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A SIMPLE FIELD INSTRUMENT FOR MEASURING AND RECORDING UP TO 16 OBSERVATIONS OF CURRENT SPEED AND DIRECTION

By

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Summary

The paper describes a new solid state based current meter which can be programmed to measure up to 16 corresponding values of current speed and direction at programmable time intervals from 50 to 5000 seconds between each observations. The results can be read from digital display through the transparent pressure tube.

Introduction

During many phases of oceanographic and marine biological work and when fishing for certain species there is a need for an easy to use, lightweight and reliable instrument which can measure the current speed and direction as a function of time and as a function of depth.

Before the 1970 users of current meters could obtain single point measurements with the Ekman type current meter. This instrument used mechanical sensors as well as mechanical memories. The memory for current speed is made from wheels and dial, and the memory for direction is a 36 compartment tray which collects small metal balls being dispensed from a compass. The users of current meters also could (and still can) obtain thousands of measurements with much heavier and more expensive tape recorder based current meters (like f.exc. the Aanderaa Instruments RCM-type instruments).

In the first case the results are obtained in the field - at the expence of continuous attention during the experiments. In the second case the user gets his results after having sent the tapes to a computer ashore.

In practical field work there is often a need for a simple instrument which can take a small numbers of current speed and direction observations at specified time intervals and display the results at any time later in the field without needing a sophisticated readout devise or say a computer.

In 1977 Gytre and Sundby described a simple instrument which could measure one observation of current speed by accumulating the number of Savonius - rotor revolutions during an integration period Ti into a small solid state memory and measure one direction by clamping the compass needle of a compass by means of and applied magnetic field. By adjusting the integration time Ti to suit the rotor characteristic, the digital number could be made to directly show the current speed in cm/s. The results could be read directly through the transparent pressure tube. Start and read-commands were given via a magnet being held outside the instrument, thus enabling repeated use of the instrument without opening it - a major counter - measure against leakage.

The mechanical design of the instrument from 1977 is shown in Fig. 1. It consists of a transparent pressure tube with a rotor cage in the lower end. Inside the tube is an electronic card which contains a timer, detectors for rotor revolutions and for compass direction, and a digital display which is switched on on command from an externally held magnet.

The complete instrument weights around 1 kg. The mechanical design from 1977 has proved basically convenient in the field and has been little changed since. The mechanical design shown has also made basis for the new instrument being described in this paper.

In practical use the instrument proved to give reliable current speed readings, but not so reliable direction readings. The latter due to unsufficient mechanical changing when the instrument was exposed to mechanical shocks. The conclusions after having tested the 1977 - instrument were:

1) The compass must be improved.

2) The instrument should be able to record a modest number of observations at programmable intervals.

The phototype of an improved instruments having the same physical dimensions as the 1977 version has now been tested. Parts of the tests have been carried out at the Institute of Marine Research's new biological station in Austevold, west of Bergen.

Electronic basis for improvements

During the present decade the electronic industry has marketed several revolutionary products. One of these products, the solid state memory based on C-MOS low current components or on magnetic bubbles, is now gradually becoming suitable for storing information from oceanographic instruments.

The simplest memories (Flip-flops) have one bit of storing capacity. They can tell whether a logical "high" signal has occurred during an observation period or not. The most advanced memories can store thousands of bits for as long time as wanted. Fig. 2 shows the principle for a random access-type memory.

The information to be recorded must be available as a digital signal. On external "write"-command the information is forced into location no k, where k is the number in the address counter. The information in location no k can be retreived at any time later by a read-signal. This will bring the wanted information to the output terminals. By connecting the output to a display device using a transparent pressure tube, the user may see the recorded information with his own eyes without opening the instrument. The physical size of an electronic memory suited for storing from one to 4000 measurements is less than 10 cm^3, which makes possible the design of very compact instruments.

Compass description

Fig. 3 shows the principle for the improved compass design which has been made for the new current meter. The goal for this design has been to arrive at an electronic equivalent to the metal balls in the Ekman current meter - which enables the user to make a crude vector averaging observation. After each observation period up to 4 of 24 one bit memories are set. Each of these memories tell whether the current direction has been within the 15 degree sector which each of them representsor not.

Current speed is measured with a standard Savonius type rotor. The magnetic inpulses from the rotor are counted in a 2 stage BCD-counter. The total information from each observation period - which is to be recorded in the main memory - thus consists of 24 bits of compass information and 8 bits of current speed information, or a total of 32 bits.

Main memory

To enable the user to take a limited number of sequenced observations, a 16 position "First in - first out" (FIFO) - register has been selected. Following a start command (which is applied by means of a magnet) this memory stores the 16 first observations and neglects further commands until next reset. On repeated read commands - also applied with a magnet, the memory will present the observations in succession with the "oldest" or "first in" - observation being sent first out. Fig. 4 shows a block diagram of the complete instrument.

The current pulses come from the standard rotor which is made by Aanderaa Instruments. This rotor is being used in thousands of instruments and its properties need not be described here. To make the interpretation easy, the rotor revolutions are counted for time intervals of 50 seconds which give a number very close to the average current speed in cm/s.

The current pulses are detected by a magnetic detector through the instrument bottom. A combination of shining lamps show the average direction (resolution ± 7.5). The results are simply read through the transparent pressure tube and noted on a shematic like the ones shown on Fig. 5 and 6.

After having read the values, the instrument can be used again by simply passing a magnet outside the "start"-position. If reprogramming is necessary, the electronic unit must be pulled out from the pressure tube to enable a new setting of the program switch. The instrument is powered from 4 "penlight" cells which will run the instrument for several months.

Results

The instrument - in prototype version - has been used to take time series and to take profiles. Fig. 5 shows a typical result table for a time serial taken at one single depth. The programmable intervals available makes it possible to observe the current speed and direction for a period of up to appr. 20 hours.

Fig. 6 shows a typical result from a profiling from a small boat. The current meter was programmed to work with its shortest possible inter-recording time interval of 50 seconds between each reading. The instrument was kept in constant depth for appr. 1 minute and then successively lowered 1 metre at the time. Fig. 6 also illustrates the value of making several compass reading during the integration period. Scattered values of the compass readings simply mean that the instrument has moved to much due to waves and ship movements which again indicate that the observation is of no or very limited value.

Conclusion

The instrument is still in a evaluation phase. However, as the instrument described simply represents an automation of data collection from well known sensors, the data precision should be comparable to well established instruments. The much smaller dimensions of solid state current meters compared to tape recorder instruments make instruments like this one less expensive to make and easier to handle.

This particular instrument was designed for manual readout. If a separate readout unit is accepted, a storing capasity of appr. 4000 observation within the same physical instrument dimensions is possible. Such an instrument is already in design. Without doubt the future bubble memories will make it possible to store millions of measurements within the same volume as in this instrument - if so wanted.

<u>Reference</u>:

Trygve Gytre and Svein Sundby. A new instrument for simple observations of current speed and direction in the field. ICES C.M. 1977/C:23.

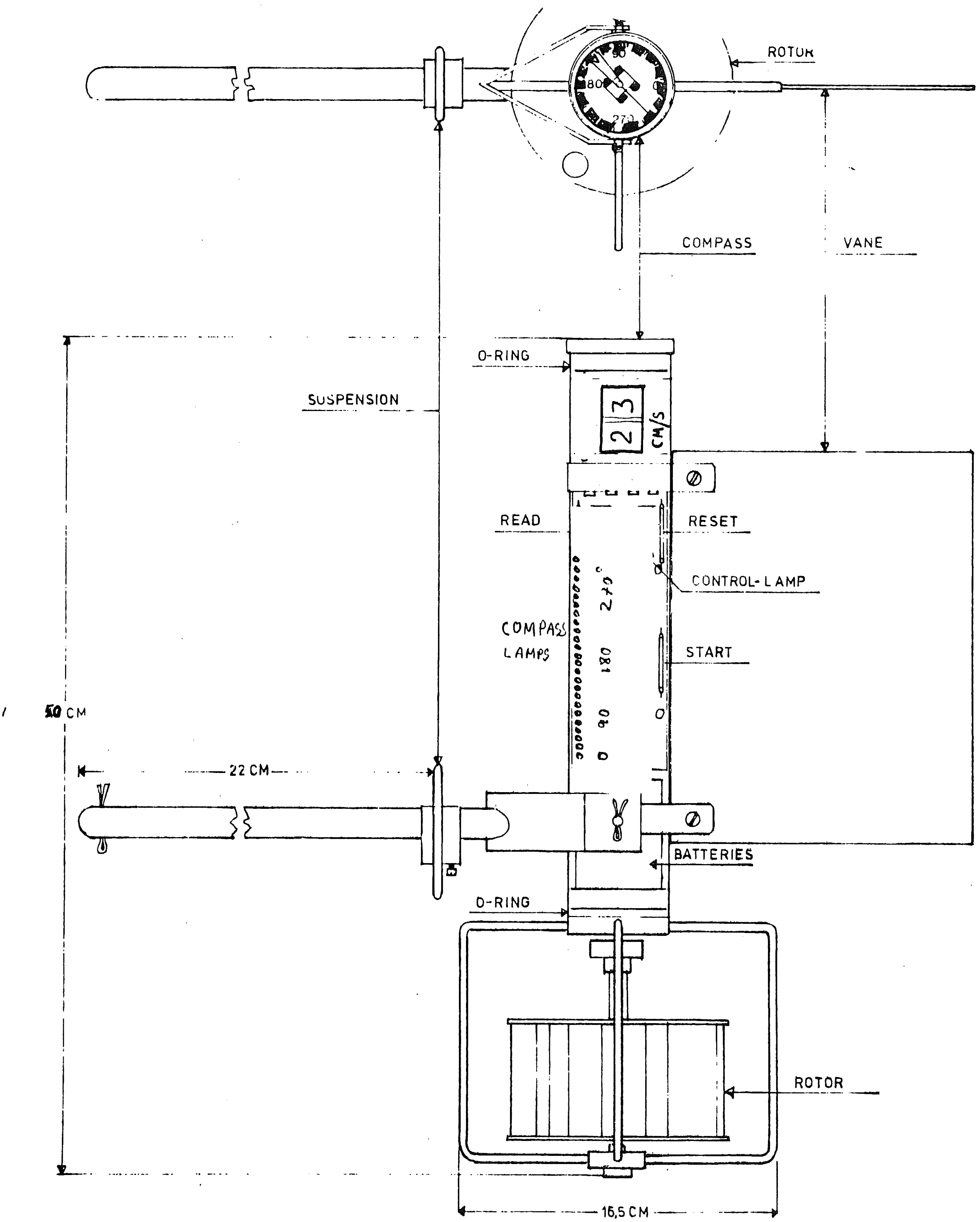


Fig. 1. Mechanical instrument design. Total weight: 1.2 kg.

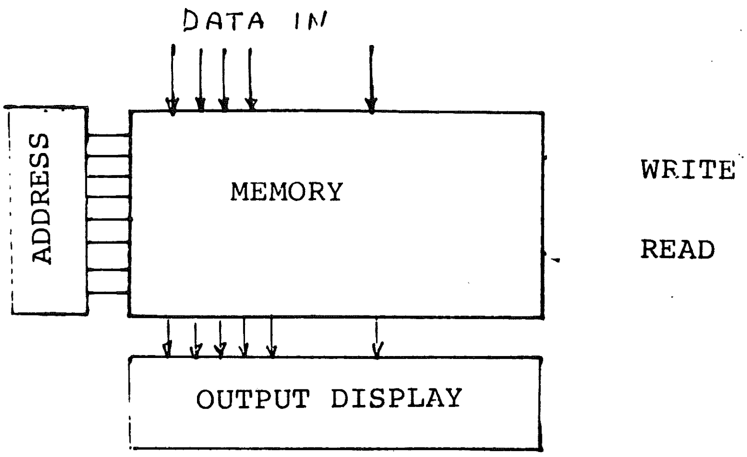
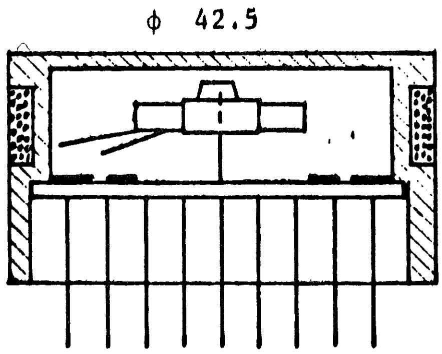


Fig. 2. Principle for RAM-type memory.



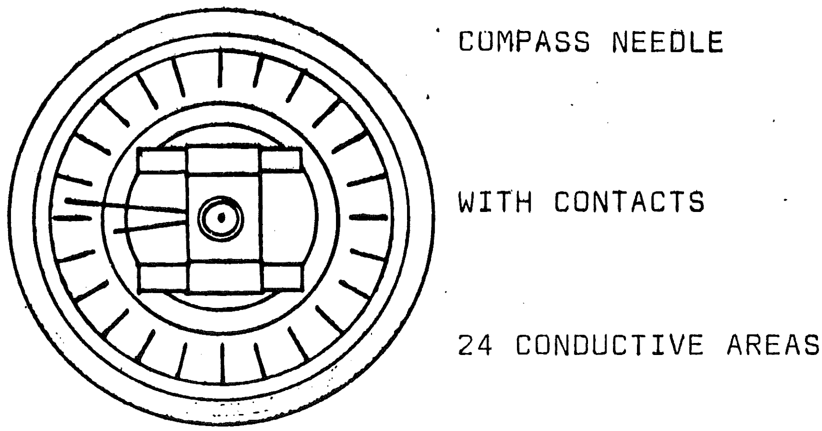


Fig. 3. Principle for 24 sector digital compass.

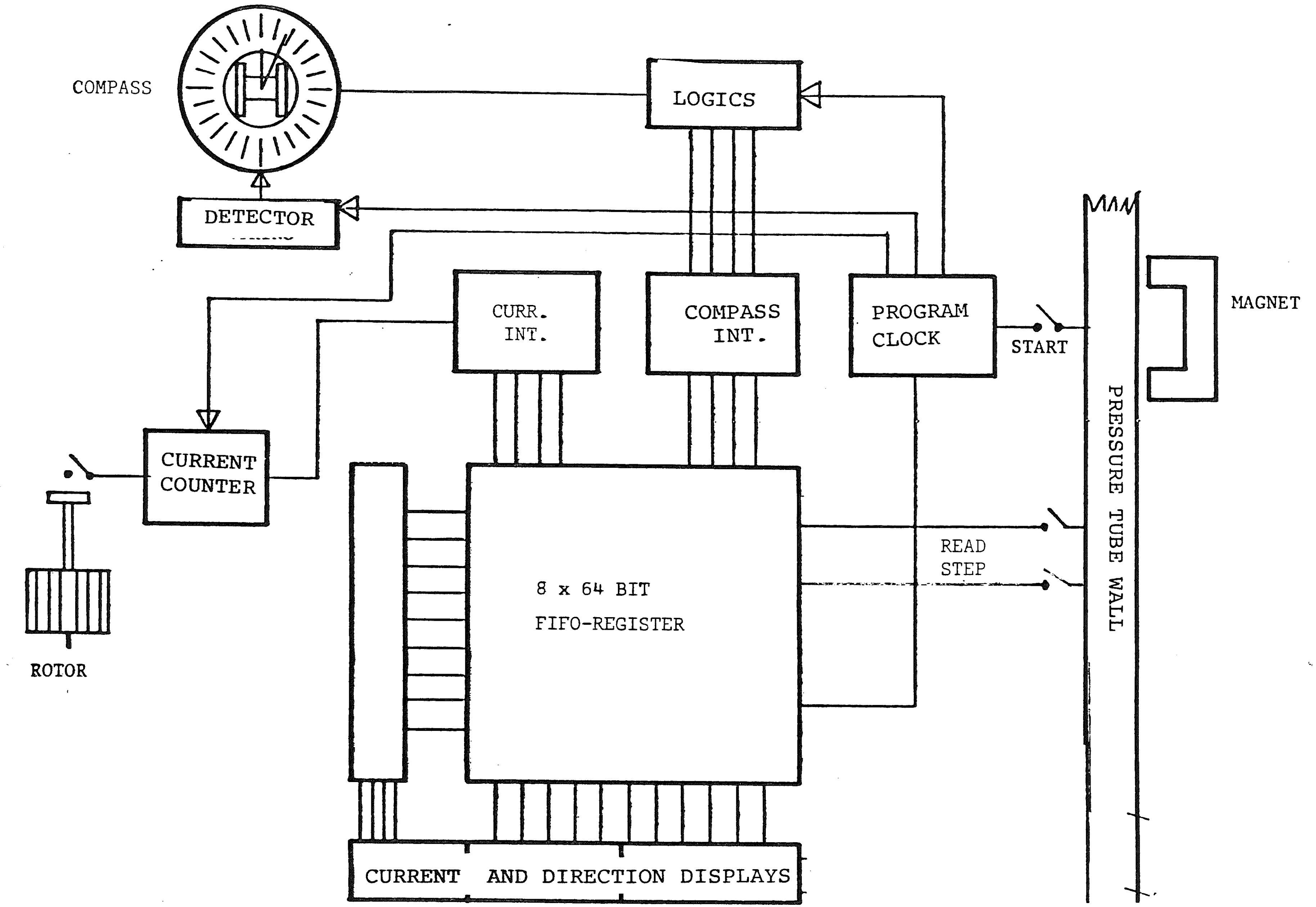


Fig. 4. Block diagram of complete instrument

STATION NO:	INSTRUMENT NO:	LOCATION NO:	INTERVAL: 100 SEC	START TIME JULY 16-79 1410	JOB NO:

OBSERVATION NO:	DEPTH M	CURRENT SPEED	DIRECTION 0	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	NOTES
1	2	2						x	x		x																
2	"	4					x	x	x																		
3	"	6							x	x																	
4	"	5									x	x		x	x												
5	"	6					x	x																			
6	"	10						x	x																		
7	"	6					x		x																		
8	"	8						x	x	x																	
9	"	5						x	x																		
10	"	7						x	x																		
11	"	7					x		x	x																	
12	"	2		x					x		x																
13	"	5				x	x																				
14	"	10						x	x	x																	
15	"	11					x	x																			
16	"	8			x	x																					

Fig. 5. Example of data from fixed position.

STATION NO:	INSTRUMENT NO:	LOCATION	INTERVAL: 50 SEC	START TIME AUG. 4- 79 1700	JOB NO:

OBSERVATION NO:	DEPTH M	CURRENT SPEED	DIRECTION 0	15	30	45	60	75	90	105	120	135	150	165	180	195	210	240	255	270	285	300	315	330	345	NOTES
1	1	20				x										x					x		x			
2	2	15	x				x								x					x						
3	3	5												x				x		x						
4	4	4		x										x	x											
5	5	8										x		x	x											
6	6	7											x		x	x										
7	7	8												x		x	x									
8	8	5													x		x	x								
9	9	5															x		x	x						
10	10	4															x	x								
11	11	5																x		x	x					
12	12	3																		x	x	x				
13	13	4																	x		x					
14	14	5																	x	x						
15	15	6																	x		x					
16	16	4																		x		x				

Fig. 6. Excample of a profling.