A PORTABLE DISTILLING UNIT.

The provision of distilling plant on naval vessels fitted with steam-driven machinery does not present much difficulty. When, however, the ship is propelled by internal combustion engines, distilling is not possible if no auxiliary steam is provided. In this connection, the portable vapour compression distilling unit described below is of particular interest as it offers many advantages both afloat and ashore.

Manufactured by Badger, of Boston, U.S.A., the unit was originally mounted on a skid. The demonstration unit, which was recently inspected under working conditions, is, however, housed in a truck which can be driven aboard an L.C.T. or wherever it may be required. One of the most obvious applications is the provision of drinking water to a flotilla of landing craft on passage, the unit being afterwards driven ashore to continue operations on land. An output of 60 gallons per hour is maintained for the expenditure of 25 gallons of petrol per day.

As may be seen from Fig. 1, motive power to operate the vapour compressor and water pumps is obtained from a 10 H.P. petrol engine which also supplies additional heat to the process through the cooling and exhaust systems.

Distillation is made possible by exchanging the latent heat of vaporisation between compressed steam and boiling water. Heat is supplied to the system from the work done by the compressor and by transfer from the cooling and exhaust systems of the petrol engine. It is necessary that as much heat as possible be retained in the process and that heat waste be kept at a minimum. For this reason, all major items of equipment are insulated against heat loss with glass wool and the hot water piping with layers of asbestos cloth.

The vapour compressor draws the vapour from the steam separator section of the evaporator, compresses and discharges it to the steam chest of the evaporator. The temperature of the steam is increased by this compression to a point higher than that of the boiling water. This causes further boiling and a corresponding condensation of the steam.

The combination heat exchanger and vent condenser cools the distillate and brine overflow, condenses the excess steam vented from the evaporator, and preheats the incoming feed water while the engine water cooler transfers

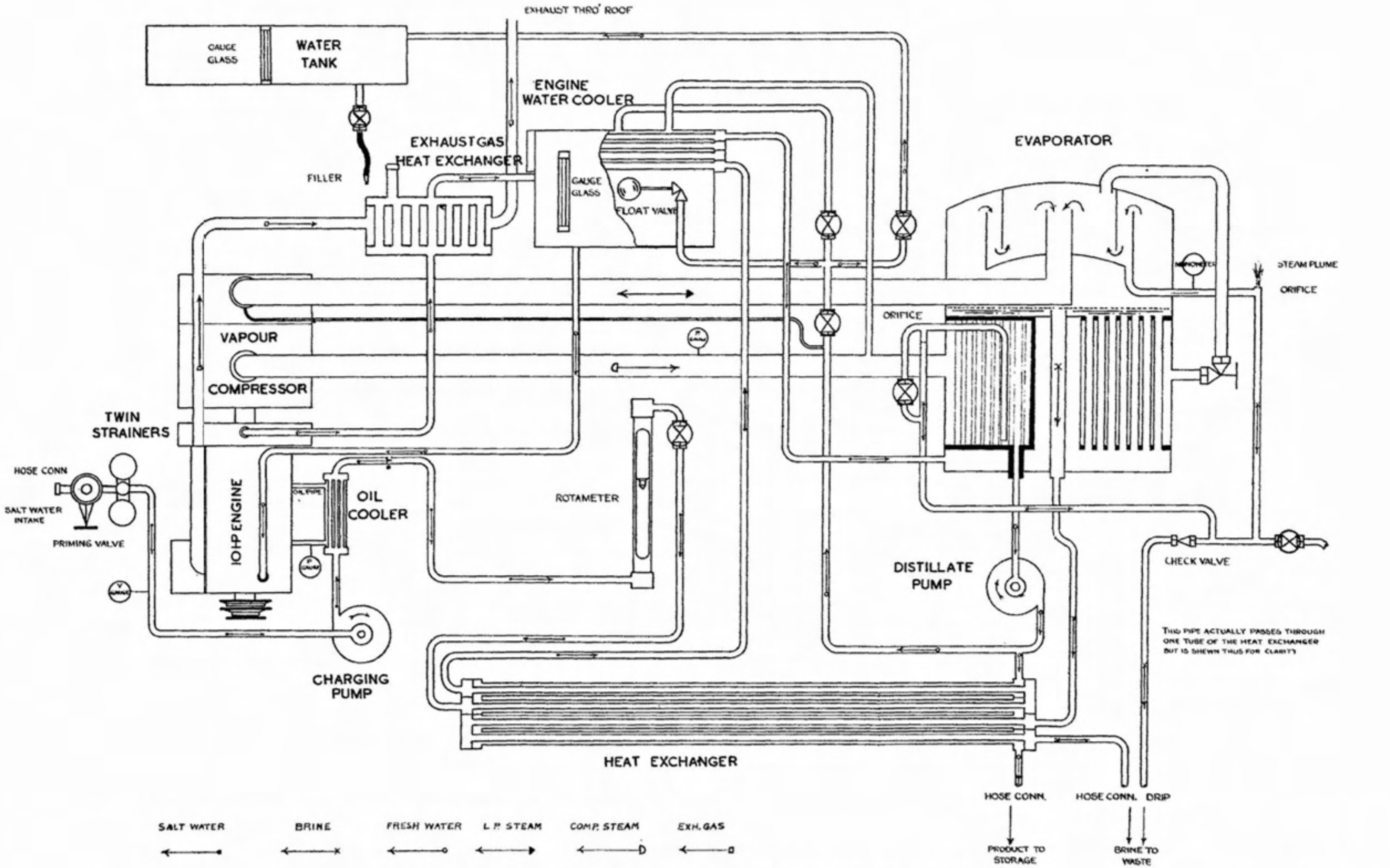

FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF PORTABLE DISTILLING UNIT

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heat from the petrol engine and exhaust exchanger to the feed water passing through the tubes in the upper section. A float valve automatically admits distillate into the cooler to maintain the required water level.

After preheating, by flowing through the heat exchanger and engine cooler, the feed water enters the bottom of the boiling section of the evaporator at a temperature just below boiling point. Heat given up by the condensing steam in the steam chest is transferred through the vertical tubes causing the feed water to reach boiling point and partially vaporise. The steam and water rise inside the tubes to the upper section of the evaporator which is simply a steam separator. A baffle arrangement allows the steam to pass on into the suction pipe of the compressor, but prevents the liquid from so doing. The liquid spills into the overflow pipe and is carried to the outside as waste.

After compression, the steam which has increased in temperature is returned along with the non-condensed steam from the engine water cooler to the steam chest of the evaporator. From this section condensed steam or distillate flows by gravity to the inlet of the distillate pump. A frothing or priming action of the boiling feed causes the concentrated brine to pass into the central overflow tube which is connected with the heat exchanger.

Feed regulation.

The rotameter is a calibrated glass tube by which the rate of flow of feed water can be determined by the position of the float inside. The top surface of the float indicates the scale reading for the flow in gallons per hour. Regulation of the feed to the evaporator is effected by a flow control valve installed in the piping on the outlet side of the rotameter. Between the time of starting and the production of steam in the evaporator, the compressor pumps air through the system. If this air were not recirculated serious damage to the equipment would result from the increased pressure. The by-pass line allows the air to recirculate and also to discharge through the vent pipe and distillate outlet to prevent the pressure reaching the dangerpoint. When steam is produced in the evaporator, the air is displaced and is forced out through the vent pipe.

A vent line is installed in the steam chest of the evaporator and connected to the vent condenser, to prevent the non-condensed vapour from accumulating and causing a vapour binding in the distillate pump. To control the amount of vapour vented during operation, a disc with a ⅛-in. orifice is placed in the line. This orifice will allow enough vapour to discharge through the vent condenser to condense approximately one gallon of water per hour. For normal operation the orifice will vent all the vapour, but when an abnormal amount of air is present the orifice is too small to allow effective venting. It is possible to increase the amount vented by opening a valve on the line by-passing the orifice.

A turbine-type pump is installed in the feed line to draw the water into and circulate it through the unit. The same type of pump is used to force the distillate through the heat exchanger and out to the storage tank or other receivers. Exhaust gases from the engine are piped through an exhaust heater connected to the engine cooling system, and since these gases are at a temperature of approximately 600° F., when they leave the exhaust manifold a considerable amount of heat is picked up by the water which is in turn passed to the raw feed.

A U-tube type manometer containing a liquid having the same specific gravity, but a lower freezing point than water, and coloured for easier reading, is connected to the evaporator vapour section to measure the operating pressure. The pressure, whether above or below atmospheric, is determined by the relative height of the liquid in the tubes.

Variations in the heat balance can be caused by changes in the engine speed and temperature and rate of the water feed. Control instruments are provided to indicate to the operator any deviations in operating conditions. One factor which cannot be determined from the instruments is the rate of brine overflow produced. For best results, the overflow rate should approximate the distillate rate because it not only makes for a better heat balance, but also decreases the scaling action in the evaporator tubes. To increase the rate of overflow, more heat must be applied to the system by increasing the engine speed.