A PETROLEUM HANDBOOK

For Private Circulation

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Petroleum Handbook

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present one under construction to transport some 1,700 tons of gasoline per day from the Wood River refinery to Toledo, 400 miles away.

In modern practice, these lines have welded joints throughout and, wherever possible, are buried. Special ditching machines have been designed for digging the trenches and for back-filling the earth after the lines have been laid. Other special equipment for cleaning the line and for coating it with a hot bituminous protective coat has been designed. This protection is very necessary to guard as far as possible against corrosion. The corrosion is due mainly to electrical causes, electromotive forces being set up owing to differences in the humidity and chemical nature of the ground, and sometimes to stray currents, when near industrial areas. This question of pipeline corrosion is of immense importance and is now receiving a great deal of scientific study and attention.

Such pipelines must be provided with pumping stations along their course, the number and position being determined by the contour of the country and by the type of oil being pumped. Extremely powerful pumps working at high pressure are employed and are usually driven by means of oil or gas engines. Such trunk lines are, moreover, usually equipped with a private telephone system connecting all the pumping stations.

The crude oil trunk lines terminate at the refineries. The finished products from the refineries are delivered to the marketing centres by rail, road, river or sea, according to conditions.

In many cases, the refineries are situated in countries which are not large consumers, as it is generally more economical to refine near the point of production and transport the finished products to the various markets overseas in the proportions in which they are needed. Refineries are, therefore, often situated on the coast where suitable loading facilities may be arranged so that the products may be transported by sea to the marketing centres, which may be thousands of miles distant.

SEA TRANSPORT

Transportation of petroleum products by sea is effected by means of vessels specially constructed for the carriage of liquids in bulk, these vessels being commonly known as tankers.

Up to about fifty years ago, all petroleum products, principally illuminating and lubricating oils, were packed in barrels and carried in sailing ships. This was a very costly method, owing to the weight of the containers, heavy handling charges and broken stowage†; moreover, the barrels, being generally leaky, were a source of danger, so that the development of vessels for the purpose of carriage of oil in bulk was a natural sequence. The first vessel designed and built for this special purpose was a steam vessel of 2,297 tons gross tonnage, which made its appearance in 1886, although several steam cargo ships had been converted into bulk oil tankers prior to that date.

The design and size of a tanker varies according to the trade for which it is intended. The coastal types vary from 500 to 2,000 tons deadweight carrying capacity, and the ocean-going types from 2,000 to 18,000 tons, the larger vessels being used on routes such as that between America and Europe, where they are in regular employment in the carriage of homogeneous cargoes. The Group's tankers are, however, designed and built for the purpose of transporting various grades of oil at the same time in order to meet the requirements of their world-wide trade. They have, at times, been called upon to carry such varying cargoes as creosote, water to oil fields where this commodity is scarce, and even whale oil from the Antarctic as a return cargo after supplying fuel oil to the floating whale oil factories and depots in the far south.

Ship's Tanks.—In principle, all tank vessels are alike in that the larger portion of the hull is subdivided into cargo oil compartments by means of longitudinal and transverse bulkheads which, with the sides and bottom of the hull, form the tanks into which the cargo is loaded. The remainder of the hull is taken up by machinery and pumproom spaces, fore and after peak tanks, cofferdams, bunker tanks, and usually a forehold.

A profile and cross-section of one of the Group's modern motor-driven tankers is shown (fig. 1), from which it will be noted that the

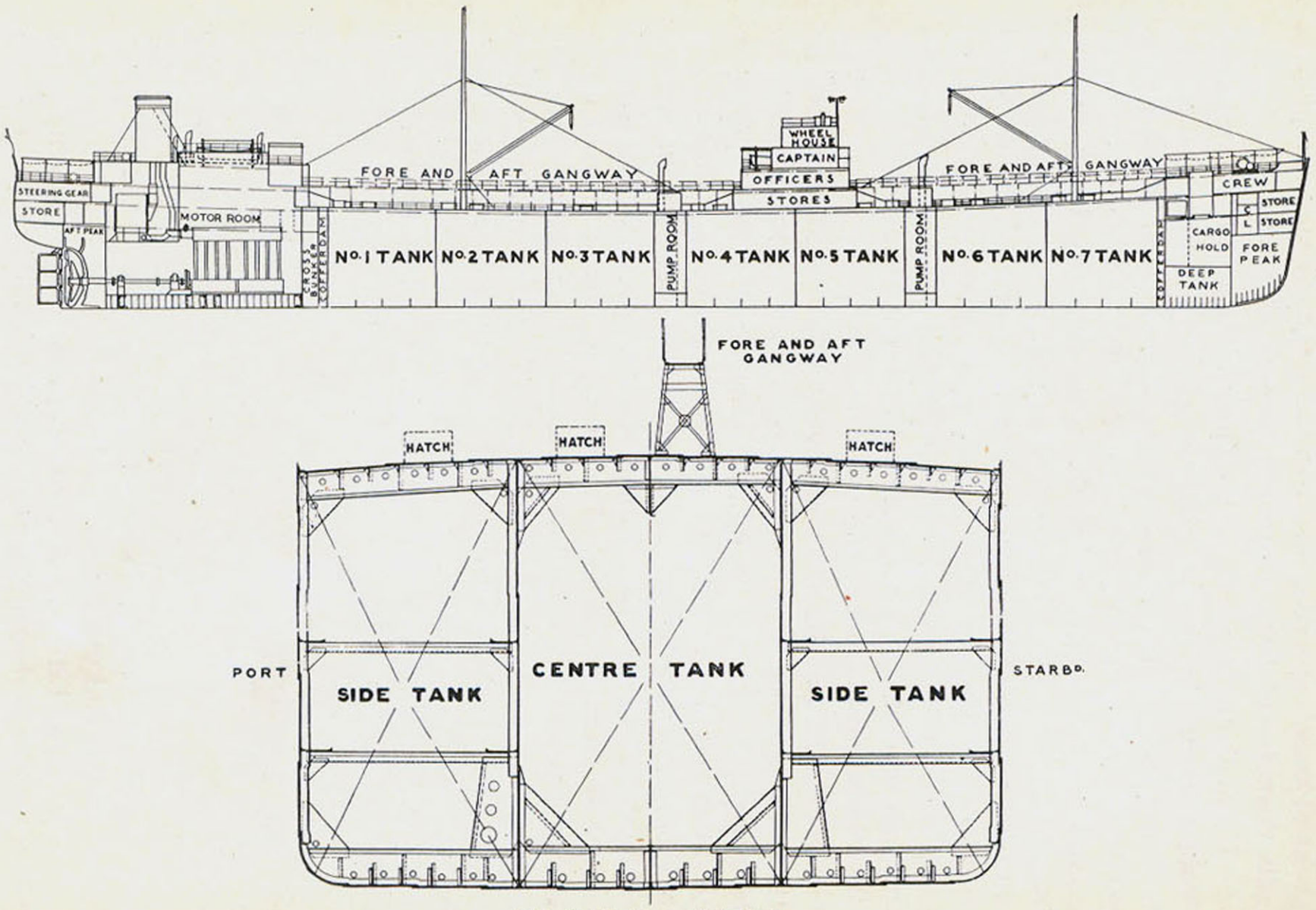

Fig. 1—Modern oil tanker.

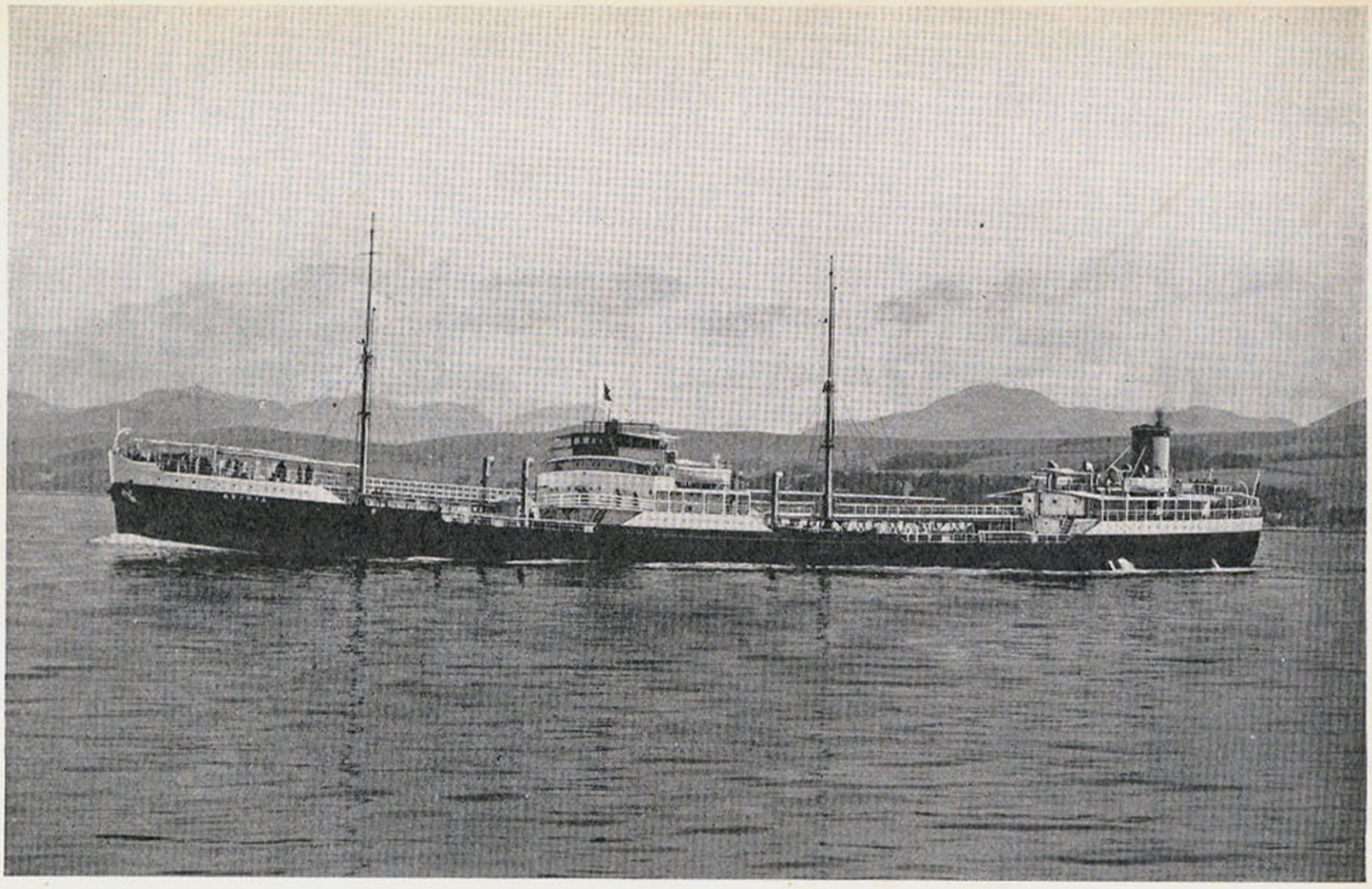

Fig. 2.—m.v. "ARINIA."

Length 483 ft. Breadth 59 ft. 3 ins. Draught 27 ft. 6½ ins. Displacement 16,822 tons. Deadweight 12,140 tons. Fitted with 8-cylinder single-acting 4-cycle supercharged motors, developing 3,500 brake horsepower. Speed 12 knots.

vessel is divided from aft to forward into the following spaces: after peak, machinery, crossbunker, cofferdam, three cargo tanks, after pumproom, two cargo tanks, forward pumproom, two cargo tanks, cofferdam, forehold and fore peak tank. Each cargo tank is subdivided athwartships† by two longitudinal bulkheads so that there are in all twenty-one separate oil compartments.

In the case of vessels which may be used for carrying heavy oils which are too viscous to pump at ordinary temperatures, the tanks are provided with steam heating coils, placed near the bottom. The steam for heating these is supplied from an auxiliary boiler, if the ship is motor-driven.

The lower part of the hull in the machinery space is fitted with deep frames which are covered with steel plating, to which the main motors, etc. are bolted, the space between this plating and the bottom of the vessel forming three cellular, double-bottom tanks, which are used for the purpose of storing (*a*) fresh water or oil for cooling the pistons of the motors or (*b*) fuel oil or water ballast. The small tank between these is used as a drain tank for the lubricating oil which is circulated through the main engine bearings. The forehold has a larger double bottom or deep tank in which bunker oil is carried. The cofferdams are safety divisions between the cargo tanks and the other parts of the vessel. When passing through the Suez Canal and also when in certain ports, these spaces are filled with water to comply with local regulations. The peak tanks are used for either water ballast or reserve boiler water as required.

Pumprooms and Pipelines.—Two pumprooms have been adopted for the purpose of enabling several grades of oil to be carried at the same time and, as they extend the full width of the vessel, they also serve the purpose of cofferdams, providing isolation spaces between the groups of tanks and preventing risk of contamination between the different grades of cargo. Each pumproom is fitted with two large cargo pumps, each capable of pumping about 250 tons per hour, these being placed as near to the bottom of the vessel as possible to reduce the suction lift to a minimum, a most important point when very volatile† oils are carried.

From the pumprooms, the main suction pipes are led forward and aft through the side tanks, the two lines being joined in each tank by means of crossover pipes, from which a suction pipe with valve is fitted in each cargo compartment, this pipe reaching to within half an inch of the bottom of the vessel. A master valve is fitted to the pipelines at each thwartship and longitudinal bulkhead, which enables sections of the pipelines to be isolated as desired. Further, the centre compartment directly forward of each pumproom is fitted with an entirely independent suction valve with piping through the pumproom to deck, which enables these two compartments to be reserved for special cargoes, such as lubricating oil.

The capacity of the cargo tanks is such that a full deadweight cargo can be loaded with the lightest grades of gasoline, so that it is obvious that, when heavier grades are loaded, some of the compartments must be left either empty or only partially filled. When black oils are carried, the two compartments referred to above are left empty and are, therefore, always kept in a fit state to load special grades of oil without fear of contamination by residue of previous cargo.

For discharging the cargo, delivery pipes run from the cargo pumps to the deck and are so arranged that each pump can deliver independently to either side of the vessel. A delivery pipe is also led to the stern of the vessel for use in ports where vessels have to moor stern on to the wharf.

Ventilation.—By reason of the nature of the cargo carried in a tanker, the tanks cannot be fitted with the ordinary type of ship's ventilator. A special venting system is fitted consisting of a main pipeline on deck running the full length of the cargo tanks with a branch pipe carried up each mast. Branches are led from each tank hatch coaming† to the main line, each fitted with a stop cock or valve. By means of this system any excess of gas formed in the tanks can be led away to the atmosphere *via* the mast pipes or, alternatively, air can be admitted to the tanks if shrinkage of the cargo, owing to cooling, renders this advisable.

Propelling Machinery.—Although there are still several tankers afloat with the machinery placed amidships, the majority have this placed aft in order to avoid the necessity of building a special oil-tight tunnel for the propeller shafting in the after cargo tanks. Most modern tankers, with the exception of those built to suit some particular trade, are fitted with Diesel (compression ignition†) engines; in fact, the steam-driven tanker for general purposes is rapidly becoming obsolete. One or two auxiliary oil-fired boilers are fitted for providing steam for winches, steering gear, cargo pumps and for the heating coils in cargo tanks when viscous oils are being carried. These boilers are also arranged to utilise the heat from the main motor exhaust gases and can generate ample steam for normal sea-going purposes by this means but, should additional steam be required, the oil fuel burning system can be brought into use to supplement the heat obtained from the exhaust gases.

LOADING AND DISCHARGING CARGO

The procedure which is followed in dealing with various grades of oil is much the same except that more stringent precautions are taken when the cargo is a low flash oil.† As soon as a tanker is moored at the loading berth and the ballast pumped out, the tanks are examined by a representative of the shore installation to ascertain if they are in a fit state to receive the proposed cargo. Connections are made by means of flexible hoses between the shore and ship pipelines and, if the cargo to be loaded is a low flash oil, all fires on board the vessel are extinguished and steam hoses connected from a shore steam supply to the vessel's steam lines. All cooking is done in special cookhouses on shore, where messrooms and smokerooms for the ship's officers and crew are also provided.

When the quantity of oil in the shore tanks from which the ship is to be loaded has been checked by representatives of the ship and installation, loading is started, the pumping being done by the installation pumps. With low flash products, such as light crude oil or gasoline, all openings on the tank lids are kept closed and the air in the tanks displaced by the incoming oil is permitted to escape to the atmosphere by means of the gas lines described above. On

completion of loading, hoses are disconnected and the pipelines blank flanged†, ullages,† specific gravities and temperatures of the cargo in each compartment are checked and noted in the vessel's cargo record book, and samples drawn for future reference. This work is carried out through special sight ports in the cargo tank hatch lids. A test is also made on each tank to ascertain if there is any water in the cargo, after which all sight ports, gas valves, etc., are closed and the vessel is permitted to light galley fires, raise steam on the boilers and prepare the main engines for departure on the voyage. The ullage mentioned above is the space left between the tank top and surface of the oil and usually amounts to about 2% of the tank's capacity to allow for expansion of the cargo should the vessel pass through seas and air of higher temperature than that which obtained during the loading period.

On arrival at the discharging port, all fires are extinguished, if the nature of the cargo necessitates this, ullages, specific gravities and temperatures are checked and samples of the cargo taken. Shore hoses are then connected and discharge of the cargo commenced by means of the ship's cargo pumps, using either shore or ship's steam as required. The rate of loading or discharge varies at different installations but the usual time required for each purpose seldom exceeds 48 hours for a full cargo of between 9,000 and 12,000 tons.

FLOATING AND SUBMARINE PIPELINES

Where deep water is available, wharves are constructed for tankers to moor alongside, but in those cases where deep water anchorage is some distance out, jetties are often constructed between the shore and the mooring point. These jetties carry the pipelines for receiving and/or delivering bulk supplies, and may be made of reinforced concrete, steel, timber or of mass construction. They may also carry decauville† track for receipt and delivery of packed stocks. Where bulk only is in question, such jetties may, in some cases, be dispensed with and a floating or submarine line substituted. Floating lines consist of lengths of rigid line, varying from 40 to 100 feet, secured to floats generally made up with old drums connected