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PREFACE

The textbook "Marine Auxiliary Machinery and Systems" consists of three parts: Marine Fluid-Pressure Mechanisms, Specialized Auxiliary Machinery and Shipboard Systems.

Each part deals with the principles and the fundamentals of the theory, design and operation of a definite group of auxiliary machinery.

The theory involved is presented on a level which enables the student to understand the operation of the machines, to evaluate their operational characteristics, to make verifying calculations and select machinery for specific cases, and also to properly analyze new designs and master their operation. The author regards the theoretical, design and reference material presented in the textbook as the basis for carrying out normal operation and maintenance of auxiliary machinery, but not as a source providing information on their design or complete calculation.

The book does not deal with the auxiliary equipment of marine plants which is an integral part of these plants and depends upon their type, being, therefore, included in the corresponding courses of study.

The first part of the textbook is concerned with reciprocating, rotary, centrifugal, propeller and jet pumps, fans and fluid drives.

The second part considers only specialized auxiliary machinery.

The third part contains all necessary information on shipboard systems and the special systems of ice-breakers and tankers.

INTRODUCTION

Machinery designed for providing normal operation of the shipboard systems, gear and installations and constituting their integral part is called auxiliary machinery.

Auxiliary machinery maintains the required operating and manoeuvring properties of the ship both at sea or in harbour, and ensures its safety. Auxiliary machinery is classified as fluid-pressure mechanisms and deck machinery.

Fluid-pressure mechanisms include the pumps and fans of the shipboard systems and marine power plants, as well as fluid drives.

Deck machinery includes the mechanisms of the steering arrangement and of the hoisting gear.

Hoisting gear includes anchoring, warping, cargo-handling, towing, boat-handling and ash-disposal gear.

In accordance with their functions, shipboard gear and deck machinery are classified as mechanisms of the:

(1) steering gear, called steering engines,

(2) anchoring and warping arrangements, called windlasses and anchoring and warping capstans,

(3) warping, or mooring, appliances, called warping capstans and winches,

(4) cargo-handling equipment, called cargo winches,

(5) boat-handling gear, called boat winches,

(6) ash-disposal equipment, called ash hoisting winches,

(7) towing equipment, called towing winches.

The rigid demands imposed by shipboard conditions on the effective utilization of floor space and cubic capacity of engine and boiler rooms compel us to employ the same mechanism for maintaining the operation of two and sometimes more systems and arrangements. Thus, for example, the ballast system pumps may be employed for the needs of the ballast, drainage, fire, sanitary and ash-disposal systems.

Another example of using one mechanism for two purposes is the windlass which actuates both the anchoring and warping appliances. Such a combination of functions, however, should ensure,

if necessary, simultaneous operation of the respective systems and arrangements without in any way impairing their effectiveness.

According to their purpose, standby, or emergency, auxiliary machinery is provided on the ship to ensure normal operation and manoeuvrability when the main auxiliary machinery is out of order.

The effectiveness of auxiliary machinery is based on:

(1) its capability of ensuring normal operation of the respective systems or arrangements under any operating or navigating conditions,

(2) its low weight and small overall size,

(3) its high economy,

(4) its low cost,

(5) its convenient operation and repairs,

(6) its dependability,

(7) its ability to operate for long periods without repairs.

The capability of ensuring normal operation under any possible operating and navigating conditions is achieved by meeting the corresponding requirements for the design, manufacture, assembly and installation of the auxiliary machinery.* Auxiliary machinery will have a low weight and a small overall size if high-quality materials are used in its manufacture, if more exact formulas are used in its design, if the units are more rationally arranged and if their speed is increased. Regardless of its purpose any auxiliary machine consists of a motive unit and operational unit or units.

Therefore, economical operation of a particular auxiliary machine depends upon the efficiencies of both the motive unit and the operational units.

Economical operation of electric- and steam-driven auxiliary machinery can be appraised by the hourly fuel consumption per horse power developed by the motive unit of the machine in operation.

Depending upon its purpose and type of ship on which it is installed, the motive units of auxiliary machinery may be steam engines, steam turbines, electric motors, hydraulic motors and internal combustion engines.

Previously, steam engines were the main types of motive units of ships having steam power plants, and electric motors—of motorships. Present-day steamships frequently have auxiliary machinery powered by electric motors which are supplied with energy produced by economical generators with economical steam drives.

At the same time, motorships are being equipped with auxiliary machinery powered by steam engines which are supplied with

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* Many of these requirements are stipulated by the U.S.S.R. Shipping Register.

steam produced in waste-heat boilers heated by the exhaust gases of the ship's internal combustion engines when the ship is under way, and by liquid fuel in harbour.

Hydraulic motors are used to some extent to power the auxiliary machinery of passenger ships because of their silent operation and infinitely variable shaft speeds.

Internal combustion engines drive auxiliary machinery on ships which do not have a power plant. They are also used to power stand-by or emergency machinery.

A specific feature of the motive units of auxiliary machinery is their low power rating, not exceeding several dozen horse power even for the most powerful pieces of machinery. This is the reason for the comparatively low efficiency of this machinery.

The most economical and convenient in operation is auxiliary machinery powered by steam engines or electric motors. The latter, due to their exceptional convenience, especially in northern latitudes, are finding ever-increasing application.

Due to the relatively low efficiency of the motive units of auxiliary machinery, economical operation of an auxiliary installation will depend to a considerable extent upon properly determining the required power of the motive unit, rational selection of the operational unit and its efficiency and also upon a strict observance of the operating rules established for the machinery.

The fuel consumption of auxiliary machinery amounts to:

(1) 2.2 to 3.7 kg of coal per hp-h when operating on live steam from the boilers* or 1.5 to 2.7 kg of motor fuel per hp-h;

(2) 1.74 to 6 kg of motor fuel per hp-h when operating on steam from a waste-heat boiler (this fuel consumption is only conditional since waste heat is utilized);

(3) 1.42 to 1.86 kg of coal per hp-h or 0.96 to 1.32 kg of motor fuel per hp-h when operating on electric power produced by a steam dynamo;

(4) 0.22 to 0.243 kg of motor fuel per hp-h when operating on electric power produced by a diesel dynamo.

The fuel consumption of the auxiliary machinery of systems, gear and the main power installations usually constitutes 10 to 15 per cent of the fuel consumption of the main steam engines, but may reach 20 to 30 per cent on certain ships.

Increased fuel consumption may also be due to nonobservance of rules for the operation and maintenance of auxiliary machinery.

Attempts should be made to diminish the adverse effect of the auxiliary machinery on the economic efficiency of the steam power installations as a whole by substituting exhaust steam from this

* Refers to steam engines with a crank mechanism.

machinery for live steam in various units of the power installation, and by employing heating systems with steam take-off and with the utilization of spent steam from the auxiliary machinery for shipboard needs.

The cost of auxiliary machinery depends to a considerable extent upon the complexity of manufacturing and installation of the machinery, and also upon its weight.

The cost can be substantially reduced by unifying and standardizing this machinery. This also simplifies servicing, repairs and the making of spare parts. The problem of selecting the type of auxiliary machinery for a given ship and the kind of energy with which it is to be powered can be properly solved only after a comprehensive analysis of various alternative thermal systems of the whole power installation of the ship.

The type of auxiliary machinery used on ships varies with the operating and manoeuvring requirements specified for the ships.