A PETROLEUM HANDBOOK

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[*By courtesy of C. L. Woolley, Esq.*

Images of baked clay, with wigs of Asphaltic Bitumen, from excavations at Ur.

FOR PRIVATE CIRCULATION

A PETROLEUM HANDBOOK

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STORAGE, TRANSPORT AND DISTRIBUTION

CRUDE oil starts its life above ground in some sort of storage tank. In general, the oil does not remain on the producing field for any length of time but is transported at once, almost invariably by pipeline, to a large " tank farm." This tank farm may be situated near the coast, or far inland, according to conditions. From the tank farm, the oil is transported either by tank steamers or by pipelines to the refineries, which may be situated many miles away.

TRUNK PIPELINES

One of the earliest long pipelines to be constructed was that built from Baku to Batoum in 1897. Nowadays, a vast network of collecting and trunk lines covers the U.S.A., amounting in all to somewhere about 120,000 miles. The Group's refineries in Mid-Continent and even Chicago, are supplied by means of a pipeline 1,400 miles long, of 10 in. and 8 in. diameter, starting from East Texas. A line of this type is laid in a trench underground and is provided with a number of pumping stations along its route. The frequency of the stations depends on the contour of the ground and the type of oil to be pumped. The high pressure oil pumps used at these stations are generally driven by oil or gas engines.

Other examples of recently constructed pipelines are that from the coast up to Mexico City, 7,000 feet above sea level, and that from Iraq to the Mediterranean, with its two terminals at Haifa and Tripoli.

THE TANKER

The tanker is a vessel constructed for the special purpose of carrying liquids in bulk. Originally an ordinary vessel fitted with separately constructed tanks, it soon evolved into a vessel which was in fact a tank itself. Modern petroleum tankers are quite the

most efficient ships sailing the seas. They load and discharge more quickly then do general cargo boats. They can carry liquid products, other than petroleum, *e.g.*, water to oilfields in desert regions, creosote from the United Kingdom to the United States, and even whale oil from the Antarctic, when returning from a trip supplying liquid fuel to the floating whale oil factories and depots.

(1) *SHIPS' TANKS.*—As will be seen by reference to Fig. 1, which shows the form of one of the Company's modern vessels, the hull is divided into a number of cargo compartments formed by longitudinal and transverse bulkheads, the tanks being numbered from aft to forward, each tank being in fact three separate compartments. At each end of the cargo tanks a smaller compartment (called a " cofferdam ") is situated, extending the full width and height of the cargo tanks, but only a few feet in length. This cofferdam isolates the cargo tanks from the other parts of the vessel and is thus a safety space, as it prevents any leakage from the cargo tanks penetrating to other compartments such as the forehold and bunker tanks, and machinery spaces. When the vessel transits the Suez Canal or is in certain ports, the regulations require that these spaces be filled with water, thus forming a seal between the cargo and the other spaces. The cross bunker and forward deep tanks are reserved for the carriage of bunker oil, the forward and aft peak tanks being set aside as water ballast spaces or for the carriage of boiler water, as required.

Each cargo compartment is provided with a hatchway in the deck, fitted with a gas-tight lid which has a small sight port or screwed plug ; the purpose of these sight ports or plugs will be explained later.

(2) *PUMPROOM.*—The pumproom is usually placed in such a position as to divide the cargo compartments into two groups, its position being governed by its effect on the loaded trim of the vessel. This, in turn, forms another cofferdam as it isolates the groups of tanks, which is an advantage when it is desired to carry two grades of oil without any risk of contamination.

Two large pumps, usually of the horizontal duplex steam-driven type, each capable of discharging up to 250 tons per hour,

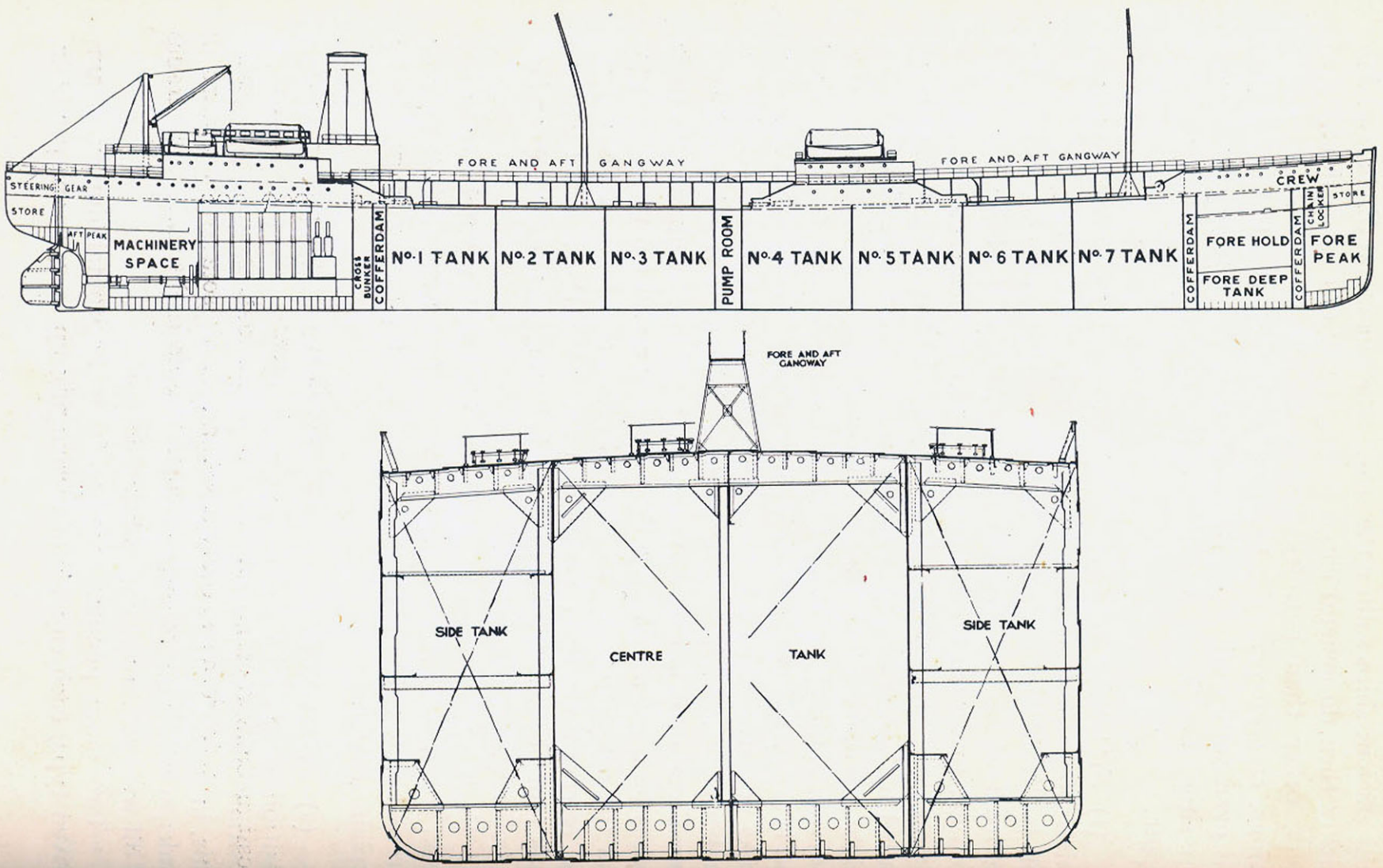

Fig. 1.—Diagram of a modern oil tanker.

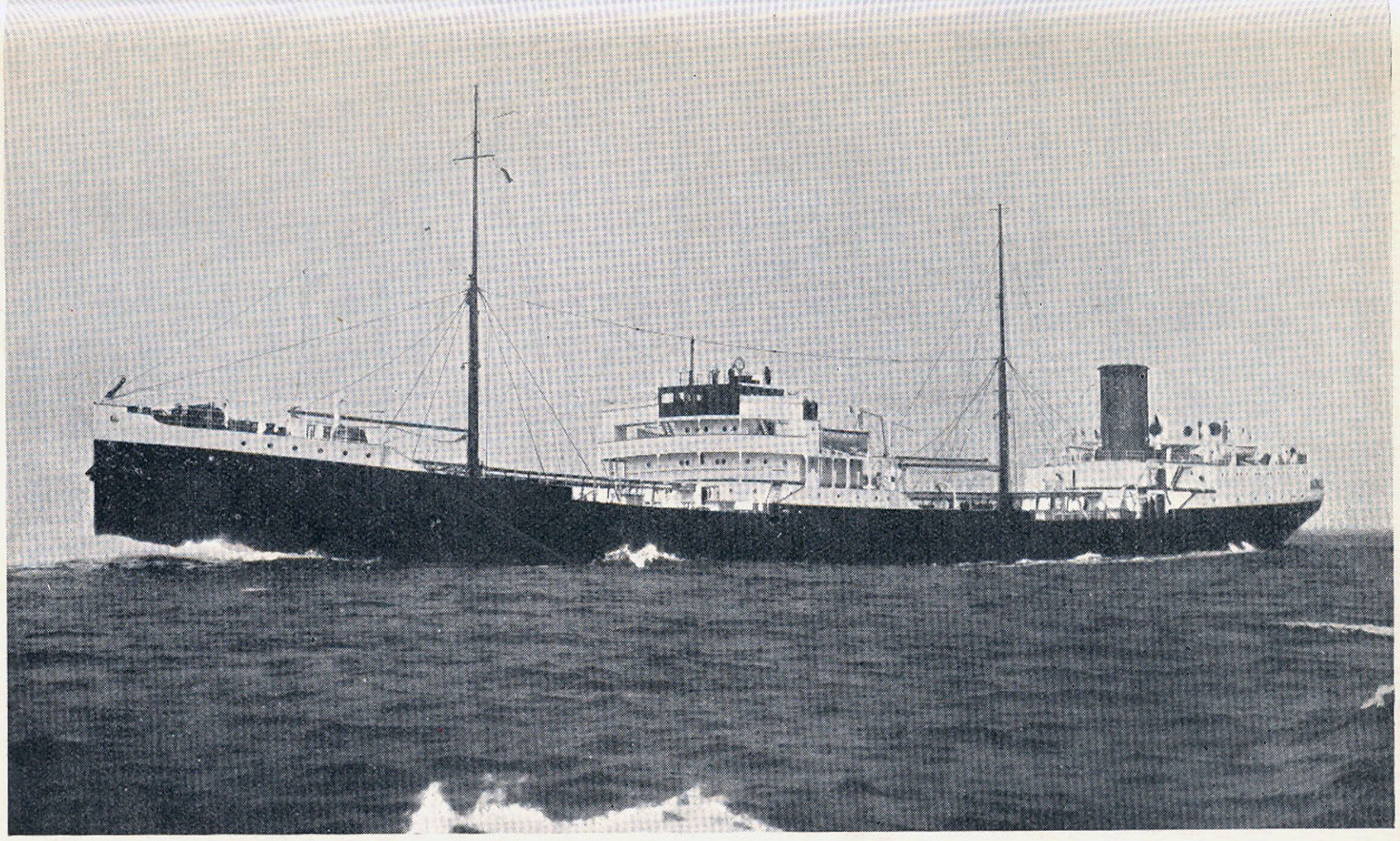

Fig. 2—m.v. "CAPRELLA."

Length—466′ 9″. Breadth—62′ 0″. Draught—27′ 7¼″. Displacement—17,395 tons. Deadweight—12,585 tons.
Fitted with Werkspoor type, single-acting, 4-cycle supercharged motors, developing 4,000 brake horse power.
Speed—12½ knots.

are placed in the pumproom as near to the bottom of the vessel as possible, to reduce the suction lift to a minimum. This is essential when very volatile oils are carried.

(3) *PROPELLING MACHINERY.*—The propelling machinery is invariably placed aft in order to avoid the necessity of a shaft tunnel passing through the after cargo tanks, an obviously potential source of danger. Of recent years, owing to the outstanding merits of the Diesel engine, steam engined tankers are rapidly becoming obsolete.

A donkey boiler for providing steam is generally necessary for the winches, steering gear, cargo pumps and also for the heating coils when the tanks are used for carrying very viscous oils.

For normal purposes the heat obtained by passing the exhaust gases through the furnaces of the donkey boiler is sufficient to maintain the required head of steam, but as it would not be possible to obtain the additional steam necessary for heating cargo, the boiler is fitted with a supplementary oil-burning system.

(4) *SHIPS' PIPELINES.*—From the pumproom, suction pipes are led through the side tanks to the forward and aft compartments, these two lines being connected by a crossover pipe in each tank from which a suction pipe runs to the bottom of the vessel, in each compartment. At each transverse and thwartship bulkhead a master valve is fitted which enables sections of the pipeline to be isolated as required.

The delivery pipes run from the cargo pumps direct to the deck by way of the pumproom and are arranged so that the pumps can deliver independently to each side of the vessel. There is also a pipeline from the pumproom to the stern of the vessel, as at several ports the ship lies stern on to the wharf.

(5) *VENTILATION.*—It will be readily understood that tankers cannot be fitted with the ordinary type of ventilator to the cargo tanks, so that a system of gas freeing pipes is arranged to enable gases to be carried to the atmosphere via a vent pipe leading up the masts; this also serves as a means of admitting air to the tanks, if necessary, due to shrinkage of cargo.

LOADING AND DISCHARGE OF A TANKER

Oil cargoes are usually defined under three headings:

(1) Dangerous cargoes, having a flashpoint below 73° F.

(2) Ordinary cargoes, having a flashpoint between 73° F. and 150° F.

(3) Non-dangerous cargoes, having a flashpoint higher than 150° F.

The procedure which is followed in loading and discharging these various classes of cargo is much the same but somewhat more complicated in the case of a product with a low flashpoint. For this reason the operations involved in the loading and discharge of a cargo of gasoline have been selected for description.

As soon as the tanker has been moored at the loading berth the master and the installation manager, or their representatives, inspect all tanks to ascertain that they are empty and in fit condition to receive cargo. All fires on board the ship are put out and from this time until loading operations are completed all cooking is done on shore, where special cookhouses, mess-rooms and smoking rooms are provided for the use of officers and crew. Steam for the ship's use is provided from the installation. (In the case of certain ships of special design, arrangements for working the pumps by means of auxiliary oil-driven motors have been adopted.) Flexible hoses are then connected from the shore pipelines to the ship's loading connections. In the meantime the measurements of the shore tanks, from which the ship is to be loaded, have been agreed by representatives from the ship and the installation. All openings from the ship's cargo tanks to atmosphere are then closed, with the exception of the gas valves, which are left open to allow of the escape of air and gas displaced by incoming cargo.

There is always more danger when loading than when discharging because in the former case gas is being expelled from the tanks by displacement from the incoming cargo whereas in the latter case air is being drawn into the tanks by the vacuum caused by the withdrawal of cargo.

When loading has been completed the hoses are cleared and disconnected and the ship's loading connections closed by means of blank flanges. Ullages, specific gravities and temperatures are

checked and samples taken, this work being done through the sight port or plug holes to which reference has already been made. The ullage is recorded as the distance from the top of the ullage plug to the level of the liquid in the tank. The ship's calibration tables will indicate the quantity of liquid in a tank for any ullage reading obtained. Each tank of the ship is then tested for water content, by means of a water finder. Ullage plugs, gas valves and all other openings from the tanks to atmosphere are closed, and the ship is then allowed to light fires and raise steam on the donkey boiler in preparation for her voyage. In the meantime the quantity of oil in the ship has been calculated and the figures compared with the quantity delivered from the shore tanks.

With ordinary oil cargoes the pressures developed during the voyage do not necessitate the use of the ventilation system, but in the case of very volatile cargoes the pressure in the ship's tanks may rise, in hot weather, to such an extent that it is necessary to release the gases formed.

On arrival at the discharging port much the same procedure is followed as when loading. Ullages, specific gravities, etc., are checked, samples are taken, the hoses connected, and the discharge of the cargo commenced using the ship's pumps driven by steam supplied from the shore.

A tanker with a cargo of 9,000 tons will normally complete her " turn round " in port in from 36 to 40 hours. Indeed, in comparison with ships carrying general cargoes, tankers spend very little time at their terminal ports, either in loading or in discharging cargo.

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 together by short lengths of flexible hose. In some cases they are left permanently in position and in others drawn up on shore and partly dismantled after each tanker discharge, being launched and re-assembled when the next tanker is due. They are only suitable for a comparatively calm sea and where this cannot be relied upon, or where such surface obstruction is objected to, submarine lines may be substituted. A submarine pipeline consists of rigid pipeline along the sea bottom, the seaward end having sufficient length of flexible hose attached to be hauled up and connected to the tanker when discharge is required. The laying of these submarine lines is a difficult and costly operation, and under some conditions, in fact, quite impracticable. Although, prior to laying they are carefully protected against corrosion by coating with asphaltic bitumen compounds and wrappings, and against mechanical damage to such coatings, their life is limited, and once they begin to fail, repair work, which has to be carried out under water, is very costly. Their application is, therefore, somewhat limited.

THE INSTALLATION

The products received by an installation are generally in marketable condition and may be distributed as received. Sometimes, however, this is not the case and some form of blending of products takes place before distribution proceeds.

The essential equipment of an installation, therefore, tends to be somewhat more complicated than if storage were the sole objective. All the same, this equipment does consist essentially of pipelines, tanks and pumps. It is proposed, therefore, to discuss these principal and characteristic items of installation plant in some detail.

INSTALLATION PIPELINES

(1) *PIPELINE JOINTS.*—Pipelines are generally made of steel, this being stronger and cheaper than cast iron. The joints may consist of (*a*) internally screwed sockets into which the ends of adjacent lengths of pipe are screwed ; (*b*) flanges, screwed or otherwise secured on to the ends of the pipes and subsequently bolted together with suitable jointing material between ; or (*c*) special