Seafish Technical Report No. SR212

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Date: May 1983 (Re-typed August 2005)

Twin Drum System for Seine Net Rope Hauling

Summary:

Seine net fishing requires the hauling of long lengths (one and a half nautical miles) of rope under tension by the use of a capstan type of whipping drum. This method of hauling has the disadvantage of snatch loads and rope slippage causing deterioration of the ropes which are a major expense to replace.

The twin drum method of hauling is claimed to eliminate these disadvantages, provide the rope with ideal support during hauling, and, hence, extend the rope life and reduce replacement costs.

A modification kit has been manufactured and tested at sea on two seine net vessels. The equipment hauled in the ropes satisfactorily during trials and on commercial fishing on both vessels. However, certain disadvantages and problems did emerge on one of the vessels.

This report describes the equipment, the trials and discusses the disadvantages and problems that did occur and makes recommendations for investigating and, perhaps, overcoming them.

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Summary

1. Introduction

The conventional method of hauling seine net ropes is by a winch equipped with two whipping drums. The rope, when hauled around the whipping drum, suffers considerable shock loading due to riding up and then suddenly slipping down the flange radius of the drum. This, coupled with slippage and the lack of support for the rope, contributes towards reducing the useful life of the rope.

The twin drum principle has been known for many years and has been employed in situations where constant torque, constant speed, or long lengths are to be handled. Typical examples are mooring winches on large vessels and hoists used on high level building sites.

Donkins Limited, who have a patented angled twin drum arrangement for their mooring and other winches, have co-operated with the SFIA in developing the twin drum method for seine net rope hauling.

2. Objective

To test, on a commercial fishing vessel, the twin drum method of hauling seine ropes and to describe the progress to date, in introducing the method to seine net fishing.

3. Description of Twin Drum Method (see Fig. 1)

The twin drum method seeks to improve on the conventional whipping drum by providing support and preventing the wear and tear the rope suffers through riding up and slipping down the radius of the drum flange. To achieve this, the rope is guided and supported in a series of grooves around two drums. Mounted alongside each other, the drums are aligned such that the rope can be wound around the twin drum assembly from groove to groove in a series of half turns on each drum. Typically, the drums will have four to six grooves, enabling four to six complete turns to be made around the twin drum assembly.

With the drums being driven round, a modest tension applied to the free end of the rope will cause the rope to tighten and be gripped by the grooves and thus hauling will be achieved. The system relies totally on the friction grip of the rope in the grooves. Hence, multiple turns of the rope around the drums multiply the grip and enable large pulls to be obtained. It will be appreciated that, as the rope is hauled in, each segment of rope is transported from groove to groove along the length of the drums, the tension in the rope progressively decreasing after each complete turn. Thus the rope tension, after the final turn, is only that required to create the initial friction grip.

Ideally, both of the drums should be driven to obtain maximum pull with the least number of turns. However, provided that a sufficient number of turns are used, one drum may simply be an idler. Thus it is possible to adapt an existing whipping drum installation to twin drum by substituting a grooved drum in place of the whipping drum with a second grooved drum as an idler.

Benefits claimed in comparison with a whipping drum are:

l. No shock loads, hence reduction of wear and tear on machinery, hydraulic system and ropes.

2. No slippage.

3. More even hauling speeds.

4. Better rope support.

5. Longer rope life.

6. Reduction of replacement cost of ropes and drums.

The twin drum system offers advantages over the conventional winch as follows:

1. Constant speed and pull.

2. No restriction on rope length.

3. Compactness, enabling sitting at the ideal point of application and with rope storage being in any convenient location.

4. Development for Seine Net Fishing

Because of the long lengths of rope used and the high replacement costs of worn ropes, it was considered that twin drum hauling would be very beneficial for hauling seine net ropes. Following discussions with Donkins Limited of Newcastle, it was agreed that a conversion for existing seine net winches would be the best way of introducing the system to the Industry. Accordingly, Donkins designed and manufactured one initial kit of components to convert the popular 'Mastra' winch which is used by many seine netters.

4.1 Description of the Twin Drum Conversion Kit

Designed to mount off the base of the 'Mastra' winch, the kit consists of the following:

1 - mounting bracket.
2 - idler drums with stub axles.
2 - driven drums bored and keyed to interchange with whipping drums.
2 - outrigger bearing arms.
4 - stub axle mounting clamps.

As shown in Fig. 2, the kit enables the idler drums to be mounted on the back of the winch in line with the winch shaft. The driven drums are mounted on the winch shaft in place of the whipping drums and the grooves in the driven and idler drums or. each side of the winch are aligned.

To achieve alignment, Donkins have patented a method of mounting the drums at an angle to each other such that a rope wrapped around the driven and idler drum will lead in perfect alignment from groove to groove. The idler drum is mounted at that angle which results in an offset of one groove pitch between the top and the bottom of the idler drum relative to the grooves on the driven drum. Thus, the rope will lead naturally from groove to groove when passing from one drum to the other.

Since multiple turns of rope are made around the twin drum assembly, a considerable clamping force will be generated between the two drums. Hence, it is necessary to fit, across the open ends of the drums, an out-rigger arm on bearings to carry the load and prevent the possibility of shafts bending. The outrigger arms have a spherical bush for mounting on the stationary stub shaft of the idler drum, whilst a self aligning ball bearing assembly is used on the rotating stub axle of the driven drum. A jacking screw permits the length of the arm to be adjusted on installation.

5. Trials

The conversion kit was originally installed on the North Shields vessel 'CONGENER'. The vessel has since been modified for pair trawling and the conversion kit has subsequently been transferred to a Fraserburgh vessel, the 'STARELLA'.

5.1 Trials on CONGENER

5.1.1 Vessel Details

The 'CONGENER' is a 23.9m (78ft) multi-purpose vessel of stern trawler design which is operated from her home port of North Shields by Skipper Alan Morse. The main engine is a Swedish Hedemora diesel, giving 630 bhp at 1200rpm. A 3:1 reduction gearbox drives the C.P propeller which is housed in a Ulstein steering nozzle.

The large aft working deck is rigged for trawling and seining. Deck area is divided into a clear forward section for fish handling, and the aft section where all deck machinery is concentrated. Twin rope reels are mounted at the forward end of the machinery section; the seine/trawl winch is on centreline aft of the reels. An extra barrel is provided on the Mastra seine winch for use with a bag rope or 'lazy deckie'.

5.1.2 Installation of Twin Drum Kit

Installation was quickly achieved in under a day by two men. The mounting holes for the idler drum clamps were drilled on site having aligned the grooves in the driven and idler drums. Checks were made to ensure a correct lead from the drums to the rope reels.

5.1.3 Sea Trials

Prior to embarking on a full fishing trip, a short test was made inshore to check the operation of the twin drum winch. Of particular concern was the passage of links and splices around the drums, also the ability to surge the ropes.

From the tests it was found that the twin drums performed extremely well. Hauling was smooth and quiet, the noise and vibration experienced with whipping drums being totally eliminated. Normally, the vessel hauled using four turns around the whipping drums and, hence, with the driven/idler twin drum assembly, it had been anticipated that eight turns would be required. However, with the positive grip of the rope in the grooves, six turns proved quite adequate. Links and splices passed smoothly around the drums and no problems were experienced with surging the ropes.

'Surging' is the term applied to temporarily stopping the haul of one rope relative to the other by allowing the free end of the rope to go slack, thus losing the tension required for the drums to grip the rope and allowing it to slip. In the course of hauling, it is periodically necessary to surge one or the other ropes to keep the gear coming in evenly.

Following the successful test, the vessel continued to use the twin drum system during normal commercial fishing. Skipper Alan Morse reported total satisfaction with the drums and anticipated a considerable increase in rope life. However, he was not able to prove the point since his vessel, the 'CONGENER', was switched to pair trawling, matched with another Morse family owned vessel.

After several months, when it had become apparent that the 'CONGENER' was unlikely to return to seining, the drums were removed.

5.2 Trials on STARELLA

5.2.1 Purpose of the Trial

In view of the unexpected curtailment of the trials on the 'CONGENER', before full assessment of the performance could be made, the intention of the 'STARELLA' trials was to gather full data to enable a proper comparison to be made between the twin drum and conventional hauling. A two-day charter of the vessel was used for instrumented trials, after which the vessel used the conversion in normal commercial fishing. The fishing trials highlighted problems that needed further investigation and, after consideration of the problems, a second fishing trial was undertaken.

5.2.2 Vessel Details

The 'STARELLA' is a 23.8m (78ft) wooden hulled vessel of the traditional Scottish seiner design. Based at Fraserburgh, the vessel is operated by Skipper/Owner, Alan Eddie, and his seven man crew.

The vessel is equipped with a shelter-deck which extends from the wheelhouse to the mid foredeck. A Mastra seine winch is sited just under the whaleback with a Beccles coiler aft of winch. The winch does not have the auxiliary whipping end as fitted on the 'CONGENER' and the coiler feeds the ropes to rope tanks which have been constructed in the forward section of the fish room. At the stern, mounted on a hydraulically actuated arm, is a power block for handling the net. The vessel is powered by a 450hp Caterpillar engine and a Dowty pump set supplies the hydraulic system.

5.2.3 Installation of Twin Drum Kit

It was anticipated that the kit would simply mount in position in exactly the same way as the 'CONGENER', but the Mastra winch, although ostensibly of the same dimensions as that on the 'CONGENER', had detail differences which did not permit the mounting bracket to be used. However, since the winch was located against vertical stanchions which supported the whaleback, a plate was welded to the stanchions to carry the idler drums. The idler drums were aligned at the correct angle to the driven drums and holes for the mounting clamps drilled to place. A stiffening angle was added to react the loads from the stanchion mounted plate on to the winch body. The outrigger arms were fitted and the winch tested. Both winch drum shafts were observed to be bent to an extent of 1 to 2m m off-set measured at the ends. The eccentricity, which the bent shafts gave, was being transferred through the outrigger arms to the idler drums, causing the mounting plate to flex.

By adjustment of the jacking screws on each arm, the affect on the idler drums was reduced to an acceptable level.

5.2.4 Instrumentation

Transducers were installed to monitor the following parameters:

Hydraulic pressure at winch motor.
Hydraulic pressure at pump.
Main engine speed.
Winch speed.

The signals were recorded on a UV Recorder for later analysis.

5.2.5 Instrumented Trial on the 'STARELLA'

This trial was intended to provide comparison data between hauling with the conventional whipping drums and hauling with the twin drum system. Two complete hauls were made with each method. The time was noted for significant stages during the hauls. The sequences were also recorded on video film.

5.2.6 Trial Observations

Twin Drum: Of immediate impact was the total smoothness of the twin drum method in comparison with the whipping drums. Noise and vibrations were almost completely eliminated. Hydraulic pressure was nominally 2000 psi for the slow haul section and 2500 to 2700 psi for the fast haul section. Short periods of surging during the course of the haul were achieved without problems.

Whipping Drum: For every revolution of the whipping drum, the rope, as it is wound on, is forced to ride up the flange radius of the drum. The lateral load generated from riding up the flange causes the turns on the drum to suddenly slip sideways to make way for the incoming turn of rope. This riding up and slipping caused considerable noise and vibration and, of course, shock loads.

It had been anticipated that the shock loads, which the riding up and slipping generated, would have been reflected in the hydraulic system but the pressure, as measured both at motor and pump, was very consistant without sudden peaks. Nominal pressure for the slow haul section was 2000 psi and for the fast haul section 2200 to 2300 psi.

5.2.7 Fishing Trials -- Skipper's Comments

Following the removal of the instrumentation, the vessel sailed on its normal six day trip off the Norwegian coast. During the course of the trip, the gear was shot and hauled 18 times using the twin drum system. The skipper made the following comments:

Bag Lifting: Difficulty was experienced with lifting large bags of say 1000kg or more of fish aboard using the twin drum system. The crewman handling the bag rope found it difficult to apply sufficient pull on the free end to cause the drums to grip. Additional turns were placed around the drums, increasing from 4 to 6 turns, in order to gain more grip, but the performance was just barely adequate and control was difficult.

Surging: Although the ropes are easily surged with the twin drum system, the skipper suspects that the ropes are 'burning', i.e. friction generated heat. This, he thinks, would be a significant problem if a bad section of rope on one side had to be taken out during hauling, requiring a long length of the other rope to be surged to equalise the rope lengths. Loud squealing noises occurred when surging.

Unloading: This vessel relies on the seine winch for unloading and the crew found the twin drum a big hindrance since the rope turns cannot be quickly cast on and off as with the whipping drums.

Pressure: The hydraulic pressure when hauling during the fast stage was higher with the twin drum than with the whipping drum, 2700 psi compared with 2300 psi. During the slow hauling section, the pressures with the two systems were nominally the same.

Speed: On these trials the rate of hauling during the fast stage was slower with the twin drum system than the single drum.

5.2.8 Modifications to System after First Trials Voyage

In view of the skipper's comments which were contrary to the experience on the ‘CONGENER’, the system on the STARELLA was re-assessed.

The major difference between the ‘CONGENER’ and the ‘STARELLA’ is the winch tensioning method. The ‘CONGENER’ was equipped with hydraulically powered rope reels which hydraulically maintain a constant tension on the free end of the rope as it leaves the winch. On the ‘STARELLA’ tensioning is achieved by the Beccles coiler which is mechanically driven by the winch. To achieve a good speed match between the winch drum and the coiler, the ratio of the chain drive must be correct. From calculations made, using effective diameters and drive ratios on the ‘STARELLA’, it was found that the coiler was retrieving the rope too slowly. With the twin drum system the coiler was 1.14% slow and with the whipping drum 4.6% slow.

The whipping drums have an inevitable degree of slip due to the incoming turn of rope forcing the existing turns of rope on the drum to move sideways; the turns slipping to make room for the incoming turn. Hence, the speed inbalance between the winch and coiler was acceptable with the whipping drums, but would result in an inefficient grip with the twin drum system. Arrangements were made to change the coiler drive ratio; the drive and driven sprockets of 15 teeth and 13 teeth were interchanged with 14 and 12 teeth sprockets to achieve the better theoretical ratio. A second fishing trial was then undertaken with an SFIA observer on board.

5.3 Second Fishing Trial on MFV STARELLA

5.3.1 The Trial

The vessel sailed to its normal fishing grounds off the Norwegian coast. The weather conditions were calm enabling full observation of the performance of the winch to be made. Four days were spent on the fishing grounds, the gear being shot and hauled 21 times. Eight hauls were made using the twin drum system until serious problems, the rope slipping back out, developed and the drums had to be removed. The normal whipping drums were used for the remainder of the fishing voyage.

5.3.2 Observations

Twin Drum: As with the previous trials, hauling with the twin drums was extremely smooth and quiet. Four turns or loops of rope were used around the twin drum assembly, this being quite adequate to create ample grip to haul the rope. Indeed, at very slow hauling rates, the last two loops were observed to be slack around the drums. This was more pronounced on the starboard side, due, it is considered, to the rope on the starboard side being more worn than the port rope. A worn rope will enter deeper into the vee of the coiler tension wheel and, hence, the effective diameter and thus the hauling speed is reduced.

The slack loops occurred at the start of the hauls and were gradually reduced as the load built up. On two occasions during the fast haul stages, the loops were observed to have expanded outwards, the extent of the expansion progressively increasing from the first to the fourth loop. Again this effect was more pronounced on the starboard side and it was noticed that the expansion was immediately corrected when a new section of rope, towards the end of the haul, came onto the winch.

The measurement of rope speed, compared with the theoretical rope speed at the drum, showed that there was an average slip factor of 1.83%. This appeared to be constant, independant of hauling rate, although the method of measurement with a hand held tachometer cannot be considered to be particularly accurate.

Marker tape applied to the twin drums clearly indicated a speed difference between the driven and idler drums. Measurements of the drum speeds showed an average slip of 2.15%. The ropes were hauled in evenly on all occasions. Surging was required as dictated by wind and tide effects on the vessel and fishing gear, but the surging required was not indicative of uneven hauling between the port and starboard winch drums.

Bag lifting was reasonably well achieved with the twin drum, but it was found necessary to use six turns or loops to obtain sufficient grip to lift large loads, in excess of about 1000 kilogram mes. Application of the turns around the twin drum assembly required the crewman to be unhurried and careful. He also had to apply considerable exertion on the free end to obtain grip.

Surging with the twin drum system was easily achieved, but only at the expense of juddering and squealing with heat build up, as indicated by steam emmitted from the ropes. At slow speeds the juddering was very pronounced, whereas at high speed, the surging was smooth but with immediate heat being apparent. One long surge at high speed resulted in clearly visible burn marks on the rope.

On a few occasions, after surging, the drums would not immediately grip the rope and manual tension had to be applied at the coiler to obtain drive. This occurred with both port and starboard drums, but on the starboard side the rope actually ran back out briefly. For the following haul, the number of turns was increased from four to five. Despite this, and again after surging, the rope ran back out. The efforts of three men were required to apply sufficient check load on the free end at the coiler to stop this. On completion of the haul, the twin drums were removed and the whipping drums were fitted.

Whipping Drums: The noise and vibration experienced with the whipping drums was a big contrast to the smooth operation of the twin drums. Measurement of rope speed by using the tachometer was impossible, due to the rope vibration which occurred both at slow and fast hauling speeds. Four turns of rope were used on the drum and at slow speeds, it was observed that the incoming turn of rope caused the turns on the drum to slip, five times per drum revolution. The increment of each slip was very small but, as hauling speed increased, the increments became bigger but with fewer slips per revolution. At all speeds there was considerable vibration in the ropes.

Measurement of rope speed and drum speed showed that the whipping drums have an average slip factor of 3.75%. As with the twin drum, the method of measurement cannot be considered very accurate, the results showing a wide scatter. However, it would appear that the slip factor was constant regardless of speed.

Surging at slow speeds resulted in slight juddering with squealing noises but with no apparent indication of heat build up. At high speeds, surging was smooth and only after a long period was heat build up evident as indicated by steam.

To perform the surging operation, the crewman, using a lever, pulls back the spring loaded wheel which normally presses the rope into the vee of the coiler tension wheel. The tension wheel no longer pulls the free end of the rope from the whipping drum and thus allows the rope to slip on the drum. At slow speeds it was observed that the crewman had to support the weight of the rope leading down into the rope tank in order to prevent the weight creating drive at the whipping drum. This indicated how little tension is required to generate drive with the whipping drums.

Bag lifting was an easy operation with the whipping drums. The crewman could easily wind turns of rope onto the drum and it only required a modest manual pull to lift large bags of fish (i.e. 1000 kilgramme or more).

Readings of hydraulic pressure taken when using both the twin drums and whipping drums showed that the twin drum absorbed more power than the whipping drum. Average pressure, during the slow hauling stage, was 145 Bar (2135 lb/sq.in) with the twin drum, compared to 132 Bar (1940 lb/sq.in) with the whipping drum. For the fast haul stage, average pressures were 176 Bar (2585 lb/sq.in) and 154 Bar (2260 lb/sq.in) for twin drum and whipping drums respectively.

Time required for each haul varied with fishing conditions from under one hour to about one and a half hours. However, the average times when using the twin drum and whipping drum systems were one hour twenty one minutes and one hour nineteen minutes, respectively. Thus, there was no significant difference in the hauling rate with the two systems.

6. Discussion

Brief experience has now been gained with the twin drum system on two vessels with differing levels of success. On the 'CONGENER', the system was apparently very satisfactory, with an anticipated promise of increased rope life. In contrast, on the 'STARELLA', apart from giving smooth vibration free hauling, the twin drum system has not been proved superior to the whipping drums. Consideration of the arrangements on the two vessels provides reasons which largely account for this.

6.1 Winch Tensioning

The constant tension provided by the hydraulically powered rope reels on the 'CONGENER' would have ensured that at all times there was adequate load to enable the twin drum system to function correctly.

On the 'STARELLA' the winch was dependant on the mechanical drive to the coiler tension wheel and, although the correct theoretical ratio can be achieved, in practice it is dependant on wear factors. Wear on the rope affects the ratio since the worn rope fits deeper into the vee of the coiler tension wheel thus the effective diameter is reduced. Similarily, wear on tension wheel sheaves allows the rope to run on a reduced effective diameter. It was observed that the starboard drums did not perform as effectively as the port drums, due to the starboard rope being slightly worn. This was clearly illustrated by the improvement in performance whenever a new section of rope came onto the winch towards the end of each haul.

The whipping drums, due to the inevitable slip caused by the incoming turn of rope, must tolerate mis-match of speeds between winch and coiler. Indeed, if the coiler speed exactly matched seriously, was faster, then excessive wear would take place at the coiler since the rope speed would always be slower due to slip on the whipping drum.

The twin drum system relies on maintaining a positive friction grip at all times and, hence, if slip is allowed to occur, it will result in a power loss in the form of frictional heat. The higher hydraulic pressures recorded with the twin drum system are a consequence of the rope slipping on the drums due to the lack of positive tensioning.

Thus for the twin drum system to perform successfully it must have a tensioning method which is continually trying to outpace the drums and thus will maintain constant tension. The hydraulic rope reels, as used on the 'CONGENER', provide a perfect tensioning method.

6.2 Baglifting and Unloading

On the 'CONGENER' the seine winch is fitted with an extra barrel and, hence, there was no requirement to use the twin drum system for unloading and baglifting as was necessary on the 'STARELLA'.

Baglifting is perfectly feasible with the twin drum system, although the winchman must take more care in applying the turns of rope around the drums than is required with a whipping drum. Six turns were used around the drums to lift heavy bags and this required considerable manual effort to achieve sufficient tension to obtain grip. Since a driven and an idler drum were employed, effectively only three turns can truly be considered as providing drive. Hence, if both drums were driven, the manual effort required would be much reduced.

Unloading does not require powerful pulls but must be a quick operation. The length of time required to apply the turns of rope around the twin drum system makes it totally unsuited for the unloading operation.

6.3 Drum Characteristics

In considering the two drum types, the following features are apparent:

6.3.1 Efficiency of Grip

From the trials experience, the whipping drum grips the rope more efficiently than the twin drum system used in the trials. This was clearly illustrated when lifting bags of fish aboard, a situation in which the tensioning pull is applied manually.

When a rope is wound around a whipping drum, the torsional movement of the turns of rope around the drum generates a high clamping force; in the same manner that a coil spring will lock onto a shaft when the coils are wound up tight. Thus, to a degree, the whipping drum is self tensioning, the tensioning pull on the rope free end is required to provide the initial torsional movement and, hence, needs only be a modest pull.

With the twin drum system, the external tensioning pull must be sufficient to generate adequate grip on the last groove (the out-going groove) in order that that strand of rope will tension and generate grip on. the next groove. The tensioning pull is transmitted from groove to groove, being added to by each turn of rope around the grooved drums. At the first groove (the in-coming groove) the pull must be sufficient to haul the load and this is dependant on there being an adequate tensioning pull on the last groove.

With the twin drum system, as used in the trials, and which consisted of a driven and an idler drum, it can be calculated that, with four turns of rope, a tensioning pull of 44 kilogram mes is required to haul a load of 1 tonne. With six turns of rope, the tensioning pull would be reduced to 9 kilogrammes.

It should be remembered that these are theoretical figures and with a wet and stiff rope, a man could well have to apply a pull of 30 kilogramme (67 lbsf) in order to lift a large bag of fish.

Thus with the twin drum system, the grip is very dependant on the tensioning pull. It is essential that the, tensioning pull keeps pace with the speed of the winch since slip will occur until the required tensioning pull has been generated. Such slip occurs under load and, hence, absorbs power, unlike the whipping drum which accommodates the inevitable slip, caused by the incoming turn of rope, in a series of jumps; each small jump resulting from the grip being released momentarily.

The removal of the twin drum system, necessitated by the rope slipping back out, cannot be considered as a failure of the twin drum system. It was a failure of the coiler tensioning wheel to hold the rope and thus provide the necessary tensioning pull that led to problems. It is, however, true to say that the twin drum system demanded a greater tensioning pull from the coiler than the whipping drum.

It should be appreciated that the twin drum system used was at the disadvantage of having only one driven drum and thus the number of turns of rope were effectively halved. Potentially, a twin drum system, with both drums driven, should provide a very effective grip and, in view of the improved rope support afforded by the grooves in the drums, the grip should be superior to the whipping drum.

6.3.2 Surging (Ability to Release Grip)

Although the twin drum system was quite capable of permitting surging, it was only at the expense of fairly rapid heat build up. The whipping drums also generate heat when surging, but it requires a very prolonged surge before this becomes excessive. No very long periods of surging were observed during the trials but it is understood that prolonged surging may be necessary; for instance, should the fishing gear become fast or if a rope length is damaged and must be replaced by insertion of a new length during the period of hauling.

When surging the tensioning pull is released, allowing the free end of the rope to become slack. With the whipping drum, the loss of tensioning pull permits the turns of rope around the drum to expand outwards, due to the natural spring in the rope, thus the grip is thus released. The load, being hauled, will tension the rope and recreate grip. However, any movement of the rope to haul in the load increases the slackness in the turns around the drum and the grip is reduced. Thus, when surging, a balance is maintained between the load and the grip necessary to hold that load. Movement of the rope, either in or out, automatically decreases or increases the grip to maintain the balance. The same is true with the twin drum system.

The twin drum system, however, differs from the whipping drum in that, to creat drive, the twin drum relies on a friction grip alone whereas the whipping drum also utilises the clamping effect of the turns of rope. The clamping effect is very responsive and is easily applied and released. In contrast, the friction grip is very progressive and, while it can be reduced or increased without removing the turns of rope, it cannot be eliminated. Thus, when surging, there is the inevitable heat build up due to the friction grip necessary to maintain the load in the rope. This applies to both systems. However, with the twin drum, there is also the heat build up from the friction required to obtain the load maintaining grip.

It is possible that surging with a twin drum system would be improved if both drums were driven. This would permit half the number of turns to be used and thus reduce the length of rope in contact with the drums. Also if the drum centers were as close as possible, this would reduce the weight of unsupported rope which creates drag on the drums.

6.3.3 Smoothness

The twin drum system is extremely smooth and quiet in operation. The rope is properly supported by the drum grooves and hence offers all the correct features for long rope life.

With the whipping drum, the rope is continuously subjected to shock loads as the turns slip on the drum. The incoming turn of rope is crushed between the drum flange and the existing turns until sufficient load is generated to force the turns to slip sideways. The fibres of the rope are distorted to produce a flat section where the rope contacts the drum. All of these are injurious to long rope life.

6.4 Viability of the Twin Drum System

Smooth, quiet, vibration free hauling, though desirable, is in itself justification for a new hauling method. An increase in useful rope life is. The twin drum system does offer improved rope live but, from the trials experience to date, it is not possible to quntify the potential saving. The twin drum kit used for the trials has not proved suitable for a vessel such as the 'STRELLA', which uses a coiler. On the 'CONGENER', the kit appeared to be very successful due to the ideal tensioning given by the rope reels. Had the system remained on the 'CONGENER' an assessment of rope life would have been possible. However, by considering typical costs involved in seine net fishing, indication of possible savings can be obtained. It must understood that these savings would only be generated with use an optimum system as described in the next section.

Seine net rope currently costs approximately £200 per coil and a typical vessel will replace between 30 and 50 coils per year at a cost of £6,000 to £10,000. Considerable rope loss occurs due to damage on seabed but if rope life was extended by only 10% through the adoption of twin drum hauling, it would still represent a worthwhile saving.

The replacement of whipping drum sheaves is a fairly high and regular expense, typically £1,000 per annum. Heavy wear takes place on the sheaves due to the inevitable slip which allows the sand particles embedded in the rope to rapidly abrade the steel. The twin drum system, when correctly tensioned, will have no slip and consequently the rate of wear on the drums will be very low. The savings to be expected from a combination of the two effects noted above would be of the order of £1000 p.a.

6.5 Consideration of a Future Drum System

From the experience gained during the trials it is considered that the following features would be required for a successful twin drum installation.

6.5.1 Driven Drums

Both drums should be driven. This would enable a high pull to be obtained with only a few turns around the twin drum assembly. Each drum would have three grooves allowing three turns of rope to be applied around the assembly. From the trials experience it can be concluded that two turns would be quite adequate to haul the seine net ropes and thus, three turns would provide a large margin of spare capacity.

6.5.2 Tensioning

Winch tensioning should be by rope reels or similar. The tensioning method must, at all times, be trying to outpace the winch in order to ensure positive tensioning.

6.5.3 Separate Drives

Separate drives should be used for the port and starboard drums. It is considered that the twin drum system, being designed for a high gripping force, is not suited to deliberate slipping and should not be used for surging. Separate drives would permit one side to be stopped whilst the other continues hauling, as occurs when surging. Clutches, fitted on each side of the winch, would allow the drums to be stopped and started but a ratchet or roller sprag clutch would be required on each side to prevent the rope pulling back out under load.

An ideal technical solution would be to use two separate twin drum winches, mounted in the most suitable positions on port and starboard, as suits the vessel's layout. The hydraulic motors of the two winches would be coupled in series and driven froma common pump set. Speed control would be by controlling the pump output, as is the practrice with most existing seine winches. Control valves, mounted in the wheelhouse or at the winches or both, would enable the iwnches to be stopped and started independently. See Fig. 5.

6.5.4 Unloading and Baglifting

The winch must have an additional output shaft for a capstan head to be used for unloading. The capstan head need only be designed for the moderate duty of unloading since the twin drum system could be used for the heavy duty of baglifting.

6.5.5 Drum Alignment

Donkin's patented method of achieving alignment by mounting the drums at an angle to each other, does give perfect alignment but complicates the provision of the drive to both drums. Drums mounted parallel to each other would permit a simple drive to be used and by offsetting the drums by half a groove width, a reasonable lead for the rope could be achieved around the twin drum assembly. The offset between the drums would induce a tendancy to twist the rope and could induce wear on the groove edges. However, the effect could be minimised by having a long centre distance between the drums and thus reducing the angle of misalignment between the rope and the drum groove.

6.5.6 Winch Design

A simple and possibly very cost effective twin drum winch could be achieved by utilising two worm reduction gear boxes. As shown in Fig. 6, the two grooved drums would be mounted on the output shafts of each gearbox with the gearboxes mounted in line, the input shafts driven by the hydraulic motor. Alignment of the drum grooves would be achieved by setting the gearboxes at the desired angle rotated about the input shafts' centres.

Due to the high loads generated on shafting and bearings with the twin drum system, the ratings of the gearboxes would be carefully checked.

7. Conclusions

7.1 The twin drum system of hauling is not suitable for use with the traditional coiler as the tensioning method. However, with the hydraulic rope reels, which the majority of seine net vessels now use, the twin drum system will perform successfully and anticipated economies in rope and winch maintenance should be gained.

7.2 The twin drum system cannot be expected to permit prolonged periods of surging without excessive heat build up. Hence, a twin drum installation should have the ability to stop and start the port and starboard drums independantly. Ideally, two separate winches would provide the most beneficial solution since these could be sited as best suited the working arrangement of any particular vessel.

7.3 It is not practicable to use the twin drum system for unloading of the catch. Therefore a twin drum winch should incorporate an additional capstan head for unloading etc.

7.4 The concept of a conversion kit, to provide existing winches with a driven and idler twin drum system, cannot be recommended, due to the problems of surging and catch unloading facilities. Manufacturers should produce purpose built twin drum winches and the twin drum system of hauling could then be introduced into the Industry as original equipment for new building or whenimproving a vessel by fitting rope reels.

8. Acknowledgements

In carrying out this investigation, considerable assistance has been given from outside of the SFIA. We should like to express our appreciation to the following:

Donkins Ltd who were involved with the initial concept and who designed and manufactured the twin drum conversion kit.

Skipper Alan Morse and his crew who tested the system initially on board the MFV 'CONGENER'.

Skipper Alan Eddie and his crew who tested the system for two trips on board the MFV 'STARELLA'. Their helpfulness and willingness is particularly appreciated since, despite problems experienced on the first trip, they readily agreed to a second trip to try to analyse the problems.

BNW Engineering of Fraserburgh who quickly and efficiently installed the conversion kit on the 'STARELLA' and who were very helpful at all times.

Appendix I

Data recorded on MFV ‘STRELLA’ hauling with

(a) Traditional whipping drums

(b) The Twin Drum System

Twin Drum Haul 1

Time	Occurrence	Comments
0540	Shoot commenced	
0707	Hauling commenced	5 loops of rope on barrels
0733		Drum speed 15 rpm Pressure 1950 psi
0742	2 coils of rope hauled	Drum speed 15 rpm
0755	Speeding up haul	
0759	3 coils of rope hauled	Drum speed 32 rpm Pressure 2000 psi
0802	5 coils hauled	Pressure 2700 psi Engine revs 750
0807	Hauling stopped to remove one loop of rope	4 loops of rope on barrels
0812	9 coils hauled	Engine revs 820
0814		Drum speed 148 rpm Drum revs back on trace
0820	Finish haul	

Nominal pressure slow haul	2000 psi
Nominal pressure fast haul	2700 psi
Total haul time	1 hour 13 minutes
Fast haul time	25 minutes approximately

Twin Drum Haul 2

Time	Occurrence	Comments
0840	Shoot commenced	
0907	Start haul	Engine revs 1300
0920	Lost drum revs on trace counted revs 20 rpm	Drum revs 140
1025	Haul finish	

Nominal pressure slow haul	2000 psi
Nominal pressure fast haul	2500 psi
Total haul time	1 hour 18 minutes
Fast haul time	20 minutes approximately

Single Drum Haul 3

Time	Occurrence	Comments
1110	Start shoot	
1138	Start haul	Pressure 1900 psi
1154	Came fast	
1222		Drum speed 20 rpm
1225		Gained drum revs market on the trace
1238	4th coil hauled	
1245	Speeded up haul	
1300	End of hauling	

Nominal pressure slow haul	1900 psi
Nominal pressure fast haul	2200 psi
Total haul time	1 hour 22 minutes
Fast haul time	15 minutes approximately

Single Drum Haul 4

Time	Occurrence	Comments
1319	Dahn away	Engine revs 1700
1325	Turning corner	Engine revs 1700
1329	First rope shot End of first rope put on barrel Engine revs reduced to 800	
1330	Commenced shooting 2nd rope	Engine revs 1700
1340	Reduced speed to pick up dahn	
1342	Picked up dahn	
1344	Commenced hauling	Drum speed 18 rpm Engine speed 900 rpm
1425	3rd coil hauled	Pressure 2050 psi
1434	Came fast	
1436	Hauling again	
1442	4th coil in	Drum speed 21 rpm
1451	5th coil in	Pressure 2050 psi
1500	Speeding up haul	Pressure 2300 Drum speed 120 rpm
1502		Drum speed 140 rpm
1503		Drum speed 150 rpm
1510	11 coils in	
1511	Haul finished	

Nominal pressure slow haul	2050 psi
Nominal pressure fast haul	2300 psi
Total haul time	1 hour 27 minutes
Fast haul time	11 minutes approximately

Appendix II

Data recorded on MFV ‘STARELLA’ during the second fishing trip with the twin drum system. SFIA observer present.

Twin Drum System

Haul No	Pressure lb/sq.in	Tachometer Rope	Tachometer Barrel	Readings Barrel PCD	Rope Speed Theoretical	ft/min Actual	Slip %
1	1900	100	95	102.4	51.2	50	2.4
	1900	90	85	91.66	45.83	45	1.8
	2700	800	750	808.8	404.4	400	1.1
2	2300	115	110	118.6	59.3	57.5	3.1
	-	110	105	113.2	56.6	55	2.9
	-	800	750	808.7	404.35	400	1.1
	-	700	650	700.9	350.45	350	0.1
3	2000	103	98	105.7	52.85	51.5	2.6
	2250	95	90	97.05	48.53	47.5	2.1
	2100	87	83	89.5	44.75	43.5	2.8
4	2000	115	108	116.5	58.25	57.5	1.3
	2000	155	135	145.6	72.8	72.5	0.4
	-	750	700	754.8	377.4	375	0.6
	-	820	780	841	420.5	410	2.5
5	2500	100	95	102.4	51.2	50	2.4
6	1900	155	145	156.4	78.2	77.5	0.9
	2600	800	750	808.8	404.4	400	1.1
7	2300	95	90	97	48.5	47.5	2.1
	2400	195	185	199.5	99.75	97.5	2.3
	2700	800	750	808.8	404.4	400	1.1
	2600	800	750	808.8	404.4	400	1.1
8	2250	187	172	185.5	92.75	93.5	0.8
	2100	185	180	194	97	92.5	4.8
	2100	188	182	196	98	94	4.2

Average Percentage Slip = 1.83%

Measurement of speed of driven and idler drums taken during hauls 7 and 8.

Readings are of peripheral speeds in ft per min.

Driven Drum	Idler Drum	% slip
92.5	91	1.6
375	370	1.3
375	367.5	2.0
86	84	2.4
90	87.5	2.8
91	88.5	2.8

Average percentage slip 2.15%

After haul No.8 the twin drum system was replaced with the whipping drums. It was not possible to measure rope speed with the tachometer due to the extreme vibrations and hence it was only possible to observe the whipping drums. Hydraulic pressures and hauling times were noted.

From haul No.16, measurement of the deck layout enabled the speed of the ropes across the deck to be timed. Thus it was possible to measure rope speed and slip factors when hauling with the whipping drums.

Whipping Drum

Haul Port Side	Haul Starboard Side
Dist. Port Warp 18.83 ft	Dist. Port Warp 20.00 ft
Drum dia 278mm	Warp dia 21mm

Haul	Time secs	Dist. ft	Speed ft/min	Revs rpm	Theo. Dist. Ft/min	Slip %
	25.8	18.83	43.79	15	46.23	5.6
16	3	20	400	130	400.63	0.1
Port Side	3	20	400	132	406.8	1.7
	23.5	20	51.06	17.25	53.16	4.1
	22	18.83	51.35	18	55.47	8.0
	23.2	20	51.72	18	55.47	7.3
17	3	18.83	376.6	126	388.3	3.1
Port Side	3.2	20	375	130	400.6	6.8
	3.0	18.83	376.6	130	400.6	6.4
	24.5	20.0	48.98	17	52.39	6.9
	23.7	19.58	49.57	17	52.39	5.7
18	26.3	19.58	44.67	15.5	47.77	6.9
Stbd Side	26.7	20	44.94	15.5	47.77	6.3
	2.9	20	413.8	136	419.13	1.3
21	15.0	19.58	78.3	26	80.13	2.3
Stbd Side	15.0	20	80	26	80.13	0.1

Average Percentage slip = 3.75%

Hydraulic Pressures

Twin Drum System		Whipping Drum	
Slow Hauling lbsf/sq.in	**Fast Hauling lbsf/sq.in**	**Slow Hauling lbsf/sq.in**	**Fast Hauling lbsf/sq.in**
1800	2700	1800	2500
1900	2500	1900	2500
2300	2700	2100	2500
2100	2250	1750	2250
2250	2600	1900	2000
1900	2500	1900	2200
2250	2600	2000	1900
2000	2700	2100	
2500	2600	1800	
2000	2700	2200	
1900		1900	
2300			
2300			
2400			
2400			
1900			
2100			
2135 average	2585 average	1940 average	2260 average

Hauling Times

Twin Drum

Haul No.	Time hrs - mins
1	1 - 37
2	1 - 08
3	1 - 28
4	1 - 10
5	1 - 23
6	1 - 29
7	1 - 11
8	-

Average time 1 hr 21 min

Whipping Drum

Haul No.	Time hrs - mins
9	1 - 08
10	1 - 25
11	1 - 20
12	59
13	1 - 25
14	-
15	1 - 17
16	1 - 15
17	-
18	1 - 25
19	1 - 35
20	1 - 09
21	1 - 27

Average time 1 hr 19 min

Appendix III

Calculation of Power required to Drive Idler Drums in Twin Drum System

Calculation of Power required to Dive Idler Drums in Twin Drum System

Power requirement may be considered as the frictional resistance only since as the speed is constant there are no inertial forces and the low speed and drum profile eliminate windage.

Load on Bearings

Consider four complete turns of rope around the twin drum assembly. The load on the roller is the total of the loads in each rope strand.

For a rope drive on a pulley, the tension in the rope can be obtained as follows:

$$\frac{T1}{T2} = \log e^{ua}$$

where

$T1$ = tight side tension

$T2$ = slack side tension

u = coefficient of friction rope on steel 0.25

a = angle of wrap 180°

$$\frac{T1}{T2} = 2.7182 \left(.25 \times \frac{180}{360} \times 2 \text{ Pi rad}\right)$$

$$\frac{T1}{T2} = 2.7182 (0.25 \text{ Pi})$$

$$\frac{T1}{T2} = 2.193$$

Consider load in rope of 1 tonne

load in 1st loop $= \frac{1}{2.193} =$ .46 tonne

load in 2nd loop $= \frac{.46}{2.193} =$ .21 tonne

load in 3rd loop $= \frac{.21}{2.193} =$ .096 tonne

load in 4th loop $= \frac{.096}{2.193} =$ .044 tonne

Total Load on Drum

1st loop	=	1 + .46	=	1.46	tonne
2nd loop	=	.46 + .21	=	.67	tonne
3rd loop	=	.21 + .096	=	.306	tonne
4th loop	=	.096 + .044	=	.14	tonne
Total lead			=	2.576	tonne
Hence load on each drum			=	2.576	tonne

Bearing Friction

$$u = \frac{Mr}{p \times d/2}$$

Mr = friction torque
p = bearing load
d = bearing diameter

Bearing manufacturers data for deep groove ball bearings quote u as 0.0042

Bearing diameter is 76mm (3 in)

$$.0042 = \frac{Mr}{2.576 \times 1000 \times 10 \times .038}$$

$$Mr = .0042 \times 2.576 \times 380 \times 1.5$$

Mr = 4.11 Newton Metres

Power Requirement

Consider idler drum speed as 150 rev/min maximum

Power = torque x angular velocity

$$= \frac{4.11 \times 150 \times 2 \Pi}{60}$$

Power = 64 watts

Hence to drive the two idler drums at 150 rev/min requires 128 watts.

Expression of this Power in Terms of Hydraulic Pressure

Hydraulic motor is a Dowmax, having a displacement of 80 cubic inches per revolution – 1.31 litres per revolution.

Drive ratio: motor 22 teeth
drum 19 teeth

$$\text{Flow per drum rev} = \frac{1.31 \times 19}{22}$$

$$= 1.13 \text{ litre}$$

At 150 revs per min hydraulic flow is 1.13 x 150

$$= 169.5 \text{ litres/min}$$
$$= 1695 \text{ metres}^3\text{/min}$$
$$= .002825 \text{ metres}^3\text{/sec}$$

$$\text{power} = \text{pressure x flow}$$
$$128 = p \times .002825$$
$$\text{pressure} = 45309 \text{ Newtons/metre}^2$$
$$(6.5 \text{ lbf/in}^2)$$

Hence both the additional hydraulic pressure and associated power to rotate the extra drums under load on the twin drum system is minimal.

Figures

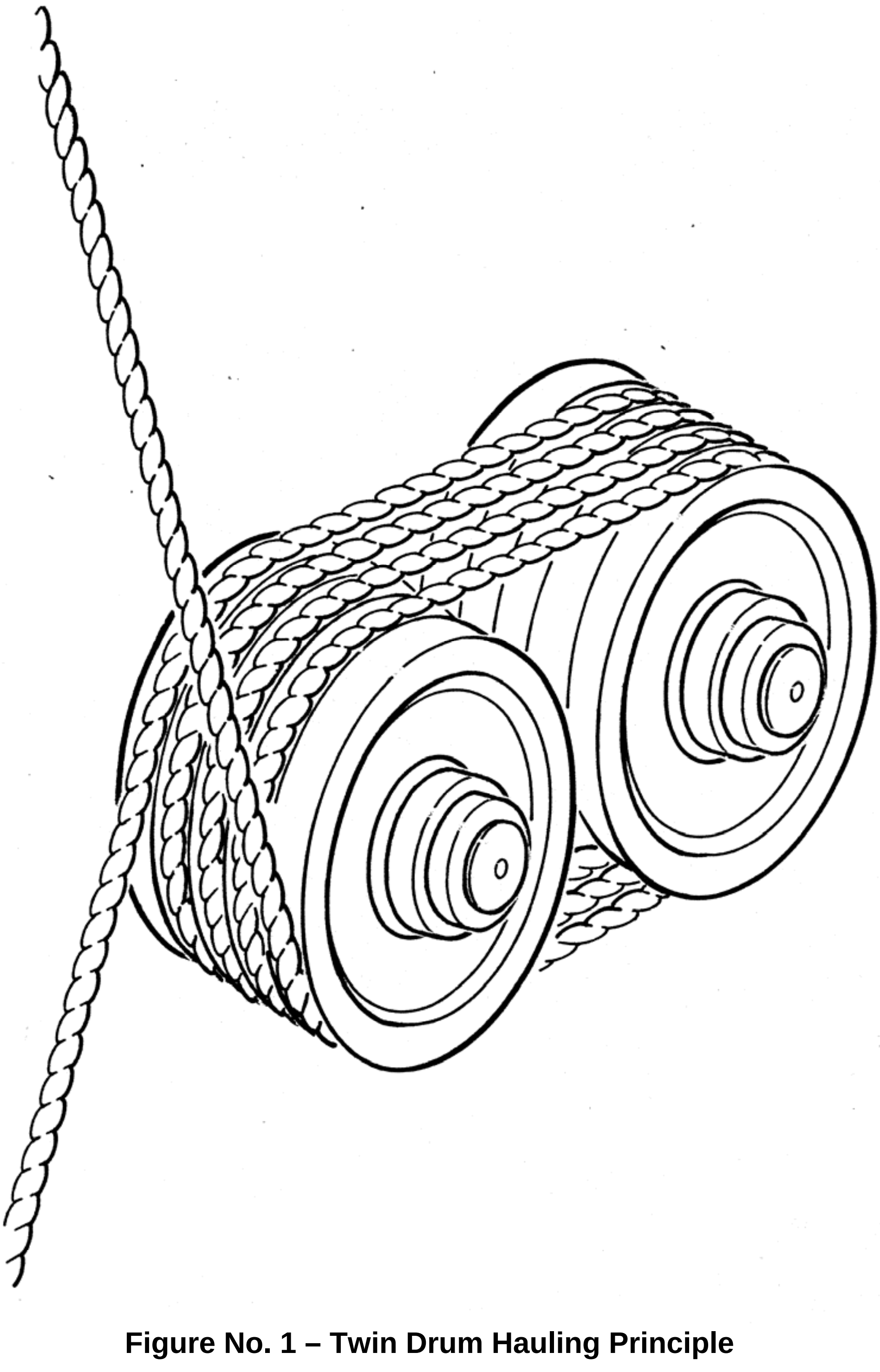


Figure No. 1 – Twin Drum Hauling Principle

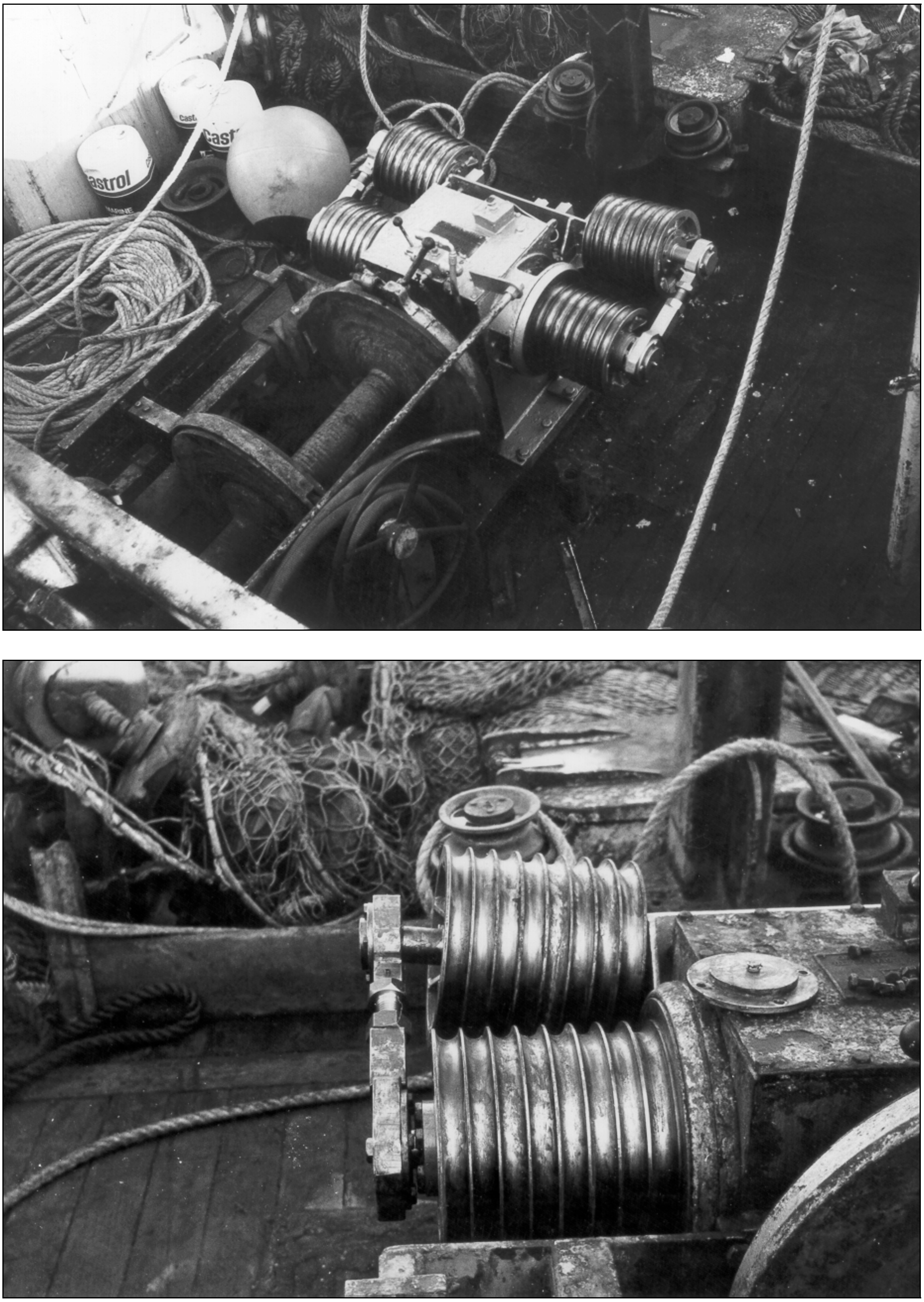
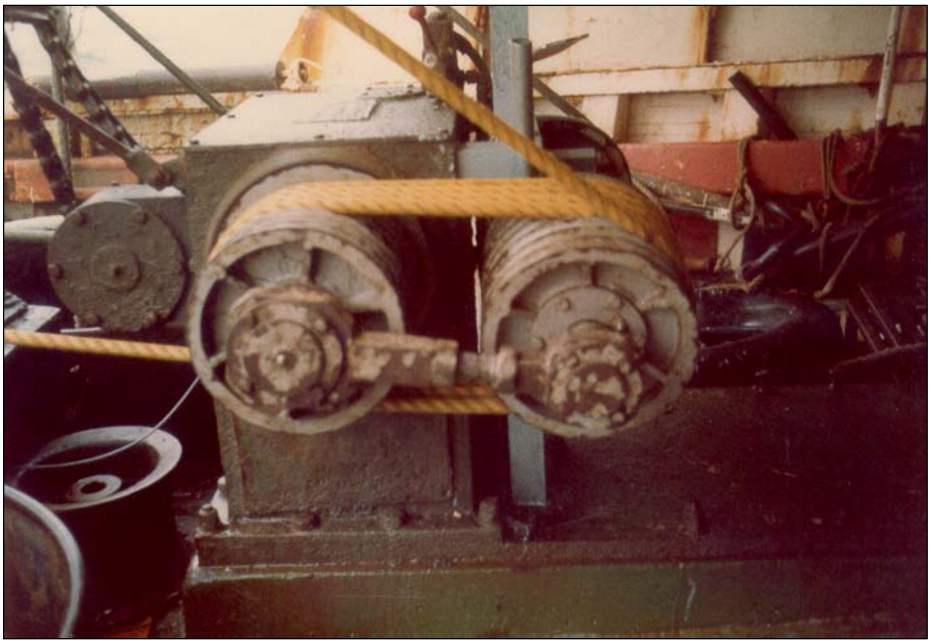


Figure 2 – Twin Drum Conversion Kit on MFV "CONGENER"



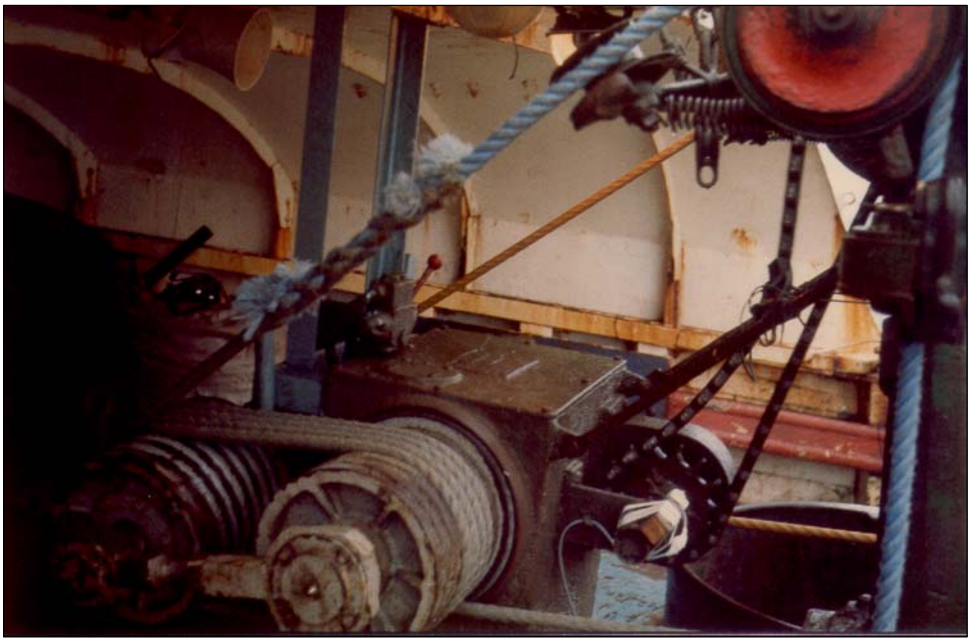


Figure 2a – Twin Drum Conversion Kit on MFV "STARELLA"

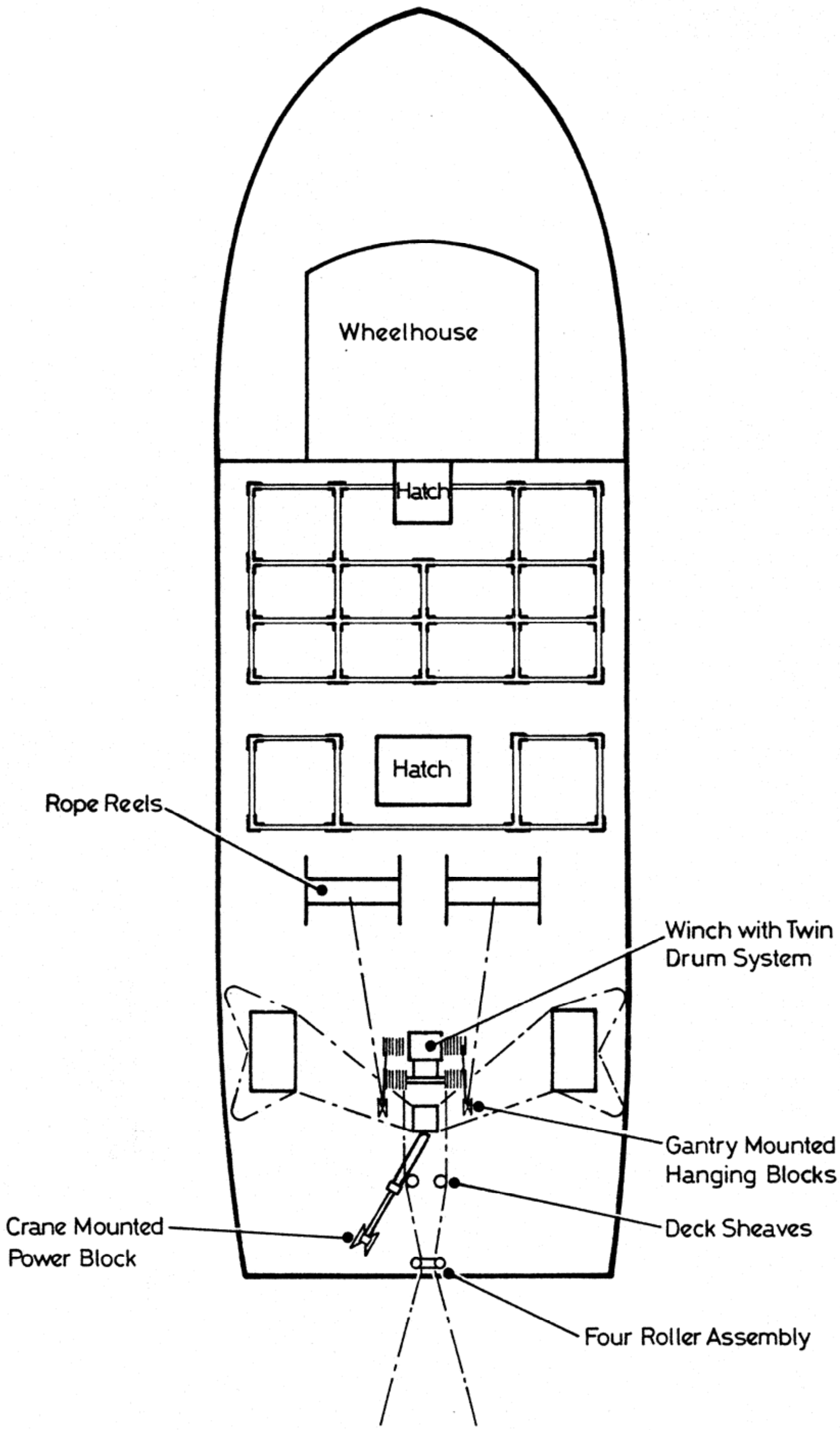


Figure No. 3 – Deck Plan – MFV "CONGENER"

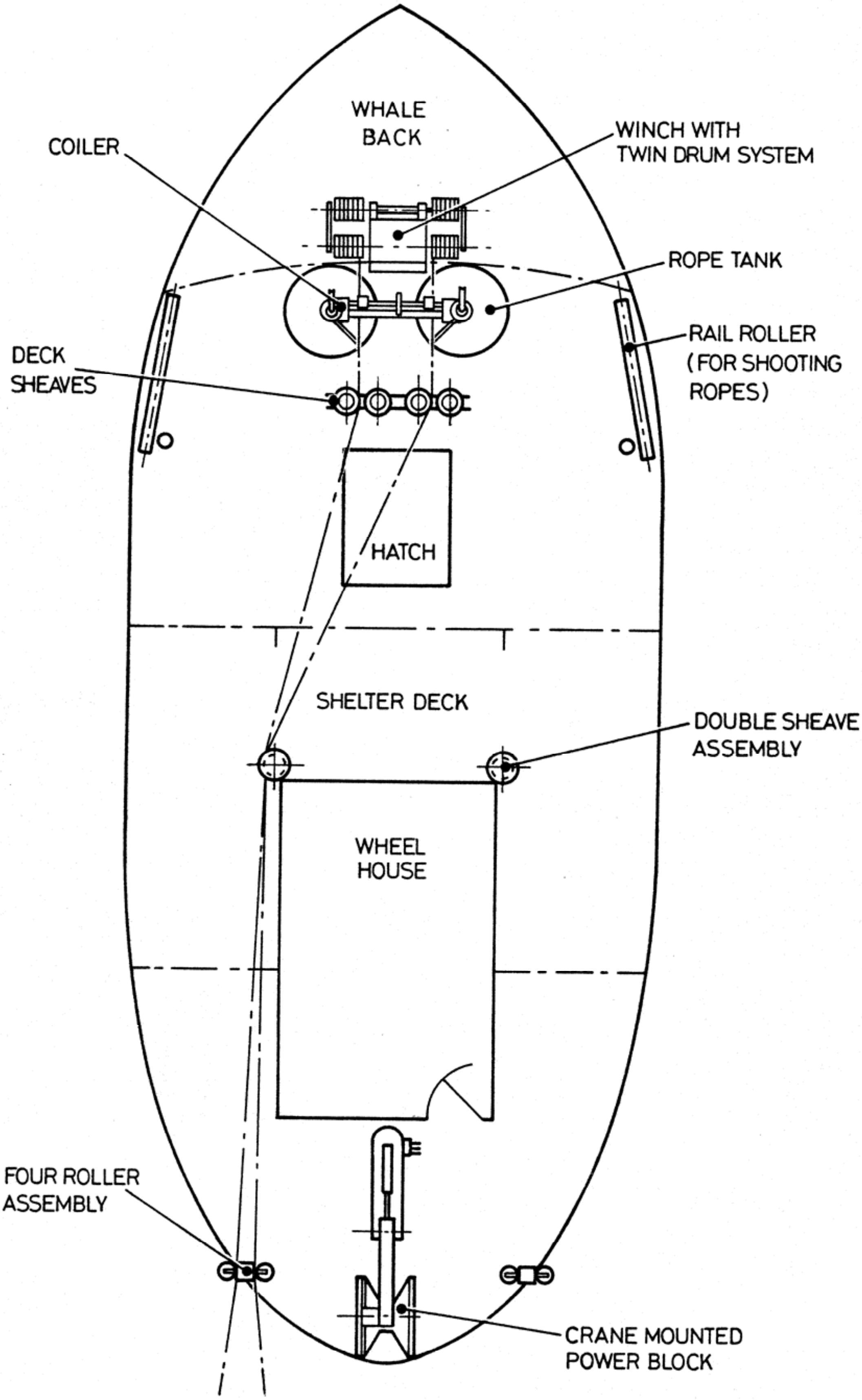


Figure No. 4 – Deck Plan – MFV "STARELLA"

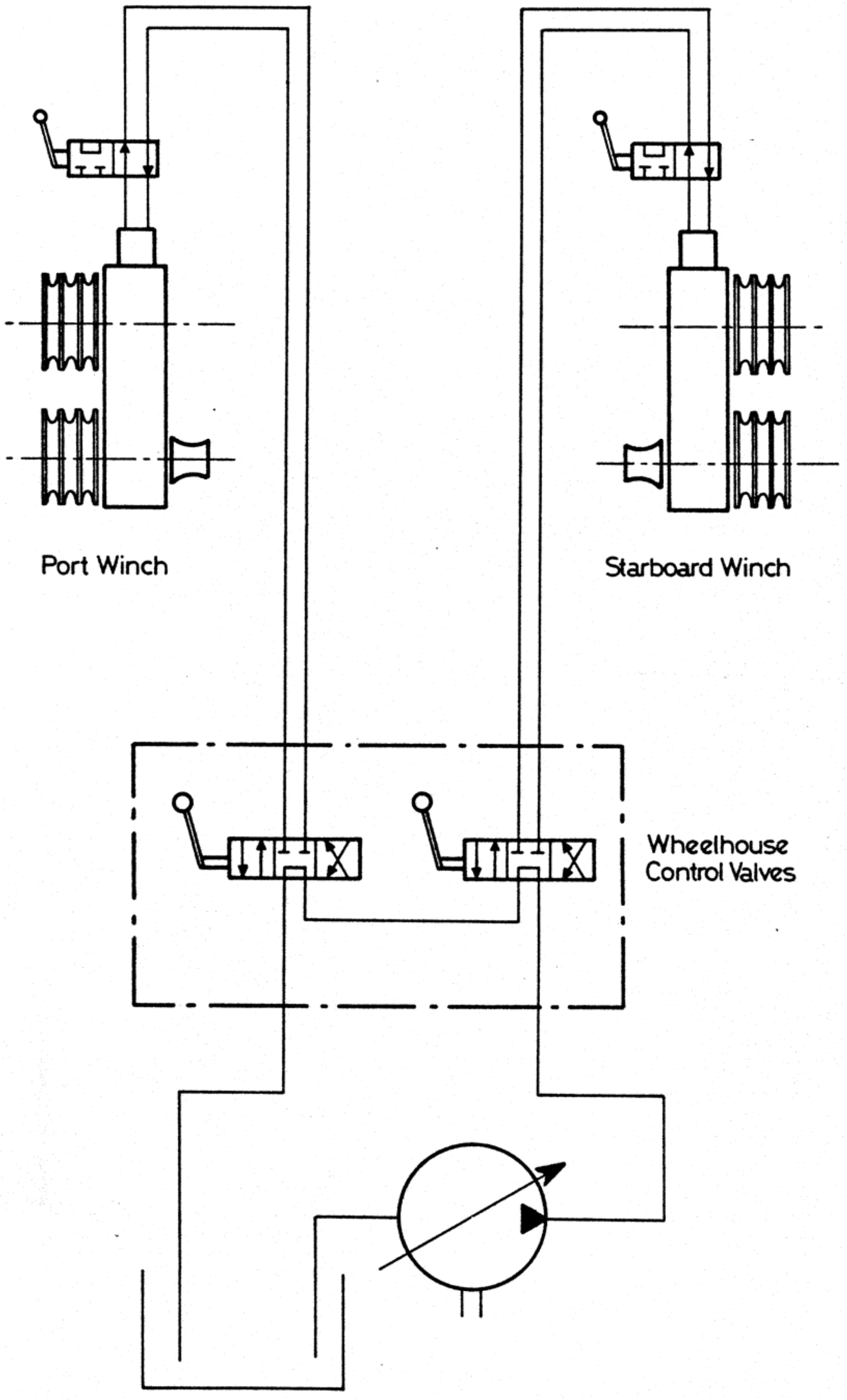


Figure No. 5 – Split Winch Circuit Layout

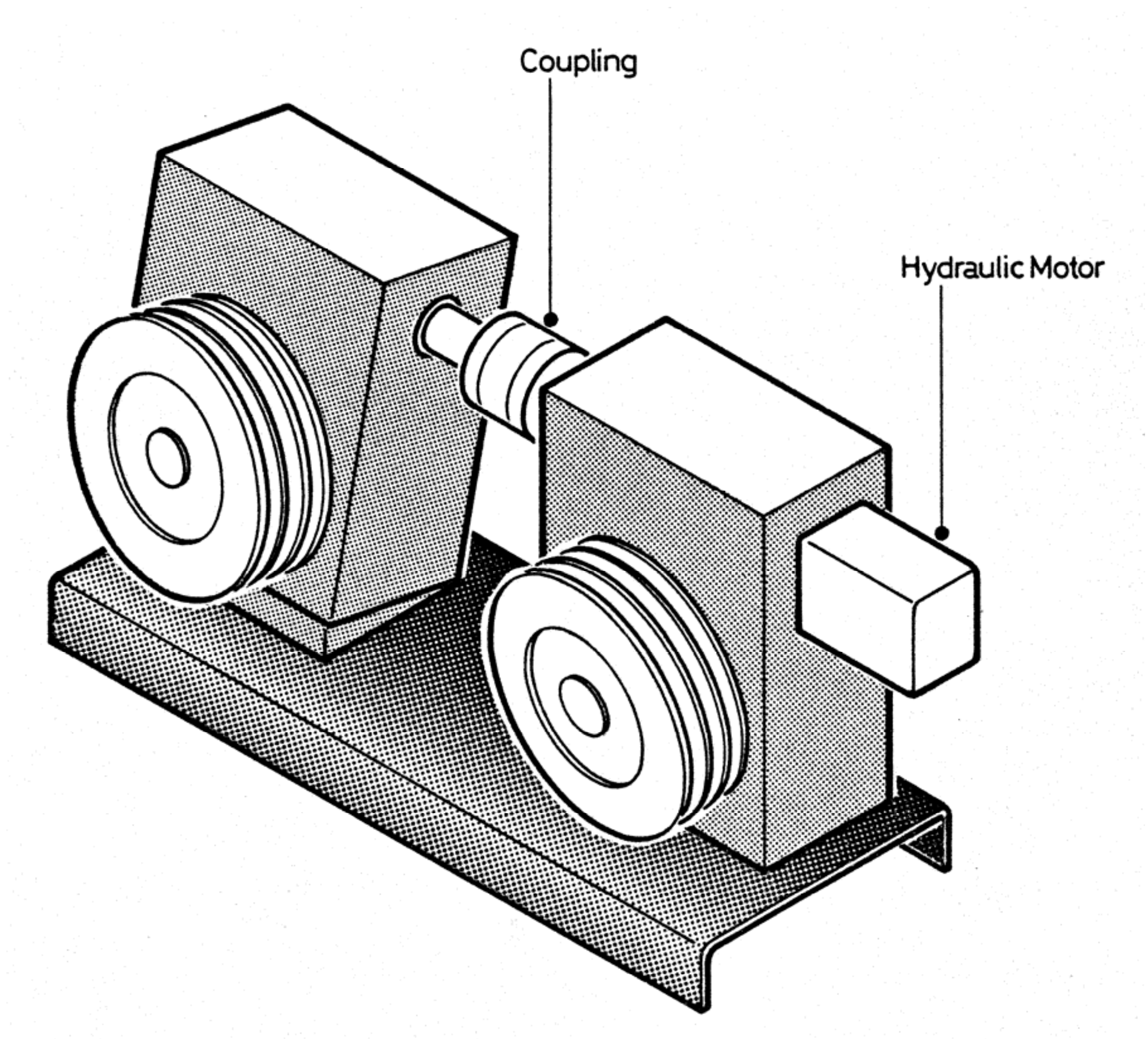


Figure No. 6 – Twin Drum Winch Utilising Worm Reduction Gearboxes