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DESIGN MODIFICATIONS TO THE AANDERAA CURRENT METER SPINDLE ASSEMBLY

by

I. G. CHIVERS

REPORT NO 19

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NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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ABSTRACT

Corrosion is one of the major problems of the marine engineer and one which is frequently solved only by empirical methods. Data available to the designer is, more often than not, inadequate in that it is impossible to cover the wide range of conditions existing in coastal and oceanic waters. A material can be seclected which will best meet the mechanical requirements and then it is necessary to establish whether it will survive to give an economic life in the marine field.

Experience has shown that a number of commercially available oceanographic instruments are not fully suited to the extreme conditions met in the marine environment. It has therefore been necessary to modify some items in order for them to maintain a reliable service at an economic level.

INTRODUCTION

Currents in the sea can be measured in depths up to about 200 metres and for periods of up to 60 days by use of a mooring similar to that shown in figure 1. One of the types of instruments used by this Institute with this type of rig is the recording current meter type RCM4, manufactured by Aanderaa Instruments of Norway (fig.2). These instruments have facilities for recording water velocity, direction, temperature and pressure on to quarter inch magnetic tape.

Whilst the recording unit itself has proved to be both satisfactory and reliable, a number of problems have arisen with the spindle assembly from which the equipment is suspended. On recovery a number of spindles have suffered severe corrosion and/or have been severely bent, the latter possibly due to trawling by fishing vessels operating in the station areas. Galvanic corrosion and severe pitting in the ball races have been major problems frequently resulting in catastrophic failure of the apparatus.

Turbulence around the meter and associated mooring equipment gives rise to both high and low frequency oscillations of the current meter assembly. The pitting in the ball races could be attributed to this movement, particularly when a high percentage of suspended matter is present in the surrounding water. It was necessary, after recovery, for each spindle assembly to be completely stripped and examined for wear so that damaged components could be replaced. Frequently the complete unit has been discarded.

DESIGN AND CONSTRUCTION

A new bearing assembly has been designed in an attempt to improve the reliability and performance of the system, figs. 3 and 4. The bending resistance of the spindle was increased by enlarging its diameter and the bearing geometry modified to alleviate pitting. Material changes were introduced, stainless steel components used for bearing surfaces being electroless nickelled and hardened. A p.t.f.e. thrust pad was positioned between the bearing retaining ring and the outer race to provide a low friction surface. This could easily be replaced if worn or damaged and also acted as an insulator to reduce galvanic action between gimbal and spindle. A comparison of the materials used in the two versions is shown in table 1.

The bearing unit was packed with "Shell" outboard grease during assembly and neoprene 'V' ring seals fitted either side of the race. This provided lubrication, corrosion protection, sealing against the intrusion of suspended particles and dampening of high frequency oscillations. All screw holes were finally sealed with wax for added protection.

DISCUSSION

The modified design spindles have been subjected to a number of trials in various localities. Previous work has shown that conventional spindles used on current meter rigs at the Inner Dowsing light tower were exposed to some of the most severe conditions. Meters recovered from this site were always in an

advanced state of corrosion and exhibited considerable wear. It was therefore decided to use this station to conduct tests on the prototype spindle manufactured to the new design. Experiments were carried out using lubricants of different viscosities, sea water lubricated, with and without V seals. It was encouraging to find that a spindle which had seals fitted and was sea water lubricated returned with only minor abrasion to the bearing surface and no indication of pitting. To date no better substitute for the outboard grease has been found, other samples tested rendering the movement too stiff or the seals were unable to retain the lubricant. Comparable efforts required to move the fin/meter assemblies are indicated in the graphs in fig. 5.

It can be seen from table 2 that during the period February 1973 to February 1974 the Bidston laboratory of IOS suffered a 33% failure(1) for the conventional spindle assemblies and only 6% failure for the modified type.

Table 3 shows an overall assessment of current meter installations for the Inner Dowsing site.

A total of six spindle assemblies were originally manufactured at the Institute, and having been used on three separate cruises these required no attention after recovery other than washing with fresh water. Subsequently eighteen more spindles have been produced and it is hoped that all current meters will be fitted with the new version.

The modified spindle assembly is slightly more expensive to manufacture but the extra cost involved is heavily outweighed

(1) "failure" indicates that a major service was required in which components needed replacing or were discarded.

when one considers the time/cost requirement for servicing and the necessity to purchase spares from Norway. Aanderaa Instruments have been notified of the problems experienced and of the modifications undertaken. During the past year some of their material selections have undergone changes resulting in a marked improvement in performance but many of the faults are still inherent.

Further study of the current meter arrays in situ is necessary as evidence has shown that meters mounted near the bottom of the taut line occasionally operate at an angle in excess of their design attitude. Tilt meters have been installed within the pressure case to provide more information on this aspect.

ACKNOWLEDGEMENTS

I wish to thank Mr. K. Taylor for his co-operation in the development and manufacture of the equipment discussed in this paper.

REFERENCES

1. HOWARD-ROGERS, T. 1968. Marine corrosion. London: Newnes. 320 pp.

2. INTERNATIONAL NICKEL LTD. 1973. A guide to the selection of marine materials. 24 pp.

CURRENT METER MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES, BIDSTON

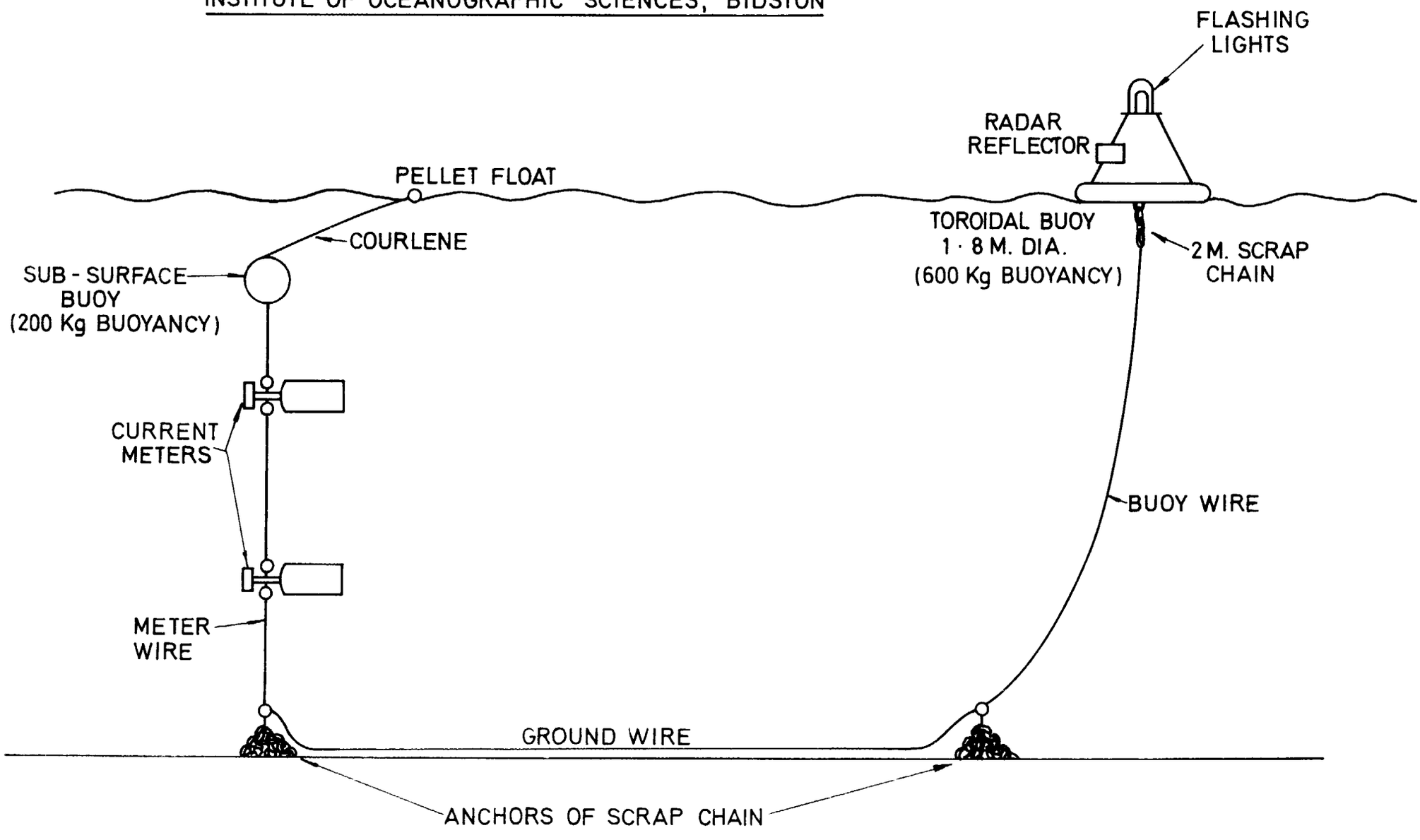
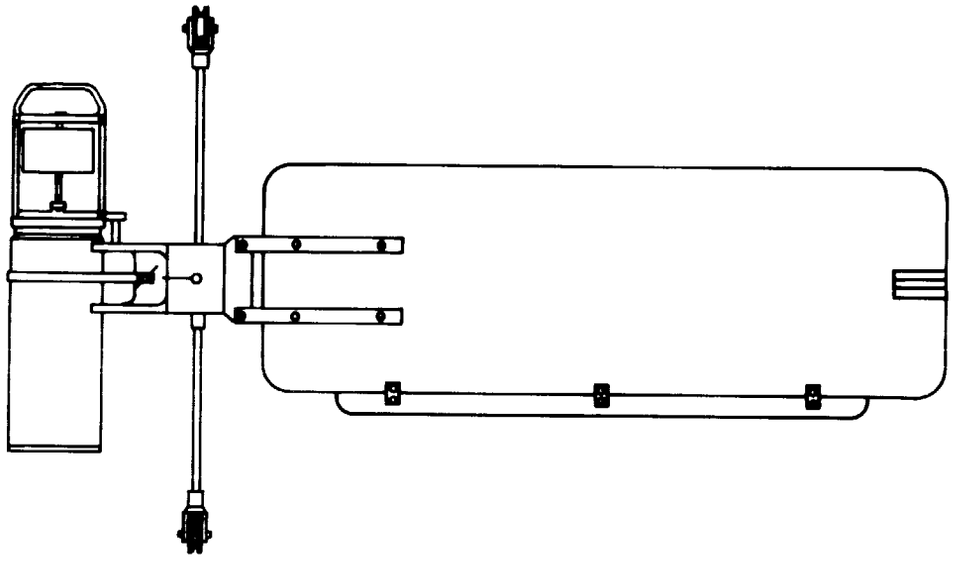


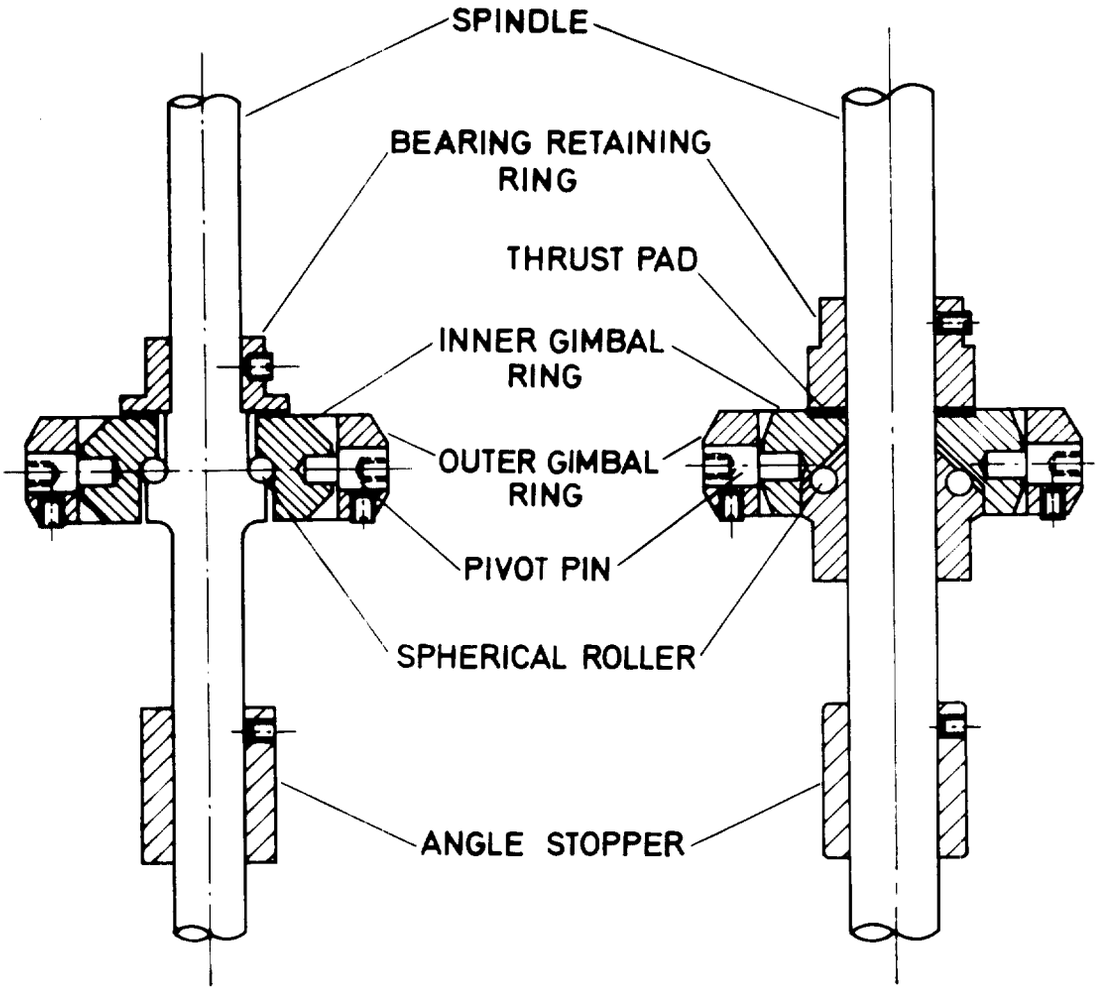
FIGURE I.



AANDERAA RECORDING CURRENT METER
TYPE RCM 4

FIGURE 2.

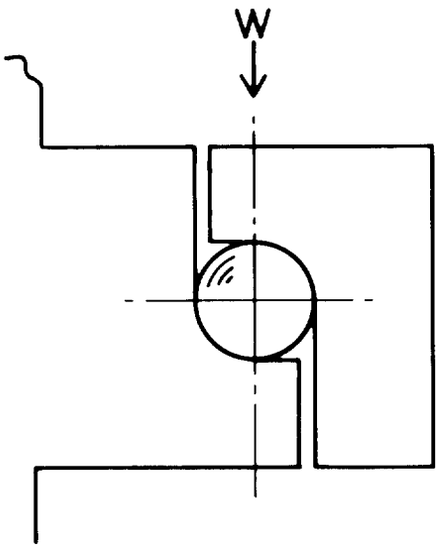
DESIGN COMPARISON OF SPINDLE ASSEMBLIES



AANDERAA
SPINDLE ASSEMBLY

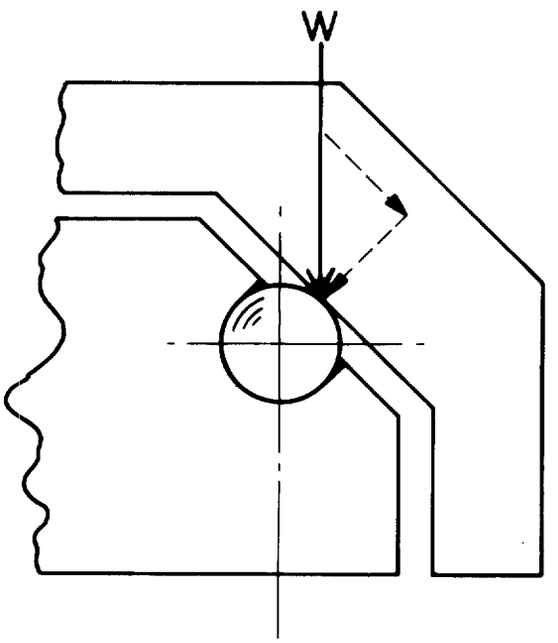
I.O.S. MODIFIED
SPINDLE ASSEMBLY

FIGURE 3.



BALL - RACE TRACKS
EQUAL LENGTH

AANDERAA
CURRENT METER



BALL - RACE TRACKS
UNEQUAL LENGTH

I.O.S. BIDSTON
CURRENT METER

BALL RACE GEOMETRY

FIGURE 4.

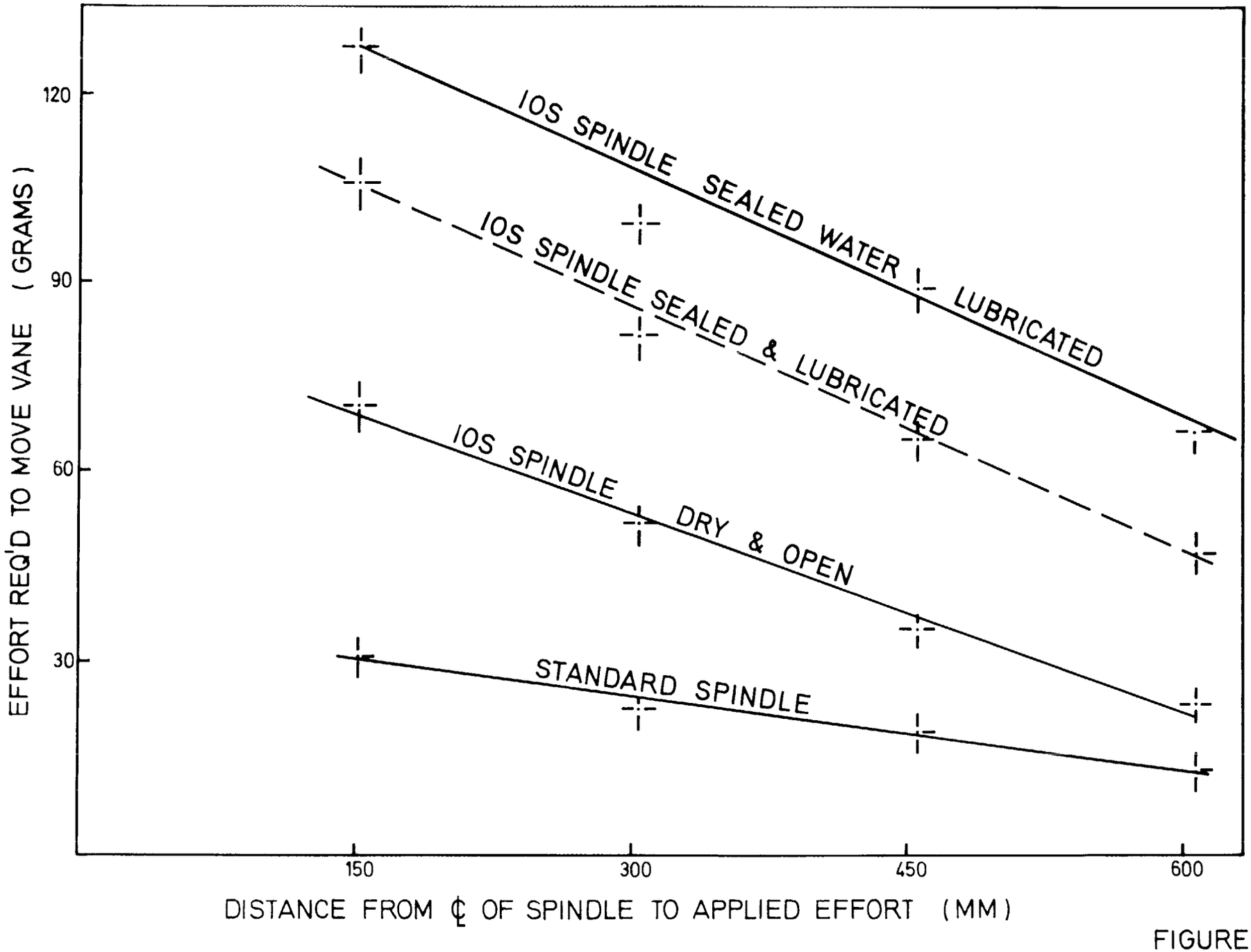

120
90
60
30
EFFORT REQ'D TO MOVE VANE (GRAMS)
IOS SPINDLE SEALED WATER LUBRICATED
IOS SPINDLE SEALED & LUBRICATED
IOS SPINDLE DRY & OPEN
STANDARD SPINDLE
150
300
450
600
DISTANCE FROM ℄ OF SPINDLE TO APPLIED EFFORT (MM)

FIGURE 5.

ITEM	AANDERAA		IOS - BIDSTON
YOKE PIECE	BRONZE ALLOY - NiPl		BRONZE ALLOY NiPl
SPINDLE	STAIN. S - S316		STAIN. S. - S316
OUTER RACE	PRE 1973 STAIN.S S.316	1973 - NYLON	STAIN. S. - S316
BEARING BALLS	PRE 1972 STAIN. S	1972 - NYLON	NYLON
GIMBAL RING	PRE 1973 BRONZE ALLOY NiPl	1973 - STAIN. S. S316	STAIN. S. - S316
BALL RACE PIVOT PIN	PRE 1973 BRONZE ALLOY NiPl	1973 - STAIN. S. S316	STAIN. S. - S316 ELECTROLESS NICKELLED & HARDENED
GIMBAL RING PIVOT PIN	STAIN. S - S316		STAIN. S. - S316
BEARING RETAINING RING	BRONZE ALLOY - NiPl		STAIN. S. - S316
THRUST PAD	NOT USED		P.T.F.E.
ANGLE STOPPER	PRE 1973 BRONZE ALLOY NiPl	1973 - NYLON	STAIN. S. - S316
ZINC ANODE	PRE 1973 NOT FITTED	1973 - ELECTRODE ZINC	ELECTRODE ZINC
BEARING SEAL	NOT USED		NEOPRENE RUBBER

Comparison of component materials.

TABLE 1.

		Aanderaa Spindle		IOS (B) Modified Spindle	
Cruise date	Approx Duration (days)	No. of Meters	Condition after recovery	No. of Meters	Condition after recovery
Feby 1973	30	2	Component replacement necessary.	1	No servicing required
June 1973	30	14	2 lost 2 bent component replacement necessary	5	No servicing required
Sept 1973	50	13	1 lost(2) 3 bent component replacement necessary	5	1 lost(2) 1 bent 3 No servicing required
Feby 1974	30	7	5 bent component replacement necessary	5	1 badly abraded due to entangling 4 No servicing required

Current Meter Deployments Feby 1973 - Feby 1974

(2) These spindles were recovered after 21 months immersion in the sea, a summary of their condition is shown in Table 4

TABLE 2

Date	Duration	Type of Spindle	Remarks
Feb 1972 to Feb 1973	360 days Meter changed at 30 day intervals	Aanderaa	Complete meter assembly changed at 30 day intervals. Spindle assemblies always needed thorough servicing or replacing.
March 1973 to Nov 1973	270 days Meter changed at 30 day intervals	IOS Bidston	Complete meter assembly changed at 30 day intervals. Two assemblies were used alternatively for a total of 135 days each without the need for servicing.

Overall assessment for Inner Dowsing site

TABLE 3

Aanderaa Spindle	IOS (B) Spindle
Severely bent	Slightly bent
Badly worn spindle stop	Gimbal in good condition
One pivot pin missing from gimbal assembly.	No surface wear in bearing.
No balls remaining in bearing.	
Unit discarded	Unit required minor servicing.

State of spindles after 21 months immersion

TABLE 4