RUNNING EXPERIENCE WITH OIL-DRIVEN ELECTRIC GENERATING MACHINERY.

The use of a lighter oil fuel in the oil-driven electro generating machinery of certain capital vessels has been attended with good results, and has led to a considerable improvement in the reliability of the machinery, together with an increase in the period between successive examinations.

Extracts of general interest from the report for the quarter ending March, 1922, are given below, together with a report from a vessel using Admiralty mixed oil. Recommendations as to the source of supply and reserve of spare parts were also received and arrangements are being made to augment the stock of spare parts to meet the requirements of the situation arising as a result of the more extended use of these engines.

"Barham."

No. 1 engine in use 900 hours. No. 2 engine in use 1,066 hours.

The use of the lighter oil has been fully justified and the improvement in running over that obtained when using the heavier oils has been well maintained.

It is considered very desirable that the tanks used for the light oil should have a separate suction so as to prevent any heavy oil being pumped into the ready-use tanks.

"Malaya."

Periods of continual running of these engines are much shortened by the unfavourable position of the air compressor, which is above and open to the lubricating well. Lubricating oil carried over with the air causes much fouling of intercooler tubes, and contributes largely to the carbonisation of fuel and exhaust valves, which necessitates frequent cleaning. It is suggested that if separate air compressors were fitted for future design, much trouble would be avoided.

The circulating water pump, although quite efficient, wears rapidly, and unless the wheels are renewed when worn the water supply to the cylinder jackets is much reduced. Experience has shown the necessity to renew the wheels after six months' normal work, and it is suggested that one spare set for each engine should be carried as spare.

The cylinders farthest from the circulating water pump are at times inclined to overheat by a reduction in the water circulation. Improvement in this particular has been effected by—

(*a*) Making a separate delivery to each three cylinders instead of the common delivery to the six as originally fitted.

(*b*) Fitting a drain pipe to the water delivery from Nos. 5 and 6 cylinder heads.

If overheating of the cylinders occur it has been found that it can be checked by giving this increased flow through the cylinder.

Cylinder overheating would be much lessened if a more ready means of cleaning jackets could be introduced into future designs, or the accumulation of scale, &c., in them lessened.

In view of the approval to now carry oil fuel suitable for use in Diesel engines, and the allocation of certain ships storage tanks for this purpose, it is suggested that the motor fuel pumps should be connected directly to these tanks. Contamination of the fuel is otherwise almost unavoidable, and the running of the engines is impaired.

The use of " Palmetto " packing in the fuel pump plunger glands and fuel valve glands, instead of the metallic packing previously fitted has given very much better results, as also has been the case in the use of copper asbestos ring joints for air, exhaust and fuel valve seatings, this joint permiting of a much more rapid changing of valves.

" Warspite."

The following routine for running the Diesel generators in harbour has, as far as possible, been carried out during the spring cruise.

One Diesel generator is run continuously for the week in conjunction with a steam turbo generator during the daytime from 0600 to 2300 when the steam generator is stopped, the Diesel generator alone supplying electric power during the night hours. This Diesel generator is stopped during the Saturday forenoon, when the 2nd Diesel generator is started up, for cleaning and refit of air compressor valves and for making good minor defects. Both Diesel generators are then run for supplying electric power during the week-end from 1130 on Saturday to 0530 on Monday.

Provided that no important defects arise it is found that each engine can be run for about 1,000 hours, *i.e.*, 6 weeks before cleaning and refitting of the valves and cleaning the piston heads and exhaust ports is necessary.

No important defects have arisen, but stoppages of the engines have been caused by the following defects :—

No. 1 *Engine.*—Skew wheels of circulating pump drive, required renewal; fractured exhaust valve spindle; defective exhaust valve (twice); leaky joint on H.P. cylinder cover of air compressor; fractured spigot of elbow piece to indicator cock.

No. 2 *Engine.*—Fuel valve choked; leaky joint on H.P. cylinder cover of air compressor; defective exhaust valve (twice); adjustment of fuel valve; leakage at fuel valve gland.

A small hand pump has been fitted by ship's staff to each engine, for emptying the oil drain tank direct into the engine

ready-use tank. This has been found desirable owing to the increased leakage from the fuel pump glands of the lighter oil now used.

"Revenge."

The first supply of American distillate oil was received in June 1921, and a marked improvement has resulted in the reliability of running and freedom from breakdown of the two Diesel dynamo engines fitted. A considerable saving of labour in connection with the cleaning and refitting of valves, &c., has also taken place.

From experiments carried out it has been found that if the engines are run continuously for periods of about 300 hours the exhaust valves become badly carbonised and the valve faces and seats, especially the former, are badly pitted. For this reason it is not considered desirable to run for periods exceeding 200 hours without cleaning air inlet and exhaust valves.

The air compressor valves can, it is considered, run for periods up to 400 hours continuously without cleaning.

The following modifications, &c., in connection with the design of the Diesel plants would, it is considered, be beneficial and might be embodied in new designs :—

(*a*) The existing type of circulating water pump (Albany Patent 25,222) is not satisfactory, considerable wear taking place in the bearings and on the teeth of the internal cog wheels. A pump of centrifugal type with a flexible drive is recommended.

(*b*) Oil cooler coils should be fitted in the lubricating oil wells to preserve the viscosity of the oil and keep it cooler.

A cooling coil $\frac{5}{8}$-in. bore has been fitted to one of the engines in this ship, the circulating water inlet being connected to a branch on the circulating pump discharge and the discharge led into the exhaust pipe jacket sleeve on No. 1 cylinder. The temperature of the oil has been reduced from about 130° F. to 110° F.

(*c*) An additional oil spray pipe has been fitted to spray direct on to the teeth of driving wheels for working the circulating pump.

The present spray pipes only spray oil on to the bearings of these wheels.

(*d*) A pressure gauge has been fitted on the circulating water pump discharge to cylinders in full view of starting platform. This enables the watchkeeper to at once notice a failure or partial failure of water supply.

(*e*) The drain plug to engine bed is very low and inconvenient for draining off the oil from the engine.

The lubricating oil hand pump fitted for pumping oil through the forced lubrication oil system has been fitted with an additional branch and cock on the discharge side

which enables a portion of the oil to be pumped out of the oil well into an oil can without necessitating the engine being stopped, and it is the practice to change and strain a certain quantity of the oil daily, thereby keeping it cleaner and reducing the wear of bearings, &c.

(*f*) It is considered that an oil separator fitted between the air compressor I.P. discharge and intercooler would greatly reduce the choking up of the intercooler and H.P. suction and discharge valves.

(*g*) Cases have occurred of the dowel pin in the keep ring of crosshead adjusting bolt shearing and thus allowing the crosshead brasses to slack back. Two dowel pins opposite each other and an even number of dowel pin holes, instead of an odd number as at present fitted in top of connecting rod, are considered preferable.

(*h*) A wash plate has been fitted in lubricating oil well to restrict the movement of oil away from forced lubrication pump suction when ship is rolling.

(*j*) The cast-iron exhaust pipe water jacket sleeves have fractured in some cases at the flange when removing for examination and cleaning of water space.

It is suggested that webs be cast on the flanges between the bolt holes.

(*k*) The steel H.P. compressor suction and delivery connecting pieces have been lengthened by $1\frac{3}{8}$ in. and the hexagonal portion of the screwed glands lengthened $\frac{3}{8}$ in. This enables the screwed gland to be more easily screwed up and also gives more space between the blast pipe nut and screwed gland for working a spanner.

"Ramillies."

Many minor stoppages of the plant have been caused by the air and exhaust valves sticking up, or thin springs failing, and by the air compressor suction and delivery valves breaking and springs failing.

The circulating pump wears out rapidly and requires frequent renewals. It is suggested that a pump of centrifugal type driven from the engine crank shaft and connected through a flexible coupling would give better results.

The shale oil for Diesel engines should be stored in separate tanks with own filling and pumping arrangements, and having no connection with storing tanks for boiler fuel oil except through portable hoses and connections. Under present arrangements a certain amount of contamination is unavoidable through filling having to take place through common pipe range and even when filling Diesel ready-use tanks by special Diesel pump the shale oil has to pass through same distributing suction box as is used for the heavier grade oils used under boilers.

The lack of headroom over the Diesel engines and the numerous large electric leads attached under the deck above make removal

of cylinder covers difficult; provision of suitable travellers and beams is suggested. In addition, the low headroom increases the temperature of the compartment and reacts on the temperature of the lubricating oil in the crank chambers. It is suggested that a cooling coil be fitted in each pump with supply from the centrifugal pump, and that the discharge pipe from the F.L. oil pump to the bearing distributing pipes be lead through a discharge strainer fitted outside the crank chamber, so as to be readily accessible. All strainers should be of 50 per cent. greater area. The F.L. oil byepasses should be lead back to sumps instead of discharging to crank chambers, which tends to raise the temperature of the oil. The ventilation of the rooms should be so arranged as to assist naturally in the circulation of air through the generator coils, and not to retard it.

The cast-iron jackets on the exhaust pipes of the Diesel engines are weak at the junction of flange and body, and should be strengthened by webs between the bolt holes or by making them of cast steel instead of cast iron.

The air compressor is somewhat inaccessible for repairs and adjustments of parts, and improved facilities in this direction would amply justify a small increase in size and weight. The cooler tubes should be arranged vertically with air passing downwards and a sump at bottom which could be easily cleaned out.

The bottom bearing of vertical shaft driving camshafts and governor is difficult to get at and adjust.

Automatic lubrication by means of mineral sperm oil should be fitted to spindles of air and exhaust valves.

The circulating water from each cylinder cover should be led to a box at back of engine to enable temperature for each cylinder to be ascertained readily.

The present tallies on the air charging valves, &c., are not easily understood by anyone unacquainted with this type of engine, and it is suggested that they should be numbered and a key diagram supplied and fixed up by the contractors as in case of Telemotor Steering Gear Change Valves,

The wedges securing baffle plates in silencers have been found to work loose from vibration, and should be secured or some alternative method adopted.

The engines and generators are designed for a load of 750 amps.; the average daytime load is 1,100 amps. without boat-hoist machinery or other special requirements. It is suggested that for new construction a margin of 25 per cent. over estimated required output should be allowed to meet the inevitable increase in the load.

"Resolution."

Since leaving Devonport on 7th January 1922, the Diesel generators have run respectively, No. 1 for 1,162 hours and No. 2 for 1,454 hours. This increase in running hours is mainly

attributed to the recent use of distillate fuel, which has proved of the greatest advantage in minimising the labour necessary for maintenance and the expenditure of spare parts, for, although these engines can be, and have been, run successfully on heavier oil fuels including Mexican, the economy and convenience of using the cheaper and heavier fuel is considered to be far outweighed by the present freedom from excessive and uneven carbon deposits which fouled the rings and caused distortion and cracking of the valve seatings.

A considerable saving in fuel consumption has been obtained by this increased use of the Diesels, although it has been largely discounted by the recent removal of the Benham boiler and the introduction of general messing, which necessitates the boiler stop valves being opened for the supply of steam to the galleys during many hours when steam would otherwise be shut off from the pipe system.

The principal difficulties experienced during this period have been excessive wear in some cases of the skew gear wheels for the circulating pump drive, but this has been remedied by the receipt of wheels of better wearing material. The involute gears of the pumps also show considerable wear, but this has been reduced to some extent by fitting outside gear wheels.

Stoppages have occasionally occurred through excessive load being thrown on the Diesels at the switchboard. No mechanical defects have been experienced beyond a fracture of the skirt of an L.P. air compressor piston, which was found to be cracked circumferentially about 2½ in. from the bottom. This cracked portion was removed, and the piston replaced, since which time it has run satisfactorily.

The jointing rings at the bottom of the liner have been found to perish and leak due to deposit from the circulating water forming in the small depression below the inlet, and so checking the cooling effect of the circulating water at this point. It is necessary to remove the liners to clear this, which has been done as opportunity occurred. It has been found desirable in order to prevent heavy oil fuel in the pipe system having access to the Diesels, to fit separate suction pipes from the double-bottom tanks in " A " boiler-room reserved for distillate to the pumps for filling the Diesel ready-use tanks.

No definite time routine was adopted for cleaning and refitting these valves. Generally when two Diesels were running throughout the day, it was found possible on reduction of the load to stop one about midnight. The valves were then tested by air pressure and if any slight leakage was detected the particular valve or valves were at once refitted, or spares, of which a set is always kept, fitted in lieu, in readiness for restarting during the morning watch. From the records available it appears that all air inlet and exhaust valves have been cleaned, and refitted as required, after periods of between 160 and 200 hours running.

"Hood."

The oil used has been that described as "Gas oil for Diesel engines," which does not appear to consist of all shale oil, if any. The results obtained are considered very good, but even better results would be expected when using a first grade pure shale oil.

From 15th May 1921, to 28th March 1922—314 days—No. 1 Diesel has been run for 3,268 hours and No. 2 Diesel for 3,703 hours.

In harbour two dynamos are always in use, a third being kept in readiness and always started for running boathoist, or when the load exceeds 1,900 amps., which is frequently the case. At sea three dynamos are always in use at normal times.

The Diesel engines are seldom in use at sea, the steam engines providing exhaust steam for making water and in the main turbines.

After refit the following routine is carried out with the Diesel engines :—

Inlet and exhaust valves cleaned after 600–700 hours.

Pulverisers cleaned and fuel valves ground after 700 hours.

Air-starting valves cleaned after every 1,400 hours.

The H.P., I.P. and L.P. suction and delivery valves cleaned after every 500 hours.

Most of the defects of the engines have been due to suction and delivery valves of the air compressor breaking (the L.P. compressor rings stick, probably through excessive lubrication): mild steel liners in delivery valve space in H.P. and I.P. compressor heads corroding rapidly and allowing salt water to enter when the engine is stopped. When the main pistons are examined about 1/64 in. carbon is found and the top two rings are always stuck.

Every effort is made to run one Diesel engine continuously in harbour, but this entails considerable skilled work. Mineral sperm oil is used for lubricating the spindles of the inlet and exhaust valves.

"Repulse."

The engine was last de-carbonised, cleaned and refitted at the beginning of November 1921. It has since run 1,210 hours.

During this time the only skilled work done on the engine amounted to 3 man-hours in making good small defects, chiefly on the air compressor.

The fuel used was the ordinary Admiralty mixed oil fuel, no shale oil being drawn or required. Oil mineral, sperm, was used in small quantities on the valve spindles and did much to keep them clean during the long period of running.

After 1,210 hours running the engine was opened out for general cleaning and refit. The condition throughout was very good. Exhaust valves were dirty and valve springs very dirty

with oil residue. There was an average thickness of carbon deposit of about 1/64 in. on piston heads. The top piston ring in each cylinder was gummed up, but the remaining three rings were free and in good condition. The engine required a thorough cleaning of fuel and lubrication systems and an ordinary refit of moving parts.

The cleaning should preferably have been carried out earlier, but the conditions of service of the ship during the later period were such as to enable the full economic value to be obtained from the Diesel engine, and so the running period was extended to the maximum.

The engine is very reliable, extremely economical and very convenient.