International Council for the Exploration of the Sea

C.M.1977/B:2
Gear and Behaviour Committee

REPORT OF THE WORKING GROUP ON RESEARCH AND ENGINEERING ASPECTS OF FISHING GEAR, VESSELS AND EQUIPMENT

Convenor and Rapporteur : E.J. de Boer,
Netherlands Institute for Fishery Investigations,
IJmuiden - The Netherlands

Meeting time and place : 18 and 19 April, 1977
Hamburg - Federal Republic of Germany

Terms of reference : C.Res.1976/2:20 (a) the Working Group on Research on Engineering Aspects of Fishing Gear, Vessels and Equipment, convened by Mr. E.J. de Boer, should meet to discuss the technical aspects of fishing gear, fishing vessels and fishing methods, electrical fishing, and the swept volume method for fishing effort measurement.

*) General Secretary, ICES, Charlottenlund Slot, 2920 Charlottenlund Denmark.

PARTICIPANTS

Belgium

G. van den Broucke	Fisheries Research Station - Ostend

Canada

G. Brothers	Department of Environment Industrial Development Branch St. John's - New Foundland
W.W. Johnson	Department of Environment Industrial Development Division Technological Branch - Halifax
P.J.G. Carrothers	Department of Environment Biological Station - St.Andrews (N.B.)

France

G. Kurc	Institut Scientifique et Technique des Pêches Maritimes - Nantes
J. Prado	Institut Scientifique et Technique des Pêches Maritimes - Lorient

Fed. Republic of Germany

T. Mentjes	Institut für Fangtechnik - Hamburg
W. Horn	" " " "
R. Steinberg	" " " "
E. Dahm	" " " "
K. Lange	" " " "

Netherlands

B. van Marlen	Netherlands Institute for Fishery Investigations - IJmuiden
T. Lantau	" "
J.G. de Wit	" "
G.P. Boonstra	" "
E.J. de Boer	" "
A. Verbaan	" "
S.J. de Groot	" "

Norway

A.K. Beltestad	Institute of Fishery Technology Research - Bergen
L. Brunvoll	Institute of Fishery Technology Research - Bergen
A. Endal	Institute of Fishery Technology Research - Trondheim
S. Olsen	Institute of Fishery Technology Research - Bergen
W. Reinertsen	Institute of Fishery Technology Research - Trondheim
A. Fernö	Department of Fisheries Biology University of Bergen - Bergen
L. Karlsen	Institute of Fishery Technology Research - Bergen

<u>Portugal</u>	
F.F. Lima	Secretaria de Estado das Pescas, Serviço de Têchnicas de Pesca - Lisbon
<u>Sweden</u>	
J.K. Lunde	Chalmers University of Technology-Goteborg
<u>United Kingdom</u>	
D.N. MacLennan	Marine Laboratory - Aberdeen
J.J. Foster	" " "
J.F. Foster	White Fish Authority - Hull
M. Hatfield	" " "
<u>U.S.S.R.</u>	
A.I. Trechev	All-Union Research Institute of Marine Fisheries Oceanography (VNIRO) - Moscow
Saburenkov	All-Union Research Institute of Marine Fisheries Oceanography (VNIRO) - Moscow
<u>F.A.O.</u>	
C. Nédélec	Fishery Industries Division - Rome
J. Schärfe	" " " "
<u>Special Guest</u>	
A. von Brandt	Former Director Institut für Fangtechnik - Hamburg

AGENDA

1. Progress reports

2. Presentation of papers

   2.1 Experimental shrimp sorting trawl project (preliminary report 1976).

   2.2 An automatic feeding system for the rotary shrimp sieve.

   2.3 The nature of trawl-net drag.

   2.4 Model tests with otter boards of new design.

   2.5 Wind tunnel tests on otter boards.

   2.6 Calcul des differences longueurs dans un chalut à cordes.

   2.7 Review of the Netherlands' Investigations into a pelegic rope trawl.

   2.8 Further experiments with sorting panels in prawn trawls.

   2.9 Selectivity experiments with topside chafers and round straps.

   2.10 Model testing of fishing vessels in open waters.

   2.11 Performance trials on a Scottish purse seiner.

   2.12 Expedition to the Antarctic 1975/76 by the Federal Republic of Germany.

   2.13 Shrimp midwater trawl development 1976, Gulf of St. Lawrence.

PROGRESS REPORT - Agenda item 1

Objective of the progress report is to inform the participants about recently started and planned activities by member countries in the fields of gear technology and vessel development.

BELGIUM

- Further experiments with a semi-pelagic net on the west coast of Ireland.
- Catching experiments of sole (Solea solea) and shrimps (Crangon crangon) using electric stimulation.
- Further experiments to catch round fish species with a beam trawl having an increased vertical netopening.
- Testing different types of gill nets for catching round fish species and sole.

CANADA

Activities of interest are based in St. John's, Newfoundland Halifax, St. Andrews, Quebec and Vancouver.

- Shrimp-beam, otter and separator trawls are being investigated on both coasts to reduce the by-catch of smelt and juvenile redfish and to extend the fisheries. A variable-dept sonar is being developed for shrimp detection.
- Acoustic methods for fishery resource inventory are being developed jointly in Halifax, St. John's and St. Andrews and technological work on complementary trawl sampling techniques is being initiated in St. Andrews.
- Purse-, drum-, stern-, and Scottish-seine and set gill-net techniques are being developed for the smaller, inshore vessels in Newfoundland, both for pelagic and demersal species, to increase the versatility and viability of the local industries.
- A system for using net slings to land fish from inshore, decked vessels has been developed in Newfoundland to improve fish quality and reduce the time and effort at dock-side.
- Trials with round, cambered, trawl doors in the Pacific are very promising, showing good handling characteristics and spreading force. Modifications to elongate the doors vertically will be tried this year.

FRANCE

- Continuation of development work on a four-panel semi-pelagic trawl which was tested when fishing both on and off the bottom.
- Experimental fishing for shrimps (Pandalus borealis) in the Greenland area with a high-headline trawl on board a large commercial trawler.
- Participation in a cruise with a Russian research vessel; objective of the cruise was to test different types of bottom, midwater and semi-pelagic trawls.
- Pair trawling experiments with two 400 h.p. inshore vessels fishing for sprat, mackerel and sardine using a net with very large meshes (16 metre stretched) in the front part of the net.
- Research into the influence of the length of the codend on the selectivity when fishing for hake.
- Continued research into the sinking speed of tuna purse-seines. During tests with a 140 metre deep (stretched) purse-seine a depth of 90 metres was reached with an average sinking speed of 11 m/min.

FEDERAL REPUBLIC OF GERMANY

- In close cooperation with the deep-sea and coastal fisheries the work by the Institut für Fangtechnik to improve rope trawls was continued. A suitable method was found to calculate the construction of the rope sections of such trawls.

Rather problematic, however, was the selection of the most appropriate rope material and the construction of the ropes. By numerous field experiments some possibilities for the solution of these problems could be found. This is of special importance, because rope trawls are more and more frequently used in the German fisheries.

- During the rope trawl trials also a trawl equipped with large meshes (1600 mm) instead of ropes in the fore-net was tested. Although the towing resistance of the two trawl versions did not differ much, the rope trawl proved to be more suitable, because on an average the catches were much bigger. Furthermore, the large-meshed trawl could not so easily be handled and repaired.
- Investigations were carried out in order to improve different types of otterboards. For this purpose, tests were made by means of wind-tunnel tests, model tests (scale 1 : 4) and field experiments with doors of normal size. Especially several constructional details of the spherical otterboards could be improved. This type of otterboard was shown to be suitable both for midwater trawling and bottom trawling under difficult conditions.
- In 1976 the model experiments in scale 1 : 4 were conducted for the first time in the area of Bornholm. Compared with the western part of the Baltic, where these experiments have been performed since 1964, in this area the underwater visibility was much better. Besides, jelly-fish which may hamper such trials to a large extent are not as abundant as in the western Baltic. The results of these experiments are summarized in two films.
- In cooperation with captains of the deep-sea fishing fleet further model tests were carried out in the flume tank at Hull. During these tests the effects of changes in the rigging of different trawls have been demonstrated. The well-known disadvantage of such experiments with models in scale 1 : 10 to 1 : 30 is that the results of measurements are not fully applicable to trawls of normal size.
- Calculations were made of the dynamic load of trawls under different conditions.
- In order to facilitate the substitution of gear suitable for catching different species, the principle of "unit" construction was applied in the design of trawls.
- Experiments with electrified beamtrawls for catching flatfish were continued in the German Bight. As in 1975, one of the trawls of the double-rigged beam trawler was electrified. From this gear all tickler chains except one were removed to reduce the weight of the gear. The average weight of the soles caught by the electrified trawl was about 45% higher than the soles caught in the conventional rigged (heavy) gear. Meanwhile, the length and amplitude of pulses most suitable for the capture of soles are almost sufficiently known, so that in the near future this method might be introduced into the commercial fisheries.

- First attemps made to collect selectivity data for Icelandic saithe by means of a 180 ft bottom trawl, failed due to the fact that at the time of the experiments (Sept/Oct. 1976) only large fishes could be caught, which were outside of the selection range of the 155 mm (polyamide) codend used in these trials. However, there is some indication that the selection factor for saithe may be approximately 3.9. The experiments will be repeated in May 1977.
- Also in Sept/Oct. 1976 the problem of meshed fish in the Icelandic redfish fishery was studied. It was found that, under the present conditions, the commercial fishery will not be handicapped by a large number of redfish entangled in the codend meshes. On an average, the amount of fish meshed by the 135 mm codend (enforced by Icelandic regulations for catching redfish), did not exceed 0.5% of the total redfish catch (codend plus cover catch in numbers). This favourable situation, however, may change completely, when relatively large-sized redfish of more than 40 cm in length should become more abundant in the Icelandic redfish stocks.
- As to fish behaviour in relation to fishing gear, the investigations concentrated upon blue whiting. Gaps in the knowledge of seasonal differences in the behaviour of this species could be filled.
- Frequently it has been observed that the elasticity of midwater trawl netting yarns is decreasing with increasing duration of trawling. The reasons for this phenomenon are unknown. Tests were made to find out the causes, but definite results are not yet available.
- In the field of freshwater fisheries, some effort was spent to introduce trawls as a means to rationalize the exploitation of fish stocks especially in lakes. In addition, the Institut für Fangtechnik participated successfully in the prosecution of the EIFAC-Intercalibration-Exercise in Finland.
- Much attention was paid to make full use of the data collected during the German Antarctic Expedition 1975/76. Now the Institut für Fangtechnik is involved in the preparation for the second cruise which will take place in the Antarctic season 1977/78. The experience gained during the first cruise will be utilized for further improvement of those krill trawls and echo sounders which proved most suitable under Antarctic conditions.

NETHERLANDS

- The technical performance data of a 2700 h.p. freezer stern trawler collected during the 1975 herring season in the Hebrides area were analysed.

- Experiments with a rope trawl derived from a 436 x 40 cm meshes (stretched) circumference midwater trawl were continued. Much attention was paid to the geometry and the behaviour of the rope trawl in comparison with the "meshed" trawl. In an effort to obtain a bigger netopening the design of the rope part of the trawl was changed. However, the results with these modified versions of the rope trawl were very disappointing. It was noticed that compared with the original midwater trawl the rope trawl was under the same conditions at a far deeper position in relation to the Süberkrüb-doors. Efforts were made to decrease this distance between trawl and doors by only replacing the meshed webbing of the lower and side panels of the original midwater trawl by ropes (paper 2.7).
- The work in the field of electric fishing remained directed to improve the selectivity when catching flatfish, eel and shrimp. Comparative fishing trials were carried out with a double-rigged beam trawler fishing for flatfish (sole and plaice) using electric stimulation.
- The development of an automatic feeding system for the rotating shrimp grader was finalized. The catch is dumped in tanks filled with seawater. A conveyor belt transports the fish and shrimps gradually from the tanks to the rotating sieve. During this transport the crew can collect the consumption sized fishes from the belt. Inside the rotating drums of the grader fish and shrimps are protected against damage by running and spraying seawater, so the discard pass overboard after having been out of the seawater for only a very short time. Moreover, this equipment has the added advantage that the labour is considerably reduced (paper 2.2).
- Research into the hydraulic dredging of mussels has continued. In order to minimize disturbance of the seabed and to limit the contamination of the mussels with sand and silt the suction head is improved. Hydraulic transport has been investigated when dumping mussels and mussel seed on the culture area. It is noticed that damage to the mussels and mussel seed has considerably reduced.

<u>Norway</u>

- The basic studies on long lining were continued. In particular the influence of hook shape and distance of the hooks was investigated.
- Selectivity experiments were carried out with a monofilament long line.
- On board an inshore vessel a mechanized gear handling system was tested.
- Field tests with an hydraulic operated gill net drum were carried out. The gill net was fitted with a new type of float line suitable for this type of operation. Encouraging results were reported.

- Commercial trials with deepsea traps showed disappointing results.
- A 75 ft vessel was fitted out for Scottish seining in the North Sea.
- Selectivity experiments with topside chafers and round straps in the Barents Sea (paper 2.9).
- Experiments with sorting panels in prawn trawls (paper 2.8).
- Very promising results were achieved fishing for blue whiting with a trawl constructed of large meshed webbing in the front panels.
- Little progress was made in the development of the integrated trawl instrumentation system.
- Development of a mechanized gear handling system for inshore purse-seining operations.
- A design was made of a purse-seine for catching saithe with hexagonal shaped meshes.
- A 85 ft vessel for automatic long-line operations was designed. With a complement of 10 persons this vessel can shoot and haul 24.000 hooks per day.
- A 70 ft combination trawler/purse-seiner was designed.
- The resistance data of fishing vessels collected by F.A.O. were re-analysed because nowadays beamier vessels are required for reasons of automation and mechanization of gear handling and fish processing operations.

Sweden

For information, the research and development in the fields of fishing vessels and gears in Sweden is carried out by the Division of Ship Hydromechanics, Chalmers University of Technology, Göteburg.

- On board the F.R.V. "Argos" gear performance data of a midwater trawl were collected. The influence of warp length, speed, bridle length and connection point of warps to the doors on warp tension, spread and angles of attack, heel and tilt of the doors was investigated. In addition to the measurements a short film of the behaviour of the doors was made by divers operating from a towed body.
- A commercial trawler engaged in two-boat midwater trawling operations was fitted out with a Kort nozzle. The fuel consumption was measured when steaming, fishing and in the bollard condition before and just after the nozzle was fitted. When fishing with the ducted propeller a fuel saving of 20 percent was recorded.

  In addition the noise generated by the propeller before and after fitting of the Kort nozzle was measured both in the living quarters and on the seabed. The nozzle reduced the noise on the seabed considerably.

UNITED KINGDOM (SCOTLAND)

- The Marine Laboratory four panel bottom trawl gear is being used by an increasing number of commercial fishing vessels. A large version of the gear was developed, suitable for vessels around 1200 h.p., to extend the vessel range (200-800 h.p.) which was covered by earlier versions of the gear. Fish catching rates with these trawls appear from commercial fishing experience to be rather better than those using traditional two panel trawls, but another advantage is the reduced risk of damage to the four panel gear when it is fished on hard ground and this feature is regarded by skippers as being most important.
- On pelagic trawling, the "delagic" trawl (a pelagic type gear which may be fished with the net in ground contact without any change of otterboards or rigging) has been used both as a single boat and pair trawl from commercial vessels fishing for white fish, but with very limited success so far and the development of this gear is continuing.
- A new project began this year, to develop a semi-pelagic trawl specially for use in the blue whiting fishery. The construction of such a net has to be particularly strong on account of the very high catch rates of blue whiting which can be experienced.
- A prototype set of mark 2 rotor boards (which incorporate a spinning rotor to control the horizontal position of a pelagic net) has been constructed, but it has not been possible to proceed with sea going trials because of continuing problems with the research vessel "Scotia".
- Wind tunnel tests have been carried out on Süberkrüb and Japanese type otterboards to measure the fluid forces at various speeds and angles of attack and tilt. The aim of this work has been to provide comprehensive data on the performance of otterboards for the development of a three-dimensional computer model of the complete trawl which will predict the engineering performance of full scale gears.
- Models of the delagic and four panel trawl gears have been used in the White Fish Authority flume tank to decide on the most suitable rigging and tailoring of the nets prior to full scale tests at sea.
- The mechanics and fish behaviour aspects of line fishing techniques are being investigated to determine the catching power of the different baits, and also the efficiency and selectivity of various hook designs. So far an artificial bait has not been found to better the natural baits such as squid and mussel which have always been used in commercial line fishing, but the research is continuing with this aim in mind.
- The development of electrical fishing systems has continued with the main emphasis being on the study of fish and shellfish reactions to various types of electrical stimulus.

UNITED KINGDOM (White Fish Authority)

- Following the catching experiments of blue whiting the main emphasis is now directed to the processing. In order to supply a processing plant in Stornoway three vessels are chartered. This plant will process the blue whiting into single skinless and boneless fillets.
- For the second year tests have been carried out with Japanese jigging equipment for catching squid. Supplementary to trips to the Rockall Bank area, two voyages to fishing grounds in the Moray Firth took place. It is the intention to extend the experiments to the English Channel area.
- A large part of the fishing gear activities was devoted to instruction in fishing gear and methods. Among others 8 trips were made to give instruction into midwater trawling operations.
- Because of the interest showed by skippers of low powered vessels in bottom pair trawling instruction in this fishing operation was given.
- Assistance was given to the Marine Laboratory to introduce the recent developed four seam trawl in the fishing industry.
- For instruction purposes in the flume tank a full range of gear models were designed and constructed.
- A basic study was carried out to check the stability of excisting fishing vessels.
- In order to correlate trawl model with full scale tests data sheets were prepared.
- To enable skippers to select fishing gears for a specific vessel trawl gear data sheets were established.

U.S.S.R.

- Research into the selectivity of trawl cod-ends.
- Deepsea trawling experiments at a depth of 1000 metres.
- Research into the influence of electrical currents and noise on the behaviour of fish.
- Development of an electric generator to supply power to electrified gears of small trawlers.
- Experiments on selectivity of bottom trawls when fishing for flounder in the Baltic Sea.

F.A.O.

1. Fishing methods and gear (Field activities)

- Burundi (Lake Tanganyika): introduction of small scale purse seine, catamaran operated, with light attraction, in the Dagaa fishery.
- Tanzania (Lake Tanganyika): introduction of small scale purse seine, with light attraction, operated from a modified local boat ("Water taxi").

Introduction of liftnet, with light attraction, catamaran operated.

- Senegal: testing of new types of inshore vessels, using improved gear, for upgrading the canoe fishery.
- Nepal: comparative fishing experiments with gillnets with different construction and various mesh sizes.
- Algeria: comparative fishing experiments between the Mediterranean traditional bottom trawl and an improved design of trawl (high opening type).
  Introduction and adaptation of an improved coastal boat, equipped with a mechanical net hauler, using more efficient trammel nets and gillnets.
- Malta: comparative fishing experiments on board a 35 m-700 h.p. stern trawler with three different bottom trawls: traditional Mediterranean, high opening with large meshes, high opening with small meshes.
- Yemen Arab Republic: introduction and preliminary testing of small scale shrimp trawls for sambouks (20-30 h.p.).
  Exploratory fishing on board a 15 m - 180 h.p. boat conducted with high opening bottom trawl (long-wing type), and shrimp trawl (Icelandic and Gulf of Mexico types).

2. Fishing vessels (Field activities)

- Senegal: introduction and testing of new types of inshore fishing vessels in FRP and wood.
- Tunesia: design, construction and demonstration of prototype coastal fishing vessels in ferro-cement plus instruction in building techniques in this material.
- West Africa Region: design and testing of extreme shallow draft fishing vessels for shallow-water conditions worldwide.
- Nepal: construction of simple wooden fishing boats for inland fisheries, together with the training of boatbuilders.
- Sudan: construction of simple wooden fishing boats and training of boatbuilders.
- Zambia: design, construction and testing of prototype FRP fishing boats as canoe replacements.

3. Promotion of fishing technology services

Several missions have been made to visit fishery institutions in developing countries (e.g. Algeria, Morocco, Tunesia, Senegal, Ivory Coast, Uruguay)in connection with the planning, establishment and initial operation of fishing technology services/units. Preliminary guidelines have been prepared to assist the institutions in the organization and selection of the adequate staff, facilities and equipment, as well as in the preparation of the initial programme of work of these services (see separate notes). More detailed guidelines, based in particular on the identification of the specific conditions and needs of the country, will soon be prepared for publication in the F.A.O. Fishing Manuals series.

4. Training course in fishing technology
To cope with the growing need for fishing technology services, in particular in developing countries, there is an urgent need for the training or upgrading of the personnel concerned, in applied fishing technology and related aspects in accordance with the local conditions and requirements.
Several courses for providing comprehensive training in fishing technology are therefore planned for the near future, in particular one at the ISTPM in Nantes for French speaking countries, one in Dakar for the CECAF member countries (French or English speaking) and one in Cochin for the IOFC member countries (English speaking).
Depending on the general technical competence of the countries involved, these courses will be organized at various levels, classified basically in two different types of course:
(1) introductory type, and (2) upgrading type. The latter type will probably be of interest not only to developing countries, but also to most developed countries when considering the general lack of institutions especially devoted to training in fishing technology.

5. Cooperation/Partnership between fishing technology services.
When establishing or upgrading a fishing technology service in a developing country, it is considered essential that contacts (e.g. on the occasion of fellowship) should take place with already existing institutes specialized in fishing technology, at an early stage, in particular, so that this service will receive the necessary technical backstopping during initial operation. Further on this cooperation will run both ways and will even become a kind of partnership, involving regular exchange of information and publication, joint programme of work, etc.
In order to facilitate these contacts, F.A.O. envisages the preparation of a complete list of experienced fishing technologists of the various F.A.O. official languages (English, French, Spanish), in developed countries. Moreover, under the regular programme of F.A.O., a programme of visits for technical consultancy related with the organization and operation of fishing technology services in developing countries has been initiated.

6. Publications.
List of publications relating to fishing vessels and gear issued in 1976-77:
- Fishing with light (F.A.O. Fishing Manual)
- Fishing boat designs: 1.} French and Spanish versions (F.A.O. Fisheries technical paper)
  Fishing boat designs: 2.}

PRESENTATION OF PAPERS

2.1 Experimental shrimp sorting trawl project (preliminary report 1976) by G. Brothers and E. Way (rapporteur: G. Brothers).

2.2 An automatic feeding system for the rotary shrimp sieve by A. Verbaan (rapporteur: A. Verbaan).

2.3 The nature of trawl-net drag by P.J.G. Carrothers (rapporteur: P.J.G. Carrothers).

2.4 Model tests with otter boards of new design by L. Karlsen (rapporteur: L. Karlsen).

2.5 Wind tunnel tests on otterboards by R.S.T. Ferro (rapporteur: D.N. MacLennan).

2.6 Calcul des differences longueurs dans un chalut à cordes par Jean-Claude Brabant et Patrick Cousin, (rapporteur: J. Prado).

2.7 Review of the Netherlands' investigations into a pelagic rope trawl by A. Verbaan (Rapporteur: A. Verbaan)

2.8 Further experiments with sorting panels in prawn trawls by L. Karlsen (rapporteur: L. Karlsen).

2.9 Selectivity experiments with topside chafers and round straps by A.K. Beltestad (rapporteur: A.K. Beltestad).

2.10 Model testing of fishing vessels in open waters by A. Endal (rapporteur: A. Endal).

2.11 Performance trials on a Scottish purse-seiner (rapporteur: J.F. Foster).

2.12 Expedition to the Antarctic 1975/76 by the Federal Republic of Germany (rapporteur: R. Steinberg).

2.13 Shrimp midwater trawl development 1976-Gulf of St. Lawrence by A. Tobey (rapporteur: W. Johnson).

PRELIMINARY REPORT - EXPERIMENTAL SHRIMP SORTING TRAWL PROJECT 1976

by G. Brothers and E. Way

1. Introduction

Since the introduction and development of the shrimp fishery in the Port au Choix area in 1970, the baby redfish stocks have been subject to intensive pressure during shrimp fishing operations for approximately nine months of each year. Unfortunately, the redfish are found in the same proximity as shrimp and accidently end up as a by-catch. Once caught and brought to the surface the redfish survival rate is minute. The immature redfish are a menace to the shrimp fishermen because of the time lost in sorting them from the shrimp. Rough figures for 1975 indicate the destruction of baby redfish in the northern Gulf was somewhere in the order of 1030 metric tons (Sandeman-1976). At the end of 1975, a total of 32 inshore vessels were involved in the shrimp fishery in the Port au Choix and Port Saunders area.

In an attempt to alleviate the destruction of immature redfish, this Branch is presently conducting an experimental project to develop and demonstrate an effective shrimp sorting trawl acceptable for commercial application in the area.

The desired objective of the project will be to maintain the present level of shrimp and groundfish catches with emphasis on drastically reducing the by-catch of immature fish, particularly baby redfish.

Although the shrimp catch is the major income for the shrimp fishermen, the by-catch is also very important. Therefore, in developing an effective shrimp sorting trawl, consideration must be given to retain the shrimp and other commercial fish, while allowing a high percentage of the immature redfish to swim free. To achieve this goal we have designed three shrimp sorting trawls and also imported a low headline Danish wing trawl. All three sorting trawls have two cod-ends, one of 1 1/4" mesh to retain the shrimp and one of large mesh to retain the commercial fish, while allowing the immature fish to escape. To determine the shrimp lost and the percent of immature redfish escaping through the top large mesh cod-end, a substitute small mesh cod-end is presently being used on the three shrimp sorting trawls.

To distinguish one sorting trawl from the other, we have numbered the sorting trawls, no. 1, no. 2 and no. 3. All three sorting panels have been installed into three 74' shrimp trawls. However, when proven effective, any of the sorting panels can be cut down or enlarged to fit the conventional shrimp trawls used in the area.

To carry out this project the M.V. "Avalon Rover", a 58' shrimp dragger driven by a 365 h.p. Caterpillar diesel engine and manned by a crew of four was chartered for 30 fishing days. Although strong winds hampered operations, a total of 26 charter days were completed. Trials conducted with modification to the sorting trawls towards the latter part of the project indicated very promising results.

2. Experimental fishing gear

74' shrimp trawl (figure 1).

The shrimp trawls used for this project are of the two seam type and have a 74' headrope and a 98'6" footrope. The various sorting panels were designed and installed into three of those trawls to determine the most effective way to separate the shrimp from the by-catch. The web in the 74' shrimp trawl consists of 1 1/4" mesh, 1.8 mm polypropylene twine throughout. The footrope of this trawl is 5/8" diameter wire covered with 4" diameter rubber disc, and suspended from the bolch rope every 3 feet by 6" toggles and chains. 4 1/2" mesh, 3 mm doubled polypropylene webbing covers the bottom lengthening piece and cod-end and also the top cod-end.

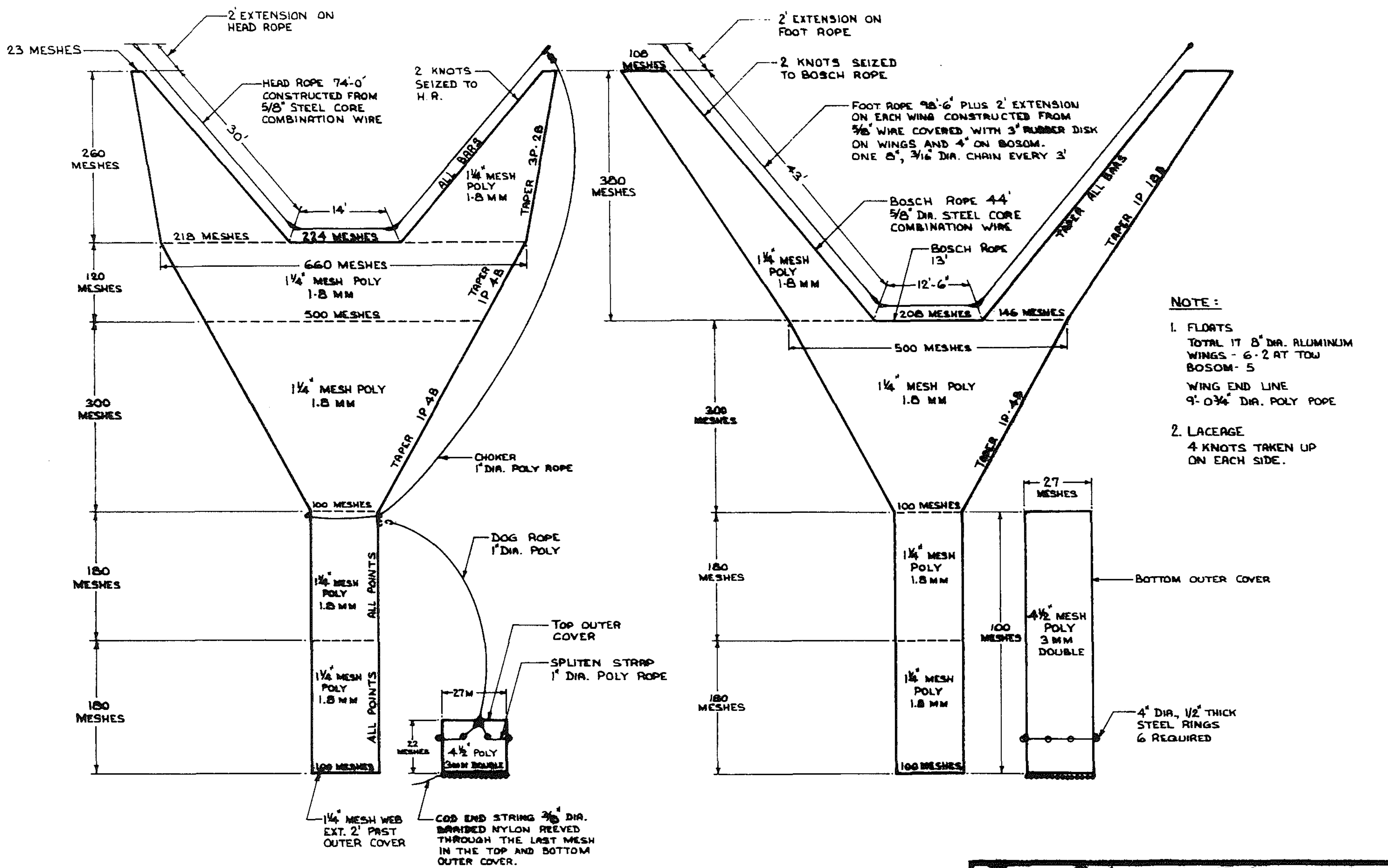
The rationale behind the use of the 74' shrimp trawl was that the same trawl was fished on the M.V. "Robin and Gail" during this summer on a shrimp and crab project and proved very effective.

All three sorting panels were constructed from 3" mesh, 2.5 mm polypropylene webbing and roped before being installed into the 74' shrimp trawls.

Table 1:

TRAWL ACCESSORIES

Length bridles & sizes Top	Bottom	Length sweeps & size	Main warp size	Dimensions of Steel V trawl doors L x H x Wt(lbs)
61'-6" (1/2" dia)	60' (5/8"dia)	60' (5/8"dia)	5/8" dia.	72" x 43" x 445



Environment Canada | Environnement Canada

74' SHRIMP TRAWL

INDUSTRIAL DEVELOPMENT BRANCH, OTTAWA
DIRECTION DU DÉVELOPPEMENT INDUSTRIEL, OTTAWA
FISHERIES AND MARINE SERVICE
SERVICE DES PÊCHES ET DES SCIENCES DE LA MER

G. BROTHERS
T. McCALLIO
NONE
SEPT. 22, 197

FIG· 1

74' Shrimp sorting trawl no. 1 (figure 2).

During the 30 day charter period 11 tows (4 days) were made using shrimp sorting trawl no. 1. This trawl has only retained 62% of the shrimp catch, while allowing 76.5% of the baby redfish to escape.

While carrying out preliminary tests on the feasibility of this trawl, 6'6" steel V-doors were used. The spread on those doors has three adjustments. While using shrimp sorting trawl no. 1, the best results were achieved when the towing warp was adjusted to the center hole of the door bracket.

To allow maximum opening of the top cod-end, five 8" diameter aluminium floats were fastened to the top of the exit tunnel, and approximately ten pounds of lead-rope was attached to the bottom of the top cod-end.

Further changes have been made to the sorting panel in shrimp sorting trawl no. 1. Fishing trials, using the modified sorting trawl to determine its feasibility had negative results in the last days fishing.

74' SHRIMP SORTING TRAWL NO. 1

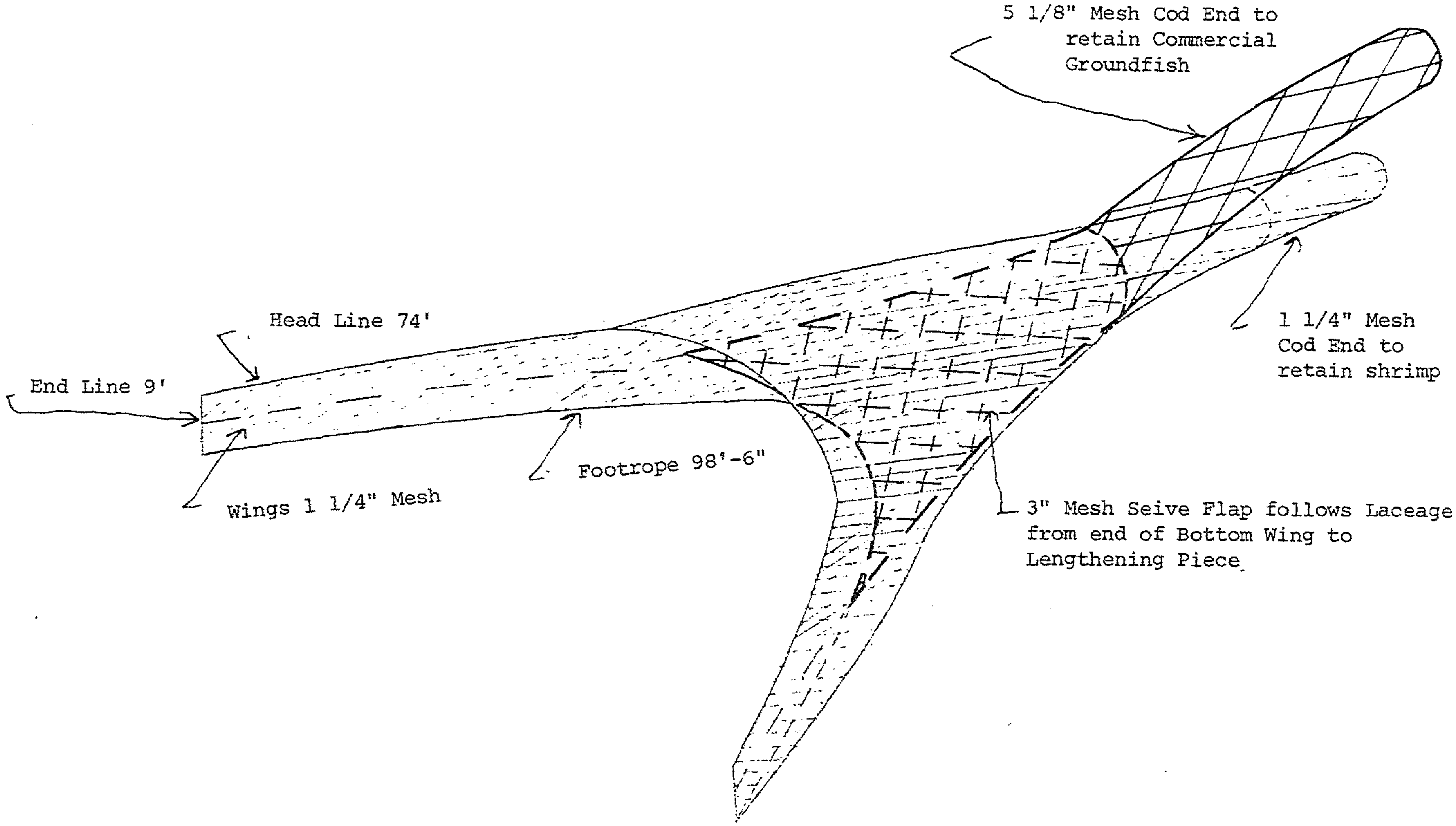


FIG. 2

74' Shrimp sorting trawl no. 2 (figures 3 & 4)

Four fishing days were devoted to shrimp sorting trawl no. 2 without modification. During this time eight tows were made in 16 1/2 hours fishing. This trawl has retained up to 97% of the shrimp catch but only allowed 26.9% escapement of the immature redfish.

While testing this trawl, the same 6'6" steel V-doors were used; however, the main towing warps were adjusted to the outside hole in the door bracket to give maximum spread.

Also on this trawl, five 8" diameter aluminium floats were attached to the exit tunnel, and approximately twelve pounds of chain was attached to the bottom of the top cod-end. However, this did not prevent a bag of commercial size fish from forming by the exit tunnel.

Further changes to this trawl were made (fig. 4) to alleviate the bag of fish by the exit tunnel. After modifications were made to the shrimp sorting trawl no. 2*, 16 tows (7 days) were made. It was with this shrimp sorting trawl that the most encouraging results were had. The average shrimp loss was 7.2% and the average immature redfish loss was 73%. In other words, in every 100 lbs. of shrimp caught, 7.2 lbs. were lost, and in every 100 lbs. of small redfish caught, 73 lbs. escaped through the sorting panel.

74' SHRIMP SORTING TRAWL NO. 2

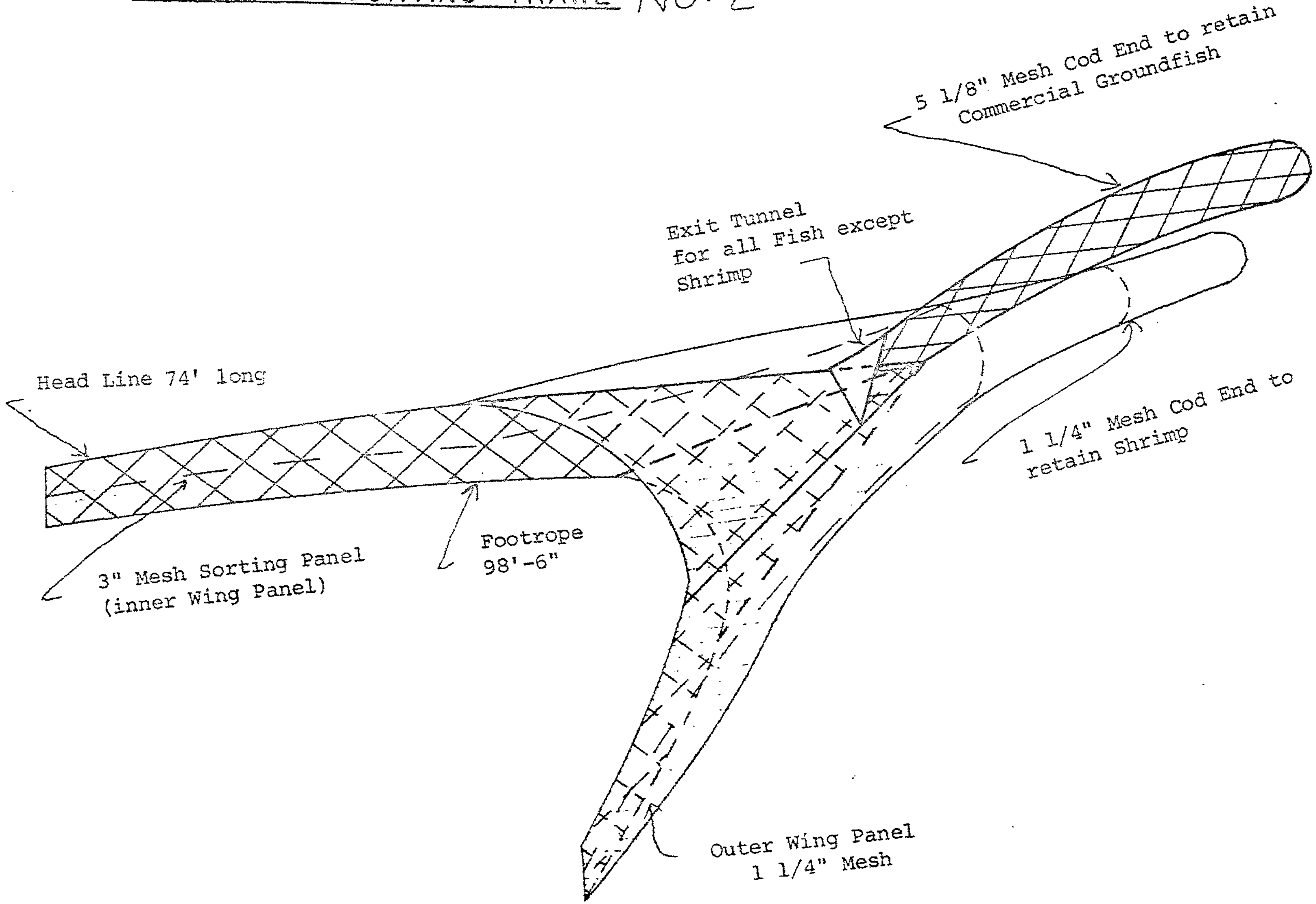


FIG. 3- A

SORTING PANEL FOR MODIFIED SHRIMP SORTING TRAWL NO. 2

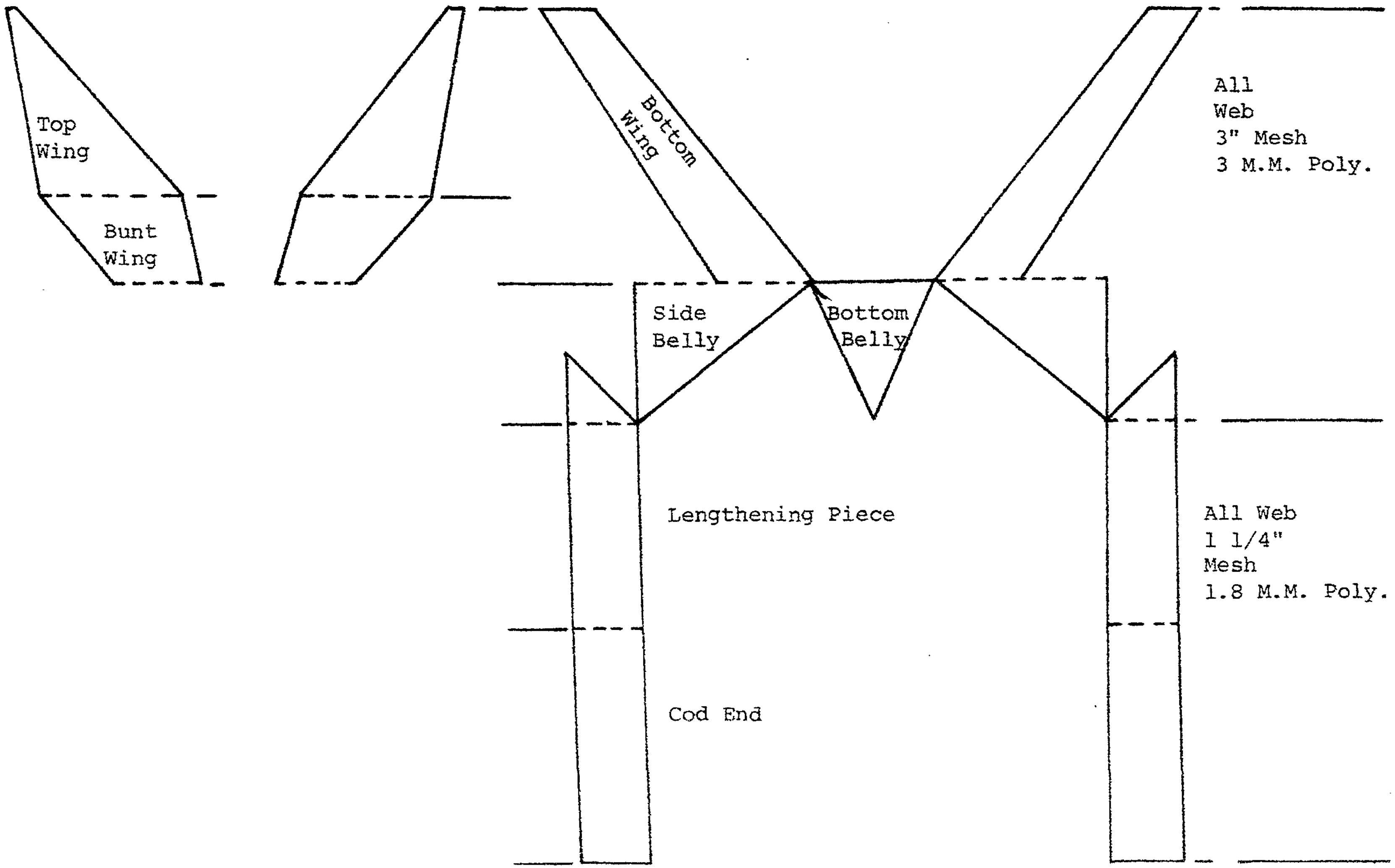


FIG. 3-B

MODIFIED SHRIMP SORTING TRAWL NO. 2*

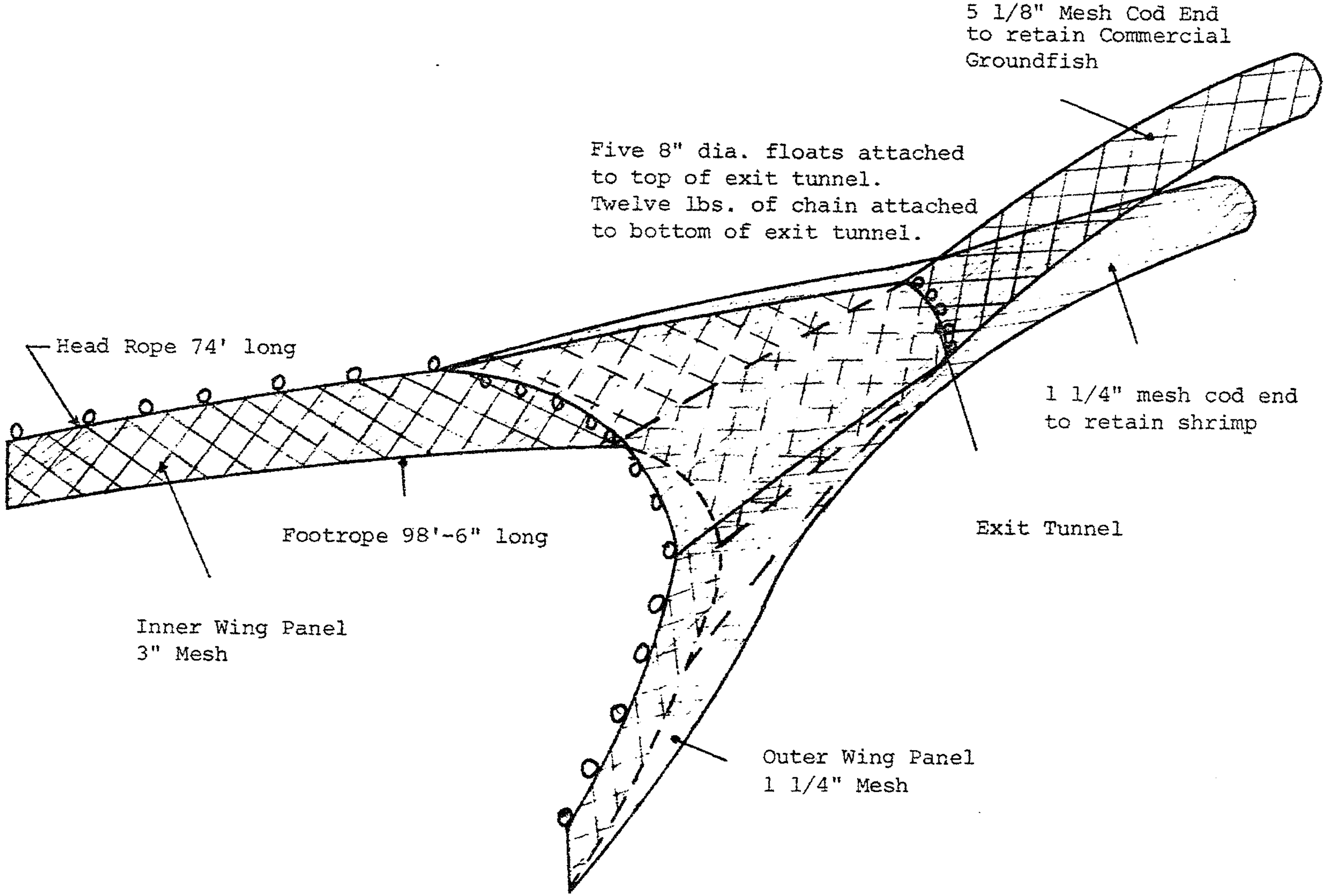


FIG. 4-A

SORTING PANEL FOR 74' SHRIMP TRAWL #2*

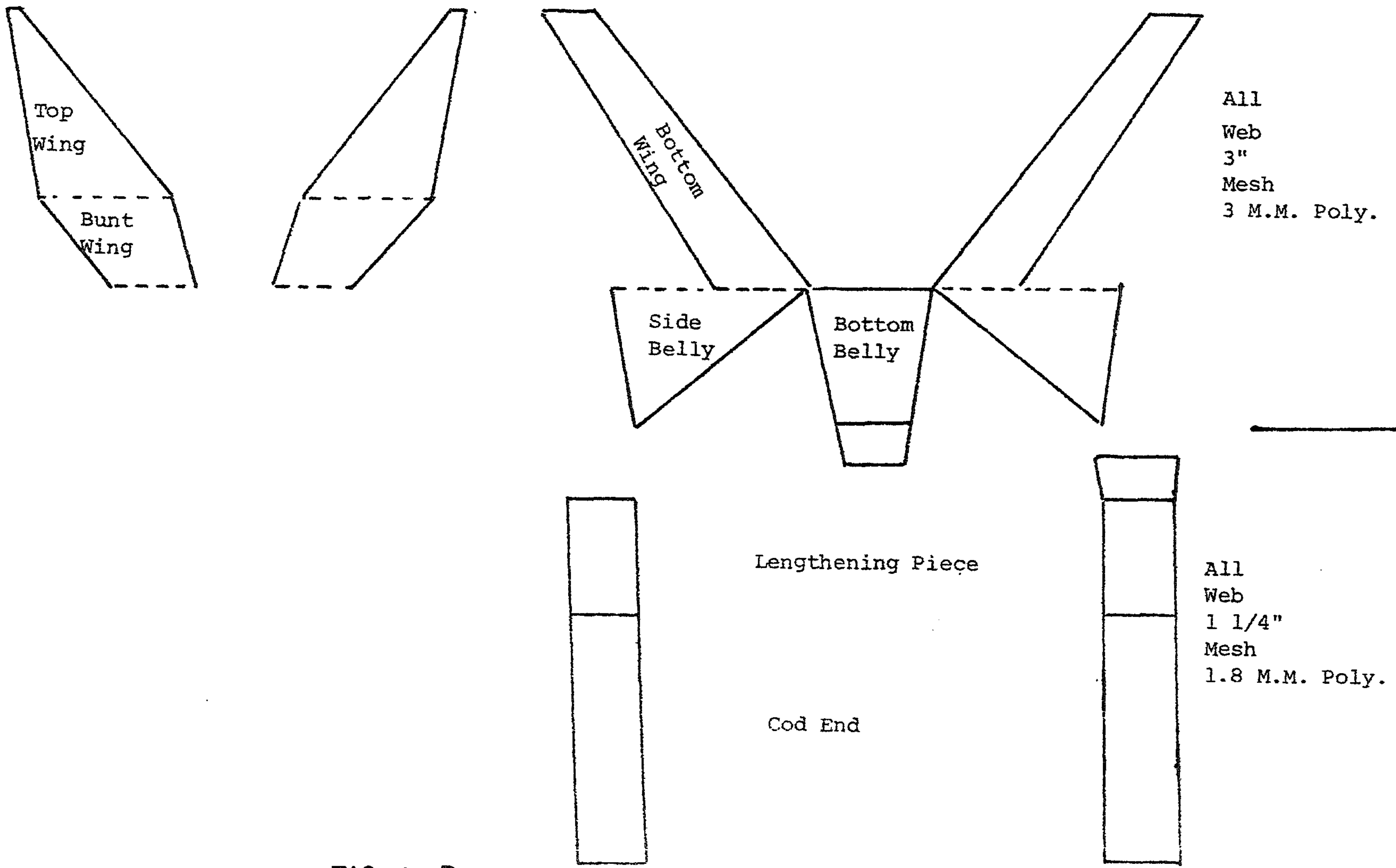


FIG. 4-B

74' Shrimp sorting trawl no. 3 (figure 5)

The principal of this sorting trawl is much similar to sorting trawl no. 1 (figure 2) exept the seive flap (3" mesh sorting panel) is much shorter. This idea, tested in Norway on a four seam trawl in 1975, achieved encouraging results; however, it produced nagative results when inserted into a two seam 74' shrimp trawl used on this project.

This sorting trawl was fished for two days but discontinued because of the very poor separation. The average shrimp loss was 67%, while the average immature redfish loss was 95%.

74' SHRIMP SORTING TRAWL NO.3.

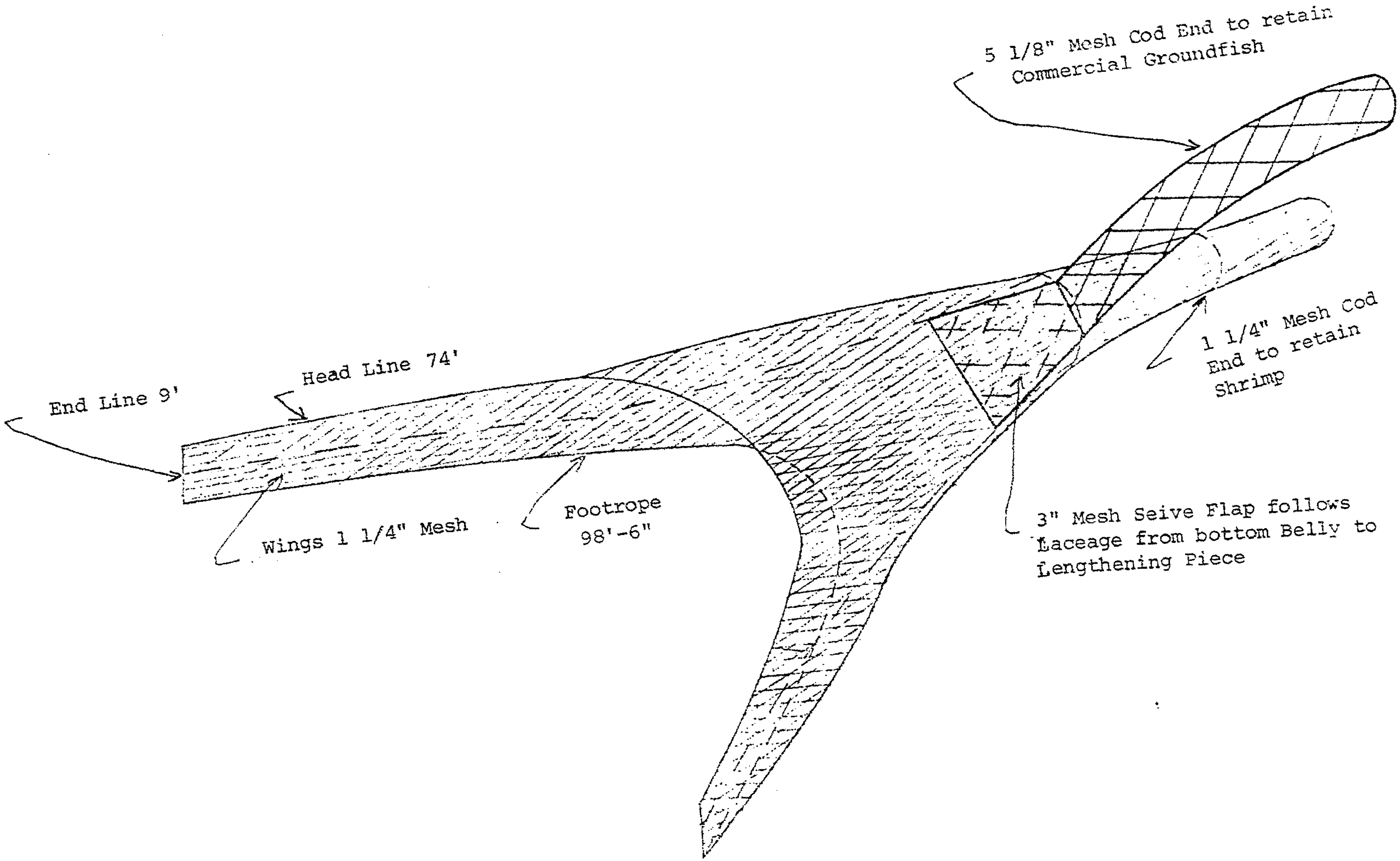


FIG. 5

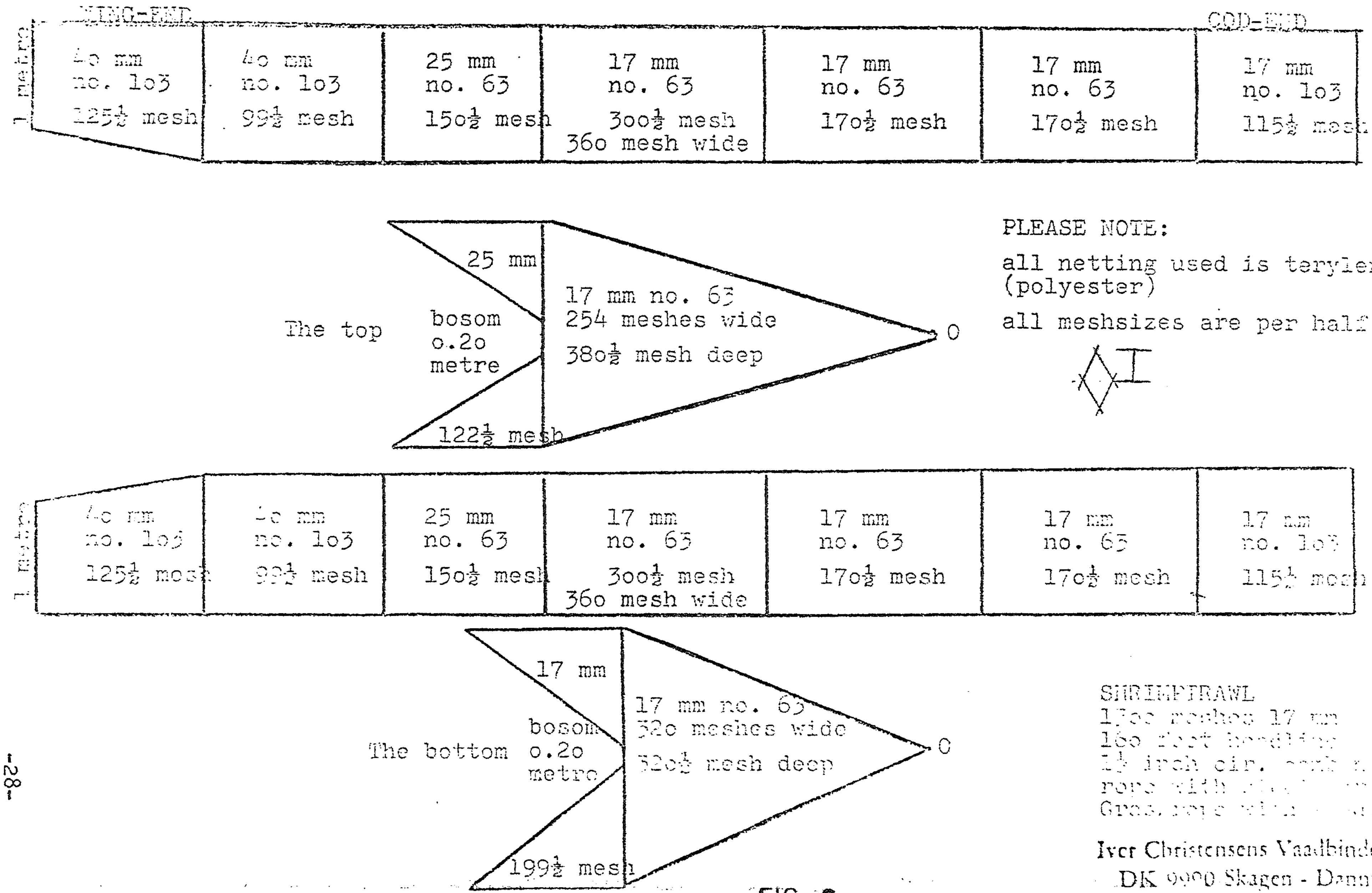
Danish wing shrimp trawl (figure 6)

During the three days fishing, using the Danish wing shrimp trawl, seven sets were made in 14.5 hours fishing.

Excellent catches of shrimp were taken, ranging from 175 lbs. to 700 lbs. per two hour set. However, all the immature redfish were retained since the trawl was not a sorting trawl.

The purpose of having such a trawl brought over from Denmark for this project, was to see if a low headline trawl would go under the immature redfish. Apparently, this does not happen since catches of immature redfish ranged from 200 lbs. to 2000 lbs. per two hour set.

The Danish wing trawl has a headrope of 160' with 40 five inch diameter hard plastic floats. It is constructed entirely of polyester netting. The mesh size in the trawl ranges from 3 1/4" in the wings to 1 1/4" mesh in the cod-end. The twine in the wings is very fine (no. 103) and very often the 5" diameter floats burst through the netting when it is being reeled on the net drum.



PLEASE NOTE:
all netting used is terylene (polyester)
all meshsizes are per half mesh

SHRIMPTRAWL
17oo meshes 17 mm
16o foot headline
1½ inch cir.
rope with
Grass rope with

Iver Christensens Vaadbinderi a/s
DK 9990 Skagen - Danmark

FIG. 6

RESULTS OF EXPERIMENT

Table of results

SUMMARY OF CATCH RESULTS

Date	Trawl type	Towing time set(hrs)	Shrimp (lbs.)	Loss %	Redfish (lb.) (1-6")	Loss %	
16-10-76	no.2	1 1/2	5	2	160	6	
16-10-76	no.2	1 1/2	5	4	160	16	
20-10-76	no.2	2	130	7	140	22	
21-10-76	no.1	2	185	57	1375	72	
21-10-76	no.1	2	80	50	900	77	
21-10-76	no.1	2	80	50	1000	80	
26-10-76	no.1	2	125	30	110	80	
26-10-76	no.1	2	210	60	800	75	
26-10-76	no.1	2	185	51	900	72	
04-11-76	no.1	2	395	55	1100	82	
04-11-76	no.1	2 1/2	415	54	1190	76	
04-11-76	no.1	3 1/2	340	58	660	76	
05-11-76	no.1	2	230	52	940	72	
05-11-76	no.1	3	220	64	410	80	
06-11-76	no.2	3	180	-	1400	36	fair
06-11-76	no.2	2 1/2	150	-	690	30	separation
16-11-76	no.2	2	105	4	250	20	
16-11-76	no.2	2	260	4	700	42	
16-11-76	no.2	2	285	3	650	53	
26-11-76	no.3	2	350	59	210	95	
26-11-76	no.3	1 3/4	400	75	520	96	
27-11-76	no.2*	2 1/2	400	12	600	50	good
27-11-76	no.2*	2 1/4	210	14	250	66	separation
27-11-76	no.2*	1 3/4	230	13	130	86	
30-11-76	no.2*	3/4	45	-	10	100	
01-12-76	no.2*	2	180	6	225	66	
01-12-76	no.2*	2	210	16	850	75	
01-12-76	no.2*	2	225	22	530	59	
02-12-76	no.2*	2	170	17	270	72	
02-12-76	no.2*	2	220	15	1000	70	
02-12-76	no.2*	3	240	17	850	70	
06-12-76	no.2*	2	75	7	300	70	
06-12-76	no.2*	2	74	5	400	75	
06-12-76	no.2*	2 1/2	42	5	210	71	
07-12-76	no.2*	3	42	5	1000	80	
11-12-76	no.2*	2	90	6	225	80	
11-12-76	no.2*	2	105	5	800	80	
16-12-76	no.1	2	120	91	100	100	
16-12-76	no.1	2 1/2	220	90	220	90	

Modified shrimp sorting trawl no. 2* - Good separation - Average shrimp loss - 7.2% - Average immature redfish loss - 73%.

During this experiment a 1 1/4" mesh top cod-end was substituted for the 5 1/8" mesh cod-end to retain all size species separated by the sorting panel.

Summary

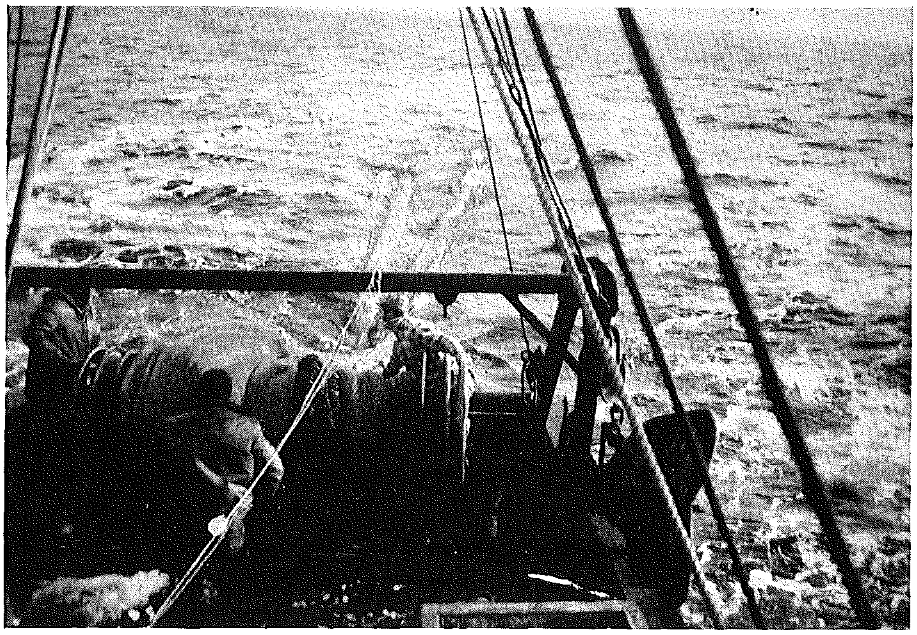
When shrimp sorting trawls were tested in Newfoundland in the past, 3" and 3 1/2" mesh nylon and vinylon twine was used for the sorting panels. This twine, like that used in our local cod traps, caused a considerable amount of redfish to mesh. However, during this project we used 3" mesh, 2.5 mm polypropylene webbing. This alleviated the problem of meshed fish entirely.

Due to the amount of immature redfish still ending up with the shrimp (23%) in the lower cod-end, we intend to use 2 1/2" mesh polypropylene webbing in the sorting panels for trials during the summer of 1977.

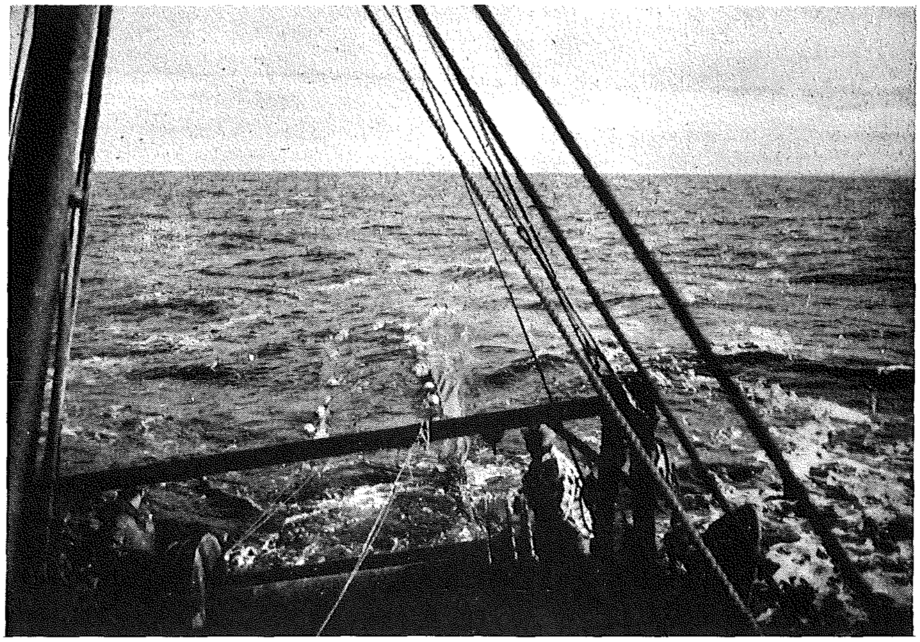
The incidental bycatch of cod, flounder, etc. has not been mentioned in the summary of catch results. All species of groundfish ended up in the upper cod-end (small meshed bag) during fishing trials. It is anticipated that the substitution of a 4 1/2" mesh upper cod-end would allow a large percentage of undersize groundfish to escape along with the immature redfish. It is also envisaged that some gilling will take place thus slightly reducing the escapement of all species.

Shrimp sorting trawl being wound on net drums. Note steel V. Doors.

Shooting shrimp sorting trawl. Note the 4" dia. rubber dics.



Shooting shrimp sorting trawl. Note double cod end and dickie lines.



Shooting shrimp sorting trawl. Trawl taking shape.

AN AUTOMATIC FEEDING SYSTEM FOR THE ROTARY SHRIMP SIEVE

by A. Verbaan.

In 1968 the first rotary shrimp sieve was installed on board of a Dutch shrimp beamtrawler. Until then the shaking sieve was commonly used. An advantage in comparison with the shaking sieve is that the shrimps are also washed in the rotary sieve. Moreover the sorting effect of the rotary sieve is better than the sorting effect of the shaking sieve.
Up to now, about 75 rotary sieves are installed on Dutch shrimp boats.
The introduction of this machine has another important aspect too. The working conditions of the crew, onboard of a shrimp trawler equipped with a rotary sieve, are better in comparison with a shaking sieve (see figure 1).
Although the rotary sieve has a good sorting efficiency, the fishermen commented that the efficiency could be better if there was a continuous instead of an interrupted supply of shrimps (Crangon crangon) into the sieve. Therefore some kind of a feeding system had to be developed.
The developing of a feeding system also had a biological aspect. The feeding system must create optimal survival conditions for undersized shrimps, -flatfish and other species.
The investigations started in 1972. In 1975 the first prototype was tested on a commercial shrimp trawler, during a whole year. The results were very succesfull.
Up to now, there are six automatic feeding systems for the rotary shrimp sieve installed, and four more have been ordered.

THE CONSTRUCTION AND PERFORMANCE OF THE AUTOMATIC FEEDING SYSTEM

The automatic feeding system consists of two glass-fibre storage tanks, filled with seawater. The cod-ends of the two beamtrawl nets are emptied into those tanks. The rotary sieve is situated between the two storage tanks (see figures 2 and 3). The storage tanks are linked by a rectangular tube. This tube allows the catch to move from the starboard tank to the port-side storage tank. A conveyor-belt carries up the catch out of the port tank and at the top of its way up the catch is transferred to the sieve by water jets.
The surface of the innersides of the storage tanks is very smooth, to prevent flatfish sticking to it.
The transport of the catch in the tanks into the direction of the conveyor-belt is assisted by means of a number of water-nozzle's.
As already mentioned, the storage tanks are filled with seawater. The shrimps and fish are therefore protected against damage and dyhydration. In this way the undersized shrimps, flatfish and other species have an optimal chance of survival.
At the topside of each storage tank two removable gratings are mounted, to stop stones and coarse benthos (see figure 4 and 5).
The capacity of both storage tanks is 0,87 m3. In case of big catches the capacity can be increased by means of a loose brim, which can be mounted on top of each storage tank. The total capacity is now 1,22 m3.
The glass-fibre storage tanks are mounted in a galvanized frame. This frame also functions as a cod-end catcher.

The flow of water and catch to the conveyor-belt is controlled by a trap door. The perforated conveyor-belt (about 50%), is made of stainless-steel.
Owing to the construction even relatively big fishes will be transported (see figure 6).
Flatfishes of commercial size are collected from the conveyor-belt by a crewmember.
At the rear of the rotary shrimp sieve the consumption shrimps are collected in baskets; the undersized shrimps. -flatfish and other species are flowing back into the sea through a rubber hose.
The conveyor-belt is driven by a D.C.-electromotor, 0,34 hp/2000 revs. The speed can be adjusted between 1,25 - 7,15 m/min.
The amount of water, required for the automatic feeding system is appr. 20 m3/h, for the rotary sieve appr. 20 m3/h and for the washing machine for the boiled shrimps appr. 10 m3/h.

THE INFLUENCE ON THE WORKING CONDITIONS

The automatic feeding systems for the rotary shrimp sieve means a change in the working conditions on board of shrimp beamtrawlers.
Figure 1 shows the processing diagrams on board of shrimp trawlers with a shaking sieve, a rotary sieve and a rotary sieve with an automatic feeding system.
The diagram gives a clear picture of the differences in working conditions between the three installations.
When judging the working conditions on a shrimp trawler (without a feeding system) on ergonomical criteria,

we have to conclude that the main part of the work by the crew is done in contradiction with the ergonomical insights.
When using an automatic feeding system, work can be carried out far better.

THE INFLUENCE OF QUANTITY AND QUALITY ON THE LANDINGS

Quantity:

In October 27th, 1975 the first four automatic feeding systems were installed on shrimp beamtrawlers.
It was interesting to study the landing-results of these four trawlers before and after the feeding system came into operation. Also a comparison in landing-results was made between shrimp trawlers with and without the feeding system. We selected trawlers with appr. the same propulsive power and usually fishing in the same area's.
The results of these investigations were remarkable.
An increase in landings could be shown. The increase in landings seems to be due to a number of factors.
Most important is that an automatic feeding system gives a continuous flow of shrimps into the sieve instead of an interrupted supply.
A continuous sorting proces gives a better and more accurate sieving result.

Quality:

A more accurate sieving of the shrimps has a great influence on the market. Moreover, there are other aspects having possitive influence on the quality of consumption shrimps. The mortality of shrimps previously caused by other methods of sieving is now almost reduced to zero, because the cod-ends are emptied in storage tanks, filled with seawater (see figure 7). Also the possibility of removing unwanted bycatch at the surface of the tanks, e.g. sprat, improves the quality. The separation of sprat from shrimps in the rotary sieve is difficult if both have the same width. Boiling a mixture of shrimps and sprat decreases the quality of the boiled shrimps due to the fat contents of the sprat.

CONCLUSIONS

The automatic feeding system for the rotary shrimp sieve is now in operation for more then one year.
At this moment the conclusions are:

- increasing of the landings;
- better quality of the consumption shrimps;
- optimal protection of undersized shrimps, -flatfish and other species (during several commercial trips it is observed that even vulnerable species, like whiting and herring, will be transferred into the sea alive);
- better working conditions for the crew;
- stronger economic position for owner and crew.

Lit.

Boddeke, Dr. R. and Verbaan, A.	The automatic feeding system for the rotating shrimp grader Visserij, oktober 1976.

Figure 1

PROCEDURE DIAGRAM

Shaking sieve	Rotary sieve	Automatic feeding system with rotary sieve
Hauling the gears	Hauling the gears	Hauling the gears
Emptying cod-ends on deck	Emptying cod-ends on deck	Emptying cod-ends into the storage tanks
Sorting of commercial sized fish out of the catch *	Sorting of commercial sized fish out of the catch *	Collection of the commercial sized fish from the conveyor-belt
Scooping up the catch on the shaking sieve *	Scooping up the catch into the rotary sieve *	
Sorting of shrimps and bycatch on the shaking sieve	Sorting of shrimps and bycatch in the rotary sieve	Sorting of shrimps and bycatch in the rotary sieve
Washing of the commercial sized shrimps *		
Commercial sized shrimps to boiler •	Commercial sized shrimps to boiler •	Commercial sized shrimps to boiler •
Scooping back into the sea of undersized shrimps, -flatfish and other species *		

* Heavy manual labour in contradiction with the ergonomical insights

• Manual labour which can be reduced to a minimum when having a good deck lay-out

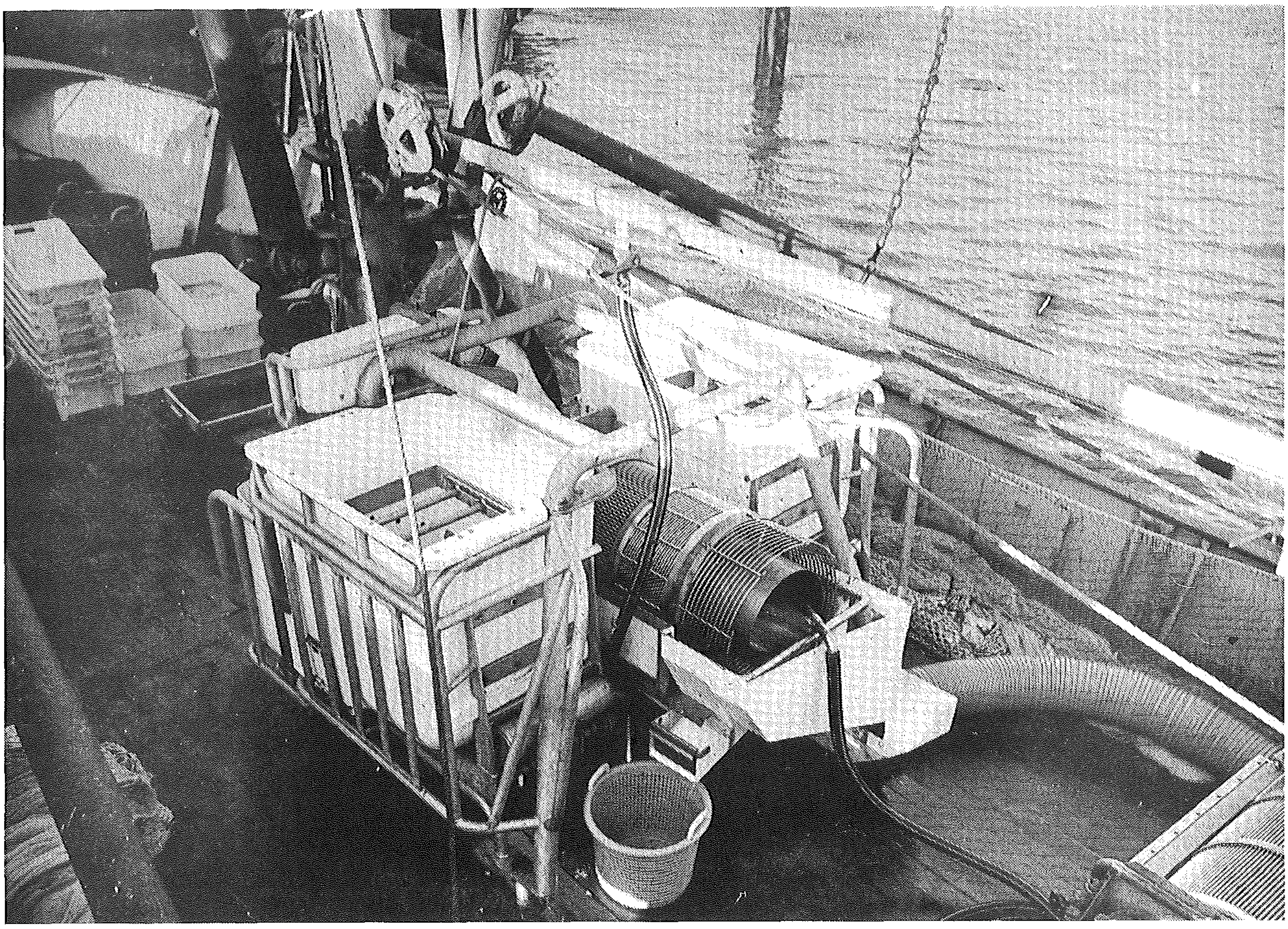


Fig. 2

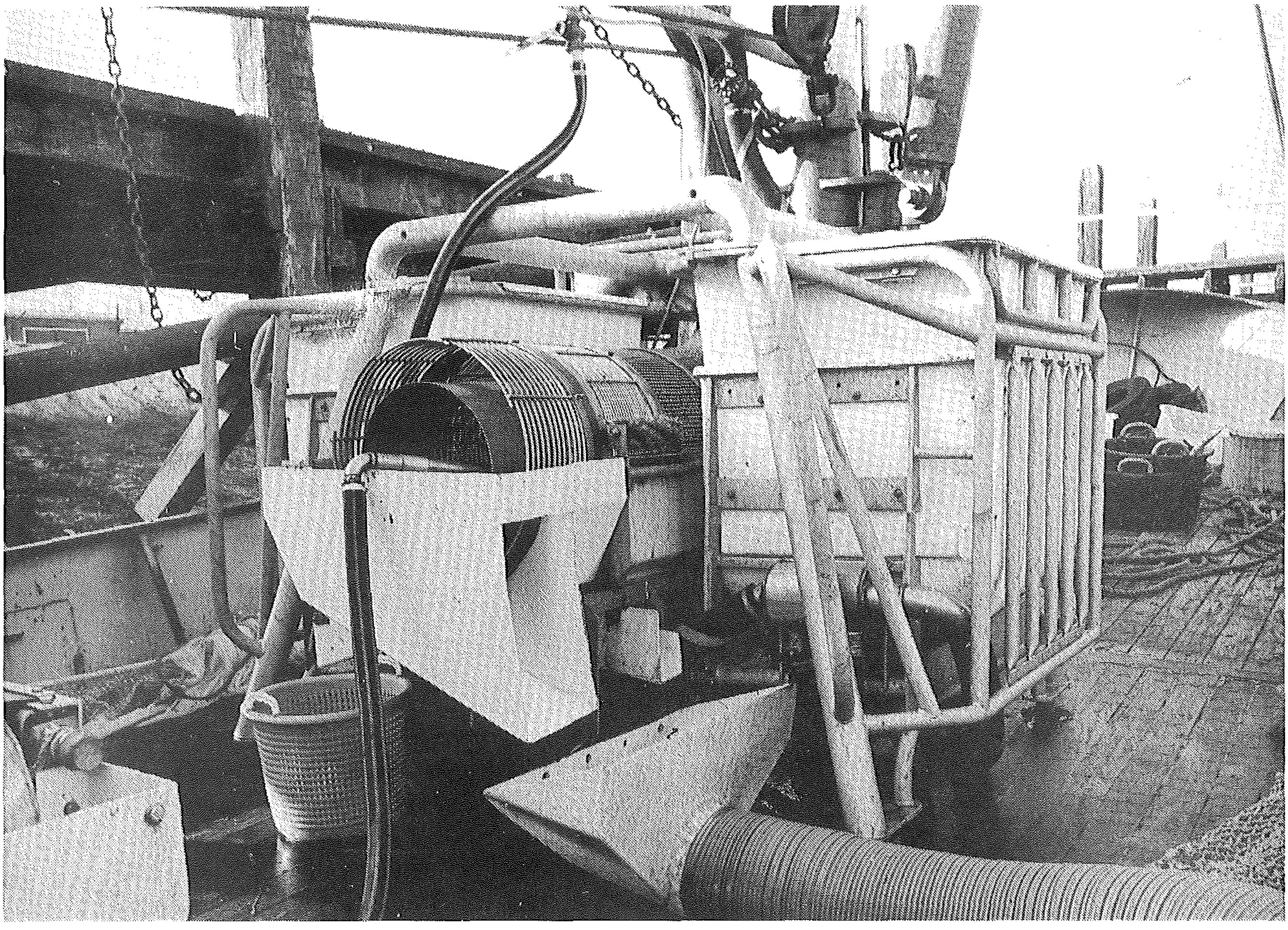


Fig. 3

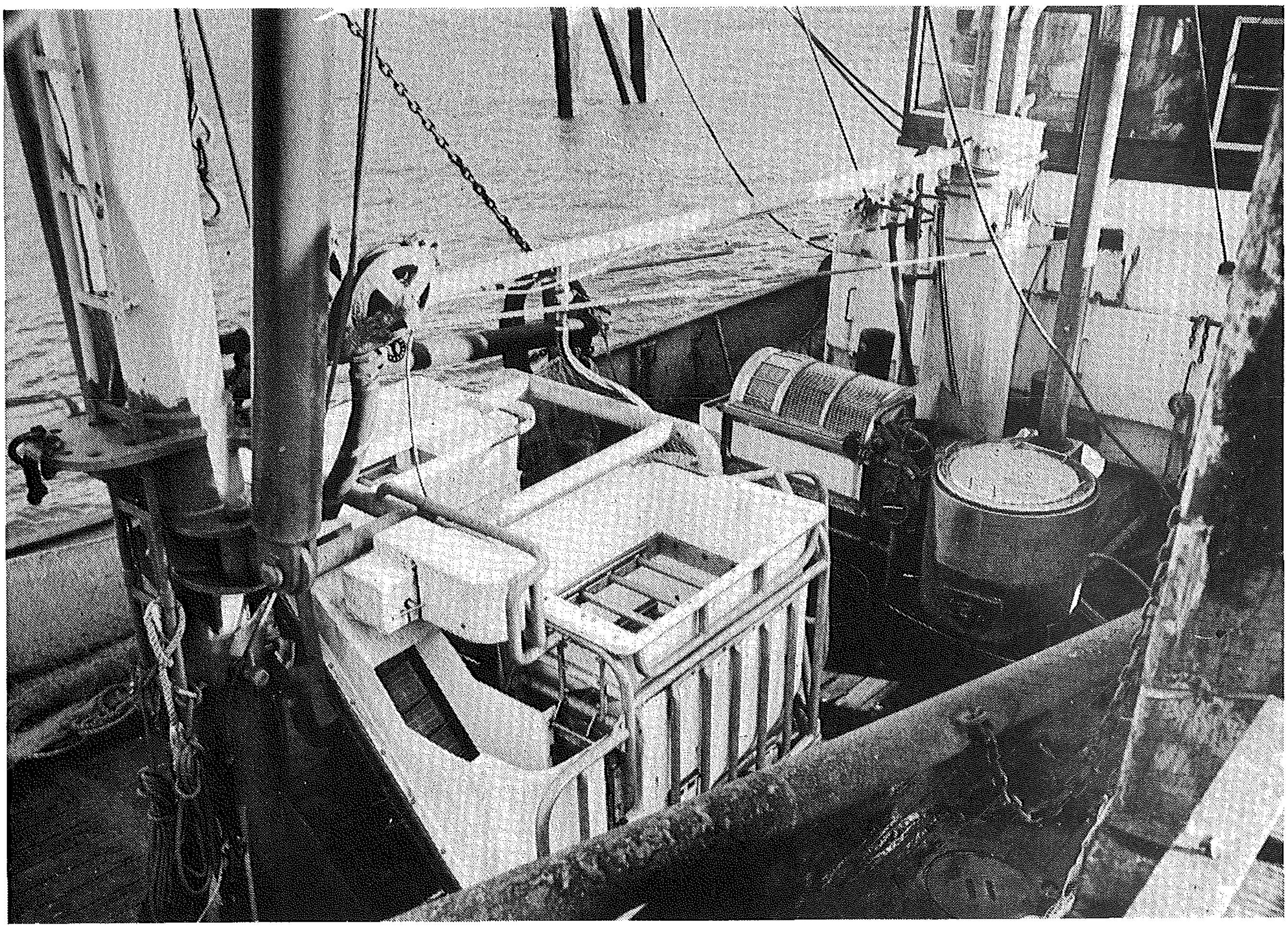


Fig. 4

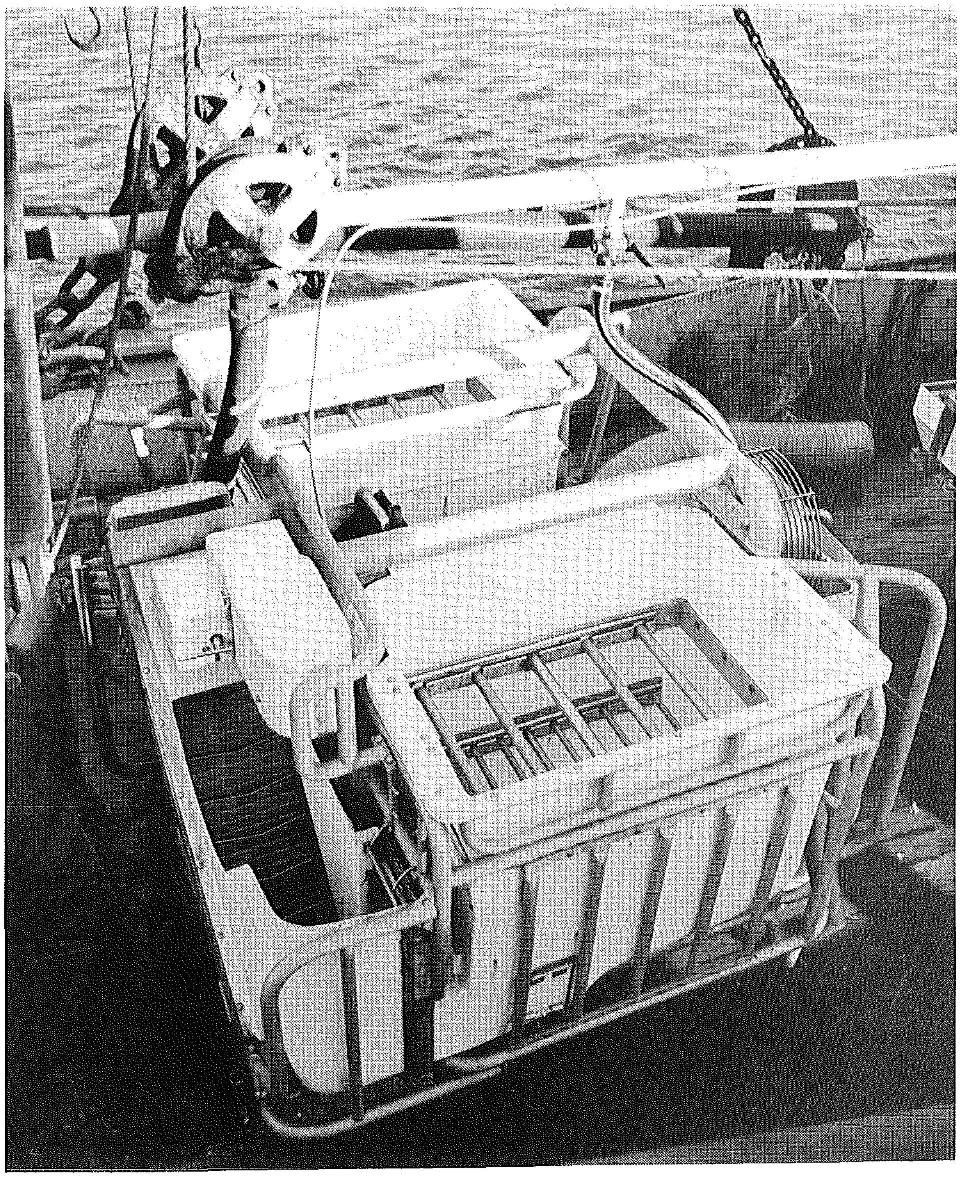


Fig. 5

Fig. 6

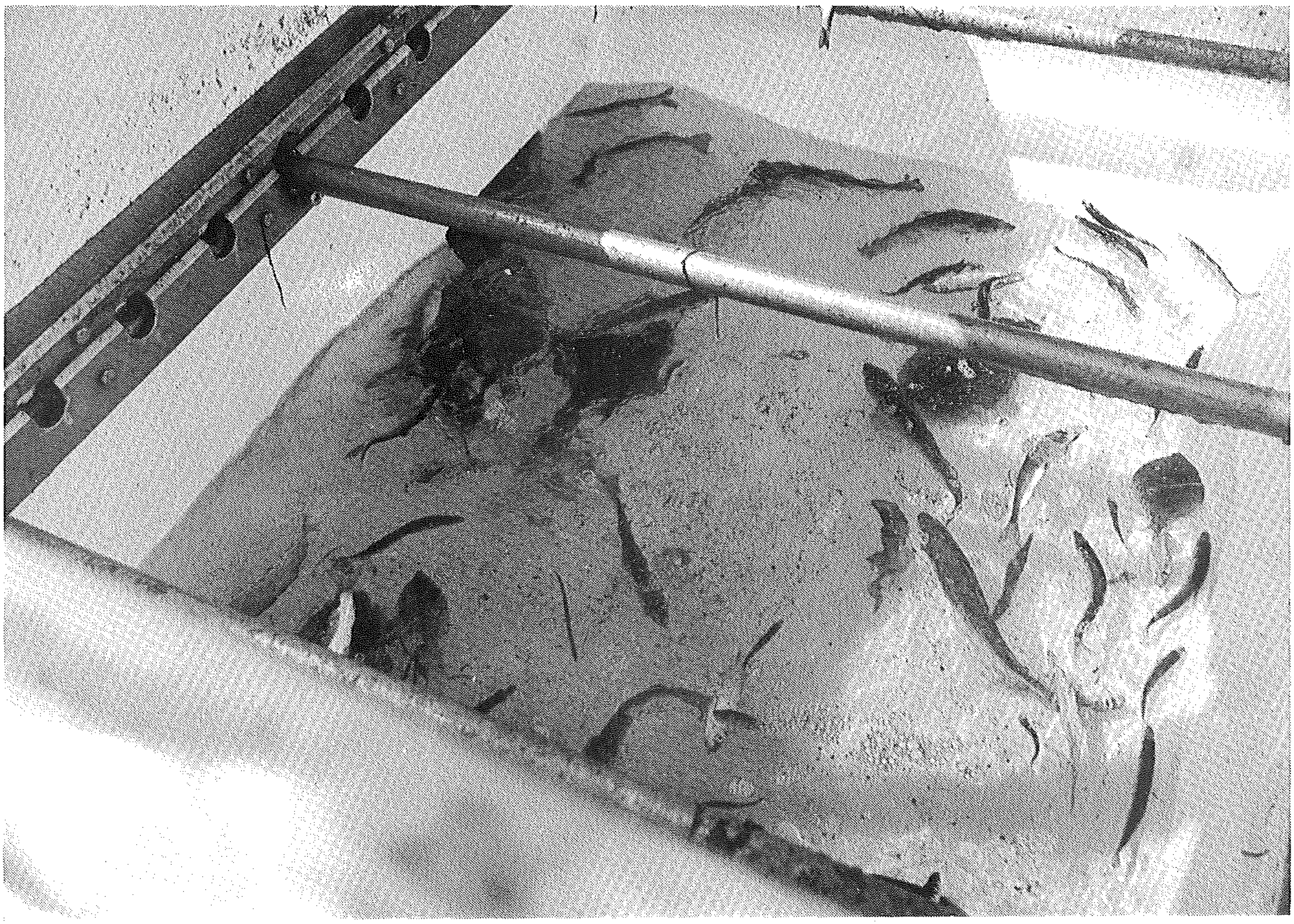


Fig. 7.

THE NATURE OF TRAWL-NET DRAG by P.J.G. Carrothers.

Historical

According to the established hydrodynamics theory, the drag of totally immersed bodies may be expressed by

$$D = C_D \cdot S \cdot \frac{pV^2}{2} \qquad (1)$$

This led early investigators such as Baranov and Tauti to express trawl-net drag by

$$D = k \cdot V^2 \qquad (2)$$

However, a few crude measurements soon dispelled this concept.

In his pioneering work in rational fishing gear technology, Crewe found trawl drag to be described adequately by

$$D = k \cdot V \qquad (3)$$

It is easy to understand how scatter in the data, as caused by rough weather, and a relatively narrow range of towing speeds, as caused by a captain interested primarily in catching fish, could justify nothing more complicated than this direct increase of drag with speed.

However, more refined measurements display a persistant curvature and contemporary practice is to express trawl drag empirically by

$$D = a \cdot V^b \qquad (4)$$

As shown in figure 1, this power function results in a much improved fit to experimental results and permits more precise interpolation, but the parameters (a, b) must be obtained experimentally for each full-scale gear by relatively expensive trials at sea, and they have no physical meaning in the trawl-drag phenomenon. This procedure cannot lead to an a priori method for predicting the drag of new trawl designs.

Present study

Over the past 14 years, a comprehensive set of underwater instruments has been developed and simultaneous measurements of selected variables, sufficiently comprehensive to define the shape and force matrix of the trawl under various towing conditions, have been taken during 73 successful tows at sea on 22 variations of trawl design and rigging.

A mathematical procedure has been developed to describe the shape of the trawl in detail by fitting catenary plan-forms and profiles for the headline, footrope, wing bridles and ground warps to the measured spread of the head-line tips and the measured height of the centre of the headline above the sea bed. The shapes, thus defined, were then used to resolve measured wing-bridle tensions into vectors.

From these results the data used in this report include:

a) Trawl-net drag as the sum of the components of the measured wing-bridle tensions lying parallel to the direction of motion.

b) Hydrodynamic pressure (q) measured by a recording pitot-meter suspended in the mouth of the trawl. Trawl speed through the water (V) was calculated from

$$V = (2q/p)^{1/2} \qquad (5)$$

using $p = 2$ lb-sec^2/ft^4 for sea water.

As an example, these data, obtained from four replicate tows with a commercial, nylon, Yankee 41-5, groundfish trawl in 37 fathoms (68 m) of water, are presented in figures 1 and 2. Obviously, in the latter, trawl-net drag (D) is very strongly dependent on hydrodynamic pressure (q) at trawl in accord with

$$D = A \cdot q + F \qquad (6)$$

As shown in figure 2 and table 1, estimation of trawl-net drag from hydrodynamic pressure at the trawl by (6) is more precise than from trawl speed by (3) or even by (4).

TABLE 1 Summary of drag parameters (± standard error)

	Hydrodynamic drag area A (ft2)	Ground friction F (lb)	Standard error of drag estimate (lb)
$D=A \cdot q+F$			
Tow 40	121.31 ± 3.83	1411.2 ± 55.4	157
Tow 41	126.61 ± 7.28	924.3 ± 78.6	261
Tow 42	113.59 ± 3.23	1121.4 ± 49.3	163
Tow 43	115.61 ± 1.67	1461.5 ± 21.9	58
Overall	116.93 ± 3.47	1291.2 ± 15.0	291
$D=a \cdot V^b$			333
$D=k \cdot V$			608

The results of this analysis, applied to data from all 22 different trawls and riggings, are supplied in table 2. The consistently low standard errors of drag estimate attest to the validity of the mathematical model represented by (6). With the "Yankee 41-5 poly braid" trawl, "shorter cables" includes both dan-leno rig and 30-ft wing-bridle rig. Data from these two rigs were not significently different in the statistical sense, and were combined. Similarly, "Yankee 41" includes both a laid polythene trawl and an Ulstron trawl, both measured with rectangular doors and with oval doors, but the different netting materials did not produce significantly different drag characteristics so the data were combined.

Estimation of trawl-net drag by (6) is more useful than by the traditional functions because the parameters A and F have physical meaning in the drag phenomenon. The slope, A, may be interpreted as the hydrodynamic drag area of the trawl net and should be a function only of the trawl construction and shape. The intercept, F, is independent of trawl speed and may be interpreted as the friction between the trawl net and the sea-bed. This ground friction should be a function of the weight of the trawl-net (including bobbin gear) in water, the type of bobbin gear and the type of sea-bed.

For exemple in figure 2 and table 1, in the statistical sense, the data from tow 40 are significantly above those from tow 42, but neither set is significally different from the regression through data from all four tows. The slopes are the same, displaying consistent hydrodynamic drag area of the trawl, and the difference in ground friction (intercepts) is probably attributable to differences in the sea-bed.

In rationalizing his use of the first power of trawl speed (V) in Expression (3) vis à vis the second power in (1), Crewe observed that, as trawl speed increased, headline height decreased, and the trawl presented a smaller frontal area, effectively decreasing the characteristic area, S, in (1). However, if such an effect existed, then the smaller frontal area at higher trawl speeds (V) should be accompanied also by a smaller hydrodynamic drag area (A) in Expression (6) at higher hydrodynamic pressures (q=pV2/2) This would cause a curvature, concave downward, in the trend presented in figure 2. Such a curvature is not present in the data from any of the 22 different trawls and riggings measured. Therefore, it must be concluded that the frontal area of the trawl, as such, does not control trawl drag. Trawl-drag formulae based on frontal area of the trawl are fundamentally incorrect.

The hydrodynamic drag of a trawl is created by the solid components of the trawl---the netting, the floats, the lines, the bobbins, etc. The hydrodynamic area, A, in (6) should thus be a function of these solid components and should not vary appreciably with changes in towing conditions. Lower headline heights at higher speeds will be accompanied by smaller angles of incidence of the netting in the square and upper belly, but this obviously has negligible effect on trawl drag.

In this analysis, it is essential to use the hydrodynamic pressure at the trawl or the speed of the trawl through the water in (6). Using speed of tow relative to the sea-bed introduces scatter as a result of tidal currents, and the speed of the towing vessel through the water is not more useful because tidal currents at the sea surface are usually several times stronger and often in a different direction than currents near the sea-bed.

The mathematic model represented by (6) was applied empirically to trawl drags calculated from warp tensions and angles measured at the vessel. Reasonably good fit was achieved with about two-thirds of the tows, but the other third of the tows gave sufficiently poor fit to preclude using this model to develop a method for predicting the drag of the whole trawl. The drag of the trawl doors is obviously more complex that can be explained by trawl speed alone. A separate analysis of trawldoor drag, probably involving door type, door rigging, warp aspect ratio, etc., will have to complement the trawl net drag given by (6) before a rational system for predicting the drag of the whole trawl can be developed.

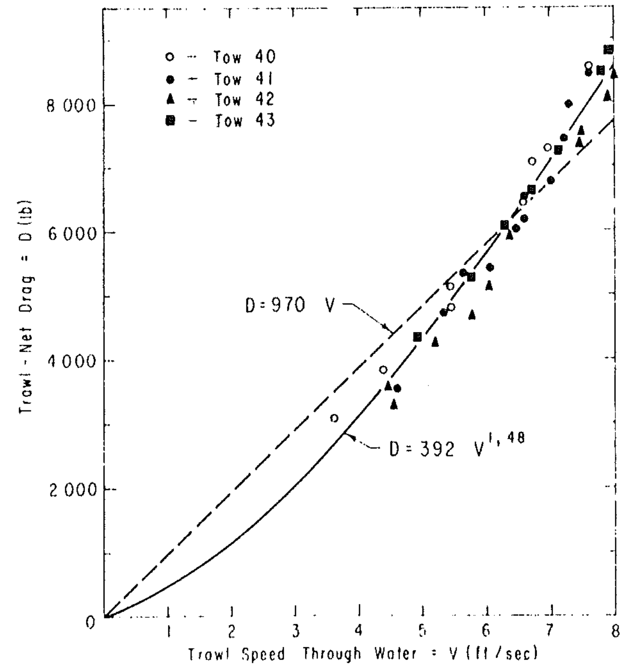


Fig. 1 Traditional functions for trawl drag.

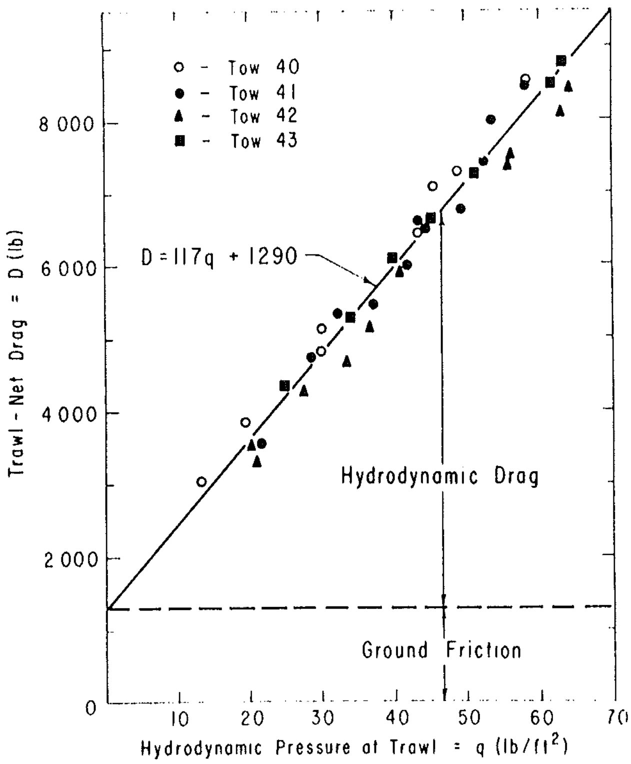


Fig. 2 Analytical function for trawl drag.

TABLE 2. TRAWL-NET DRAG FROM HYDRODYNAMIC DRAG AREA AND GROUND FRICTION

Trawl and Rigging	Tow No(s)	No. of Data Points	Drag Area (ft^2) A	Ground Friction (lb) F	Drag Estimate (lb)
ENGEL HIGH-LIFT					
Oval Doors	1+2	13	150.1(±28.5)	3214(±1181)	±1521
Oval Doors & Kite	3	7	224.5(±10.7)	2008(± 115)	± 305
Rect. Doors & Kite	4	8	146.3(± 9.6)	3763(± 141)	± 398
Rectangular Doors	5+7	18	162.8(±20.1)	2932(± 860)	±1100
WEST COAST	8+9	14	130.0(± 5.5)	1779(± 282)	± 296
YANKEE 41 HIGH LIFT	10	8	123.3(±10.7)	2972(± 185)	± 523
	11	8	180.6(±12.0)	888(± 135)	± 381
YANKEE 35	13-16	32	53.5(± 1.3)	540(± 44)	± 92
YANKEE 36	17+18	15	79.4(± 2.5)	313(± 62)	± 95
YANKEE 41-5 POLY LAID					
Disc Footrope	19-20	27	102.3(± 2.8)	1975(± 127)	± 201
Rubber Bobbins	23-28	58	104.4(± 1.9)	1324(± 84)	± 215
YANKEE 41-5 POLY BRAID					
Long Cables	29+31-34	42	116.9(± 2.4)	898(± 128)	± 245
Shorter Cables	35+36+38	23	107.9(± 3.9)	1669(± 220)	± 274
YANKEE 41-5 NYLON	40-43	37	116.9(± 3.5)	1291(± 150)	± 291
YANKEE 41					
Rectangular Doors	44-47	36	110.6(± 1.5)	1108(± 60)	± 122
Oval Doors	48-51	38	111.7(± 2.1)	787(± 96)	± 176
SKAGEN	62-65+67	45	89.3(± 1.9)	1301(± 85)	± 208
GRANTON	70+71	13	146.6(± 8.5)	238(± 365)	± 299
ATLANTIC WESTERN III	72+74+75	30	134.5(± 4.3)	1906(± 174)	± 336

± Standard Error

MODEL TESTS WITH OTTER BOARDS OF NEW DESIGN by Ludvig Karlsen

Mr. Tor Bjørnung of the Bergen Engineering High School has designed a stream line type of otterboard and carried out tests with scale models.

Three different versions of the board have been tested, one (SYM 21) for use only in midwater, and the two others (ASYM 11 and ASYM 21) for use both in midwater and bottom trawling. The area of the scale models ranged from 0.56 to 0.61 m2 and the maximum chord lengths from 0.67 to 0.74 m.

Measurements were performed in open water with a test rig operated from a small motor boat. Although the test program suffered from test rig imperfections and other short comings, and partly bad weather conditions, promising results with respect to the hydrodynamic characteristics of the boards were achieved. As seen from figure 1 a lift coëfficient of 1.6 was found for the midwater version at an angle of attack of 30 degrees, while a lift/drag ratio of 4.5 was realized for an angle of attack of 13 degrees.

As seen from diagram 2, the lift coëfficient for the semipelagic version, ASYM 11, tested in midwater conditions was found to be about 1.35 for an angle of attack of 25 degrees, the lift/drag-ratio of that board was superior to the midwater version.

For the third version of the board, ASYM 21, measurements of angle of attack were incomplete, but from the polar diagram (figure 3), where comparisons are made with some other types of otterboards, it can be seen that its characteristics are sligthly inferior to the midwater version, SYM 21.
In addition to measurements of the hydrodynamic characteristics, the test program also included examination of the flow patterns (stream-lines) over the surfaces of the boards.

Reference:

Tor Bjørnung: Rapport fra modellforsøk. Prosjekt: Utvikling av ny tråldør (unpublished).

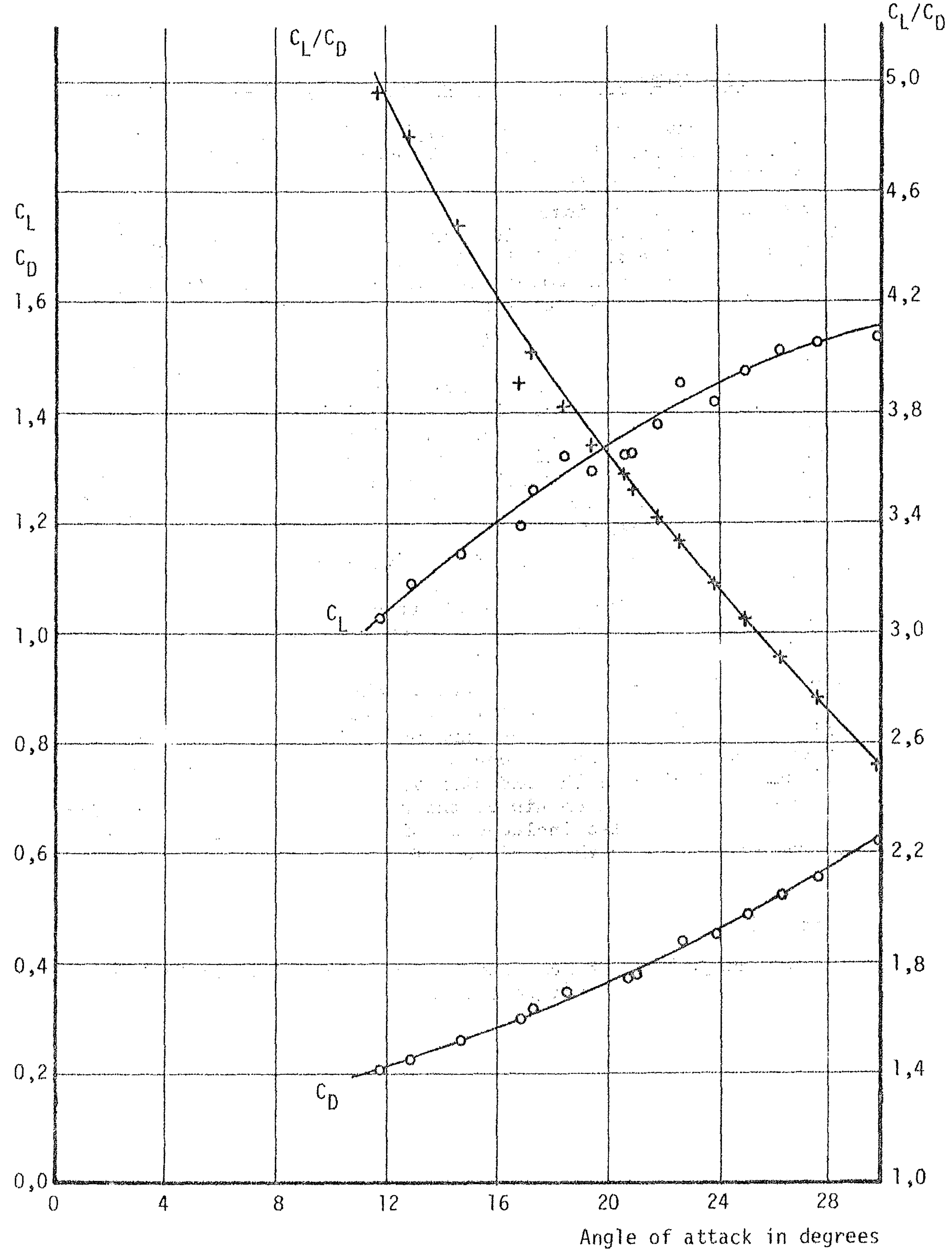


Fig. 1. Lift and drag coefficients for SYM21.

Reynolds Number = $1{,}143 \cdot 10^6$

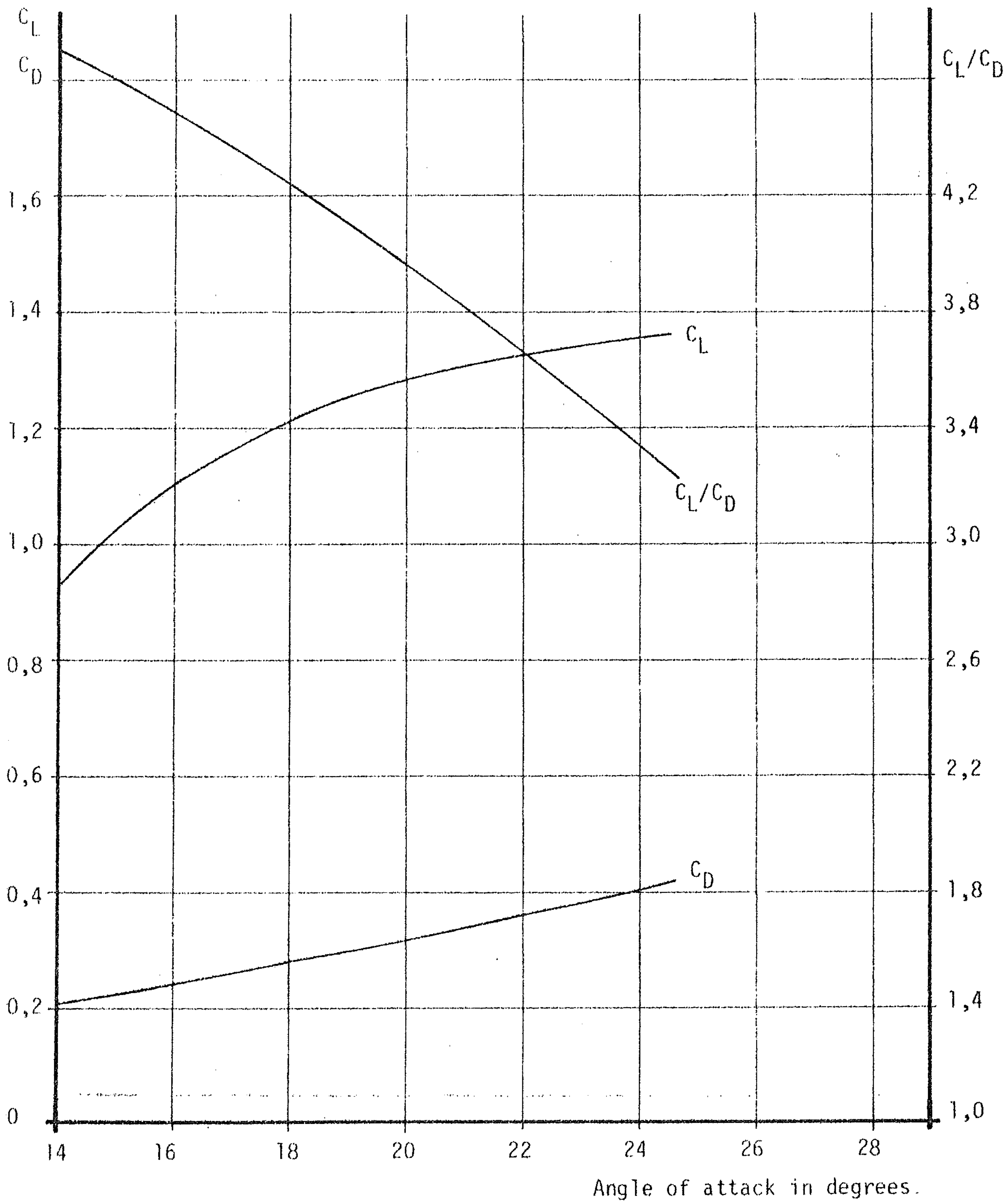


Fig. 2. Lift and drag coefficients for ASYM11.
Reynolds Number = $1,26 \cdot 10^6$

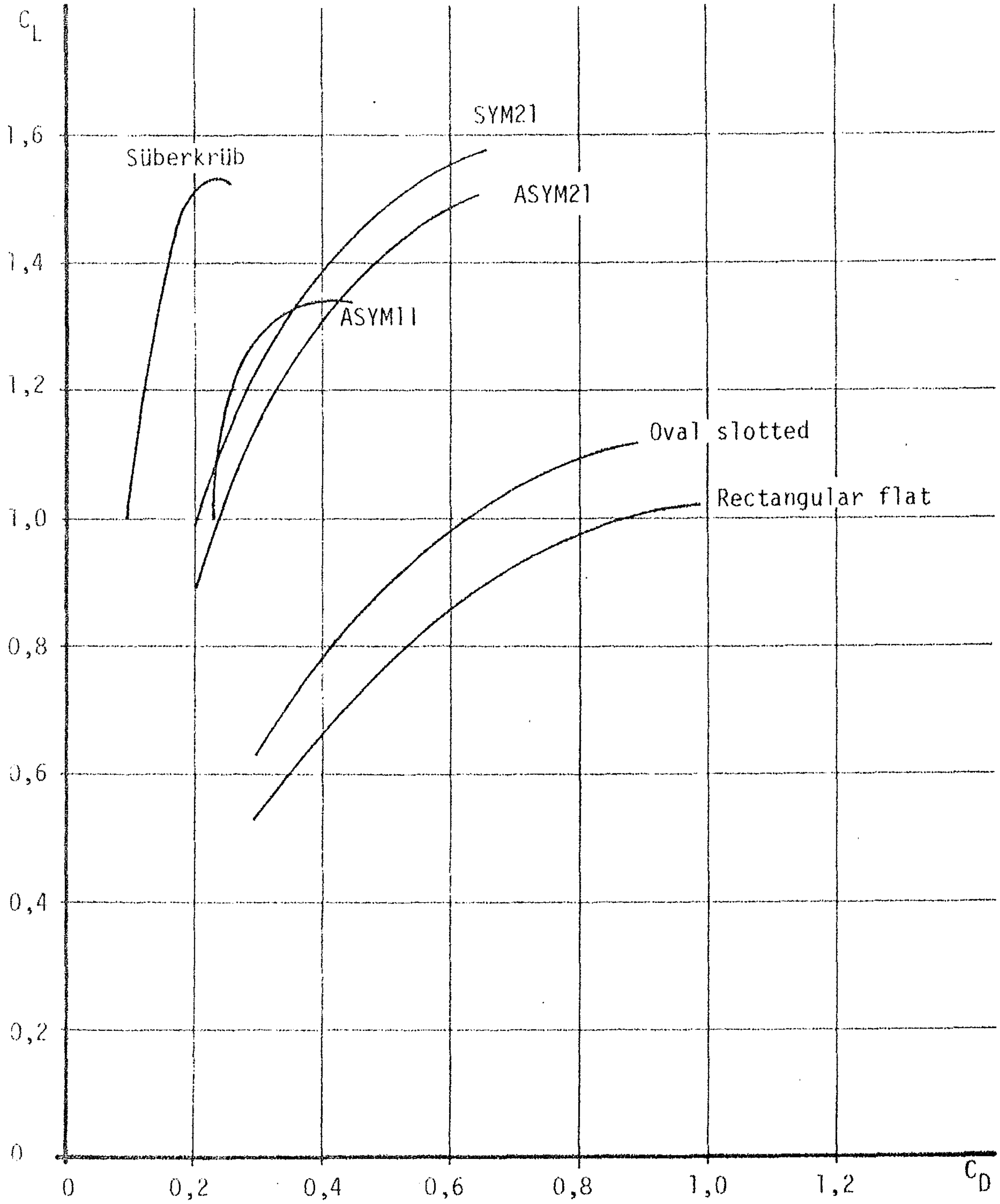


Fig. 3. Polar Diagram for SYM21, ASYM11, ASYM21 compared to some other types of otter boards.

WIND TUNNEL TESTS ON OTTERBOARDS by R.S.T. Ferro.

Introduction

A comprehensive series of tests were undertaken in a 10.9 m2 wind tunnel in March 1976 (Hawman, 1976). Models of both Süberkrüb and Japanese type otterboards (F.A.O., 1974) at a scale of approximately 1.8 : 1 with respect to 4.5 m2 full scale boards were studied at different speeds and ranges of angle of attack and tilt.

These large models were used to minimise scale effects although it was then necessary to apply a tunnel blockage correction. However, these corrections were small at angles of attack below the stall before complete separation of the airflow around the model had occurred.

There were three main objectives for the tests:

1. To investigate the applicability of low aspect ratio wing theory to otterboard performance in order that predictions of the hydrodynamic performance of other designs of door could be made.

2. To supply complete performance data on two types of door.

3. To investigate the effect of Reynolds Number on the performance data.

Results

In order to assess the test data in terms of low aspect ratio wing theory it was first necessary to present the data in an appropriate form. (Note that the term "low aspect ratio" in aerodynamics refers to wings having aspect ratios less than say 5. A Süberkrüb otterboard with aspect ratio of about 2 may be known as a high aspect ratio otterboard but it is in the aerodynamics sense, a low aspect ratio wing). The British Hovercraft Corporation undertook this analysis work under contract to the Marine Laboratory.

The effective angles of attack and tilt and the effective aspect ratio were calculated with respect to a fluid dynamic datum plane - the "no lift" plane for which the normal force is zero at zero effective angle of attack.

Figure 1 shows one example plot of the normal force coefficient against effective angle of attack. The curve passes through the origin since the angle of attack is referred to the "no lift" datum plane.

A small but significant crossflow term is evident as predicted by theory - that is, before the stall point, the variation of the coefficient with angle of attack is non linear due to an additional component often taken to be proportional to sin2 (angle of attack).

At high attack angles the value of the coefficient (at all tilt angles) becomes 1.22 which may be compared with a value of approximately 1.25 for a 16% cambered plate estimated from the figures given on page 3-17 of Hoerner 1965 (see also pp 7-16 et seq).

The six force and moment coefficients were determined at each of two speeds for seven angles of attack from 0° to 60° and for each of these cases at eight angles of tilt from -20° to $+43^\circ$.

The two speeds represented full scale towing speeds of 2 and 4.5 knots.

To investigate the effect of Reynolds Number a lower wind speed equivalent to 1.5 knots full scale was also used. The range of Reynolds Numbers was from 7.6 x 10+5 to 22.8 x 10+5 for the Süberkrüb door. There was no significant difference in the results over this range of Reynolds Number. However, it should be noted that any sudden change in behaviour would be expected to occur only at Reynolds Number below about 2 x 10+5. Such low values are not likely to be encountered except in a water channel or towing tank when model speed is determined by Froude Number.

Future work

The limited comparisons which are possible at present show agreement between the model and full scale results. Further trials results will be obtained to determine the extent of the agreement. It is hoped that these model tests may be useful in determining the performance of other otterboard designs and that they will prove sufficiently reliable to be used as input to computer programs which model the behaviour of complete trawl gear.

References

Hawman, J. 1976 "Wind tunnel tests of a 72" x 30" Süberkrüb and a 56" x 37" Japanese type otterboard each tested at speeds equivalent to 4.5 and 2.0 knots in seawater". British Aircraft Corporation WT Report No.3375.

Hoerner, S.F. 1965"Fluid-Dynamic Drag". Published by the author.

SUBERKRUB OTTERBOARD.

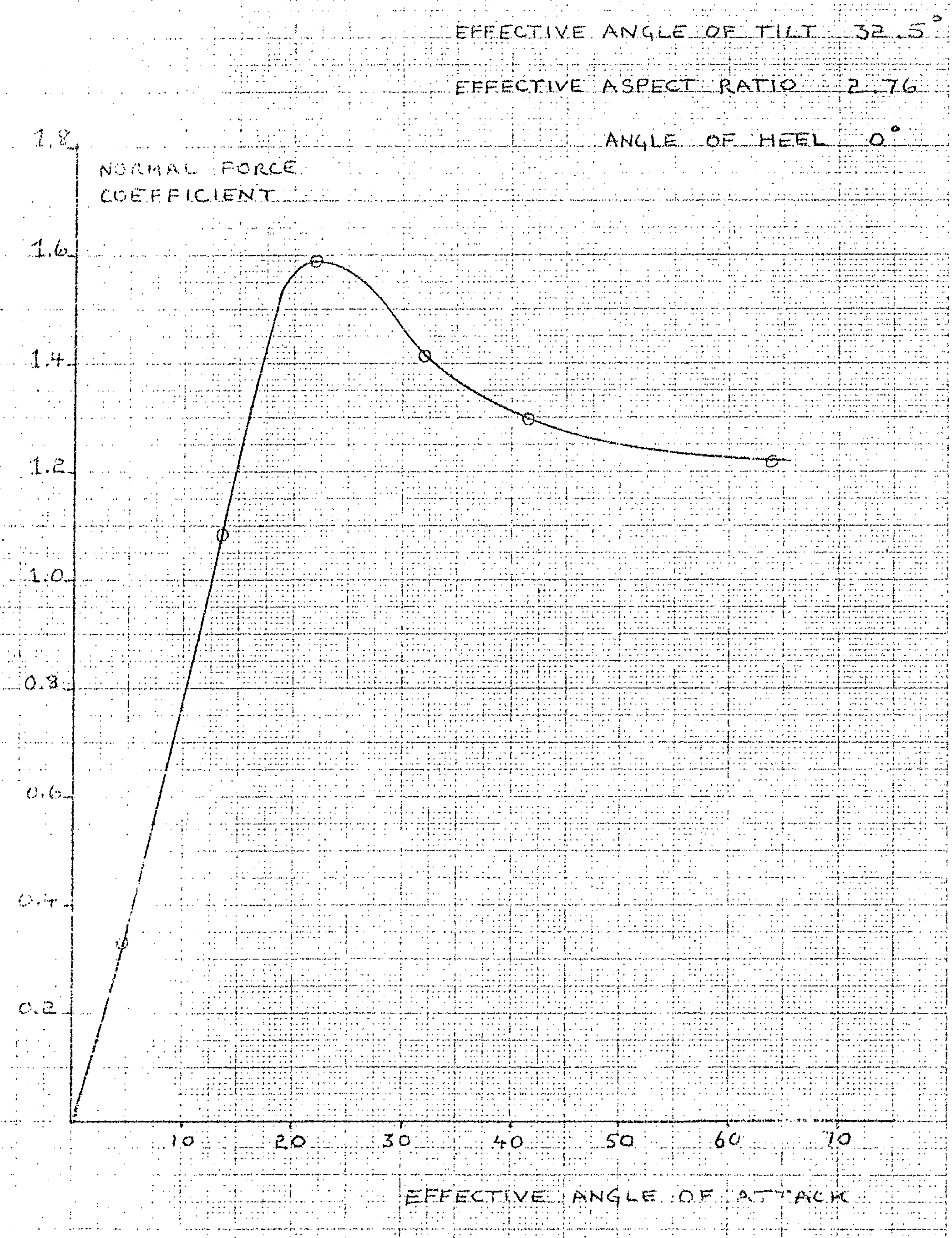


FIGURE 1

CALCUL DES DIFFERENTES LONGUEURS DANS UN CHALUT A CORDES

par Jean-Claude Brabant et Patrick Cousin.

L' étude d'un plan de chalut (pélagique) à cordes par rapport à celle d'un chalut entièrement en mailles nécessite une opération nouvelle qui est la détermination de la longueur des cordes, de la longueur des ralingues d'ouverture et de l' emplacement des différents points d' amarrage de ces cordes.

La méthode décrite ci-dessous est basée sur une représentation simplifiée du chalut en pêche et le calcul des différents éléments fait apparaître la possibilité d'une détermination graphique assez simple.

HYPOTHESES PRELIMINAIRES

- La section transversale du chalut au niveau où les cordes sont amarrées sur le filet est considérée comme étant rectangulaire.

  Les cordes sont situées dans 4 plans dont l'ensemble forme un tronc de pyramide rectangulaire.

- Les ralingues d'ouverture étant soumises à des forces non réparties uniformément sur leur longueur mais en des points précis, celles-ci dessinent un polygone dit funiculaire (fig. 1).

  La courbune des ralingues due à leur traînée propre est négligée.

- Les cordes sont amarrées à l'extrémité de pointes de filet en mailles de 1600 mm ou 3200 mm (maille étirée) dont les bordures renforcées d'un cordage en nylon ou polyéthylène forment des têtières. Ces dernières ont une longueur qui dépend du nombre de mailles (en hauteur) des pointes, déterminé en fonction du nombre de cordes voulu. Celles-ci sont établies dans l'axe des pointes afin que la traction s'exerce dans leur plan de symétrie.

- On estime que les tractions sont égales sur chaque pointe.

METHODE DE CALCUL

Celle-ci est établie en ne considérant qu'une demi face puisqu'il existe une symétrie bilatérale. Le dynamique des forces (fig. 1) permet de déterminer les angles des différentes parties de la ralingue.

Pour un même ensemble de forces il existe une infinité de funiculaires possible en fonction de la distance du pôle O ce qui revient à dire que la longueur des ailes n'est pas définie à priori.

Il faut donc se fixer une longueur arbitraire (X) qui peut être vousine de celle d'une aile de chalut en mailles de grandeur équivalente.

Enfin, il est nécessaire d'estimer l'ouverture des mailles pour fixer la distance entre les cordes.

Détermination du funiculaire en fonction de X:

Etant donné que:

X est la hauteur de l'aile (à partir du carré)

Y est la longueur des deux cordes centrales*

x_1, x_2, x_i .... x_n représentent la distance longitudinale entre 2 points d'amarrage consécutifs des cordes sur la ralingue

l est la distance transversale entre deux cordes voisines (calculée pour une ouverture de maille de 10%)

ε est la distance supplémentaire introduite par l'obliquité (8° et 5° respectivement dans les plans horizontaux et verticaux) de la dernière corde commune à 2 faces, $\varepsilon = (X + Y) . \operatorname{tg} 5$ ou $8°$

On peur écrire:

$$X = \sum_{i=1}^{n} x_i$$

$$= \frac{l}{\sum_{i=1}^{n} \operatorname{tg}\alpha_i} + \frac{\varepsilon}{\operatorname{tg}\alpha_n}$$

où $$\operatorname{tg}\alpha_i = \frac{\sum_{j=1}^{j=n} Fj}{\sum_{j=1}^{j=i} Fj} \times \operatorname{tg}\alpha_n \quad (1)$$

* Notons que, de façon précise, les longueurs X et Y ne sont pas égales sur les faces de dessus et de côté étant donné que celles-ci font un angle différent avec l'axe du chalut.

$$\text{donc } X = \frac{1}{\operatorname{tg} x_n} \cdot \sum_{i=1}^{n} \frac{\sum_{j=1}^{j=i} Fj}{\sum_{j=1}^{j=n} Fj} + \frac{\mathcal{E}}{\operatorname{tg} \alpha_n}$$

comme F1 = F2 = Fn = 1 unité de force

$$X = \frac{\left(\frac{n+1}{2}\right) 1 + \mathcal{E}}{\operatorname{tg} \alpha_n}$$

$$\text{d'où } \operatorname{tg}\alpha_n = \frac{\left(\frac{n+1}{2}\right) 1 + \mathcal{E}}{X} \qquad (2)$$

et d'après (1) il est possible de culculer les angles des autres segments de la ralingue *

Construction graphique:

Les longueurs X et $\left(\frac{n+1}{2}\right) 1 + \mathcal{E}$ de l'équation (2) peuvent être portées sur le plan (fig. 2) et permettre la construction graphique de l'angle α_n et donc des autres angles α_i après division de la longueur X en n parties égales. On construit ainsi directement sur le plan du chalut le dynamique des forces.

Cas particulier:

Pour éviter qu'à la jonction entre 2 faces consécutives du chalut ne se trouve un trop grande vide dû à l'obliquité de la corde commune à celles-ci, il est possible de faire partir trois cordes au lieu d'une seule de ce point, la tension de chacune d'elles est alors le tiers de celle unique.

Le raisonnement précédent est applicable, mais:

$$X = \sum_{i=1}^{i=n-1} \frac{1}{\operatorname{tg}\alpha_i} + \frac{\mathcal{E}}{\operatorname{tg}\alpha_n}$$

$$X = \frac{1}{\operatorname{tg}\alpha_n} \cdot \sum_{i=1}^{n-1} \frac{\sum_{j=1}^{j=i} Fj}{\sum_{j=1}^{j=n} Fj} + \frac{\mathcal{E}}{\operatorname{tg}\alpha_n}$$

* Les angles calculés sont reportés et les longueurs lues sur un plan à l'échelle ou bien les segments x_1 ou x_2, etc sont calculés à l'aide de relations trigonométriques.

Comme F1 = F2 = Fi = 3 Fn = 1 unité de force

$$X = \frac{1}{tg\alpha_n} \cdot \frac{(n-1)\frac{n}{2}}{n - \frac{2}{3}} + \frac{\varepsilon}{tg\alpha_n}$$

$$\text{et } tg\,\alpha_n = \frac{1\,(n-1)\frac{n}{2}}{X\,(n - \frac{2}{3})} + \frac{\varepsilon}{X}$$

A partir de cette valeur de tg α_n il est possible de calculer les tangentes des autres angles.

Conclusion

Une maquette de chalut à cordes au 1/25e calculée d'après la méthode ci-dessus a été essayée dans le bassin d'essai de Boulogne-sur-Mer.
Les différentes pointes de filet étaient tirées suivant leur axe et leurs extrémités se situaient pratiquement toute dans un même plan. En annexe est joint un plan de chalut pélagique pour un bateau de 400-500 ch calculé d'après le principe démontré (fig. 4).

L'analyse de l'équilibre des forces au point d'amarrage des bras sur la pointe de l'aile, laisse penser que l'angle x_n est plus ou moins déterminé en fonction du nombre relatif de cordes sur les faces horizontales et verticales, de l'angle du bras et des faces.

Les tensions se répartissent également sur le filet uniquement pour un écartement et une ouverture déterminée de l'engin. Au moment du filage et du virage, par exemple, la traction s'exerce presque totalement sur les 4 cordes formant les arêtes de la pyramide.

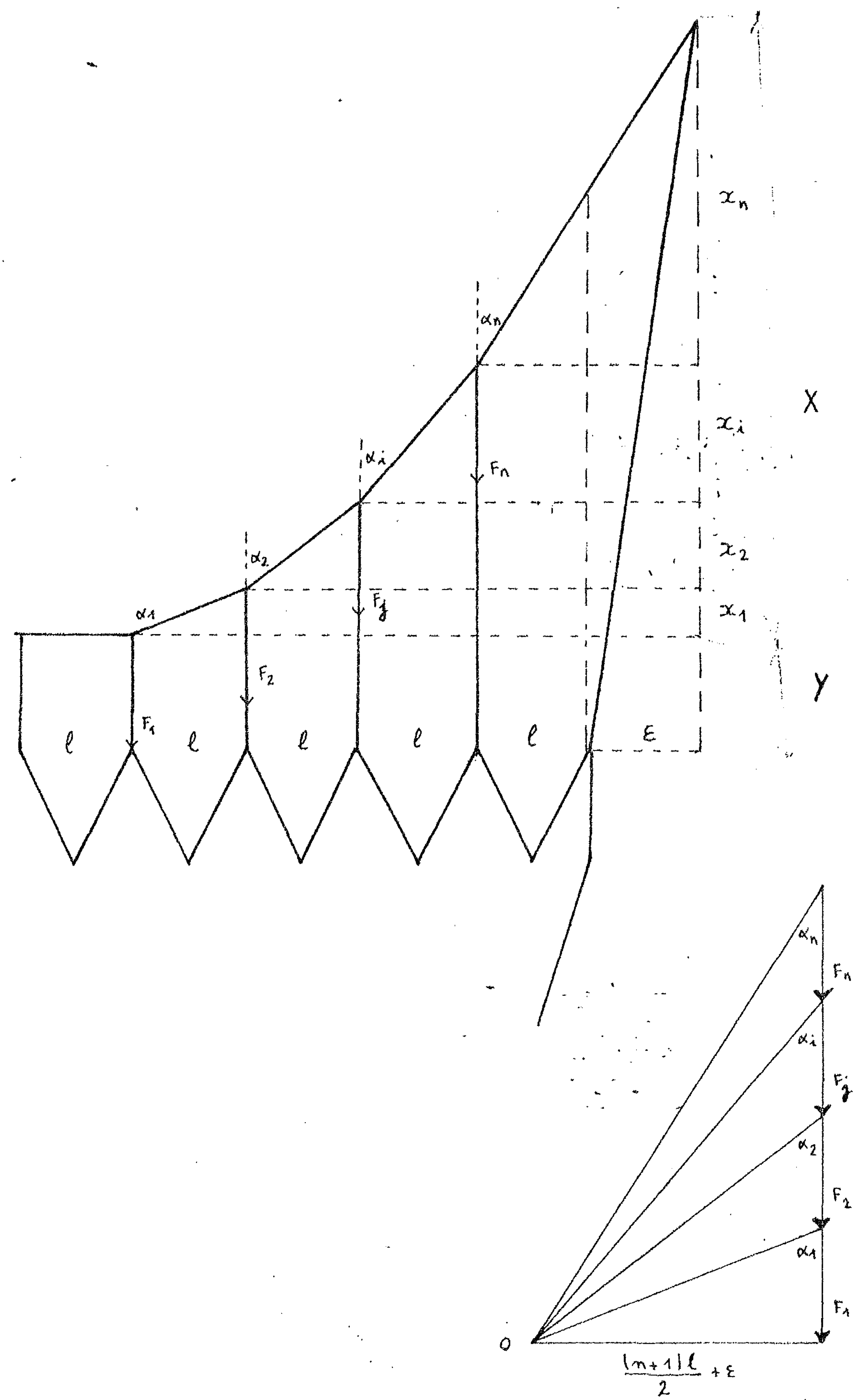

x_n
α_n
X
x_i
α_i
F_n
x_2
α_2
F_j
x_1
α_1
F_2
Y
F_1
ℓ
ε
α_n
F_n
α_i
F_j
α_2
F_2
α_1
F_1
O
$\frac{(n+1)\ell}{2}+\varepsilon$

Fig. 1

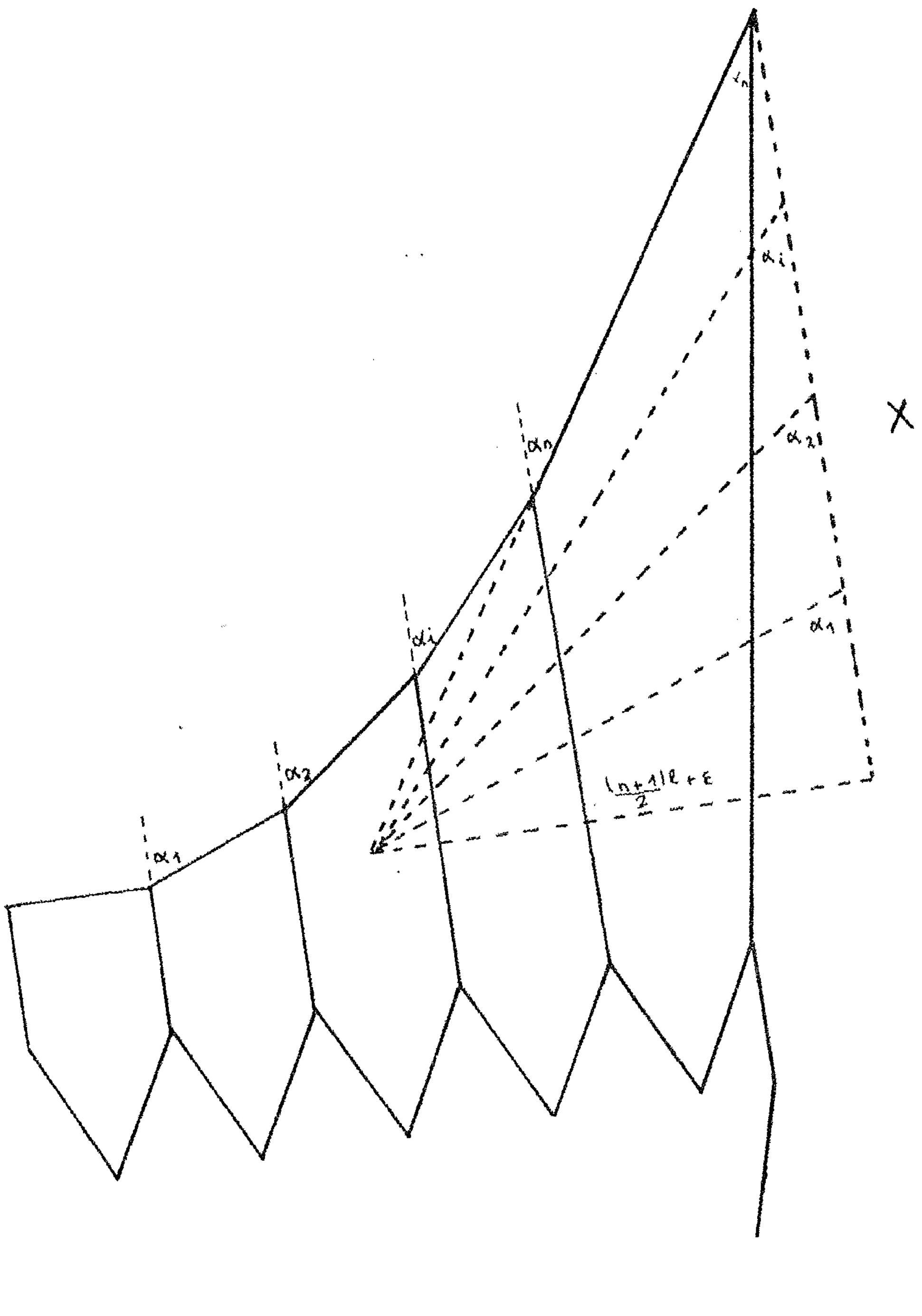


Fig. 2

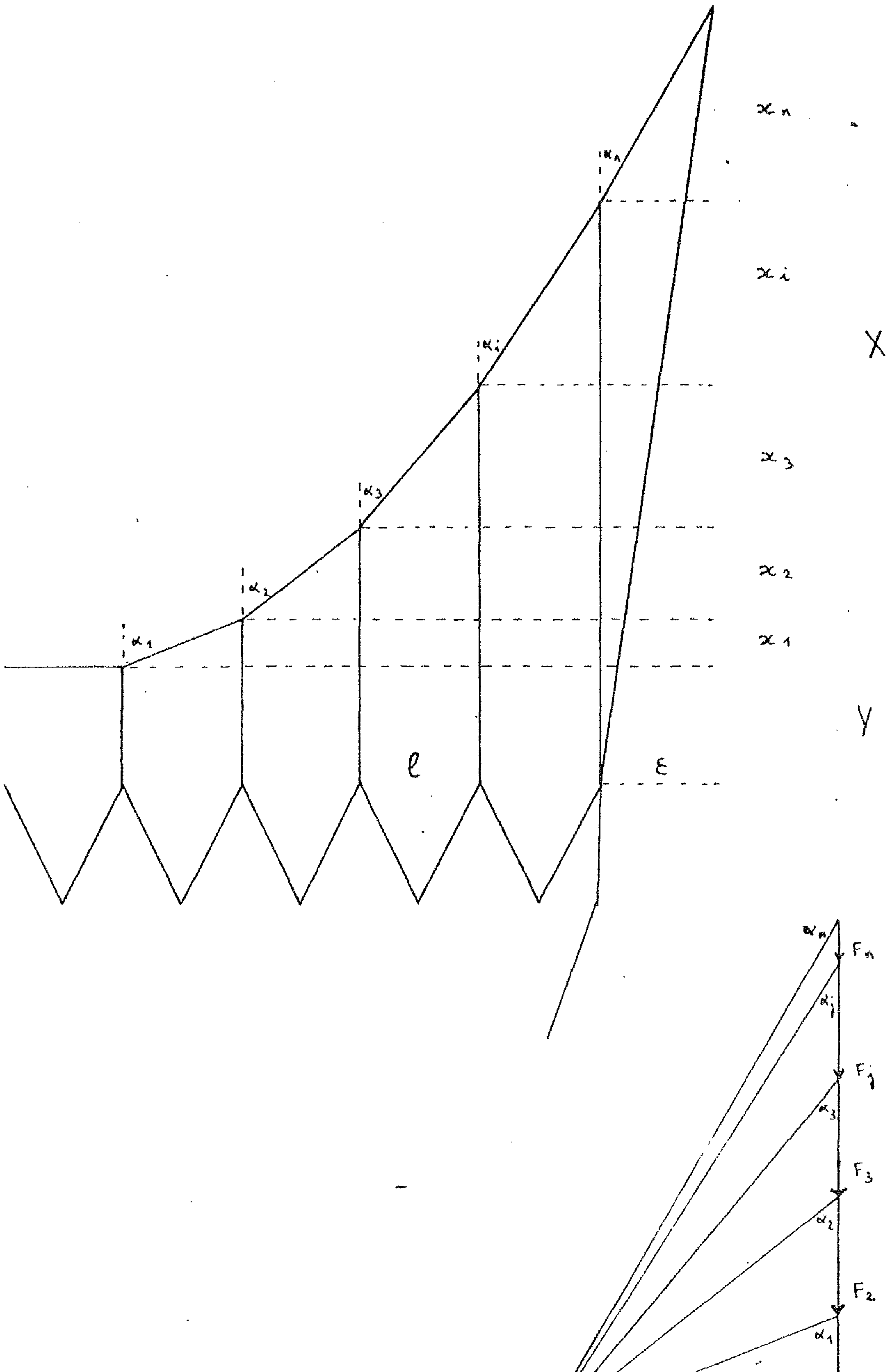
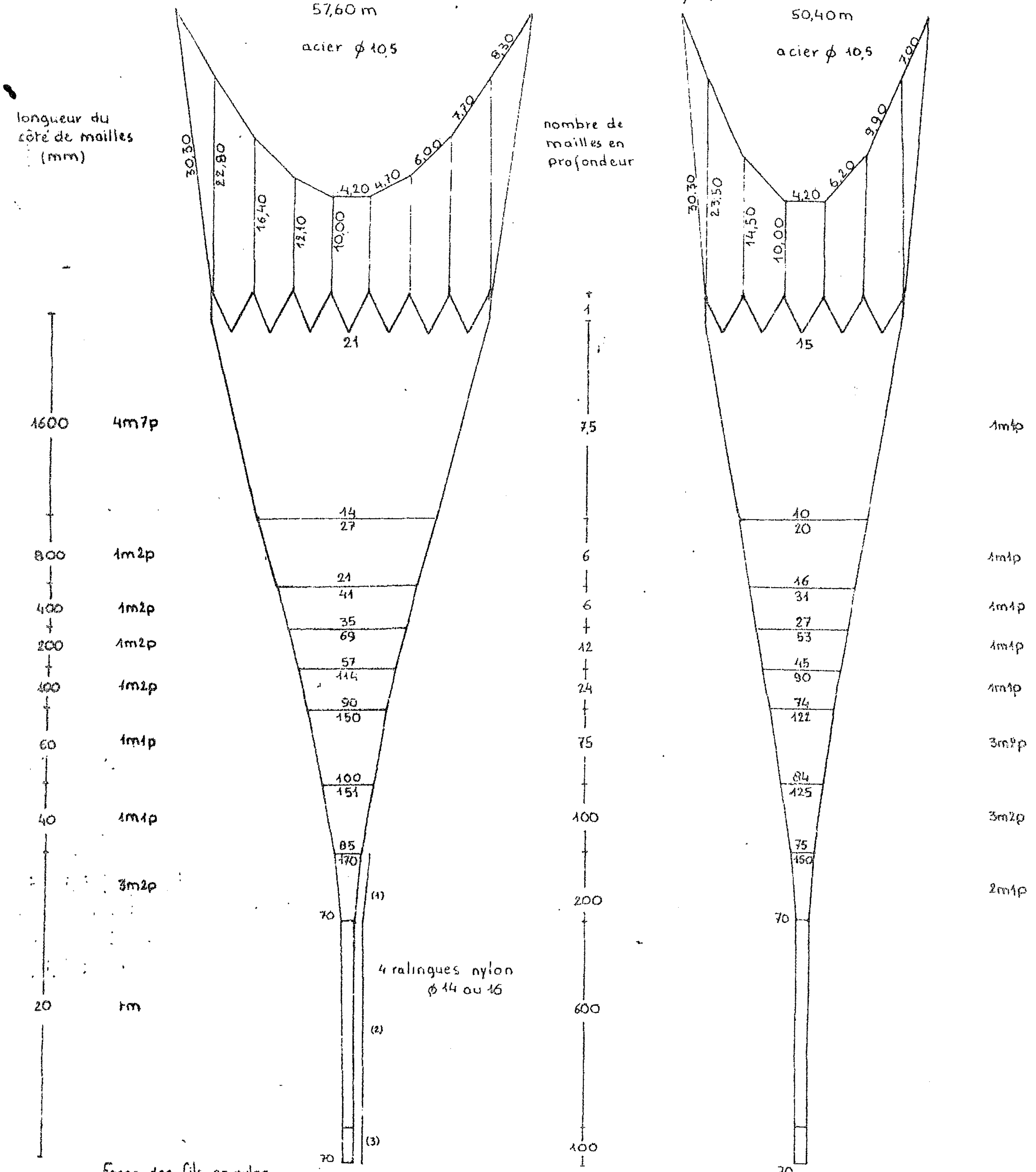

x_n
x_i
X
x_3
x_2
x_1
Y
α_n
α_i
α_3
α_2
α_1
ℓ
ε
F_n
α_j
F_j
α_3
F_3
α_2
F_2
α_1
F_1

Fig. 3

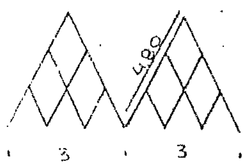


Force des fils en nylon

1600 mm en 110 m/kg ou 9100 R tex
800 mm en 180 m/kg ou 5500 R tex
400 mm en 270 m/kg ou 3700 R tex
200 mm en 400 m/kg ou 2500 R tex
100 mm en 600 m/kg ou 1660 R tex
60 mm en 1060 m/kg ou 940 R tex
40 mm en 1060 m/kg ou 940 R tex
(1) 20 mm en 1060 m/kg ou 940 R tex
(2) 20 mm en 600 m/kg ou 1660 R-tex
(3) 20 mm en 600 m/kg lacé double

Note: les mailles de couture sont à ajouter aux largeurs [illegible]

Détail des pointes



Têtières nylon ou polypropylène ϕ 6 ou 8

Chalut rectangulaire 4 faces 57,60 x 50,40 m	1 bateau de 400.500 CV
type pélagique à cordes	ech 1/400e Ref: P 149
Institut des Pêches Maritimes	Boulogne/mer II 77

Review of the Netherlands' Investigations into a pelagic rope trawl by A. Verbaan.

SUMMARY

As alreay mentioned in the "Report of the Working Group on Research and Engineering Aspects of Fishing Gear, Vessels and Equipment" number C.M.1976/B:7 item 4.3., the research for rope trawls in the Netherlands started in January 1976. The main object was to catch, with this type of trawl, herring on a rough bottom.
One of the criteria is that the rigging of rope trawls must be the same as the rigging of a meshed midwater trawl for the same propulsive power.
In that case it is easy for the fishermen at sea to switch from a common midwater trawl to a rope trawl.
The first rope trawl design was derived from the common midwater trawl of 434 meshes with a stretched length of 800 mm. This midwater trawl is used by vessels with a propulsive power of 1100-1300 hp.
During the whole year 1976 a number of different rope trawls were tested under almost the same conditions and in the same area with the F.R.V. "Tridens".
The tests were carried out under full midwater conditions. In order to compare the different trawls, a number of parameters has to be measured simultaneously. The geometry of these trawls, especially of the front parts, could then be determined.

Paper C.M.1977/L:25 contains details of the most relevant information on the research into the rope trawl in the Netherlands.

Further experiments with sorting panels in prawn trawls

by Ludvig Karlsen

Further trials with the HH-separating panel in prawn trawls continued in northern Norway in September and November 1976 with two trawlers, the 110 feet "Feiebas" and the 60 feet "Rundfjell".

In March 1977 the work continued with the "Rundfjell", and a separating panel was also installed on the 46 ft commercial prawn trawler "Rønvikbuen", fishing in the Bodø area.

The "Feiebas" achieved good separating of small fish with a HH 80/40-net (80 m/m in upper part and 40 m/m in lower part of the net) in a heavy 1400 meshes highopening Super Trawl. As illustrated in figure 2 about two-third of the 1-group cod and haddock were sorted out. However, a prawn loss of nearly 20% on average, was not considered acceptable.

The trials on board the "Rundfjell" with a HHR 80/50 panel in a light 1300 meshes Sputnik Trawl gave rather disappointing separation of small fish, while prawn retention was very good (96.5%). Altering to 60 mm mesh size in the upper part of the net improved fish separation radically, while shrimp retension was still acceptable. Average prawn loss for the experiments with the HH 60/50-panel in September was 6%, in November 9.5% and in March this year 6.5%.
Figure 3 and 4 give the figures of cod and haddock separation for the two latest experiment periods.

During the trials on board the "Rønvikbuen" more than 90% of small (16-25 cm) haddock and about 70% of small (10-14 cm) Norway Pout was sorted out with a HH 60/50-net in the 30 fathom (length of fishing line) wing trawl, while on average 10.5% shrimp loss was experienced for the 6 hauls with the fish bag in operation.

Experiments with separating panels in the Ocean Trawls will continue this summer during a cruise in the Barents Sea, with main object to improve separation of small flounder and redfish and reduce shrimp loss for these heavy types of trawls. With respect to the coastal trawl types, experiments will continue this year on smaller scale to establish more accurate figures of the sorting qualities of the HH-nets. Besides, more attention will be paid to introduce the nets to the fishermen. According to plans trials will be arranged with 5 commercial trawlers, of which "Rønvikbuen" was the first, in different shrimp fishing regions of Norway to use the nets for certain periods in commercial fishing operations.

References:

Karlsen, L. 1976. Experiments with selective prawn trawls in Norway. ICES Gear & Behaviour Comm., CM1976/B:28, 1-7, 1tab., 2 figs.

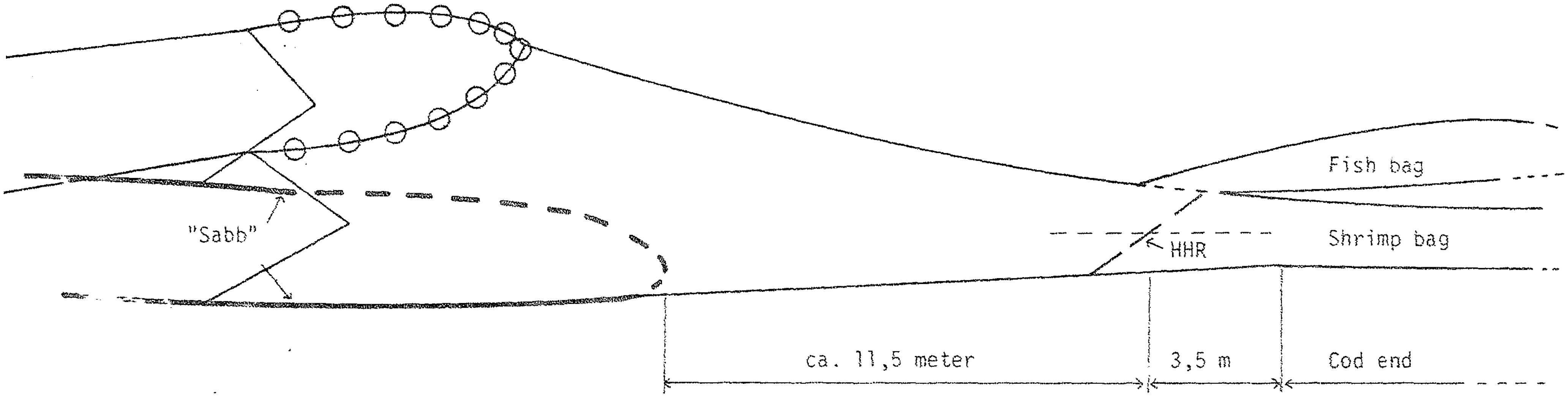


Fig. 1. Position of HHR separating panel in 1300 meshes Sputnik Shrimp Trawl.

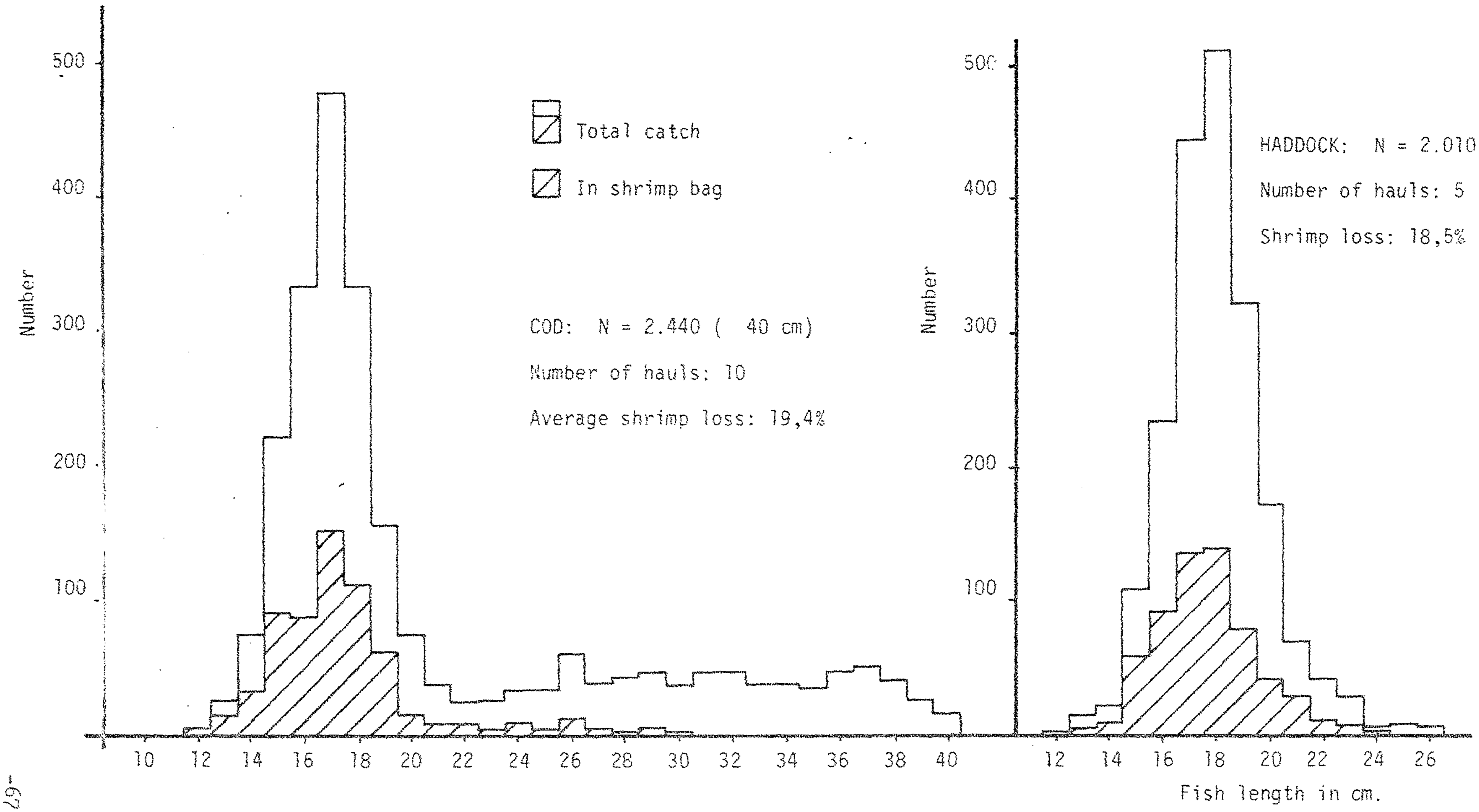


Fig. 2. Total catch of fish and catch in shrimp bag (Trawl cod end) for 1400 meshes Super Shrimp Trawl with HH 90/40 sorting panel. M/S "Fejebas" in Northern Fjords in September 1976.

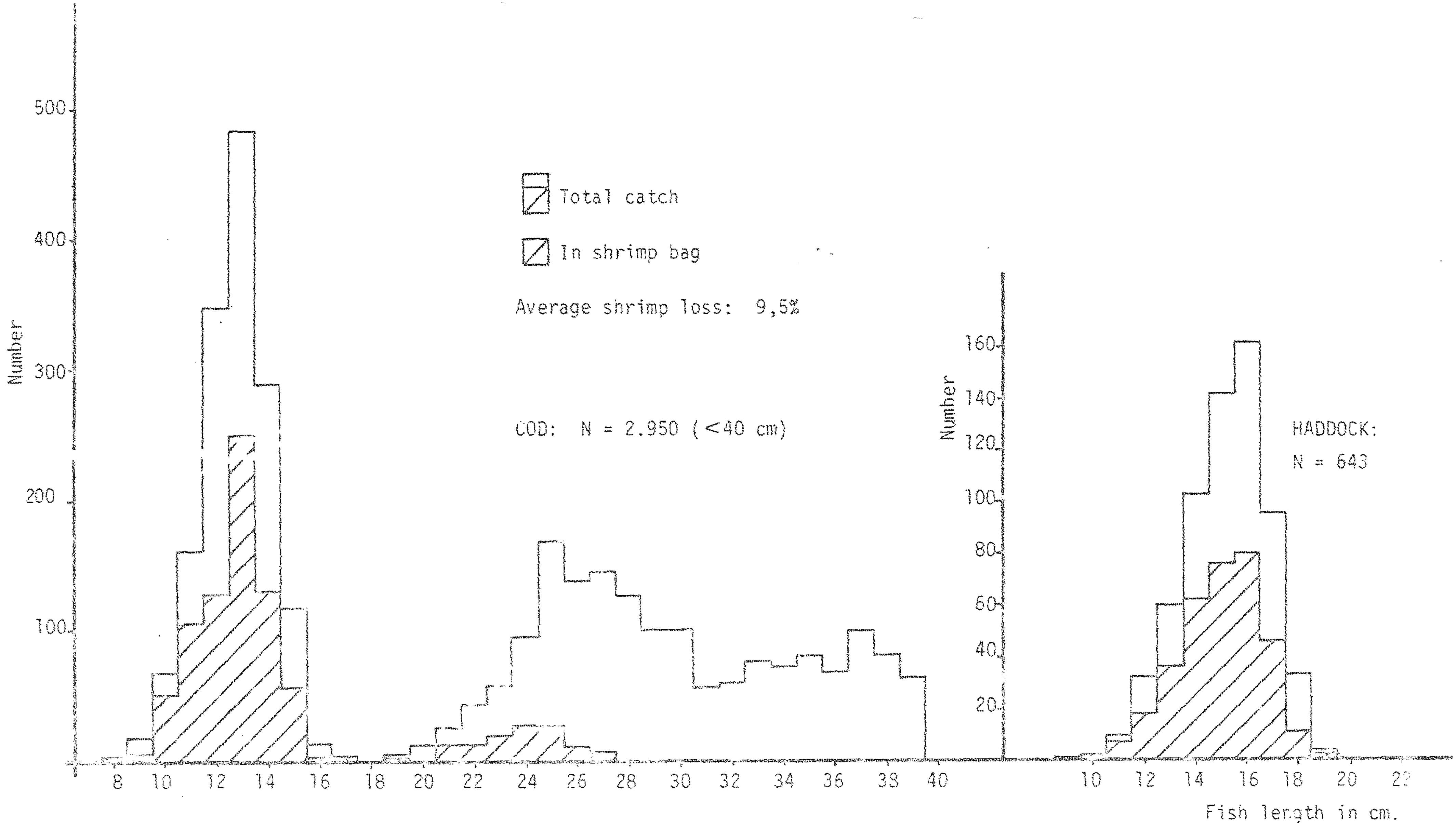


Fig. 3. Total catch of fish and fish in shrimp bag (Trawl cod end) for 1300 meshes Sputnik Trawl with HHR 60/50 separating panel. From 8 hauls in Northern Fjords in November 1976 with "Rundfjell".

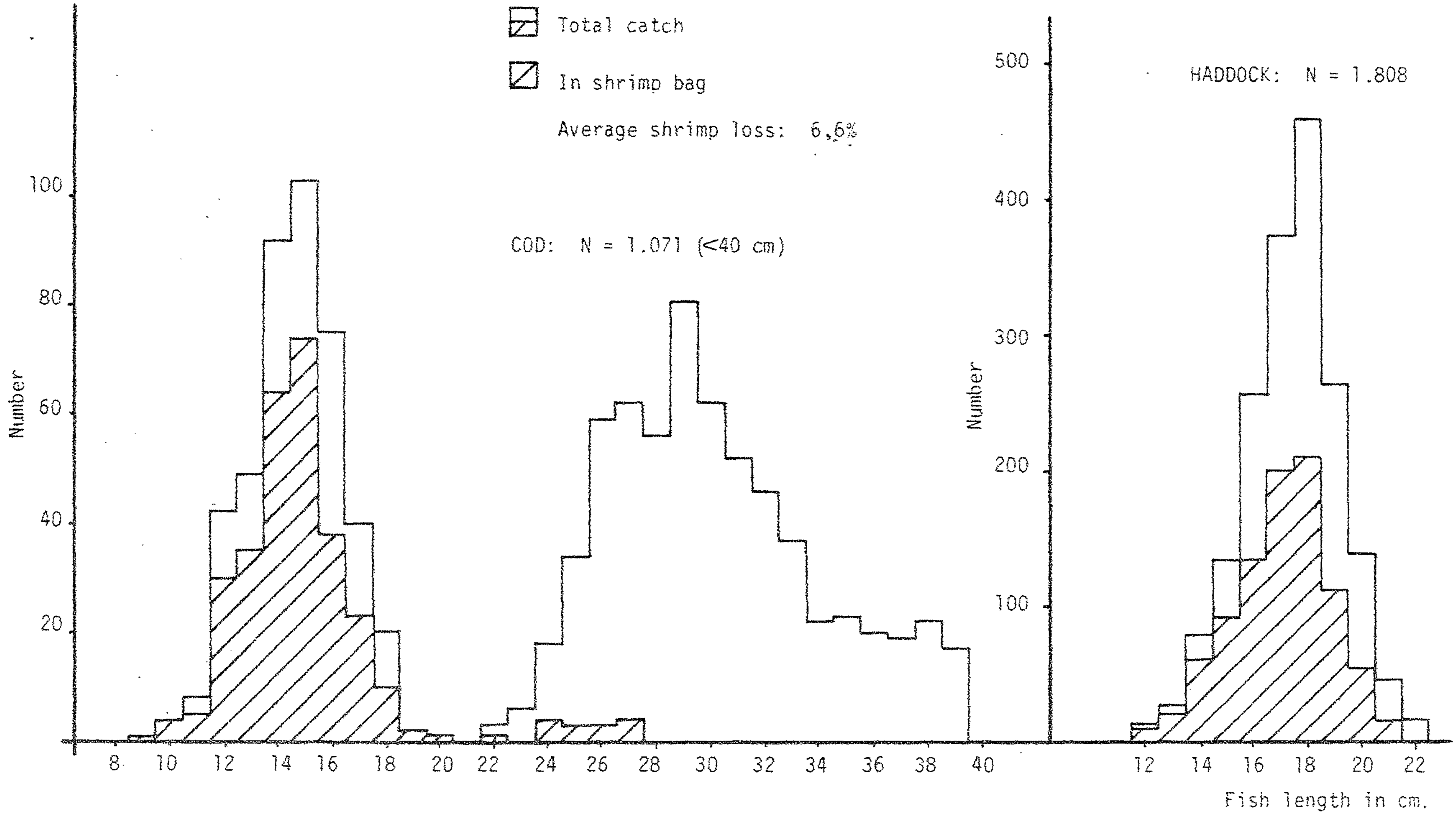


Fig. 4. Total catch of fish and fish in shrimp bag (trawl cod end) for Experimental Trawl with HHR 60/50 separating panel. From 7 hauls in Northern Fjords in March 1977, with "Rundfjell".

Selectivity experiments with topside chafers and round straps

by Arvid Kolbjørn Beltestad

The aim of the experiments was to examine the effects on codend trawl selectivity by using different types of topside chafers and round straps. The experiments were carried out in September/October 1976 on board the 41.2 m commercial stern trawler "Vikheim" during a cruise to the Barents Sea.

The trawl used was a standard Granton bottom trawl with a nylon codend of 130 mm mesh size. The codend cover, of polyethylene, was fitted to the codend in accordance with ICES specification.

Three topside chafers of different mesh size, 2, 3 and 4 times that of the codend mesh size, were tested. The chafers, made of polyamide, were fitted to the codend along the forward, lateral and rear edges only.

The round straps used were of 22 mm polyamide. The straps were only fixed through loops on the lacing ropes of the codend. The distance between each round strap was in all hauls 1.1 m. The selectivity was examined for three different strap lengths, respectively 50, 45 and 40% of the circumference of the codend (stretched meshes).

For comparisons, the selection factor was estimated from standard covered codend hauls without topside chafers or round straps.

Fiftyfive successful trawl hauls were carried out in the areas of Tiddly Bank and Thor Iversen Bank on fairly good concentration of medium and large cod. The catches of round fish taken were almost exclusively cod, by-catches of other species were neglectable. Total catches ranged from 0.4 to 3.5 metric tons per 2-4 hours fishing time. For the analysis hauls were grouped in intervals of 10 boxes (of 45 kg) total catch (codend + cover). The selection factors were estimated from selection curves, using three-point moving averages and fitted by eye. The selection factors obtained from grouped hauls are plotted against the average total catch for standard hauls and with topside chafers in figure 1 and for standard hauls and with round straps in figure 2.

The results indicate that for standard hauls the selection factors decrease with increasing catch. The same reduction with increasing catch is also apparent for topside chafer with 2 and 3 times the mesh size of the codend.

It is also evident that for similar sized catches the selection factor estimated for all chafers are somewhat lower compared with the standard hauls.

A reduction in selection factors with increasing catch is not so obvious for round straps (figure 2), but the material is rather scanty. Also the round straps do not seem to effect the selectivity markedly unless when the strap length is reduced to 40% or less of the circumference of the codend.

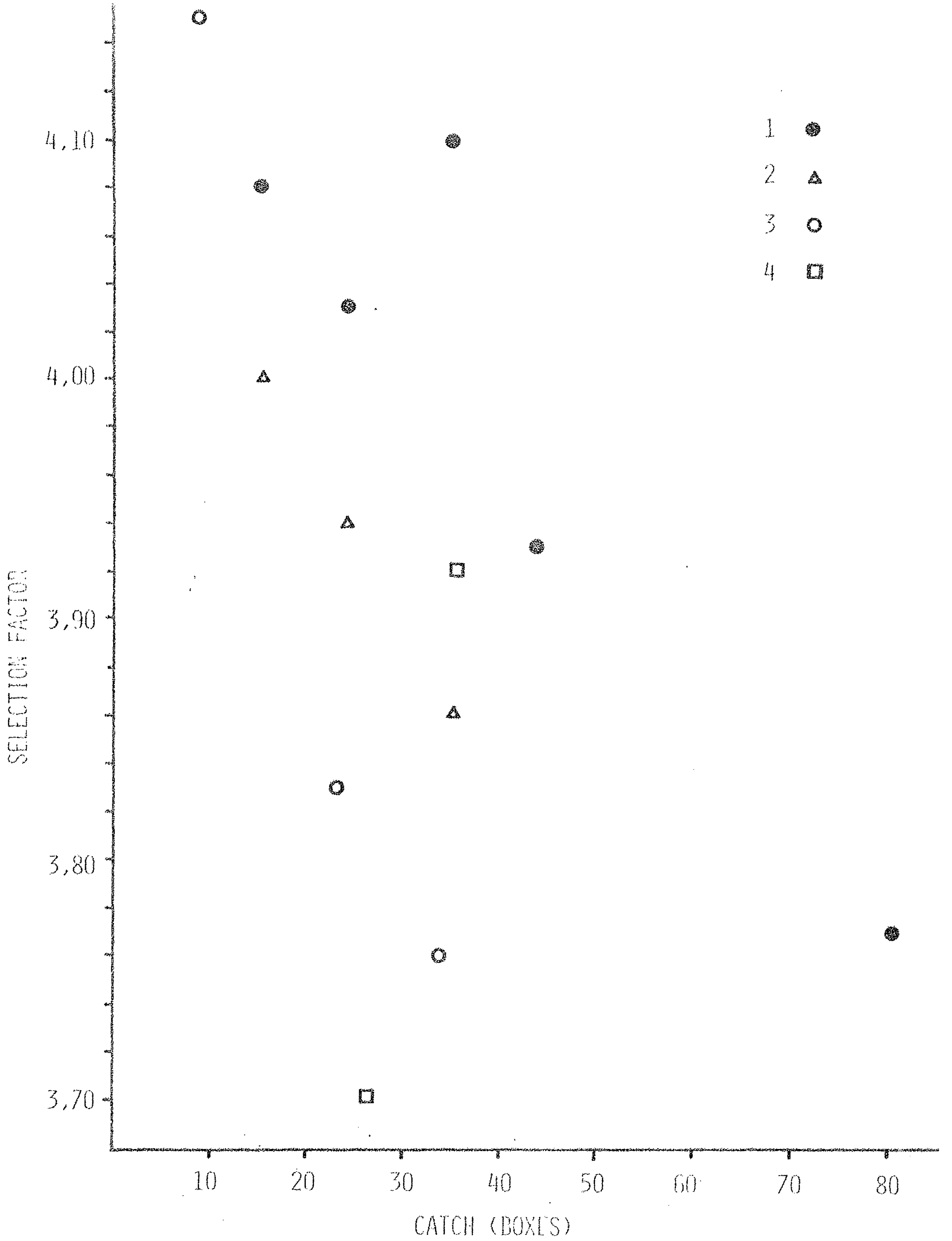


Fig. 1. Relation between selection factors and average total catch for standard hauls and topside chafers.
1 = Standard hauls,
2 = With chafers two times mesh size of the cod end,
3 = " " three " " " " " " "
4 = " " four

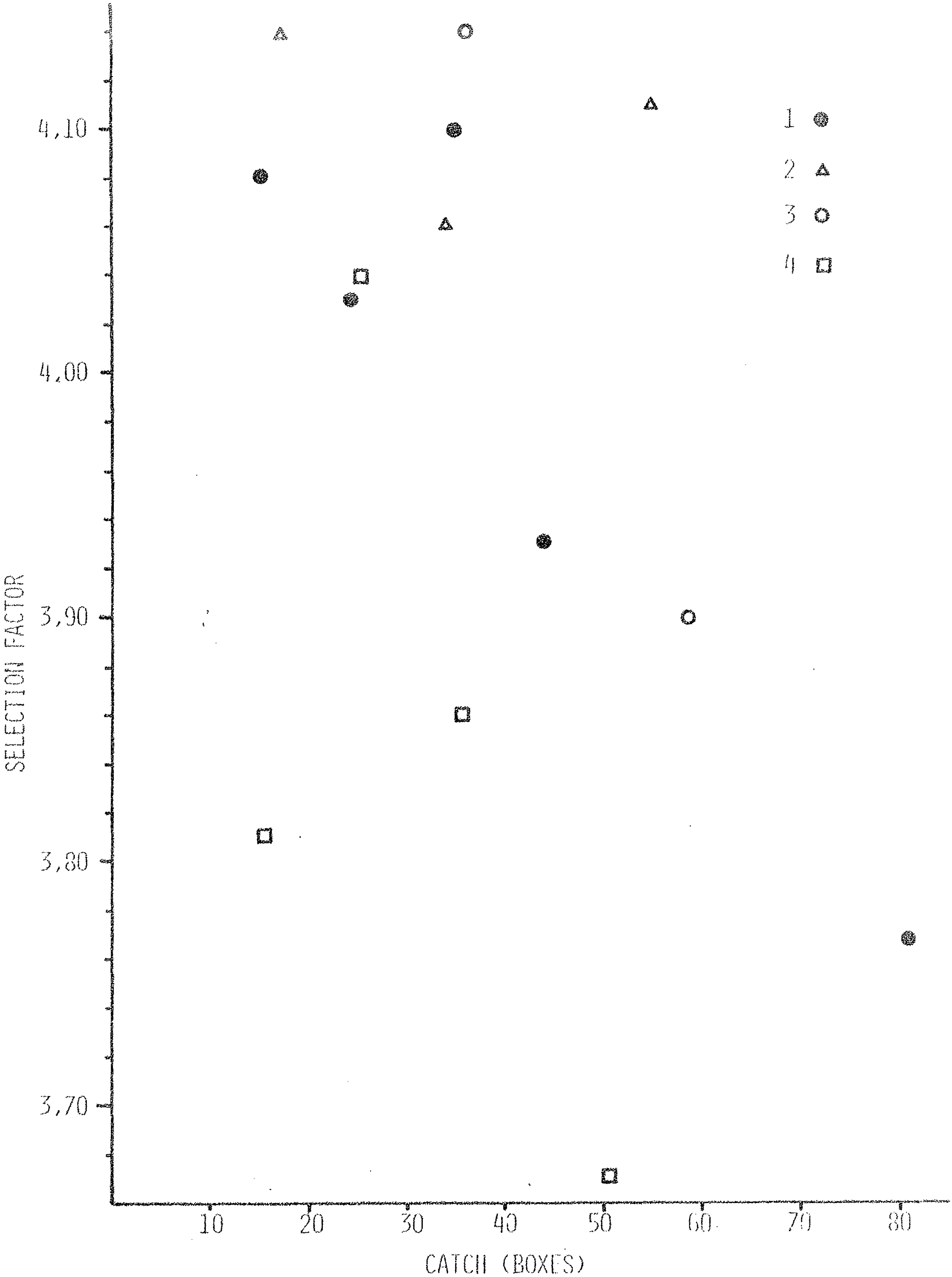


Fig. 2. Relation between selection factors and average total catch for standard hauls and round straps.
1 = Standard hauls,
2 = Straps length of 50% of circumference of the cod end,
3 = " " " 45% " " " " " "
4 = " " " 40% " " " " " "

Model testing of fishing vessels in open waters

by A. Endal.

Introduction

The rapid change in the infrastructure of the Norwegian fisheries has resulted in a demand for new types of fishing vessels with the highest degree of safety, flexibility and adaptability. To meet this demand a lot of designfactors must be changed, which in turn will lead to vessels with hullforms and layout widely different from vessels of the past.

The vessel division of the Institute of Fisheries Technology Research therefore felt a strong need for systematic examination into the resistance- and seakeeping characteristics of these new types of vessels.

Our seakeeping research can be divided into three categories:

I Development of an easy and reliable procedure for evaluating the seakeeping characteristics of a vessel during the design stage.

II The establishment of a set of design-criterias determining the sea conditions that will result in "Breaking-off fishing".

III Providing better knowledge about the sea conditions on the Norwegian continental shelf.

I Development of procedures

a. Background

The most common way to determine ship motion and seakindliness, is by use of the superposition theory (Ref. 1). The significance of this principle is that if we know the "response amplitude operator" (RAO) for a certain response, we can predict the response in any actual or imagined seaway, described by its energy spectrum, provided that the response would vary linearly with the wave height.

By using this procedure we have two possible sources of error:

1. The theoretical calculated RAO is inaccurate.
2. The investigated conditions lies outside the linear regime (too steep and high waves).

Bearing in mind that fishing vessels usually operate in severe conditions with relatively high and steep waves, the mentioned error sources are likely to occur.

Since little has been done to investigate the limitation of this procedure on fishing vessels (at least little is published), the Institute felt the need of an investigation into this field.
The best way to conduct these investigations, is to compare theoretical calculated RAO with RAO calculated from full- or model scale measurements (free running).

When the measurements are made in the sea conditions ranging from calm to rough and for all ship headings, this will give us valuable data concerning the two error sources.
At the same time other useful features of the vessels behaviour can be studied, i.e. frequency of shipping green water over bow and stern, propeller racing, emergence of bow, tendency of broaching, general manoeuvrebility, and speed loss in waves.

When we started the research program it was soon clear that with the mentioned outline, neither full scale nor tests in the NSFI Ship Model Tank in Trondheim would be suitable both from a practical and economical view.

We therefore decided to develope our own model-testing technique in open waters, in order to provide as much data as possible at minimum cost.

b. Preliminary investigation

To investigate the applicability of our technique, preliminary tests started summer 1976.

First we had to find a usable test area, without disturbances from other vessels and currents. This was rather difficult, without travelling too far out on the fjord. At a distance of 1 km from our base we found an acceptable area where we could perform our tests.

The tests were made with a 2.7 m (scale 1:5) long model of a semi-planing fishing boat. The model was propelled with an aircooled engine, delivering approx. 8 HP at 3600 o/min.
No attempt was made to scale propeller rpm. Instead the engine was run to give the desired ahead speed. The engine speed and rudder action were radio-controlled from a speedboat.

On board instrumentation consisted of a gyro for the measurement of pitch and roll, and a vertical accelerometer, the data from which could be used to derive the heave motions.
For the measurements of thrust, a transducer was mounted on the propeller shaft.

The speed was measured by means of a "pitot-tube" connected to a pressure transducer.

All the data was recorded on a Tandberg 4-track tape recorder placed onboard the model. Before the testing started, the model, complete with all the above equipment, batteries, power supplies etc., was ballasted to the correct displacement with reasonable values of the C.G. position and longitudenal and transverse radii of gyration.

Wave conditions were recorded by means of a free-floating accelerometer wave buoy, the signals from which were fed by means of a cable to a tape recorder on board the speed boat.

The tests were carried out in the following manner:

First the wave conditions were recorded ten minutes in the middle of the selected area.

Then the model was run with the desired speed at various headings to the predominant wave direction for approx. 10 minutes (see figure 1).

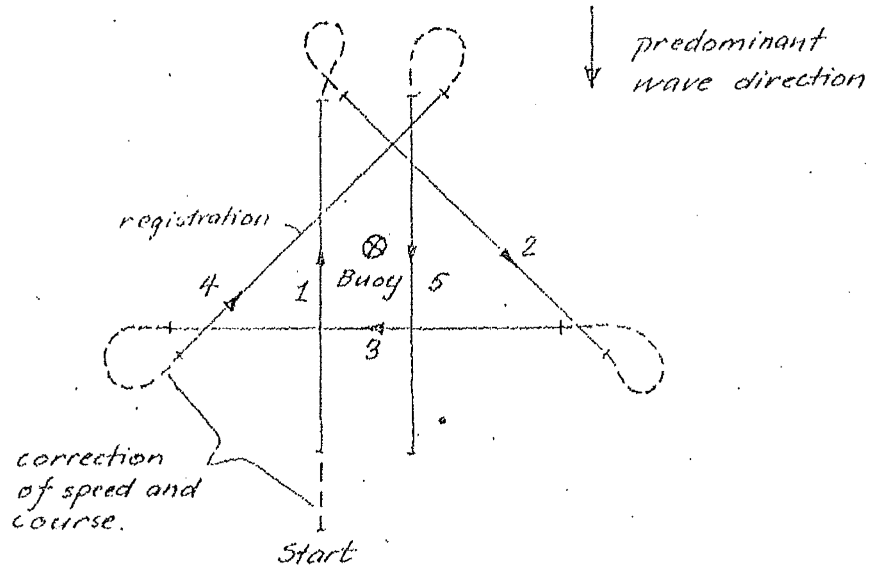


Fig. 1. Running of the model with 5 headings.

Between each heading the model was manoeuvered in such a way, that is was running in the neighbourhood of the buoy.

This was done to ensure that the model encountered the wave conditions recorded by the wave buoy.

During most of the trials we measured the pitch, roll and speed. On the fourth channel we recorded comments via walkie-talkie.

Wave recordings were also made if the weather changed significantly.

c. Results from the preliminary tests

The first aspect we had to control, was whether the sea conditions in the test-area had a reasonable similarity to the sea conditions on the Norwegian continental shelf.

This was done by spectral analysis of the wave data and comparison with analytical wave energy spectra. Investigations carrier (ref. 2) showed that the JONSWAP spectrum would give the best representation.
Figure 2 shows a typical wave energyspectrum from one of the trials, compared with a down scaled JONSWAP spectrum.

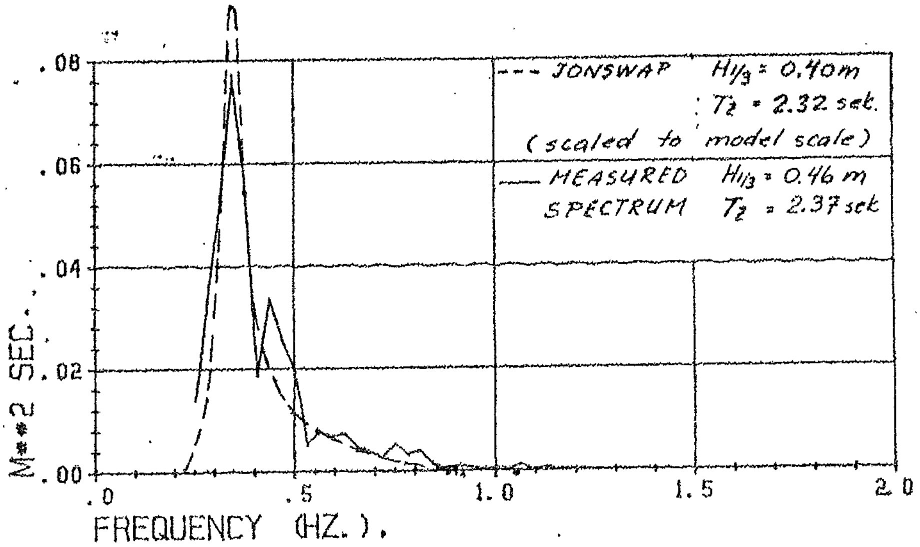


Fig. 2 Wave energy spectra.

As we see from this figure, the conformity was good and it was therefore concluded that the test conditions in the Trondheim fjord would be suitable for our purposes.

Unfortunately these preliminary investigations gave us little motion data, because a lot of operating experience had to be gained and mistakes were of course made.

However, the only intention with these tests, was to get an indication whether the procedure was usable or not.

The data are not fully analysed, lacking the data of pitching. Some of the rolling data obtained are shown in figure 3.

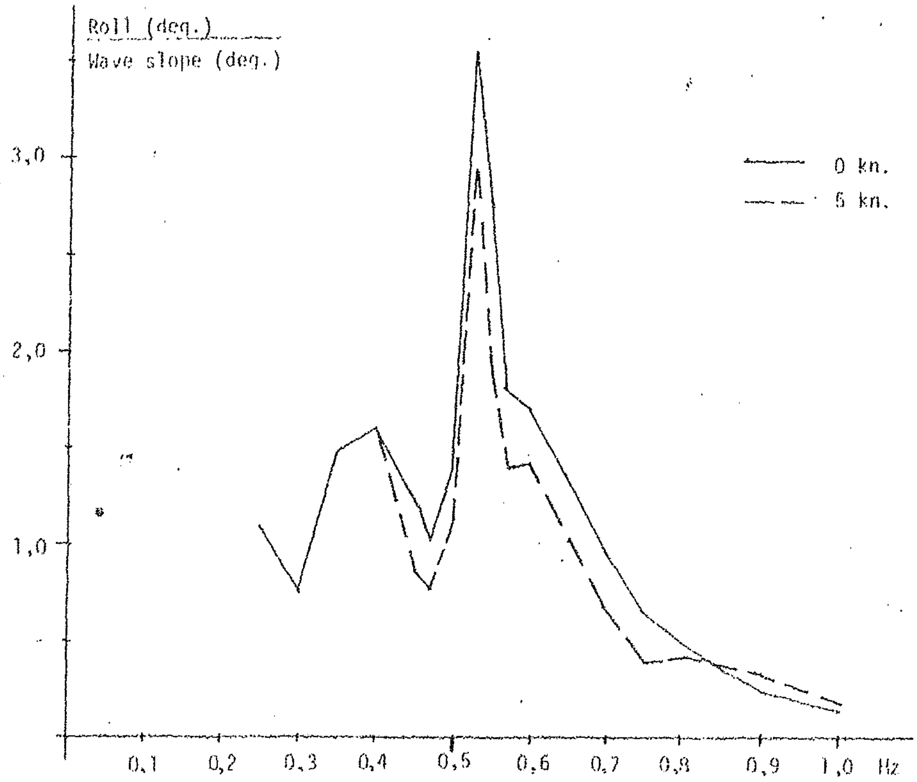


Fig. 3 The Response Amplitude Operator (RAO) for rolling i beam sea.

The results indicated that the method could be suitable for obtaining quantitative data, provided that a more sophisticated measuring- and analysing technique is developed.

During the tests we also made some qualitative observations of the vessels seakeeping abilities, and a film was also taken.

When the film is shown at a speed scaled with a factor of the square root of the model scale, the motions will appear to be close to the full scale rate. This can prove to be a useful way to reveal characteristics not covered by the other data.

The conclusion must therefore be that this is a possible way to get a better understanding and description of the vessels seakeeping abilities.

d. Future work.

With basis in the experience from the preliminary investigation a new procedure is under preparation.

The objective of this work, is to develop a "simple" and reliable procedure for collecting and analysing data.

In this work emphasis has been concentrated on a reduction (saving) of equipment and weights on board the model.

The planned system is shown in figure 4. With this system we will have the following possibilities:

- Measure data in the model, and transmit them by radio to the base of operations.

- To store the data, with possibilities of retrieving them in the original form.

- Surveillance of selected events (for instance the rolling motion), on oscilloscope or plotter.

- Calculation of the spectra and/or other interesting statistical properties, by the use of a mini-computer.

- Graphical presentation of data on a display.

This procedure will give us much more flexible and accurate testing operations.

By continious surveillance of the data we will be able to detect failure of the equipment, significant changes in sea conditions, etc.

The most important feature is that the analysis is performed immediately, and this will enable us to make changes in the testing program in order to investigate interesting aspects that might be revealed during the tests.

With this new procedure we are hoping to carry out the following investigations:

I <u>Motions:</u>
Measure heave, roll, pitch and surge, and make qualitative observations of bow emergence and shipping of green water at bow and stern.

II <u>Manoeuvering:</u>
Perform the "circle trial", measuring the tactical diameter for various conditions and rudder deflections (see figure 5). Perform the "pull-out test", in order to test the course stability of the vessel.

The test procedure is to put the model into a turn with the rudder, and when turning steadily the rudder is put amidships and the resultant rate of turn is measured (see figure 6). In addition qualitative observations will be made of the vessels ability to maintain course in waves and tendency of "broaching-to" in following sea.

III <u>Resistance:</u>
Measure the thrust and speed at different headings in waves (speed-loss).

IV Filming of special situations.

We expect to have part of the equipment available this summer, and to start test runs, establishing procedures etc.

This paper is an attempt to describe very briefly the work we have performed in this field, and to outline what we have in mind for the future.

Our intention with this work is to develop more suitable methods for investigating the seagoing qualities of the new types of vessels we are developing. Methods that will yield practical results, and that will enable us to design vessels that will meet the exacting demands of the future.

References:

1. St. Denis, M. and Pierson, W.J.
"On the motions of ships in confused seas"
SNAME, Vol. 61, 1953.

2. Houmb, O.G. and Overvik, T.
"On the statistical properties of 115 wave records from the Norwegian continental shelf".
Division of Port and Ocean Engineering. The Norwegian Institute of Technology, Trondheim. Published January 1977.

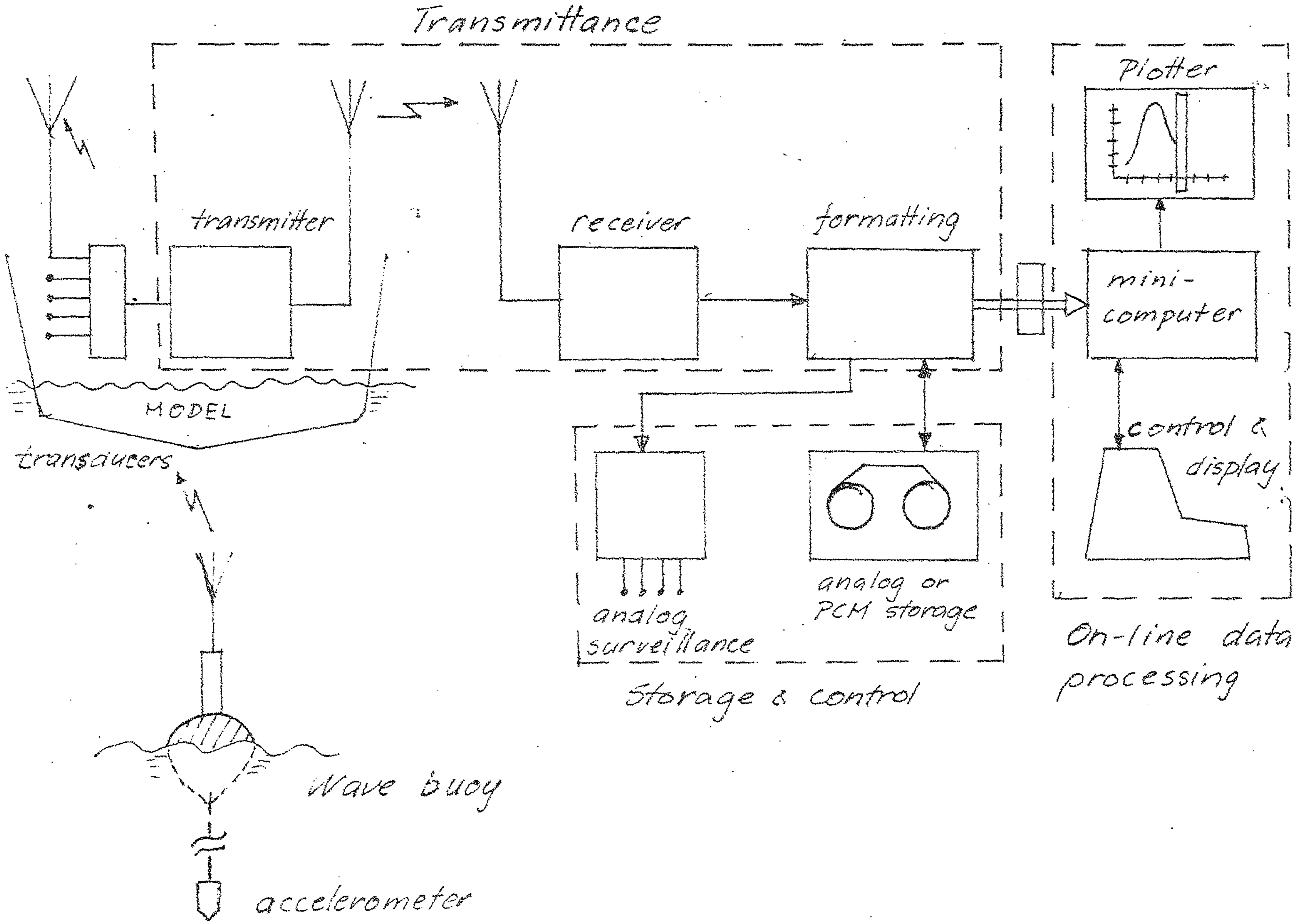


Fig. 4 The system for data analysis

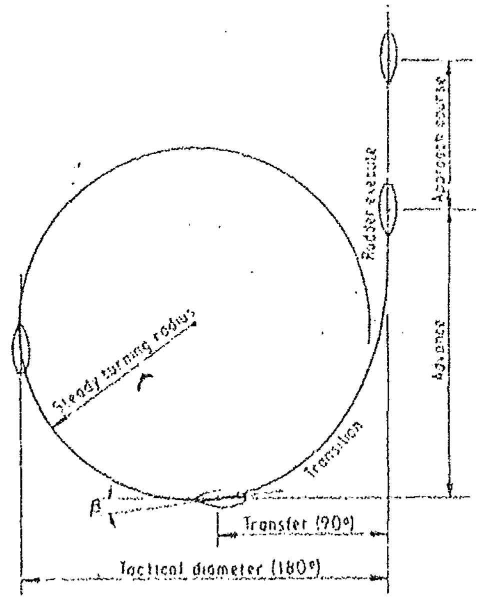


Fig. 5 Circle - trial.

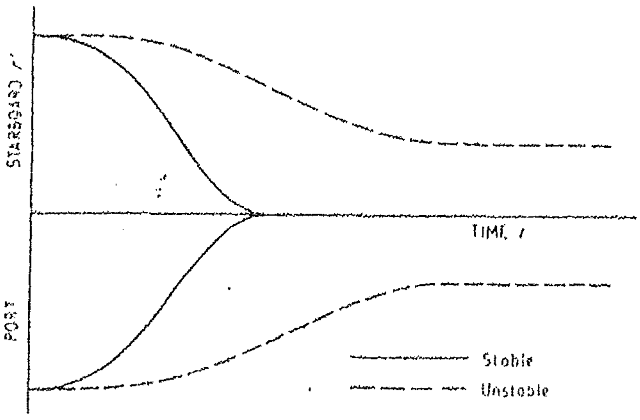


Fig. 6 Results of four "pull-out" tests.

Performance trials on a Scottish purse seiner.

Introduction

The Industrial Development Unit of the White Fish Authority has since its formation in 1963 been actively engaged in carrying out instrumented performance trials on selected types of fishing vessels. The vessels which have been the subject of these trials have included Scottish fly draggers (2), pelagic pair trawlers (2), demersal side trawlers (2), wet stern trawler (1), double beam trawler (1) and freezer stern trawlers (5). It has been the aim of the Unit to cover as far as possible, all methods of fishing operations carried out by the United Kingdom fleet. The object of this work has been to obtain reliable data on the performance of the vessels and their equipment to assist in subsequent development programmes to improve their efficiency and safety of working methods.

The latest vessel type to be of the subject of an instrumented trial was a Scottish purse seiner. This vessel is typical of the second generation purse seiners being introduced into the Scottish herring fleet. The skiff has given way to side thrusters at bow and stern and the fishroom consists of a conventional fishroom in the forepart and three insulated fish tanks in the aft part. These tanks are built "in situ" and designed to carry the catch in chilled sea water using fresh water ice taken onboard in port.

Purse seining is a relatively new type of fishing operation in the context of the British fishing industry. The first purpose built vessel entered service in 1967 and the number has increased yearly to its present level of 35. Whilst it was possible to see each successive vessel becoming more sophisticated than its predecessor with large installed powers, more powerful winches and side thrusters, no quantative measurements had been taken to establish the manner in which this machinery was being used. To fill the gap in existing knowledge, the Herring Industry Board and the White Fish Authority made arrangements in 1972 with the owner of a vessel then in the process of being designed to have a scientist cabin with permanent wiring for instrumentation built into the vessel. The vessel was delivered in May 1974 and instrumented measured mile trials carried out in September of that year, followed by side thruster trials in March 1975 and fishing trials in June 1975.

Description of vessel

The vessel was designed and built by Hall Russells, Aberdeen with the dual role capability of purse seiner or trawler (figure 1).

The vessel is of all welded steel construction with an overall length of 26.94 m and a design displacement of 300 tonnes.

Further details of the vessel and its equipment is given in table 1.

Instrumentation

The instruments for the trials were supplied and installed by the Industrial Development Unit.

The various parameters measured together with corresponding transducers and location are listed in table 2.

Data was either recorded on a multi-channel U.V. recorder or noted by hand.

Performance trials

Measured mile

To establish the free running performance of the vessel, three double runs and one single run of the Aberdeen measured mile were carried out. One pair of double runs were carried out for each nominal engine speed setting of 910, 830 and 730 revs/min. The time on the measured mile was limited by the deterioration in the weather as indicated by the maximum pitch and roll ampitudes recorded during run 7 and listed in table 4. The measured shaft powers, ship's speed and engine revolutions are given in table 3.

Correction to ship speed for shallow water effect on the mile has been made using Schlichting's method (Reference 1) and the results in the form of speed/power and speed/engine revolutions curves shown in figure 2.

Side thruster trials

These trials were carried out by mooring the vessel broadside to a quay with suitable bollards using a single headline and stern line. Into each line was connected strain gauged tension link.

The output from the link being carried inboard and recorded on U.V. recorder via an electrical cable. The procedures adopted for the trials was based on those for bollard pull trials for tugs as given in Reference 2.

During the trials main engine was recorded by hand from the bridge engine tachometer as the propeller shaft was clutched out and no readings could therefore be taken from the shaft speed transducer.

Side thruster supply pressure readings were recorded on the U.V. recorder from pressure transducers at the control valves.

Thruster input shaft speeds were collected for each thruster from a magnet and read switch mounted on the drive shaft from the hydraulic motor to the thruster.

The results of the trials are given in tables 5 and figures 3, 4, 5 and 6.

Fishing trials

The purse seine was shot three times in sheltered water during daylight. The purpose of this exercise was to establish a "normal" operational level against which future commercial fishing operation measurements could be compared. In addition to an operational log being made and data recorded in the U.V. recorder, both a cine film and still photographs were taken of the Triplex roller to record the angle of the net during the "dry up" process.
The object of the filming was to attempt to relate the angle of the net and Triplex roller pressure to the heeling moment produced on the vessel.
The results of these are shown in figures 7, 8, 9 and 10.

Discussion

Measured mile trials

The maximum continuous rated power of the main engine is 560 KW but during the trials the maximum shaft power measured was 585 KW. Assuming a loss in gearbox transmission of 4% the engine was developing 609 KW and therefore working in the overload region. This suggests that the design pitch of 1330 mm is too high for the propeller.

The speed/power curve in figure 2 illustrates the classical characteristics associated with this size and type of fishing vessel.

The most striking feature is the fact that to achieve the last 10% increase in speed an increase in power of 55% was required.

Side thruster trials

Dr. Norrby (reference 3) determined a non-dimensional coefficient α for the evaluation of side thruster performance. The definition of this coefficient is given by:

$$\alpha = \frac{T}{(\rho \pi)1/3 \quad (P_o D)2/3}$$

where
T = Nett thrust
ρ = Mass density of water
P_o = Power delivered to thruster impeller
D = Diameter of impeller

On the basis of published data he found that realistic thruster performance lay between values of 0.52 and 0.58. Examining the results in table 5 the average value for the foreward thruster (omitting run 20/1) was 0.56 and for the after thrust 0.52. These figures in range found by Norrby and the thrusters can be considered to be operating satisfactory in relation to the power input and impeller diameter. However, comparing the maximum thrust of each unit, the foreward thruster although seemly more efficient than the after thruster on an α comparison in fact produced 12.5% less thrust. This difference is probably associated with higher losses in the longer hydraulic circuit between the pump unit in the engine room and the foreward thruster compared to that of the after thruster.

Fishing trials

Vessel stability and fishing gear loads

In its normal mode of operating with its purse net stowed in its net pound, the vessel is in an upright condition. As the net is shot away the vessel heels approximately 6° - 7° to port. With a total gear weight of 14.5 tonnes this implies that the centre of gravity of the stowed gear is some 1.3 m to starboard of the centreline. This figure is reasonable considering that the purse rings are stowed at the starboard bulwark and the leads are stowed just inside the starboard bulwark.

Under the combined action of the purse wire tensions and the net tension at the Triplex, the vessel changes heel to starboard through approximately 11° - 15°, to a measured maximum starboard roll and heel of 8°.

Consider minutes 16 to 17, shot 1/1 and assume roll centre to be at the waterline:

Total mean purse wire tension	=	8.43 tonnes
Lever (half beam of ship)	=	3.66 metres
Moment due to purse wire tension	=	30.83 tonne metres
Mean Triplex Pull	=	0.99 tonnes
Lever (from examination of figure 10)	=	5.70 metres
Moment due to Triplex Pull	=	5.64 tonne metres
Mean thrust (aft thruster)	=	0.50 tonnes
Lever (centre of thruster below W/L)	=	1.40 metres
Moment due to thruster	=	0.70 tonne metres

There is no moment due to wind force as wind is blowing from dead ahead.
Now heel due to an external moment is given by:

$$GM_F \sin \theta \times \text{Dispt.} = \text{Moment}$$

$$\sin \theta = \frac{\text{Moment}}{GM_F \times \text{Dispt.}}$$

$$= \frac{37.17}{0.66 \times 260.3}$$

$$= 0.2164$$

$$\underline{\theta = 12.5^\circ}$$

This heel change compares very well with that measured, which shows that the assumption of a half beam lever for purse wire tension is valid, and that an approach to purse seine vessel stability in this manner is possible.

In this trial the maximum purse wire tensions and corresponding Triplex pull were approximately 65% of the weight of the purse seine and rings, etc. It is suggested that this proportion could be applied to other vessels working purse nets.

After the pursing operation is complete the net is "dried-up" and the vessel progressively returns to an upright position under the moment applied by the Triplex pull and the net being stowed back on board.

It should be noted that the maximum roll angles due to weather, recorded in the sheltered waters of The Minch were 13.7° to port and 7.8° to starboard. It would seem, therefore, that the maximum combined roll and heel likely to be encountered during a normal fishing operation in sheltered waters would be 14° (roll) + 8° (heel) i.e. about 22°.

Use of side thrusters

The thrusters tend to come into use during the pick up of the dahn buoy and throughout the actual "drying-up" process after the net had been pursed and the rings brought to the purse gallows. It is noticeable that the after thruster was almost in continuous use whilst the foreward thruster was used only occasionally. The reason for this was the need to hold the vessel in a steady position relative to the wind whilst countering the turning moment on the vessel caused by the power block hauling the net.

The maximum thrust calculated from measurements of hydraulic pressure and thruster motor speeds during these trials was 0.76 tonnes foreward and 0.87 tonnes aft. These compare with the maximum of 0.91 and 1.04 tonnes respectively achieved during the thruster trials. Each thruster was therefore operating within its working range, but these results suggests that more powerful thrusters would be required to work the vessel effectively up to winds of Beaufort 5.

Purse winch load/speed/power requirements

Typical winch loads during pursing are shown in figure 8. The load rises steadily to a maximum of about 5 tonnes per barrel when the purse wires are vertical and then falls sharply to about 2 tonnes as the purse rings are brought to the gallows.

Mean hauling speed on the purse line was 0.32 m/s corresponding to a mean drum speed of 20 revs/min. Power and torque figures to sustain this load at 20 revs/min were 29 KW and 1400 Kg:f:m respectively. These were well within the rated winch performance figures of 50 revs/min, 82 KW and 160 Kg:f:m.

Propulsion power requirements

The maximum propulsion power requirements during the purse seining cycle was 220 KW and was incurred towards the end of the net shooting sequence, the power steadily increasing from approximately 50 KW as the dahn buoy was shot away.

During the pursing operations 130 to 150 KW was used and approximately 55 KW during the "drying up" with an occasional increase to 100 KW for manoeuvring the vessel out of the net.

Triplex load/speed requirements

The net was "dried up" by the Triplex net hauler at a rate of 0.15 m/s with a steady load of approximately two tonnes. The rating for the hauler was 3 tonne at 0.25 m/s.

References

(1) "Principles of Naval Architecture"
Ed. J.P. Comstock. Pub. S.N.A.M.E. 1967.

(2) British Ship Research Association
"Code of Procedure for Bollard Trials of Tugs"

(3) Dr. R.A. Norrby
"Evaluation of Side Thruster Performance"
International Shipbuilding Progress, Vol. 21, 1974.

TABLE 1

M.F.V. 'COURAGE'

GENERAL PARTICULARS OF VESSEL AND EQUIPMENT

Name:	COURAGE
Type:	Purse Seiner
Fishing Letters:	BF 212
Owners:	George West & Partners
Builders:	Hall, Russell & Co.
Builders No:	965
Length B.P.:	22.86 metres
Length O.A.:	26.94 metres
Breadth Mld:	7.315 metres
Depth Mld:	3.960 metres
Max.Cont. Rated Power:	560 KW
Max.Cont. Rated Speed:	900 RPM
Side Thruster Manufacturers:	Brødr. Brunvoll Motorfabrikk A/S.
Side Thruster Type:	SPH-105 (Both Thrusters)
Impeller diameter:	850 mm
Motor type:	Vickers 50 M-300A-IC-200
Main Winch:	Karmoy
Net Winch:	Triplex 504/300/1A
Purse Seine Gear Weight:	14.5 tonnes
Float Line Length:	567 metres
Ground Line Length:	631 metres
Maximum Depth:	155 metres
Weight of Lead Line:	3000 Kgs.
Weight of each Purse Ring:	6 Kgs.
Size of Floats:	150 mm x 190 mm.

table 2

M.F.V. 'COURAGE' - LIST OF INSTRUMENTATION

Parameter Measured	Transducer Used	Location	Recorded By
Shaft R.P.M.	Photo Electric Pickup	Intermediate Shaft	U.V. Recorder
Shaft Torque	Strain Gauge	Intermediate Shaft	U.V. Recorder
Elapsed Time	Stopwatch	-	Hand
Vessel Roll	Motion Gyro	Scientists Cabin	U.V. Recorder
Vessel Pitch	Motion Gyro	Scientists Cabin	U.V. Recorder
Vessel Heave	Accelerometer	Scientists Cabin	U.V. Recorder
Rudder Angle	Rotary Potentiometer	Rudder Stock	U.V. Recorder
Propeller Pitch	Rotary Potentiometer	Gearbox	U.V. Recorder
Ship's Head	Magnetic Compass	Wheelhouse	Hand
Fwd. Thruster Pressure	Strain Gauge Pressure	Control Valve	U.V. Recorder
Fwd. Thruster R.P.M.	Magnetic Proximity	Drive Shaft	U.V. Recorder
Aft Thruster Pressure	Strain Gauge Pressure	Control Valve	U.V. Recorder
Aft Thruster R.P.M.	Magnetic Proximity	Drive Shaft	U.V. Recorder
Fwd. Warp Tension	Strain Gauge Load Cell	In Warp	U.V. Recorder
Aft Warp Tension	Strain Gauge Load Cell	In Warp	U.V. Recorder

TABLE 3

M.F.V. COURAGE

Measured Mile Results

Date	23.9.74
Course	Aberdeen
Water Depth	6 fathoms
Undocked	11.9.74.

Run No.	Direction	Start Time	Time On Mile	Ground Speed (Kts)	Tide Current (Kts)	Water Speed (Kts)	Water Speed Correct for Depth (Kts)	Engine R.P.M.	Shaft Torque (lbf.ft)	S.H.P.
1	North	17.40	5m 53s	10.20	0.87 S	11.07	11.34	894	11730	784
2	South	17.55	5m 0.15s	11.99	0.92 S	11.07	11.34	892	11380	758
3	North	18.06	7m 5.65s	8.45	0.94 S	9.39	9.60	726	7250	393
4	South	18.20	5m 48.4s	10.33	0.93 S	9.40	9.61	724	6930	375
5	North	18.30	6m 21.95s	9.43	0.90 S	10.33	10.56	800	8730	522
6	South	18.43	5m 22.8s	11.15	0.83 S	10.32	10.55	798	8470	505
7	North	18.50	5m 49.85s	10.29	0.79 S	11.08	11.35	894	11250	752

Draft Forward	2.591m - 8.5 ft to U.S.K.
Draft Aft	3.505m - 11.5 ft to U.S.K.
Draft Mean	3.048m - 10.0 ft to U.S.K.
Trim	0.914m - 3.0 ft by the stern
L.W.L.	24.51 m - 80.41 ft
Propeller Pitch	1330 mm

S.G. of water	1.017
Displacement	271.8 tonnes - 267.5 tons
L.C.B. Position	10.62m - 34.84 ft from AP
	50.06% LWL from aft
Block Coefficient	0.5194

TABLE 4

M.F.V. COURAGE

Date 23.9.74.
Course Aberdeen

Maximum Ship Motions and Rudder Angles on Measured Mile

Run No.	Direction	Engine R.P.M.	S.H.P.	Water Speed Knots	Pitch (Maximum) Degrees		Roll (Maximum) Degrees		Rudder Angle (Max) Degrees	
					Bow Up	Bow Down	To Port	To Stbd.	Port	Stbd.
1	North	894	784	11.07	4.3	5.2	2.7	7.7	0.5	3.6
2	South	892	758	11.07	5.8	5.2	6.1	9.9	1.3	3.8
3	North	726	393	9.39	5.7	3.6	2.6	7.9	0.5	3.8
4	South	724	375	9.40	3.8	3.6	7.3	10.8	1.3	6.4
5	North	800	522	10.33	8.0	8.7	4.6	9.2	2.4	3.4
6	South	798	505	10.32	7.8	6.5	8.2	10.8	1.2	4.5
7	North	894	752	11.08	14.2	11.5	7.4	15.2	1.7	2.2

TABLE 5

M.F.V. 'COURAGE'

SIDE THRUSTER TRIAL RESULTS

Date: 20th May, 1975

Place: Fraserburgh

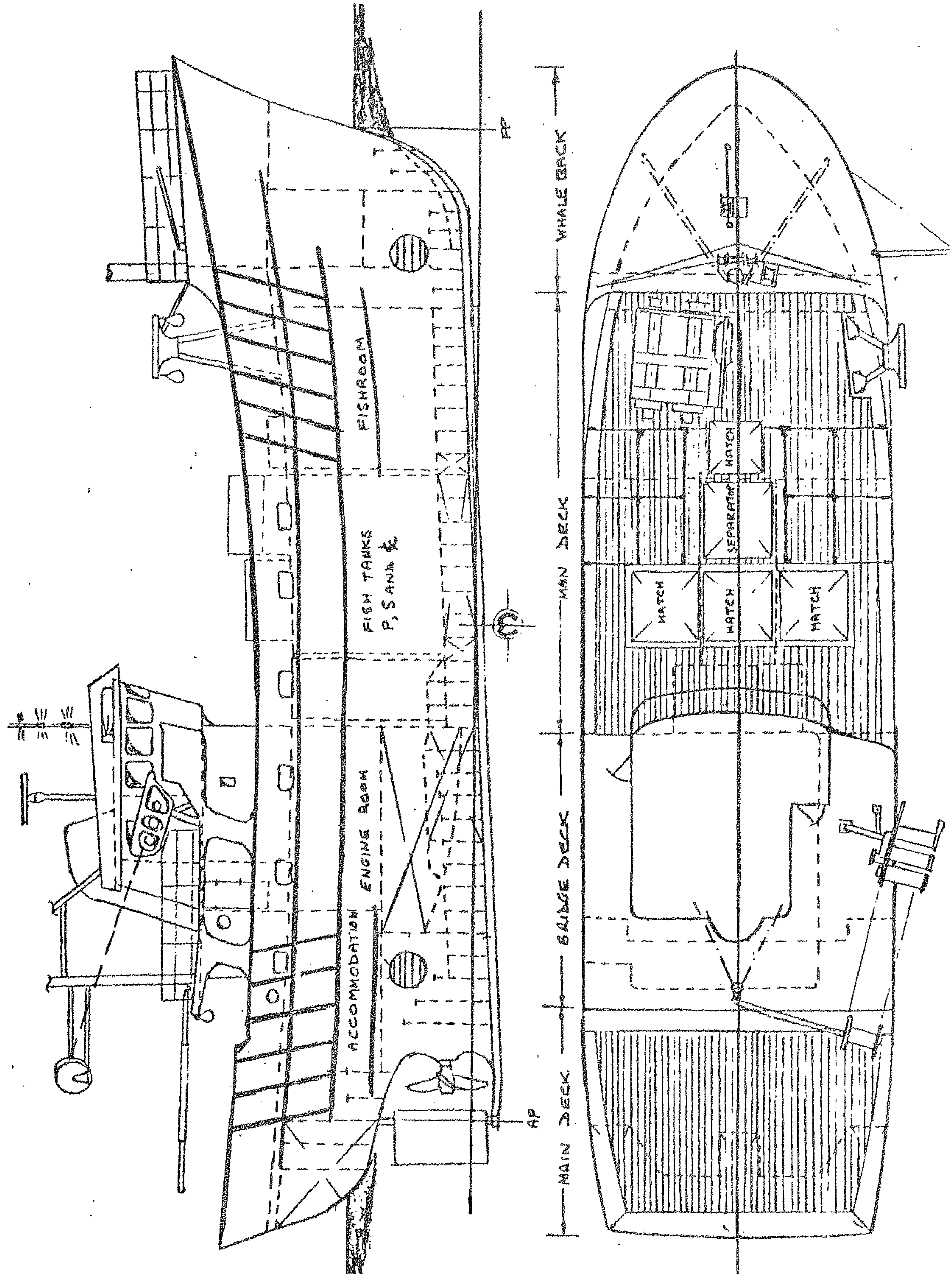
Water Depth: 5.95 metres

Run Number	Nominal Main Eng. Speed (R.P.M.)	FORWARD THRUSTER					AFT THRUSTER				
		Hydraul. Pressure (BAR)	I/P Shaft Speed (R.P.M.)	I/P Shaft Power (KW)	Thrust (Tonnes)	Perf. Coeff. α	Hydraul. Pressure	I/P Shaft Speed (R.P.M.)	I/P Shaft Power (KW)	Thrust (Tonnes)	Perf. Coeff. α
20/2	720	24	506	4.6	0.12	0.34	111.9	1136	52.9	0.95	0.53
20/3	720	109.3	921	39.2	0.81	0.56	0	0	0	0	-
20/4	720	109.1	927	39.3	0.91	0.62	109.0	1126	51.1	0.91	0.52
20/5	820	111.1	928	40.1	0.83	0.56	125.7	1224	64.0	1.04	0.52
20/6	620	89.9	836	29.5	0.59	0.49	82.3	972	33.3	0.65	0.50

M.F.V. Courage

Figure 1

Sketch Arrangement



M.F.V. COURAGE

MEASURED MILE TRIAL

ABERDEEN 23/9/74

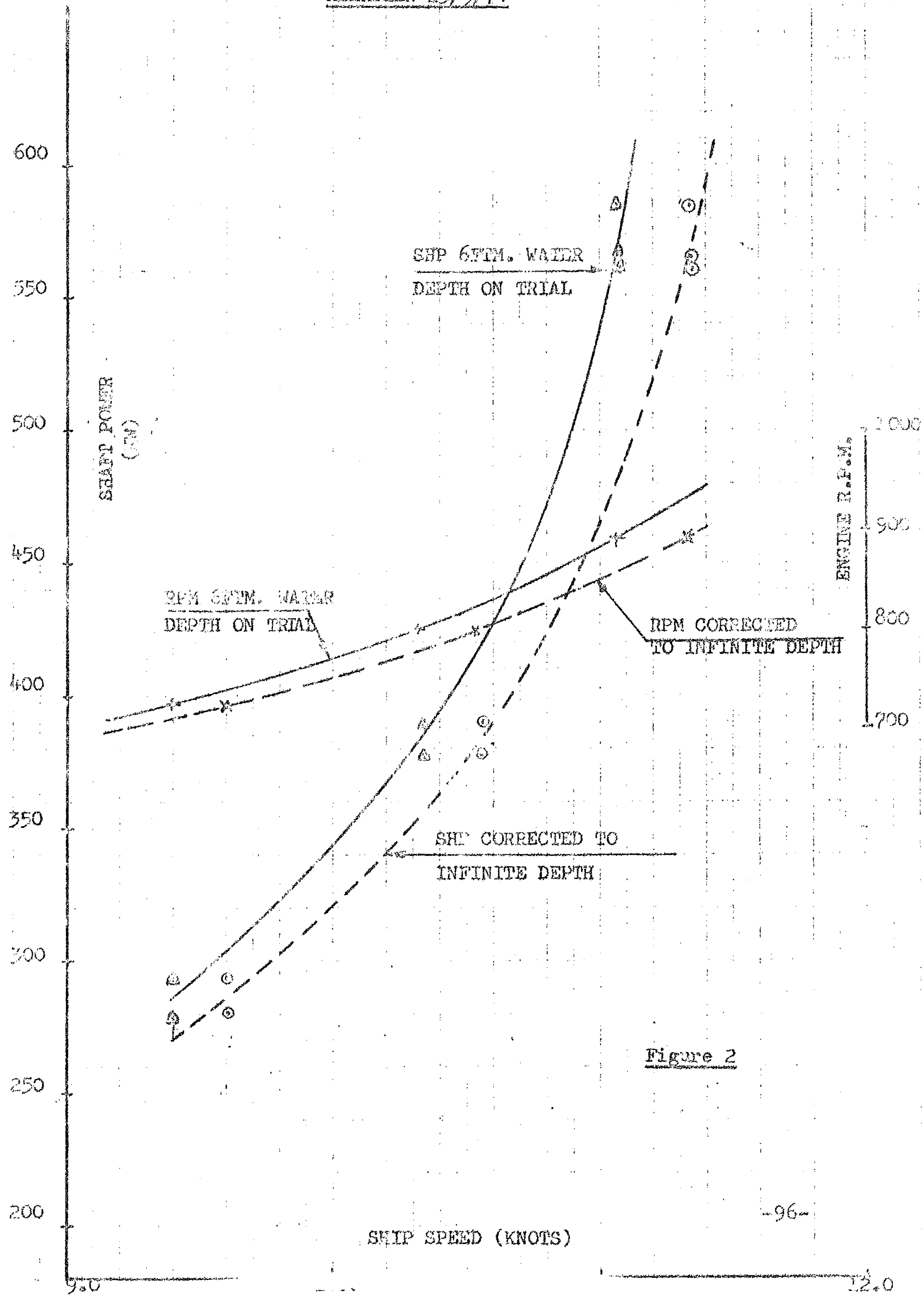
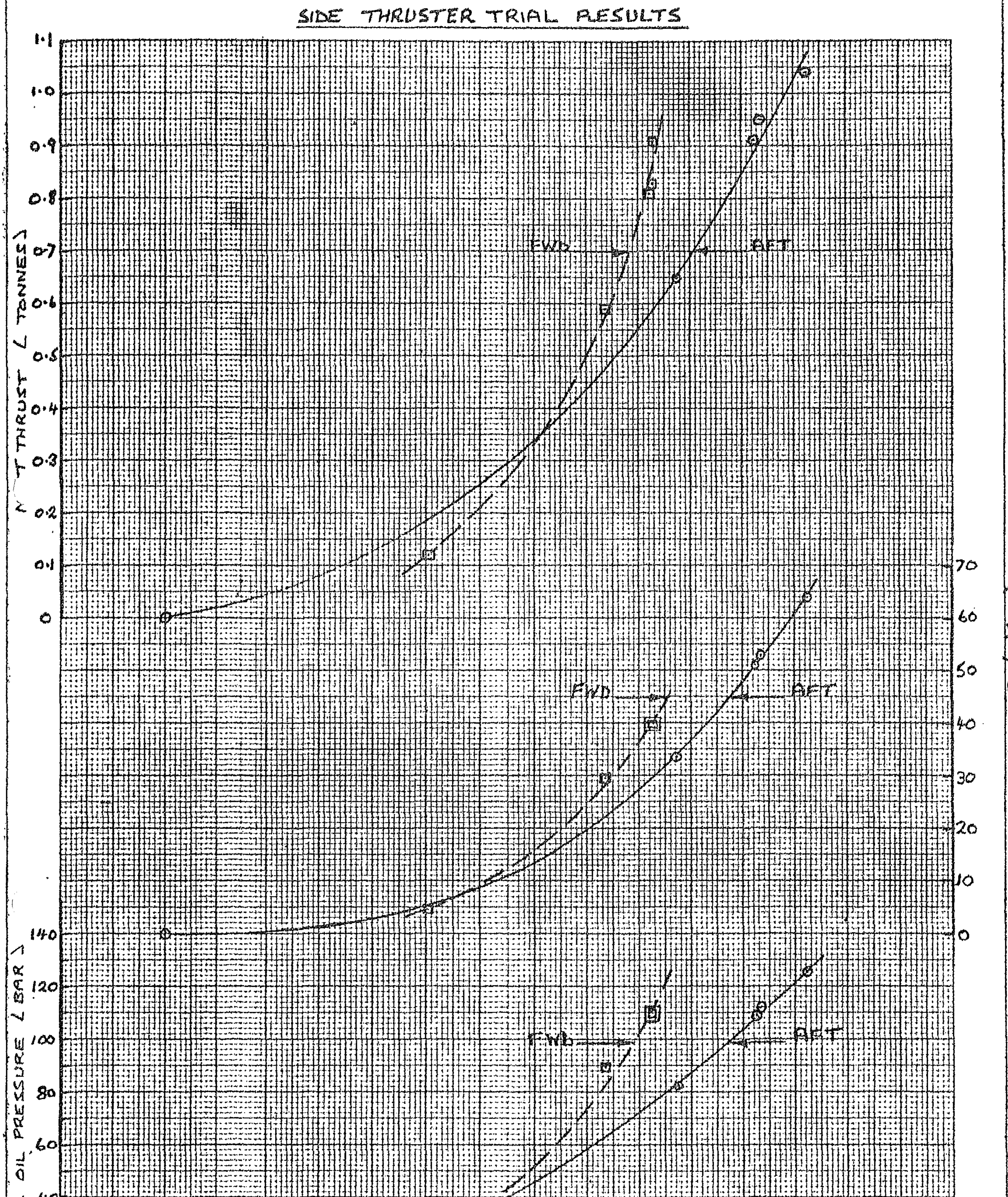


Figure 2


SIDE THRUSTER TRIAL RESULTS
THRUST (TONNES)
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
FWD
AFT
IN-PUT SHAFT POWER (KW)
70
60
50
40
30
20
10
0
HYDRAULIC OIL PRESSURE (BAR)
140
120
100
80
60
40
20
0
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300
THRUSTER IN-PUT SHAFT SPEED (R.P.M.)

M.F.V. COURAGE

SIDE THRUSTER TRIALS RESULTS

FIGURE 4

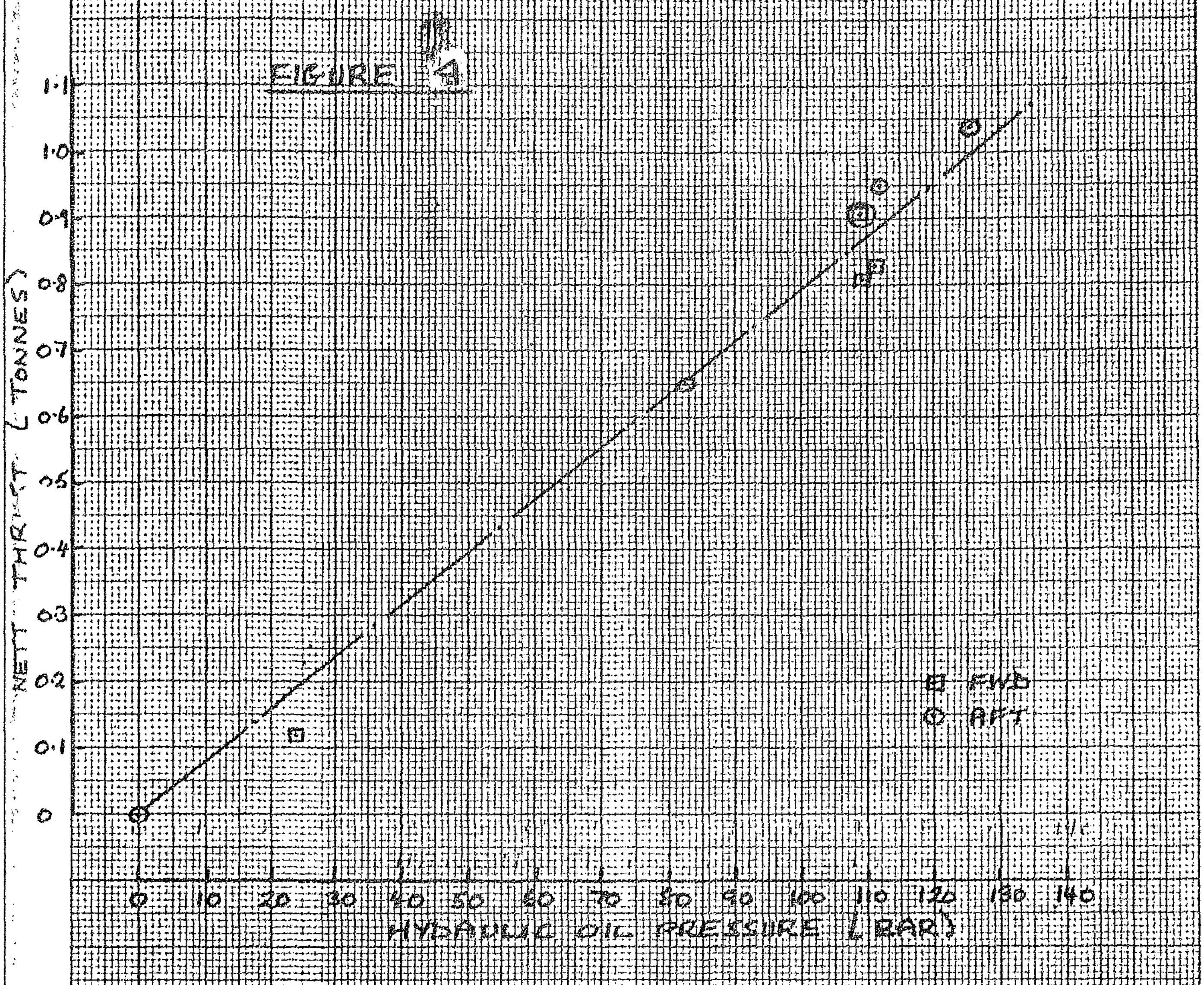
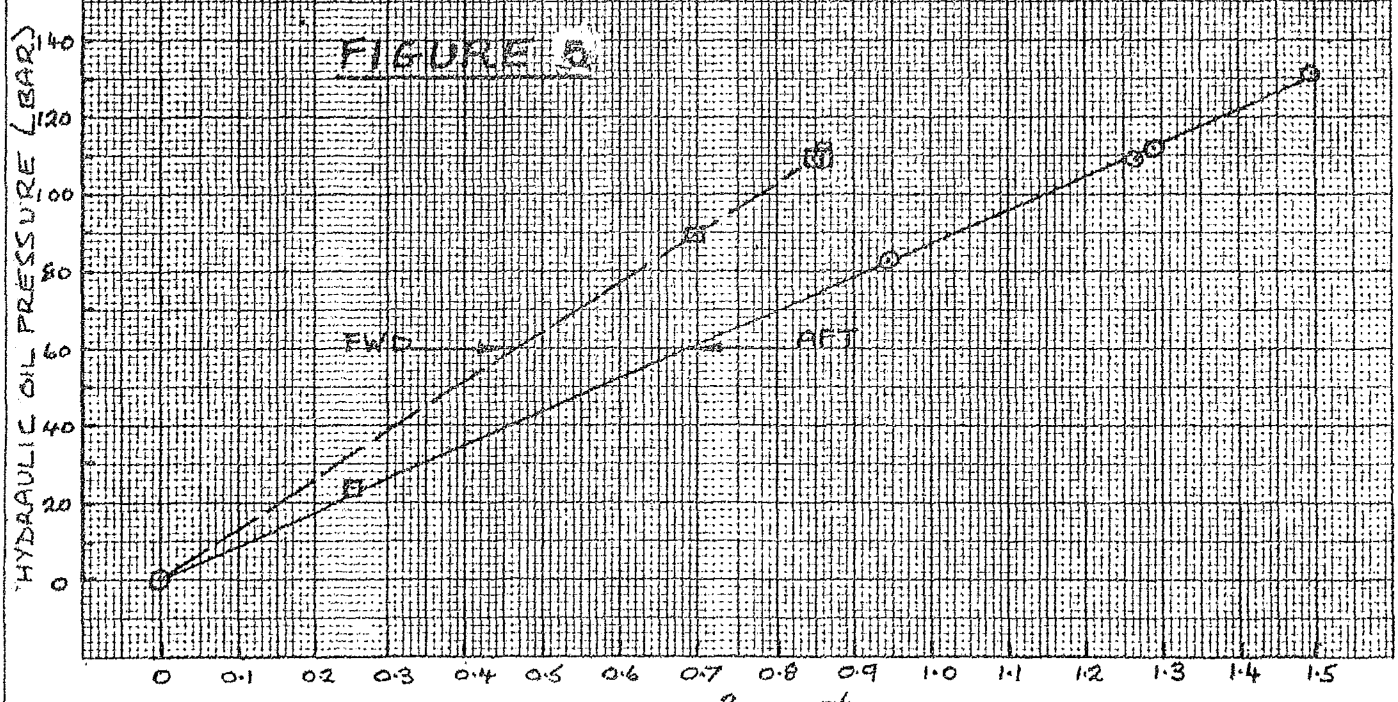
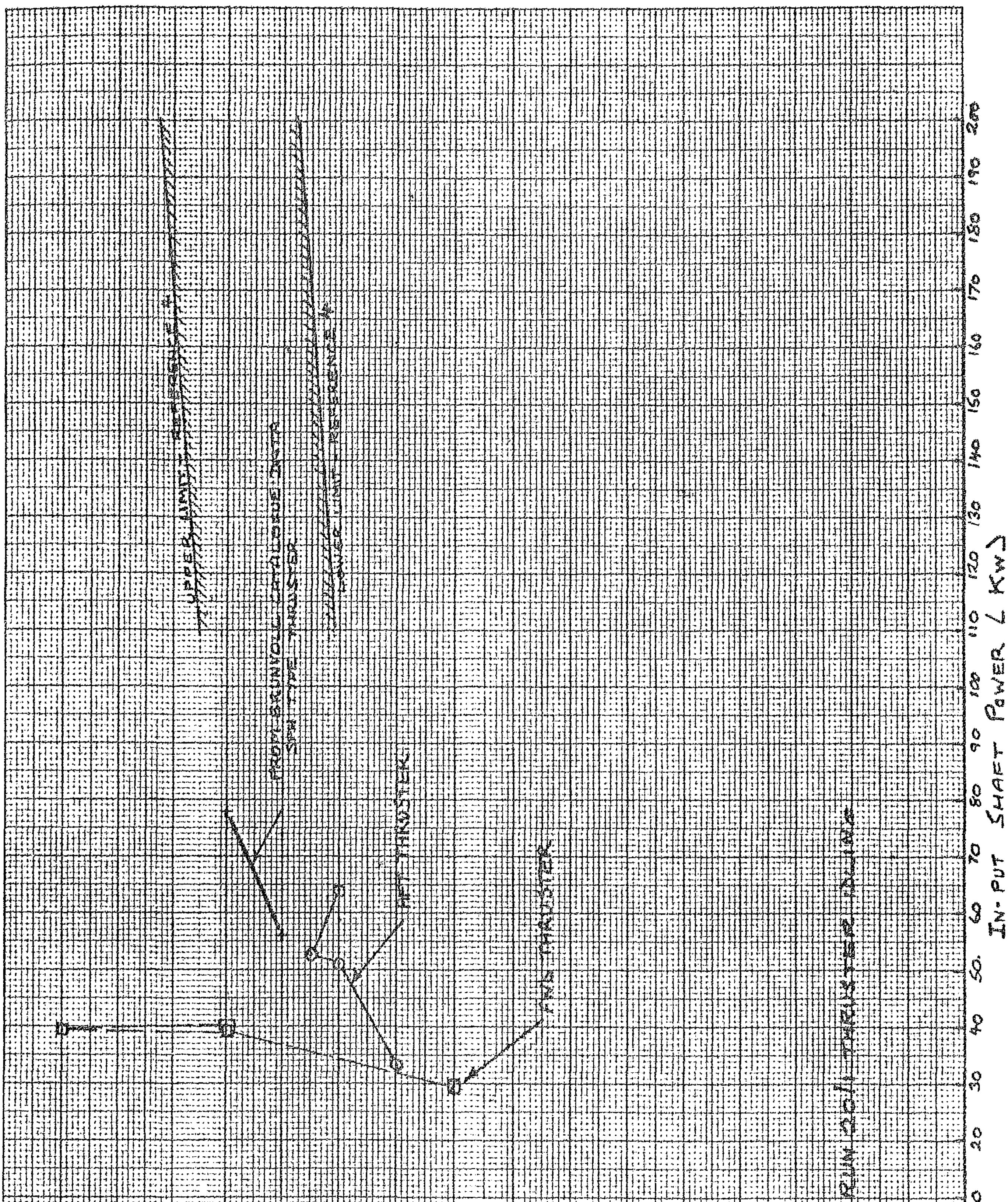


FIGURE 5

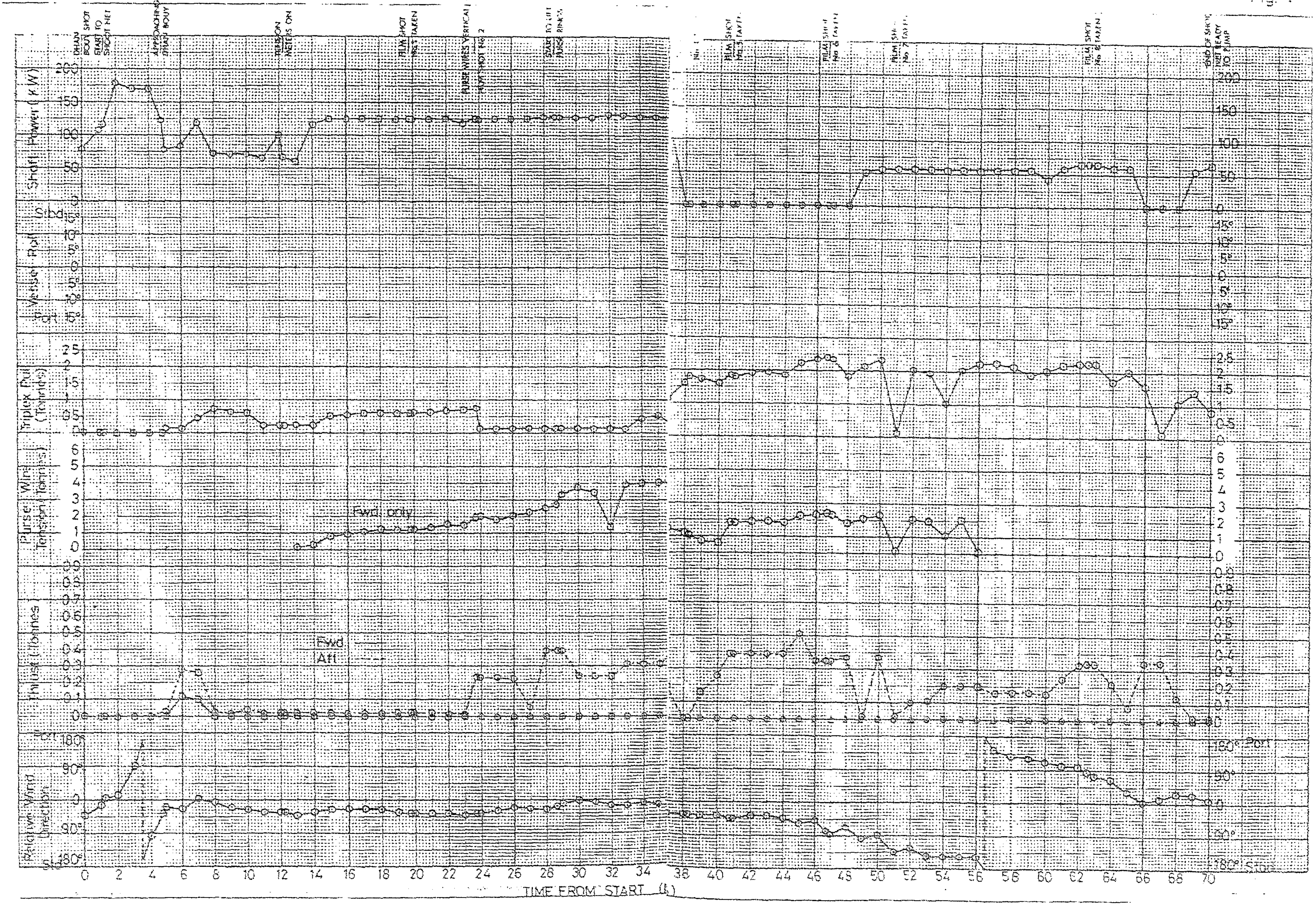


SIDE THRUSTER TRIALS RESULTS

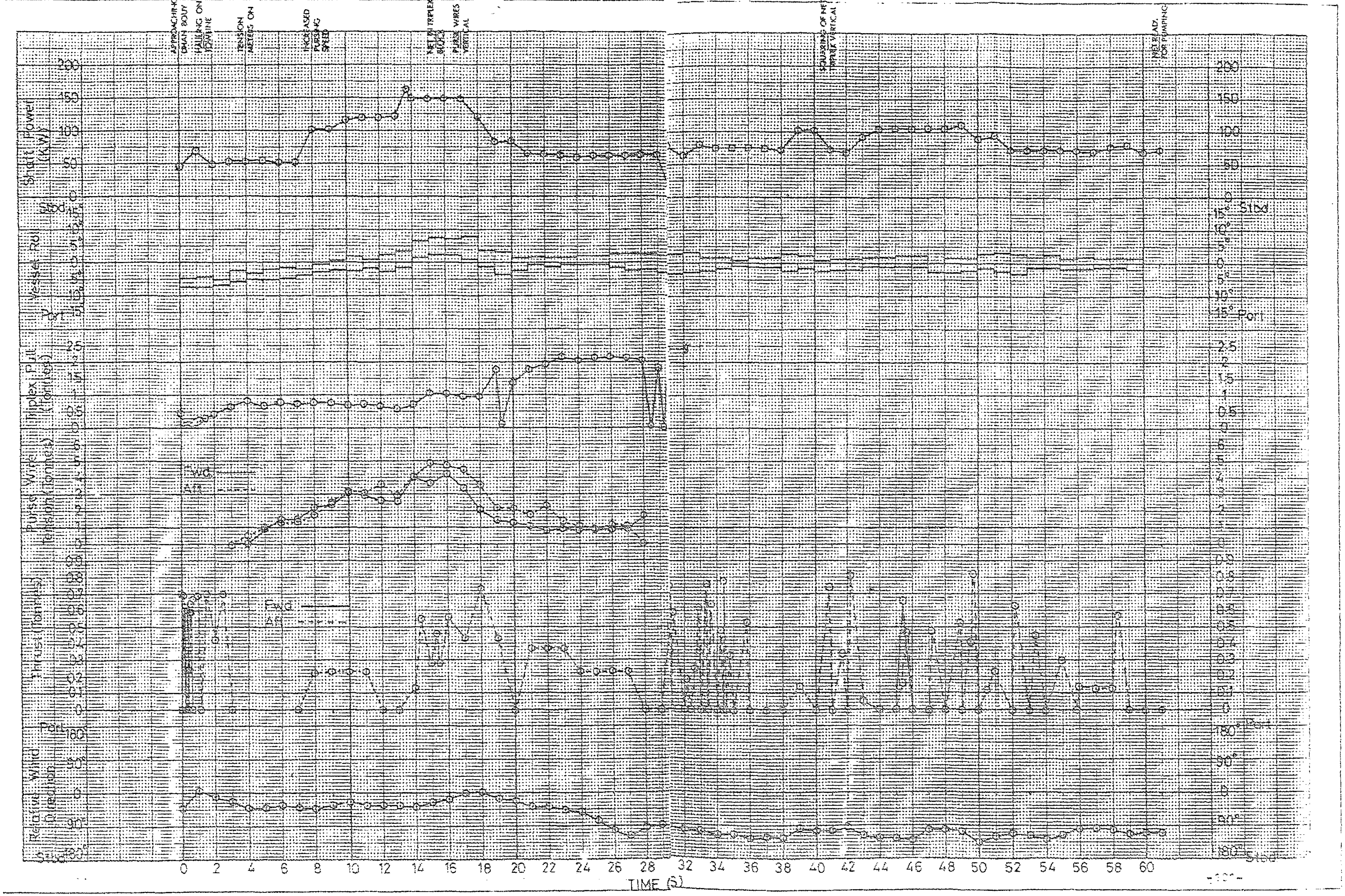


MFV Courage - Fishing Trials Shot No 2

Fig. 7



MFV Courage - Fishing Trials. Shot 1/1 Wind Force - BF 5 Fig. 8



MFV Courage - Fishing Trials. Shot No 1 Wind Force :- BF 3-4 Fig. 9

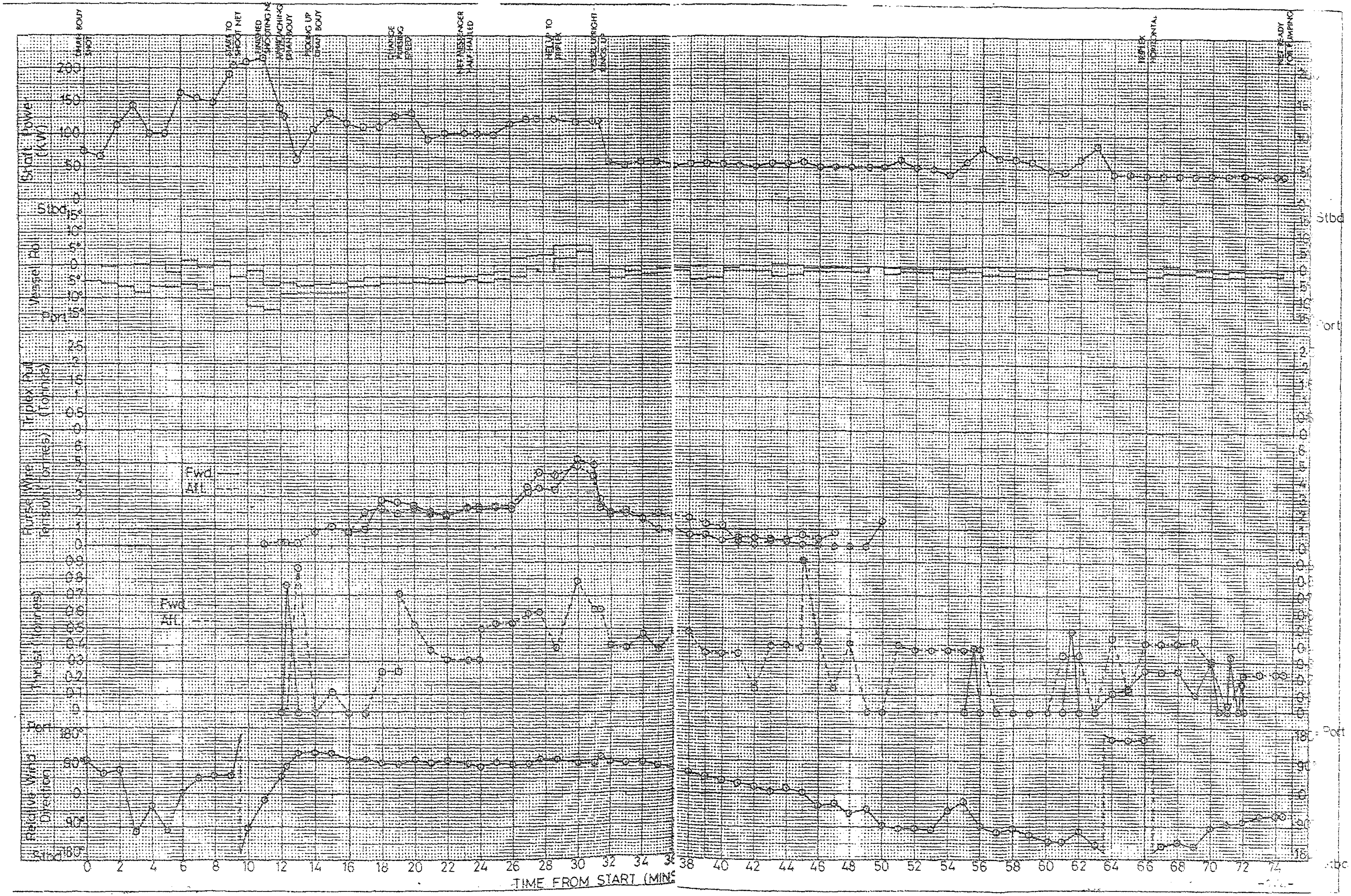


FIGURE 10

M.F.V. 'COURAGE'

STILLS FROM CINE FILM

SHOT 30/2

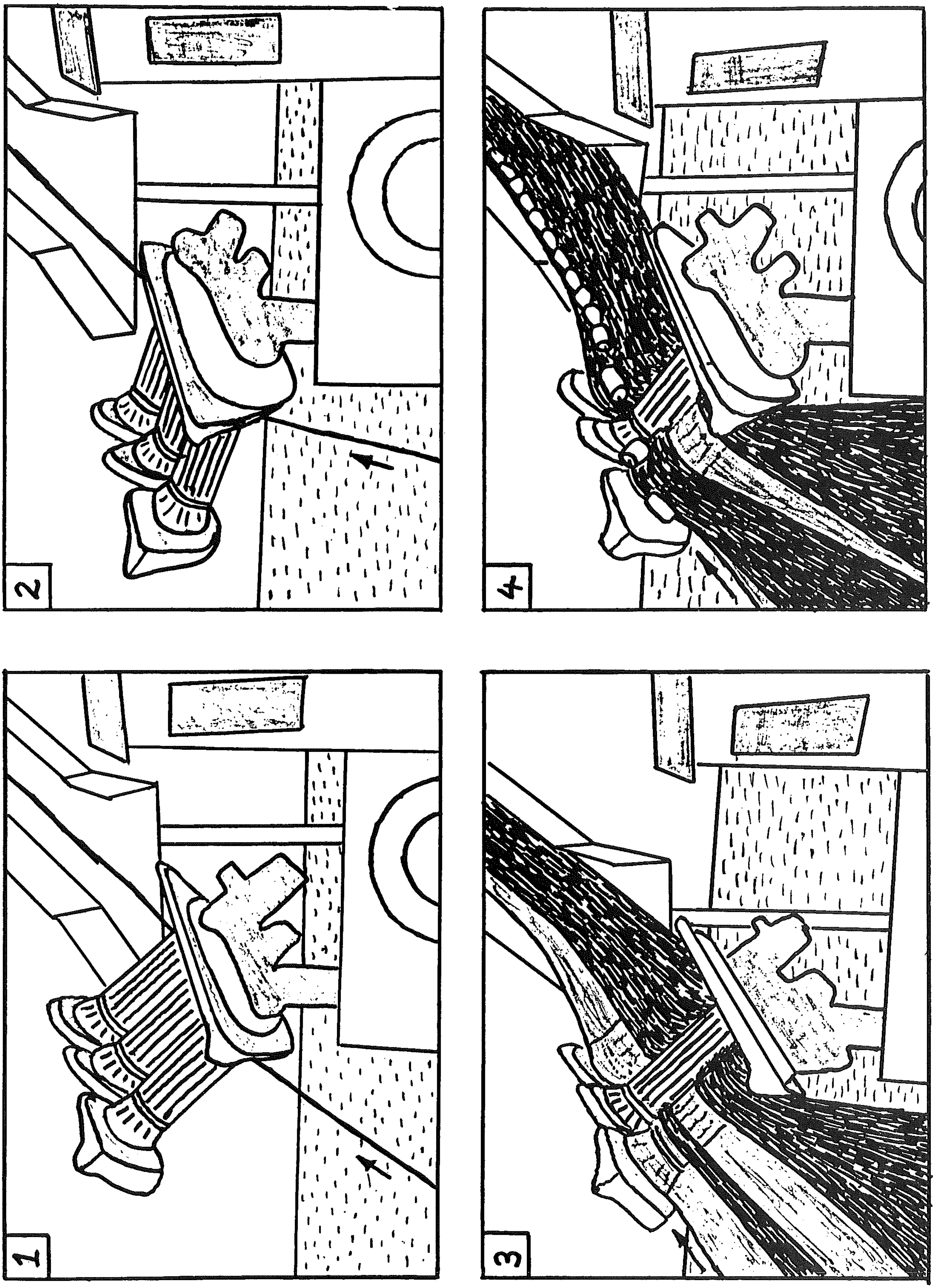
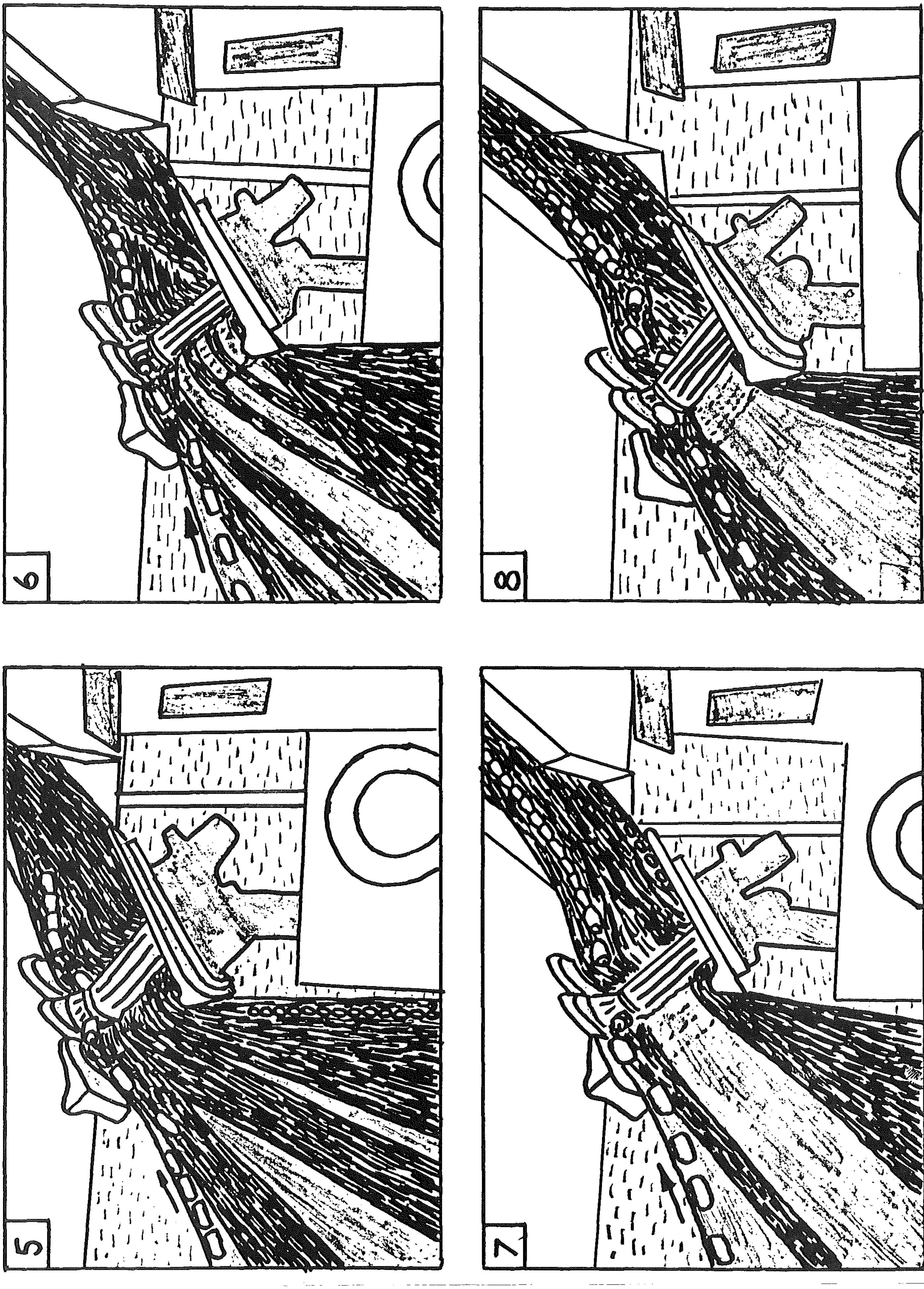


FIGURE 10 - Cont'd



Expedition to the Antarctic 1975/76 by the Federal Republic of Germany.

In view of in particular the very substantial resources of krill in the Antarctic and their potential importance as human food and for other purposes, the Federal Republic of Germany undertook an expedition for research and exploration of krill and fishes in the Antarctic sector of the Southern Ocean. The expedition was carried out by the Federal Research Centre for Fisheries in Hamburg in collaboration with the Institute for Marine Science at the University of Kiel. The necessary financial means were provided jointly by the Federal Ministries of Research and Technology and of Nutrition, Agriculture and Forestry.

The cruise started on 20 October 1975 from Bremerhaven and finished there on 14 June 1976. The survey was undertaken with the German FRS "Walther Herwig" (2250 GRT, 4600 hp) and the government-chartered trawler "Weser" (2176 GRT, 3000 hp). The 6 months work in the Antarctic was divided in 3 parts as follows:

I	: 16 November 1975	-	13 January 1976
II	: 20 January	-	12 March 1976
III	: 18 March	-	20 May 1976

Parts I and II started and ended in Montevideo (Uruguay), with refuelling in Port Stanley (Falkland Is.). Part III started from Montevideo and ended in Cape Town (South Africa). During each part 20 scientists and technicians worked on board (12 on "Walther Herwig", 8 on "Weser") who were replaced after each turn, together with part of the crews.

The area of investigation during part I was between the eastern part of the Burdwood Bank and the waters around South Georgia south to the ice edge at about 60°S latitude. During part II the survey of the Scotia Sea was repeated, and the shift of the ice allowed to investigate the areas of the South Orkney and South Shetland Islands. FRS "Walther Herwig" worked also on two sections in the Weddell Sea (southern limit 67°S, 44°W), whereas FMS "Weser" investigated a grid of stations west of the Antarctic Peninsular up to about 66°S/68°W. During the third part the survey in the Scotia Sea and around South Georgia was again repeated and the area of investigation then extended to the waters east of the South Sandwich Islands. After refuelling in Cape Town the last 3 weeks until 20 May were spent in surveying the ocean area between 50° and 60°S latitude and 6° and 18°E longitude. The total distance sailed by each ship during the entire cruise was about 47.000 nautical miles.

The programme of the expedition was fully integrated between the following three main sectors:

a. biology and environment,
b. location and catching,
c. processing and product development.

In the field of biology a wide grid of stations was worked using mainly the RMT (rectangular midwater trawl) and neuston-sledge for obtaining quantitative scientific catches of krill and its young stages, as well as fish brood and other plankton. Altogether 282 RMT- and 226 neuston stations were sampled. Together with a large amount of adult krill caught during 209 hauls with the pelagic krill trawl these samples will provide a picture of the quantitative horizontal and vertical distribution of krill over a fairly wide area. The sorting and evaluation of the samples is presently being done, including detailed studies on biological parameters. Preliminary results show that dense concentrations of krill were observed particularly north and east of South Georgia, in the Scotia Sea north of the South Orkney Islands, around the South Shetlands, and west of the South Sandwich Islands. Usually krill was most abundant in the upper 50 metres of the sea but sometimes also deeper (80-100 m). Of special interest are sizeable catches of krill close to the bottom as deep as 260-300 m, caught together with fish (South Georgia and South Orkneys). Krill catches otherwise did not contain by-catches, and- different from expectations- hardly any pelagic fish were caught. Also the catches of cephalopods were neglectable, possibly due to the type of gear used. Some problems arose at certain times in certain areas with mixed catches of krill and salps.

A large amount of material for biological studies of fish became available through 201 hauls with 200 ft bottom trawls on the shelf areas around some Antarctic islands and on the western side of the Antarctic Peninsular. Detailed studies on various species such as _Dissostichus spec_, _Notothenia rossi marmorata_, _N.gibberifrons_, _Champsocephalus gunnari_ and others are presently in progress.

It is expected that the biological data after careful evaluation will help to improve the overall basis for the estimation of krill and fish resources in the survey area and their potential for long-term fisheries utilisation. They should also contribute towards a better understanding of some aspects of the ecosystem in these waters which must be taken into account for a proper management of a future krill fishery.

Parallel to the biological studies a substantial programme of hydrographical work was carried out to investigate environmental factors in relation to krill distribution. Oceanographic data were collected mainly on 384 stations with Nansen bottles lowered down to 750 m depth, 395 bathythermograph stations, and 21 stations with "profilers" for current measurements.

About 2900 salinity and 1124 silicate measurements were taken. From the data available it will be possible to present the environmental situation in the area covered by the survey in 38 oceanographic profiles, running mostly N/S and E/W.

In the field of location and catching of krill quite satisfactory results could be obtained. Locating krill shoals with echo sounders of high frequency (150-200 KHz) did not present major problems and such concentrations could to a certain degree also be detected with normal fishfinders (33 KHz). For catching the krill pelagic trawls were developed on the basis of commercial gear already available. The trawl is about 95 m long, with about 1200 meshes around the opening, mesh sizes at the mouth 200 mm, and with a small-meshed inside cover over the entire length of the net. With this pelagic trawl quite substantial catches of krill were obtained, amounting in some cases to more than 30 tons per hour, with a maximum of 35 tons in 8 minutes. The overall average of all hauls made by FMS "Weser" was in the order of 8-12 tons per hour. Difficulties arose sometimes in having too large catches, and emptying of the net presented then some problems. Further studies will be made to improve the gear and more experience is needed for the quantification of krill from echo traces so that in future gear operation can be adapted to catch only quantities which can actually be processed on board the vessels.

Fishing with 200 ft bottom trawls on the shelf areas around the islands and off West Antarctica resulted usually in catches of up to 1.5 tons per hour, but occasionnally they were much higher on some places (mainly Notothenia rossi marmorata and Champsocephalus gunnari). Besides of the shelf off South Georgia, where 25 fish species were observed with 8 being of commercial interest, the bottom of the shelves was rather rough and difficult for trawling.

In the field of krill processing and product development a wide range of techniques was tried during the expedition. Priority was given to aspects of using krill for human consumption, although krill meal was also produced on board and landed for further studies in relation to the use as animal feed and for aquaculture. Considerable quantities of raw and cooked krill and of raw and cooked minced krill meat were also deep frozen and taken home for further processing ashore for the development of marketable products. The minced meat was produced by use of a bone separator (Baader) which allowed a satisfactory removal of the chitin. Experiments were also made for the preparation of krill powder/paste through coagulation by steam.

Finally it should be mentioned that scientists from Argentina, France, Great Britain and South Africa participated actively in the German expedition.

Exchange of hydrographical data and satellite observations was arranged with institutes in the U.S.A. After the expedition contacts were intensified with scientists in a number of countries.

It is hoped that the Federal Republic of Germany will be in a position to undertake a second expedition of this kind during the season 1977/78.

Summary of shrimp midwater trawl development 1976 - Gulf of St. Lawrence by A. Tobey

New Brunswick shrimp trawlers in the Gulf of St. Lawrence fish with the bottom trawl for pink shrimp (Pandalus borealis) on the productive fishing grounds in the area of the island Anticosti. Pink shrimp migrate during the hours of darkness vertically from the bottom to heights of over ten feet. Because the bottom trawls used in this fishery have a very low vertical opening, the commercial trawlers mostly notice a substantial decrease in shrimp catches at darkness. Therefore the vessels must interrupt fishing at night, because even the fuel costs are not covered by the value of the catch. The limitation of fishing only during daytime results in relative long trips with the associated deterioration of shrimp caught early in the trip. By changing over to midwater trawling in the dark hours it is expected that the fishing time per day could be greatly increased, resulting in reduced trip duration and improved quality of the landed product.

In the period of July 1st to October 31st 1976 experiments with two basic midwater trawls were conducted by the Fisheries and Marine Service of the Department of Fisheries and the Environment, Canada and the New Brunswick Department of Fisheries. The first midwater trawl used was a Diamond VII with 1 1/8" mesh in the lengthening piece and codend. The second trawl was a 1556 mesh midwater trawl with 4 3/4" mesh wings reducing to 1 1/2" mesh lengthening piece and codend. It was experienced that shrimp caught with midwater trawls usually have been larger in size than those caught by bottom trawls and in addition, the amount of immature redfish bycatch decreased considerably in comparison to the bottom trawl. A full report of this project is published as technical report No. 701 by the Industrial Development Division, Technology Branch, Environment Canada and the Research and Development Branch, Department of Fisheries, New Brunswick.