A C T A I C H T H Y O L O G I C A E T P I S C A T O R I A
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Fishing gear

NEW EQUIPMENT FOR MODEL RESEARCH STATION AT IŃSKO*

NOWA APARATURA DO BADANIA MODELI WŁOKÓW W STACJI BADAŃ MODELOWYCH W IŃSKU

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The purpose, range and manner of operation of a multi-sensor measurement system WSP-TRAWL has been described. The system is used at the Model Research Station at Ińsko for measuring parameters characterizing the geometry and drag of trawl models. The system is supplemented with photo and video equipment.

INTRODUCTION

Trawling is still of a considerable importance for the Polish sea fisheries. Therefore problems of trawl construction and operation play a significant role in teaching and research programmes of the Faculty of Marine Fisheries and Food Technology which educates cadres for the fisheries.

Experimental work in this field of technology calls for setting up special research facilities adjusted to the existing needs and technological-financial possibilities.

Practical experience accumulated during the above projects was made use of to set up, in 1971–1975, the Model Research Station at Ińsko (Kwidziński et al. 1985).

The Station was formally established in 1975 as a unit belonging to the Department of Fishing Techniques. The Station is situated by Lake Ińsko having numerous advantages for the research pursued, namely favourable hydrological conditions (mainly a high water transparency), elongated shape, easy access, and also picturesque landscapes.

The aims of the Station are:

—to carry out research-development projects in fishing techniques and trawl construction, with a due consideration to the needs of fisheries,

—to carry out practical training of students in fishing gear construction and exploitation,

—to demonstrate new technological achievements to fishing vessels officers.

Additionally, the Station serves as a diving base for the training of divers and for experimental work involving SCUBA diving.

* The equipment was produced as part of research project No. PB0781/S3/93/04 financed by the State Committeefor Scientific Research in 1993/1995.

Technological improvements in trawl designs, visible, among others, in the use of new, more resistant materials (DYNEEMA, DIOLEN) (Świniarski et al. 1995) and improvements of their hydrodynamic properties, result in a considerable increase of their size. This is not without impact on the method of testing their models. Correct representation of the shape and forces depening on the hauling regime need an increased number and range of trawl parameters to be measured.

The above factors as well as progress in microelectronics prompted the work on a modern system for measuring large trawl models, tested in a lake of the Model Research Station at Ińsko (multisensor measuring system "Trawl" - WSP TRAWL).

The research was carried out, i.a., within the framework of a programme "Determination of geometric and drag characteristics of trawl from model studies" grant no PBO781/S3/93/04. The research resulted in a designing and construction of WSP-TRAWL, a multisensor measuring system.

WSP-TRAWL is the result of longterm collaboration in theoretical and experimental work between scientistists from the Department of Fishing Techniques, University of Agriculture in Szczecin, and the Acoustics Faculty of the Gdańsk Technical University (Świniarski et al. 1994, Marszal and Kilian 1983).

The design of the system makes it possible to use it, after the necessary adjustments, for measuring and controlling the operation of trawls on small trawlers (such as Baltic cutters).

STATION'S FACILITIES

Measurement platform

Trawl models tested are towed by a specially designed catamaran-type measurement platform (Fig. 1).

The platform is a motorised (2×77 kW), two-hull craft (a catamaran), 11.7 m long, 8.3 m wide, with displacement of 83.4 kN. The maximum speed is 4.5 m/s; the maximum tractive effect is about 6 kN at the 3 m/s speed. The platform's construction makes it possible to tow a trawl model in two ways:

1. The main body of the trawl, supported by two beams in the bow is towered underneath the platform. The trawl mouth opening is pro-set and can be adjusted within the ranges of 0.5–7.6 m and 0.25–6.5 m horizontally and vertically, respectively. The model can be directly viewed in motion after removing the deck boards. The model resistance is measured with electric force gauges, mounted on top of the beams.
2. A model with its rigging (towing ropes, otter boards, weights) is towed behind the stern on warps put out hauled in by means of a hydraulic winches. In this case, the process of trawling used on board stern trawlers is being modelled (Świniarski et al. 1987).

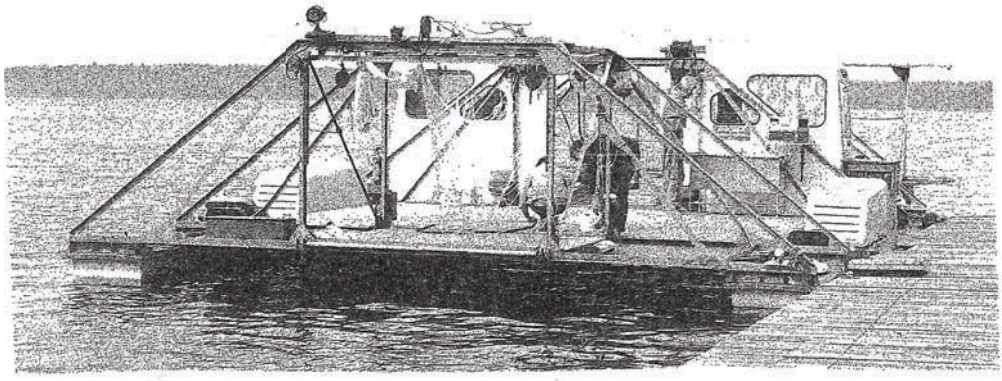


Fig. 1. The catamaran-type measurement platform

PURPOSE AND RANGE OF APPLICATIONS OF WSP-TRAWL

The aim of the system is to measure the magnitudes characterizing the geometry and drag of pelagic and bottom trawl models and individual trawl elements (Świniarski et al. 1995). The following main magnitudes were measured:

—trawling speed in relation to water measured with an A.OTT screw log, with electronic processing; measurement range: 0.1–5.0 m/s, error smaller than 1%, with a possibility of selecting a programmed screw type (V—[m/s]);

—stretching forces of warps, measured with dynamometers (submerged) with a range of 1 500 N or 10 000 N; measurement error smaller than 1% (R, R1, R2, R3, R4—[N]);

—depth of model trawl headline/footrope (distance from the water surface), measured with a pressure sensor, range up to 50 m, accuracy of 0.1 m (ZP—[m]);

—distance of trawl model headline/footrope from the bottom, measured with an ultrasonic sensor (echo sounder principle), range up to 50 m, accuracy of 0.1 m (ND—[m]);

—trawl vertical opening, measured with ultrasonic sensors, range up to 50 m, accuracy of 0.05 m (AB—[m]);

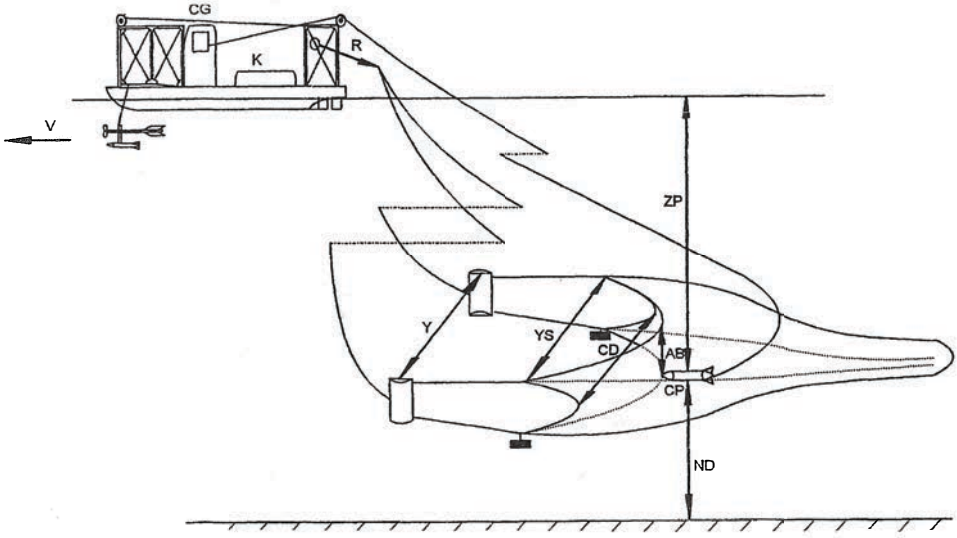
—trawl horizontal opening, measured with ultrasonic sensors, range up to 50 m, accuracy of 0.05 m (CD—[m]);

—opening between otter boards, measured with ultrasonic sensors, range up to 50 m, accuracy of 0.05 m (Y—[m]);

—opening between wing tips, measured with ultrasonic sensors, range up to 50 m, accuracy of 0.05 m (YS—[m]);

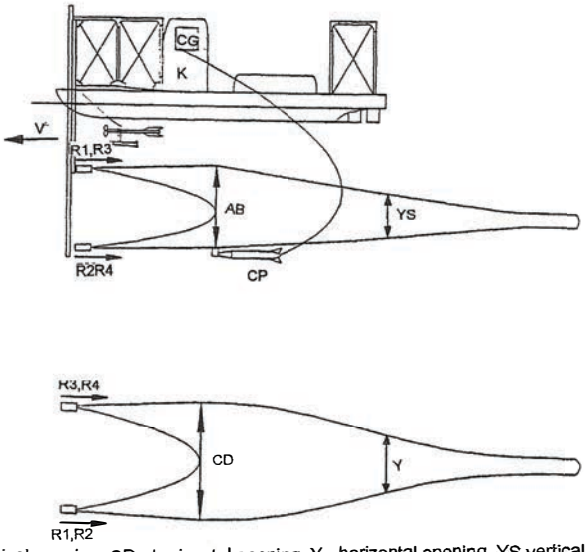
—additional measurements of two distances between two pairs of converters Y and YS, range up to 50 m, accuracy of 0.05 m (YX, YSX—[m]).

Figure 2 presents an example of a measurement variant of a pelagic trawl model hauled by warps. Figure 3 shows a measurement graph of the belly of a pelagic trawl model hauled on outriggers with an adjustable distance. Pairs of sensors Y and YS are placed in the trawl belly. By moving them into selected positions, its shape may be accurately measured.



V - velocity; K - catamaran; CG - board control unit; CP - underwater conrol unit; ZP - grountrope depth; ND - distance of grountrope from the bottom; R - drag force; Y - opening between trawl doors; YS - opening between wing tips; CD - horizontal opening; AB - vertical opening.

Fig. 2. Measurement diagram of WSP-TRAWL on warps



AB -vertical opening, CD - horizontal opening, Y - horizontal opening, YS vertical opening, R1, R3 - upper forces, R2,R4 - lower forces, R1, R2 - forces , left side, R3, R4 - forces, right side, K - catamaran, CG - onboard control unit, CP - underwater control unit, V - velocity.

Fig. 3. Measurement diagram of WSP-TRAWL on outriggers

SYSTEM STRUCTURE

Three main elements make up the measuring system:

—processing unit on board the research vessel (data recording and processing computer);
—onboard measurement control unit with a set of sensors;
—underwater measurement control unit with a set of sensors.

A block diagram of the system is shown in Figure 4.

Measurement control units are independent blocks of microprocessors. They control the measurements, preliminarily process and compress measurement data, and communicate with the central point. Each control unit is equipped with:

—analog-digital converter with an analog multiplexer;
—timers enabling measurement of signals in the sensors with a frequency or pulse output;
—binary (digital) output and input ports, enabling the control of the sensors;
—series transmission port RS 232.

The following magnitudes are measured in the on board control unit:

—speed of the vessels, by means of the timer summing up pulses from the screw log;
—forces in trawl warps, by means of tensometric converters of force into 4–20 mA standard current, current/voltage converters, a multiplexer, and an analog-digital converter.

The onboard control unit is also equipped with an ultrasonic transmitter and converter, which serve to measure the distance from the vessel to the tested trawl model.

The following magnitudes are measured in the underwater control unit:

—depth of headline/footrope, by means of a tensometric pressure sensors and an analog-digital converter;
—distance by means of a set of ultrasonic converters of transmitting and receiving systems of the transmitter and receiver with multiplexers, control system, and timer.

Distance measurements are made in a hydroacoustic system of a range-finder transmitting data to the central computer (with the exception of the distance to the bottom), by measuring the time elapsed from the moment of transmitting the ultrasonic pulse by the transmitting converter to the moment of its reception by the receiving converter. Distance measurements are made by means of one transmitter and one receiver, operating in a single frequency of 60 kHz.

OBSERVATIONS AND PHOTOGRAPHIC AND VIDEO DOCUMENTATION OF TRAWL MODELS

There is diving eqiupment and underwater cameras at the station and its staff are trained divers. The photo equipment consists of two water-tight cameras with a short focal distance and a water-tight video camera (for filming at a depth of 100 m) with a "fish-eye" lens, and two 50 W halogen lamps.

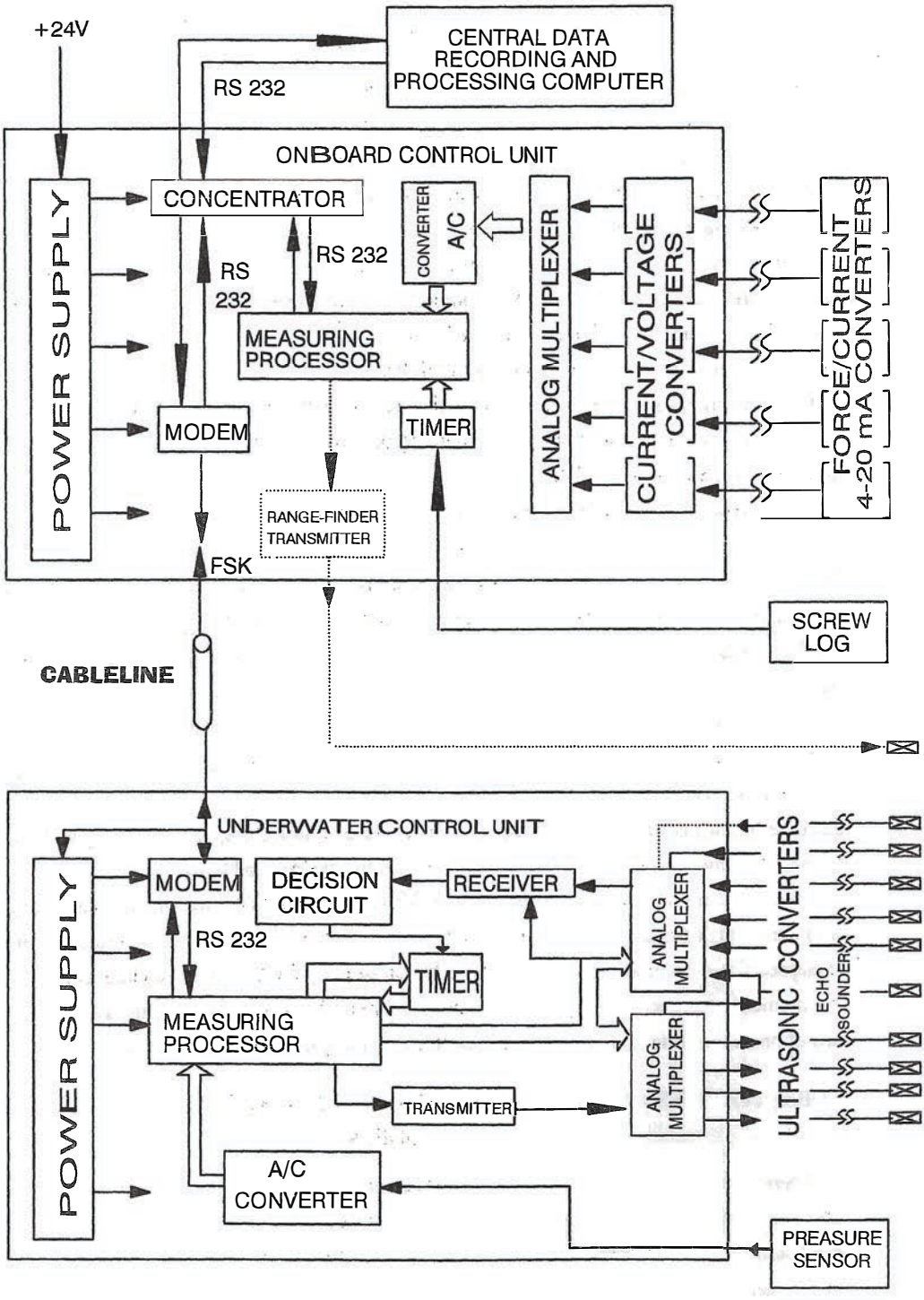
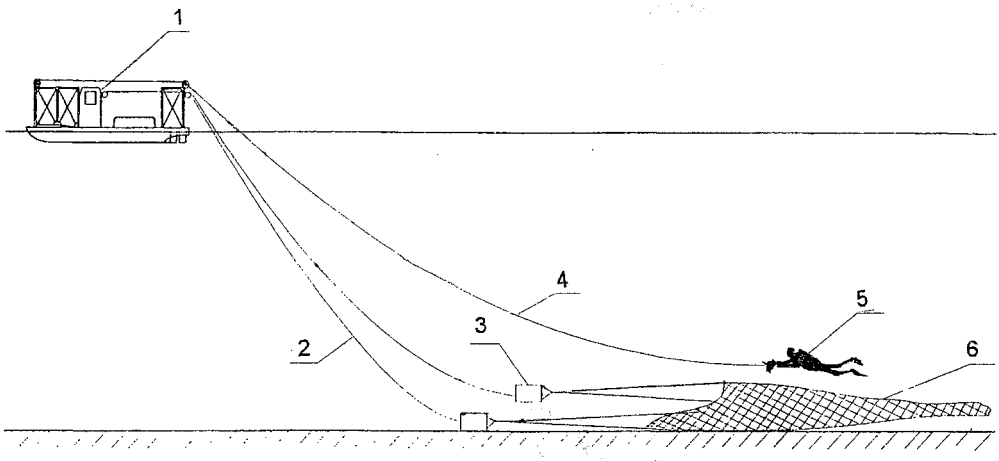


Fig. 4. Block diagram of TRAWL measurement system

Preliminary observations of the model hauled on outriggers are made from a measurement platform. Detailed observations of the shape of the entire model hauled by warps and its individual elements are performed by a diver hauled together with the model; he also takes underwater photographs and makes video films (Fig. 5).



1 - catamaran, 2 - warp, 3 - trawl door, 4 - tow/phone cable, 5 - driver with aquaplane, 6 - trawl model.

Fig. 5. Underwater observation of trawl model by driver

Photographs in Figs 6, 7 and 8 show the shapes of trawl model elements studied.

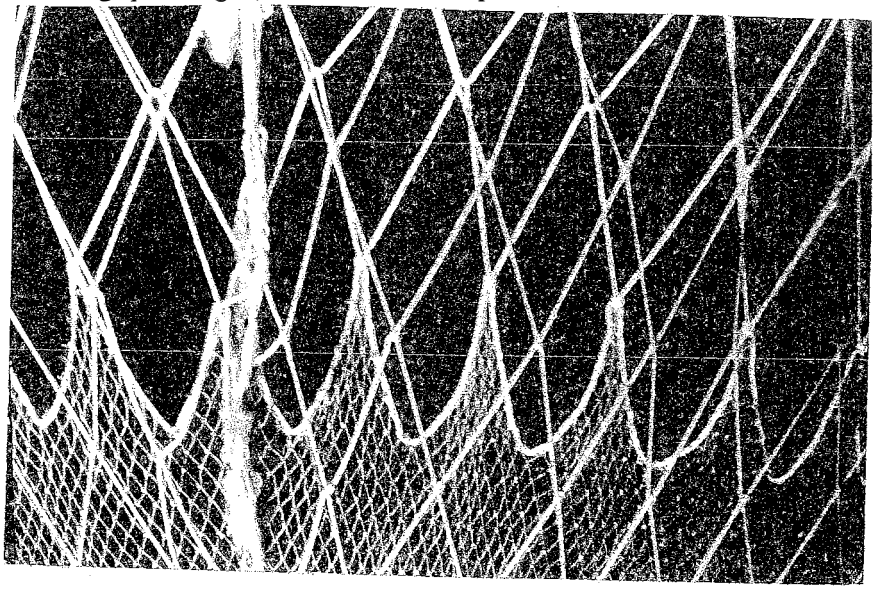


Fig. 6. Fragment of a belly

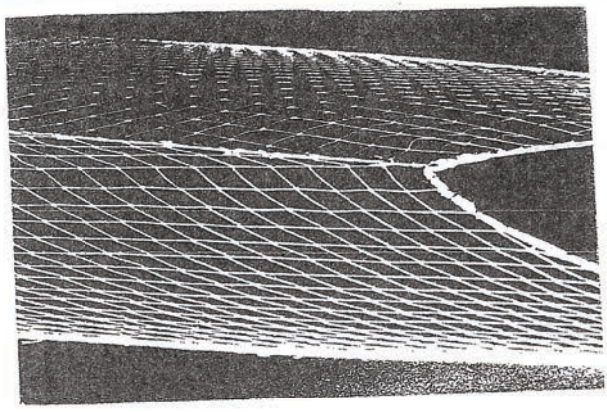


Fig. 7. Demersal trawl wing

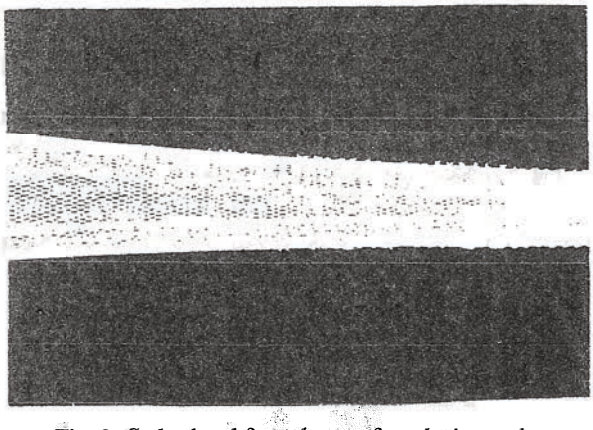


Fig. 8. Codend and frontal part of a pelagic trawl

DATA PROCESSING

Measurements are continuous; the data are fed, via underwater and onboard transmitters and cable systems, to the onboard computer to be displayed on the screen and in 5-line data blocks. The screen simultaneously displays 3 data blocks and the most recently marked block. Marking the blocks which contain important data sets facilitates their identification when scrolling through a body of data stored in the computer memory.

Data processing begins with selection of appropriate data blocks; these are subsequently imported to an Excel spreadsheet, statistically treated, and printed out as tables pertinent to a given tow or as graphs showing relationships between the variables analysed. Table 1 is an example of a computer output of data describing characteristics of a model.

Table 1

Operating parameters of model pelagic trawl net 2 520 m in circumference, scale 1:10, DYNEEMA

	t (s)	V (m/s)	ND (m)	ZP (m)	AB (m)	CD (m)	YS (m)	Y (m)	R (N)
01	0246	2.17	10.32	13.66	13.43	13.92	0.00	24..98	4682
01	0247	2.16	10.29	13.46	13.43	13.92	0.00	25.01	4781
01	0248	2.17	9.87	13.41	13.27	13.94	0.00	25.03	4759
01	0249	2.18	9.84	13.41	13.48	13.93	0.00	25.09	4792
01	0250	2.18	10.77	13.46	13.45	13.92	0.00	25.10	4781
02	0358	2.07	0.00	13.66	13.29	14.04	0.00	25.38	4518
02	0359	2.07	7.80	13.56	13.25	14.05	0.00	25.41	4375
02	0360	2.06	6.79	13.66	13.26	14.08	0.00	25.40	4375
02	0361	2.05	7.87	13.71	13.39	14.09	0.00	25.38	4430
02	0362	2.05	6.77	13.71	13.50	14.09	0.00	25.30	4408
03	0439	2.04	6.06	14.85	13.62	13.98	0.00	25.22	4397
03	0440	2.04	0.00	14.80	13.63	13.95	0.00	25.12	4288
03	0441	2.05	6.09	14.80	13.63	13.97	0.00	24.88	4233
03	0442	2.06	0.00	14.85	13.52	13.98	0.00	24.69	4266
03	0443	2.07	7.79	14.85	13.51	13.98	0.00	24.59	4299
04	0640	1.82	5.18	20.79	14.37	13.52	0.00	24.20	3717
04	0641	1.82	5.05	20.84	14.26	13.57	0.00	24.09	3674
04	0642	1.83	5.10	20.84	14.33	13.53	0.00	24.11	3717
04	0643	1.83	5.11	20.84	14.53	13.50	0.00	24.13	3674
04	0644	1.81	5.74	20.84	14.48	13.47	0.00	24.13	3707
05	0698	1.89	10.75	19.65	14.08	13.51	0.00	24.62	3860
05	0699	1.90	9.73	19.65	13.98	13.48	0.00	24.66	4025
05	0670	1.90	10.69	19.65	14.02	13.47	0.00	24.73	3904
05	0671	1.92	10.76	19.60	13.91	13.51	0.00	24.80	3959
05	0672	1.90	11.11	19.65	14.08	13.51	0.00	24.77	3783

Rigging in natural scale
Length of warps—500 m,
Trawl door—9.5 sq.m. double foil,
Bridles—163.5 m + extension of bottom bridle—5 m,
Legs—132.5 m + extension of bottom leg—2 m,
Main sinker—1 500 kg,
Sinkerspe—800 kg on prountrope (chain),
Flexikites—5 pcs × 2 sq.m.,

t—time; V—velocity; ND—distans of grountrope from the bottom; ZP—grountrope depth; AB vertical opening; CD—horizontal opening; Y distance between trawl doors; R—drag force.

In 1994, a research project "Gigantic trawls for harvesting scattered pelagic fish stocks in the open ocean" nr 5 564 893c/1585 was carried out by the Department of Fishing Techniques. The new equipment used to test models of gigantic trawls proved fully applicable. The 1:10 models reached 16 and 14 m vertical and horizontal opening, respectively, the board-to-board distance being 25 m.

To compare the structural, geometric, and drag-related characteristics of trawls, models of trawls with shortened (Fig. 9) and full (Fig. 10) wings and with rope bellies with rhomboid (Fig. 10) and hexagonal (Fig. 9) meshes were tested. Shortening of the wings resulted in the vertical and horizontal gap increase by about 5 and 4%, respectively, the drag per 1 m^2 belly opening being reduced by about 6 %. Rhomboid meshes used instead of hexagonal ones have slightly (by about 2%) worsened the trawl geometric-resistance properties.

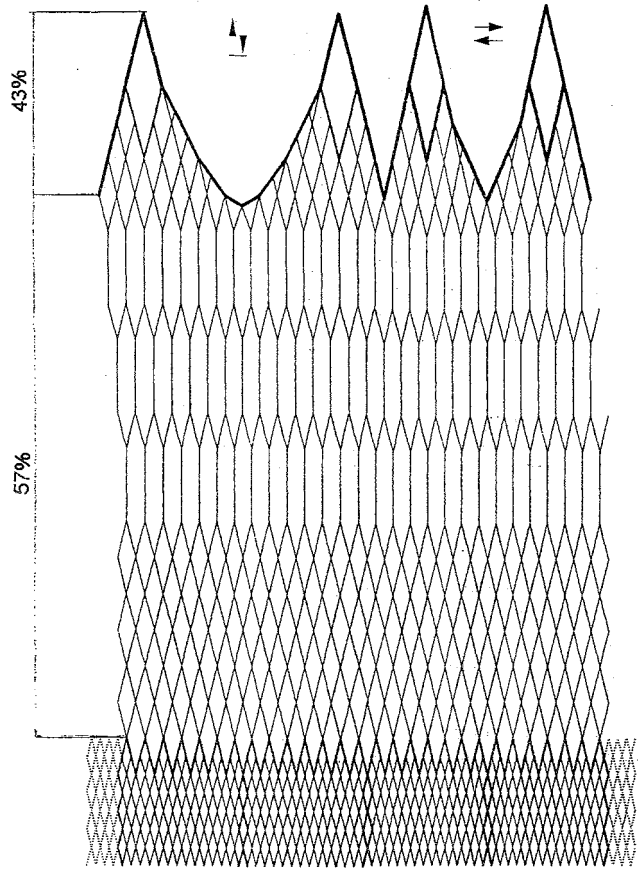


Fig. 9. A pelagic trawl with shortened wings and part of the rope belly with hexagonal meshes

In 1995, the measuring system will be used to test trawl models on board SNB-AR1, the Agricultural University's research boat operating in the Baltic.

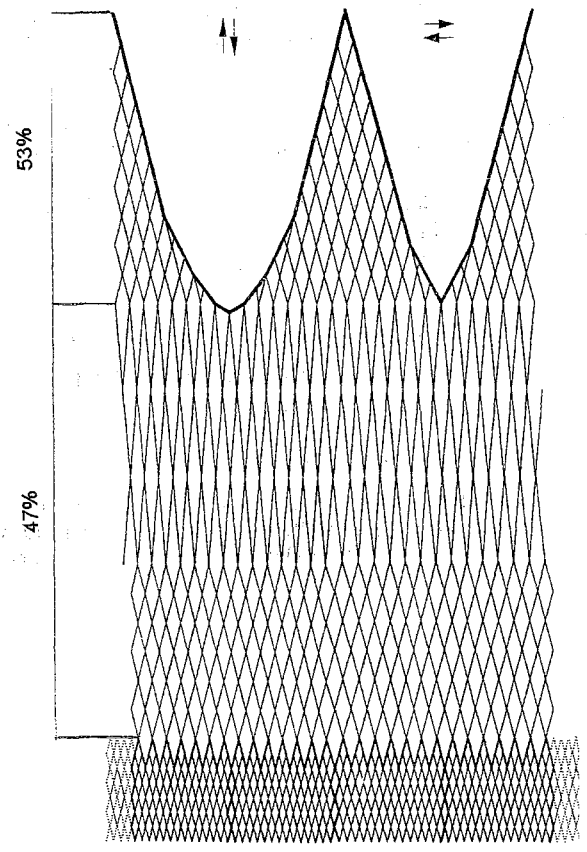


Fig. 10. A pelagic trawl with long wings and part of the rope belly with rhomboid meshes

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NOWA APARATURA DO BADANIA MODELI WŁOKÓW W STACJI BADAŃ MODELOWYCH W IŃSKU

STRESZCZENIE

Opisano cel, zakres i sposób działania wieloczujnikowego systemu pomiarowego „TRAWL" (WSP-TRAWL). System jest stosowany w Stacji Badań Modelowych w Ińsku do pomiaru wielkości charakteryzujących geometrię i opór modeli włoków. W skład systemu wchodzi również aparatura fotograficzna i filmowa.

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