

M.S. "HENRY FORD II"

# DIESEL POWER *of* M.S. HENRY FORD II

By MALCOLM McLAREN

CHIEF ENGINEER, MOTORSHIP HENRY FORD II

**T**HE motorship *Henry Ford II* is of the lake type with engine room aft, having a length of 612 feet, a beam of 62 feet, a draft of 24 feet, gross tonnage 8877 tons, and net tonnage 7074 tons. The crew consists of 34 men, of whom 11 are assigned to the engine room.

In a normal season of about 8 months, extending from April 1 to December 1, the vessel carries approximately a million tons of cargo to the Ford Rouge plant.

The cargoes consist of iron ore, limestone, and coal, the ore being loaded at Lake Superior ports. It requires about 4 hr to load and about 9 hr to unload at the plant. The limestone is loaded at Calcite, Mich., and the coal at Toledo, Ohio. It is not unusual for the vessel to carry a 15,000-ton cargo to the plant. The amount of the load depends somewhat upon the depth of the Rouge River which varies as much as 18 in. during the season. On the run from the Rouge plant to where the cargo is taken aboard the vessel takes on water ballast which amounts to about 4000 tons. This ballast is pumped out as the cargo is received. The average speed of the vessel is 13 mph with cargo and 14½ mph with water ballast.

The foregoing details will give some conception of what is required of the power plant. The engine-room crew is employed the year around as the 4 months' lay-up is required to overhaul the machinery which is always kept in first-class condition. The crew's quarters and the food are on a par with the best hotels.

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## THE POWER PLANT

The power plant consists of a main engine of the Sun Doxford opposed-piston two-cycle type with a maximum horsepower of 3500 at 85 rpm; two 6-cylinder two-cycle Worthington engines of 450 hp at 274 rpm, each driving a 300-kw 240-v generator. They supply the current for the auxiliaries which are all motor-driven. One of these generators is always in reserve.

In addition there is a Junkers opposed-piston-type engine of 50 hp at 500 rpm, driving a 35-kw 240-v generator, which is used in an emergency for the steering gear only.

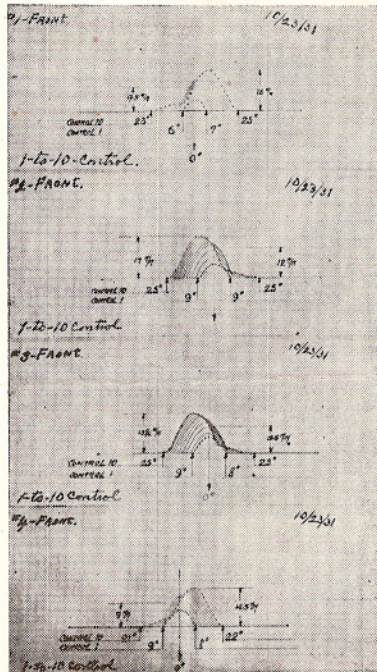
One donkey boiler, 15 ft 8 in. high and 6 ft diam, supplying steam at 150 psi, is used for steam whistle and heating water for the rooms and galley, as well as to keep the main-engine jacket water at the correct temperature when the engine is not in use.

The average fuel consumption for the entire power plant is approximately 175 gph; main engine 140 gph; Worthington engine 25 gph; boiler 7 gph; and Junkers engine 3 gph. The Junkers is only in operation in close quarters, such as making and leaving port, and running the rivers.

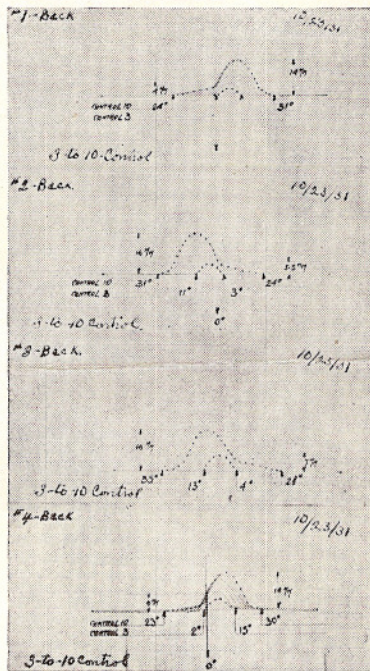
## MAIN ENGINE

As noted, the main engine is a Sun Doxford, opposed-piston, two-stroke-cycle type with solid injection; cylinders are 23⅝-in. bore, while the stroke of each piston is 45⅝ in., giving a combined stroke of 91¼ in. The mechanical efficiency is approximately 90 per cent thus providing a shaft horsepower of 3150.

Referring to the cylinder construction, the liners are 11 ft in



(Front valve-lift cards)  
 FIG. 1 COMPLETE INDICATOR CARD TAKEN ON MAIN ENGINE



(Back valve-lift cards)

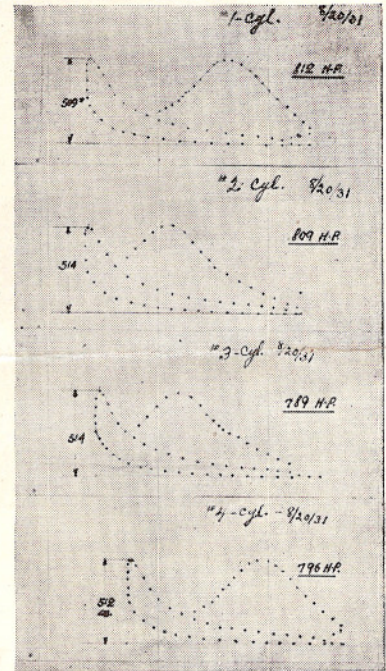


FIG. 2 INDICATOR, AND COMPRESSION CARDS TAKEN ON MAIN ENGINE

length and the exhaust ports at the top are opened to a considerable extent by the passage of the upper piston, before the scavenging ports at the lower end of the cylinders commence to be uncovered by the bottom piston. The scavenging air is furnished by an independent motor-driven blower of 10,000 cfm capacity at 2 psi pressure.

There are two fuel valves for each cylinder, the one in the front of the engine being slightly above the mid-point of the liner, while that at the back is somewhat below. The rear valves are not in operation while the engine is running astern. The fuel valves are operated by a camshaft which receives its motion through a system of gears from the main shaft. The lubrication of the engine is on the forced-pressure system.

In maneuvering, the engine is started with air pressure of 600 psi, and after one revolution the fuel oil is cut in at 2000 psi pressure. There are two main fuel pumps; an independent motor-driven pump which is used to supply fuel pressure when maneuvering, and a fuel pump which is driven from the main-engine shaft, for use when the engine is in operation. The engine can be slowed down to as low as 18 rpm and up to 85 rpm on the fuel oil used.

The cylinders are water-jacketed and the water temperature must be kept at 150 F for starting purposes. The water jacket is also used to maintain the cylinders at the proper temperature while the engine is in operation.

It might be well to state that the engine is heated up at the start of the season and not allowed to cool off until the end of the season. This stops expansion and contraction and prevents water leakage from the jackets.

For economical and smooth operation it is important to keep the engine equalized, that is for each cylinder to deliver the same amount of horsepower, this is, very easily done on this type of engine and adjustments can be made while the engine is in operation.

There are three types of indicator cards that can be taken

from the engine to assist in balancing it. They are "power" cards, "valve-lift" cards, and "compression" cards. The adjustments are made by increasing or decreasing the lift of the fuel valve.

A complete set of cards taken from the engine appears as Fig. 1.

It would be well for anyone interested in Diesel power to look them over. They were taken under actual working conditions, giving the valve timing, fuel consumption, ignition pressure, etc.

For successful operation and a minimum amount of liner wear, it is essential to use a good grade of Diesel fuel oil, which will greatly assist in keeping the engine repair bills low. Following is the specification of the fuel used on the vessel. The fuel is a hydrocarbon oil, free from grit and fibrous or other foreign matter likely to clog or injure the valves, and conforms to the following constants:

Flash point F (Cleveland open cup), DF	Viscosity (Saybolt SU at 100 F) sec (max)	Water and sediment (AST D-96-28) per cent (max)	Carbon residue, per cent (max)	Sulphur, per cent (max)	Pour, DF	Ash, per cent (max)
175	220	0.5	1.0	0.75	0.10	0.8

After a season's run, with the oil as specified, when the engine is opened up, no traces of tarry deposits are found in the cylinders, and all piston rings are perfectly free in their grooves. The piston heads are also found to be quite free from carbon or other deposits.

AUXILIARY ENGINES

Each of the two auxiliary generator engines is operated alternately every 30 days. They supply the current for all the auxiliaries on the vessel, which are 70 in number, including 6 mooring winches, an anchor windless, 2 steering gears, 2 refrigerating machines, 2 hatch winches, and all the service pumps. All the service pumps are in duplicate and are used alternately.

There are two Worthington air compressors which supply the air for starting purposes; the air is pumped into air bottles or chambers and used as needed; the air pressure in these bottles is constantly kept at 650 psi.

#### DIESEL OPERATING SUGGESTIONS

A few hints on successful operation of Diesel engines follow:

1 It is important to keep the lubricating oil clean and free from water and dirt; also to keep the engine water jackets free from scale and grease.

2 Keep the piston clearances as specified by the engine builders.

3 A constant check of the exhaust temperature is essential. If it rises above normal it indicates excessive fuel consumption or improper timing and may cause considerable trouble.

Fig. 2 shows a set of indicator, compression, and valve-lift cards taken on the main engine of the motorship *Henry Ford II*

TABLE 1 DATA FROM ENGINE-OPERATING CARDS

	Indi- cated horse- power	Ignition pressure, psi	Valve open front B.D.C., deg	A.D.C., deg	Valve open back B.D.C., deg	A.D.C., deg
No. 1 cyl....	812	509	20	26	20	26
No. 2 cyl....	809	514	23	25	21	25
No. 3 cyl....	789	514	22	25	20	25
No. 4 cyl....	796	512	22	25	22	25
Total.....	3206					

$$\text{Fuel consumption} = \frac{140 \times 7.46}{3206} = 0.325 \text{ lb per ihphr}$$

on Lake Superior; ship loaded, 19-ft draft, strong head wind. The valve-lift cards were taken on 1 to 10 control for the front valves and 3 to 10 control for the back valves; Table 1 contains the data. Conditions of the run were as follows: Fuel pressure, 5000 psi; control on No. 7; engine revolutions, 82.4 per min; speed, 13.4 mph; fuel consumption, 140 gph.