TECHNOLOGICAL ASPECTS OF THE MODERN NORWEGIAN PURSE SEINE FISHERIES

by

J. Hamre and O. Nakken

Fiskeridirektoratets Havforskningsinstitutt

Bergen, Norway.

1.o INTRODUCTION

The species fished by Norwegian purse seiners are herring (Clupea harengus), sprat (Clupea sprattus) , capelin (Mallotus villosus), mackerel (Scomber scombrus), bluefin tuna (Thunnus thynnus), coalfish (Gadus virens) and polar cod (Gadus saida). The most important fisheries are, however, the herring fishery which takes place along the whole Norwegian coast, the mackerel fishery off the southern coast and the capelin fishery off the north coast of Norway. The bulk of the purse seine catches has so far been used for industrial purposes (i.e. reduction).

The purse seine has been used by the Norwegians since the very beginning of this century, but it was first after the last world war that the fishery developed on a large scale. In Fig. 1 are shown the yearly catches of herring, capelin and mackerel caught by Norwegian seiners since 1945. The curves indicate that the seiners have had two good periods, one culminating in 1956 and one which seems to have culminated in 1967. Inbetween these periods is a poor one (1958-63). It is also noted that the catches before 1964 consisted of herring mainly, whereas the recent yield from the purse seiners also include considerable quantities of mackerel and capelin.

The increase in the yearly catches of herring during the first period was due to large investments in seiners equipped with nets operated from two dories. The natural basis for this fishery was the Atlanto-Scandian herring stock exclusively. This stock was very abundant during the period concerned due to several rich yearclasses (Dragesund, 1970).

In the late 1950's, the strength of the Atlanto-Scandian herring stock was reduced drastically due to failure in the recruitment, and the Norwegian purse seiners, loosing their only source for exploitation, ran into a serious economic crisis. This was met by various measures of government loans and guaranties in order to convert the boats to other types of fisheries, mostly trawl and longlines. Some attempts to find new fishing grounds for the seiners were also made but without success. This was in short the situation for the large Norwegian purse seine fleet when the Puretic power block became known to the Norwegian boat owners in the early 1960's. In the beginning the new device was met with a somewhat sceptical view, especially with regard to its application to the very large seiners. But every doubt about the superiority of the new technique was overthrown when the firs boats equipped with the new gear started to land large catches of herring from the North Sea during the autumn of 1964. These fishing grounds which were new for Norwegian seiners soon proved to be inhabited by herring and mackerel schools of high catchability to the new gear and purse seining became again very profitable. By 1968, about 450 vessels were fitted for the new seining technique, representing a new investment of at least 725 million N. kroner (Mietle 1969).

The aim of the present paper is to give an account of the technological background for the development and to describe the present state of the Norwegian purse seining technique. As a conclusion to the paper the authors have pointed to some recent trends in the development which may be of importance for the future prospects of the fisheries.

2. HISTORICAL REVIEW.

According to Thor Iversen (1912), the purse seine technique was introduced in Norwegian waters at the very beginning of this century. The Norwegians learned the method from the Swedes, who had used purse seines in the Bohuslän fishery since the early 1880's. The nets were of the American one-dory type with the fish bag located at the one end. This system has later been used in various Norwegian coastal fisheries such as those for juvenile herring, sprat, cod, coalfish, mackerel and tuna. The boats were relatively small up to 80 feet long, with pilot house and engine room situated in the stern. Most of the seiners carried the net on the aft deck, but a few boats operated their nets from the deck in front of the wheelhouse. The nets varied in size and construction according to the type of fishery. Those used for sprat and juvenile herring measured some 300 x 70 meters whereas the tuna nets could be up to 800 x 90 meters.

The deck arrangement and operation of the nets were similar for the various fisheries. (Hamre 1963). The seiners carried a seine skiff, which was towed when searching for fish. Usually the seine was accompanied by a towing boat which main task was to keep the seiner square with the shot net. When fishing on submerged fish schools the seiners made use of bas-boats from which the shooting of the net was directed. The net was shot to starboard, often with full speed. For hauling in the net the seiners used a long roller with mechanical drive. Winch power was used for drying up the fish strapping in the bunt webbing sectionally. The fish were brailed aboard except for large fish (tuna), which were hoisted in individually.

The one-dory seiners took part in the various fisheries and only changed the nets according to the fish they were searching for. At the end of the 1950's Norway had some 450 such seiners participating in the various coastal fisheries. The introduction of the power block became of great importance to this fleet.

But the largest catching power of the purse seine fleet was, however, constituted by the big seiners which were equipped for the two-dory purse seining system. This system is also of American origin and became known to the Norwegian west coast fishermen at the same time as the one-dory net was introduced on the east coast. The first two-dory net was tried by the west coast steamer "Bremnes" under the herring fishery at Iceland during the summer of 1899. The method proved to be very successful and purse seining for herring in Icelandic waters during the summer became a very important fishery in which fishermen from various countries participated (Iversen 1912). The Norwegian steamers equipped for herring seining soon started to operate also in Norwegian waters, first in the winter herring fishery on the west coast but later their activities were expanded to fish juvenile herring and capelin on the north coast. As stated previously, the fleet of two-dory seiners grew rapidly in the early fifties, and Norway had about 300 such vessels when the power block was introduced.

2.1 The power block.

Schmidt (1959) has described the development of the Puretic power block and Jakobsson (1964) how this new net hauling device was adopted by the Icelandic herring seiners. Jakobsson states that low catches of herring since 1944 forced the Ice-

landic fishermen to change from the two-dory, 18 man system, to a one boat system using only 10-11 men. At the time of the introduction of the power block most of the Icelandic seiners had already changed to the one-dory system. According to Jakobsson, the main advantages of the power block system for the Icelandic fleet were: (a) saving of time and labour in operating the nets, (b) enable the fishermen to handle larger and deeper nets, and (c) made it possible to handle larger catches without the assistance of other crews.

The introduction of the power block had the same effect for the Norwegian small sized seiners which already were equipped with the one-dory net. But for the big seiners the new system led to a complete change in the fishing tactics and it was these large boats which best could utilize the advantages the new system had to offer. The fleet of two-dory seiners were more over in a very serious economic situation due to low catches obtained with the traditional gear, and most of the boat owners had at the time no other choice but to try new fishing methods. These circumstances exaggerated the speed at which the fleet was converting to the new system.

The break through for the power block in the Norwegian fleet came as a result of the development in the Icelandic herring fishery. In 1961 Norwegian fishermen went to Iceland to study the technique developed by Mr. Haraldur Agustsson in which the net could be handled from the upper boat deck aft of the wheelhouse (Jakobsson, 1964). This arrangement met the requirements of the big seiners for carrying the net, because they had no free deck space aft of the bridge. The Icelandic net had also been adjusted to the new hauling technique. The hang-in had been lowered from 60% to

40-45%, which made the net more tight in the hauling direction and the bunt end was cut down in depth so that the fish could be dried up by help of the block only. Details of the first net which was tried on board a Norwegian herring seiner in 1962 is shown in Fig. 2.

The new seining technique caused a revolution of the fisheries. In the course of 1963-64, most of the two-dory seiners were equipped with the new gear. The power block system had many advantages and purse seining became suddenly profitable, as new species and grounds could be exploited which previously had not been available to the old seiners. This lead in turn to investment in new and bigger boats, and increased size and efficiency of nets. The building up of the fleet was mainly based on the herring and mackerel stocks in Skagerak and the North Sea, but the new technique has also been of great importanc for the herring and capelin fisheries of the north Norwegian coast. This last season (Jan.-April 1970) the purse seiners caught some 900 000 tons of capelin, and it is believed that the capelin stock may become the main natural source for the large seiners in the years to come.

3. THE VESSELS

As indicated above the Norwegian purse seining fleet may be divided into two groups according to the size of vessels and type of fisheries:

1) Vessels larger than 80 feet catching herring, capelin, mackere and polar cod in the open sea and coastal waters.
2) Vessels less than 80 feet catching sprat, juvenile herring, coalfish and tuna in coastal and inshore waters.

3.1 Vessels larger than 80 feet.

In addition to the fleet of converted two-dory seiners, 130 new vessels of more than 80 feet were equipped with power blocks or similar net hauling devices in the period 1963-68 (Mietle 1969). Of these, 70 were quite new vessels, 30 were converted whalers and 30 were former trawlers or transport ships. These new seiners were large ships, 120-190 feet with a loading capacity of 350-700 tons. But the design of the new boats and the deck arrangement did not differ much from the converted two-dory seiners.

Up to the middle of the 1960:s, it was generally believed that vessels smaller than 120 feet would best fit the new technique. Recent trends in the development does, however, show that this idea has changed completely (Table 1), and even quite new vessels are now lengthened and their decks lifted, so that their loading capacity may increase with up to 30 %. The bulk of the catch has been prepared and stored for reduction purposes only. During 1968-69 some 50 seiners were, however, equipped with tanks in which the fish can be stored for human consumption (Mietle 1969). In the tanks, the fish are kept in cooled sea-water, the cooling of the water is either done by ice or by a combination of ice and a cooling machinery. Due to the tendency of failure in the availability of herring and mackerel such tanks are now being installed in most of the boats.

Fig. 3 shows a typical Norwegian purse seiner. The deck arrangement is almost similar to that described by Jakobsson (1964). The net is carried on the boat deck behind the wheelhouse while the pursing and brailing operations are carried out on the main deck. Some of the biggest vessels have two net bins and two nets

both ready for shooting (Fig. 4). Smaller seiners may carry the net on the main deck at the stern. The crew consists of 9-12 men. They are accomodated in single and double cabins, have a large messroom and good sanitary conditions. This, of course, vary with size and age of the ship, but on an average the social standard is largely improved in recent years.

In the wheelhouse the following standard equipment is found: Decca navigator, radar, radio direction finder, autopilot, radiotelephone, V.H.F. radiotelephone, walkie talkie sets, sonar and echosounder. In addition some seiners are equipped with Loran.

3.2 Vessels less than 80 feet.

The group of small seiners did also previously operate their nets from the stern and were the first ones to adapt the power block for hauling in their nets.

Fig. 5 shows a small Norwegian seiner. The net is carried on the main deck behind the wheelhouse and the technique used is quite similar to that of the large one (Fig. 3). However, the dimensions and capacities of the equipment are reduced according to the size of the vessel. The standard equipment in the wheelhouse is: Decca navigator, radar, radio direction finder, radiotelephone, walkie talkie sets, sonar and echosounder.

The crew consists of 7-9 men and they are accomodated in two cabins, one fore and one aft.

Generally the catches of this fleet is used for human consumption

4. THE NETS

With regard to tuna nets reference is made to the paper by Hamre (1963). The net used for coalfish is of a similar construction, but has smaller mesh/es/ and much lighter twine in the fish bag. Although now handled by power block, these nets are not specially built for that purpose.

The nets in use for catching mackerel and herring, capelin and sprat are all designed for power block hauling. The shape of the nets and the rigging are similar for the various type of nets, but the size of the net and the dimension of the webbing differs according to which fish species was to be caught. As to details, the nets have no standardized construction but differ according to the skippers personal idea of how a net should be made. But a fisherman has a very limited knowledge of the behaviour of his net when shot, and the many but small individual differences in net rigging have probably no operational significance.

The details of net design presented in the following paragraph, does not refer to particular nets, but are the average samples of net specifications collected from four Norwegian factories.

4.1 Details of the herring-mackerel net.

Details of the net used for catching adult herring and mackerel are shown in Fig. 6. In order to give an idea of the recent development in the net design two sketches of nets have been given, one demonstrating the nets made in 1964-65 (A) and one sketch showing details of nets made in 1969 (B).

Nets made during the conversion period were similar to the

Icelandic nets described by Jakobsson (1964) but slightly bigger. The nets made recently have also the same shape and rigging, but the size of the gear has increased both in length and depth. But the most marked change occurs in the dimension of twine, the new nets now being made are much heavier and stronger. It is natural that the larger seiners added to the fleet recently require larger and stronger nets but, it is also a fact that most of the nets made before 1968 were too weak. Particularly for catching mackerel during winter and spring when the fish strongly resist against being forced up into the cold surface water. Thousands of tons of mackerel have been lost because of the light webbing used in the many nets made during the period 1964-67.

The webbing is hanged to the corkline with a hang-in ratio ranging from 35 % in the bunt end to some 50 % in the centre. The hang-in to the leadline is some 10 % less, which makes the groundline correspondingly longer. Plastic floats with a central hole are used instead of cork, and lead pieces fitted to a terylene rope are used as sinkers. The lead weight of the nets made in 1965 were some 4 kg per meter leadline, whereas this weight now is increased to some 6 kg per meter. The purse rings are made of brass or stainless steel, weighing 4 kg or 6 kg.

Skirt is used in some nets, but dimensions and shape may vary. In large nets the skirt is made up to 300 mesh(es) deep, 62.8 mm bar mesh size. Twine 210 d/60. The skirt usually covers half of the central portion of the net. At the wing end the nets are prolonged by a triangular piece of webbing to which the edge rope is attached. This webbing is made of relatively big meshes (50 mm bar) and thick twine (210 d/90), and its function is to obtain a well balanced pull on both the lines when hauling in the edge rope.

In some of the first nets made for power block hauling, knotless netting was used in the central portion of the net. The knotted netting has, however, been predominating in this type of net.

4.2 Details of the sprat and capeline nets.

Sketches of typical nets used for fishing sprat and capeline are shown in Fig. 7. These nets are very similar in size and rigging, but the capeline net is somewhat heavier. The latter is built for use on the large seiners and is supposed to handle much bigger catches. The capelin net has not been made bigger according to the increased size of the seiners as was the case for the herring and mackerel net. This is due, most likely to the circumstance that the capelin fishery often takes place in very shallow water close to the coast. With the exception of the bunt end and selvage the sprat and capelin nets are normally made of knotless netting.

5. THE OPERATION

Jakobsson (1964) has described in details how the Icelandic fisher men handle their nets made for power block hauling. The same system is used by the Norwegians, and the slight differences of tactics which may occur are no doubt of minor importance. Only some few relevant things which may be specific for the Norwegian seiners will be mentioned here.

5.1 Fish finding

The acoustic instruments for fish finding have been further improved and in this respect reference is made to the paper given by Mr. G. Vestnes.

5.2 Shooting and pursing

Sonar guided shooting as described by Jakobsson (1964) is performed by Norwegian skippers in case of very hard competition. Experience has, however, shown that the chances to obtain a successful shot are improved by the use of a bas-boat to locate the top of the school. Bas-boat guided shooting is therefore preferred.

A recent device for keeping the purse line square with the net under the shooting operation is a movable ring needle. This can be moved 1.5 to 2 meters out from the shipside reducing the risk of getting the webbing entangled on the purse line.

Specially made purse winches with capacities up to 20 tons are now installed on board the most modern seiners. They are placed on the port side opposite the gallow and on a platform so that the wire can run directly to the gallow blocks. To shoot and purse a 600 meter net takes about 20 minutes. When shooting on very deep schools, the pursing operation may, however be prolonged with some minutes in order to leave time for the net to sink.

5.3 Net hauling

Various kinds of hydraulic net hauling systems are now in use. Three of these are shown in Figs. 3, 4 and 5. The capacities of these systems are varying within a wide range, but large purse seiners use mainly net winches or power blocks with a capacity of 4-6 tons. The hauling of a 600 meter net is completed within 35-50 minutes.

During the hauling the vessel is kept square with the net,

either by use of towing boat or trust propellers. Quite a number of the larger seiners have got trust propellers of 100-150 h.p. both fore and aft. The need for auxiliary vessels is thus reduced.

5.4 Brailing

The mechanical hauling in of the net is continued until the catch is dry enough for brailing. Brailing is now in most cases carried out with fish pumps. If the fish are heavy to dry, pumping is started as soon as possible in order to avoid net-breaking. In the most difficult cases pump tubes of up to 30 meters in length may be used. To prevent the seiner from capsizing when drying-up a heavy catch there is a specially made netholder mounted to the starboard rail. By this invention the bag can be untied within a few seconds if neccessary for the safety of the vessel.

6. TRENDS OF FUTURE DEVELOPMENT

Returning to Fig. 1, the tendency of the catch curves indicate decreasing herring and mackerel catches, but a yearly improvement in the yield from the capelin fishery. With regard to the former species, the curves reflect decreasing stock strength due to the high exploitation rate caused by the purse seine fleet. In order to prevent further overfishing of these stocks, extensive regulation measures on the Norwegian herring and mackerel fisheries were brought into force from the 1st May this year. The new law prescribes considerably lower catches of these species in the first years to come.

The future prospects of the capelin fishery are on the other hand a bit more optimistic, especially after the last seasons

record catch of some 900 000 tons. This general situation in the natural resources has been the guide line for the recent development of the fleet. The boat owners do now regard the capelin fishery to be the main basis for fishery management at least for the first years to come. In this fishery the transportation of the catch from the fishing ground to the factories is extraordinarily time consuming in relation to the time it takes to load the boats. As a compensation for time loss when sailing, the boats receive a price per ton of fish according to the distance of transportation.

This favour, to a very large extent, the seiners with high loading capacity. The tendency of increasing the tonnage of the seiners by lengthening the hull and lifting the main deck which, although very discernible last year, is believed to be far more outstanding in 1970 (Table 1). As the existing capacity of the purse seine fleet is considered to be too large for profitable management (Mietle, 1969), a large number of the less profitable seiners has to be removed from the fleet. If no measures are taken with the aim of guiding the development into some other direction, the fleet may soon be reduced drastically in number. This reduction will take place in the group of smaller boats mainly, and the Norwegian purse seine fleet may within some few years consist of a relatively small number of seiners with large loading capacity and highly specialized in fishing for industrial purposes.

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Table 1. Number of vessels according to size and total capacity of each size group in 1000 mt.

	Size of vessel in tons	100 190	200 290	300 390	400 490	500 590	600 900	Total
1967	number	103	145	73	27	30	14	392
	capacity	15,5	36,3	25,6	12,2	16,5	10,5	116,4
1969	number	92	121	71	28	38	23	373
	capacity	13,8	30,2	24,9	12,7	20,9	17,3	119,7

Fig. 1.

Yield of the Norwegian purse seine fishery 1945 - 69. a) Herring b) Capelin c) Mackerel.

Fig. 2.

The first Norwegian herring purse seine made for power block hauling. The net consists of 36 strips of 600 meshes each, laced together vertically. Around the net is a 60 meshes selvedge strip of twine 210 d/30.

The webbing is hanged on to double terylene ropes, the hang-in percent on the cork line is some 10% higher than for the lead line. The net had 1,300 plastic floats and 1,050 kg of lead sinkers. The 37 purse rings (4 kg) are mounted in bridles made of terylene ropes.

Fig. 3.

Typical Norwegian purse seiner built in 1967. General particulars: LOA: 41,1 m, B:8,23 m, T: 4,25 m, hold capacity: 400 tons, fuel capacity: 85 tons, freshwater: evaporator and 9 tons tank, main engine: 800 h.p., auxiliary motors: 35 and 125 h.p., speed: 12 knots, accomodations for 14 men.
1) purse winch, 16 tons, 2) blocks for purse line, 3) purse gallow, 4) breast boom, 5) ring wire, 6) fish holds, 7) fish pump and de-watering screen, 8) main boom, 9) boom for fish pump, 10) seine winch, 3 and 6 tons at high and low speed respectively, 11) seine slide, 12) transport drum, 13) ring needle, 14) net bin, 15) towing boat, 22 feet, 100 h.p., 16) bas boat, 20 feet, 30 h.p., 17) transverse thrust propellers, 100 h.p. each.

Fig. 4.

Net hauling arrangement.
1) Seine winch, 2) jockey drum, 3) transport drum and crane, 4) ring needles, 5) net bins.

Fig. 5.

Small Norwegian seiner built 1962.

General particulars: LOA: 21,2 m, B: 5,2 m, T: 2,7 m, hold capacity: 80 tons, fuel capacity: 12 tons, freshwater capacity: 6 tons, main engine: 300 h.p., auxiliary motor: 10 h.p., speed: 10 knots, accomodations for 10 men.
1) purse winch, 4 tons, 2) blocks for purse line, 3) purse gallow, 4) breast boom, 5) fish hold, 6) ring needle, 7) power block, 8) net bin, 9) bas boat, 18 feet, 30 h.p.

Fig. 6.

Typical Norwegian herring and mackerel purse seines from 1965 (A) and 1970 (B). The nets are made up of vertical strips of 960 meshes each and laced together. Around each net is a 60 meshes selvedge strip of twine 210 d/72 and gradually reduced in strength inwards to twine 210 d/30. The strips are strengthened at the end as follows:
A) 100 meshes of 210 d/18 at the top and 200 meshes of 210 d/12 at both ends.
B) 100 meshes of 210 d/24 and 200 meshes of 210 d/18 at both ends.
The mesh size is 15.7 mm bar except for the strips of twine thicker than 210 d/24. Here slightly bigger meshes are used (16.5 mm and 17.4 mm bar).

All webbing is made of knotted nylon twine.

Fig. 7.

Norwegian sprat (A) and capelin (B) purse seines for power block hauling. The sprat net consists of 51 strips of 960 meshes each. Around the net is a 84 meshes selvedge strip of twine 840 d/3. The whole net is made of knotless webbing of mesh size 7.4 mm bar. The webbing is hanged to double terylene ropes and the hang-in percent on the lead line is some 10% less than on the cork line. The net has 1,100 kg lead and 32 rings 4 kg each. The capeline net is made up of 37 strips of 960 meshes each. Around the net is a 60 meshes selvage strip of twine 210 d/60 decreasing in thickness to 210 d/24. The strips of the wing are strengthened at both ends by 200 meshes of twine 210 d/18. The mesh size is 9.8 mm bar (10.1 mm in the bag). The net is hanged similar to the sprat net. It has 1,600 kg lead and 32 rings 4 kg each.

Figure 1

Figure 2

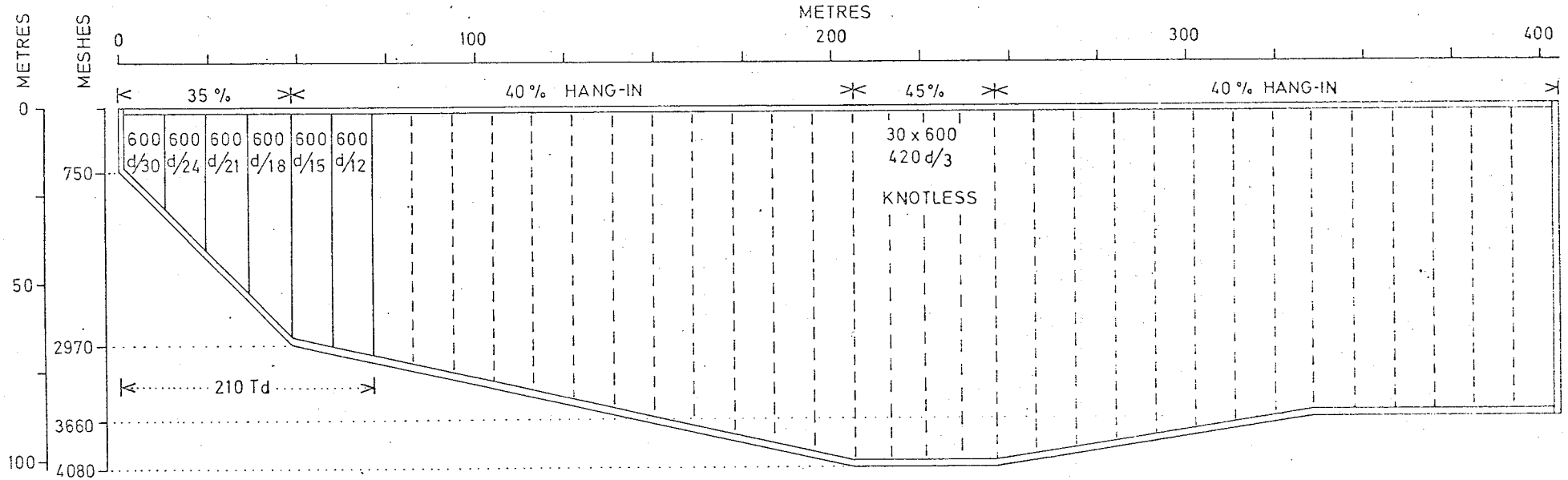
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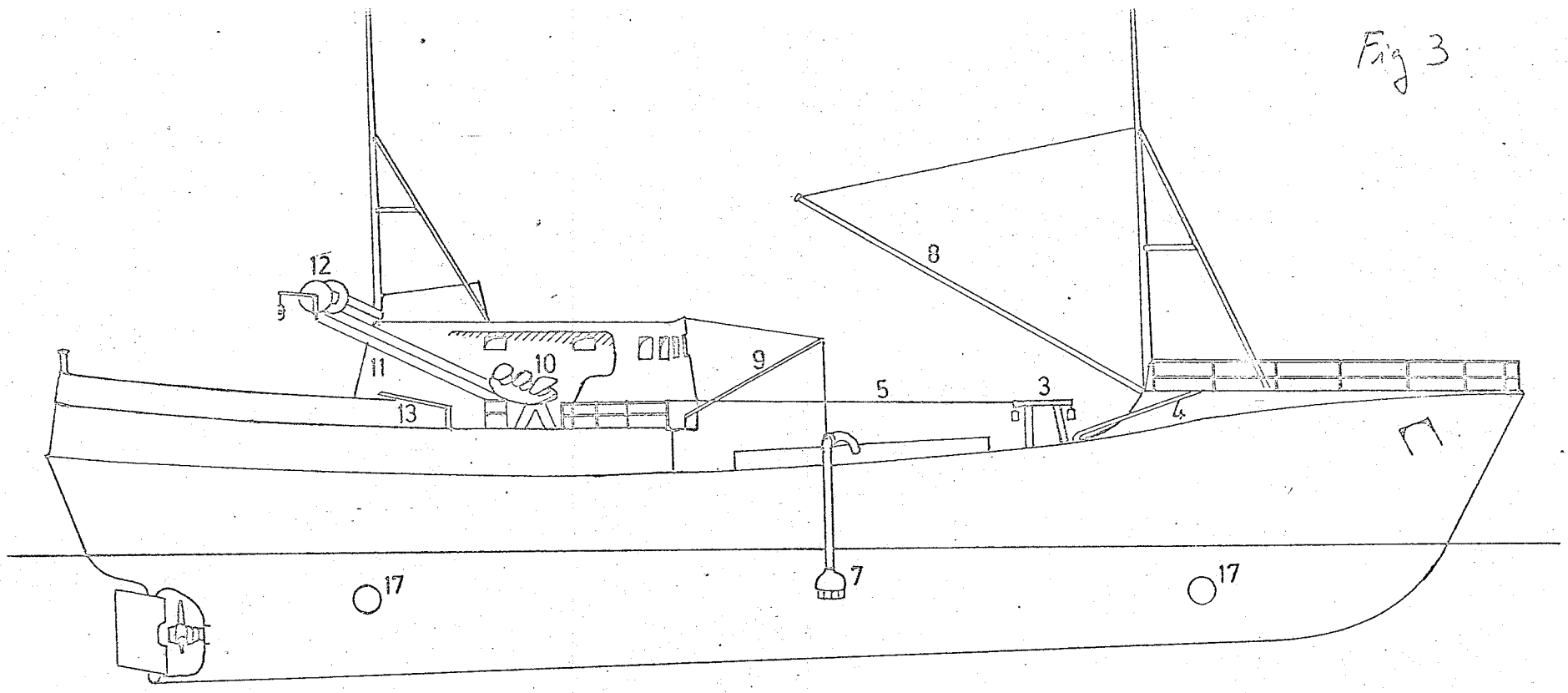
Fig 3



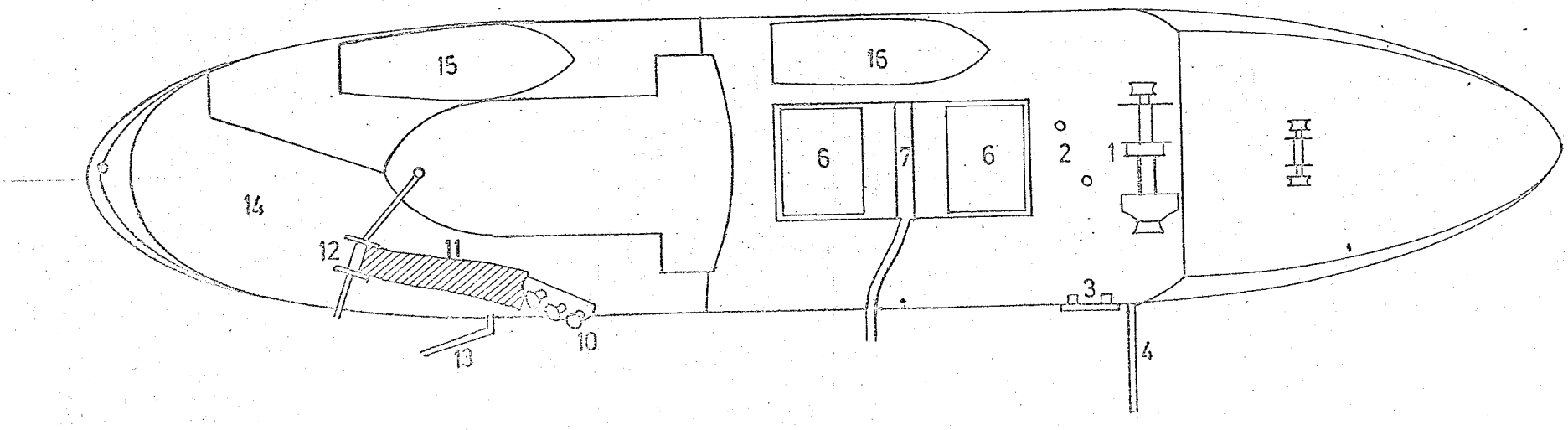


Fig. 4

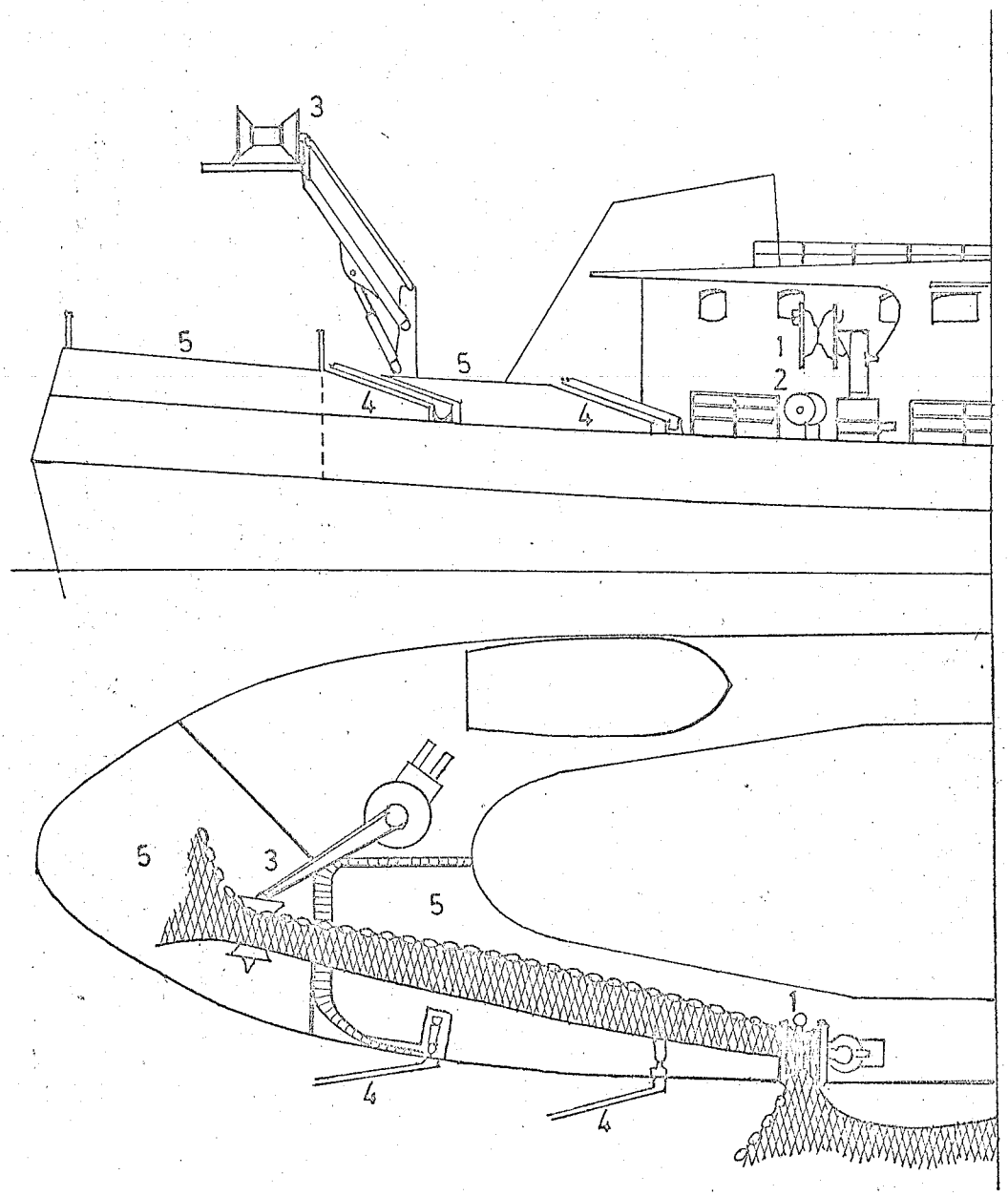
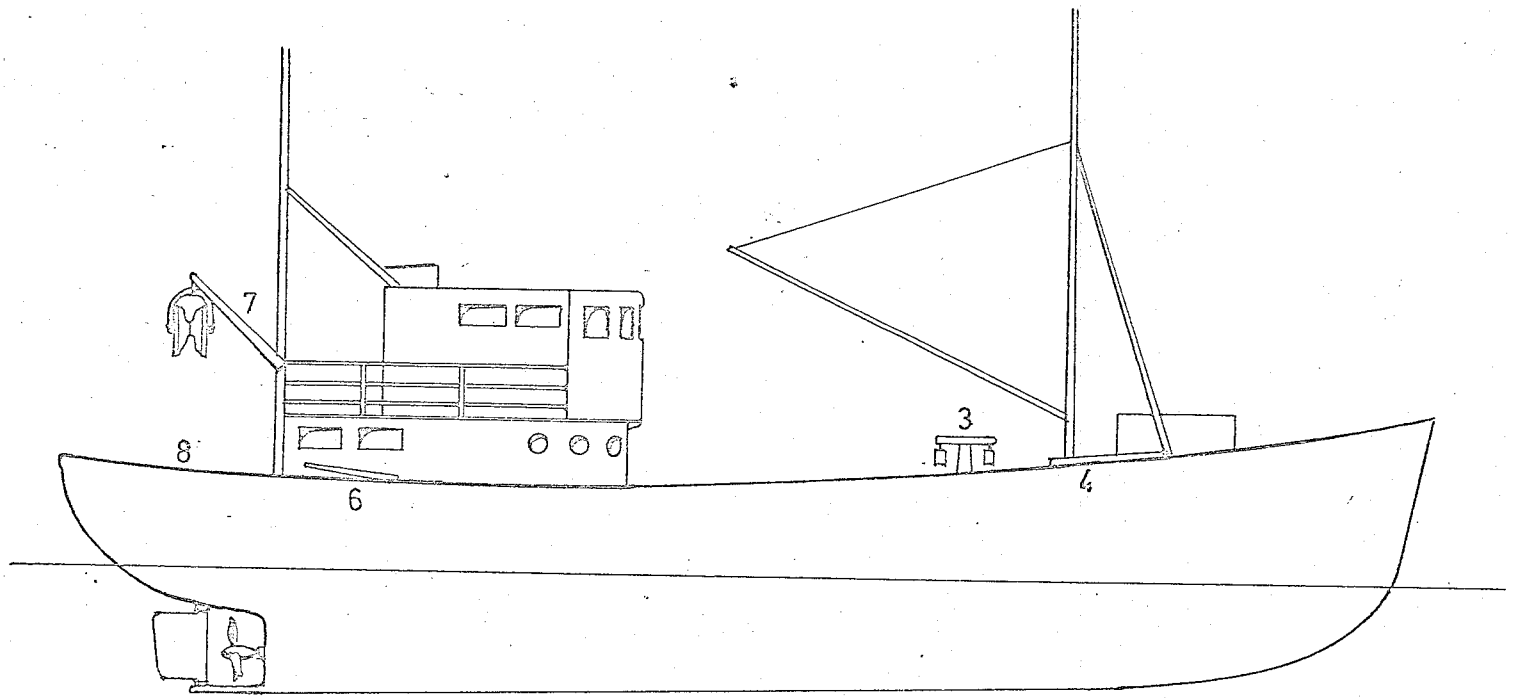


Fig 4



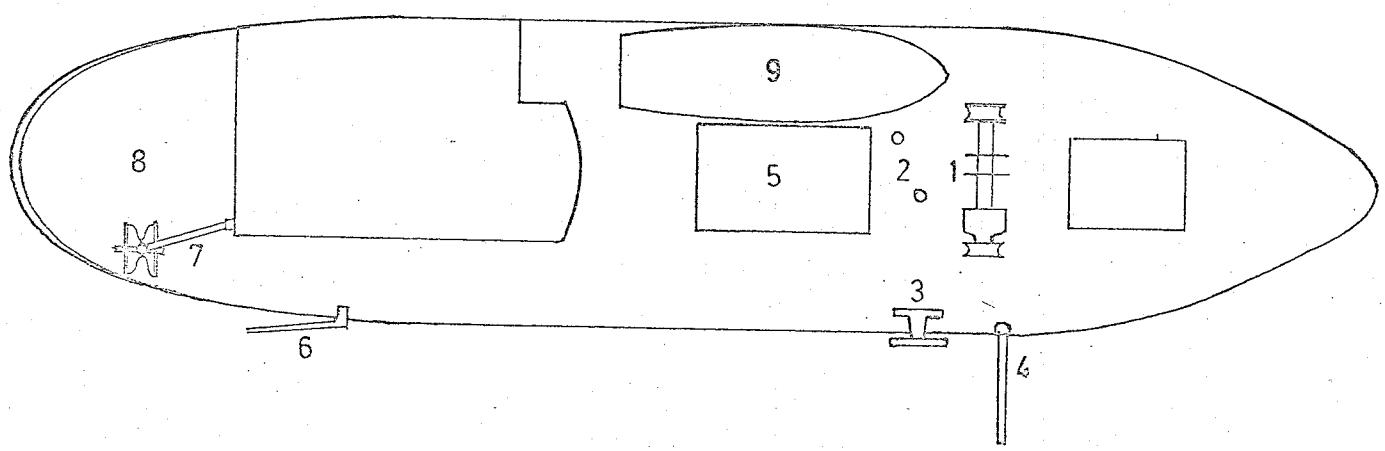


Figure 6

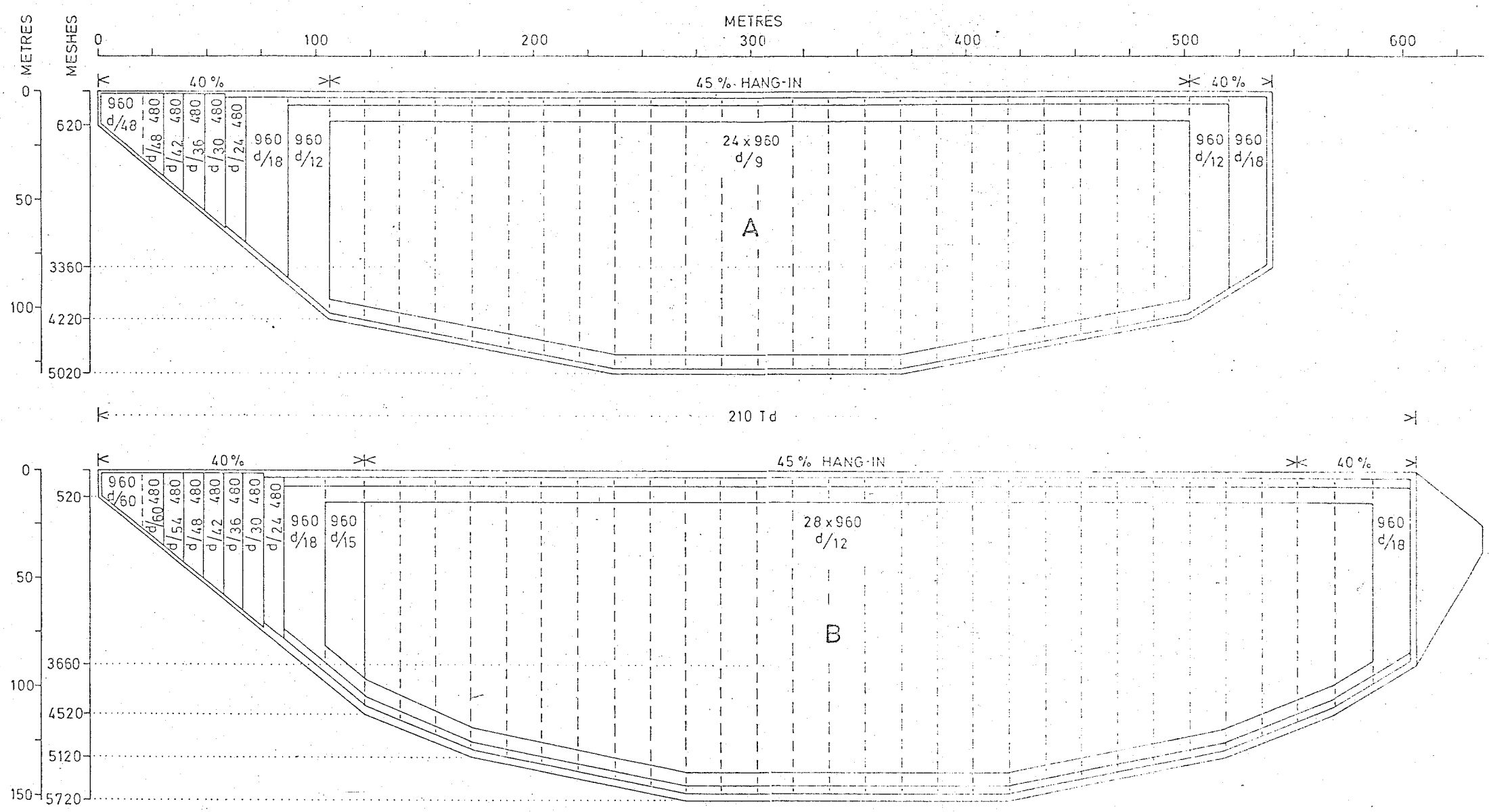

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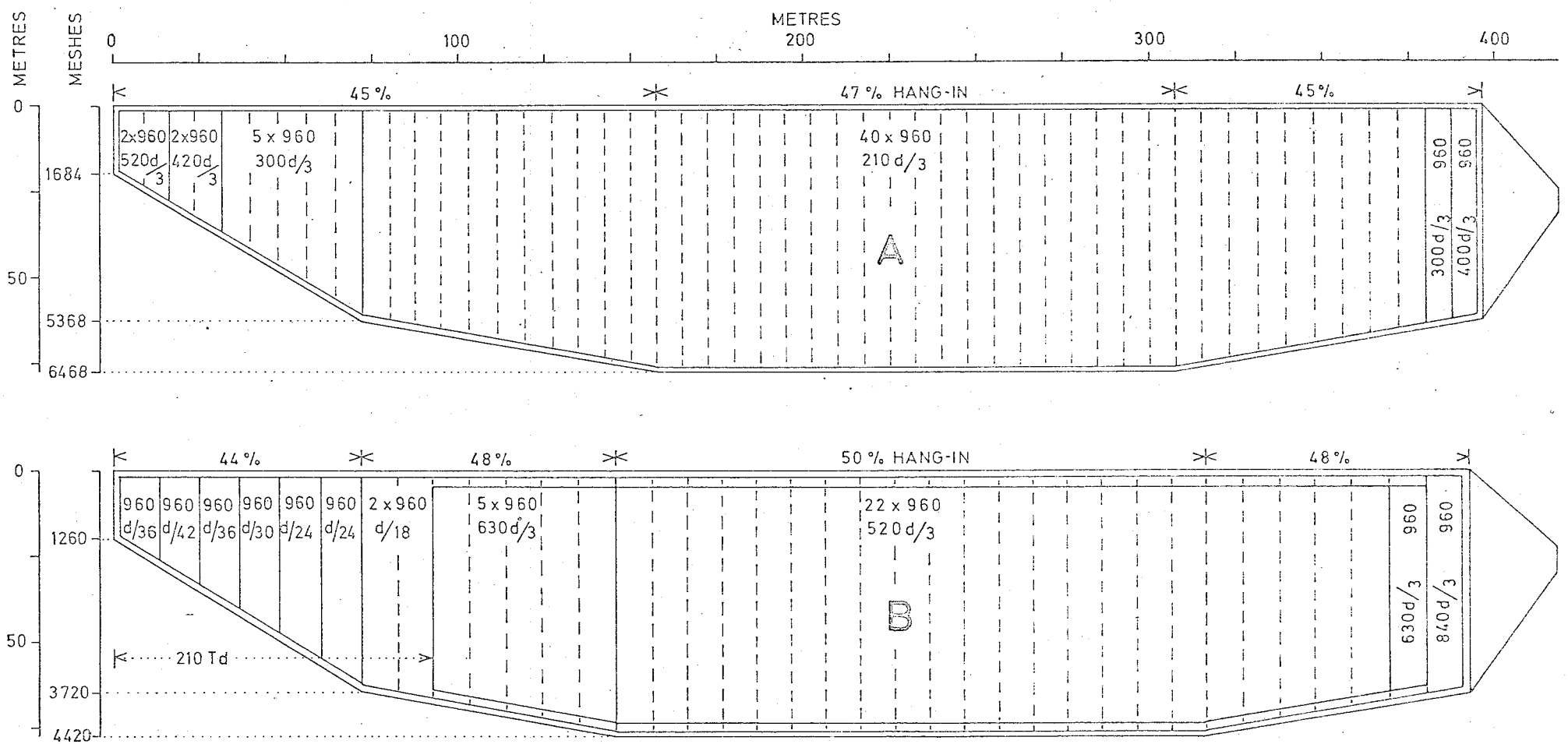
Fig 7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2x960 420d/3
5 x 960 300d/3
40 x 960 210 d/3
A
960
300 d/3
960
400d/3
44 %
48 %
50 % HANG-IN
48 %
0
1260
50
3720
4420
960 d/36
960 d/42
960 d/36
960 d/30
960 d/24
960 d/24
2 x 960 d/18
5 x 960 630 d/3
22 x 960 520 d/3
B
960
630d/3
960
840d/3
210 Td