GLASGOW REPORT No 48950

"VICEROY OF INDIA".

Main Propelling Machinery.

Two Turbine Alternators.

9000 Kilowatts. Maximum Rating.

2720 Volts. 3 - phase.

2690 R.P.M.

Maximum speed rating 3110 R.P.M.

6536 Kilowatts, 3150 Volts.

Two Synchronous Motors each -

8500 S.H.P.

3150 Volts.

109 R.P.M.

3 - phase.

There are two separate windings in the Propelling Motor Stator and therefore six H.T. Leads are attached to each motor. In event of a fault developing in either of the windings, it can be cut out and the motor used at half power.

For ordinary synchronous running the rotor is excited through two sets of slip-rings by direct current at 220 Volts supplied by the auxiliary generators.

In addition to the provision made for synchronous running which depends on the re-action between the rotary field of the stator due to 3 - phase alternating current and the excited rotor magnets, it is necessary to provide means for starting the/

the rotor and to develop speed until synchronism is obtained.

Thus initial heavy torque is obtained, the inductance of the rotary field acting on the copper bars forming a squirrel cage winding on the outer periphery of the rotor. As a safeguard against currents which may be induced in the rotor windings a resistance is introduced between the ship-rings of the motor by which induced currents are short cir: :cuited and damped down when sudden changes are made in speed or direction of rotation.

In this field connection it is necessary to have double pole switching as a protection to the D.C. machinery and circuits against a heavy surge of the induced voltage due to the already stated sudden changes.

Both alternators and motors are completely enclosed and ventilation is provided by fans mounted on the end rings of the rotor windings.

Provision is made for circulating the air through the machines by means of an independent fan on the closed ventil: :ated system. The air in the system is cooled in the base of the machines by impinging on tubes through which sea water is circulated.

Any desired connection between the alternators and motors may be obtained by means of the switches on the forward side of the control panel.

At maximum power when both alternators are used together the two outboard switches are closed and the mid or tie switch is left open. At slower speeds where only one alter: :nator is in use for both propelling motors the main switch of the/

the alternator in use is closed and the tie switch is also closed, thus connecting up the two motors in parallel on one alternator.

The control panel doors are so interlocked that no door can be opened when the high voltage is on the bare connections inside the cubicle, the "Castell" figure lock being used.

Reversals are obtained by use of two sets of five contactors situated inside the control cubicle. These contactors are operated simultaneously to avoid single phase running. To reverse a motor one contactor is opened and closed and the circuits on the other two phases are reversed.

It should be noted that while manoeuvring the alter: :nators run continuously even with the propeller stopped.

When both generators are in use the motors run independently as regards both speed and direction. When, however, only one alternator is in use the motors being synchronous must run at the same speed, although the direction of rotation may be different.

To obtain fully the manoeuvring advantages it is necessary to have both turbines running.

Regarding the control panel, the tie switches are controlled by wheels at the fore end of the cubicle. The central panel on the aft side of the cubicle holds the gauges recording turbine pressures etc. The cubicle is mounted athwartships and the right and left panels hold the instruments and alarms for starboard and port alter: :nators and motors respectively. The instruments include an/

an ammeter for each phase of the alternator and a volt meter also amp and volt meters for the full exciting circuits. Coloured indicator lamps are ranged along the upper part of the panel to show irregularities of current supply to ventilating fans and exciters and the earthing of any of the main circuits. When any of these indicating lamps light an alarm bell also rings.

The temperatures in motors and generators are recorded by means of Pyrometers operated by the temperature of the coils in which they are embedded. Six points are embedded in each alternator and propelling motor. For the purpose of detecting temperature rise a cold junction is mounted on each panel, the temperature indicators being mounted on their respective panels.

Special care has been given to the insulation of the alternator and motor windings - particularly to the high tension circuits. Shellac is not employed. The method of insulation employed has been recently developed by The British Thomson-Houston Company. To insure that the various Mica wrappings round the conductors are effectively closed without any air spaces, each coil after being wound with its insulating strip was placed in a vessel from which all air was exhausted. It was then in the same vessel impregnated with hot bitumen under pressure. The coil was then removed and, after the surplus bitumen had been allowed to run off and the remainder had set nearly hard, was placed in dies under considerable pressure. Practically all the bitumen is now extracted and the insulation on the conductors, except for a preliminary wrapping of asbestos, consists/

consists almost entirely of mica with traces of bitumen filling the cavities between the mica. This process was repeated several times till the desired thickness of insul: :ation was obtained.

Each coil was thoroughly tested and stood up to a pressure test of 7,000 to 9,000 Volts for a considerable period.

System of Control.

The control levers are mechanically interlocked so that it is impossible to move them in any but the correct sequence. Before any lever operating an electrical connection can be moved it will be necessary first to move the lever controlling the steam admission to the turbine to the lower speed setting (i.e. one fifth full speed). The full movement of this lever then permits the lever controlling the fields of both generator and motors to be removed. (These are low voltage 220 volts on the motors and 80 to 100 volts on the generators). The removing of the fields causes the alternator to go dead and also releases the reversing lever of the main circuit.

If the vessel is moving ahead at any speed over $\frac{1}{5}$ full speed, before any electrical connection can be operated the steam admission to the turbine must be cut down to that corresponding to the amount of steam required by the turbine to drive the ship at $\frac{1}{5}$ full speed. Only then will it be possible/

possible to remove the fields of the motors. If any one alternator is driving two motors the fields must be removed together as the levers operating the fields will be connected. It follows then, that if the steam admission is limited overloading cannot take place. Since the same lever is used for steam admission above $\frac{1}{5}$ and the control of the excitation circuits, all manoeuvring must take place at $\frac{1}{5}$ speed. This lever is interlocked with the slower speed steam admission lever, so that the latter cannot be used for reducing speed below $\frac{1}{5}$ unless the full speed lever is in its slowest position and correspondingly the slower speed lever must be in its maximum speed position.

The grouping of the levers is as follows:-

Port Motor	Starboard Motor.

For each propeller three controlling levers are provided for operating contactors and speed setting of the governor.

A. A direction lever.

B. A field and speed controlling lever.

C. A dead slow speed lever (below $\frac{1}{5}$ speed).

These, as already stated, are all mechanically interlocked to ensure correct operation. Thus the direction lever "A" can only be moved if the manoeuvring lever "B" is at "stop".

The/

The field lever "B" in its first half of travel operates the field contactors in the correct sequence for starting the motor.

For the remaining half of the travel, the control is on the governor of the turbine, the speed setting of which varies between $\frac{1}{5}$ and full speed. A micrometer adjustment is also provided on this lever which permits of fine speed settings. This lever is interlocked with the slow speed lever "C".

An electrical interlock prevents the circuit breaker on the main D.C. switchboard from closing unless the field levers are both on the "stop" position. This prevents the fields being switched on to the machines after a shutdown on the D.C. side without bringing the field levers to the "stop" position and starting up in the usual way.

STARTING.

1st. Place "slow speed" lever "C" in the "open" position.

2nd. Place the direction lever "A" in the required position "Ahead" or "Astern".

3rd. Move field lever "B" to notch one. This movement puts excitation current on the field circuit of the alternator which immediately builds up and starts the propeller motor running as a squirrel cage induction motor.

4th. Move this lever "B" to the second notch and by watching the speedometer indicator it will be been that the induction motor gains speed and comes up into line with the alternator speed, at which time the two pointers on the speedometer (one for the alternator and one for the propelling motor) are directly opposite each other. At this point the induction motor is in synchronism with the alternator.

5th/

5th. Move lever "B" to notch 3 which closes the field circuits on the propelling motor and turns this motor from an induction motor to a synchronous motor. As soon as the motor has drawn into step, (which can readily be seen by the falling of the amperes in the phases of the motor) the lever is put into the "run" position.

6th. The speed adjustment can now be made by the same lever right up to full speed.

To shut down, the same sequence of events must take place, but in the reverse direction.

MACHINE HEATING.

In order to heat the alternators and motors while lying idle and so prevent the accumulation of moisture in the windings switching is provided, which enables a small current to be circulated through the field windings of the various machines.

This switching simply puts the alternator fields in series and they then get current from either exciter generator. The motor fields are also connected in series and current is obtained direct from the D.C. bus bars.

Load on Propulsion Circuits.

at 100 R.P.M.

2 Alternators - Line Amps 1225
Line Volts 3150
Field Amps 200.

at 96 R.P.M. - Line Amps 910.
Line Volts 2720.
Field Amps 220.