickers Electrical Company during the past year have included some important work on improvements in connection with magnetic crack detectors. A new type of detector—the "FC" type—has been developed for testing large numbers of relatively small, mass-produced components, which the apparatus can deal with at the rate of 20 or more per minute; a method of magnetisation is applied which has not been previously used. An improvement in the so-called "red fluid" type of detector has eliminated the need for the special care in stirring the red fluid to ensure satisfactory results, and the apparatus is now far simpler to handle. Metallurgical research work has included further investigations of the question of development of thermal stresses in the manufacture and treatment of large and high-tensile steel forgings, and of the precipitation hardening effect in molybdenum-vanadium steel. The latter is of special importance in connection with the development of high-temperature steam installations. Progress has been made with the analysis of stress distribution under "creep" conditions, including relaxation effect, in parts subject to bending, whilst the theory of the "creep" of metals under compound stress (which appears to be confirmed by tests on the bending of pipes subjected to internal pressure), has been further developed and is now being applied to the calculation of the changes in stress distribution caused by the "creep" of machine parts. Further research work on the "creep" of steel containing molybdenum and vanadium, as employed in steam turbine practice, has been carried out, and the effects on the "creep" resistance of Mo-Va steel due to additions of chromium has also been investigated. Equipment for carrying out "creep" tests at temperatures in excess of those usually employed, has been installed, and two units have now been operating satisfactorily for some months at these very high temperatures.—*"The Metropolitan-Vickers Gazette", Vol. XX, No. 335, January, 1942, pp. 22-28.*

**Pointers for Power Engineers.**

The American engineering journal *"Power"* runs a regular feature called "Practical Aids to Operation", and among those in the December issue is the suggestion for using a clothes wringer to extract oil from cotton waste. The wringer is fitted on to an oil drum, and the writer who is responsible for the tip declares that it saves $21 a month. Another equally simple suggestion is the manufacture of a large block of wood from short lengths of planking, to serve as a table for punching holes in gaskets, etc. The construction of such a table is shown in Fig. 5, from which it may be seen that all that is required for the assembly for the short planks are some lengths of steel section and four long bolts.—*"Practical Engineering", Vol. 5, No. 107, 5th February, 1942, pp. 71-72.*

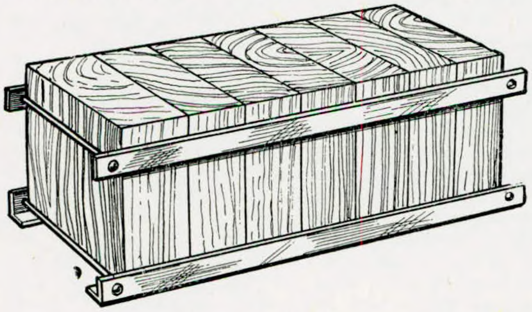


FIG. 5.

**Crankshaft Lathes.**

An invention relating to crankshaft lathes has recently been patented in this country. The chief object is the construction of a lathe in which it is possible to turn or finish all the throws of a multi-throw crankshaft simultaneously or in only a single working process and without having to change the position or centre mounting of the crankshaft in the lathe, thereby saving a considerable amount of time and labour. This is effected by the provision of what is in effect a double crankshaft lathe, the crankshaft to be turned and a guide crankshaft being mounted between fixed centres. The guide crankshaft has a tool holder freely pivoted on each throw, which is supported by the corresponding throw of the crankshaft being turned.—*"Practical Engineering", Vol. 5, No. 107, 5th February, 1942, p. 82.*

**Precision Drilling.**

Drilling machines are probably the least accurate tools used in a marine engineering shop owing to the difficulty of setting up the work in such a manner as to ensure that the centre of the hole to be drilled coincides with the axis of the drill. To surmount this difficulty, a tool-positioning device termed a "centerscope", originally developed in the U.S.A., has now been made available in this country. It is claimed that this device enables an experienced operator to centre the work with an error of only 0·00005in., while a man not familiar with the instrument can do so at once with an error of less than 0·0001in. The instrument comprises a microscope having a magnification of $\times 40$, the body of which has a projecting shank of hardened and ground steel for insertion in the drill chuck. The eye-piece is inclined away from the axis of the microscope to facilitate access, and has two parallel lines which are spaced to suit general shop practice. Since the work centre is usually indicated by the intersection of two lines marked off at right angles, the instrument is adjusted first to one line and then to the other. For face-plate work in a lathe, the centerscope is operated from the tailstock. —*"Shipbuilding and Shipping Record", Vol. LIX, No. 7, 12th February, 1942, p. 187.*

**Steamer Capsized in Dock.**

The Marine Court at Hamburg recently held an enquiry into the circumstances of an accident which occurred in a graving dock at Gothenburg, Sweden, on October 22nd last, when the German steamer "Martha Peters" capsized. While the vessel was undergoing repairs in the dock, it became necessary to undock her for two days, as the dock was required for a newly-built ship. Some of the side plates of the "Martha Peters" were still out of position, but they were above the water line. When the ship's ballast tanks were filled through hoses prior to undocking, the centre tanks were overlooked, as they were erroneously believed to be full. The dock was flooded at 7 p.m. that evening, and within 10 minutes there was 9ft. of water in it. One of the dock gates was then opened a little, with the result that water streamed in more quickly on the S. side, causing the vessel to heel over, slide off the block and capsize to port. She was subsequently pumped out and repaired. The Court found that the accident was due to the failure to flood the centre tanks of the ship after these had been emptied by the dock staff without informing the ship's officers. No blame attached to the master or crew, but the mishap proved that it was of the utmost importance for the officers of a vessel about to be undocked to satisfy themselves concerning the state of ballast tanks which affect the ship's stability.—*"Lloyd's List and Shipping Gazette", No. 39,713, 25th February, 1942, p. 11.*

**Subdivision.**

When the technical history of this war comes to be written, it will be interesting to learn how many ships succeeded in reaching port in a partly flooded condition due to underwater damage of a more or less serious nature. The records of the last war make it probable that the number of such vessels, in proportion to the total, at any rate so far as ordinary merchant ships are concerned, is not likely to be large, since few cargo vessels attain even a one-compartment-floodable standard of subdivision. When they do so it is usually because of special owners' requirements, excluding the cases of unusually buoyant cargoes such as timber. Oil tankers, of course, have an extremely good subdivision over a great part of their length, in addition to which they possess an exceptional strength of structure, but they may be relatively vulnerable at the ends, and particularly so at the stern, with engines aft in probably a single long compartment. Recent improvements in construction have doubtless resulted in an increased ability of the transverse bulkheads to survive as a structure under hydrostatic load, but on the other hand the effects of the explosion of a modern torpedo or mine are far more severe than was the case in the last war. The value of bulkheads in cargo vessels, except as partitions between holds and as structural diaphragms, may be open to question if they do not confer any higher degree of safety when damaged than has been suggested, but they do at least serve to protect cargo in adjacent holds from the effects of sea water when the damage is only slight, besides simplifying the pumping problem. Furthermore, the importance of W.T. bulkheads in limiting a possible loss of transverse or longitudinal stability, due to a moderate amount of free water, must not be overlooked.—*"Shipbuilding and Shipping Record", Vol. IIX, No. 9, 26th February, 1942, p. 251.*

**How a Tanker was Towed in from Mid-Atlantic.**

A British tanker, torpedoed in the Atlantic by a U-boat, has been safely brought into port with an oil cargo worth over £250,000. She is the 6,500-ton "Tahchee", built at Middlesbrough in 1914. The ship was torpedoed at night and set on fire, and, as she seemed likely to sink, the crew had to take to the boats, being subsequently picked up by the Canadian corvette "Orillia". When, however, it was seen that the "Tahchee" still floated, her master (Capt. W. Bannan) went back on board with the chief officer (Mr. A. M. Canner), chief engineer (Mr. C. E. Probert) and third engineer (Mr. W. E. Taylor). The captain and chief officer extinguished the fire while the two engineers went below to examine the engines. Having determined to try to save his ship, Capt. Bannan went back to the corvette and called for a volunteer crew. Twenty-seven of his own men returned, and three engine-room ratings from H.M.C.S. "Orillia". After raising steam in one boiler, the "Tahchee" was got under way, using hand-steering gear. On the following morning the corvette took the tanker in tow, although neither vessel had any proper towing equipment. With the help of the corvette and her own engines, the "Tahchee" was able to make about seven knots. Owing to the heavy demands made on the corvette's supply of fuel by the tow, it was decided to replenish her tanks from the tanker's fuel oil. The "Orillia" accordingly slipped the towing wire, but unfortunately the "Tahchee's" windlass carried away and the cable ran right out, the whole of the towing gear being lost. The corvette then came alongside and an attempt was made to give her oil fuel through an ordinary canvas firehose, but the oil was too heavy to pump and the tanker's steam-heating system had broken down, so the attempt had to be given up for the time being, and both ships continued under their own steam. During the night the steam-heating system was got going again, and used to heat the oil and make it thin enough to pump through hoses. Next morning the "Orillia" came alongside again and this time it was found possible to pump 30 tons of oil into her tanks in a very short time, notwithstanding trouble with the canvas hoses which were not made to stand this high pressure and kept on bursting. By this time the "Tahchee's" engineers had managed to raise steam in the second boiler and the tanker was again able to proceed under her own power. She was brought safely into port after covering 592 miles in five and a half days.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 8, 19th February, 1942, p. 245.*

**Ship's Ordeal in Atlantic.**

A ship now under repair in a British yard recently suffered considerable damage in one of the worst Atlantic gales ever experienced. The vessel was homeward bound in convoy when they ran into a storm which reached hurricane force. The five men in the engine room had to carry out their work lashed to the controls for 28 hours without a break, as it was impossible for them to stand upright. During this time the 72-year-old chief engineer, who had come to sea out of retirement, was lashed in his bunk, disabled by rheumatism. The steering engine, which was located on the after deck, gave trouble, and while attending to it, the second engineer had two ribs fractured by a tremendous wave which crashed over him. In order to ease the ship, the captain decided to heave to, but at a critical moment a valve stuck and the engines stopped, with the result that the vessel wallowed helpless in the heavy sea with a list of 30°. Whilst the engineers were struggling to get the engines restarted a tremendous crash shook the engine room, which was filled with pieces of flying metal and clouds of steam. By a miracle all the staff escaped unhurt into the comparative safety of the messroom, where they learnt that all the boats had been smashed and washed away. They thought the ship had been mined or torpedoed, and, too exhausted to move, they lay on the messroom floor and waited for what they feared was the end. Two hours later the second and third engineers crawled back to the engine-room entrance. It was found that the damage had been caused by a huge wave which had smashed in some of the hull plating and fractured the auxiliary steam pipes, causing the compartment to be filled with steam. For 70 hours the tired engineers worked to repair the damage and get the engines running again. The ship crawled into port seven days later, with her valuable cargo of oil intact.—*"The Journal of Commerce", No. 35,586, 26th February, 1942, p. 2.*

**Removing Broken Studs.**

A method of removing a stud or bolt, the head of which has broken off flush with, or below, a surface, is described in a recent issue of *"Power Plant Engineering"*. When flush, a nut of the same size as the broken bolt, or slightly smaller, is welded by means of a heavily-coated rod, to the buried thread. When cool, the bolt or stud can then be withdrawn with a spanner in the usual way. If the bolt or stud has broken off some way down the thread and has left a portion in the hole, a copper or brass ferrule of the right fit for the hole is dropped into the latter and cut off flush with the surface, after which a nut is welded to the ferrule and stud, the space in the ferrule extending down to the latter being filled with the weld metal. When cool, the bolt is then withdrawn with a spanner. Breakages of this kind are sometimes due to seizure brought about by rusting between the threads, and the heat of welding causes the bolt or stud to expand and crush out the rust, which thereby loses its binding properties. The suggested procedure is illustrated in Fig. 2.—*"Practical Engineering", Vol. 5, No. 113, 19th March, 1942, p. 237.*

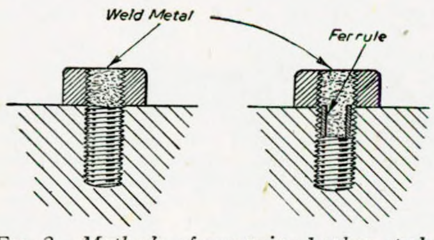



FIG. 2.—*Methods of removing broken studs.*

**Flanges v. Angles.**

For many constructional purposes in ship work where angle bars are normally used, either as stiffening members or connections, there exists the alternative of substituting a flange formed on the plate by cold pressing. The simplicity of the operation and the saving of a line of rivets favours the use of flanged plates in the interests of cheapness and saving of time, and provided the material is of the required ductile quality, there can, in general, be little objection to the practice. It is true that the steel at the radius of the bend is cold-worked in the plastic range, and loses some of its toughness in the process, but the actual strength, particularly the elastic limit stress, is almost certain to be increased, and the deterioration in elongation may be expected to be more marked in the direction of bending than along the flange line. As the latter will usually coincide with the direction of rolling of the plate, which tends to show greater strength than the perpendicular direction, there need be little fear as to the strength of the flange, even when it acts in tension. Where the flange or angle forms the inner flange member of a beam, it is, of course, necessary to have an equivalent total sectional area in either case, although the absence of holes in the flanged construction tends to equalise the strengths even when the full area of the bar is not reproduced. For purely connecting purposes the sole disadvantage of a flange as against an angle is a slightly reduced rigidity at the heel, the importance of which depends on the direction of the principal tripping loads. Where welded construction is in question, it is fairly common practice to dispense with both angles and flanges wherever feasible, and in any case a line of welding can be saved by the substitution.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 9, 26th February, 1942, p. 251.*

**Trends in Marine Lubrication.**

The authors begin by enunciating the modern theories of lubrication, define "fluid" condition, and explain how it is affected by oil stability. The effects of low and high-temperature heat oxidation conditions on both turbines and Diesel engines are discussed, and the occurrence of the so-called "boundary" condition in reciprocating movements and gears is briefly considered. It is pointed out that various compromises become necessary when choosing single oils with many requirements. Extreme-pressure lubrication and its uses are discussed, and various aspects of the theory of wear are dealt with. The dependence of modern lubrication on additional agents, such as anti-oxidants, detergents, extreme-pressure agents, etc., is examined, and the characteristics of some of these substances are briefly referred to. The concluding part of the paper is devoted to practical considerations of modern marine lubrication and of probable future developments.—*Paper by Lt.-Col. S. J. M. Auld, O.B.E., D.Sc., and C Lawrie, read at a general meeting of the N.-E. Coast Institution of Engineers and Shipbuilders, on the 20th February, 1942.*

**Admiralty Views on Boilers for New Merchant Ships.**

The Admiralty have issued a memorandum giving the comments of the Merchant Shipbuilding Department on various recommendations and suggestions affecting ship construction and repair made in the Forty-first Report of the Select Committee on National Expenditure. Section II of this report dealt with merchant shipbuilding, and the Admiralty observations on the Committee's remarks on ships' boilers are as follows: "(6) In para. 6, the sub-committee state that they 'were informed that in one case the Merchant Shipbuilding Department insisted on the installation of boilers which are heavier, less efficient and more costly in labour, materials and upkeep than the type which some shipowners would prefer, and which are, in addition, unpopular with the firemen who will have to tend them. When a certain ship-owning company asked that the design should be reconsidered, and suggested an alternative and less costly type of boiler of a well-known design, they were told that the Department were not prepared to discuss the question'. (7) It is thought that the first type of boiler referred to is the normal Scotch type, and that the second is another type of boiler which has not, according to the information of the Admiralty, been fitted in a tramp ship by any private tramp owner. The Admiralty do not consider that the present would be a suitable time for fitting an experimental type of boiler in tramps, in view of the probability that more skilled attention would be required than in the case of the type of boiler which is universally fitted. However, should a shipbuilder apply for a licence to build to the order of a private owner a vessel of the cargo-liner type, incorporating this special type of boiler, the Admiralty would not on this ground oppose the grant of a licence, it being assumed that the owner would see to it that the number and quality of the boiler-room personnel would be such as to ensure any special attention required. But in fact, no application made on behalf of a private shipowner has contained a request for permission to fit this type of boiler. (8) The incident mentioned in the second part of para. 6 is thought to refer to criticisms made by a certain firm of shipowners to which the management of a steam tramp has been entrusted by the Ministry of War Transport. This firm criticised the intention to fit Scotch boilers in the vessel in question, indicating a preference for the other type of boiler referred to in the preceding paragraph. Apart from the considerations already mentioned, it would have been useless to discuss the fitting of an alternative type of boiler in this instance, since Scotch boilers had already been tested and were ready for installation".—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,574, 12th February, 1942, p. 8.*

**Compact Steam Generator.**

The latest type of Vapor-Clarkson steam generator is a very compact unit occupying a floor space of only 36in. by 24in., with a height of 28in. to base of chimney. The weight of the complete unit, inclusive of a ½-h.p. driving motor and control panel, is only 580lb. The output of steam at pressures up to 200lb./in.$^2$ and superheat temperatures up to 600° F., is about 300lb./hr., and the unit is suitable for a wide variety of purposes, since it is also capable of providing only saturated steam, or, if desired, merely hot water. The oil-fired boiler is of the continuous-coil watertube type and has a heat release of something like one million B.Th.U. per cu. ft. of combustion space. Full pressure and output is attained from cold within about three minutes from starting up. The fuel used is Diesel oil, from 10 to 12lb. of steam being produced per lb. of oil. The boiler coil is of open-hearth steel tubing, whilst the body and fire components are of close-grained cast iron. The whole tube unit is readily removable for cleaning. The auxiliaries are all grouped around the boiler and the arrangement of the various connections and automatic controls is shown in the accompanying diagram. The design of the unit embodies a number of improvements on earlier types of this generator (*originally described in abstract on p. 241 of* TRANSACTIONS, *December, 1939*). The motor drives the main air fan and oil pump shaft at 1,830 r.p.m., and from this shaft there are belt drives to the ignition shaft, running at 880 r.p.m., and feed-pump shaft, running at 450 r.p.m. All these shafts run in tapered roller bearings. The control of the unit can be wholly or partially automatic, the output being varied by regulating the speed of the driving motor, which is effected by means of a stepped resistance in the motor circuit, whereby any desired output can be manually selected to suit the particular job in hand, the set operating automatically to maintain that output without too frequent operation of the pressure switch. Referring to the diagram, fuel oil drawn from the tank by the pump is delivered to the fuel manifold and fuel control by-pass. When starting, this fuel is returned to the tank by the fuel by-pass until such time as the water pump has built up a predetermined pressure in the coil. The fuel then flows to the atomiser, which opens at a pressure of 60lb./in.$^2$, the oil being ignited by a sparking plug connected to a magneto. Should the oil fail to ignite, a switch in the smoke stack operates to shut down the whole set, and as this switch requires manual resetting, attention is drawn to the matter so that the trouble can be investigated and rectified. Steam is generated as soon as heat begins to be released in the combustion space, and should the pressure rise above a predetermined amount a pressure switch operates and shuts down the driving motor, thus interrupting the supply of fuel, air and water. When the pressure falls again this switch restarts the motor. Should the superheat temperature become excessive, the superheat control by-pass operates, by-passing a certain amount of the fuel so that less reaches the burner and thus reducing the heat release in the combustion space. Over-heating from any cause leads to the operation of the switch in the smoke stack and the shutting down of the unit. When hot water is desired instead of steam a second feed-water pump is fitted, with a separate set of control valves. By bringing this pump into operation the amount of water passing through the coils is increased, whereas the fuel is burnt at the same rate as before. Consequently hot water is produced and its temperature can be varied by adjusting the suction valve of the second feed pump.—*"The Engineer", Vol. CLXXIII, No. 4,496, 13th March, 1942, p. 236.*

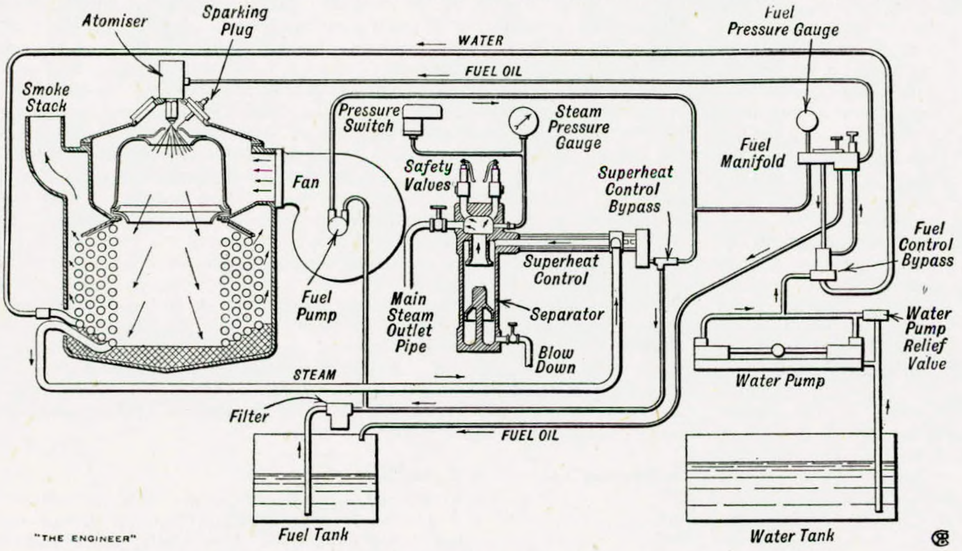



*Diagram of connections and automatic controls*

**Internal Cleaning of New High-pressure Boilers before Raising Steam.**

Experience with the large high-pressure boilers of the American Gas and Electric Service Corporation has shown that the use of Calgonite for the removal of foreign matter inside the boilers after assembly, when applied in the proper concentration, is highly effective. Calgonite is a proprietary substance, the main constituent of which is presumably calgon (sodium-hexa-meta-phosphate). It is a very good emulsifying agent and penetrates all interstices of the boiler tubes, joints and seams. The boiler is thoroughly washed through with cold untreated water and then with condensate before being closed up. It is afterwards completely filled with water treated with sodium sulphite (a de-aerating agent) and the temperature gradually raised to 200° F. The water is maintained at this temperature for five hours by means of a hydrokineter, after which the water level is lowered for the addition of 6·7lb. of Calgonite and 1·3lb. of caustic soda per 1,000lb. (67lb. and 13lb. per thousand gallons, respectively) in solution. The water is then slowly heated to a temperature of 320° F., the pressure being raised to 75lb./in.$^2$, after which the boiler is blown down intermittently, the solids in the water being progressively reduced from approximately 15,000 to 5,000 parts per million. Over a period of 20 hours the pressure is gradually raised to 275lb./in.$^2$ (414° F.) and maintained at this figure for five hours. During this period the steam is vented from the boiler and the blow-down continuously operated, further reducing the solids to 500 p.p.m. At 275lb./in.$^2$ the superheater and H.P. steam drum are blown to atmosphere. After draining the boiler, an inspection of the visible surfaces should show that they are quite free of oil and other impurities, no further boiling out being required. The boiler is then reclosed. Compared with tri-sodium-phosphate the Calgonite treatment is more expensive, but its advantages are that it reduces the caustic alkalinity of the boiler feed water and that its continuous application does not involve much risk of any calcium of phosphate deposits in the feed pipes. The treatment is being increasingly used in the U.S.A.—*S. B. Jackson, "Electrical Review", Vol. CXXX, No. 3,352, 20th February, 1942, p. 245.*

**Aluminium Bronze Propellers.**

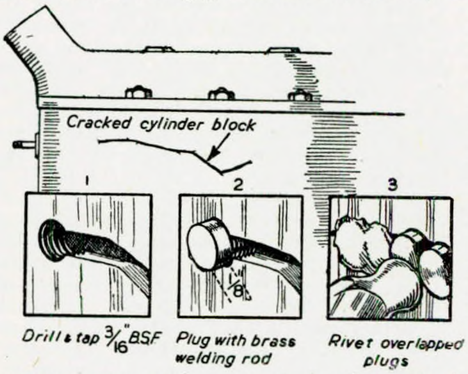
In a paper recently presented before the Institution of Engineers and Shipbuilders in Scotland, Dr. Beeching described the results of experimental tests with aluminium bronze propellers, which indicate that this material is superior to manganese bronze and high-tensile brass as regards ability to resist erosion of the kind which is liable to affect high-speed marine propellers. The laboratory tests included investigations of the effect of water-hammer impact on small specimens which were vibrated, while immersed, through a very small amplitude, but at a relatively high frequency so as to generate the necessary velocities and accelerations. Notwithstanding the difficulty of correlating such tests with full-scale practice, the author succeeded in establishing that different methods of tests employed by different experimenters have in general given the same order of superiority, where similar materials have been tested, irrespective of the test procedure and of the severity of the impact forces applied. An interesting point which emerges is that a reduced severity of impact gives a wider range of results and hence better discrimination. A legitimate inference seems to be that under severe enough conditions there is little to choose between different metals, although normally this does not apply. This conclusion may help to explain apparent anomalies in the behaviour of various materials and alloys used for making screw propellers.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 7, 12th February, 1942, p. 187.*

**Screw Propeller Theory.**

The object of the paper is to present an account of propeller theory, collected from various sources and with certain additions, in a form suitable for immediate practical application. The author begins with a short explanation of the simple momentum theory which is extended to include both rotational and axial inflow. He points out that the Glauert theory for an infinite number of blades also uses the momentum inflow values, but that these are now calculated for each radius individually and applied to the known aerofoil characteristic to predict the performance of each blade section and hence that of the screw as a whole. The inflows of the Goldstein vortex theory are, however, more nearly accurate, as they allow for a finite number of blades and so-called "tip effect", the performances so predicted being in reasonable agreement with model and full-scale data. The paper concludes with a description of an approximate method of calculating the pressure distribution over the blade sections for any arbitrary shape of section, and a discussion of its application to cavitation conditions.—*Paper by J. Lockwood Taylor, D.Sc., read at a general meeting of the N.-E. Coast Institution of Shipbuilders and Engineers, on the 6th February, 1942.*

**Repairing Cracked Cylinder Blocks.**

Welded repairs to cracked cylinder blocks of car or boat engines are not always possible under present conditions, so that alternative methods of making good such defects may have to be sought. The writer thoroughly recommends the following method of repair, which may be carried out on even the most badly cracked cylinder blocks, and is, in the opinion of the writer, equal to the best welding job in effectiveness, although far less expensive. Furthermore, it is frequently possible to make this repair without removing and dismantling the engine. A $\frac{3}{16}$-in. hole is drilled at the beginning of the crack, as shown in the sketch, and tapped $\frac{3}{16}$-in. B.S.F. A length of $\frac{3}{16}$-in. brass welding rod, threaded to suit this hole for about $\frac{1}{4}$-in., is then screwed into it and cut off $\frac{1}{8}$-in. proud of the hole. Similar holes are drilled, tapped and plugged along the entire length of the crack, spaced in such a manner that their diameters overlap each other, so that the screwed lengths of brass welding rod are partially screwed into adjacent lengths. The heads of the plugs are then riveted over with a light hammer. The writer asserts that this repair will last the lifetime of the engine.—*G. Knowles, "Practical Engineering", Vol. 5, No. 112, 12th March, 1942, p. 205.*




*Method of repairing a cracked cylinder block.*

**Flame Cutting and Electric Welding in Shipbuilding.**

An article by C. A. Rober in a recent issue of *"Metal Progress"*, purports to show how valuable the idea of designing shipbuilding yards for progressive welding work has proved itself to be. The author gives a short account of the flame-cutting and welding procedures in use at the Fore River Yard. Several types of flame-cutting equipment are employed, and this has replaced other and more expensive equipment, in addition to reducing the strain on the overtaxed machine-tool industry. Hard cutting is used only for work not adapted to machines, specialised machines being utilised for cutting pipe flanges and plate collars, and multiple cutting machines for making floors and other structures where circular or elliptical openings are required. A multiple-flame torch is used for the annealing of flame-cut surfaces on alloy steels of high hardenability in order to reduce the self-hardening edges to the necessary degree of machinable hardness. A flame gouging torch reduces the cost of preparing joints for welding, and is of value in excavating castings to remove defects. About 95 per cent. of the welding in the shipyard is done by the manual metallic-arc method, and as welding positions must follow the ship lines, about 75 per cent. of ship welding is in the vertical or overhead positions, but in the shops every effort is made to use positioners, shoring or rotating equipment to obtain the flat position. A section of the article deals with the qualification of welders.—*Abstract No. 884, "Welding Literature Review", Vol. 3, No. 1, February, 1942, pp. 637-638.*

**Welding Gas-filled Tanks.**

An article by D. E. Crooker in *"The Stabilizer"* describes a method of testing the safety of a petrol tank, on which it is proposed to carry out soldering, brazing or welding work, by piping exhaust carbon dioxide into the tank. The exhaust gases are first passed through a fire screen to prevent hot pieces of carbon from going into the tank. The carbon dioxide, being heavier than oxygen, is piped to the bottom of the tank, driving the oxygen to the top. A special two-way cap must be used for a tank having only one opening. Gas escaping from the top of the tank is then piped to a nearby combustible-gas indicator made by inserting a fire screen within a cylinder. Within the casing of this cylinder, on the atmospheric side of the fire screen, is a spark gap which emits a continuous spark furnished by a standard high-tension coil. The opening of the incoming gases is equal in size to the discharge so that the indicator chamber is filled with gases under pressure driven from the tank. Outside the fire screen of the gas indicator (but inside the casing) the escaping gas is ignited and burns so long as the fumes from the tank contain sufficient oxygen and gas fumes to make the mixture combustible.—*"Mechanical World", Vol. CXI, No. 2,877, 20th February, 1942, p. 160.*

**The Testing of Welds.**

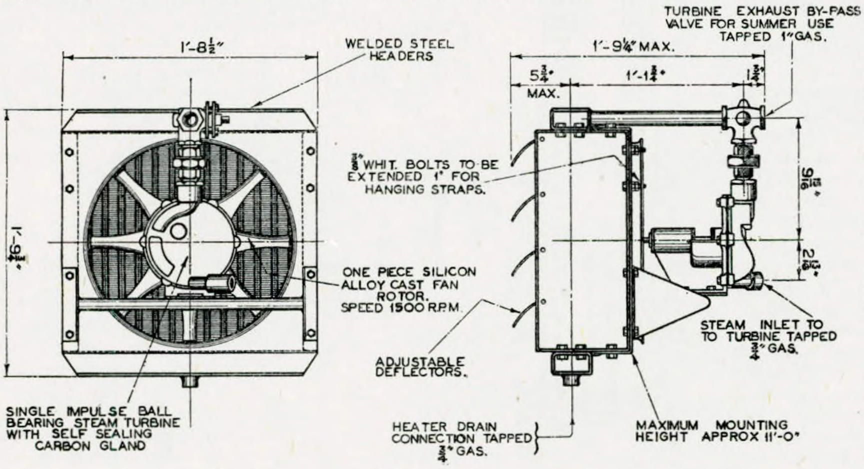
The purpose of the paper is to present a critical and informative survey of the tests applied in industry for the purpose of assessing the strength properties of welded joints. Fatigue, tensile, bend, impact and special crucial tests are discussed in detail, and the significance of these tests, together with factors which may be peculiar to welding and which influence the results obtainable, are dealt with. The author gives a number of representative test results from authoritative sources, and tabulated data of the main results obtained by British, American and Continental investigators. He expresses the hope that these figures will prove helpful to designers, especially in view of the increasing use of welding in the engineering and shipbuilding industries at the present time. This increase has been accelerated by the war-time requirements of industry generally. The need for speedy production, and the replacement of iron castings by fabricated mild steel in order to obtain improved resistance to explosive shock, are two of the main considerations involved. It is therefore important that testing methods should be thoroughly understood in their relation to welding, and the author has endeavoured to deal with the subject in the light of his own experience with this in mind. Brief reference is made to X-ray and magnetic methods of inspection.—*Paper by H. N. Pemberton, read at a general meeting of the N.-E. Coast Institution of Engineers and Shipbuilders on the 6th March, 1942.*

**Refractory Linings of Furnace Walls.**

The furnace brickwork of a modern marine boiler continually wastes away until it becomes so thin that it must be repaired or rebuilt. As the fusing temperature of practically all refractory materials and firebricks is above 3,000° F., actual melting of the furnace linings seldom occurs, although in oil-fired boilers or in furnaces with thick walls the inner lining is subjected to a degree of heat which approaches the actual furnace temperature, with the result that such walls are liable to suffer serious damage in a short time. Attention to refractory materials is therefore centred on the reduction of this wasting away of the furnace walls. The two main causes of furnace wall and arch failures are: (*a*) complete rupture or breakage of the structure; and (*b*) gradual wastage of the refractory used to cover the furnace walls. As regards (*a*), a complete failure of the structure is rare nowadays, and in the few cases which do occur, the failure is due to the unequal expansion of the structure caused by variations in temperature, or, in some rare instances, by a lack of homogeneity in the refractory used on the walls. Unequal expansion imposes considerable stresses on the brickwork and may cause it to bulge. From bulging it is but a very short step to ultimate rupture of the whole wall. The adoption of steel supports for boiler furnace arches and improvements in design, together with the development of superior refractories with low co-efficients of expansion, have, however, done much to reduce this form of failure. As regards (*b*) wastage is the worst enemy of furnace walls and may take place in four different ways: (*1*) by abrasion; (*2*) by melting of the refractory itself; (*3*) by the fluxing of the refractory with the ash; and (*4*) by spalling due to the refractory itself or caused by the formation of slag. Wall failure brought about by direct abrasion from fire tools or clinkers may be regarded as being of secondary importance, as it is uncommon, but abrasion caused by the impingement of the flame in the region opposite the burners in the combustion space is liable to be severe. It is brought about by fluxing and depends on the gas velocity and acceleration of the flow. With turbulent combustion and the high velocities and accelerations associated with this motion, the flame abrasion is great. Wall failure by direct abrasion from either of these causes can be prevented by improvements in furnace design. Practically all refractories used in furnace construction have a fusing temperature above that reached during combustion of the fuel, with the possible exception of some oil-fired furnaces or furnaces built with over-thick walls. It is seldom, therefore, that the refractory actually melts away. Ash fluxing is caused by deposits in the form of small particles of coke or carbon, which burns with an intense heat and gives rise to globules of molten ash, which adhere to the furnace wall. A chemical reaction takes place, the refractory material dissolving into the molten ash, which trickles down the wall. Such rivulets of molten ash and refractory continuously expose new surfaces of furnace wall, and so a wasting process occurs by the continued formation of fresh drips of this viscous ash-brick mixture. Spalling is really mechanical rupture due to unequal expansion of the wall bricks and may, in its most elementary form, be closely related to that action, causing complete failure. A more common form of spalling is however due to the action of a coating of ash-slag formed on the surface of the wall or blocks. This coating may adhere strongly to the brick, and on cooling becomes a dense, glassy mass which contracts more than the brick, thereby giving rise to tremendous forces which crack the walls and pull off pieces of the brick. This action may continue indefinitely until the entire wall is wasted away.—*R. A. Collacott, B.Sc., "The Marine Engineer", Vol. 65, No. 775, February, 1942, pp. 28-29.*

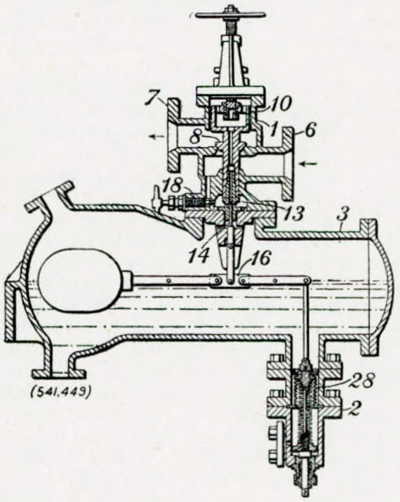
**Turbine-driven Unit Heater.**

In this "turbo-unit" heater the fan is driven by a small steam turbine and the exhaust from the latter is condensed in a spiral-tube heating battery in front of the fan. Steam at pressures as low as 30lb./in.$^2$ can be employed, the whole of the total-heat of the steam being given up and the heater dissipating some 130,000 B.Th.U./hr. with a steam consumption of not more than about 160lb./hr. The fan handles about 1,500 cu. ft./min., and there are adjustable louvres for directing the stream of warmed air. For summer use, the exhaust from the turbine can be by-passed in order to obtain the benefit of the air movement without the addition of heat. The unit, which weighs 102lb. complete, is easily erected and requires no electric wiring or other service, the only connections being the ¾-in. pipes for the steam inlet and exhaust drains. The absence of electricity is claimed to render this type of heater particularly suitable for use in a damp atmosphere, or where there is a risk of fire or explosion. No vacuum is formed in the heating battery, the condensate emerging at atmospheric pressure; it should not be trapped. The single-stage impulse turbine runs in ball bearings and has a self-sealing carbon gland, different nozzles being supplied to suit various steam pressures. The general arrangement of the unit is shown in the accompanying illustration.—*"The Power and Works Engineer", Vol. XXXVII, No. 429, March, 1942, p. 101.*




**Feed-water Control Valve.**

One of the latest British patents to be published concerns a feed valve which is claimed to give a closer control of the feed in accordance with fluctuations in load on the boiler. Referring to the accompanying sectional diagram, the feed valve is housed in a casing (*1*), and another casing (*2*) contains a diaphragm which is acted on by the steam flow variations in the main steam line. Both these casings are mounted on a float chamber (*3*) which is in direct connection with the water and steam spaces of the boiler. Pipe connections (*6* and *7*) on the feed-valve casing lead respectively from the feed pump and to the boiler. At the upper end of the feed-valve stem is a piston (*10*), which is an easy fit in the casing. The lower end of this valve stem is hollow and fits inside a chamber (*13*), where a needle valve (*14*) controls the opening at the bottom end of the valve stem. A link connects the needle valve to a floating lever (*16*) in the float chamber. The feed water entering at the inlet (*6*) passes into the chamber (*13*) through a passage controlled by another needle valve (*18*). The top of the valve-stem bore opens above the piston (*10*), and the under side of this piston is exposed to the boiler pressure. The floating lever (*16*) is pinned to the ends of two pivoted levers, one of which carries a float, whilst the other is linked to a floating diaphragm (*28*) in the form of a bellows. The lower end of the bellows is secured to the casing, and a coil spring keeps the diaphragm extended. A union in the lower part of the casing (*2*) is connected to the superheater outlet. In operation, the feed valve (*8*) is held in equilibrium by the pressures acting on opposite sides of the valve and on the slack-fitting piston (*10*). The feed pressure acts on the under side of the valve and, through the needle valve (*8*), on the lower end of the valve stem. The boiler pressure acts on the top of the feed valve (*8*) and the under side of the piston (*10*), while the upper side of the latter is exposed to a pressure which will vary up to the feed pressure by an amount determined by the opening of the needle valve (*14*). The water level in the float chamber corresponds to the water level in the boiler and if this level falls, the float raises the needle valve (*14*) and shuts off the flow of feed water to the space above the piston (*10*), the water already collected above this piston leaking away. The resulting loss of pressure above the piston causes the feed valve to open and admit more water to the boiler. Simultaneously the lower end of the valve stem leaves the needle valve (*14*) and thus opens the passage of the stem, again admitting feed water to the upper side of the piston (*10*) so that equilibrium is restored. A rise in the water level in the boiler has the converse effect. At the same time the position of the valve (*14*) is under the control of the load on the boiler, any increase causing the pressure at the superheater outlet to fall and the bellows to contract against the spring, thus raising the floating lever (*16*), and hence the pilot valve, to open the feed valve. A drop in the load closes the feed valve.—*"Engineering", Vol. 153, No. 3,975, 20th March, 1942, p. 240.*




**Denmark's First Diesel Electric Vessel.**

A small craft of 97ft. 3in. by 24ft. 3in., named the "C. F. Krarup", recently completed in Denmark, is equipped with Diesel-electric machinery, and is the first Danish vessel to employ electric propulsion. Two 150-b.h.p. 6-cylr. Frichs engines are installed. They run at 1,100 r.p.m. and each engine is coupled to a 90-kW. 220-volt dynamo supplying current to two propulsion motors. The propelling machinery can be manœuvred direct from the bridge. The vessel is to be employed on submarine cable work.—*"The Motor Ship", Vol. XXIL, No. 266, March, 1942, p. 411.*

**Fast Passenger Ship Launched in France.**

According to a recent report from Vichy France, the first liner to be launched since the Franco-German armistice has been put into the water at La Seyne, near Toulon. The ship is a turbo-electric passenger and cargo liner for service between Marseilles and North African ports, and is named the "Kairouan". She was ordered in 1939 by the Cie de Navigation Mixte, of Marseilles, and her machinery was to have been of a design similar to that of the "Normandie". It was ordered from the same engine-builders. The new ship is stated to be a twin-screw vessel of about 467ft. in overall length, with a beam of just over 60ft. and a draught of about 24ft. 3in. at a displacement of some 8,300 tons. Accommodation is to be provided for 1,500 passengers, of whom 575 are first-, second- and third-class passengers, and the remainder deck passengers. The ship is also able to carry about 4,000 tons of general cargo, the cargo spaces including cooled chambers and compartments equipped with forced ventilation which are intended for the carriage of early vegetables. The propelling machinery, which is to develop 24,000 s.h.p. on two screws, will comprise two sets of turbo-alternators supplying two a.c. propulsion motors. Steam will be provided by Lamont forced-circulation oil-fired boilers operating at a pressure of about 500lb./in.$^2$ and total temperature of 750° F. Power for the electrically-driven auxiliary and deck machinery is furnished by d.c. turbo-generators, low-voltage current being employed for lighting purposes in order to reduce the risk of fire due to short circuits. —*A. C. Hardy, B.Sc., "The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,568, 5th February, 1942, p. 3.*

**Electricity on Board Modern Ships.**

The electrical equipment of modern American ships is of a high order and, in addition to complying with the rules of the U.S. Maritime Commission, it has to meet the requirements of the American Bureau of Shipping, the Bureau of Marine Inspection, and Navigation, the Marine Standards (para. 45), the American Institution of Electrical Engineers' Rules, the Senate Report No. 184, and the U.S. Public Health Service. Hitherto it has been usual to employ d.c. on the 3-wire system with 120 volts for lighting and 240 volts for power circuits, but in the large turbo-electric tankers now under construction, the a.c. system is to be used for all purposes. U.S. cargo liners have two, three or, in the case of those also carrying passengers, four generators, driven by Diesel engines in motorships and turbines in steamers. In addition, there is a Diesel-driven emergency generator. Motors for below-deck service are drip-proof at the top halves of the brackets, with semi-enclosing covers for the bottom halves. Ventilation of the motors from end to end is thus possible by fans, which frequently form an integral part of the armature construction. Waterproof terminal boxes are generally employed and controllers are usually in drip-proof cabinets mounted on the bulkheads. The fact that a motor is running is indicated by a red light on the door of the cabinet, which is illuminated only after the motor has run up to speed, as determined by the action of the last accelerating relay. Waterproof push-button stations of the rocker-arm type are used. Shunt field rheostats are separately mounted, and controllers are either of the unit or group type, acceleration being effected by the definite "adjustable" time method, with the provision of overload protection. The universal use of line switches makes it possible to isolate each circuit near the motor to be disconnected. Control fuses are employed, and where pressure switches are fitted for the full automatic operation of compressors or pumps, selector switches are also provided for the semi-automatic operation of these auxiliaries by means of start-stop buttons. Windlass and winch motors on the exposed decks are housed in waterproof covers arranged to "fit" the winches, the brakes being likewise enclosed and only the master switch exposed. Provision is made against moisture due to condensation within the enclosures. The relatively small space within the master switches has an electric heater which is connected in circuit when the winches are out of use. The resistances and control panels for the deck machinery are protected, either in winch-houses or, for the windlass and capstan, by placing them below the exposed deck. Test links for armature shunts are fitted and line switches and control fuses are included. The windlass is available for both anchor handling and warping, a dual-control circuit being provided for hoisting and lowering the anchors in one case and warping the ship in the other. The system differentiates between the windlass and capstan operations by means of a selector switch set-up for a dynamic-braking lowering circuit when the windlass brakes are released, and a straight-reversing connection when the wildcats are held tightly by the hand brakes and the warping heads are free to turn. The warping winch may be used in conjunction with the steering gear for emergency steering. Hence, the winch has a symmetrical straight-reversing circuit, and the master controller, besides being marked "forward" and "reverse", is also stamped for right and left rudder operations. The motors of the 3-ton and 5-ton winches are rated at from 35 to 50 b.h.p. and have magnetic controllers reversing with a master switch. They are of the open-contactor panel type, with a water-tight master switch and open resistances. Overload and low-voltage protection is provided, as is dynamic braking. Acceleration when hoisting and deceleration when lowering are automatic on the last two points to give smooth operation and minimum current values, the light-hook lowering speed being 200 per cent. of the normal full-load hoisting speed. The master switch is of the pedestal type with 5-point reversing for single-geared winches and 6-point reversing for heavy-duty winches. The winch-houses are ventilated by exhaust blowers, and all panel assemblies are readily accessible for proper servicing. The resistance assemblies are scattered about, baffles between the units being provided to reduce heating up. In addition to handling cargo, the winches may be used for handling steel hatch covers, adjusting chutes, setting up conveyors, moving barges, hoisting and lowering gangways, loading stores or heaving on light lines. Electric motors are utilised for driving all engine- and boiler-room auxiliaries, including the feed pumps and forced-draught fans in steamships. All the galley equipment is electric, including the ranges. Some of the Diesel-driven ships are fitted with electric couplings between the main engines and the reduction gears for damping out engine vibrations and for providing a ready means of disconnecting the engines from the propeller shaft if necessary. Group-type controllers are largely used below deck, each unit consisting of a 1-in. thick ebony asbestos lumber panel with the necessary contactors and relays at the front, and the starting resistances, bus bars and terminals at the back. The circuits are protected by 2-pole breakers with overload and short-circuit trips. A start-stop push-button station is provided for each motor circuit.—*"The Motor Ship", Vol. XXII, No. 266, March, 1942, pp. 406-408.*

**Emergency Fuel Storage.**

A useful method of emergency fuel storage has been adopted at a power station abroad. A canal barge, specially equipped for the purpose and having a capacity equal to one day's requirements of the power plant in question, is moored close to the latter. In order to keep the oil fuel sufficiently fluid for pumping, the barge is fitted with steam heating, the steam being supplied by the adjacent power station.—*"Mechanical World", Vol. CXI, No. 2,879, 13th February, 1942, p. 136.*

**Harland and Wolff Opposed-piston Engine with Circular Crosshead.**

In Fig. 1 are shown, diagrammatically, front and side elevations of an improved type of opposed-piston Diesel engine with circular crossheads for the side rods, developed and patented by Harland and Wolff, Ltd., of Belfast. Some detail diagrams of some of the main parts are also shown. The cylinder liner (*1*) is fitted in the main framing (*2*), and the upper or exhaust piston (*4*) is connected to a yoke to which are secured the side rods (*12*). These rods are attached to the circular crosshead (*9*) and, together with the main crank (*5*), the eccentric rods (*8*) drive the crankshaft. The crosshead (*9*) slides on an extension (*14*) of the cylinder liner (*1*), and the bore is relieved at the sides by the formation of

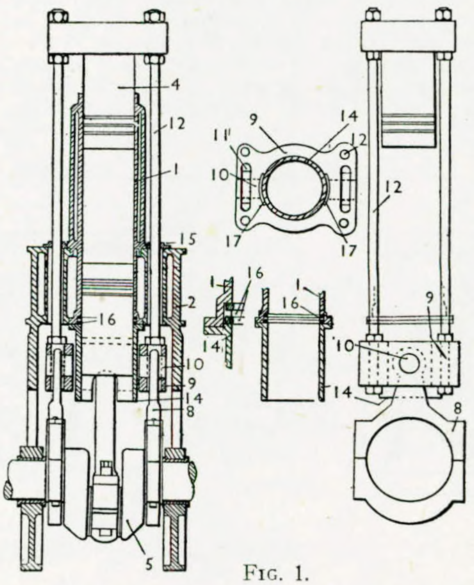


FIG. 1.

recesses (*17*), thereby facilitating the fitting of the pins (*10*) which are located at the top of the eccentric rods (*8*). Slots (*11*) are provided for the heads of the rods. The extension (*14*) is bolted to the liner (*1*), and the position of the joint is arranged so that inwardly bearing scraper rings (*16*) may be used to remove oil from the lower piston skirt. Scraper boxes (*15*) are also fitted around each of the side rods where they emerge from the main framing at the upper end.—*"The Motor Ship", Vol. XXII, 266, March, 1942, p. 421.*

**Stern Gland with Packing Tightened by Oil Pressure.**

Harland and Wolff, Ltd., Belfast, have recently patented an improved type of stern gland, in which oil pressure is used to keep the packing tight, thus overcoming any difficulty of adjustment owing to limitations in space, such as is frequently the case with the stern tubes of multiple-screw ships. Referring to the accompanying illustrations (Fig. 2), a pump (*5*) supplies oil to the stuffing boxes through non-return valves (*6*) and pressure gauges (*7*) are provided. Surplus oil tanks (*23*) are connected to the gauge pipes, the lower part (*25*) of each tank being filled with oil to the level of the port (*24*), when the entrapped air in the upper part (*26*) of the tank is at atmospheric pressure. The action of the pump (*5*) creates a pressure in the system, compressing the air in the surplus oil tanks and transmitting pressure to the stuffing boxes. The oil tanks (*23*) act as compensating devices, as without these the pressure in the stuffing boxes would fall rapidly with only a small amount of leakage. In the enlarged views showing the construction of one of the stuffing boxes, the inner end of the gland (*9*) compresses the packing (*10*) between the propeller shaft (*4*), and the stern tube (*11*), which is attached to the bulkhead (*15*) by a flange (*12*). The outer end of the gland represents an annular piston in a cylinder (*13*) and is not in contact with the running shaft. It may be seen that packing rings (*19*) are provided on the inner wall of the cylinder (*13*) and on the outer wall of the annular piston. The cylinder is attached to the stern tube by a ring (*14*), which has a rebate on its inner edge (*16*) overlapping a fluted flange (*7*). The projections formed by the flutes pass through grooves in the edge (*16*) of the fixed ring. By turning the cylinder (*13*) the projections on the flange (*17*) engage behind the shoulders formed by the rebated and fluted edge (*16*) of the fixed ring (*14*). This method of attaching the cylinder enables it to be withdrawn with the least possible loss of time. Both the combined piston and gland (*9*) and the cylinder (*13*) are made individually as an integral casting so as to eliminate joints and are fitted to the shaft (*4*) when it is being placed in position.—*"The Motor Ship", Vol. XXII, No. 266, March, 1942, p. 421.*

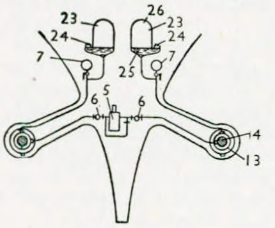
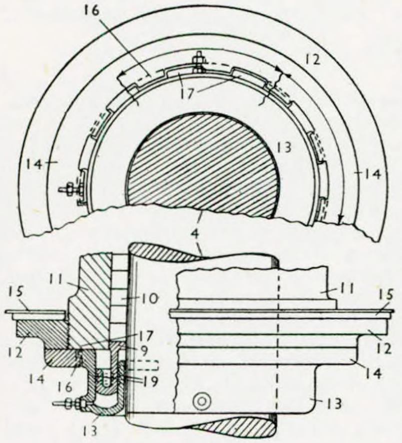


FIG. 2.



**Detecting Cracks.**

The October, 1941 issue of *"Machine Design"* contains an article which describes two useful methods of detecting cracks in pipes or metal surfaces. The suspected area must be thoroughly cleaned and wiped over with machine oil, the latter being cleaned off after it has remained on the surface for a few minutes. Chalk is then rubbed on with a cloth, and after a while the cracks are revealed by hair-like stains where the oil has seeped from them into the chalk. An alternative suggestion is to mix some red lead and petrol, and rub the mixture on to the suspected surface. The petrol evaporates and the dry red lead is rubbed off, when the cracks will become visible in red lines.—*"Practical Engineering", Vol. 5, No. 107, 5th February, 1942, p. 72.*

**Use Not Made of Engineers.**

Failure to make full use of the abilities of engineers in the war effort drew strong criticism from the president of the South Wales Institute of Engineers, Lt.-Col. S. B. Haslam, when he spoke at the Institute luncheon in Cardiff. He pointed out that in future and after the war serious consideration would have to be given to the question of utilising and adapting the many factories and works erected for the purpose of war to the best advantage for the purposes of peace. This will, he suggested, be a job for the engineer to settle. It will not be one for the politicians, or, with due respect to a hard-working body of men, the civil servants. The speaker went on to say that no use had been made of the Institute in that respect since the war started, as although various committees of supply had been set up, no applications or requests had been received by the Institute for the nomination of suitable men, with an intimate and expert knowledge of the industries and jobs concerned, who might have rendered invaluable service on such committees. In the early days of the war, and at the request of the authorities, a central register was set up, for which a record of the members and their special knowledge was compiled at considerable trouble and expense, to meet just such contingencies. Production was one of the chief interests of engineers, and men who are used to production and have been handling the job the whole of their lives should be more capable of seeing that production is carried out to the best advantage and with due economy, than non-technical men, however eminent these might be in their profession. When handling man-power, practical knowledge, not theoretical knowledge is the thing on which such committees should be based.—*"The Journal of Commerce and Shipbuilding" (Shipbuilding and Engineering Edition), No. 35,568, 5th February, 1942, p. 7.*

**Electrics v. Hydraulics.**

A letter from a gentleman who describes himself as a maker of electrical control gear, deals with the respective merits of hydraulic and electrical control systems for aircraft and other purposes. The writer expresses the view that where it is necessary to transmit a linear motion, short in length, slow in action and which must stay put in any desired position, hydraulic control should be adopted. Where rotary motion is required, especially continuous running, then electric motor operation is to be preferred. Although there are many considerations which may affect each individual case for one reason or another, the writer declares that where hydraulic supply or electrical supply are equally available, the choice of the method of control should be the one best suited for the purpose from a mechanical aspect. Electrical control may be made to do anything, but it has certain disadvantages, *viz.* (*1*) In order to reduce weight it is generally necessary to employ high-speed motors, so that an immense gear reduction has to be effected to produce a linear movement of, say, 1ft. in a minute or half a minute, with a motor running at anything from 5,000 to 7,000 r.p.m.; (*2*) the starting current of a motor switched direct on is the same as the stalling current; and (*3*) there are a great number of points which require inspection and servicing with electrical gear, such as commutator brushes, gearing, lubrication of gearing, limit switches and protective devices, whereas in the case of hydraulic control gear a release valve to prevent overloading is practically the only protective device which is necessary. The operation of this valve does not stop the action of the hydraulic control gear concerned, whereas the operation of an overload circuit breaker or fuse in an electric control system instantly puts the latter out of action until the circuit breaker is re-closed or a new fuse is fitted. In cases where the movement must stop and stay put, or which comes up against a stop at either end, limit switches have to be provided with a very careful adjustment. These small auxiliary devices give more trouble than the main drive, as they have to make and break contact at an exact moment, the contact has to be good and the break must be clean. Such devices have, therefore, to be designed with the utmost care. The duplication of electrical control wiring has been suggested, but the writer points out that it is just as easy to duplicate hydraulic pipe lines; only two pipes are needed for this purpose, whereas four wires are required for a reversible motor. Prior to the last war, electrically-controlled gun turrets were tried in some of H.M. ships and proved an utter failure owing to trouble with creep and the great difficulty experienced in arresting the movement at any exact position. An electric motor has considerable inertia and therefore overruns after the circuit is broken unless some form of brake is provided. A good instance of the correct use of electrical and hydraulic transmission is to be found in certain modern machine tools where the main spindle is operated by a motor, while various other motions, such as the traverse, feed and so on, are hydraulically operated. Had it been feasible to operate these motions by a motor drive, it would have certainly been adopted. Lastly, the writer stresses the fact that whereas it is possible to train men to service hydraulic gear in a very short time, it may take months to train them to service electrical gear, and that good electrical mechanics are by no means easy to find.—*"Flight", Vol. XLI, No. 1,728, 5th February, 1942, p. 122.*

**Life of a Modern Vessel.**

Certain shipowners, when ordering new ships, were in the habit of specifying increases in the scantlings approved by the classification societies in order to prolong the lives of their vessels, notwithstanding the fact that to increase the life of a ship's hull when changes in propelling machinery and other improvements may render her obsolete long before she is worn out, is an uneconomical procedure. The scantlings laid down by the classification should normally suffice to give a ship a life of 24 or 25 years—*i.e.*, until she has passed her second No. 3 survey, by which time she will probably have outlived her usefulness. Nevertheless, statistics prove that the average length of life of a steel ship is something over 30 years, and, according to Lloyd's Register, 20 per cent. of the world's tonnage afloat in 1939 was 25 years of age or over. The percentages of such old ships in the various mercantile marines varied considerably, Holland having only 9 per cent., the U.K. 11 per cent., Italy, Spain and Sweden 30 per cent., and Greece 44 per cent.—*"Fairplay", Vol. CLVIII, No. 3,066, 12th February, 1942, p. 226.*

**Arrival of the "Ocean Vanguard".**

The first of the 60 cargo steamers ordered from the two new Todd shipyards by the British Purchasing Commission in the U.S.A. has arrived at a British port from the Pacific Coast with a varied and valuable cargo of 8,699 tons. This vessel, the "Ocean Vanguard", was completed in just over six months at an entirely new yard by workmen the majority of whom had had no previous experience of shipbuilding. The ship's machinery and equipment has come from all parts of the U.S.A., sometimes over great distances, and much of it is of British design. The 2,500-h.p. triple-expansion engine, is somewhat smaller than the average engine of similar power built in this country, but the vessel's engineers are stated to be entirely satisfied with its performance. The average coal consumption of the three single-ended Scotch boilers which generate steam at a pressure of 225lb./in.² and 550° F. total temperature, is about 25 tons a day. The auxiliary machinery includes two 15-kW. steam-driven generators running at 450 r.p.m. and supplying current for lighting purposes at 110 volts.—*"The Shipping World", Vol. CVI, No. 2,539, 11th February, 1942, pp. 135-138.*

**The "Ocean Vanguard" in Collision.**

The censor has now permitted it to be known that while the "Ocean Vanguard" was making her maiden voyage to this country in convoy, she was involved in a collision. While going at speed, the ship ran into another vessel, with the result that the "Ocean Vanguard's" forepart was severely buckled. Temporary repairs were effected and the hull remained quite watertight. As is known, this American-built ship is of 90 per cent. welded construction, and it is stated that under the circumstances which prevailed, the hull would not have remained watertight if it had been riveted instead of welded. The bold decision made by the British authorities in placing orders for welded ships in the U.S.A. has, therefore, proved to be a sound one.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,598, 12th March, 1942, p. 6.*

**Deadweight and Gross Tonnage.**

It may be that because all the American statements regarding ship construction refer to deadweight tonnage, whereas in this country it is usual to speak of gross tonnage, the American shipbuilding effort has been over-estimated. We were promised that six million tons of shipping would be completed in American shipyards during the present year. This, of course, is only equivalent to about 4,125,000 gross tons, but when this is explained to non-shipping men they are liable to express disappointment because their hopes have not been fully realised, notwithstanding the manifest unfairness of any such attitude. Mr. Shinwell was mistaken in saying that Lord Rotherwick, the president of the Chamber of Shipping, had contested the figures of shipbuilding announced by President Roosevelt and had reduced them by almost half. What Lord Rotherwick did was to calculate that the increased U.S. merchant shipbuilding programme of fourteen million deadweight tons was approximately equal to nine-and-a-half million tons gross of shipping. Gross tonnage is, perhaps, a more convenient term to employ for calculating world's shipping.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 35,568, 5th February, 1942, p. 6.*

**West African Repair Yards.**

The Elder Dempster Lines are reported to be rapidly developing the ship-repairing facilities of Freetown and Lagos. In the past year a good deal of repair work has been carried out on board ocean-going vessels at both these ports, and with the increased employment of West Africans, a considerable extension of this work is envisaged. A quantity of new machinery and equipment has been installed, including plate-bending machines, pneumatic hammers, lathes, boring machines, portable Diesel-driven welding plant, an annealing furnace, an 8-ton travelling crane, plate rolls, refrigerating and electrical plant at Freetown, and metal-spraying equipment, wood-planing and moulding machines, log band saws, etc., at Lagos. A new three-roll plate-bending machine installed at Freetown can be used for the cold bending of mild steel plates up to 16ft. 9in. wide and 1in. thick, or up to 27ft. wide and ⅜-in. thick.—*"South African Engineering", Vol. LIII, No. 2, February, 1942, pp. 40-41.*

**Marine Engineering School in Canada.**

A training establishment for the instruction of Merchant Navy crews in marine engineering subjects has been set up at Prescott, Ontario, under the auspices of the Canadian Government. Successive short courses, including instruction in the operation of the engine-room machinery installations of ocean-going ships, will be given to men desirous of qualifying as trimmers, firemen or greasers. Candidates with suitable qualifications will also be permitted to take the examinations for engineers' certificates. Graduates will be sent to one of the Merchant Seamen Manning Pools, to await appointment to ships. Two such manning pools are already in operation at Halifax and Montreal, while a third is under construction at Vancouver. The engineering school at Prescott is the first of several such training centres being established in Canada. A school for seamen has been opened at Hubbard's Cove, Nova Scotia.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 12, 19th March, 1942, p. 354.*

**Education of Engineers.**

In a letter to the editor the writer states that he is an apprentice at the marine engineering works of a small, but very well known, shipping company owning six excursion steamers and a number of tenders and launches which are operated between certain popular resorts on the South Coast. The firm's superintendent engineer and marine superintendent is also the manager of the works where all the maintenance work, etc., is carried out. The apprentices take a course of study by correspondence from one of our leading marine engineering colleges, half the tuition fee being defrayed by the firm. The course enables the apprentices to take Part A of the B.O.T. examination for a second engineer's certificate, and those who succeed in passing become eligible to take Part B on completion of the prescribed period of sea service. During their five years' training the apprentices obtain practical experience in the works, serve as junior engineers on board the company's steamships, become competent drivers of motor launches and do duty as second refrigerating engineer for a period of six months, so that on completion of their apprenticeship they not only hold certificates as second engineers, but have undergone an exceptionally thorough course of practical training ashore and afloat, during which they have had ample experience in carrying out the usual repair jobs and obtained a good insight into the life of a marine engineer. The writer claims that the method of home tuition adopted for the apprentices is a great convenience under the circumstances which prevail in this country at the present time, and that even air raids and hours of overtime leave him a fair amount of time for study.—*H. J. Pover, "The Marine Engineer", Vol. 65, No. 776, March, 1942, p. 57.*

**Training in Medium-sized Works.**

An article in *"The Journal of the Industrial Welfare Society"*, which describes an apprentice school run by an engineering works employing considerably less than 1,000 workers, should dispel the fallacy of the widely held theory that only very large firms can be expected to organise long-term training schemes in a systematic way. The object of the scheme is to give the apprentices a 5-year course of training in the shops and in a special school attached to the works, but separate from the works organisation. In the first year most of the practical work is done in the school under the tuition of a highly qualified instructor working directly under the chief engineer. Second- and third-year apprentices do a smaller proportion of their practical work in the school, whilst fourth- and fifth-year apprentices do the whole of theirs in the shops. At the end of the five years an apprentice should be able to qualify for the National Certificate in Mechanical Engineering.—*"Mechanical World", Vol. CXI, No. 2,879, 13th February, 1942, p. 144.*

**Uses and Limitations of Filtration of Waste Oil.**

The increasing use of oil filters capable of removing small particles of carbon, etc. from engine lubricating oil has made it possible to filter used oil and obtain a filtrate which is free from the dirt which gives it its black and opaque appearance, but, at the best, such filtered oil is always darker in colour than the unused lubricant. Advocates of these super-filters contend that certain constituents of the oil are oxidised while it is in use, and, as the filter removes these oxidation products, the reclaimed oil is better than the new oil. The questions which demand an answer, however, are: (*1*) What changes take place in lubricating oil during use? (*2*) What constituents other than dirt are removed from used oil by the filter? (*3*) Do these constituents normally contribute to efficient lubrication? (*4*) If so, can any steps be taken to replace them? Analysis of the tarry mass which is removed from used lubricating oil by a filter indicates that much of it is carbon or carbon compounds due to the breakdown of some of the constituents of the oil, while metallic particles, chiefly iron, are also present in substantial proportions. If the black mass is calcined so as to burn off all the carbon and its compounds, a disconcerting quantity of red oxide of iron remains. Even so, the removal of these undesirable constituents of used oil by the filter does not affect the problem of the quality of the filtrate, since their complete removal necessitates the employment of a filter capable of retaining very small particles and to obtain this result it is frequently essential to utilise adsorptive principles. Pure mineral oil is not usually influenced by adsorptive materials, and for this very reason it has been found desirable to incorporate with the stable mineral oil which constitutes the backbone of most lubricants, a small proportion of a fatty acid or other similar lubricant which will respond to the adsorptive properties of the bearing surfaces which have to be lubricated, giving to the combined lubricant that property of "oiliness" which is so important if circumstances arise which bring boundary conditions into operation. This combination of two different types of oil is an attempt to make the best of both worlds, the "best" being the highly stable nature of the petroleum and the excellent boundary conditions of the fatty acid. Under oxidation, however, it is the better constituent which chiefly suffers, leading often to sludge or other objectionable products which the super-filter removes. In these circumstances it may be found that the filtered oil, while being quite a good petroleum, is weak in the constituents providing oiliness. Adsorption is a phenomenon due to surface energy and is almost certainly electrical in origin. The very nature of the molecules of the lubricants affording oiliness renders them attractive to adsorptive surfaces and thus filters employing a septum operating on this principle are often capable of removing valuable constituents from a lubricant which are certainly not dirt. It has been shown by experiment that one passage of oil through a filter paper reduces the oiliness content to less than one-tenth of its initial value. The makers of many modern filters openly claim the use of adsorptive septa, and it is not always easy to discriminate between those in which it is employed with intent and those in which it develops spontaneously. Even the finest wire gauze used in old-type filters presented very little surface to the passing oil in comparison with the present-day "edge" filters employing paper packs, in which the paper fibres present very large surfaces, or the compressed septum of fuller's earth or similar material, which is made up of immense numbers of finely divided particles. As regards the formation of sludge and its visible removal by these modern filters, it must be remembered that some of the oxidation products which are comprised in the sludge are soluble in hot oil, and, since most oil is heated before filtration in order to reduce its viscosity, it follows that any soluble sludge will almost certainly pass the filter no matter how efficient the latter may be. It is therefore clear that the reclamation of used oil is not without its pros and cons. If a filter retains all visible dirt, it is almost certain to retain some, at least, of the beneficial constituents, and it may pass soluble dirt, the presence of which is by no means desirable. Nevertheless, the filtering of used oil by means of modern filters is well worth while if it is borne in mind that the filtrate may not be quite up to the standard of the new oil. In some cases it may be feasible to use the filtered oil for less exacting purposes, whilst in others it may be found practicable to mix the filtered oil with equal quantities of new oil and employ the mixture for its original purpose. Since a certain amount of oil is lost in use and in the process of filtering, this practice effects a definite economy both to the user and in the consumption of a vital war material.—*A. H. Stuart, Ph.D., B.Sc., "Petroleum", Vol. V, No. 3, March, 1942, pp. 49-50.*

**The Care of Lubricants.**

Recovery of lubricating oils in quantity involves one or more of the following operations: (*1*) settling, (*2*) filtration, (*3*) centrifuging, (*4*) chemical or hot-water treatment. Coagulation of the finer particles is attained by treatment with hot and dilute solutions of sodium silicate or trisodium phosphate. Settling tanks of large capacity provide for the precipitation of fine particles or grit and carbon in suspension, this operation being assisted by a solution of brine. The tanks must be heated to above the end-point distillation temperature of the fuel with which the oil may have become contaminated—about 360° F. This is a lengthy operation, taking many days—up to a fortnight in the case of the heavier oils. Filtration is also a long process, but where space and weight of plant is a factor which can be ignored, this process can be carried out as a part of the functioning of the machinery, the filtering equipment being built into the latter. Where this is not possible, the used oil is replaced by fresh supplies, the efficient reclamation of the used lubricant being relegated to special refineries set up for this purpose. There is convincing evidence of the commercial economy of oil reclamation, although the figures given vary considerably according to individual methods of costing. Overhead charges include the amortisation of the plant for reclaiming, and such factors affect the final figure, but in every case there is a high return on the capital invested, the lowest being 100 per cent., whilst others reach 300 per cent. Generally, reclamation costs are higher than they need be, on account of the tendency to endeavour to attain the specification of new oil. So many people judge the lubricating properties of an oil by its colour, whereas in actual fact, colour or brightness have no bearing on the lubricating properties of an oil, but being concerned only with the appearance for selling purpose, add to the cost unnecessarily. By cutting short the reclamation process when the real properties of the oil have been recovered, one operator makes a saving in reclamation costs of 7 per cent. By far the greatest number of reclaimers confine themselves to a single operation—that of centrifuging—which appears to meet practical requirements without incurring excessive expenditure.—*"Petroleum", Vol. V, No. 3, March, 1942, p. 46.*

**Diesel Engine Lubricating Oil Comparisons.**

The paper on "Diesel Lubricating Problems" presented at a recent meeting of the American Society of Automotive Engineers by A. E. Smith and J. P. Stewart, of the Socony Vacuum Oil Company, was mainly concerned with high-speed machinery, but it also contained information of value relative to other types of oil engine. Although laboratory machines have been devised for testing the film strength or load-carrying capacity of Diesel engine lubricants under conditions similar to those under which the latter are required to function, such tests are not always conclusive. In their paper the authors described a series of tests carried out under commercial conditions for the purpose of determining this characteristic of a lubricant. It involved the rapid bringing up to a specific fuel rate of a single-cylinder four-stroke engine and maintaining this rate over a period of three hours. The engine speed was regulated by varying the load, and a new cylinder liner, piston, rings and filter element were used for each test. The "load-carrying capacity" of a lubricant is the highest fuel rate—*i.e.*, heat input to the engine—that it will tolerate before failure occurs. Failure is determined by an examination of the pistons, rings and liners at the end of the test, a scratched condition indicating failure. The authors' tests on these lines showed that the paraffinic residuums and distillates appear to have substantially the same load-carrying capacities, which are higher than those of naphthenic distillates. When paraffinic stocks were added to naphthenic oils, the load-carrying capacity was increased in some cases, whereas in others there was little change. The authors' conclusions were that the load-carrying capacity of a blend of lubricating oils cannot be judged by the load-carrying capacities of its constituent stocks. Paraffinicity, as indicated by viscosity index, is no measure of load-carrying capacity. As regards carbon deposits in engines—which are of special importance in high-speed engines—the best overall performance was obtained with oils prepared from Coastal crude, the next best being with oils prepared from mid-Continent crude, whilst the poorest results were obtained with Pennsylvania oils.—*"The Motor Ship", Vol. XXII, No. 266, March, 1942, p. 392.*

**Conversion of the Swedish Lloyd Liner "Patricia".**

The Svenska Lloyd's passenger liner "Patricia", which was for many years engaged in the Tilbury-Gothenburg service, is now a submarine depôt ship of the Royal Swedish Navy. Built on the Tyne in 1926, she is a single-screw vessel of about 3,900 gross tons, with triple-expansion engines and oil-fired boilers which give her a service speed of some 14 knots. Originally named the "Patris II", she was employed in the Mediterranean under the Greek flag for several years prior to her acquisition by the Svenska Lloyd for £71,500 for service as a relief ship for their North Sea passenger service. Several months ago, the renamed vessel was purchased by the Swedish Admiralty for about £117,500 for conversion into a submarine depôt ship, and she is now doing duty as such. The cost of converting the vessel for this service has amounted to no less than £387,500, exclusive of the cost of certain materials supplied by the Swedish Admiralty. The conversion work included the provision of four separate coke-burning galley ranges, and special tanks and piping for cooling drinking water—of the kind, it is said, used only on board the most modern passenger ships cruising in tropical waters. New navigation equipment, criticised as unnecessary for a ship which may spend only about 25 days a year at sea, has cost over £7,500. The total expenditure involved in the purchase and conversion of this comparatively old ship has exceeded the approved estimates by some 40 per cent. and has been the subject of sharp criticism in the Swedish press, more especially as the cost of a new depôt ship for submarines would have been substantially lower. On behalf of the Swedish Admiralty it is pointed out that the construction of a new ship would have taken many months longer than the time involved in converting the "Patricia", and that under the circumstances this is all that matters. The converted vessel is now acting as a depôt ship for nine submarines and their crews.—*"The Shipping World", Vol. CVI, No. 2,543, 11th March, 1942, pp. 193-194.*

**Floating Aeroplane Bases.**

A question was recently asked in Parliament as to the reasons why the seadromes invented by Mr. F. G. Creed had not been made use of in the present war, and whether, in view of the considerable improvements which the inventor claimed to have made in them, the Government would reconsider their original decision to reject the invention (*see abstract of F. G. Creed's paper on p. 73 of* TRANSACTIONS, *May, 1939*). Mr. Attlee replied that the type of seadrome advocated by Mr. Creed had been examined on a number of occasions since 1937, by engineering experts in and outside the Services, and that its rejection for Service use was due to strategical and tactical considerations, and not merely on engineering grounds. The decision could not be affected by structural modifications to the proposed seadrome.—*"The Journal of Commerce", No. 35,601, 16th March, 1942, p. 4.*

**Saturated Steam for New Ships.**

The coal consumption of the reciprocating-engined cargo tramps at present under construction is likely to be slightly higher than was usual immediately before the war, owing to the utilisation of saturated steam instead of superheated steam. It should not, however, be assumed that the omission of superheaters in the new vessels is due to any objection to this method of saving fuel; the position is that, on balance, it has been thought better to simplify the boiler-room arrangements at the expense of fuel consumption. A similar view would not be taken in normal times. When superheated steam is employed it is desirable to make the superheater elements and H.P. piston valves of special steel—a procedure which it may not always be convenient to follow at the present time—and the amount of oil required for internal lubrication makes it essential to provide special arrangements for purifying the feed water drawn from the main condenser. In practice, this means the installation of a duplicate system of gravity or pressure-type feed filters, in addition to which it becomes necessary to guard against the risk of contaminating the boiler feed water where direct contact-feed heaters are used. All this adds to the expense of the machinery, as well as to the time required for its construction and installation.—*"Fairplay", Vol. CLVIII, No. 3,070, 12th March, 1942, p. 334.*

**Embrittlement of Steel.**

When steel is subjected to the high temperatures associated with modern boiler practice, it undergoes certain changes in its mechanical properties, including a gradual reduction of its tensile strength. Investigations have enabled some idea to be obtained of the stress which various grades of steel can safely withstand at any given temperature without excessive deformation, although since the creep of a material is a function of the time to which it is subjected to stress, too much reliance cannot be placed upon these results. Moreover, certain alloy steels also tend to become embrittled under the combined action of high temperature and high stress, this being particularly noticeable in bolts and studs where there are severe changes in contour. The house journal of a well-known firm of combustion engineers recently described some investigations of the determination of temperature embrittlement, from the results of which it would appear that the Izod test gives the only satisfactory method of assessing embrittlement, the Brinell hardness figures being of little comparative value.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 11, 12th March, 1942, pp. 315-316.*

**New Duties for Wrens.**

The latest naval activity in which Wrens will replace naval personnel is the maintenance of ships and aircraft. This branch will be known as W.R.N.S.(M.), and among the unskilled jobs of work planned for it are the cleaning of ammunition, sparking plugs and boats, sweeping, painting, greasing and polishing, and engine cleaning. Semi-skilled work will include machine work of a simple repetitive character, the stripping-down of light machinery, repairs of light metalwork and woodwork, and the repair of steampipe lagging. The Wrens will work alongside men ratings at naval bases.—*"Shipbuilding and Shipping Record", Vol. LIX, No. 12, 19th March, 1942, p. 363.*

**The Ballasting of Cargo Ships.**

This paper has been prepared to promote a discussion on the immersion of cargo vessels in ballast condition, but the author points out that as ballasting to maintain stability is a matter of design confined to particular cases, he has not attempted to deal with this. Tabulated particulars are given in the paper of the ballast draughts in general cargo ships, colliers and oil tankers under certain assumed conditions, and the author puts forward a criterion for use in the assessment of the suitable ballast draught in such ships.—*Paper by H. Bocler, read at a general meeting of the N.-E. Coast Institution of Engineers and Shipbuilders, on the 20th March, 1942.*

**Future Supply of Fuel Oil.**

Disquieting statements have appeared in regard to the effect of the loss of the Netherlands East Indies oilfields on the supply of liquid fuel to this country, but it is, perhaps, not realised that the total petroleum production in the N.E.I. in 1941 was only 7,800,000 tons out of a total world output of nearly 300 million tons, so that the East Indies output was under 3 per cent. of the total. The oilfields of the U.S.A. were responsible for some 185 million tons, and in 1941 America produced about 9 million tons more oil than in 1940, a corresponding increase being anticipated during the present year. The normal annual increase of production in the U.S.A. is, therefore, greater than the total output of oil in the N.E.I., and the amount of oil fuel available for the Allies should be greater this year than in 1941, despite the loss of the East Indies oilfields. Iran produces more oil than the N.E.I.—rather more than 10 million tons per annum—and the U.S.S.R. has an output of nearly 30 million tons. Venezuela also produces about 27 million tons of petroleum per annum. It can be said, therefore, that according to recent figures, the Allied and Allied-controlled countries still have a daily oil production of about 800,000 tons, whilst the Axis and Axis-controlled countries, including synthetic production in Germany, have a daily production of little more than 41,000 tons, and the N.E.I. oilfields, before they fell into Japanese hands, had a daily output of 27,000 tons.—*"The Oil Engine", Vol. IX, No. 107, March, 1942, p. 273.*

**Speed Control of Electric Fans.**

Magnetic means of varying the speed of induced-draught fans driven by constant-speed motors are being utilised in America. According to *"Power"*, a well-known electrical manufacturing concern has made for one customer 21 sets of control gear for speed ranges up to 10 to 1, in sizes of from 75 to 250 h.p. Each set is self-contained on its own pedestal bearings and base, flexibly coupled to the driving motor and driven fan. Electro-magnetic flux linkage takes place between two elements.. The outer member is a "stator ring" consisting of a circular steel backplate to which is clamped a laminated iron core, slotted for a squirrel-cage winding, which is rotated on roller bearings by the driving motor. The inner member, which drives the fan, consists of a steel spider carrying six magnetic poles without damper windings in their faces, the pole windings being connected to collector rings through which d.c. is conveyed for excitation. The driven speed relative to that of the driver is determined by the magnetic slip between the two elements, and is controlled by the amount of current permitted to flow in the magnet coils by an adjustable rheostat, which thus regulates the torque transmitted from the motor magnetically through the coupling to the fan. The d.c. excitation is provided by copper-oxide rectifiers that are fed with a.c. through variable-voltage adjustors actuated either manually or by Hagan automatic combustion-control equipment.—*"Electrical Review", Vol. CXXX, No. 3,354, 6th March, 1942, p. 314.*

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