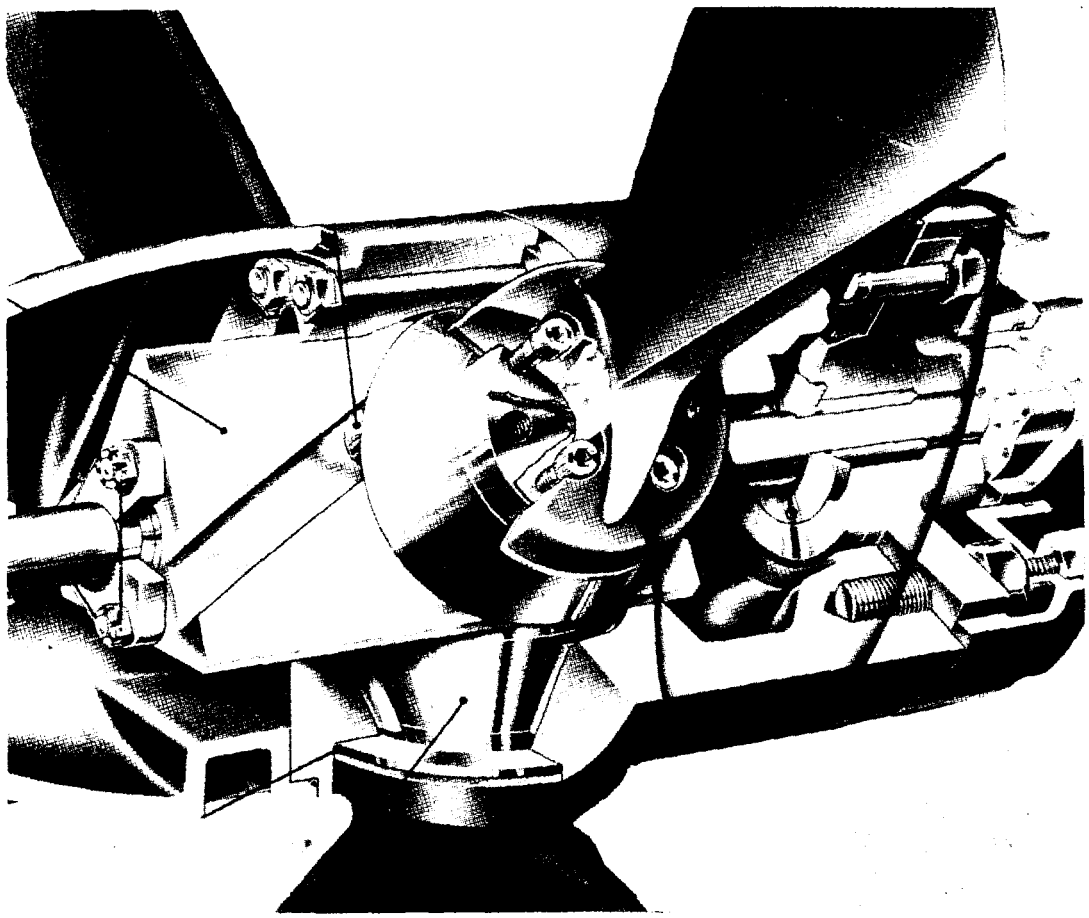

FIG. 1—SECTION OF PROPELLER SHOWING BLADE SECURING BOLTS

UNDERWATER REPLACEMENT OF A C-P PROPELLER BLADE

BY

COMMANDER B. H. LAWSON, R.N., C.ENG., M.I.MECH.E., M.I.MAR.E.

While returning to Bahrain from Dubai in March, 1970, H.M.S. *Beagle* suddenly developed a severe vibration. Shaft revolutions were immediately reduced and neutral pitch selected, but as this had no effect on the vibration, both shafts were stopped. Divers soon discovered that one blade of the port propeller was missing, but no objects were visible in the water to account for its detachment.

The slipping facilities in Bahrain are too small for a vessel of the size of *Beagle* so, as a spare blade was carried by H.M.S. *Bulldog*, it was decided to tackle the problem with divers led by the artificer diver from H.M.S. *Jufair*.

Investigation showed that of the six 'Unbrako' bolts securing the blade to the root, the forward three had sheared flush with the root while the after three had had their heads torn off. The thrust ring, 'O' seals and blade root washer and packing had been lost but, with the exception of the washer and packing, spares were available on board.

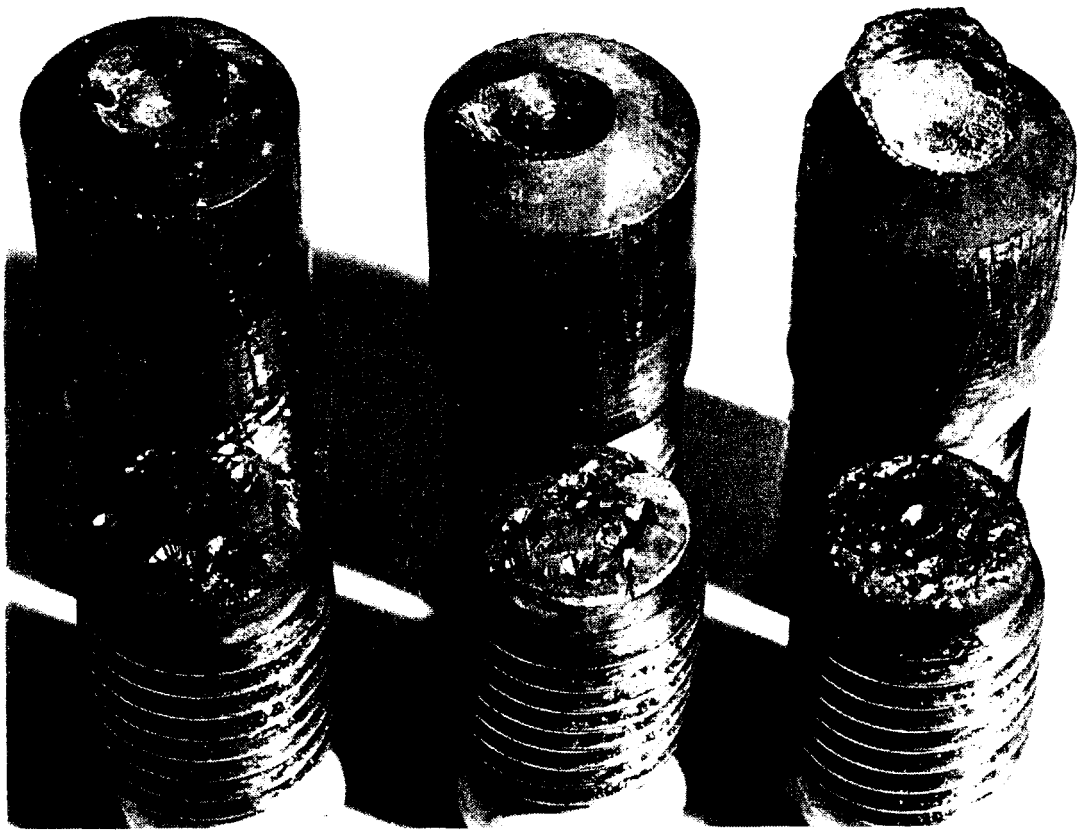

FIG. 2—FRACTURED SAMPLES OF BOLT SHOWING LOCATIONS OF FAILURE

The three after bolts were easily removed, but the phosphor bronze material resisted the attempt to drill holes for an 'Easyout' in the forward ones. This was probably due to the difficulty in getting sufficient leverage on the drill under water, but eventually the alternative of a punch and hammer proved successful. The main difficulty, however, was experienced in ascertaining the thickness of blade root packing required. Too much would have resulted in excessive blade tip flutter while too little would have caused the pitch control mechanism to be locked solid. A clearance of 0·004 in. was considered the ideal to aim at and the task of taking leads was commenced in order to determine the thickness of packing required. In dry dock this would have taken a matter of a few hours but under water, the task of slinging the new blade exactly over the recess in the blade root, lowering it into position and fitting and tightening a couple of bolts was both frustrating and time consuming. Without the Divers Underwater Communication Set it may well have proved impossible. In addition, the water temperature, although about 70 degrees F, somewhat limited the length of time the artificer diver could remain below — even in a rubber suit. In all, the blade was put on and taken off some six times, although half of these were accounted for by the blade root washer being made too thick in the first instance. An estimate of this thickness had been made by measurement from the drawing as no dimension for it was stated. It was noted that an eyebolt had been welded to the hull over the starboard propeller; a similar one on the port side would have greatly assisted the task of manoeuvring the blade up and down. Such is the law of cussed awkwardness!

Finally the bolts were torqued up, the operation of the pitch motor was checked and its performance over the manoeuvre from full ahead to full astern was compared with that of the starboard one. The bolts were locked by the simple expedient of hammering nails of the appropriate interference fit

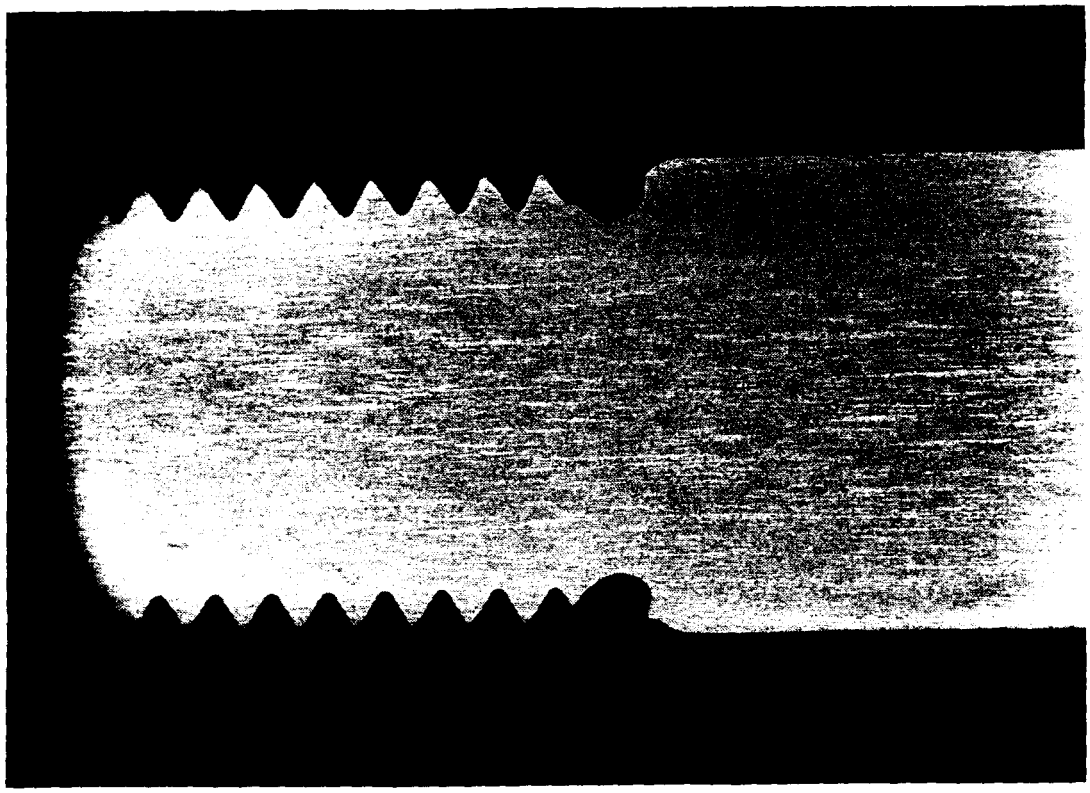

FIG. 3—MACROSECTION SHOWING AMOUNT OF UNDER-CUTTING AT SITE OF FAILURE IN SOME BOLTS (X 2)

between the heads and the recesses and after a two-hour sea trial the recesses were sealed by caulking with lead pellets.

In view of the fact that the ship was due for docking on her arrival home, no attempt was made to recharge the hub with grease. It would have been a further time consuming operation and the ship was already a day late on her departure date. As there was still plenty of grease round the blade root and very little use would be required of the control mechanism on the trip home, this was considered a fair chance to take.

As far as is known, the ship arrived in Chatham without further mishap. The cause of the original failure is a matter of conjecture. The blade was reported as having a slight kink in its edge and this may have resulted in a vibration which ultimately caused the bolts to fail. Examination of the bolts at the Central Dockyard Laboratory in Portsmouth may give an indication of the probable cause.

Ship Department Comment

H.M.S. *Beagle* completed the surveying season and returned to Chatham in June without further mishap or reduction in performance. It is estimated that some 14 000 miles were steamed during the period between fitting the spare propeller blade and arrival at Chatham.

The report by the Central Dockyard Laboratory attributed the bolt failure generally to corrosion fatigue and excessive undercutting at the termination of the threaded portion, this being coincident with the site of failure of the three forward bolts, and a sharp corner under the bolt head at the point where the three after bolts failed. The material was found to conform to the specification BS233 CA104 and no merit was seen in a change of material.

Subsequently reference was made to the manufacturer and a change of bolt design was evolved. The adverse features highlighted in CDL's report were

eliminated and the bolt head was changed to a male hexagon in lieu of the socket type.

When the ship was docked at Chatham all blades were removed from the port propeller for examination of the hub. No evidence was found of sea water contamination or any other detrimental effects. On refitting, the new design bolts were used.

The following extract from a letter by the Commanding Officer of H.M.S. *Beagle* is also of interest:—

> 'On 29th December, 1969, on leaving Bahrain, the engine room reported feeling a bump on the port shaft. This was not felt on the bridge, and no excessive vibration was experienced thereafter.
> However, on 30th December the screws were examined by divers, and a slight shake in the leading edge of one blade of the port screw was observed. This blade is the one which subsequently broke off'.

The slight shake referred to was later defined as '5 inches of the blade tip was bent out of line to a maximum of $\frac{3}{8}$ inch'. It is not clear whether an object was struck at this time, but it is a possibility that this occurred and caused one or more of the bolts to be over stressed and so contributed to the eventual failure in March.

In conclusion, it is believed that this is the first instance of a repair to a C-P propeller being carried out while the ship is still afloat and reflects considerable credit on all concerned.

HOW TO WIN AT WORDSMANSHIP

After years of hacking through etymological thickets at the U.S. Public Health Service, a 63-year-old official named Philip Broughton hit upon a sure-fire method for converting frustration into fulfilment (jargonwise). Euphemistically called the Systematic Buzz Phrase Projector, Broughton's system employs a lexicon of 30 carefully chosen 'buzzwords':

Column 1	*Column 2*	*Column 3*
0. integrated	0. management	0. options
1. total	1. organizational	1. flexibility
2. systematized	2. monitored	2. capability
3. parallel	3. reciprocal	3. mobility
4. functional	4. digital	4. programming
5. responsive	5. logistical	5. concept
6. optional	6. transitional	6. time-phase
7. synchronized	7. incremental	7. projection
8. compatible	8. third-generation	8. hardware
9. balanced	9. policy	9. contingency

The procedure is simple. Think of any three-digit number, then select the corresponding buzzword from each column. For instance, number 257 produces 'systematized logistical projection', a phrase that can be dropped into virtually any report with that ring of decisive knowledgeable authority. 'No one will have the remotest idea of what you're talking about', says Broughton. 'But the important thing is that they're not about to admit it'.