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INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1977/B: 3
Gear and Behaviour Committee

REPORT OF THE SPECIAL JOINT SESSION ON BIOLOGICAL AND TECHNOLOGICAL ASPECTS OF ELECTRICAL FISHING.

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

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REPORT OF THE SPECIAL JOINT SESSION ON BIOLOGICAL AND TECHNOLOGICAL ASPECTS OF ELECTRICAL FISHING (ANON.)

Convenors	:	E.J. de Boer (Working Group on Research on Engineering Aspects of Fishing Gear, Vessels and Equipment)
	:	C.S. Wardle (Working Group on Reaction of Fish to fishing Operations)
Chairman	:	G.P. Boonstra Netherlands Institute for Fishery Investigations IJmuiden - The Netherlands.
Meeting time and place	:	19th April 1977 Hamburg - Federal Republic of Germany

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

PRESENTATION OF PAPERS

Etude d'un système de pêche par lumière, champ électrique et pompe pour la capture des sardines, Sardina pilchardus (WALBAUM)

by R. le Men; Institut scientifique et technique des Pêches maritimes, Nantes, France.

The paper was presented by G. Kurc.

L'étude et le principe d'un nouveau procédé de pêche par lumière, champ électrique et pompe ont déjà fait l'objet de nombreuses publications. Cette communication a seulement pour but de faire le bilan des conclusions, directement utilisables sur un plan pratique, auxquelles nous sommes parvenus après de nombreuses expériences en laboratoire sur des sardines vivantes.

Nous avons établi (1) qu'un champ électrique de 15 V/m devrait être suffisant pour assurer l'attraction, par taxie anodique, des sardines d'un moule commercial. La fréquence 50 Hz est alors la valeur minimale capable de donner des résultats positifs. Il est cependant préférable d'utiliser une fréquence voisine de 100 Hz qui assure des résultats meilleurs et surtout plus certains. Pour la durée des impulsions rectangulaires il ne faut pas descendre en dessous de 0,5 ms. De très bons résultats ont été enregistrés avec 1 ms.

En 1976, nous avons étudié à partir de ces données, le système des électrodes afin d'obtenir une zone de pêche aussi grande que possible. Il a fallu tenir compte de certains impératifs. Pour des raisons pratiques nous avons considéré que la tension appliquée entre les électrodes ne devait pas dépasser 500 V. Par ailleurs, l'anode qui se confond avec l'embouchure de la pompe aspirante ne doit pas présenter une trop grande surface, sinon les poissons attirés vers sa périphérie risqueraient d'échapper à l'attraction hydrodynamique de la pompe.

Les résultats obtenus en 1971 (2) ont servi de base de travail. Les conclusions auxquelles nous avons abouti et qui ont fait l'objet d'un rapport (3), sont les suivantes:

Avec une anode circulaire de 1 m de diamètre, isolée au dos et une cathode circulaire de 6 m de diamètre distante de 5 m de l'anode et en appliquant une différence de potentiel de 350 V entre ces électrodes, la zone de pêche théorique atteindrait 204 m3. En montant la tension à 500 V elle atteindrait 300 m3 et pourrait sans doute dans ce cas être encore augmentée en écartant devantage les électrodes.

Un bilan de la dépense énergétique a également été établi en fonction de la tension appliquée et du stimulus utilisé. Les puissances consommées sont indiquées en kilowatts dans le tableau suivant:

tensions stimuli	350 V	400 V	450 V	500 V
50 Hz - 1 ms ou 100Hz - 0,5 ms	51 (KW)	66,7	84,4	104,2
100 Hz - 1 ms	102	133,4	168,8	208,4

(1) Rapport scientifique "Etude de l'attraction anodique des sardines, <u>Sardina pilchardus</u> (Walb.), par un stimulus électrique impulsionnel" par R. le Men, Janvier 1976 (non publié).

(2) "Etude du champ électrique nécessaire à la taxie anodique du poisson". Rev.Trav.Inst.Pêches mariti., 35 (1), 1971, p.21-34 par N. Diner et R. le Men.

(3) Rapport scientifique "Etude d'un système d'électrodes pour la capture des sardines <u>Sardina pilchardus</u> (Walb.) par R. le Men, juillet 1976 (non publié).

Ensuite nous avons essayé d'apprécier en poids les captures possibles qui bien entendu dépendront du moule des poissons présents et de la densité de leur concentration. En se limitant à la pêche au coup par coup, C'est-à-dire que dans ce cas les électrodes ne seront mises sous tension que lorsque les poissons auront été regroupés, sous les effets du lamparo, dans la zone de pêche, les captures théoriquement réalisables au cours d'une opération de pêche sont indiquées dans les deux tableaux suivants:

- pour 350 V

densités moules	30/m3	50/m3	75/m3	100/m3	150/m3	200/m3
20/kg	306 (kg)	510	765	1020	1530	2040
30/kg	204	340	510	680	1020	1360
40/kg	153	255	282,5	510	765	1020

- pour 500 V

densités moules	30/m3	50/m3	75/m3	100/m3	150/m3	200/m3
20/kg	450 (kg)	750	1125	1500	2250	3000
30/kg	300	500	750	1000	1500	2000
40/kg	225	375	562,5	750	1125	1500

Il est également possible d'envisager la pêche en continu. Dans ce cas les électrodes resteront en permanence sous tension et cela suppose que les poissons pénètreront continûment dans la zone de pêche. Il est difficile de prévoir les captures ainsi réalisables. Elles dépendront essentiellement de la quantité des poissons présents et de leur comportement en banc vis à vis du champ électrique. La pêche en continu ne devrait être pratiquable qu'en présence de concentrations de sardines très importantes.

La pêche électrique, technique hautement automatisable, devrait permettre une meilleure sélectivité en taille des captures que les engins classiques et par conséquent une meilleure gestion des stocks.

Discussion:

The discussion started with remarks on the combination of light- and electrical attraction. An important question was asked about the number of operations within a certain time. The answer was that for light attraction only three to four operations were possible during one night. For the combination of light and electricity no answer can yet be given. Asked about the set-up of the installation Kurc answered that a report with full details will be published later.

A further discussion developed about some fish species being unwilling to cross a thermocline and the training of species to certain stimuli.

Asked about the type of lamps which were used, Kurc answered that a 500 W commercial type underwater lamp was used of a spherical type. The time of the year in which the experiments took place was from April to November.

Asked about fish being paralysed near the anode Kurc answered that this could be the case but that they were nevertheless sucked up by the pump.

Size selectivity is present but species selectivity is doubtful as was confirmed by others.

Kurc ended the discussion with the remark that practical application is doubtful because of the high cost.

Progress Report - Electrical fishing.

by Peter A.M. Stewart, Marine Laboratory, Aberdeen, Scotland.

The comparative fishing experiment for flatfish using a divided beam trawl was repeated to obtain more data on the selective effects of electric and chain ticklers. The net was divided from the beam aft to twin codends. One side was rigged with an electrode array and the other with a chain tickler. Each haul thus gave a direct catch comparison. Analysis of the catch data indicated that the electrified system was as efficient as the mechanical system but caught fewer juvenile flatfish. This supported the results of previous cruises.

Work was started on the development of electrical fishing equipment for otter trawls. An electrified Nephrops trawl was tested on FRV Clupea. The design and performance of the equipment are described in a separate presentation to the meeting.

Experiments on the reactions of flatfish to fixed electric screens were carried out. A large underwater cage was set up at a field site on the west coast of Scotland. A section of cage wall was replaced by an electrified screen. Fish approached this barrier with caution and, on finding it to be harmful, turned back. The barrier remained effective for the duration of each test and few fish escaped. Fish herded towards the barrier however,were less inhibited by the electric field and a greater percentage escaped.

Work has continued on experiments to define the mechanism of electrotaxis and some progress has been made. Direct excitation of muscle fibres appears to be responsible for forced swimming under electrical stimulation.

The design and testing of electrical fishing equipment for an otter trawl.

by Peter A.M. Stewart and George M. Cameron, Marine Laboratory, Aberdeen, Scotland.

Presented by Peter A.M. Stewart.

Introduction:

The crustacean *Nephrops norvegicus* is found on muddy ground occupying extensive subterranean burrows. When in these burrows *N.norvegicus* is safe from capture by trawls and emerges to forage when the light level is low (Chapman, 1971). This behaviour accounts for the large diurnal variations in trawl catch rates.

Studies on a natural colony of *Nephrops norvegicus* demonstrated that an electric stimulus could force these animals to emerge rapidly from their burrows (Stewart, 1974). The optimum stimulus for inducing this response was found to be bursts of DC pulses at a frequency of 10 Hz. The time taken to emerge was estimated at between 1 and 2 seconds.

Experimental electrified trawling using a divided beam trawl demonstrated that the use of this stimulus on a fishing gear could increase catch rates (Stewart, 1975). The divided beam trawl was selected (a) to simplify catch comparisons, only one side of the gear being electrified during each haul and (b) to provide a stable, robust framework to support a pulse generator and electrode array. Although this gear is adequate for experimental purposes, its catch rate for *Nephrops* is too low for it to be commercially useful, with or without electric ticklers.

To exploit the work which has been done on this subject it appears that, for the present at least, equipment suitable for using on commercial otter trawls should be developed.

In the Scottish fishery for Nephrops the trawls used have a low headline height (1 or 2 m) and are towed by vessels of around 200 hp, using V-doors, at speeds in the range 1.0-1.5 m/s. To electrify the area in front of the groundrope, it is necessary to provide an electrode system approximately 16 m wide and, at the very least, 3 m in length to apply the stimulus for long enough for emergence to be possible. An electrode array of this size cannot, at present, be energised with a battery pack and power has to be supplied from the towing vessel. Pulse generating equipment to provide the appropriate pattern of electrical stimulation can in practice be arranged in only two ways. (1) Either the pulse generator can be mounted on the gear close to the electrode array and supplied with power at mains voltage, (2) or it can be on board ship and transmit high-voltage pulses to transformers on the gear. It is not practical to use large diameter, high voltage cable on a small vessel on the grounds of safety and cost. A gear-mounted pulse generator is the practical solution, therefore, and the obvious place to fit a pulse generator feeding an electrode array rigged ahead of the groundrope, is on an otter board. V-doors are the most suitable as the pulse generator can be mounted in the angle of the door where it is relatively protected. Further, the tendency of V-doors to "roll"over obstructions minimises damage due to impact.

The experimental work on electrical fishing carried out in Aberdeen during the last few years has enabled experience to be gained in the design and operation of electrical fishing systems.

The system designed for the otter trawl was based on the experimental gear described in a previous article (Stewart, 1975), but modified to give a higher power output. Trials were carried out on the fishery research vessel "Clupea".

EQUIPMENT:

a. Fishing gear

In figure 1 the gear used for the development exercise is shown. This is a standard design of *Nephrops* trawl modified for use on a 600 hp vessel. V-doors 1.4 m by 2.4 m were used. A heavy groundrope, chain with rubber discs, was used to ensure good bottom contact.

b. Power supply

FRV "Clupea" has available power of 103 kVA which is ample for electrifying a Nephrops trawl. The power supplied to the gear was 50 Hz single phase AC via a 22.5 kVA variable transformer which limited the current surges experienced by the generator.

The supply cable from ship to gear was armoured and had a breaking strain of 4 tonnes. The cable had two power cores of multi-stranded copper each of 3.2 mm2 cross-sectional area, and two coaxial lines for control of the pulse generator and monitoring of the electrode voltage. This cable was mounted on a special winch with a large diameter barrel and fed over large diameter sheaves to avoid sharp twists in the cable run. Sharp twisting of copper cables leads to work-hardening and shortens their useful life.

c. Pulse generator

The circuit diagram of the pulse generator is shown schematically in figure 2, which also illustrates the power supply connections and electrode wiring.

The pulse generator was an SCR switched capacitor discharge unit with a resonant commutation circuit. The unit was set to deliver 1 second long bursts of 10 Hz with 1 second intervals between bursts. Surface control was achieved by providing the voltage for the control system independently of the main supply. The pulse generator was enclosed in a strong steel housing 0.16 m in diameter and 1.45 m long. The assembled unit weighed 54 kgm in air and 24 kgm in water. The housing was mounted on special brackets in the angle of the V-doors.

d. Electrode array

The design of the electrode array presented problems. To electrify the gear effectively required an electrode array about 16 m wide. The length of the array was chosen to be 5 m which should give at least 2 and possibly 3 bursts of pulses at any point at a towing speed of 1.0 to 1.5 m/s, and hence increase the effectiveness of the gear.

The electrodes can be rigged either parallel or at right angles to the direction of motion. The latter course could lead to snagging, especially with multiple electrodes and the former method was adopted. Ten electrodes, 1.5 m apart, were thought sufficient to provide the necessary field strength throughout the zone of interest. The voltage between two long parallel cylindrical electrodes, radius r_o, at a distance D apart, is described by:

$$V_x = V_o \log_e \left(\frac{D-x}{x}\right) / 2 \log_e \frac{(D-r_o)}{(r_o)}$$

where V_x is the voltage at a point on the line joining the centres of the two cylinders, distant x from one of them, and V_o is the voltage between the cylinders.

The electric field strength at the same point E_x is given by:

$$E_x = \frac{dV}{dx} = V_o \left(\frac{1}{x} + \frac{1}{D-x}\right) /2 \log_e \frac{(D-r_o)}{(r_o)}$$

The electric field strength decays rapidly away from the electrodes and at the mid-point where $x = D/2$ is at a minimum value:

$$E_{D/2} = 2V_o/D \log_e \frac{(D-r_o)}{(r_o)}$$

Taking typical values, $r_o = 0.5$ cm and D in the range 1.0 to 1.5 m, $\log_e \frac{D-r_o}{r_o}$ varies from 5.3 to 5.7.

If $V_o = 50$ V and D = 1.5 m, then $E_{D/2} = 11.7$ V/m and this is the minimum value in the plane of the electrodes. This value is less than the minimum value found necessary to induce emergence (Stewart, 1974). A separation of 1.0 m gives $E_{D/2} = 18.9$ V but the field strength over most of the area is then excessively large.

The resistance R, between two parallel electrodes of length L, as above, is given by:

$$R = \frac{\rho}{\pi L} \log_e (D/r_o)$$

where ρ is the resistivity of sea water.

An approximate calculation of the resistance of a suitable 16 m wide electrode array with alternate positive and negative electrodes gives:

R = 0.01 Ω for 1.5 m separation, and
R = 0.0056 Ω for 1.0 m separation

These values are extremely low. To develop 50 V between electrodes of 0.01 Ω resistance, it is necessary to pass a current of 5000 A. Further, this value is comparable to lead resistance and the voltage needed to pass 5000 A would be in the region of 100 to 150 V.

The higher the pulse current required to energise the electrodes the bulkier the equipment becomes. The output voltage can be increased however, with a small increase in size. It seemed rational therefore, to investigate methods of connecting the electrodes which would result in a higher load resistance being presented to the pulse generator, thus increasing the required voltage but reducing the current.

Using a simple model electrode array several series-parallel wiring schemes were assessed. The system shown in figure 2 was selected. The electrodes were connected in the sequence 2-3-3-2 and in the model system the current in the loop connecting two sets of three electrodes was measured and found to be about 80% of the input current. This suggested that the 2-3-3-2 sequence was effectively routing the current to produce an effective high resistance network. First order calculation of the resistance of this array gives a figure of 0.045Ω.

The electrode array for the Nephrops gear was towed from a wire attached to the sweeps just aft of the doors. The fore end of each electrode was 1 m astern of the wire and attached with synthetic fabre rope. The electrical connections were made with 16 mm2 copper cable.

OPERATING EXPERIENCE

a. Electrical equipment

The characteristics of the electrode array were determined by making measurements of voltage and resistance in the sea. It was found that the inter-electrode voltage was uniform throughout the array and that the resistance was 0.115Ω, i.e. more than twice the value calculated from a first order approximation.

The calculation ignores, however, the catenary taken up by the electrode support wire, contact effects and differences in the resistivity of the sea and sea bed. All of these factors are difficult to include accurately in a calculation. It is proposed to study the electrode array on a field site where it will be possible to make more detailed measurements.

The pulse generating equipment performed satisfactorily. Unlike previous experimental systems used by the Marine Laboratory, this equipment did not contain an isolating transformer. This means that if part of the main circuit of the pulse generator is energised and becomes shorted to the housing, or an electrode lead becomes exposed near the trawl door, the door can become live and on a steel ship current will flow between the door and the hull. In a commercial system it would be essential to incorporate an automatic protection device such as an isolating transformer.

A slip-ring winch is an essential item for handling a power cable with an otter trawl, to cope with turning manoeuvres and sudden increases in warp tension e.g. when a door temporarily digs into the bottom. The alternative is to pay out an excessive amount of power cable which can become tangled around the gear. The cable resistance was found to be a significant limiting factor at high power levels. 3Ω per line was measured on 400 m of 3.2 mm2 cable. Larger diameter copper conductors are required for the operation of this size of electrode array.

The cabling around the otter board was, as expected, the most vulnerable part of the electrical system. Damage was experienced once whilst an otterboard was being moved. Cabling in this area should be heavily protected. No damage was sustained by the inter-electrode cabling. This part of the system is vulnerable however, and it is proposed to use larger diameter single-core armoured cable in future trials.

b. Fishing Gear

The gear was inspected by divers before and after the attachment of the electrical equipment, and, as far as could be ascertained, the attachments had no effect on the geometry of any part of the gear.

Trials were carried out on Nephrops grounds in the Moray Firth at depths between 60 and 80 m. Catch rates with the gear were satisfactory at 2 to 4 baskets per hour. The catches were measured and statistically analysed. There was insufficient data to allow a meaningful comparison to be drawn between catch levels with and without an electric stimulus due to the high catch variability. The size distributions of the catches could be compared however, and analysis suggested that the "electrified" catch contained a significantly greater proportion of large nephrops.

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Stewart, P.A.M.	1974	An investigation into the effect of electric fields on Nephrops norvegicus. J.cons.int.Explor. Mer., 35(3): 249-257.
Stewart, P.A.M.	1975	Comparative fishing for Nephrops norvegicus (Linnaeus) using a beam trawl fitted with electric ticklers. Mar.Res.1975, no.1: 10 pp.

Discussion:

A question was asked about the system being ready for commercial use. The answer was "No".

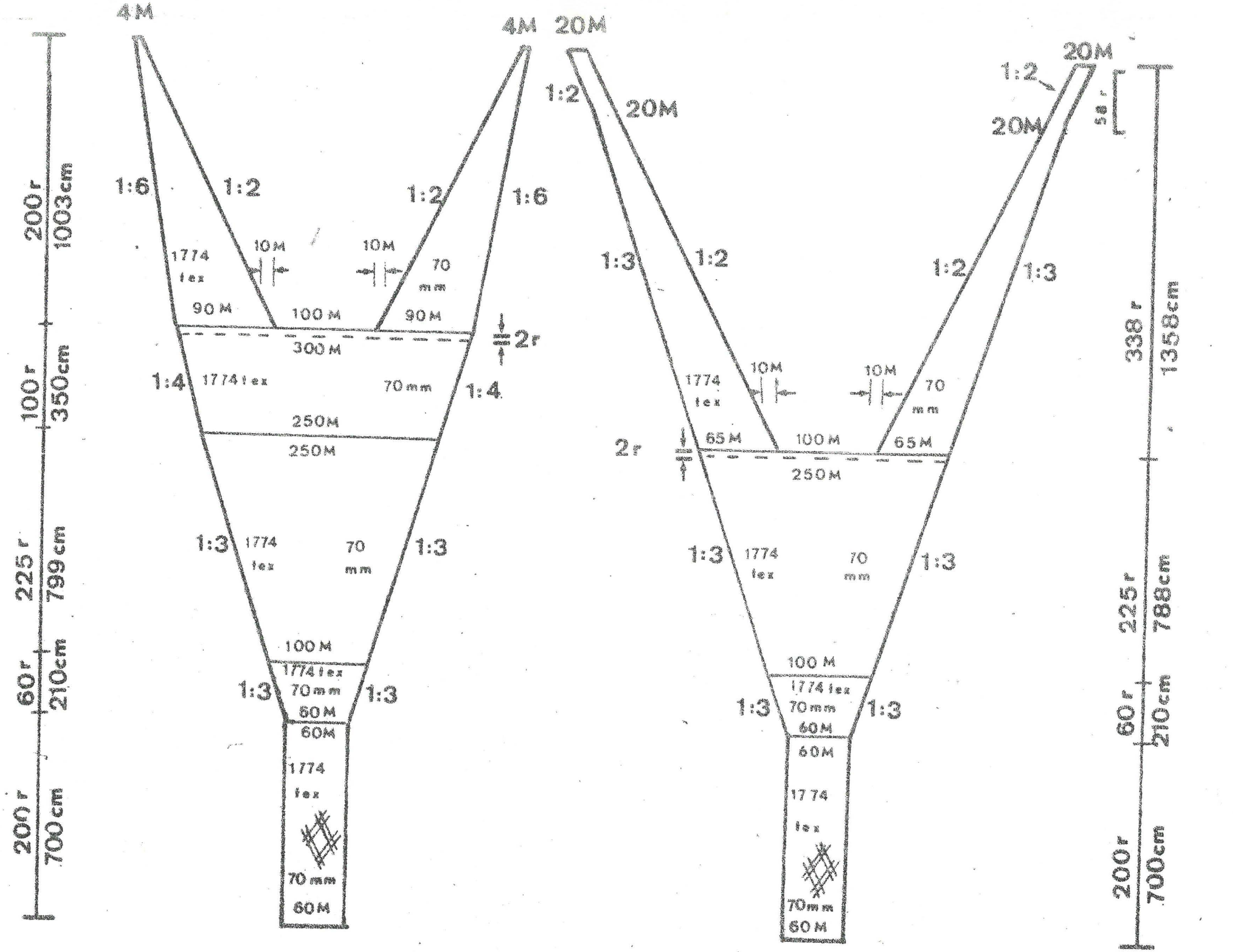


Fig.1 Nephrops trawl for 600 hp vessel

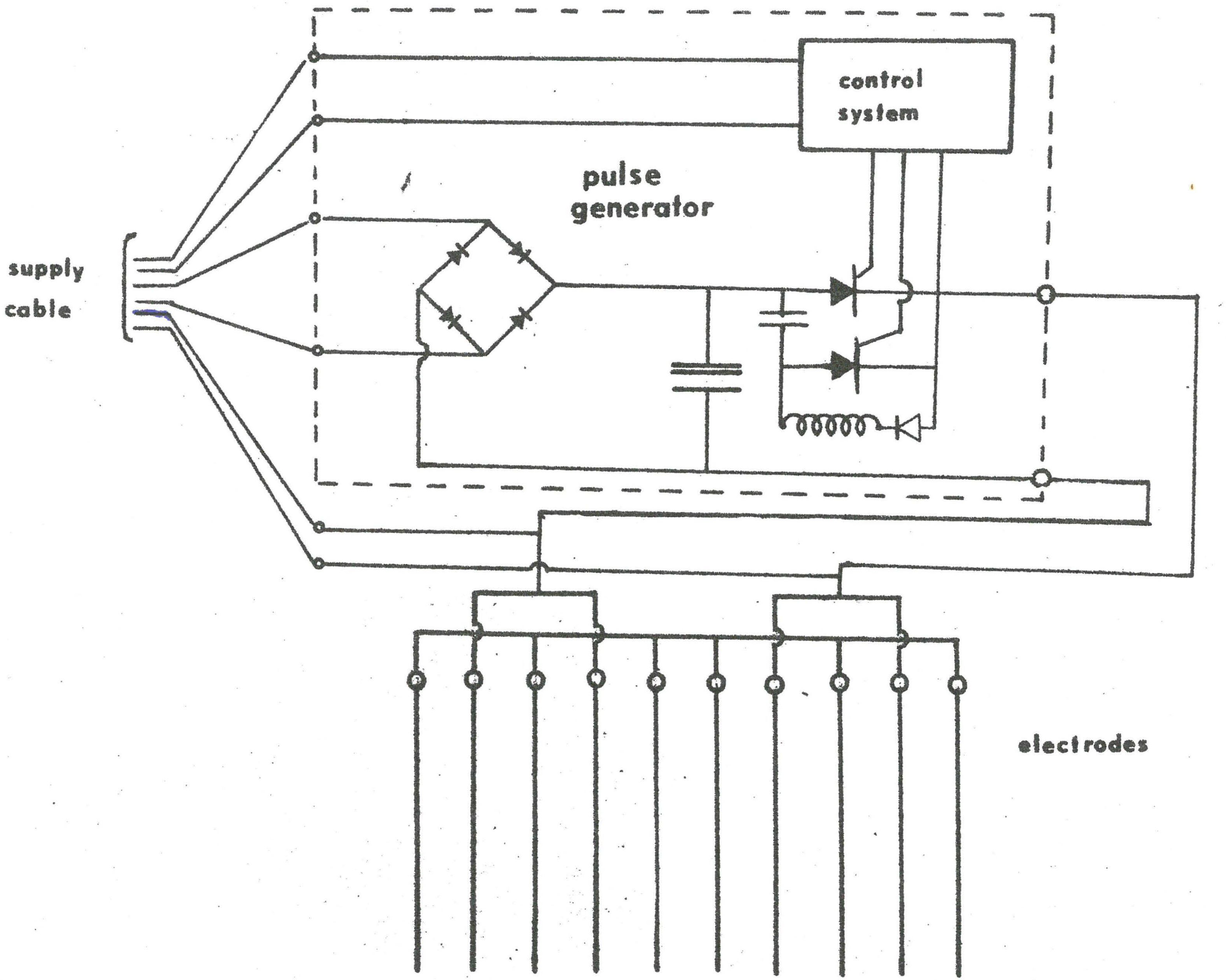


Fig 2 Electrical system ...

With E				
Number of fish per haul	4.94	7.5	6.5	11.12
Weight per haul (kg)	1.47	2.14	1.75	3.51
Weight per fish (kg)	0.298	0.285	0.269	0.361

The next table gives the increase in catch in %.

Experiment number		4.1	4.2
Pulse length m/sec.		0.34	0.51
Increase in catch in % with E			
Number	%	+ 13.19	+ 70.45
Weight	%	+ 54.78	+114
Increase in weight per fish	%	+ 36.7	+ 25.5

This table gives an indication that the shorter of the two pulse-length (0.34 m/sec.) gives a better selectivity because the weight per fish is higher. There is also evidence that with an increase of voltage over 110 V the catch drops sharply.

Discussion:

Asked about the measurement of resistance between the electrodes, Horn answered that this was calculated. The resistance on the bottom appears to be higher because most bottom types have a higher resistance than the sea water. Horn expects a commercial application of electrical stimulation of flatfish in the near future. Doubt was expressed about a shorter pulse giving a better selectivity.

Comparative electrical fishing for shrimp and flatfish on commercial vessels in 1976.

by: G.P. Boonstra, The Netherlands Institute for Fishery Investigations, IJmuiden, the Netherlands.

Introduction:

This paper is a condensation of two internal reports of the Technical Research Department of the Netherlands Institute for Fishery Investigations. Only the most relevant information is given.

Shrimp:

The shrimp trials took place in April and May in the so called "Sylt" area (Chart 1) and were carried out on request of the shrimp-fishermen's organisation in the Northern part of the Netherlands.
Previous trials in the Scheldt Estuary indicated that an increase in catch of shrimp through electrical stimulation is 30% on the average, depending on conditions of turbidity. Because the by-catch in that area is very important, a commercial introduction was not taken into consideration.
The trials were carried out with the shrimp vessel "Bona Spes" WR 17, a 71 gross-tonnage vessel with a propulsive power of 400 h.p.
To limit the towing-force to 2500 kgf, the vessel uses a special propellor during the shrimp fishing period.
The pulse generator was the same one as used in the previous trials.
The rigging was also identical (figure 1)
Pulse frequency 5 Hz
Peak Voltage at the end of the electrodes 35 V.

The conditions for electrical shrimp fishing were unfavourable. The shrimp catches were very good over the whole period and the turbidity of the water was high.

Under those conditions shrimp catches by day were just as good as by night, contrary to a year earlier when day catching was not possible because of the very clear water. Table 1 gives a summary of the tows in May while they are also presented in graph 1.

The conclusion is that the mechanical stimulation of the ticklers has a negative effect by night as well as by day in turbid water.
Electrical stimulation during the night reduces this effect from -19% to -8%.
Optimum electrical shrimp fishing would have to be carried out by day only while during the night the electrical ticklers would have to be removed. The overall conclusion of our research in this field is that electrical shrimp fishing is now a technical possibility. It is however feasible only in clear water conditions, which are the exception rather than the rule.
It is therefore unlikely that shrimp fishermen will adopt the system although a few of them have been considering the use of our system during part of last winter when the water was clear, the catches small and the price high.

Flatfish:

The electrical stimulation of flatfish seems to have more future for reasons which have been discussed before. The application however, is not as easy as for shrimp fishing, although progress is being made.

In the Netherlands we have, so far, chosen for the same system as used in the shrimp fishing, i.d. the pulse generator mounted on the beam gear.
This pulse generator is much bulkier and heavier than the shrimp generator because of the higher frequency, longer pulses and higher voltage.

The first trials on a commercial scale in 1975 resulted in a breakdown of the step-down transformer in the pulse generator because of overheating and some other problems as a result of the extremely high currents.
The transformer is now immersed in oil and has not caused any problems during the 1976 trials.

The system as a whole consists of:

- A 3 kVA 220 V AC diesel-generator;
- A regulator/monitoring unit with a separation transformer, variable transformer and a Voltage and Ampere meter;
- A 500 meter Enag netsounder winch operating from the 110 V DC ships mains. This winch leads the power supply cable to the pulse generator;
- The power supply cable. The cable is a coaxial type cable with low resistance (4.6 ohm/km for the core and 5.6 ohm/km for the shield) to minimize the voltage drop. The cable has a breaking strength of 800 kgf;
- The electrodes, which have so far been made of copper aerial wire linked to a light chain as shown in figure 2.

The link between the power supply cable and the pulse generator is made by connecting the two cables in a junction box, which is then filled with a two component resin.
The result is an absolute watertight connection.
Trials with stainless steel electrodes resulted in a voltage drop towards the end of the electrodes because of the resistance of the stainless steel.
The trials in 1976 were carried out from May 24th till July 2nd. The vessel was the "Breehorn" WR 87 of 59 gross tons and a propulsive power of 225 h.p.

Results:

The results of a number of comparative tows are represented in graphs 2, 3, 4 and 5.

The catch on both sides was approximately the same.

Figures 2 and 3 show the electric and non-electric sides respectively.

The selectivity aspect is not very clear in this series of trials yet.

There is one reason which may account for that.

Although there were no breakdowns technically, the diesel-generator voltage was not stabilized. The peak voltage of the first pulse in a cycle was thus 65 V but the next pulses were only 45 V.

For the next series of trials the diesel-generator will be replaced by a stabilized rotary-converter and the peak pulse voltage increased to 95 V.

The peak voltage so far was limited to 70 V because of the rating of the buffer capacitors.

Advantages and disadvantages of the system:

As already mentioned before, the Dutch system has the pulse generator mounted on the beam.

This system has a number of advantages and disadvantages.

A great disadvantage is that the heavy, bulky pulse generator impairs the handling of the gear and gives a slip stream which may influence the catch unfavourably.

To fix the pulse generator rigidly to the beam, the five parts of the beam gear have to be welded- or bolted together. Those five parts are: two shoes and three pipes.

The first disadvantage can probably be lessened. A newer version of the pulse generator could possibly be smaller (fewer capacitors) and lighter (other material than stainless steel).

Advantages are:

- The cable to the pulse generator is a power supply cable. In our case the maximum voltage is 220 v AC. This gives no problem with slip rings whilst the danger factor is almost nonexistent with a floating AC source separated from the mains by a 1 : 1 separation transformer.

- The cables from pulse generator to electrodes are short and give little loss.

Continuation:

A new series of comparative fishing for flatfish has been planned for 1977.
The same pulse generator will be used again, slightly modified to produce pulses of maximum 100 V.
The pulse length will be decreased from 0.7 m/sec to ca. 0.5 m/sec. The frequency will be 25 Hz continuous.
The intention is to fish for about 8 weeks.
We hope that this program will bring us a step forward towards the realisation of an electric stimulation system which can be used commercially.

Discussion:

During the discussion the philosophy behind the experiments were emphasized:

a. Better survival chances for the discards
b. Better selectivity
c. Decrease of costs (fuel, chains, etc)

A plea was made to look into the survival chances of fish as regards to fishing speed for different types of fishing. This appears to be an urgent matter. Survival tests have been done in beam trawl fishing with fishing speeds of 4 - 4.5 knots. The present fishing speed is sometimes over 6 knots and the results of the former tests may not be valid any more. The development of a flatfish grader was discussed and it was made clear that this development can only be seen in connection with electrical stimulation.

Doubt was expressed about the wisdom of experimenting with low powered fishing vessels because there are hardly any left. A question was asked if comparative tests have been done between a high powered vessel with normal gear and a low powered vessel with electrified gear. The answer was: "No, but this will have to be the final comparison". Comparative fishing with one high powered vessel is impossible because either the normal or the electrified gear does not fish efficiently depending on the fishing speed. Comparison between two vessels will have to be made over a long period and the results should be compared after both owners have done their bookkeeping. A final question was asked about the possibility of guiding juvenile red fish in another direction than towards the codend. Answer: "Theoretically possible but the practical application needs to be looked into.

TABLE 1

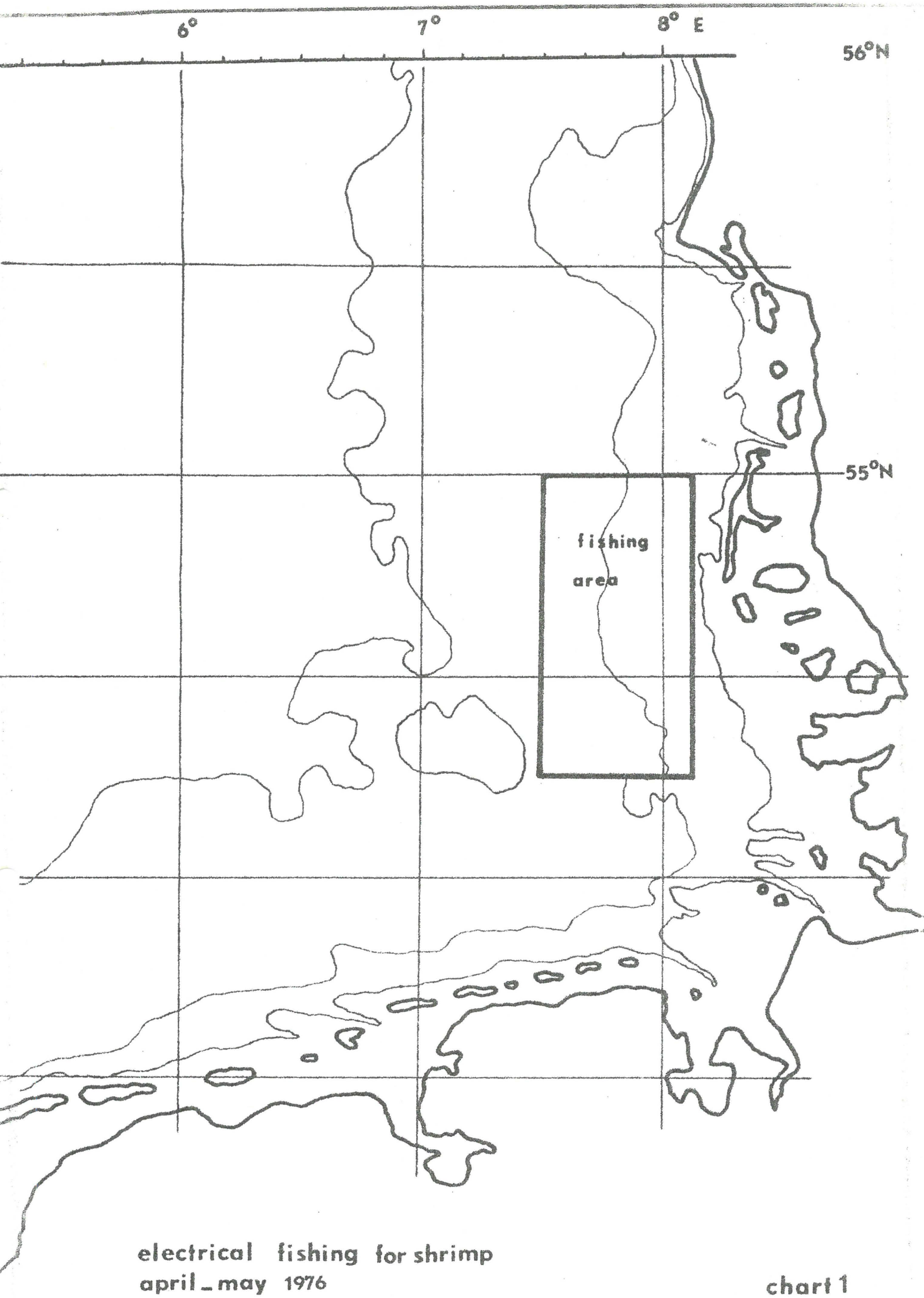
SUMMARY OF THE TRIALS IN MAY 1976.

The non-electric (control) side = 100% (consumption shrimp)

Non-electric control tows during the night	(11)	E =	2681 l	-19%
		NE =	3310 l	
Electric tows during the night	(8)	E =	2570 l	- 8%
		NE =	2784 l	
Non-electric control tows during the day	(5)	E =	1355 l	-16%
		NE =	1612 l	
All electric tows	(33)	E =	11303 l	+11%
		NE =	10194 l	
Electric tows during the day	(25)	E =	8733 l	+18%
		NE =	7410 l	
Electric tows during early morning	(6)	E =	2028 l	+50%
		NE =	1350 l	

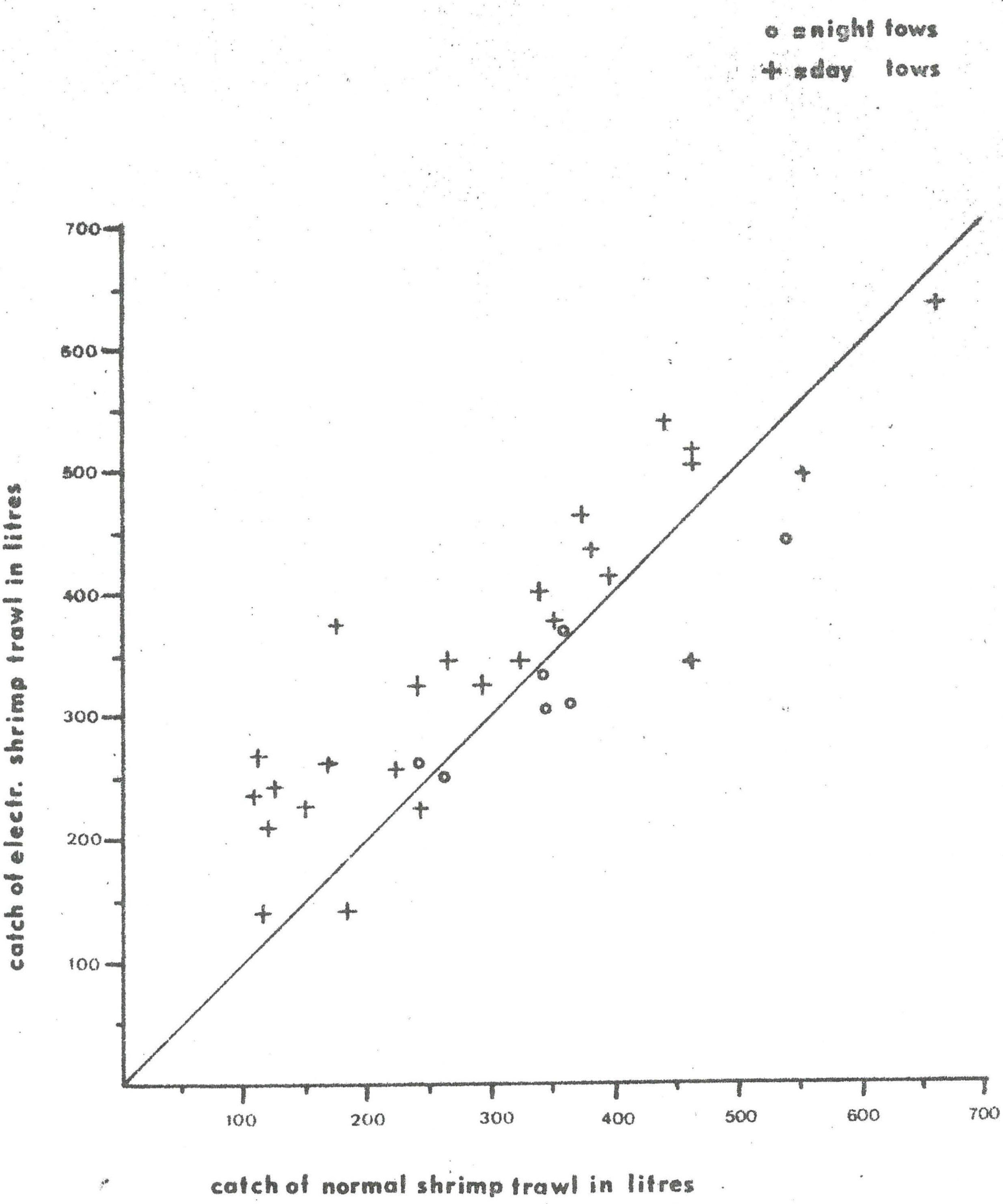
Average catch per tow per side (consumption shrimp) = 310 l

The relation consumption shrimp : undersized shrimp in the 33 electric tows is for the electric side 11303 : 6046 = 1.87 : 1 and for the non-electric (control) side 10194 : 6893 = 1.48 : 1. If we take the control side (undersized shrimp) as 100% we get an absolute reduction of undersized shrimp on the electric side of 12% (E = 6046 l NE = 6893 l).

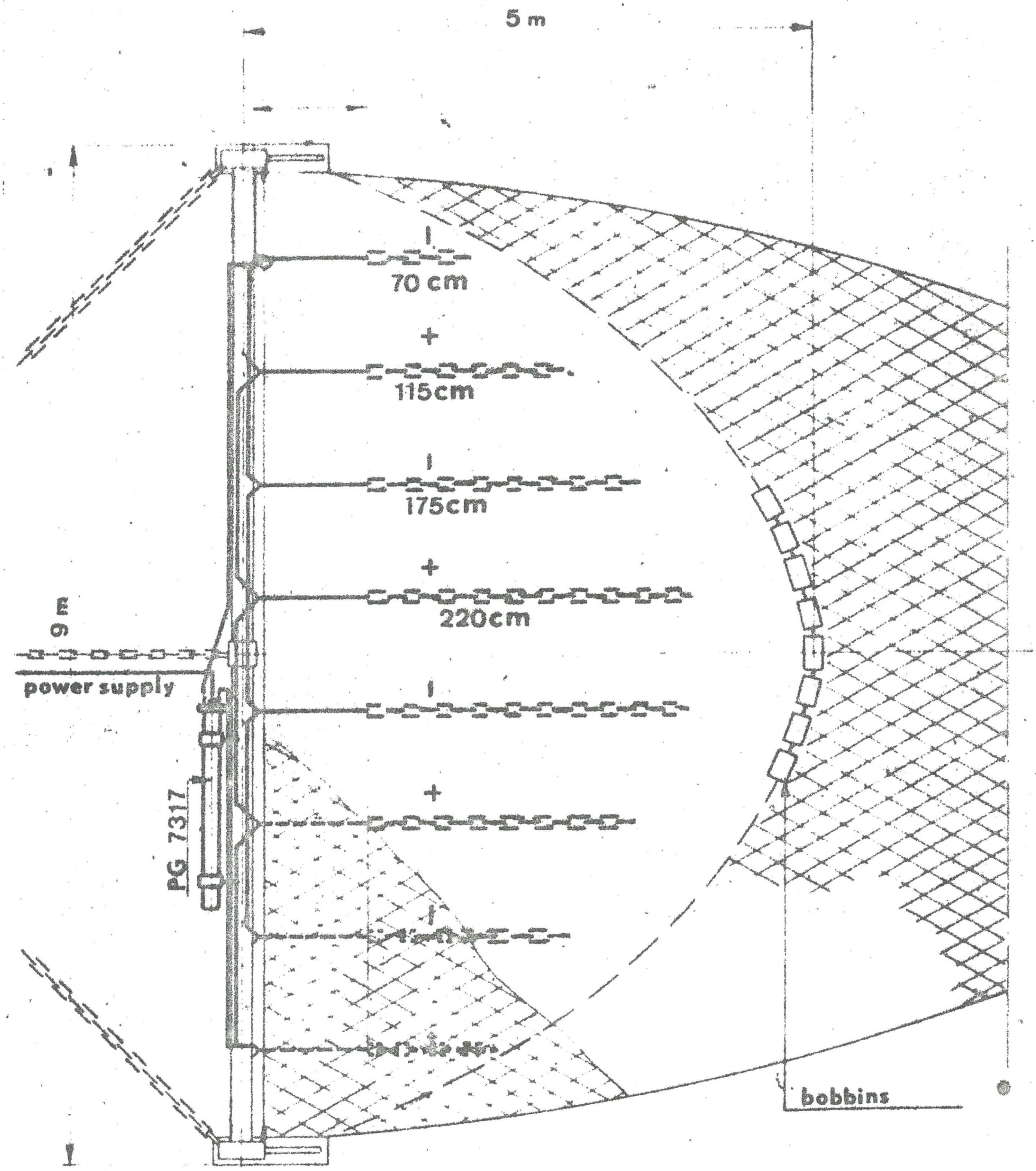


electrical fishing for shrimp
april – may 1976

chart 1



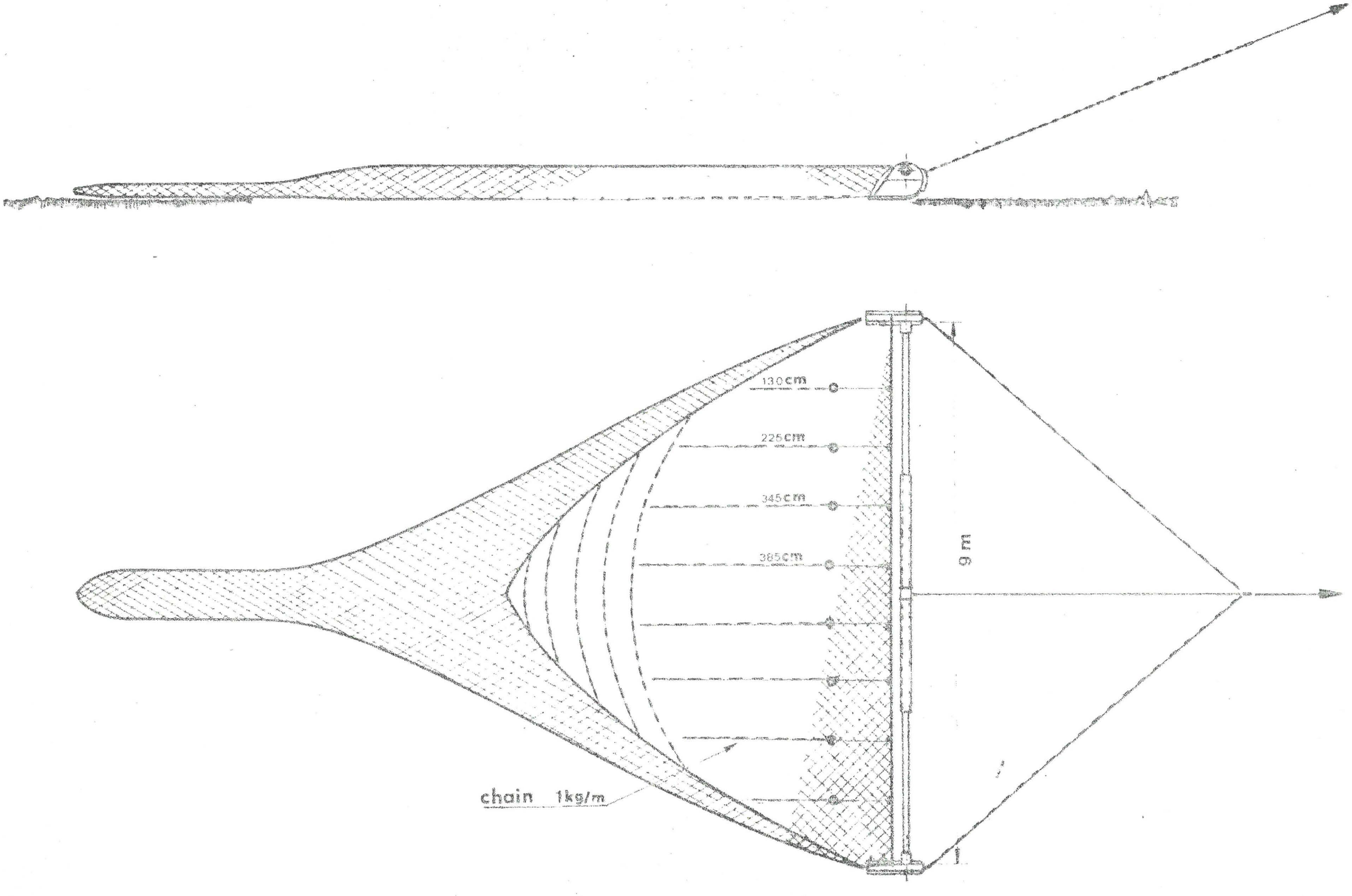
Benaming comparative electr. shrimp trawling 1976			Formaat A4 — graph 1
	Schaal	Gecontroleerd	
Auteursrecht voorbehouden volgens de wet	Getekend	Gezien	Rangschikmerk



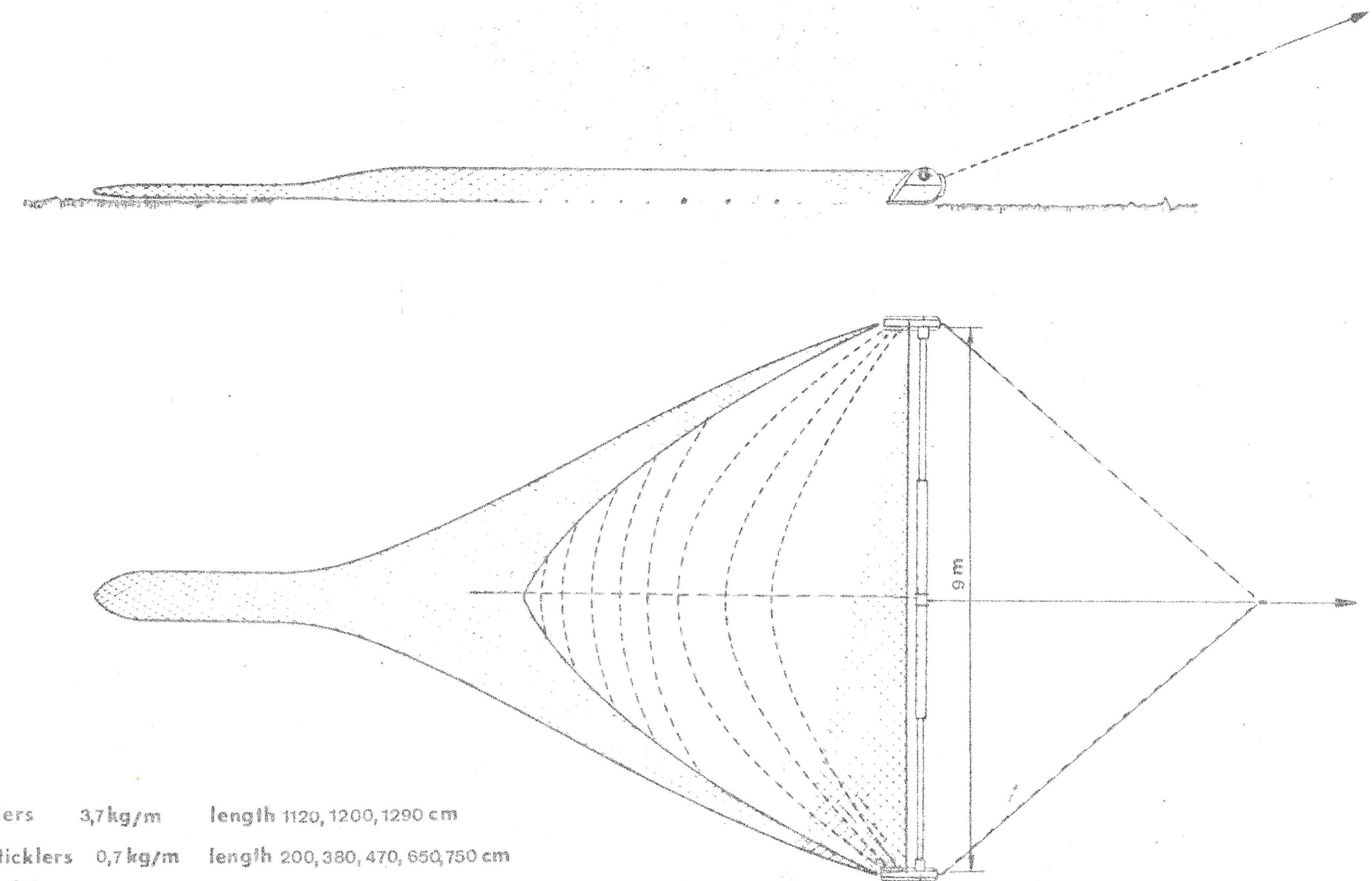
Benaming **electrical shrimp fishing** 1976

Schaal | Gecontroleerd | Formaat A4

FIG. 1



Benaming			Formaat	
flatfish fishing, electrode rigging WR87			A3	Fig. 2
TECHNISCH VISSERIJONDERZOEK	Schaal	Gecontroleerd		
	Getekend	Gezien	Rangschikmerk	



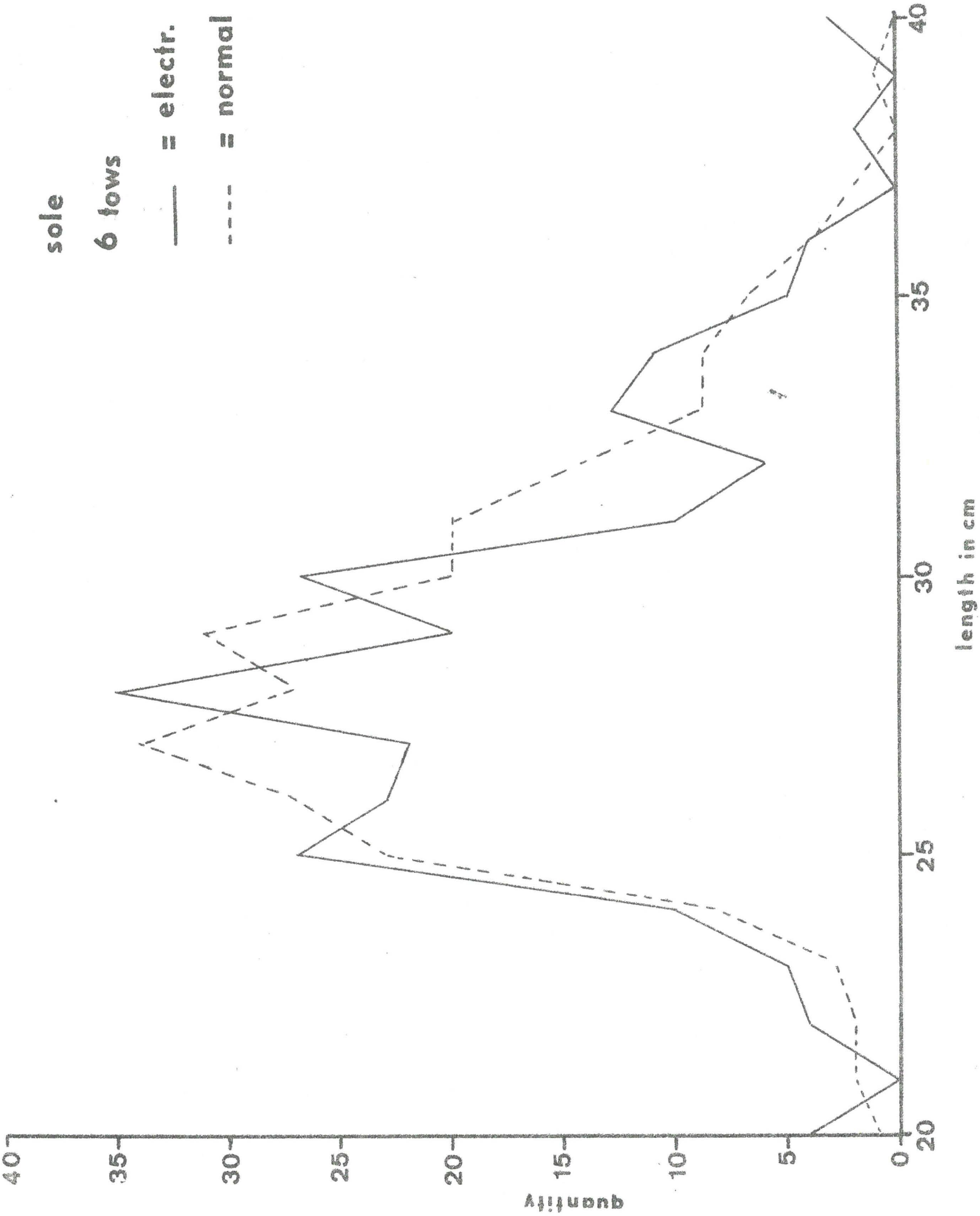
ticklers	3,7 kg/m	length 1120, 1200, 1290 cm
net-ticklers	0,7 kg/m	length 200, 380, 470, 650, 750 cm
groundchain	35 kg	length 1780 cm

Benaming
flatfish fishing, normal rigging WR 87

Formaat A3 | Fig. 3

TECHNISCH VISSERIJONDERZOEK

Schaal | Gecontroleerd | Getekend | Gezien



Benaming

comparative electrical fishing

	Schaal	Gecontroleerd	Formaat A4
Auteursrecht voorbehouden volgens de wet	Getekend	Gezien	graph 3
			Rangschikmerk

Figure 4. Deck lay—out of a shrimp vessel

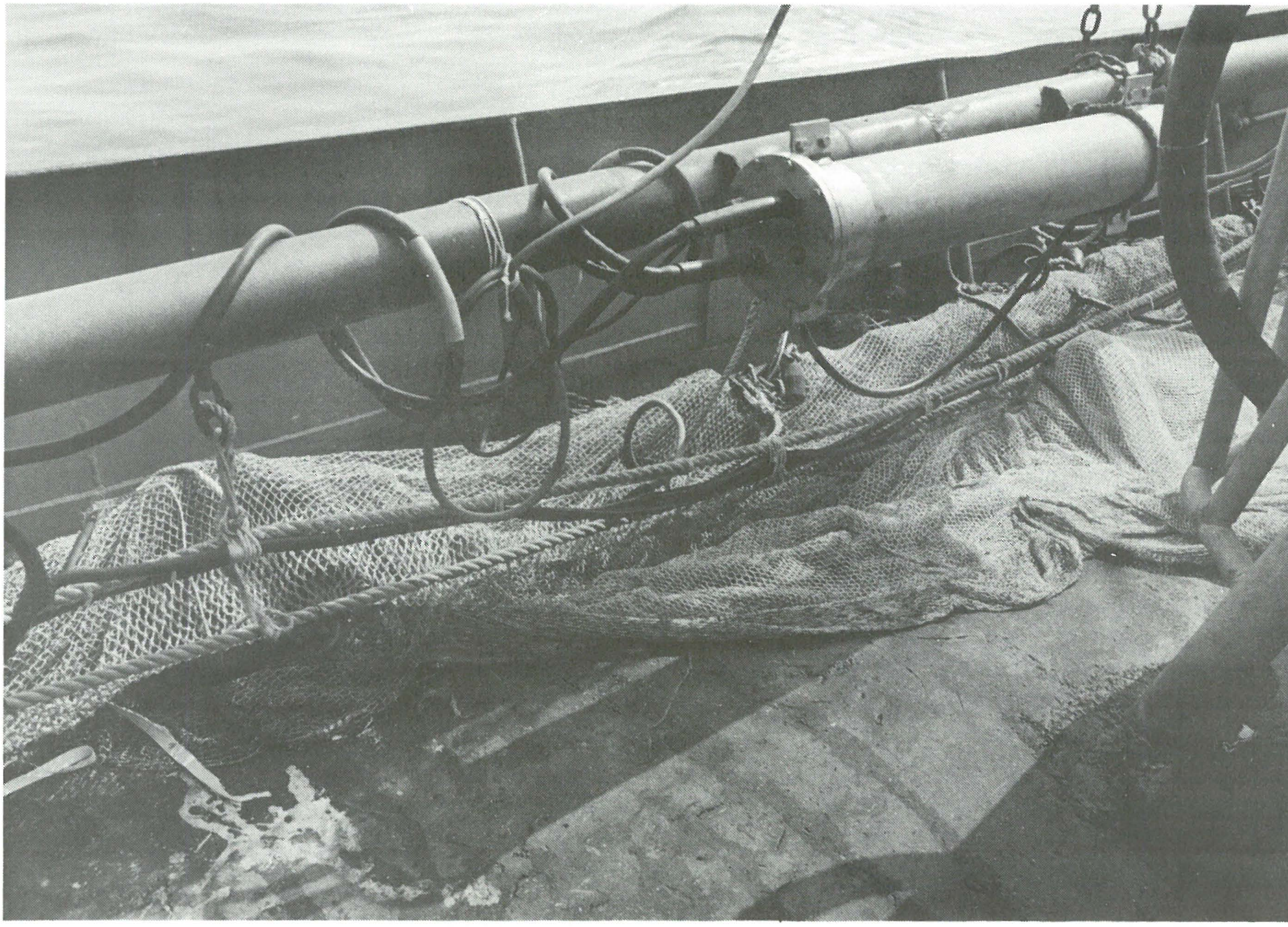


Figure 5. Shrimp pulse generator mounted on the beam

Figure 6. Winch with power supply cable on board WR 87

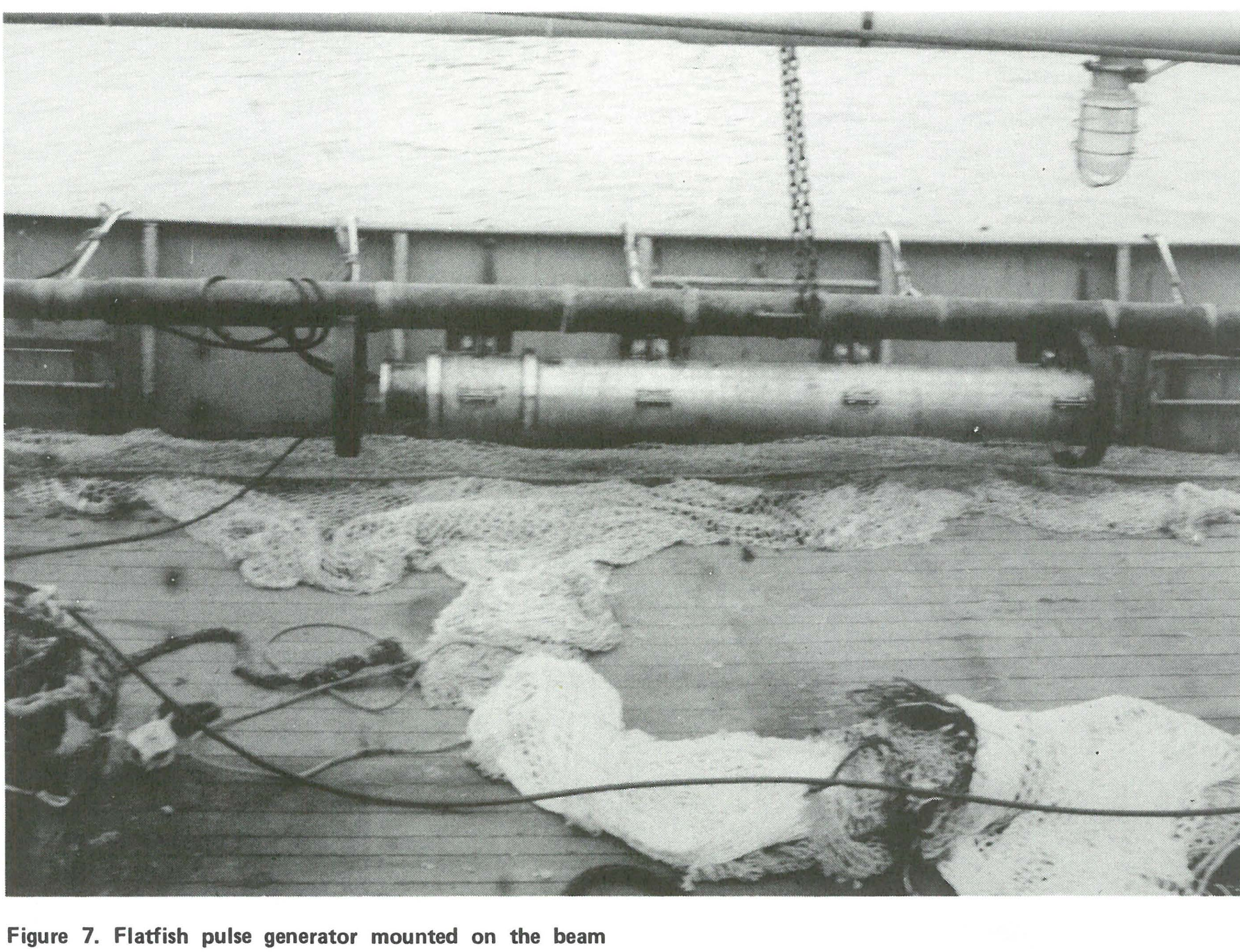


Figure 7. Flatfish pulse generator mounted on the beam