NOTES FROM SEA

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MARINE ENGINEERING

Comments by D.M.E.

Diesel Generators—H.M.S. ' Keppel '

The following remarks are appended regarding the taking of ' bumping clearances ' after overhaul of the port Diesel generator (Paxman 12 YHAZ).

When the cylinder heads were fitted, it was found that two copper sealing rings had been fitted under each cylinder head. Their thickness was measured and found to be 0·044 and 0·032 in. giving a total of 0·076 in.

B.R.1332 (13), handbook for Admiralty Standard Diesel Engines Range 2, Chapter 5, states that ' sealing rings of three different thicknesses are available : a " standard ", which is 0·048 in., a 0·016 in. undersize and a 0·016 in. oversize.'

New piston rings were fitted, but the cylinder liners were not renewed as the condition of the bores was good ; the wear on the original diameters being from 0·003 to 0·009 in., well below the allowed maximum of 0·015 in. (B.R. 1332 (13)). There was the normal slight ridging at the top of each bore at the upper limit of ring travel.

As the reasons for the rather unusual fitting of two sealing rings in each cylinder were not known, it was decided on re-assembly to verify the bumping clearances using different combinations of sealing rings. A first check was made by fitting together two sealing rings, of 0·064 in. and 0·048 in., in each cylinder. Bumping clearances on each cylinder were then taken in accordance with the instructions with the following results : –

'A' bank—0·035 to 0·045 in.
' B ' bank—0·026 to 0·039 in. } Designed —0·050 to 0·060 in.

After re-checking these readings it was obvious that something was at fault. The cylinder heads had been replaced on the two sealing rings of a total thickness almost twice that designed. An investigation was carried out into the possibility of the top piston ring fouling the slight ridge at the top of ring travel in the cylinder bore, before the piston could come into contact with the cylinder head, when being poled up. This check was done by removing the top ring of each piston of ' B ' bank and again taking bumping clearances, which gave readings of 0·115 in. against the previous 0·026 to 0·039 in. thus confirming the above supposition.

The ridge at the top of each cylinder bore of each bank was then removed by careful grinding and the pistons and cylinder heads re-assembled, using one oversize sealing ring (0·064 in.) per cylinder. Bumping clearances were again taken and the designed clearance of 0·050 to 0·060 in. obtained for the whole engine.

The ship's records do not show when or why the two sealing rings were fitted to each cylinder head, but it is assumed that they must have been fitted thinking to obtain the designed bumping clearance on some previous occasion ; the mistake was in believing that the piston was bumping, when in fact the top ring was fouling the top ridge in the cylinder bore.

This fact would have been apparent only if the full procedure had been repeated after fitting the two rings ; re-zeroing the dial test indicator, releasing the large end bolts and poling up the pistons would have given exactly the same readings as before, in spite of the extra sealing ring.

It is evident that the engine had been running with a reduced compression ratio which possibly partly accounts for the previous history of difficult starting.

Since it appears to be comparatively easy to be misled when checking the bumping clearances, even when the cylinder wear is still small, it is suggested that a warning be added in B.R. 1332 (13) or an amendment to the effect :—

> ' To avoid false bumping clearance readings, it is essential to make sure that the piston is in fact bumping, and not being stopped by the piston ring taking on any ridge at the top of the cylinder bore. If such a ridge exists, either remove the top piston ring while taking bumping clearances or grind out the ridge.'

Comment

The remarks have been noted with interest and handbooks in the B.R.1332 series are being amended accordingly.

It is observed that, in the interests of standardization, only the largest size of cylinder head joint ring is now being stocked by S.P.D.C.s (B.R.1986, Chapter 3, Art. 0332 refers), and it will be unnecessary in future to check bumping clearances after fitting new cylinder head joint rings.

ORDNANCE ENGINEERING

40 mm. Mk 6 Mounting—Firing Gear Hydraulic System—H.M.S. ' Albion '

Simplifix couplings for the pipes of the hydraulic systems may only be broken, or tightened in order to stop leaks, once. Thereafter any further tightening has no effect other than to close the pipe in and make the leak worse. As it is necessary to remove certain of the pipes in the 40 mm. Mk 6 mounting during routine maintenance work (e.g. removal of auto-loaders) the use of these couplings causes considerable trouble.

Comment

Care was taken during the design stage of this equipment that pipes, etc., did not unnecessarily obstruct maintenance work : appropriate manufacturing drawings include notes to this effect. If, due to manufacturers errors or incorrect repair work at some time, this feature has been lost, the pipes concerned should be replaced so that the obstruction is removed.

The criticism of the ' simplifix ' couplings is not accepted (though, to be fair, the existence of such a school of thought must be admitted). Experience with these couplings shows that, although they will not last indefinitely, they may be broken and satisfactorily remade a considerable number of times, so long as they are tightened with care. It is of interest to note that they are manufactured to B.S.2051, Part 1, which states that ' The fittings shall be capable of having the joint broken and remade six times and shall provide a sound joint on each occasion.' In the case of any item claimed by a manufacturer to conform to a British Standard, complaints may be taken up with the B.S.I.

4·5 in. Mk 6 Mounting Rammer Control Gear—H.M.S. ' Daring '

The rammer became inoperative during a shoot, and it was found that the rear toe of lever (9) had broken off. The lever had been welded at the point of fracture, but it was not clear if this was done during manufacture or as a repair. Marking on the lever indicated that, in the ' breech closed ' position, the clearance between the end of the control valve spindle and the centre toe of the lever had been taken up.

Comment

A number of ships seem to have had trouble with this lever. Similar failures occurred during early trials on the mounting, and the lever, which was originally of welded construction, was modified in shape and made solid. It is known that the lever was replaced on the same gun in H.M.S. *Daring* in 1955, and it is probable that a lever of the original design was used. In more recent cases of failure, replacements have been manufactured locally of En 32 A (U.T.S. 32 tons/sq in.) in place of the original material, which was V 3 (corresponding to En 3 A, U.T.S. 28 tons/sq in.). A modification to the rammer release gear is currently being considered, and the material for lever (9) is being upgraded to En 32 A. ; this is principally due to the fact that higher stresses will be imposed on the lever after modification.

The real trouble in this case seems to be that it is possible for a physical foul to occur between components operated by the lever. This can happen if the control valve spindle or the engaging locking bolt rotate slightly (e.g. due to wear between rubbing faces) so that the bolt will not enter the valve spindle slot ; or if, with the rammer head forward and the breech closed, the clearance between the locking bolt and the control valve spindle slot rear face is too small (e.g. due to the rammer head not giving sufficient movement to the bell crank lever, due to wear of components or to incorrect setting of the breech block return springs). The former possibility can be eliminated by tapering the two flats on the locking bolt : the latter can only be bowled out by careful checking of all the operations and clearances concerned.

4·5 in. Mk 6 Mounting Mantlet Weathering—H.M.S. ' Delight '

The mantlet weathering of these mountings has always been defective. A and B mountings are flooded whenever a little rough weather is experienced, and it is impossible to inflate the rubber tubing sufficiently to prevent the entry of water past the mantlet plate.

The tubing fitted is far too thick and heavy, and it is not possible to build-up sufficient air pressure inside it to give the expansion required to form a good seal. This difficulty has now been satisfactorily overcome on A mounting by replacing the tubing with a patternized tubing of vulcanized rubber coated with Necol lacquer.

Comment

The provision of a suitable tubing for weathering arrangements in enclosed mountings has always presented a problem. The tubing must be flexible, but not so flexible that blistering occurs at unsupported points ; it must not distort through permanent expansion ; it must be oil resistant, and must not perish or crack with weather or climatic changes ; it must be easily bonded to angle or T-pieces. Many of these requirements are met by Neoprene tubing, and this has been used with some success in new mountings. However, as mountings age there are often increases in the spaces to be taken up by the tubing, either through wear of the rubbing parts or distortion of the structure, and Neoprene has proved insufficiently resilient to take these up. In addition, longitudinal cracking has occurred in the Neoprene tubes after some time in service.

It has been established that a pure rubber tubing treated with Necol lacquer is the best material for the purpose. Unfortunately, there is a tendency for such tubing to ' blister '. In newer equipments (e.g. the 3 in. Mk 6 mounting) this is overcome by enclosing the tubing for three-quarters of its periphery in a metal support, and forming the tubing during manufacture to provide a tongue which gives the necessary sealing contact. To apply this method to existing equipments would involve extensive modification, and is not justified.

Trials are being carried out, however, on the 4·5 in. Mk 6 mounting to decide on a suitable thickness of Necol lacquered natural rubber tubing that will give reasonable expansion without serious ' blistering '.

M.R.S. 8 Dual Ballistic Unit—H.M.S. ' Crossbow '

Oil was found to be leaking from the sump of the unit, under the lower rear covers. These covers are secured by cheese-headed screws, and by replacing these with hexagon slotted screws it was possible to apply more efficient tightening in the limited space available. This could only be done with the screws along the outer edges of the cover, as the centre-line screws are of unusual length and could not be replaced.

This action considerably reduced the leakage. It is suggested that the fitting of lead washers to the lower edge screws to prevent seepage through the screw holes would provide further improvement.

Comment

There is no doubt that relatively minor difficulties of this nature can cause a lot of trouble. They are, unfortunately, very difficult to eliminate during the design of the equipment, as they rarely become evident until a unit is installed in a ship, and may then cause difficulty in only a few cases where no alternative site is available for the unit.

In this case, approval has been given to the actions proposed. It is open to question, however, if the use of a ' round the corner ' screwdriver would not have avoided the need for hexagon slotted screws.

G.R.U. Stabilizer Mk 3—H.M.S. ' Cavalier '

During pre-refit trials of the gunnery equipment, the G.R.U. stabilizer developed an intermittent high frequency jitter in training.This was investigated, and it was observed that : -

(*a*) The jitter frequency and the time taken for it to disappear increased with running time

(*b*) It extended over a long training arc before stabilizing out

(*c*) It usually commenced on an arc between green 60 and red 40 degrees, but occasionally commenced on after bearings

(*d*) It appeared to be independent of elevation or training rates, except that it would not commence below 4 degrees/sec training left, or 7 degrees/sec training right

(*e*) The jitter was of 5 c.p.s. carrier frequency with a 1 c.p.s. modulation ; amplitude ranged from 5 to 7 minutes

(*f*) The carrier and modulator waves were present in all pen recorder traces, though at a much reduced amplitude when the motion was stable.

From these symptoms it was deduced that the defect was in mechanical, rather than electronic components. This was confirmed by fitting spare amplifiers and tachogenerator, and by adjustments to electronic controls.

The sensitive element was then checked for wander and timed for rates, and the air dashpot was removed and readjusted, but no fault could be found. A further check was carried out by connecting the stator terminals of the director fine order transmitter to the stator of a coincidence transmitter in an A.G.E. dummy director, and using the Sx and Sy connections from this in place of the training pick-up signal to the follow-up servo amplifier. With the sensitive element stopped and pegged it was possible to train the stabilizer in this manner. Resultant instability gave almost identical traces to those taken under normal conditions, showing that the cause of instability was definitely located in the follow-up servo.

The safety training clutch was then examined, and although there was a tendency for the clutch to slip and eventually slacken off slightly, this was eliminated and the slipping torque adjusted to the correct figure, with no improvement to the servo performance.

Attention was then paid to the existence of backlash in the training drives. A small amount of backlash could be felt at several points, and this had been suspected as a possible cause of the instability from the beginning of the investigation ; in view of the known difficulty of analysing backlash effects it was preferred to eliminate other possibilities first. On closer examination, it was evident that the backlash effect was very considerable, particularly as there were five pairs of mating gears in the drive from motor to rack, thus amplifying and summating the actual backlash at the individual points. It was, in fact, possible to move the motor shaft 15 to 20 degrees without moving the stabilizer.

It was clear that the fault could only be rectified by the fitting of a replacement training assembly, and supply of this was requested. In order to improve performance of the unit in the interim, it was decided to reduce the overall gain of the servo. This was at first done by fitting 10 K. ohm attenuators in the amplifier input lines, but although stability was thus achieved large errors were introduced in training follow. A compromise was reached by fitting 5 K. ohm attenuators, and adjusting the pre-retardation circuits, using a decade box to select the new values.

It is considered that the long-term solution to the problem lies in a redesign of the whole of the training drive assembly, in such a way that the number of components is reduced.

Comment

This report arrived in Admiralty at a moment when the redesign of the training drive along the lines suggested had been completed, and stocks of modified assemblies had just reached the numbers necessary before a general modification could be introduced. Thus the replacement assembly supplied to *Cavalier* was of the new design.

Unfortunately, this did not quite have the effect that had been hoped for. Although the ship's officers were no doubt delighted to have their suggestions implemented so quickly, difficulties arose when the new assembly was fitted. These difficulties were mainly due to a typographical error in the instructions for fitting, but they certainly caused considerable trouble.

The interesting feature of the report is the systematic way in which the defect was diagnosed. It is very easy, when faced with intermittent instability in a servo, to jump to conclusions on its cause ; it would have been easy in this case to assume that backlash was excessive without eliminating other possible causes. This is particularly the case in a unit like the G.R.U. stabilizer, which is very easily regarded as ' untouchable '

4·5 in. Mk 5 Mounting Rammer—H.M.S. ' Cossack '

During a shoot the rammer compressor bracket recoiled and ran out with the gun, failing to cock. It was found that the tripper bolt had jammed in the down position. No cause could be found for this until the tripper bolt guide rollers were measured, and their diameters found to vary between 0 and 0·013 in. oversize, with three rollers at maximum reading. As the gun had operated satisfactorily for many years, it is assumed that at some time during routine examination two of the larger rollers had been replaced opposite to each other, and that subsequently some very minor distortion of the bracket had taken up what clearance was left, causing the jam. Although no distortion was detected, this assumption was borne out by the fact that the gear operated correctly when it was reassembled with the four larger rollers in the lower position.

Comment

The official verdict on this is that it is an isolated instance of incorrect manufacture. Looking a little deeper into the matter, however, it is possible to draw certain other (not necessarily correct) conclusions. Several years ago a modification was authorized to replace the original rollers with new ones of case-hardened mild steel. This modification was carried out in *Cossack* at rather short notice and, due to a shortage of the new rollers, a set was manufactured locally. It can only be assumed that the oversize rollers were fitted to compensate for wear in the other components; whether the oversize rollers were originally fitted as a complete set of equal-sized rollers on only one mounting, and have been subsequently redistributed during stripping, it is impossible to say. The moral is, if even minor changes are made that will affect interchangeability, a proper record should be made of this fact.

Gun Direction Binocular Sight Mk 1—H.M.S. ' Whitby '

The elevation index drum on the open sight linkage was found to be corroded. The first sign of this was ' blistering ' of the black lacquer finish of the drum, on its outside edges. On removing the drum for closer inspection, a large section of its surface broke away, apparently due to corrosion : the metal appears to have flaked away at the broken edges.

Comment

The drum is manufactured from an aluminium alloy, and is a plain pressing in a form similar to an annular L-leather. The corrosion was rather unusual in appearance, as it had taken place apparently simultaneously throughout the metal, causing it to flake away and leave a broken edge such as would be expected if the drum had been built up by bonding together twenty or thirty thicknesses of aluminium foil. The corrosion was localized to two areas, and it was noted that these were where the drum was in contact with other parts : one where the periphery of the drum is in contact with the open sight arm, and one where the elevation pointer is in near contact with the drum over the arc 25 to 50 degrees elevation.

This form of corrosion is known as exfoliation. It occurs when the advance of the corrosion along the grain boundaries of the metal is naturally directed in more or less straight lines through the material, rather than along the ' crazed ' boundaries near the surface. In this case it seems that the grain structure of the drum had been left in a suitable condition for this to take place, probably during pressing, and that the presence of two contacts, one at either end of the cylindrical portion, had directed the corrosion electrolytic currents along the paths provided by the grain boundaries.

This is a rather difficult form of corrosion, because it is not easily observed until the damage is serious. However, it is fortunately not very common, and as there have been no other reports of similar defects in this component it is regarded as an isolated instance.