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AUTOMATION OF SMALL TANKER "SEIHO MARU NO. 38"

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I. INTRODUCTION

The automation of ships is an universal concern of all people in the shipping and shipbuilding industries.

Various attempts have been made in this field. They are summarized as follows:

1) Automation of the main engines and auxiliary machines
2) Automation of the mooring gear
3) Automation of the cargo gear
4) Rationarization of the daily life of crew

Numerous subdivided items of specialized fields are included in each of above headlines. An attempt to automate ships in this country dates back to November, 1961 when the Mitsui Shipbuilding and Engineering Company built the Kinkazan Maru, a 10,000 ton ocean-going cargo liner for the Mitsui Line.

The Ministry of Transportation was quick to realize that the environment surrounding the world shipping industry favored automation of ships and encouraged studies for conceptual designing of completely large automated high economy ocean-going cargo liner, by providing subsidies.

With regard to small ships, the Ministry consulted with several shipbuilding companies about their plans and published their views. As a result, many ships, particularly ocean-going vessels, launched after the above mentioned Kinkazan Maru came out equipped with a considerable amount of automated equipment, making Japan a leading country in the field. With regard to small vessels, however, because of the high initial cost involved, the introduction of automated equipment has not been so spectacular. Fuji Electric has long played a pioneering role in the technical development of heavy electrical goods for marine use.

In the field of automation, especialy instrumentation, despite our relatively late start, we have also come to enjoy the reputation of being the largest supplier of automatic combustion control equipment for boilers, and data loggers. Now we have achieved so complete automation of the small tanker Seiho Maru No. 38 that we take pleasure in reporting below the outline.

II. OUTLINE OF AUTOMATION

The Seiho Maru No. 38 is a completely automatic 1000 k*l* clean tanker and is a joint product of the pioneering spirit of the owner, Kansai Unyu K. K., a wealth of technical knowledge of the Fuji Electric Group, and the experienced shipbuilding technique of the shipyard, K. K. Usuki Tekkojo.

We adhered to the following principles on designing the automation system of this ship.

1) All steering and control gears should be centralized in the bridge in order to realize a completely unattended operation of the engine room and reduce the size of crew to half that of conventional ships.
2) All modernization equipment to be used on this ship should be of such as already tried and proven reliable in other ships or land-based models whose suitability for marine applications is especially tested. Reliability is our prime concern. It is our belief that unproven equipment, no matter how superior the theory may be, will bring about very serious consequences in an automated ship with a relatively few crew, if it would be out of order on high seas.
3) Due attention should be paid to economic factors in all designing and manufacturing plans. Be-

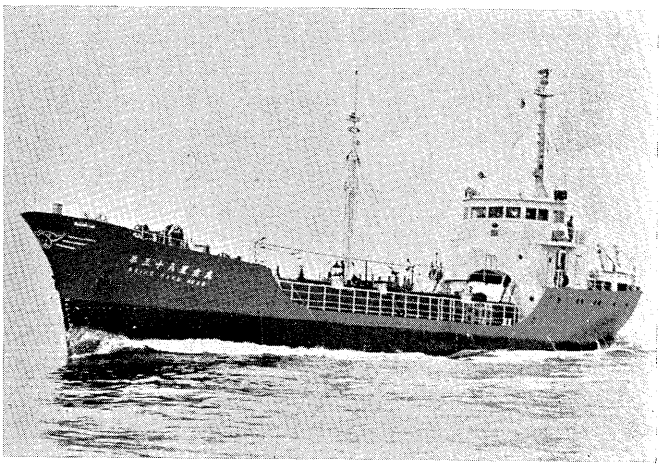


Fig. 1 Seiho Maru No. 38

cause nothing can last long unless it is commercially rewarding.

The result of our undertaking done with these considerations in mind has proven highly satisfactory.

Goods supplied by Fuji Electric Group are as follows:

Electric power apparatus, electric instrumentation, reduction gearing, and electrical applicances by Fuji Electric Co., Ltd.; high-speed diesel engines by Fuji Diesel K. K.; radar and radio communication equipment by Kobe Kogyo Corp.; and lead storage battery by Furukawa Battery Co.

In this paper however, our discussion will be limited to the diesel engines, reduction gearing, power equipment, and instrumentation which play the greatest role in the automation of the ship.

1) Particulars of the ship

Overall length	56.80 m
Breadth	9.00 m
Depth	4.40 m
Full draft	4.00 m
Gross tonnage	630.97 t
Dead weight	850.00 t
Cruising speed at full load	12.0 kn
Class	JG 2nd class coastal

2) Cargo oil tank capacity
1160 m^3 (consisting of four sections)

3) Cargo gear

Main cargo oil pump	1 horizontal, 2-stage centrifugal type 350 m^3/hr
Stripper pump	1 vertical piston type 170 m^3/hr

4) Fire fighting equipment
CO_2, remote control system

5) Crew
Captain, Chief engineer, First officer, First engineer, Second officer, Electrical engineer, and two others Total: Eight

There are two outstanding facts worthy of special mention with respect to the composition of the crew. Firstly, a new job classification of "electrical engineer" has been created. As explained in later, most of the automatic controls of this ship are electrically operated and for inspection and maintenance, knowledge and ability in electricity are quite essential.

Secondly, the size of the crew has remarkably been reduced. It is less than half of the crew required on a conventional ship of the same size, and compared with the other small automated ships launched two months earlier the excellence of the ship is apparent (*Table 1*). For further comparison, the degree of automation obtained thus far in larger ships is represented by a crew reduction from approximately 45 to 35.

It is clear, therefore, that the reduction of the number of the crew in this ship is very remarkable.

Table 1 **Examples of Conventional Automation of Small Tanker**

Name of Ship	Kibo Maru No. 55	Fuyo Maru No. 5
Type	Clean tanker	Bulk carrier
Weight	1300 t	1350 t
Shipyard	Kishima dock	Tohoku dock
Diesel Engine	2×505 ps (1477 rpm)	2×600 ps (600 rpm)
Propeller (fixed pitch)	Double shaft (373 rpm)	Single shaft (251 rpm)
Number of Crew	11	12
Launched	December, 1963	December, 1963

III. DOUBLE-ENGINE SINGLE-SHAFT INSTALLATION SYSTEM

In Eupope a multiple-geared engine is said to have been in practical use for over forty years. In our country as well, it has long ceased to be a unique idea. However, at least for ship propulsion purposes (regardless of the size of the ship), diesel engines of low speed with 90 to 400 rpm have traditionally been used.

This may be attributed to the fact that low speed engines are relatively free from failures. The low reliability of reduction gearing which is indispensable to medium and high speed engines may also have contributed to this trend. However, technological advance in medium and high speed engines has been quite remarkable lately and much practical experience has been gained through their applications in land-based power sources.

The technique of gear munufacturing has also markedly improved, making the adoption of geared engines for marine propulsion quite attractive because of their light weight and compact size. During the past several years, the Fuji Electric Group has delivered approximately forty sets of geared diesel engines for tugboats.

These were a combination of the Fuji Diesel's medium speed engines (1000～500 ps, 500～600 rpm) and the Fuji-Voith Schneider propellers with built-in bevel reduction gears, manufactured by the Fuji Electric. Now we are the greatest supplier of this kind of device in Japan.

Records show that a 1350 ps double-engine single-shaft system was adopted as early as 1934, when the 4180 ton freighter the Shinsyu Maru was launched at the Mitsubishi Kobe Shipyard. In recent years, an eight-engine two-shaft installation system was employed in the Japan National Railways ferry the Tsugaru Maru and several other ships.

It is also reported that several Japanese diesel engine manufacturers are currently in the process of negotiating technical co-operation with European companies who have established experience in the manufacture of multiple-geared engines. In addition

to the Seiho Maru No. 38, which is the subject of our present discussion, the Fuji Electric Group has supplied this engine system for a 250 ton tuna fishing boat and is currently negotiating two additional contracts. The multiple-geared engines thus appear to have bright prospects of being used in increasing numbers for ship propulsion purposes, and Ministry of Transportation has established a subsidy program to assist the development of technology in this field.

Some of the advantages of the multiple-geared engine are as follows.

1) It facilitates the discovery of the optimum efficiency of the individual propeller within the limit of structural permittion of the ship.
2) Its weight, including that of the reduction gearing, is lighter and its size is extremely compact.
3) It is possible to vary the number of engines to be operated depending upon the amount of partial load. This contributes to fuel economy.
4) If one of the engines fails it is easy to remove it from the propeller system, without stopping the ship.
5) The moment of inertia of the shaft is greater than that of the directly coupled system. This lessens the speed regulation to which the propeller is subject in bad weather, making the steady engine operation possible.
6) Remote control is more easily applicable to it than the directly coupled engine because of its high speed and compact size.
7) As an additional possibility, since it is amenable to manufacture in lots, more uniform quality and part interchangeability can be assured. In certain cases, replacement of the entire engine may be possible.

As regards item (2), above, the actual results obtained with the Seiho Maru No. 38 are shown in *Table 2*.

Table 2 **Comparison of Conventional Ship and Seiho Maru No. 38**

	Conventional Ship	Seiho Maru No. 38
Engine Weight	27 t (one low speed)	5 t×2 (two high speeds units)
Weight of Reduction Gearing	—	5 t
Total Weight	27 t	15 t
Weight Ratio	100%	56%

As regards item (3) above, it is possible to avoid the contamination which characteristically occurs with a supercharged engine operated at low load, by withdrawing one of the two engines from the propeller system, when the ship is to be run at less than half load.

Furthermore, a controllable pitch propeller system is applied to this ship, making the most efficient operation of the engine possible. Because, even if one of the engine is removed from the propeller system, it is possible to operate the other engine at the rated number of revolution, by setting the propeller pitch approximately at 70%.

As regards item (4), the use of hydraulic coupling between the engine and the reduction gear (*Fig. 4*) provides the following advantages:

(1) It absorbs the torque variation of the engine and prevents the unwanted effects of torsional vibration from being transmitted to the gear and the main shaft. It also prevents the unbalance in load distribution which is liable to occur due to the dissimilarity in governors of the two engines. It further prevents the propeller vibration from being transmitted to the engine.

(2) If one of the two engines fails, it can quickly be removed from the system by closing the magnetic valve of the hydraulic coupling, thereby interrupting the oil feed and causing the residual oil in the coupling to be ejected by centrifugal force.

(3) Upon completing necessary repairs to the failed engine, it suffices that the magnetic valve of the hydraulic coupling be opened to refeed the oil to start and restore the repaired engine to the system; no further considerations or adjustments are necessary. In such a case elastic rubber or flexible spring couplings would require stoppage of the other engine also, taking into consideration the effect of torsional vibration.

(4) Furthermore, the use of the controllable pitch propeller enables engine operation at a constant number of revolution and in a single direction.

a) Therefore, it is possible to run the main generator by belt during the voyage, eliminating the need for a special diesel engine for the generator. This saves the cost of installation and its maintenance.

b) At the time of oil pumping up, one diesel engine is sufficient for operating the cargo oil pump, ensuring the same benefits as described in item (3), above.

IV. DIESEL ENGINES FOR PROPULSION AND REDUCTION GEARING

The following are the particulars on the diesel engines for propulsion and the reduction gearing.

1. Particulars of Diesel Engines

Model	8 HD 19 H
Output	700 ps
Speed	1200 rpm (fixed speed and direction)
System	4 cycles single acting, airless injection oil trunk piston type

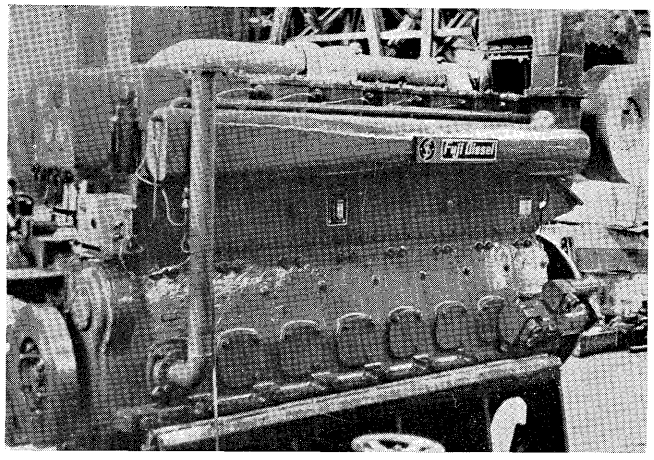


Fig. 2 Diesel engine

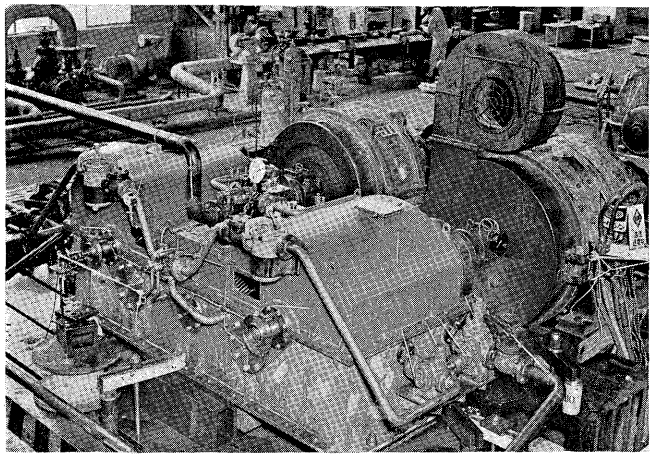


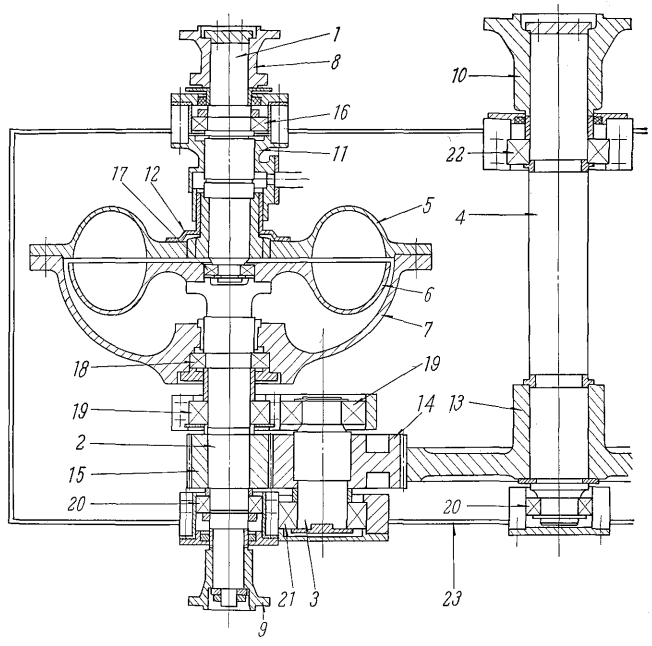
Fig. 3 Reduction device under testing

Cylinder diameter	190 mm
Cylinder stroke	225 mm
Number of cylinders	8
Mean piston speed	9.0 m/sec
Fuel oil	JIS K-2205 1st class No. 2 (A-heavy oil)
Lublicating oil	JIS K-2215 3rd class No. 3
Fuel oil consumtion rate	185 g/ps/hr
Lubricating oil consumption rate	3 g/ps/hr
Superchanger system	Exhaust gas turbo-charger with air cooler
Combustion system	With precombustion chamber
Cooling system	Fresh water cooled
Overload output	770 ps
Overspeed stop	115%
Starting system	Two 15 ps starting motors

Main engines are started by the synchronous start of two starting motors. The necessary power is obtained from the 24 v battery which also supplies electricity to the preheaters of the main engines.

2. Reduction Gearing

We shall now outline the operation of the reduction gearing according to *Fig. 5*.



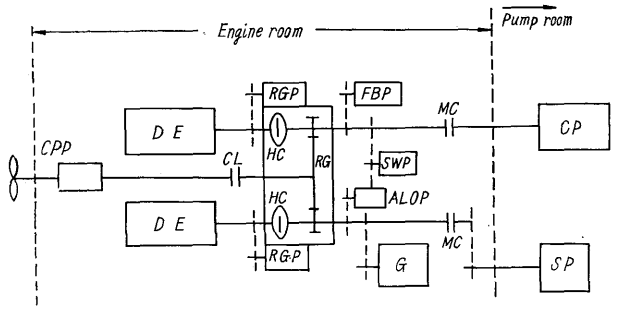
1. Input shaft
2. Output shaft
3. Intermediate shaft
4. Propeller shaft
5. Pump runner
6. Turbine runner
7. Runner cover
8. Input flange
9. Flange for auxiliaries
10. Output flange
11. Oil supply flange
12. Labyrinth flange
13. Wheel gear
14. Idle gear
15. Pinion
16. Spherical roller bearing
17. Cylindrical roller bearing
18. Ball bearing
19. Spherical roller bearing
20. Spherical roller bearing
21. Spherical roller bearing
22. Spherical roller bearing
23. Lower casing

Fig. 4 Cross-sectional view of reduction device

1) For example, the oil pump for the starboard engine (*RGP*) is actuated by the said engine through the silent chain. The *RGP* consists of one lubricating oil pump for the reduction gearing and the other oil pump for the hydraulic coupling. The former lubricates the various parts of the reduction gearing and the latter sends oil to the hydraulic coupling when the magnetic valve is opened. The hydraulic coupling is then actuated and operates Generator (*G*), Fire Ballast Pump (*FBP*), Sea Water Pump (*SWP*), and Auxiliary Lubricating Oil Pump (*ALOP*) as shown in *Fig. 5*. If the hand-operated clutch has been pre-engaged, the propeller turns.
2) Secondly, the magnetic valve of the hydraulic coupling of the port engine is opened, the oil pump for the starboard hydraulic coupling also pumps oil into the port engine coupling, thus making it possible to start the port engine without using the starting motor.
3) When pumping is desired while the ship is at anchor, one main engine can operate the Cargo Oil Pump (*CP*) and the Stripper Pump (*SP*) by operating the Magnetic Coupling (*MC*).

V. ELECTRIC POWER PLANT

The electric power plant consists of three systems, namely a 50 kva main ac generator driven by V-



DE: Diesel engine (1200 rpm)
CPP: Controllable pitch propeller (300 rpm)
CL: Hand operated clutch (to be off when CP is in operation)
RG: Reduction gearing
HC: Hydraulic coupling
RGP: Oil pumps for reduction gearing (1500 rpm) (consisting of one oil pump for reduction gearing and one for hydraulic coupling)
FBP: Fire ballast pump (1800 rpm)
SWP: Cooling sea water pump (1800 rpm)
ALOP: Auxiliary lubricating oil pump
G: Main generator (1800 rpm)
MC: Magnetic coupling pump (1200 rpm)
CP: Cargo oil pump (1200 rpm)
SP: Stripper pump (280 rpm)

Fig. 5 Explanation diagram of reduction gearing

belt from the main engine, a 25 kva auxiliary ac generator directly coupled to the 32 ps auxiliary engine, and 800 amp-hr storage battery. The relationship between these power sources and the load is shown in *Fig. 5*.

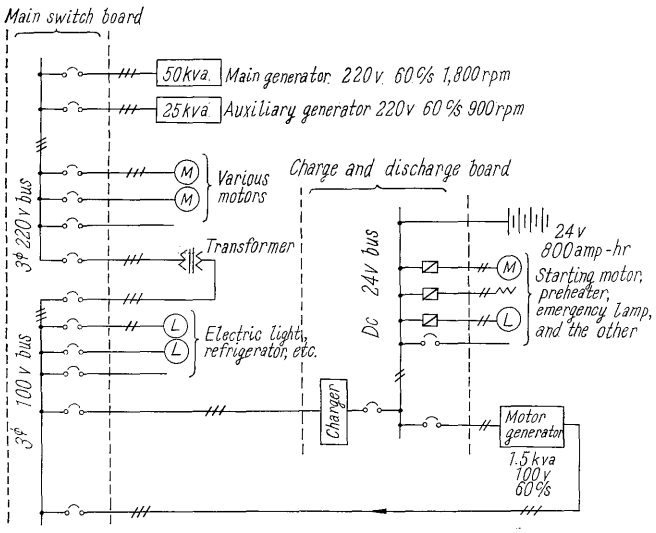


Fig. 6 Electrical network in the ship

The 25 kva auxiliary generator feeds the load while the ship is at anchor, that is when the main engine is not operating. It also serves to feed the priming pump motor for the main engine and the automatic control circuits. After the main engine is started, this auxiliary generator should be stopped and the 50 kva generator switched on.

In addition to their conventional applications the 800 amp-hr storage battery is used to feed the starting motors of the main engines and the diesel engine for auxiliary generator driving. Furthermore, while the main and auxiliary engines are not operating, for instance, during the midnight hours, it is used to drive the 1.5 kva motor-generator for feeding the load requiring a 100 v (60 c/s) source, such as lights and refrigerators. For these purposes, the storage battery is designed to have much larger capacity than those ordinarily used for small ships.

In order to ensure long battery life and eliminate the need for frequent charging, a floating charge system equipped with an automatic charge voltage regulator was adopted in spite of its rather high cost. However, equal charging or hand-operated charging is also possible by means of a change-over switch.

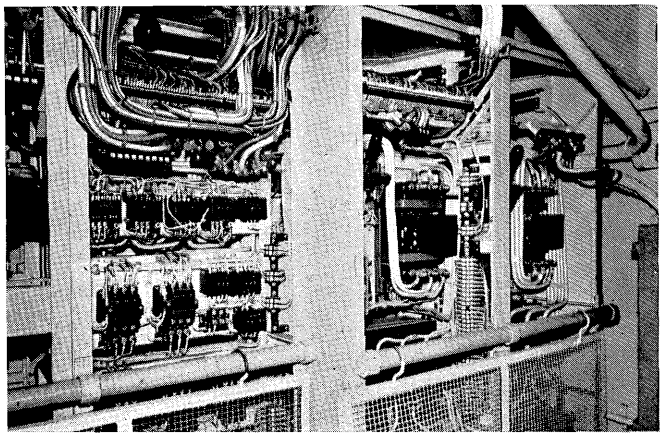


Fig. 7 Back view of main switchboard

The main switchboard functions not only as an ordinary switchboard but also a group starter, being equipped with magnetic contactors for starting motors and thermal type overcurrent relays. All these are accomplished by efficient use of the available switchboard space without any increase in size. Furthermore, these motors are remotely controlled from the electric control panel for auxiliaries located in the bridge and the pushbutton panel at the entrance to the engine room.

The main switchboard also contains static type self-exciters for the main and auxiliary generators and is extremely compact in design.

VI. AUXILIARY APPARATUS FOR MOORING

In order to rationalize the time and labor consuming mooring operations, the following mooring equipment has been used:

In addition to all the conventional functions, the anchor windlass used on the Seiho Maru No. 38 is equipped with two drums for mooring in the bow section of the ship.

The drum in the front section of *Fig. 8* is called the "bow winch" and the similar drum located beyond the chain drum is called the "stern winch".

These pairs of chain drums and mooring drums are driven by a 22 kw pole change wound rotor type

motor installed underneath the forecastle deck. Each of these four drums is equipped with a pressed oil operated clutch and a brake.

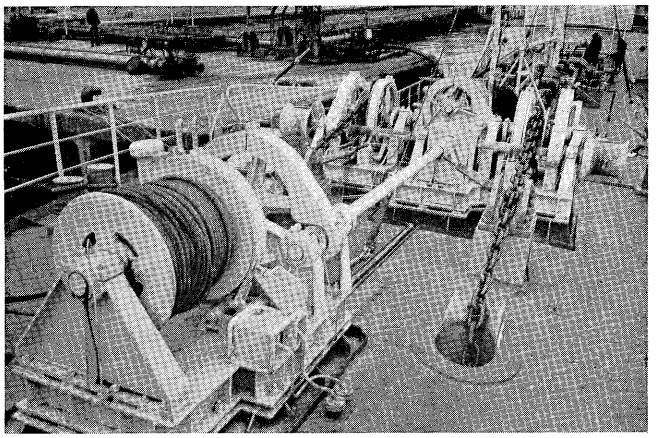


Fig. 8 Anchor windlass with mooring winch

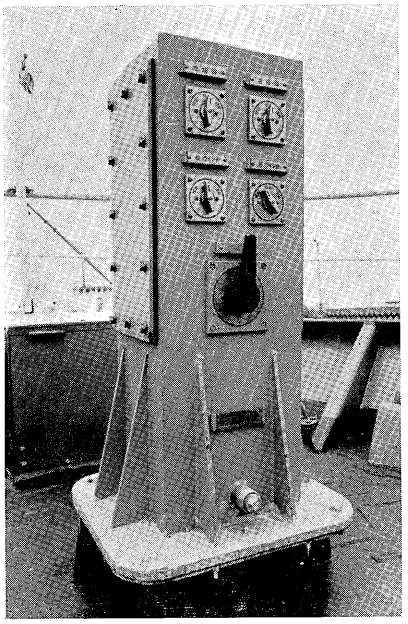


Fig. 9 Master controller for anchor windlass

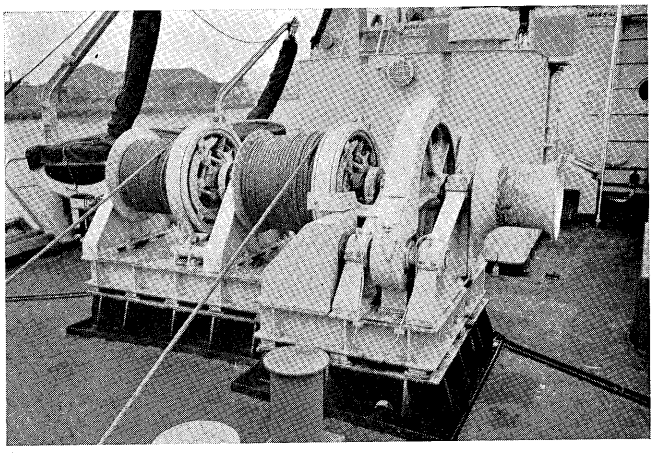


Fig. 10 Mooring winch

The operation of these drums is centralized at the master controller on the forecastle deck as shown in *Fig. 9*, resulting in great reduction of manpower.

The capacity of the chain drums is 5 t 9 m/min each and that of the winch drums is 3 t 10 m/min each.

The motor is designed to be capable of operating three of the four drums at full load.

The mooring winch at the stern is of similar design and its drums have a capacity of 3 t 10 m/min each.

VII. BRIDGE EQUIPMENT

In addition to all the equipment found on a conventional ship, the bridge of the Seiho Maru No. 38 has an electric control panel for auxiliary equipment, an electrical meter panel, a main engine control panel, two sets of recording instruments, level indicators, and an annunciator, so that all sort of ship maneuvers and equipment operations can be controlled from the bridge.

The equipment are arranged as indicated in *Fig. 11*, and *Figs.12,13* show the equipment actually arranged on the ship. The panel in the left front corner in *Fig. 12* is the main engine control panel and that directly above (over the window) is the annunciator. Next right to the annunciator is the electric meter panel. On the floor further to the right is the No. 2 recorder. In *Fig. 13*, the equipment directly to the right of the steering control is the propeller control panel; underneath the window to the right is the electrical control panel for the auxiliary equipment. Functions of these control gears are outlined below.

1. Electric Control Panel for Auxiliaries and Electrical Meter Panel

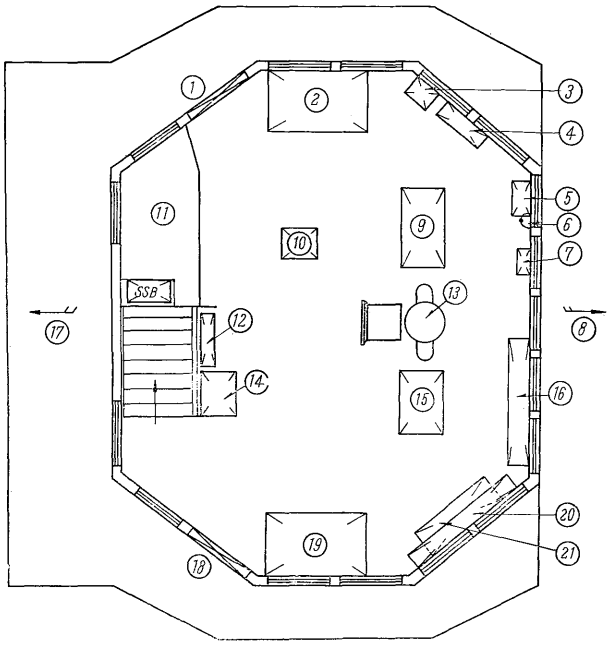
In order to start the main diesel engine, it is necessary first to press the pushbutton start switch located on the electric control panel for auxiliaries, and start the 25 kva generator engine which in turn activates the control circuit.

In addition, the same panel has various operating switches which make it possible to control remotely the important auxiliary motor. By means of a synchroscope on the electrical meter panel, it is possible to conduct parallel running of the main and auxiliary generators.

2. Main Engine Remote Control Panel

This panel serves for remote control by means of pushbutton switches of the starting and stopping of the two main engines described in Chapter IV.

On the panel are installed for each of the two main engines a set of instruments, such as a tachometer, a fuel position indicator, a governor switch, pushbutton switches for starting and stopping, hydraulic coupling switches, various lamps, and power supply switches for control circuits. The dial plates of the instruments are treated with electro-lumines-



① Sliding door
② No. 1 recorder
③ AVR for radar
④ Level meter
⑤ MCP control panel
⑥ Fire alarm bell
⑦ Clock
⑧ Bow
⑨ Main engine control panel
⑩ Radar
⑪ Chart desk
⑫ Composite distributor panel
⑬ Magnetic compass
⑭ Inboard order device
⑮ Propulsion control panel
⑯ Alarm panel
⑰ Stern
⑱ No. 2 recoder
⑲ Electrical meter panel
⑳ Electric control panel for auxiliary

Fig. 11 Arrangement of navigation bridge

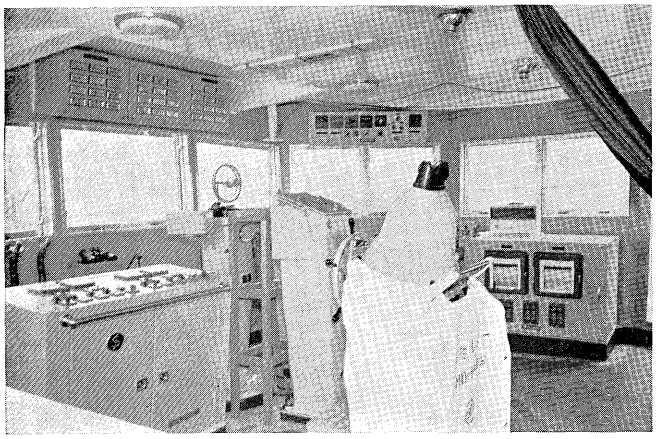


Fig. 12 View of navigation bridge (1)

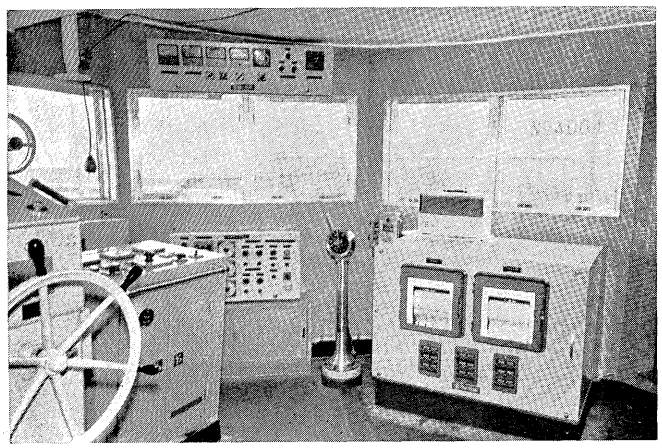


Fig. 13 View of navigation bridge (2)

cent material for easy visual observations at night. The brightness level is regulated by a slidac.

In order to start a diesel engine, the following conditions must first be fulfilled.

1) The magnetic valve for the fuel oil must be open

It goes without saying that unless the valve is open, no fuel can be supplied and the engine cannot sustain the movement started by the starting motor.

The magnetic valve will close in the event of an automatic stop caused by engine failure.

It is necessary, therefore, to reopen the valve by pressing the reset pushbutton when the repair has been made.

2) The two main engines cannot be started simultaneously

If the start buttons for the two engines should be pushed at the same time an unnecessary drain takes place on the storage battery for the four starting motor and in certain instances the resultant voltage drop will become so great that the engines cannot be started smoothly. The life of the storage battery may be unduly shortened.

3) The control switch for the hydraulic coupling must be in an " off " position

The presence of oil in the hydraulic coupling will require that the motor have torque enough to overcome the friction in the propeller shaft producing the same harmful strains on the storage battery, as in the case of item 2), above.

4) The blade pitch of the propeller must be in the " zero " position

Starting the engine before the oil in the hydraulic coupling has been completely ejected could cause an unexpected motion of the ship, creating a dangerous situation especially in a crowded harbor.

After all these conditions have been satisfied, a lamp lights indicating the completion of preparations for starting; then it is possible to start the engines by remote control from the bridge.

The time schedule from the pressing of the start button till the attainment of the rated engine speed is shown in *Fig. 14.* The start of the ship is completed with activation of the alarm circuit. If, for any reason, the rated speed cannot be attained within 30 seconds, the miss-start detector will close the fuel valve; thereupon, some steps must be taken for the necessary trouble-shooting.

If, during the operation of one of the two engines at rated speed during the voyage, it is necessary to start the second engine, it suffices only to turn on the filling oil switch of the hydraulic coupling of the second engine, thus making it possible to avoid the unfavorable operation of changing the blade pitch to zero. As soon as the main engine is started the 50 kva main generator begins to operate and the 25 kva engine is switched off after some parallel running.

The stopping of the engine can be effected by pressing the stop pushbutton switch which closes the fuel valve. Also, sixty seconds after the depression

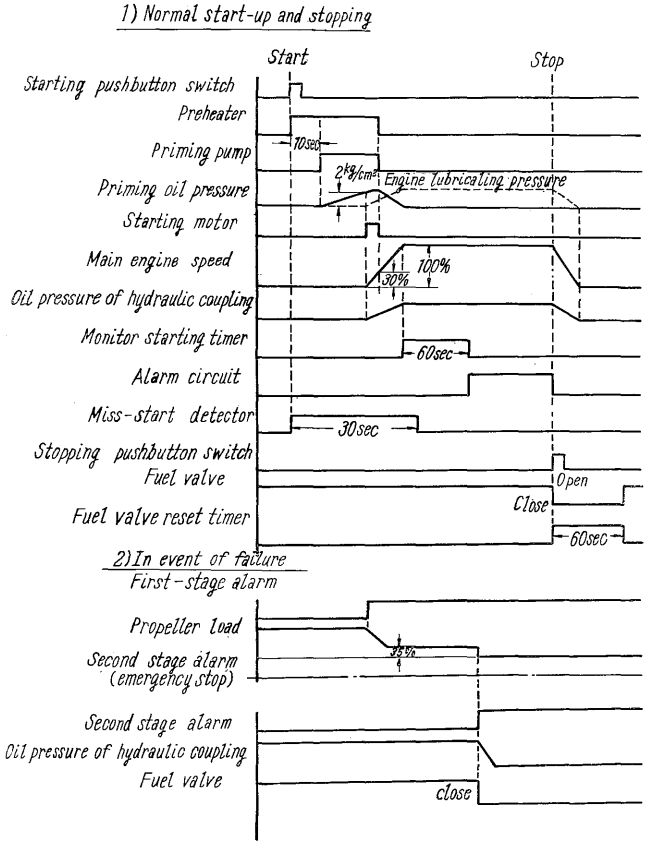


Fig. 14 Time schedule

of the stop switch, the fuel valve reset timer is actuated to open the valve in preparation for the next start-up.

In the event the lubricating oil pressures of the main engine or of the reduction gearing drop to less than 2 kg/cm² or 1.5 kg/cm, respectively, a lamp will light on the annunciator panel located above the window in the bridge and an alarm buzzer will sound. If trouble occurs to one of the two main engines operating at full power the blade pitch of the propeller will be automatically adjusted to change the propeller load on the two engines to be 70% of the rated output of each engine.

On the other hand if the ship is running with either engine operating at less than 70% of rated output, the propeller load will be automatically controlled under 70% so as not to overload the main engine.

If this failure cannot be remedied and the lubricating oil pressures of the main engines or of the reduction gearing fall below 1 kg/cm², the failed engine is automatically stopped; at the same time, the supply of oil to the hydraulic coupling is cut off, thereby removing the engines from the propeller system.

3. Propeller Remote Control Panel

The controllable pitch propeller used in this ship is remote controlled from the control panel and can be turned in either the positive or negative direction to produce either a forward or reverse thrust. On the control panel there are a propeller pitch setter, a propeller pitch indicator, a propeller tachometer, and various kind of lamps and switches. As in the case of the main engine control panel, the meters are treated with electro-luminescent material.

4. Principal Recording Instruments

The recorders are used to record the temperature and pressure of various important fluids in the main engines and the reduction gearing. They are composed of four electronic self-balancing type multi-recorders. One of them is 12-point recorder and three are 6-point recorders. As shown in *Fig. 15*,

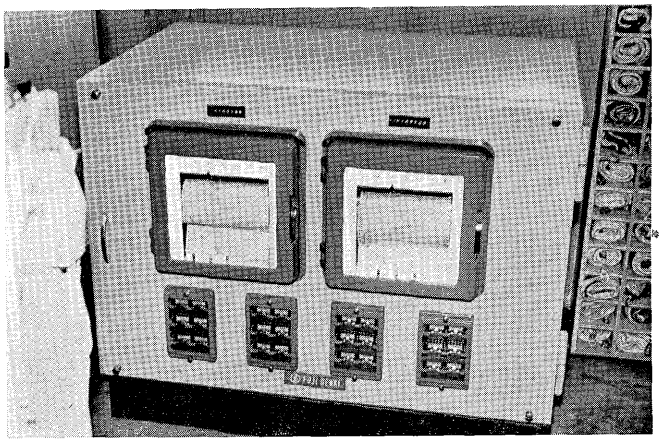


Fig. 15 Recording instrument No. 1

they have pointers as well as alarm contacts which can be preset to desired levels. In the event of failure, these alarm contacts transmit signals to the annunciator panel.

The recorders enable centralized visual supervision and automatic recording of the measured values of the various equipment in the engine room; thus, coupled with the use of the annunciator they enable unattened operation of the engine room. Furthermore, by simply pasting the recorded data into the logbook, the time and labor previously required for manually posting such data will be eliminated.

5. Level Meters

The level meters located above the window on the port side serve to indicate the levels of the fuel oil side tank and the bilge.

6. Annunciator

The annunciator consists of a buzzer and 34 indicator lamps, each occupying a 50 mm × 100 mm space on the panel. The trouble locations covered by the annunciator are shown in *Table 4.*

VIII. MEASURING AND ALARM TRANSMITTERS

As temperature transmitters, a C-A thermocouple is used for the main exhaust gas and a platinum

Table 3 **Automatic Recording Points**

Particulars			Points
Pressure	Main Engine	Lubricating oil inlet.	2
		Cooling fresh water inlet	2
		Cooling sea water inlet	1
	Reduction gearing lubricating oil inlet		1
Temperature	Main Engine	Exhaust gas temperature	10
		Cooling fresh water outlet	2
		Cooling fresh water inlet	2
		Lubricating oil outlet	2
		Lubricating oil inlet	2
	Reduction gearing lubricating oil inlet		1
	Hydraulic coupling oil outlet		1

Table 4 **Alarm Points**

Particulars			Points
Main Engine	Cooling sea water pressure drop		1
	Lubricating oil inlet pressure drop		2
	Cooling fresh water temperature rise		2
	Lubricating oil inlet temperature rise		2
	Super-charger exhaust gas temperature rise		2
	Speed drop		2
	Speed rise		2
	Exhaust gas temperature rise		8
Pressure Oil Motor for Controllable Pitch Propeller		No voltage	1
		Overload	1
Controllable pitch propeller head tank level (lower limit)			1
Steering Motor		No voltage	1
		Overload	1
Reduction Gearing Lubricating Oil		Temperature rise	1
		Pressure drop	1
Hydraulic Coupling Oil		Temperature rise	1
		Pressure drop	1
Diesel Engine for Auxiliary Generator		Cooling water temp. rise	1
		Lubricating oil press. drop	1
Fuel oil service tank (lower limit)			1
Engine room bilge level rise			1

resistor for the lubricating oil temperature. So pressure transmitters, a buldon tube type pressure gauge is used; for level measurement, a float-type level transmitter with stainless steel tape is employed.

IX. CONCLUSION

The automation of any kind of ships is still at an incipient stage, certainly leaving much to be developed and making more time necessary to fully evaluate the performance of automated ships already in service. It is our belief, however, that with the cooperation of the progressive owner, Kansai Unyu Company, we have made a great stride forward with the automation of the Seiho Maru No. 38. The Fuji Electric Group continues the study of the operating and equipment results of the ship and with the cooperation of the shipping and shipbuilding industries tries to develop unique technology to serve any and all automation needs of ships.