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Gear and Behaviour Cmtte
(Ref. Fisheries Improvement Cmtte)

LES OPERATIONS DES PECHERIES DANS LA MER DU NORD SEPTENTRIONALE AYANT TRAIT A LA SECURITE DES PIPE-LINES SOUS-MARINS

par

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Sommaire

Les statistiques portant sur les opérations des pêcheries sont présentées pour les engins de pêche les plus lourds et plus couramment employés pour la prise des poissons démersaux. Dans le cas des chaluts à panneaux, les efforts des pêcheries ont été analysés selon la puissance du navire remorqueur. Les forces de remorquage et la géométrie de ces engins est décrite et en établissant un rapport entre ces caractéristiques et les données relatives aux efforts de pêche, on obtient une base permettant de calculer la probabilité et la sévérité des chocs entre les engins de pêche et les installations sous-marines comme, par exemple, les sections de pipe-lines exposées.

International Council for the Exploration of the Sea

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Gear and Behaviour Committee
(Ref. Fisheries Improvement Ctte)

FISHING ACTIVITIES IN THE NORTHERN NORTH SEA RELEVANT TO THE SAFETY OF UNDERWATER PIPELINES

by

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Summary

Fishing effort statistics are presented for the heavier and more commonly used demersal fishing gears. In the case of otter trawls, fishing effort has been analysed according to the power of the towing vessel. The towing forces and geometry of these gears are described, and relating these features to the fishing effort data provides a basis for calculating the probability and severity of impacts between fishing gear and underwater installations such as exposed sections of pipeline.

1. Introduction

The extraction of oil and gas from the North Sea has led to the installation of many permanent structures such as production platforms, suspended well heads and submarine pipelines. The North Sea is perhaps more intensively fished than any other area of comparable size, and where there is fishing activity in the vicinity of a structure which protrudes from the sea bed there is a possibility of impacts by the demersal types of fishing gear which operate in contact with the sea bed. The possibility of damage to submarine structures in such circumstances has important consequences not only because maintenance work on underwater installations is expensive, but also there may be a pollution danger, for example if oil were to leak from a damaged pipeline. Moreover, submarine structures present an additional hazard to fishermen who must take into account the cost of gear damage in deciding where and when to fish.

Around production platforms there is of course a statutory safety zone of radius 500 metres which vessels are prohibited from entering except in certain circumstances, and in any case platforms are visible on the surface so that it is not difficult to avoid them. There are numerous suspended well heads, but each one presents an obstruction at only one point, and the main requirement is that sufficient details of well head locations should be provided so that fishermen can avoid them as they would other known obstructions such as wrecks. As an additional safeguard suspended well heads are normally buoyed.

Pipelines give rise to a rather different problem, since they often run for long distances to connect oil fields with shore terminals and there is no surface indication that a pipeline is present except for short lengths associated with platforms and shore terminals. However, the current practice is to attempt the burying of all pipelines by excavating a trench around the pipe after the laying operation. Even the heaviest trawl gear should only penetrate soft ground to a matter of inches and hard ground not at all, so there should be no complications about fishing over the route of a completely buried pipeline, but unfortunately the presence of rock outcrops or certain soil types can prevent complete burial of a pipeline. These difficulties seem to be more prevalent in the northern parts of the North Sea where it is generally accepted that some pipeline sections cannot be buried and consequently these sections are liable to be hit by fishing gears. It is important therefore for the fishing industry to have information about the routes of submarine pipelines and particularly of those sections which cannot be buried.

The kind of damage which may occur when a fishing gear strikes a pipeline is not considered here, but see Gjorsvik et al 1974 and 1975. The intention in this paper is to catalogue the more important types of gear, their mechanical characteristics and the extent of their use in the northern North Sea as a basis for considering the safety of exposed pipeline sections.

It is suggested that readers who are not familiar with the terminology of fishing techniques should first read section 3 which includes some basic information on this topic.

2. Distribution of Fishing Activity

In conjunction with the physical characteristics of gear the amount of fishing which goes on in the vicinity of pipelines will determine the risk of damage to these installations. In this context the most relevant information is the number of vessel-hours spent actually fishing, that is to say excluding the time spent steaming or on such activities as net mending, and the level of fishing activity is discussed below in terms of vessel fishing hours per year accumulated within rectangles measuring 1° of longitude by ½° latitude. The area considered in this report is that bounded by latitudes 57N and 62N, and longitudes 5E and 4W (Figure 1).

The official statistics from which these data have been extracted are based on information collected from skippers at the end of each voyage. A vessel may cover several rectangles during one voyage, but it is the practice to allocate all the fishing effort for one voyage to the one rectangle where most time has been spent, so differences in detail between adjacent rectangles may not be all that significant.

The total fishing effort by trawl and seine for UK registered vessels fishing in the northern North Sea and landing at UK ports, is shown in Figure 1(a), but the more detailed analysis presented in Figures 2-5, 7 and 8 relates only to UK vessels landing in Scotland. However, the latter represents some 94% of the total UK fishing effort in the relevant area as may be seen from a comparison of Figure 1(a) with Figures 2 and 7, first deducting 39,134 hours from the Figure 2 total for shellfish trawling which is not included in Figure 1(a).

Of course the fishermen of many other nations operate in the northern North Sea, and Table I, which has been derived from data published in the ICES Bulletin Statistique, shows how the catches of the more important demersal species during 1975 were divided between the UK, other EEC countries and the rest of the world respectively. It is evident from this table that the character of the UK fishery has been rather different from that of other countries through the emphasis on catching fish for human consumption rather than the industrial species which are used to produce animal feed or fertiliser.

The large quantities caught in the industrial fisheries do not imply a commensurate proportion of vessel fishing hours, because the catch rates relative to those when fishing for human consumption have to be much higher for economic reasons. Sandeels and Norway pout are the only industrial species fished significantly by bottom trawl in the North Sea. The sandeel is confined to sandy ground and fishable concentrations are typically found along the edges of banks and the crests of submarine ridges, normally in shallow water down to 40m depth. On the other hand, the Norway pout is most abundant in depths from 100-200m (ref. 2). Both species are fished using an otter trawl with small mesh netting and a light ground rope. Norwegian and Danish vessels in the small to medium size range, not exceeding 800 HP, are the most prominent in the industrial fisheries. It may be concluded that industrial fishing gear being relatively light has less potential for damaging pipelines than the heavier types of trawl which are used in the human consumption fisheries.

In 1975 the UK share of demersal food fish production in the northern North Sea was 31%, but in view of fishing limit developments since that time it may be that the current fishing effort in the North Sea by non EEC countries will be at a lower level. Further, the landings data given in Table I include those from Norwegian coastal fisheries which are not relevant to oil production in the British sector. It is reasonable to assume, therefore, that an analysis of UK fishing activity (about which more detailed information is available) will be a good indication of the overall pattern in parts of the northern North Sea where pipelines have been or are intended to be laid.

The one exception which should be mentioned is beam trawl fishing. The heaviest beam trawls are used by Dutch and Belgian fishermen. Figure 6 shows the fishing hours by Dutch and Belgian beam trawlers in 1975, extracted from data kindly supplied by Dr de Groot of the Rijksinstituut voor Visserijonderzoek, Ijmuiden and it can be seen that the activities of these vessels are confined to eastern parts of the area under consideration. Beam trawling is far more significant in the southern North Sea, and the fishing hours listed in Figure 6 represent only 0.3% of the total fishing effort by beam trawl in the whole North Sea.

Fishing is far from being a static business, and the pattern of fishing activity is liable to vary from year to year according to where fishermen see the best chance of success. Added to the natural factors which influence the availability of fish, there are many outstanding questions on the issue of fishing limits and on quota regulations to conserve the stocks, so it is difficult to predict how fishing patterns will develop over the years ahead except to say that they will not be constant. As far as beam trawling is concerned, however, this method is used primarily in fishing for sole and shrimp and from a consideration of the distribution of these species there is nothing to suggest that the level of beam trawling in the northern North Sea is liable to increase.

The beam trawl has a considerable potential for damaging pipelines on account of the high towing speeds combined with the weight of gear but the otter trawl being so much more widely used has more significance in connection with the safety of pipeline routes in the northern North Sea. For this reason otter trawling has been considered in more detail as regards the engine power of towing vessels (Figures 2-4). While different sizes of gear are used even on vessels of the same nominal horse power, in general terms it is possible to correlate ranges of vessel HP with corresponding ranges of the size and weight of gear components.

Figures 2 and 3 show the distribution of otter trawling in 1975/76 according to vessel HP, and Figure 4 shows the division of total hours between heavy and light trawls. Note the change in the vertical scale of Figure 4 to take account of the preponderance of activity by vessels below 800 HP. During these two years, no demersal fishing time was recorded for UK vessels over 2000 HP in the northern North Sea. Light trawls were used mainly by vessels under 400 HP and not at all by those over 800 HP, while heavy groundrope gear was used mainly in the range 400-800 HP. Comparing 1975 with 1976, it can be seen that latterly there has been a reduction in the average HP of trawling vessels, but otherwise the pattern of activity shows the same general features between the two years. The most intensive fishing was by the smallest vessels working mainly inshore but also on a number of popular grounds further out.

Figure 5 shows the hours fishing by demersal pair trawl in 1976. Demersal pair trawling is mainly used in the industrial fisheries by smaller vessels up to 400 HP, but the larger vessels that normally pair trawl for herring (typically 600 HP boats) may go for white fish when herring are scarce. This type of fishing is a fairly recent development which is still on the increase and it is likely that the total hours recorded for future years will be much higher.

The seine net is used extensively throughout the northern North Sea (Figure 7). The total hours recorded for this method are slightly less than those for otter trawling, but the seine net activity is the more evenly distributed by area.

Scallop dredging (Figure 8) is only significant in inshore areas around the Shetland Islands.

3. Fishing Gears used in the North Sea Demersal Fisheries

The single boat otter trawl and the Danish seine are the principal fishing methods currently used in the North Sea. These methods each account for around 35% of the total fishing effort in the North Sea, but in terms of potential for damaging underwater installations the otter trawl is the more significant since it has heavier components, in particular the otter boards and groundrope. For this reason, otter trawls are described below in rather more detail than are the other fishing methods.

The demersal pair trawl, the shellfish dredge and the beam trawl are the only other fishing methods which merit consideration as regards their effects on pipelines.

Single Boat Otter Trawls

Figure 9 shows the configuration of an otter trawl when it is fishing. The horizontal opening of the net is maintained by the hydrodynamic and ground friction shear forces acting upon the otter boards, while the net is opened vertically by the opposing action of the ground rope weight and the floats attached to the headline. The function of the bridle wires, apart from connecting the net to the otter boards, is to shepherd fish into the path of the net so that the effective area fished by the gear is rather greater than that covered by the net alone. The length of the bridle may be between 30 and 110 m, depending on the type of fishing and the shorter bridles would be preferred on rough ground to reduce damage to the gear. As much as 70% of the bridle length may be in ground contact. The bridles and legs together constitute the sweep system, and sometimes there is a more complicated assembly of wires relative to the simple system shown in Figure 9, with the aim of increasing the vertical net opening. Some of the alternative sweep systems currently in use are illustrated in Figure 10, but mostly these variations from the traditional pattern are confined to vessels below 800 HP. The angle between the bridle and the direction of tow will be in the range 10-30° and the distance between the otterboards will be 2 or 3 times the horizontal opening of the net.

Nets

Trawls are constructed from a number of netting panels, laced on to connecting ropes, and the mesh size increases section by section from the codend forwards. Virtually all trawls are now made of synthetic twines, the most popular being nylon and polythene. The forward the lower sections where the net is near the ground are the most liable to damage from stones or any other obstructions on the sea bed. Floats made of plastic or aluminium alloy are attached to the headline, and to provide extra lift a kite made of wood or aluminium may be used occasionally. This could be attached directly to the headline and upper netting panel or it may be flown from a system of wires connected to the sweep system.

Groundropes

The different types of groundrope used with otter trawls are illustrated in Figure 11. Only vesselsbelow 800 HP would use the light rope rounded or weighted fibre types, while larger vesselsuse the spherical or cylindrical bobbin groundropes to keep the gear hard on to the ground. A heavy groundrope suitable for vesselsin the 1000 HP to 1500 HP class would be typically 43 m long (including the wing rubbers) with 53 cm diameter spherical bobbins in the bosom but smaller (46 cm) bunt bobbins, and in air this groundrope assembly would weigh more than a ton. The bobbins and rubbers are strung on to a number of wire sections connected by shackles (Fig 12), so that the breaking strain of the groundrope should it catch on an underwater obstacle will be determined by the strength of this central wire. The groundrope wire diameter would be similar to that of the trawl warps, but the breaking strainwould be rather less partly because of their shackle connections and sometimes because old wire tends to get used for groundropes.

While a bobbin groundrope (or at least the bosom section) will always run in firm contact with the sea bed, the effect of the bobbin diameter is to keep the lower netting panels clear of the ground to a corresponding extent. The chance of a bobbin groundrope coming fast rather than riding over the top of an obstacle will depend upon the dimensions of the latter relative to the bobbin diameter.

Warps

The length of warp between the towing vessel and the otterboards is typically 3½ times the water depth. No part of the warp will be in ground contact unless a fault develops such as an otter board falling on its back. The warp will act as a spring coupling, especially in deep water when there is more curvature due to the weight of wire. This factor could be important in considering what happens to a gear after it collides with a pipeline. There will be more elasticity in the ship/gear system when the warp is curved. When an otterboard strikes an obstacle, the initial impact force will be too short in duration to be influenced by any stretching of the warp, but persistent forces such as those which arise when a gear slides along a pipe after the initial impact will depend upon water depth.

Otterboards

Three main types of bottom running otterboard are used by European fishing vessels, as shown in Figure 12. The traditional wood and steel flat otterboard is widely used by all sizes of fishing vessel and the flat area of the board ranges from $0.3m^2$ to $6.5m^2$. The size and weight of otterboard which a fisherman will select will depend on a number of other factors apart from engine power, in particular the age of the vessel and the type of net, so that in practice a range of otterboard sizes would be found on fishing vessels of the same nominal horse power (Figures 13 and 14). Depending on size the flat otterboard may be a simple construction, or ruggedly constructed of stout oak or elm timbers, bound and strapped with iron bars, having steel plates fastened on the back and front of the lower planks and a heavy steel keel bolted or welded to the bottom edge.

The Vee boards are made entirely in steel and are used mainly by vessels under 800 HP. They are less efficient spreading devices than flat boards but the hinged towing bracket allows the Vee board to ride more easily over obstacles. The largest size available commercially (appropriate for a 800 HP vessel) is $5.5m^2$ in area and weighs 822 kg.

Oval otterboards are used only on the larger trawlers. They are made of wood and heavily protected with steel plates. A 2500 HP vessel might use $5m^2$

boards weighing 1000 kg. As far as the UK fleet is concerned, such vessels operate in distant waters, and they would seldom if ever fish in the North Sea except that the occasional tow may be made on passage to other grounds. On the other hand, large vessels from eastern block countries do operate in the North Sea and oval otterboards are commonly used on Russian trawlers.

Recently the French designed polyvalent otterboard has increasingly been adopted by larger continental and Humberside based trawlers. These are cambered otterboards made entirely of steel and having an oval shaped perimeter. The warp is connected to a towing plate welded along the horizontal centre line on the front face. Two short plates welded onto the rear of the back face provide connecting points for the backstrops. Polyvalent otterboards are fitted with moveable ballast plates so that the total weight can be adjusted to suit fishing conditions. Further information about the matching of otterboard size to vessel power will be found in reference 3.

General Performance

The horizontal opening of a traditional two panel net typical of those used by 1200 HP vessels would be around 18 m, and with 55 m sweep lengths the corresponding otterboards separation would be 55m. The more modern nets such as the Marine Laboratory four panel trawl have some 20% more in the horizontal net opening but about the same otterboard separation due to a lower sweep attack angle.

The attachment points on an otterboard are arranged to give an appropriate angle between the plane of the board and the direction of tow, depending on the otterboard type between 20 and 50°, and the balance of the otterboard is such that it heels outwards so that the hydrodynamic force has a downward component which helps to keep the board on the ground. It should be emphasised that a fishing gear is not a rigid structure and there will be significant variation of the geometry and towing loads under the influence of changing ground contact conditions and the movement of the towing vessel. Consequently the performance figures quoted above should be regarded merely as being representative of the range which will occur in practice even when comparing two vessels and gear which are nominally the same. Bottom trawls are towed at speeds between 3 and 5 knots, depending on ground conditions and the size of gear relative to vessel power.

The procedure adopted when the gear comes fast on an underwater obstruction is as follows. The engine power is cut as soon as this situation is detected, but due to the momentum of the vessel the warp loads increase drastically as the ship decelerates although the winches should slip when the load rises to about 15 tons. Assuming that at least one warp remains intact, the warps are wound in until tight with the vessel vertically above the obstruction. The ship may be manoeuvred to try freeing the gear by pulling from a direction opposite to that of the original tow, and during these operations the pull on the obstruction could rise to the maximum loading for the winch. Only as a last resort would the warp be cut to free the vessel.

Demersal Pair Boat Trawls

In demersal pair trawling no otterboards are used, and the net mouth is held open by the two towing vessels maintaining station some distance apart. The nets are similar to those used for single boat demersal trawling with either two panels or more often four panels and of size to match the combined towing power of the two vessels. Generally a light ground rope is used; it is unusual to use heavy bobbins but hollow free-flooding plastic bobbins threaded on wire or chain may be employed, or chain may be hung in bites from a fibre ground rope. Chain may also be used for part or all of the lower legs together with one or two weights weighing up to 200 kg each to hold the lower leg in ground contact. The warp length is longer than that used in single boat trawling and it may be as much as twelve times the water depth with a considerable part of the warp length in ground contact to herd fish into the path of the net.

Beam Trawls

The beam trawl is used mainly by Dutch vesselsin the sole fisheries of the southern North Sea. At the present time however, there is little beam trawling activity in the northern North Sea and only a brief description of the gear and method will be given here.

The heaviest beam trawl in current use (Fig 15) comprises a funnel shaped net attached to a tubular steel beam that spans and is welded onto two steel runners called trawl-heads. The trawl heads are bent to shape and have a heavy steel shoe welded to the underside. Rings or drilled brackets are welded to the front of the trawl head to facilitate shackle connection of the towing bridles. Provision is made for connecting a number of tickler chains between the trawl heads. The beam, which may be up to 12m long is usually made in three sections, the outer sections socketed to the middle section, the sections being held together by the in-pull component of the tension in the towing bridles.

The net, though similar in shape to an otter trawl usually has fewer divisions and the belly often is much more deeply shaped to accommodate the array of tickler chains in front of the groundrope. No floats are used on the headline. It is attached along the length of the beam and back of the trawl-heads. The groundrope, which may consist of small rollers or rubber discs on wire, bare chain or lead-weighted fibre rope, is attached to the front of the belly and behind the trawl heads. The length of the beam and height of the trawl-heads determine the dimensions of the net mouth area and no otterboards are required to hold it open. The combined weight of beam and trawl heads rangesfrom 1000 kg - 3000 kg. Modern beam trawlers are purpose built for towing two beam trawls simultaneously and they range in power from 400 HP to over 1200 HP. The vessels are fitted with two pivoted beams, one each side, which, when lowered for trawling provide low profile outboard towing points for the gear.

Seine Netting

In seine netting two long lengths of rope with a drag net between their seaward ends are set on the seabed from the vessel to surround a large area where there are known to be fish (Fig 16). The ropes are then hauled simultaneously to drag the net back to the vessel whilst the vessel is stationary or just keeping way. Hauling power therefore is the more important parameter to which the fishing gear is matched rather than the engine power. The nets consist of a funnel shaped bag with codend and either long or short wings. They may have two panels or four panels. Floats are attached to the headline and the ground-rope may be a lead-weighted fibre rope or combination wire and fibre rope with free-flooding plastic spherical bobbins threaded on. Sweeps range in length up to 55 m. The dan lenos, one on each side, may be short wooden poles, ballasted with iron at their lower end, wood hoops or light triangular metal frames. The ropes are made of manilla or synthetic fibres, or a mixture of both, and range in diameter from 18mm to 25mm and depending on sea bed conditions. From four to twelve coils of rope joined end to end may be used on each side, and the length of a standard coil is 220m. Seine net vessels range in length from 12 to 72 m.

Method

When fish are located the vessel steams away for some distance depending on ground and sea conditions and the extent of the fish concentration. A marker buoy with flag (the dan) is attached to the free end of the first rope then dropped over the side. The vessel now steams around one side of the position where the fish have been located, paying out rope as it goes. When the vessel has passed the fish it moves across to shoot the net behind the fish (relative to the dan). The vessel then heads back to the dan, paying out the remaining coils of rope. By the time the gear has been set and the dan has been picked up and to retrieve the first rope, nearly all the length of rope on each side has sunk to the sea bed.

Both ropes are then hauled simultaneously, slowly at first, the ropes herding fish towards the path of the net as they close. When the ropes are about halfway closed, as seen from the vessel, hauling speed is increased and when they are seen to be nearly closed they are then fast hauled until the net is up to the vessel. The load in the ropes rarely exceed ½ ton. This method of seine netting is often called Fly Dragging. In the alternative Anchor Seining technique the marker buoy is anchored and when the vessel returns to it, after setting the gear, the vessel is made fast to the anchor rope which then holds the vessel against the pull of the gear whilst hauling is in progress.

Shellfish Dredges

In the northern North Sea dredges are used for catching scallops and queens, mainly in coastal waters round the Shetlands and to a much lesser extent off Orkney. Figure 18 shows a typical dredge. It is made of steel and consists of a ruggedly constructed triangular frame with the cape forged into a towing ring and the centre and side members extended beyond the base and bent such that a tooth bearing bar rakes the sea bed when the dredge is towed. The length of the tooth bar varies from 1.2m to 1.9m. The teeth are spaced approximately 100 mm between centres and protrude about 65 mm below the bar. A belly made of steel rings linked together is secured behind the tooth bar and a cover made of heavy synthetic fibre usually of polyethylene is joined to the sides and back of the belly and carried forward to the base of the frame to form a bag in which the catch is retained. The total weight of the dredge varies from 50 kg to 100 kg. A recent innovation is the use of shock absorbing springs to connect the tooth-bar to the frame.

In deep water a reversible type of dredge can be used. It is fitted with two opposing tooth-bars so that the dredge will fish either way up.

Another type of dredge has been designed specifically for catching queens. It consists of a low profile oblong steel box frame with runners incorporated at each end. A chain bag is fitted behind the frame. It has no tooth-bar and no triangular fore frame. Towing chains are used instead of the latter.

Dredges are mainly worked by vessels ranging in length from 6m to 24m and recently even larger vessels have been dredging for scallops and queens. The smallest vessels may tow one or two dredges and more powerful vessels up to three dredges from each side, the dredge being connected in line to a towing bar at the end of each warp.

Further information on the design and construction of fishing gear may be found in references 5 and 6.

4. Conclusions

In this paper a factual description has been presented of the bottom fishing gears commonly used in commercial fishing, the physical characteristics of these gears and the distribution of fishing activity in the northern North Sea. The gears most commonly used in this area are the smaller otter trawls and the seine net, but the low momentum of these light gears implies that their influence in contact with exposed submarine installations should be limited to abrasive effects. The most important gear to be considered as regards shock and point loading effects on pipelines is undoubtedly the heavy otter trawl as used by vessels larger than 800 HP. The momentum of a heavy beam trawl is also substantial, but this gear is seldom used in the northern North Sea.

The effects of fishing activities on pipelines are currently being investigated under a research programme with international support. Should it be found that such effects are significant, the alternative courses of action which may be considered in order to overcome or at least to reduce the problem would include (1) the improvement of pipeline trenching techniques, (2) the stronger construction of pipelines and especially of the coating material, (3) the modification of fishing gear and (4) the restriction of fishing activities around pipeline routes.

5. Acknowledgement

The authors wish to thank Miss A M Shanks for her assistance and advice in connection with the statistical data presented in this report.

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Table I. 1975 landings from ICES Area IVa (northern North Sea), for demersal species which are mainly caught by trawl or seine. All figures are in metric tons, nominal live weight.

	UK	Rest of EEC	Other Countries	Total
Human consumption species				
Cod	37361	10973	6203	54537
Haddock	52584	26259	29113	107956
Saithe	11651	30009	142638	184298
Whiting	23907	43942	2877	70726
Flatfish	6993	1161	323	8477
Dogfish	5736	211	11580	17527
Shellfish	1510	1343	497	3350
Total	139742	113898	193231	446871
Industrial species				
Norway pout	26582	245630	360869	633081
Sandeel	13205	99023	33282	145510
Total industrial	39787	344653	394151	778591

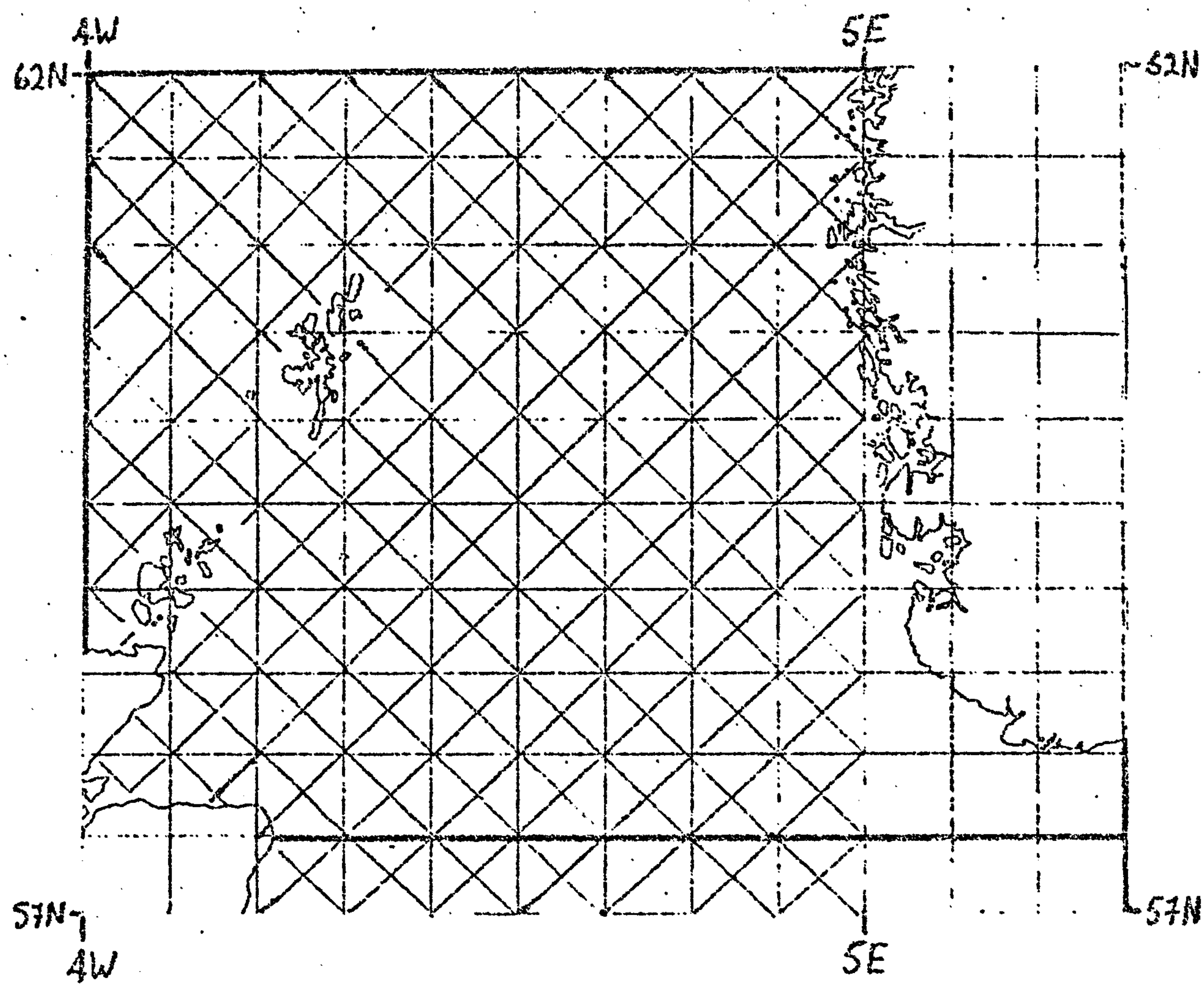
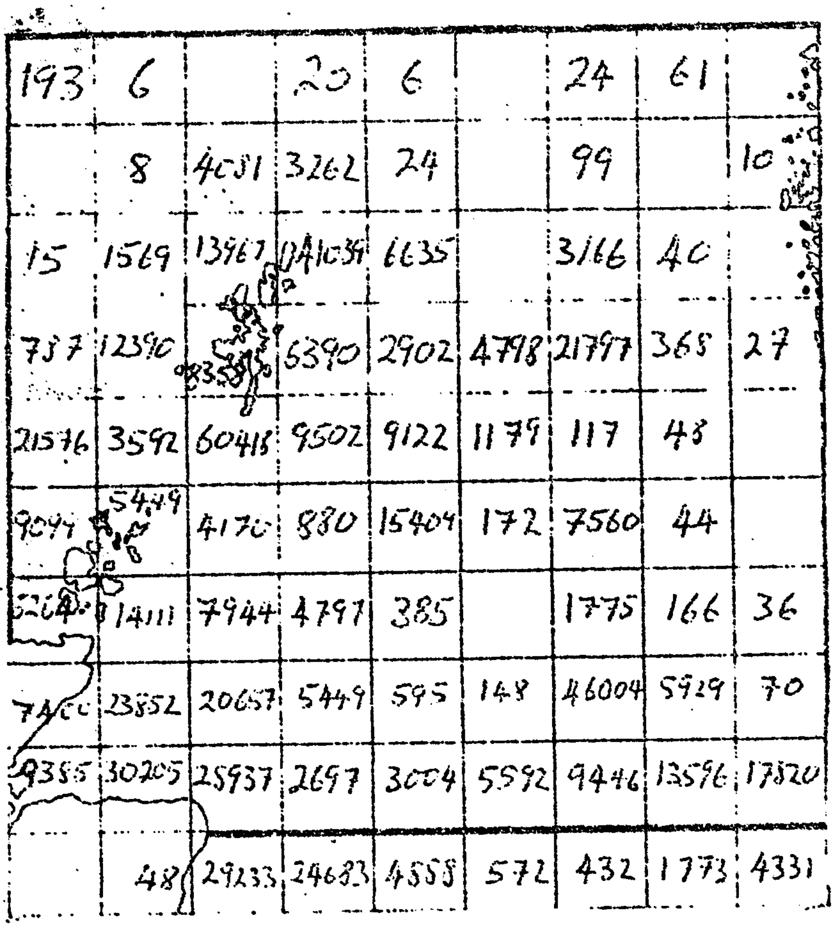
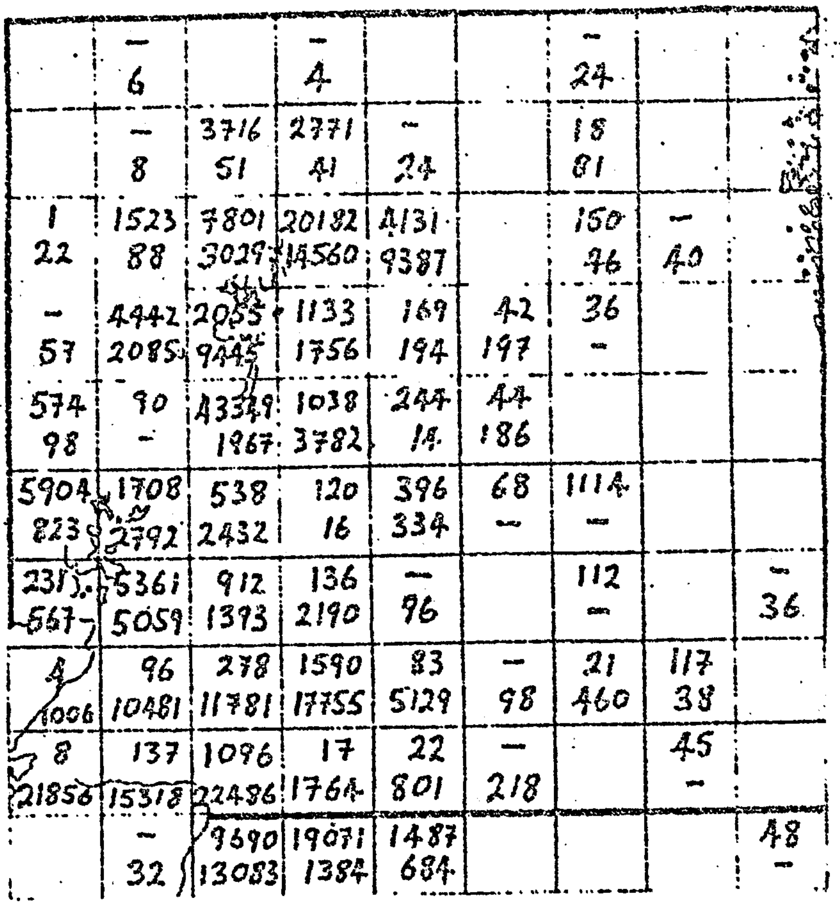


Figure 1 . The part of the North Sea considered in this paper. The solid black line indicates ICES area IVa for which certain statistics are quoted.



Total Hours:- 612609

Figure 1(a). Total U.K. hours fishing by otter trawl and seine (excluding shellfish gears) in 1975.



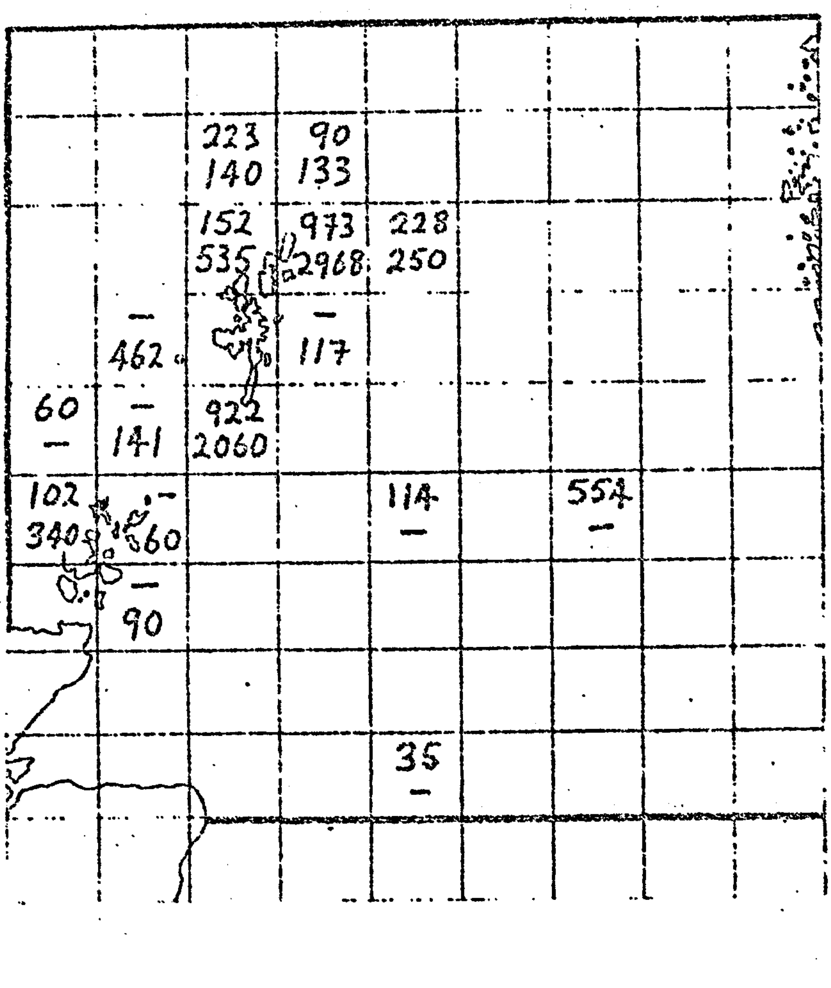
Small vessels

Upper and lower numbers relate to HP ranges:-

401 – 800
< 400

Total hours:-

143919
187309



Large vessels

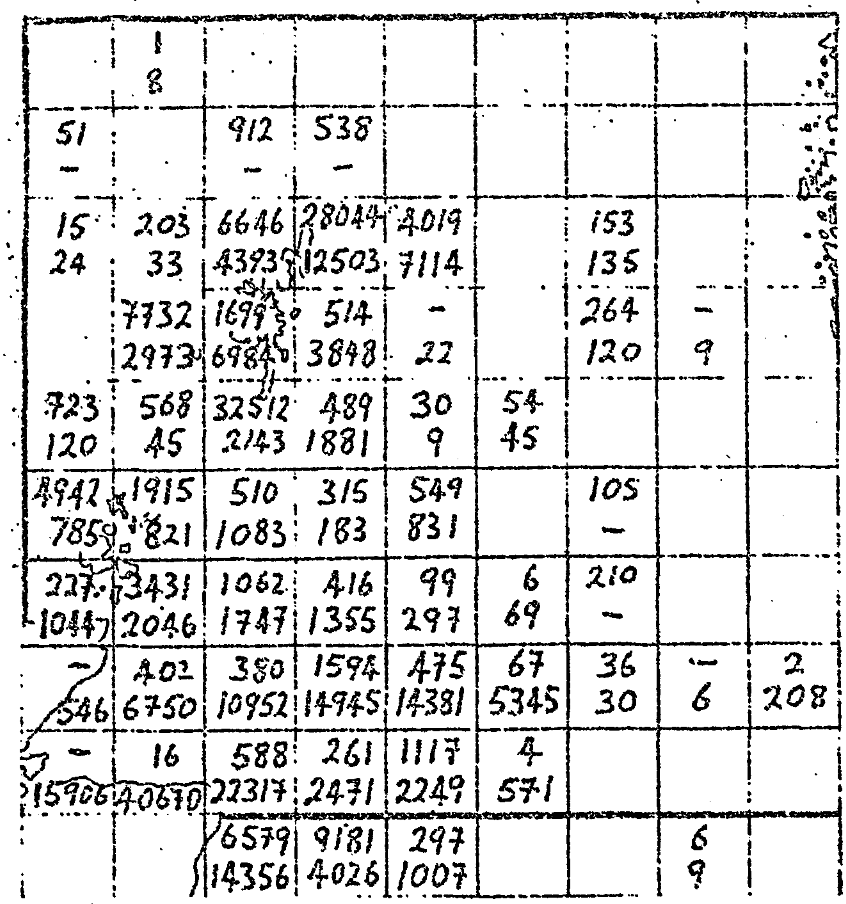
Upper and lower numbers relate to HP ranges:-

1201 – 2000
801 – 1200

Total hours:-

3453
7296

Figure 2. Hours fishing by otter trawl in 1975.



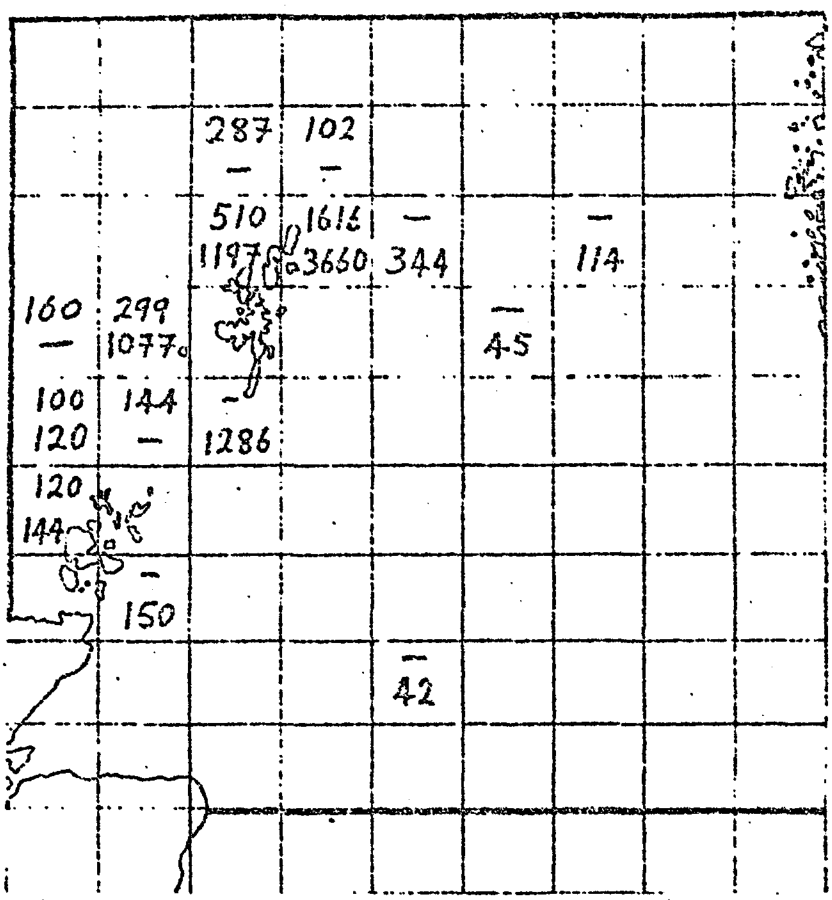
Small vessels

Upper and lower numbers relate to HP ranges:-

401-800
< 400

Total hours:-

119959
209415



Large vessels

Upper and lower numbers relate to HP ranges:-

1201-2000
801-1200

Total hours:-

3338
8179

Figure 3 . Hours fishing by otter trawl in 1976.

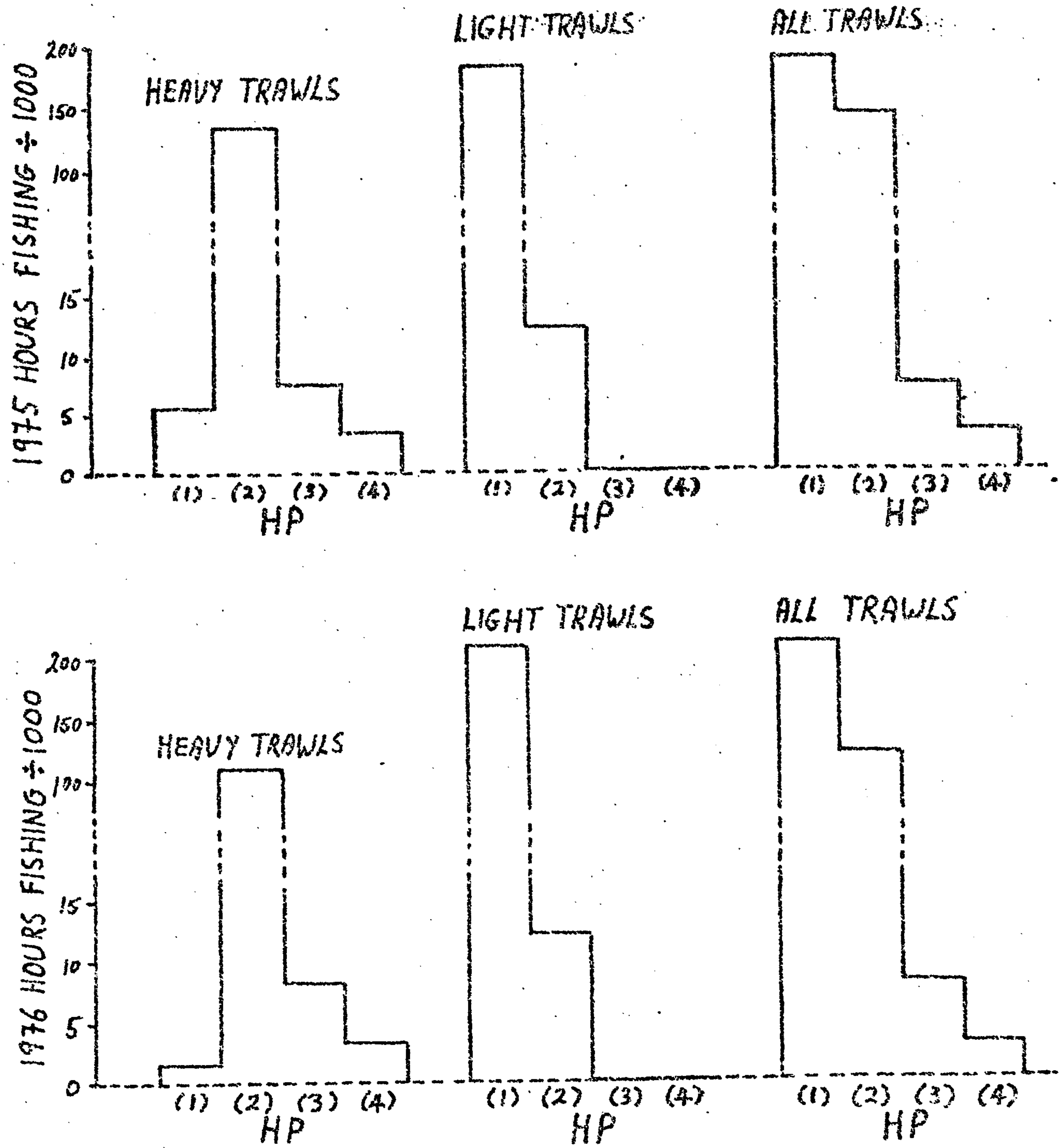


Figure 4 . Hours fishing by otter trawl in 1975/76, against vessel power and type of gear. The HP ranges as numbered above are (1) less than 400, (2) 401 - 800, (3) 801 - 1200 and (4) 1201 - 2000.

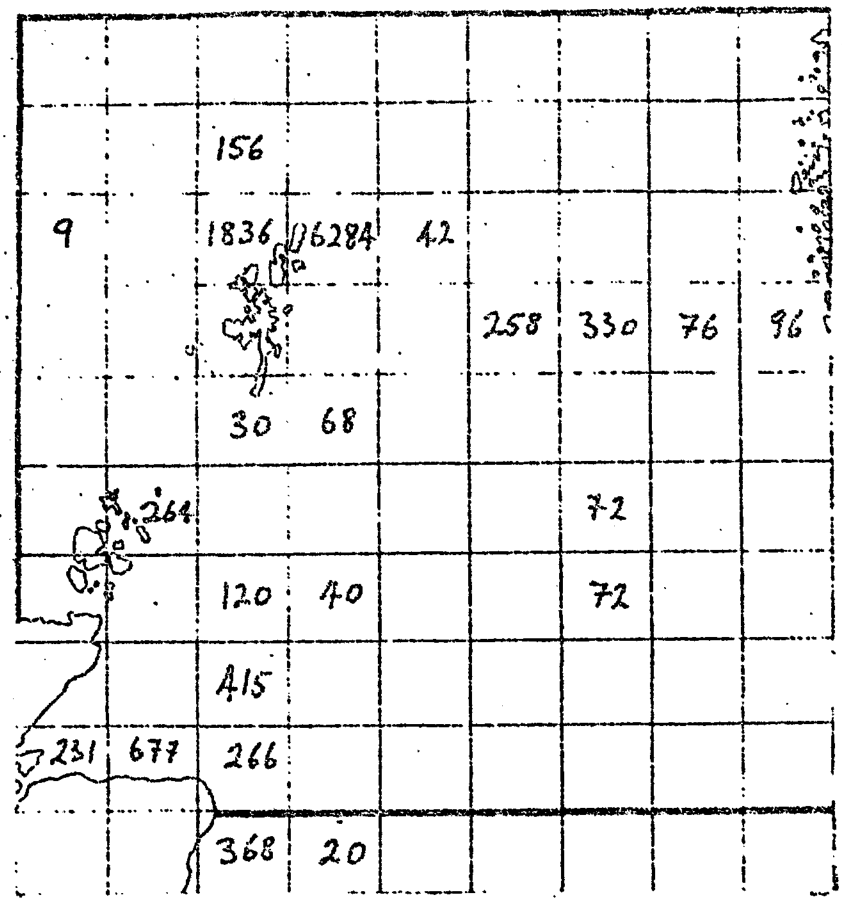


Figure 5.

Hours fishing by demersal pair trawl in 1976.

Total hours:-
11730

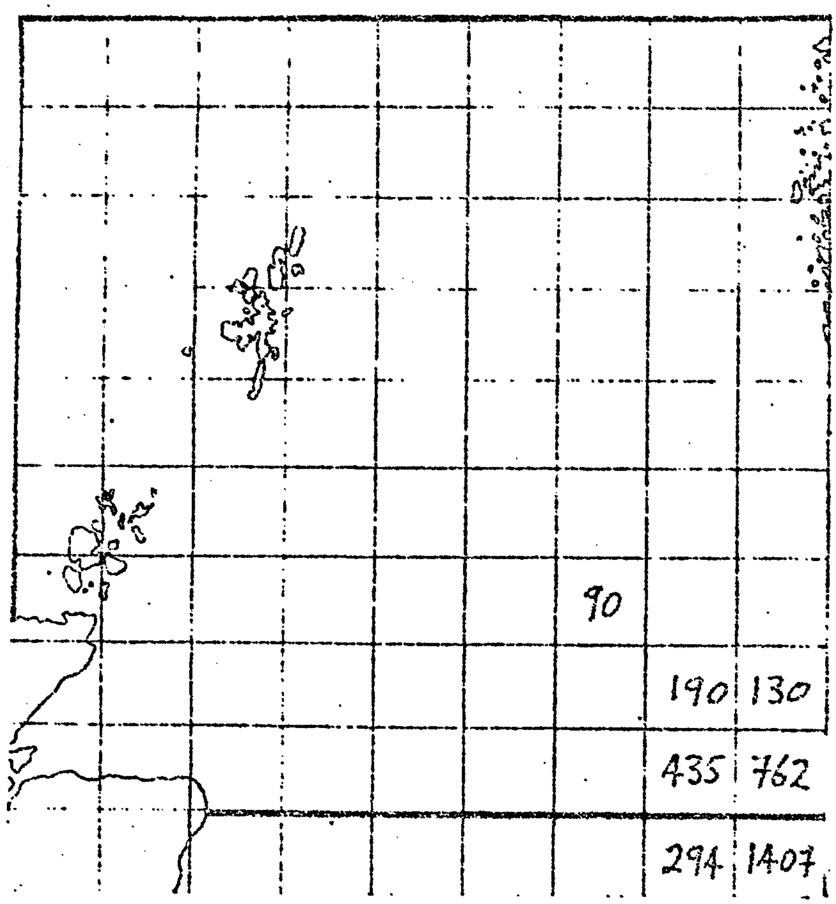
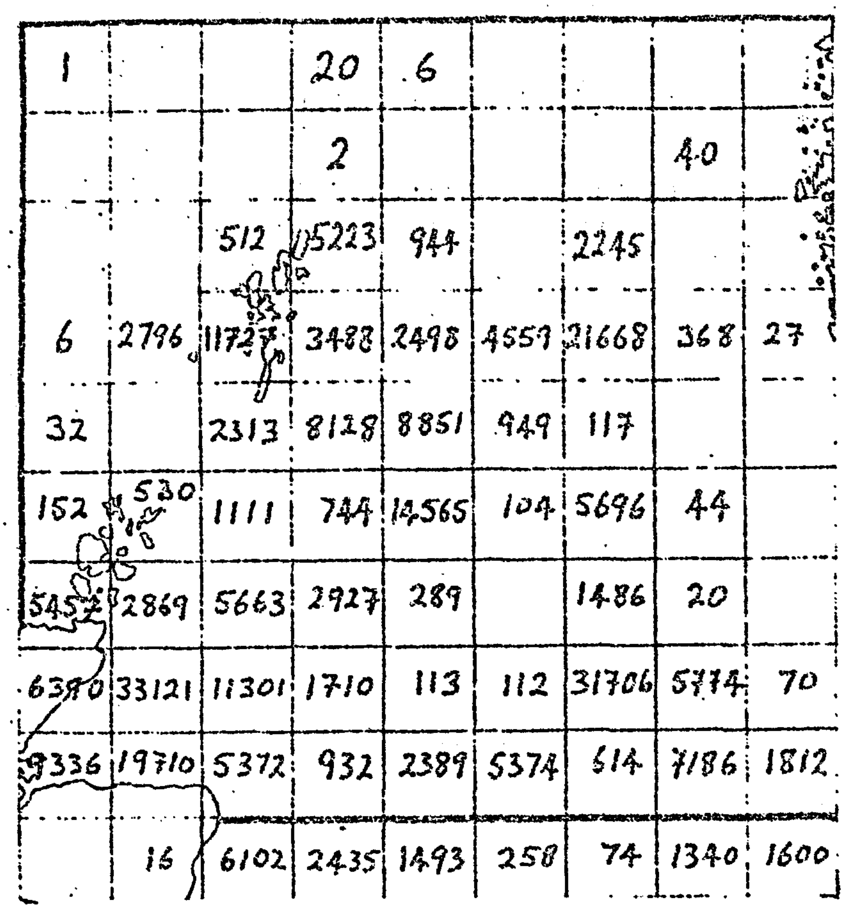


Figure 6 .

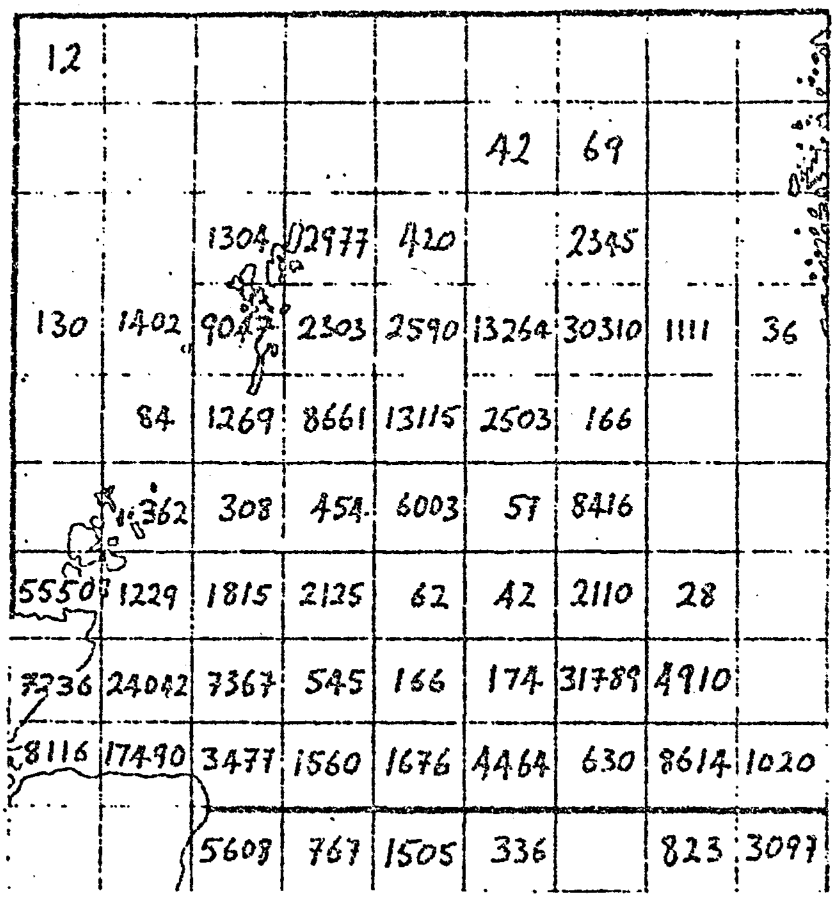
Hours fishing by beam trawl in 1975.

Total hours:-
3308



1975

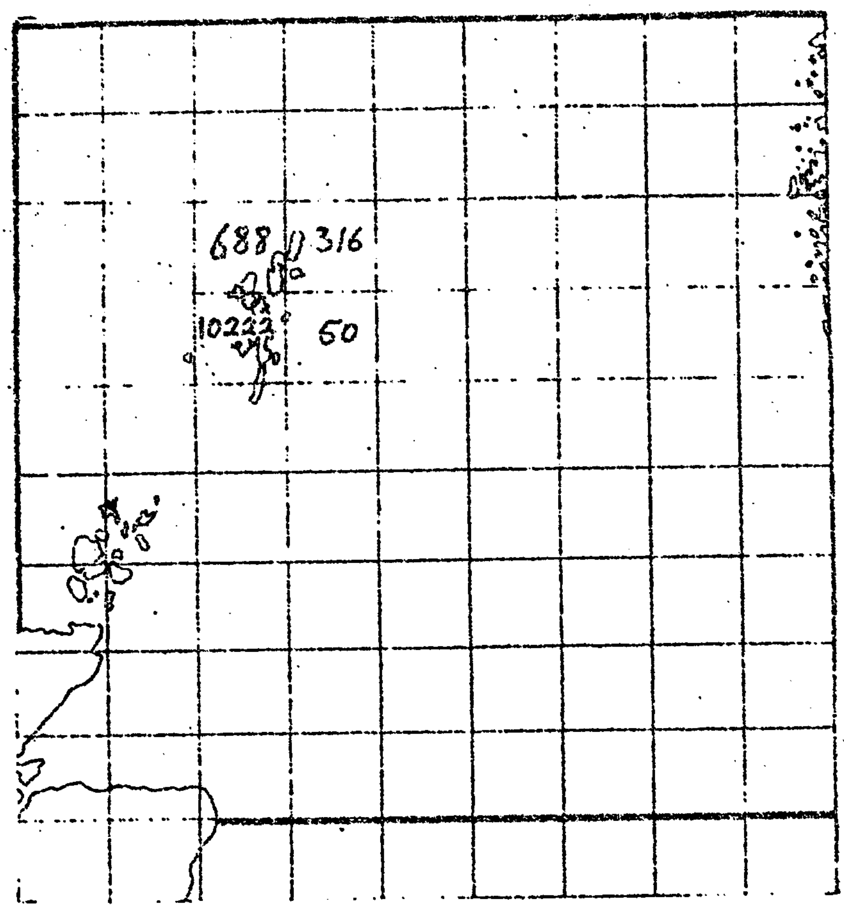
Total hours
274517



1976

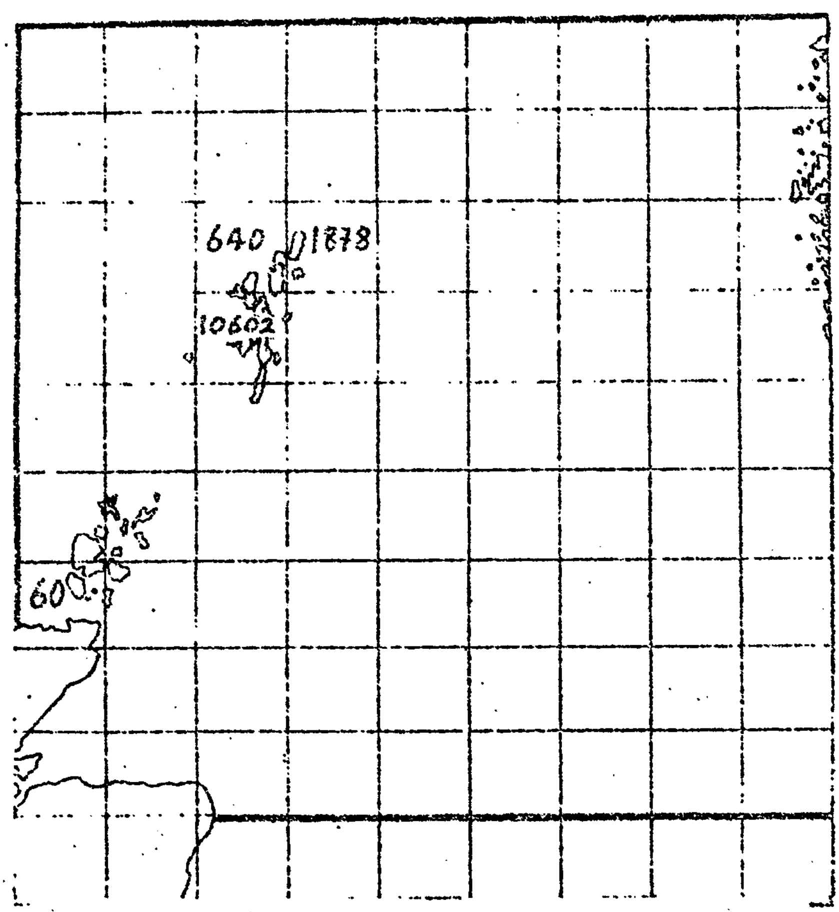
Total hours
257133

FIGURE 7. HOURS FISHING BY SEINE NET IN 1975/76



1975

Total hours
11276



1976

Total hours
13186

Figure 8 . Hours fishing by scallop dredge in 1975/76.

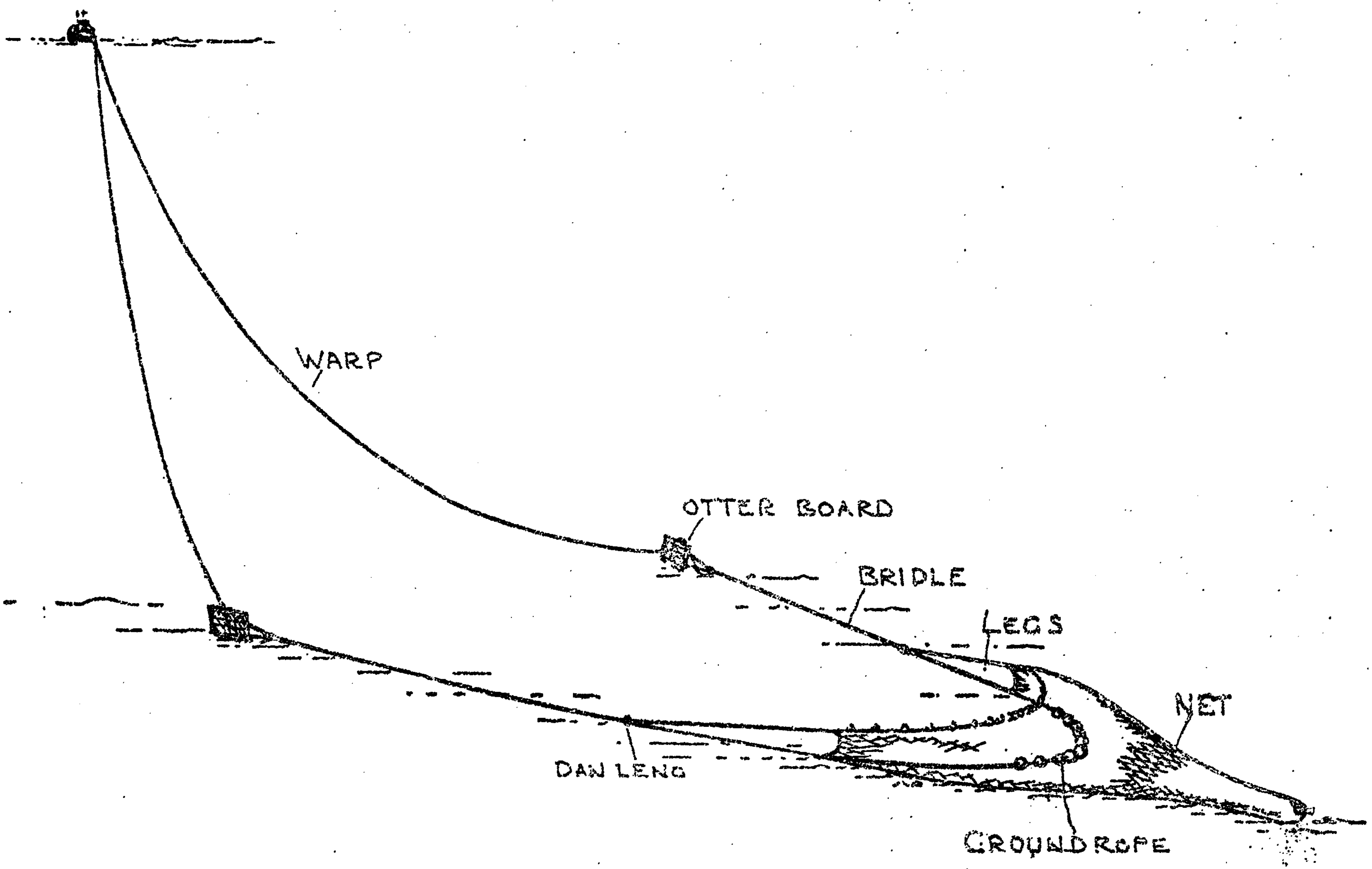


FIGURE 9 THE PRINCIPAL COMPONENTS OF OTTER-TRAW GEAR

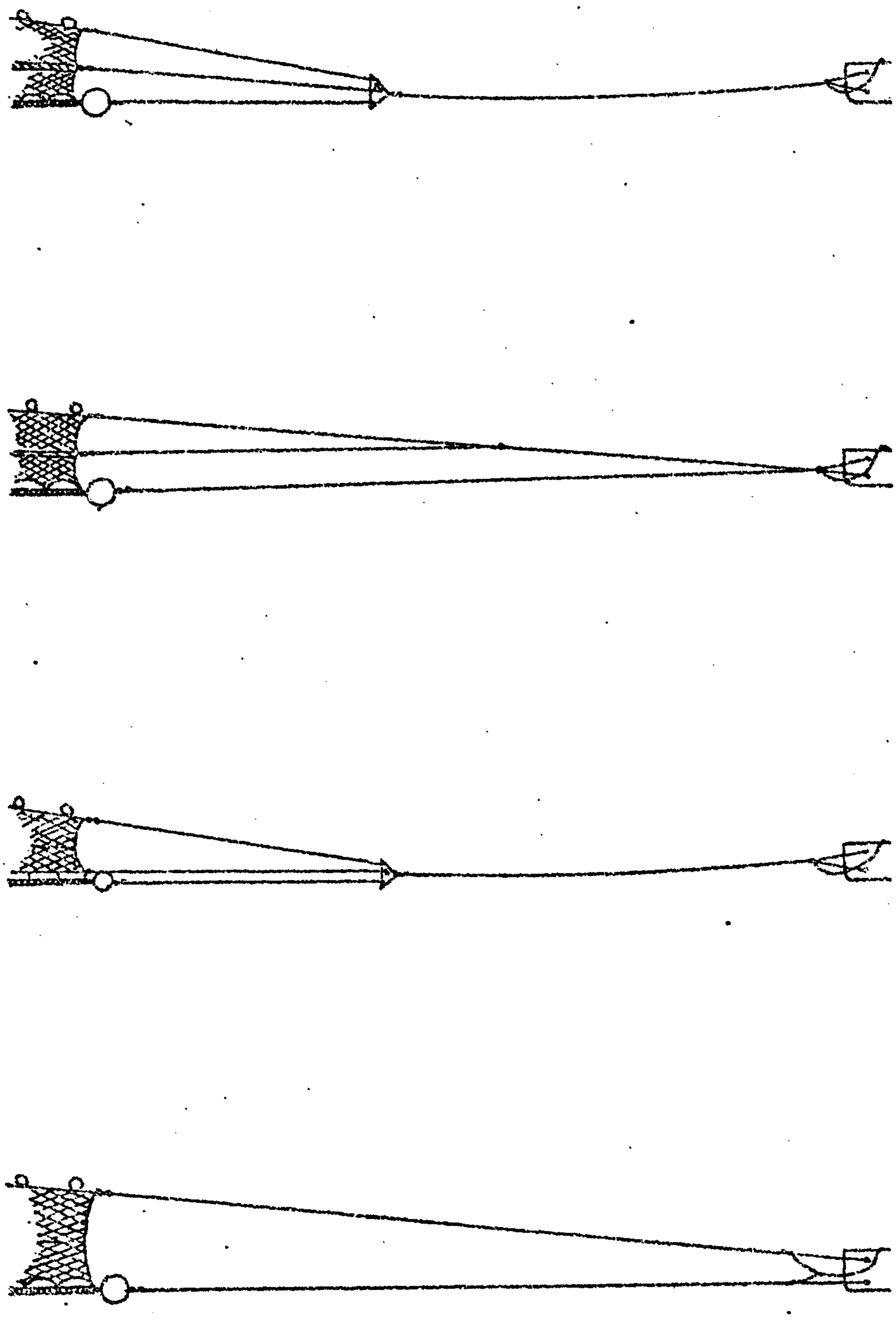


FIGURE 10. ALTERNATIVE BRIDLE SYSTEMS FOR OTTER-TRAWING

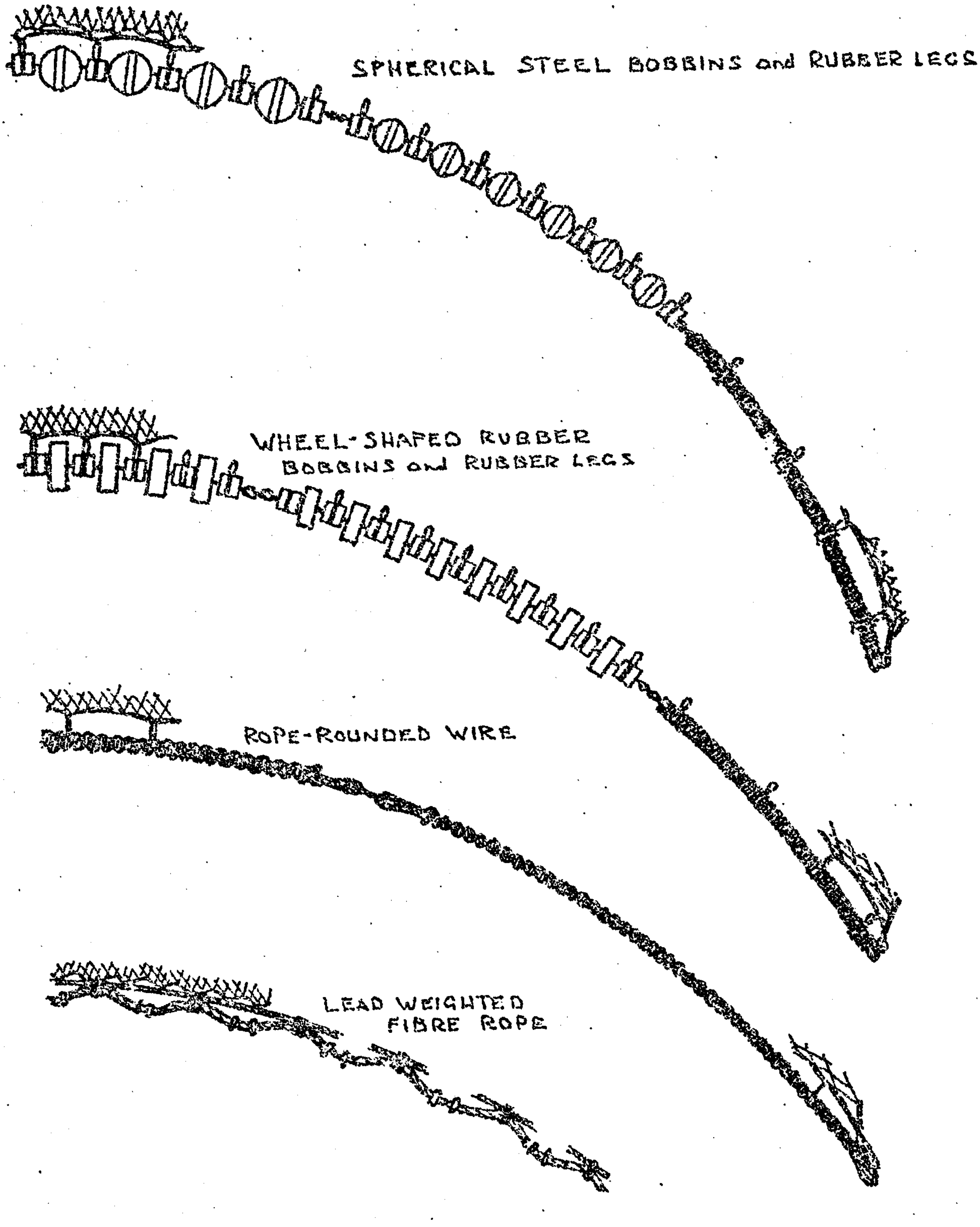
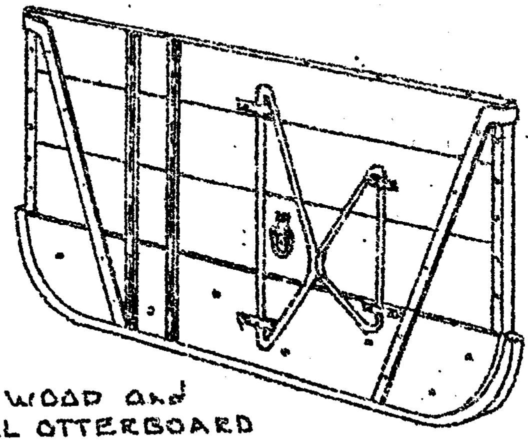
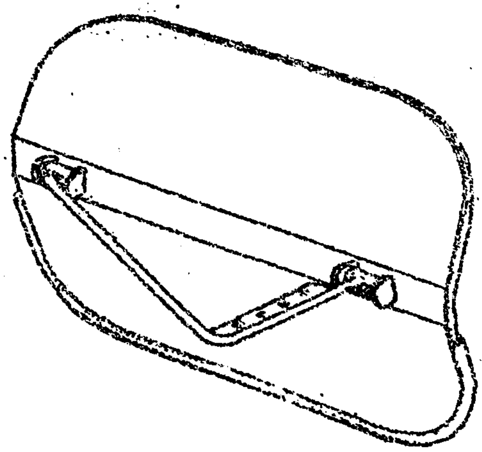


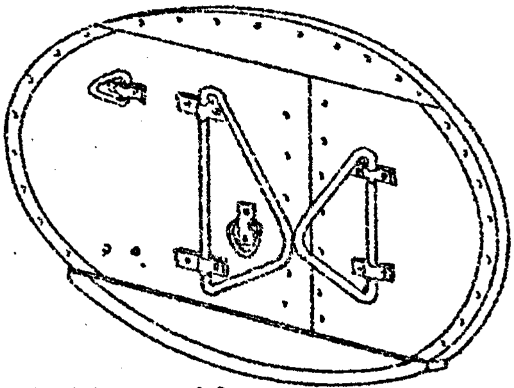
FIGURE 11. GROUNDROPES



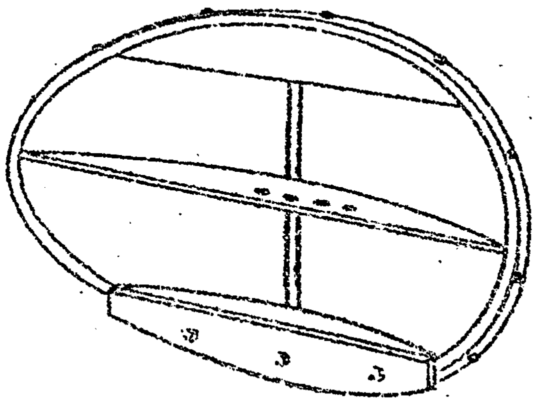
FLAT WOOD and STEEL OTTERBOARD



STEEL "V" BOARD

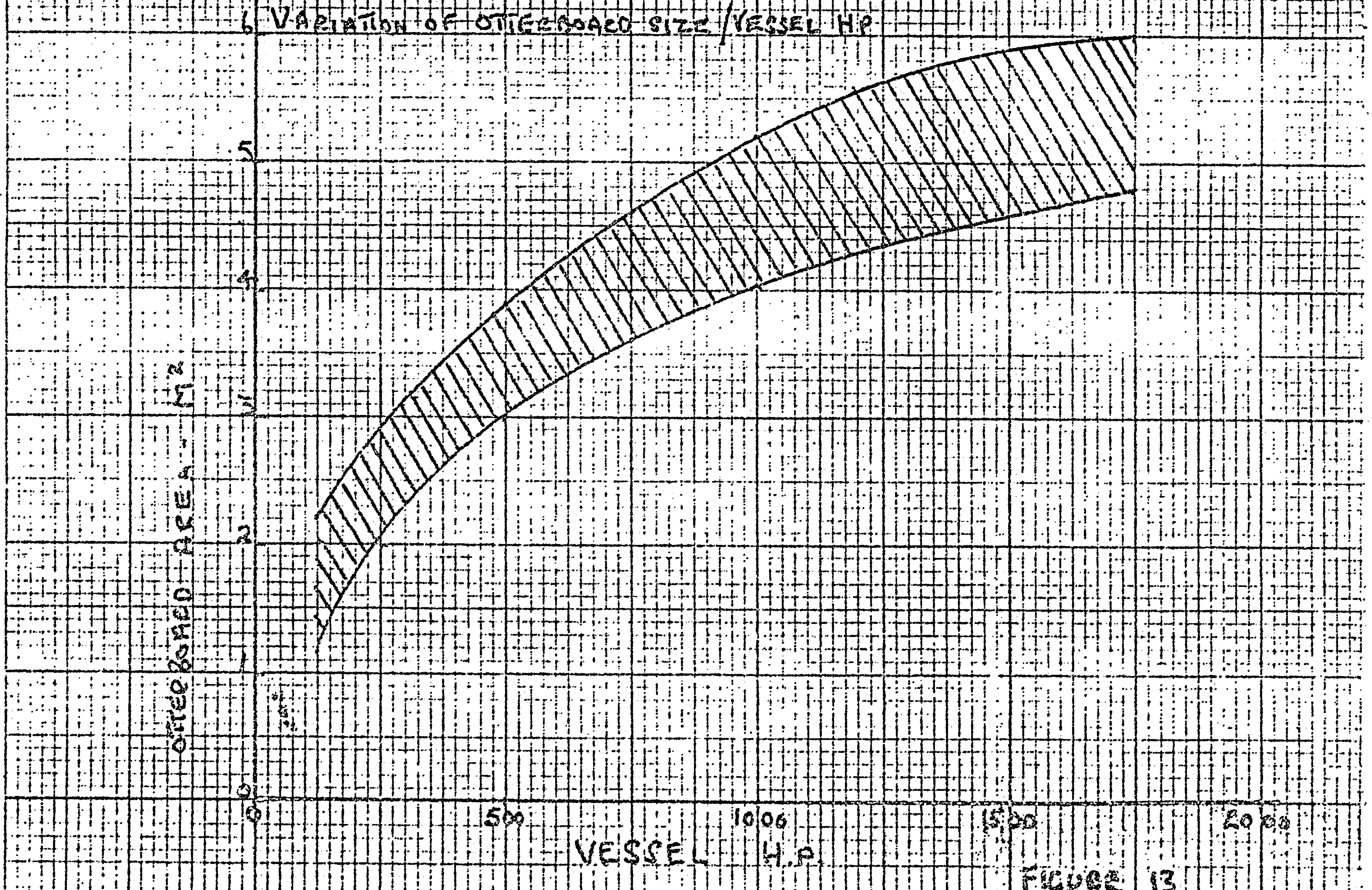


OVAL OTTERBOARD



OVAL and CAMBERED OTTERBOARD (POLYVALENT)

FIGURE 12 OTTERBOARDS



VARIATION OF OTTERBOARD SIZE/VESSEL HP
OTTERBOARD AREA - M²
0
1
2
3
4
5
6
0
500
1000
1500
2000
VESSEL H.P.

FIGURE 13

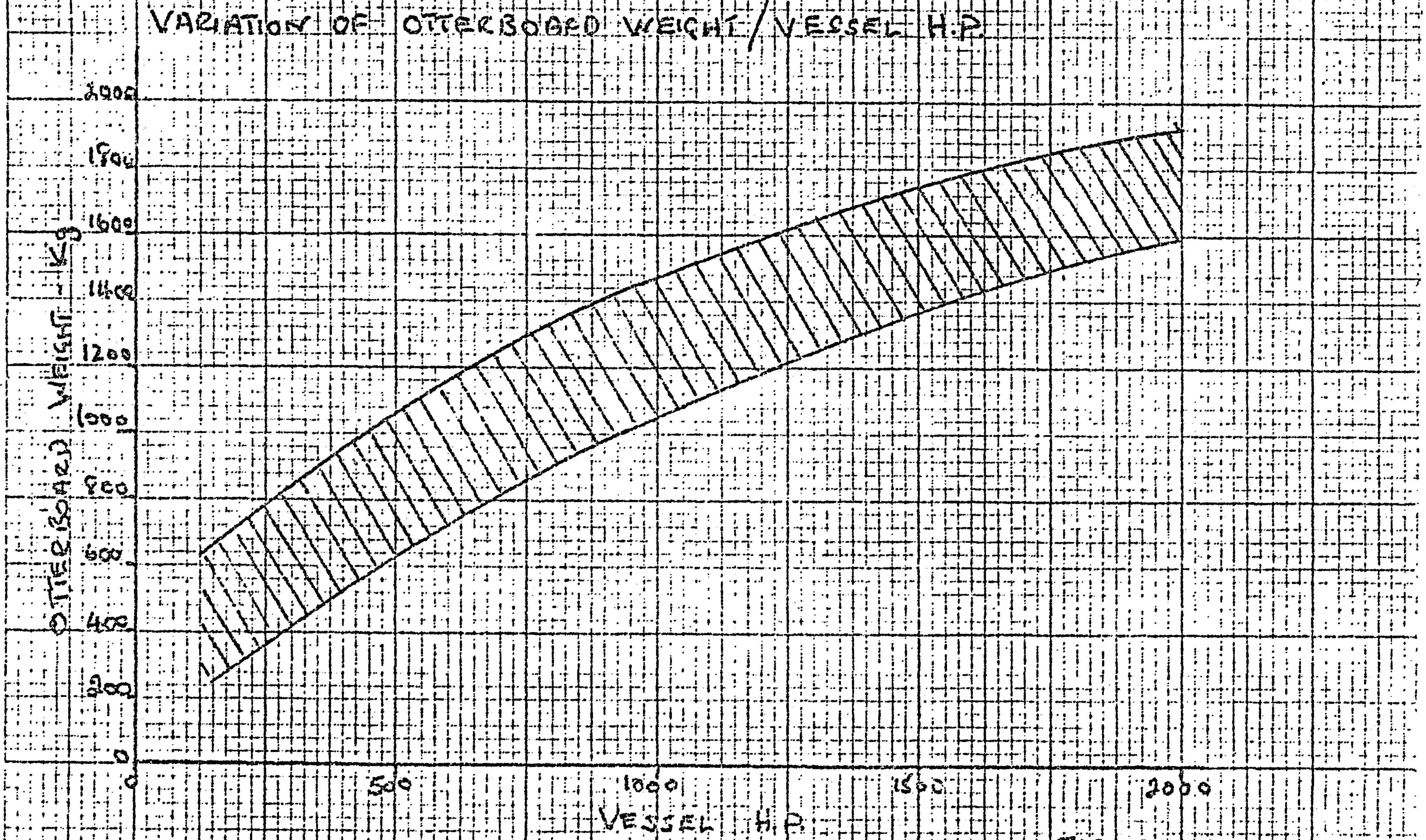
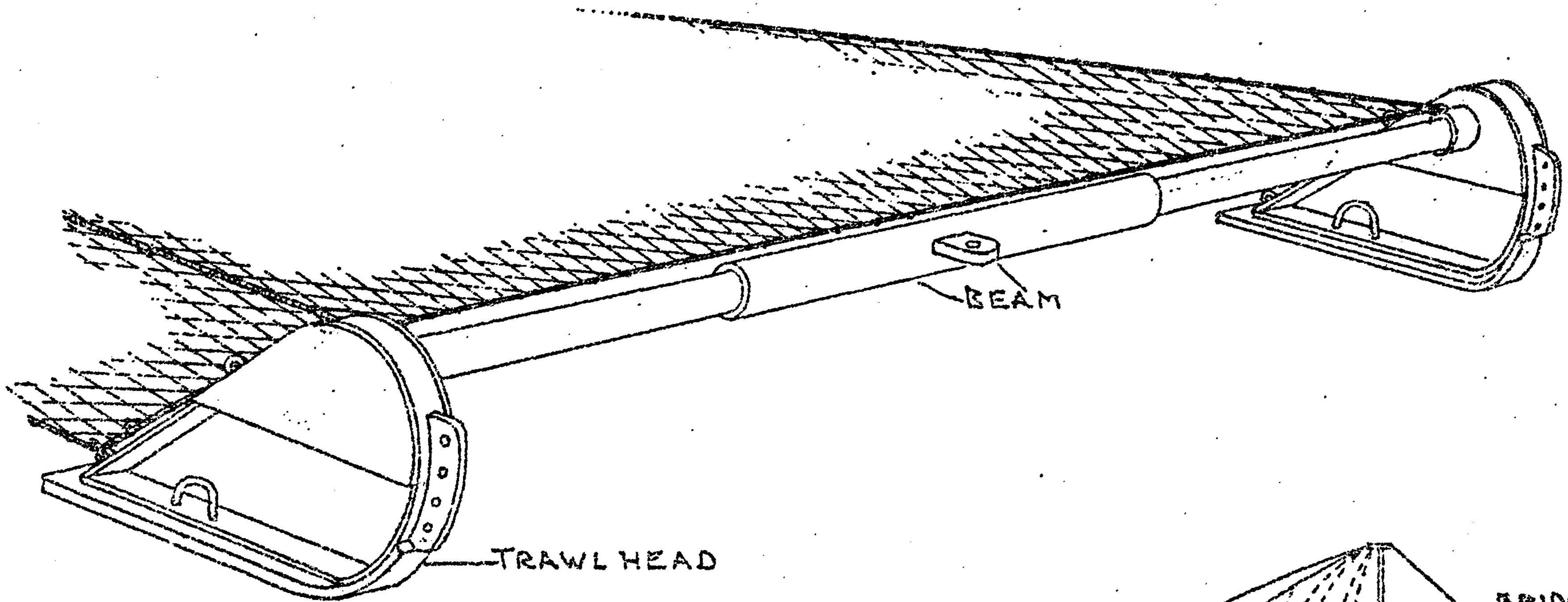

VARIATION OF OTTERBOARD WEIGHT / VESSEL H.P
OTTERBOARD WEIGHT - Kg
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
VESSEL H.P

FIGURE 14



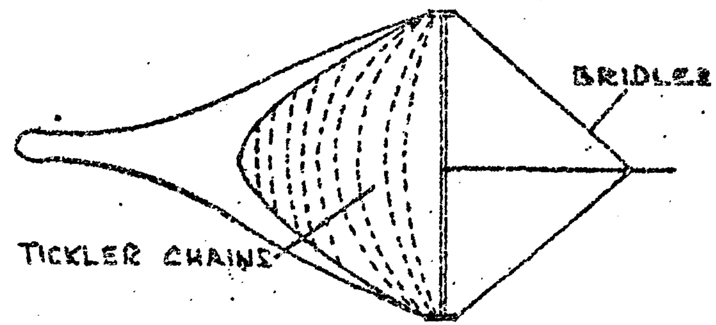


FIGURE 15. THE DUTCH BEAM TRAWL

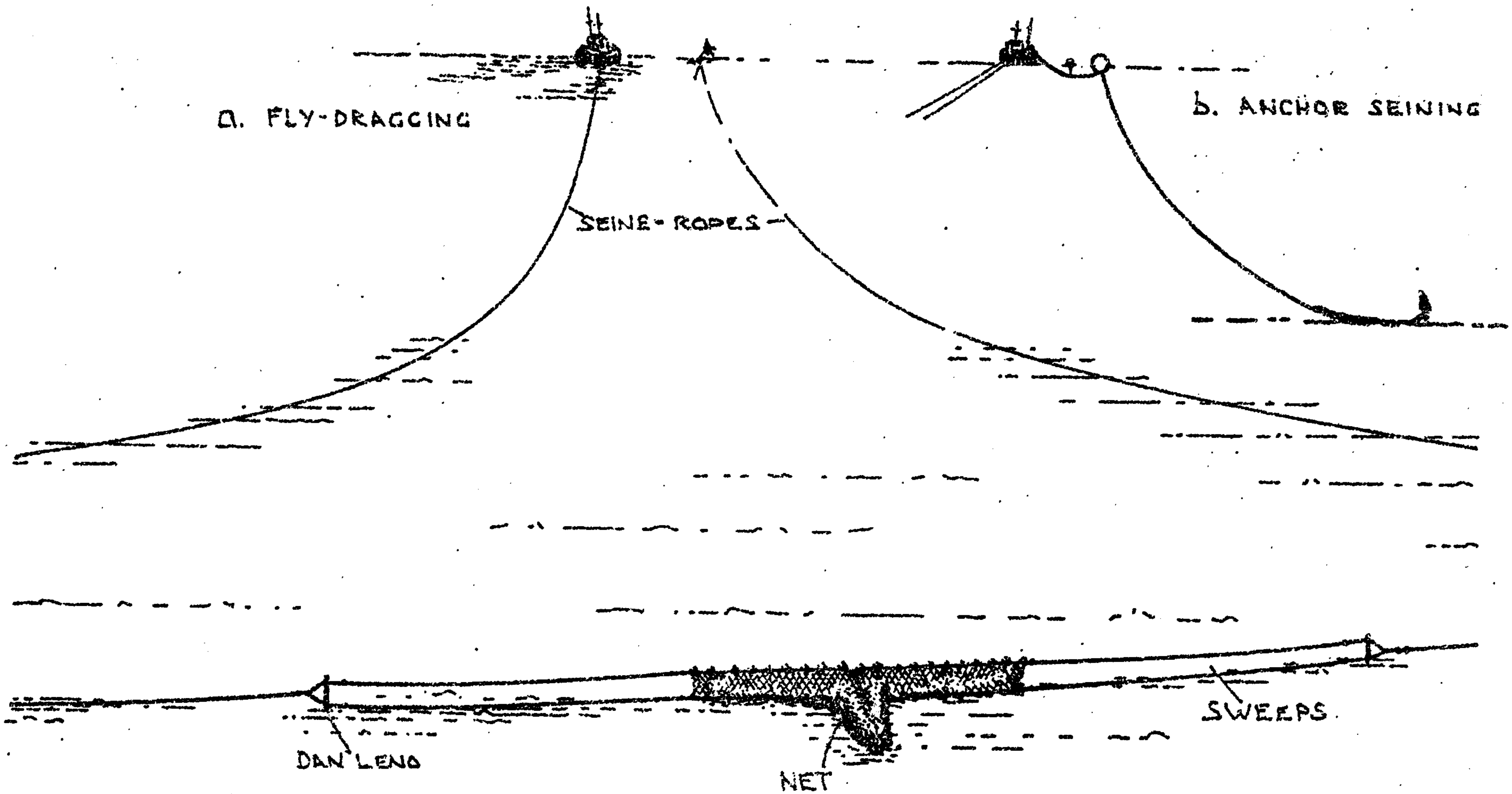


FIGURE 16 SEINE-NET GEAR

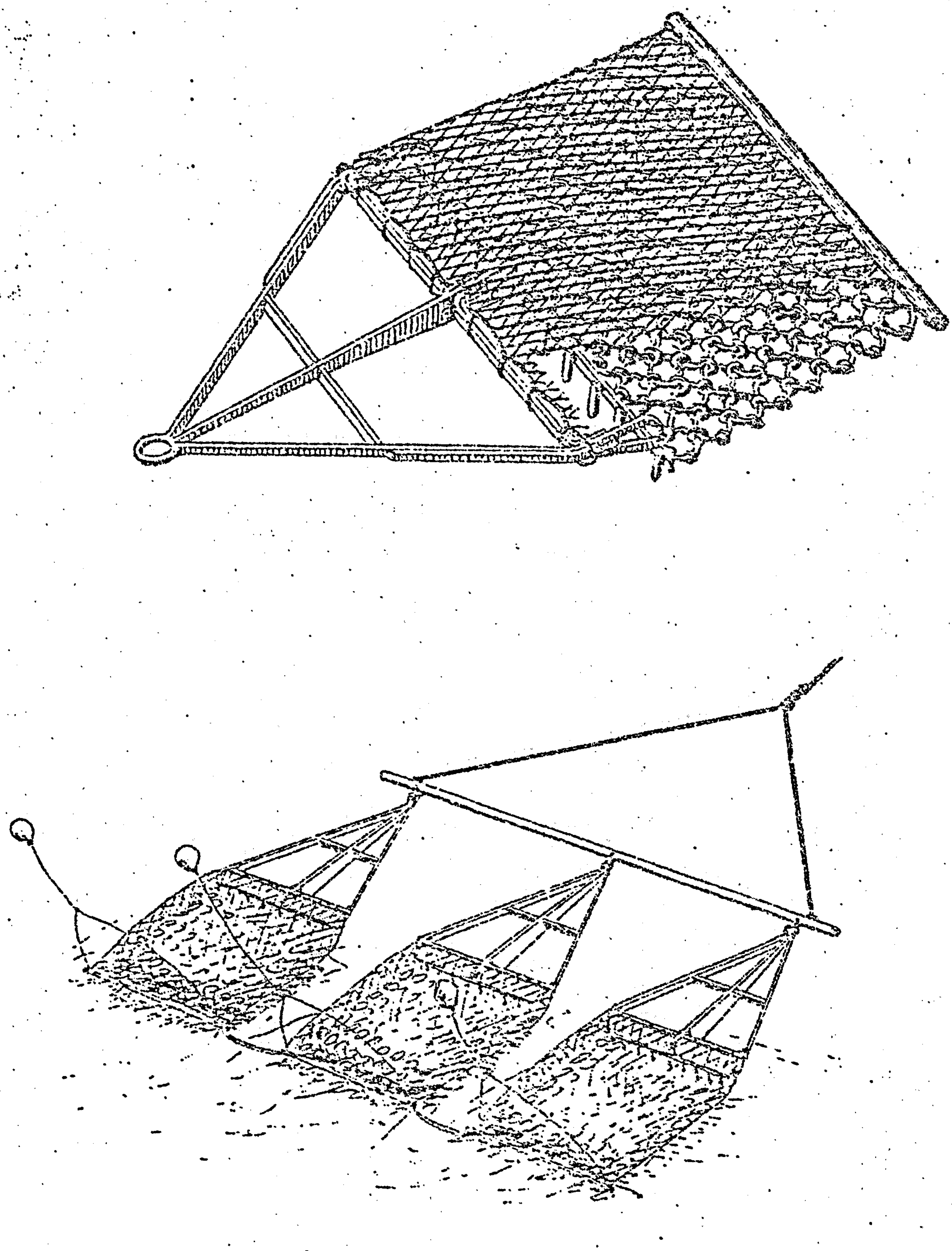


FIGURE 17 SHELL-FISH DREDGE