THE « SNELLIUS » DEEP-SEA ANCHORING EQUIPMENT

by

J. P. H. PERKS, Senior Officer.

(Extract from the Reports on the Snellius Expedition 1929-30, Vol. 1, chapter 1, Appendix N° 3 — E. J. BRILL, Leiden, 1937).

Prior to the Snellius-Expedition, deep-sea anchoring, the main object of which is the carrying out of current observations, had only been performed a few times by other ships. In 1878, an American schooner, the *Blake*, anchored in 4,000 metres of water, after having tested for two years an equipment which included an anchor-cable running via the bowsprit and mast to the after-deck.

The experience gained by these vessels, however, could not serve as preparation and guide for the use of the equipment which the progress of science had placed at our disposal.

In the years 1925-1927, a German Atlantic oceanographic expedition had been fitted out on board the *Meteor* with an anchoring equipment which proved to be very serviceable in practice. It was to be expected however, that the circumstances under which H.M.S. *Willebrord Snellius* would have to anchor in the eastern part of the Netherlands East Indian archipelago would differ in many respects from those of the *Meteor,* for the tropical waters, although generally speaking less affected by atmospheric disturbances would present swifter currents in the numerous straits and passages which form the connections between the enormous basins and troughs. Anchoring at greater depths, which would not simplify the manœuvre, also had to be reckoned with.

Only a very restricted space was available on board H. M. S. *Willebrord Snellius* for the accommodation of the anchoring equipment. Whereas on the *Meteor* the anchor cable drum was at a distance of about one-third of the ship's length, 25 metres, from the bow, here the whole equipment was installed at a distance of less than 12 metres from the stem on a small deck, which already held a large steam windlass engine, a skylight, four ventilation shafts, forecastle stoppers, hawse pipes and bollards. Consequently, rollers had to be affixed to lead the anchor cable to the various apparatuses, resulting in a considerable increase in weight.

EQUIPMENT

On the port side, just behind the top of the stem a frame had been placed in which three rollers were mounted ; two long cylindrical rollers stood vertically on either side of a third, lying horizontally behind them. The diameter of the last mentioned roller was smaller in the middle than at the sides. As the cable over the roller changed its direction at an angle of nearly 90° the dimensions had not been taken too small, to avoid too sharp a turn. From this point the cable ran along about 25 cms above the deck all the way ; its course inboard, shown in Fig. 7, 8 and 9, is explained in the following.

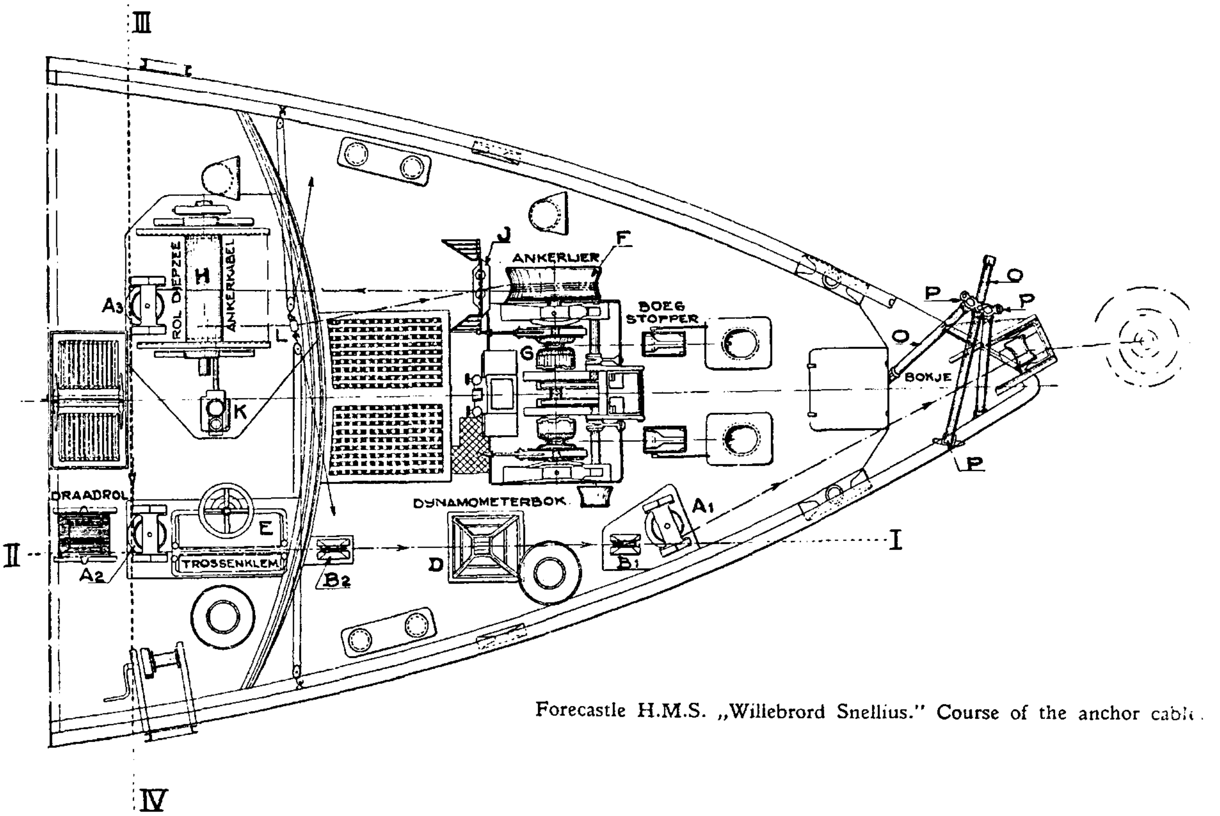
From the stem roller the cable ran along the starboard side through the first disc A1, under the first counting disc B1, over the disc C of the block of the dynamometer D and further under the second counting disc B2 to the clamp E, past the discs A2 and A3 and then under the cable roller to the large roller of the capstan F. After several windings round the large roller the cable, guided by a block L passed on to the top of the cable roller H. Next to this drum on the starboard side was a boat steam engine K, which had to hold off and roll up the wound in cable.

The anchor capstan was provided with a larger roller.

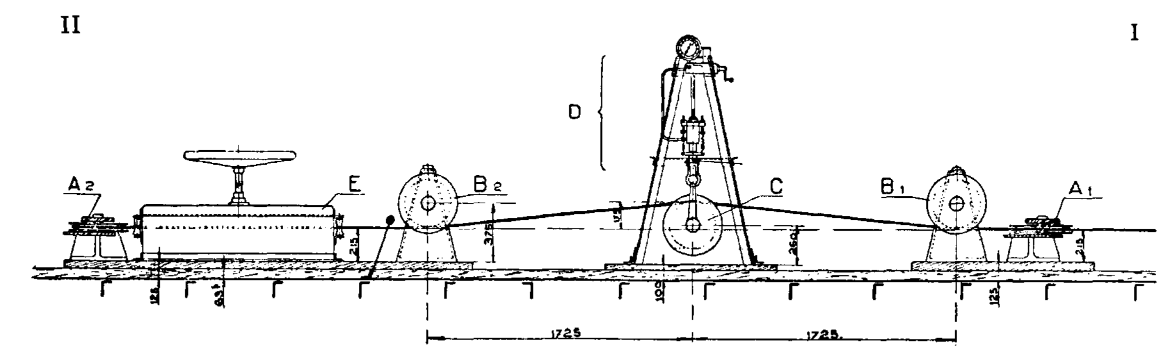
The frames of the vertical counting discs were both equipped for the placing of a revolution counter. One could be used to indicate metres of cable paid out, the other metres of cable hauled in. The circumference of the discs was exactly one metre.

The dynamometer, supplied by the firm of Amsler, Schaffhausen, was placed between the vertical discs.

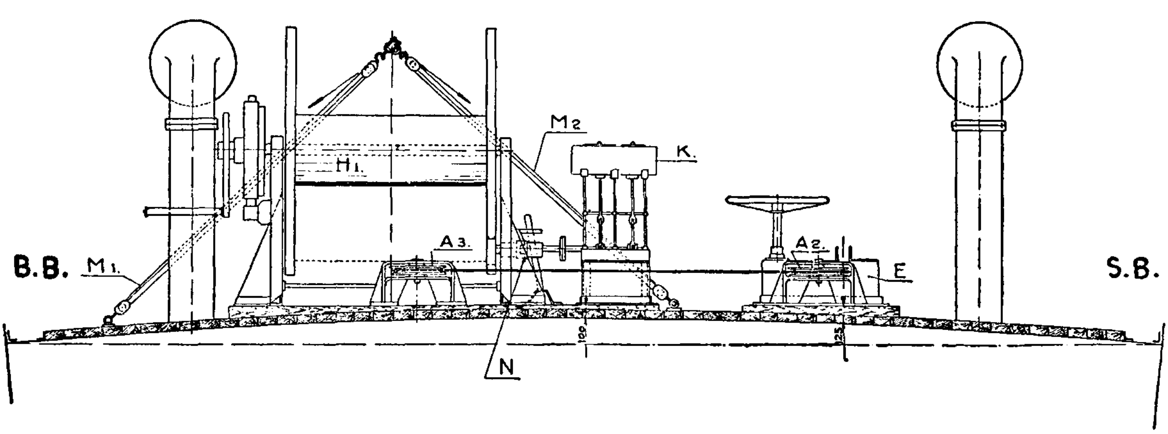
The hanging disc C, of this dynamometer lifted the cable up, as it were, 17.5 cm half-way between the counting discs. Briefly, the dynamometer was set up as follows : on a brace a cylinder was suspended, in which a piston with a rod running downwards could move, from which rod the disc hung.



Forecastle H.M.S. „Willebrord Snellius." Course of the anchor cable.



Section I—II of fig. 7.



Section III—IV of fig. 7.

The cylinder was filled with oil and connected by means of a tube with a screw pump to which a manometer was fitted, showing the pressure in the cylinder. The scale graduation showing hundreds of kilograms, ran up to 12 tons.

The pump could be kept filled from a reservoir through a ball valve, by means of which the piston could be pumped up so high that the cable was lifted up 17.5 cm each time.

To offset the weight of the disc itself, four spiral springs were fitted to the bottom of the cylinder. To minimise the effects of jolting on the manometer and to enable the readings to be taken more easily, a throttle valve had been fitted.

The cable clamp E, consisted of a box of particularly heavy construction. By means of a large handwheel, two sets of blocks could be put in motion in it, after transmission by means of shafts and worms, which in their turn worked two very long clamping shoes. These shoes were made of hard bronze and provided with an almost semi-cylindrical groove, through which the cable ran.

The cable could be laid in the open clamp from above.

The roller of the anchor capstan was about 50 cm wide, cylindrical in the middle, smooth, unlined not covered with wood, with a diameter of about 120 cms, but running out shell-shaped at the sides.

The number of turns taken round this roller varied with the depth, the amount of cable paid out, the smoothness of the cable etc. Before and behind this capstan roller, the cable passed a vertical frame with guide rollers, which rollers were affixed to it two by two on slides, which could be moved athwart ships, two above and two below.

The anchor cable was entirely wound on the cable drum, the inner end once pushed through an opening and there fastened and locked in a sort of heavy clamp on one of the side walls. The length was 7500 metres and made it possible to anchor to a maximum depth of about 6500 metres, this being the greatest depth that had been known up to the beginning of the expedition, from a sounding carried out by H. M. *Siboga* in the Moluccas. It was free of kinking as a result of the fact that the two windings of the strands of which the cable consisted were twisted in opposite directions ; moreover the cable was conical, i. e. the diameter of the inner end was greater than that of the outer end, which effect was produced by new strands being gradually added to the windings and the use of thicker strands. Its strength grew with the load to be expected ; the circumference increased from 3 cm to 5 cm.

The cable drum was constructed of several heavy parts ; the actual reel was connected by means of two cast-iron bosses to the side walls, which were also reinforced with ribs running diagonally. Through the reel ran a solid shaft, at the port end of which was a brake disc with a conical seat. Outside this, on the port frame, a larger ratchet disc was affixed with a seat on the inside and a toothed edge at the circumference. The disc could be held by means of a heavy pawl. When the ratchet disc was turned towards the conical seat of the drum shaft, and the pawl was turned " in ", the anchor cable was prevented from running out.

Across from the cable drum on the starboard side a boat steam engine was set up, the crank axle of which could be connected by means of a coupling to an extended axle with pinion, the teeth of which engaged in a gear wheel of the starboard reel wall.

The necessity of a steam engine for turning the drum had been discovered on board the *Meteor* during a trial trip, when it was not considered feasible to have the cable, which had been hauled in by means of the anchor capstan, wound up for hours at a stretch by the crew and especially to hold it taut with sufficient force clear of the capstan.

For anchoring, use was made of mushroom anchors, so called from their form, which ensured the gripping of the sea bottom in any position. The first equipment with this type, consisted of one anchor of 200 kilos and one of 100 kilos. Later on, after the 100 kilo anchor had been lost, only 200 kilo anchors could be used. This weight may appear small when it is considered that the displacement was nearly 1200 tons and such ships generally make use of 1000 kilo anchors — and in the case of surveying vessels even anchors of 1200 kilos — with heavy chains. Here, however, the great weight of the run-out cable and its resistance in the water played an important part. A length of 16 mm cable (15 fathoms = 27 metres) with swivel served as a fore-runner to the anchors.

To hold the end of the cable, after it had been fastened to anchor or chain, there were three stoppers. For the regular winding up of the cable on the drum, a guide block was set up, which could be drawn to and fro by means of two tackles. In view of the very short distance from the drum to the capstan roller the guiding of the cable appeared to be a difficult matter. It was found, however, that the friction on the capstan roller could be made sufficiently great so that from this roller to the end of the drum the cable did not need to be kept too taut.

The weights of the principal parts were :

Stem rollers	400	Various stoppers	80
Cable drum	1480	Anchor cable	5700
Guide discs	550	Cable clamp	1000
Capstan roller	1000	Gin of dynamometer	140
Frame with rollers	210	Dynamometer	20
Steam engine	360	Anchors	430
Wooden foundations	400	End chain	180

or a total of about 12 tons.

Fore on the port side, part of the rail was removable, so that a small derrick could be set up there. Three spars 2.5 metres long, and 1 decimetre in diameter had been set up, each provided with a broad 5 cm thick iron band at the ends. With the aid of some slings and D-shackles any desired construction could be effected. This arrangement instead of a fixed anchor davit gave great satisfaction. When turning in or out had to be stopped temporarily, for instance because the cable had to be attended to, use was made of so-called shears-stoppers, fig. 10 which were introduced generally, both for the dredging cable and for all sorts of sounding wires. For these latter, thinner lines of 0.8 and 0.9 mm they were even the only serviceable ones.

These shears-stoppers consisted of two steel blocks, hinged together. On the two free extremities two steel cables of even length had been affixed, each about 1 metre long, the ends of which were spliced to form one cable, which could then be fastened to a bollard. The sides of the blocks, which were turned towards one another, were provided with semi-circular grooves (which were sometimes again grooved themselves) in which the anchor cable or the sounding wire could be laid. The drawing shows that the stopper was automatically tightened according as the cable exercised greater power.

Statement of the Anchor tackle used

N°	Location of the station	N° station	Echo depth (metres)	Cable paid out (metres)	Anchors used
1.	Makassar Strait	39 a	2,250	3,000	100+200
2.	Sawoe Strait	135 a	1,150	1,850	
3.	Lifamatola Strait	253 a	1,800	2,500	
4.	Celebes Sea	308 a	4,850	6,500	
5.	Java Sea	312 a	± 40	—	ordinary
6.	Angelika	317 a	2,400	3,300	200
7.	Poeloe-Pisang (Obi)	354 a	1,350	1,950	200
8.	Banda Sea	364 a	4,450	5,600	200

Anchoring. As a result of the efforts to simplify the method of anchoring to be followed, a mode of operation was at length found, after anchoring at the above mentioned stations, which might be recommendable for future use. The anchor tackle consisted, in the order indicated, of (generally) a 100 kilo anchor, 30 metres of cable, a 200 kilo anchor, 15 fathoms of chain, some ballast and the anchor cable. The use of a swab under the first anchor was dispensed with ; the expectation that small fauna living on the sea bed would be entangled in the strands and brought to the surface was not fulfilled.

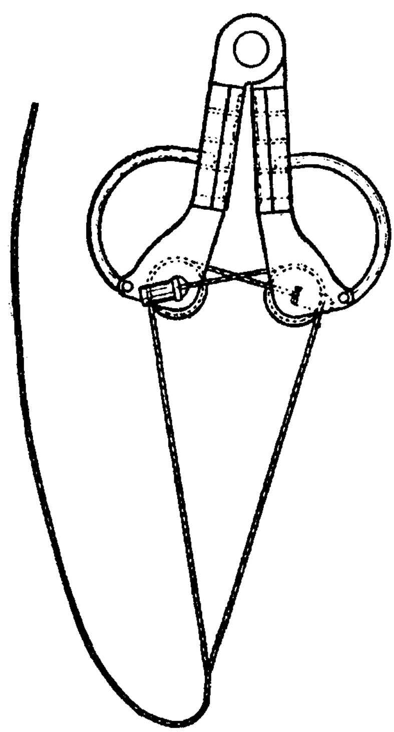
The end of the anchor cable was attached to the puddening of the small anchor by means of a fisherman's bend which, secured by three plain stoppers, was entirely prepared in advance and was now fastened to the small anchor with a heavy D-shackle. The small anchor was veered out on the anchor cable. Two heavy stoppers were placed on the anchor cable, one about 30 metres from the first anchor, which was fastened to the bowl of the second anchor and a second, which was fastened to the inner end of the end chain. That part of the cable which passed the second anchor was covered to prevent its being damaged. Thus the cable ran from the first anchor to the clamp on the bowl of the second anchor, then loosely along the 15 fathoms of end chain to the second clamp and then as anchor rope inboard. 100 to 50 kilos of ballast were attached to the last point where rope and clamp were made fast. Instead of the 100 kilo anchor, ballast could also be used, but this was not considered to be so good ; later on however, it was decided to use ballast, after the impression was obtained from the position of mud and damage in connection with echo depth that the ship was anchored in front of a sweep of the cable, 1 1/3 times the depth being let out even with fairly strong current and wind. Moreover, as already mentioned, a 100 kilo anchor was no longer available.

The second anchor, which had already been hung overboard on the derrick, was veered out with the end chain by means of a sloop winch on the after sloop deck, at the same time as the anchor cable was veered out by means of the anchor capstan ; of the latter some metres more than the length of the chain were veered out.

The only delay was in making fast the end of the chain of the second clamp ; this did not take long, as the shoulder block with which the chain had been veered out was thrown in not exactly at the end but a few metres from it, so that it could easily be worked with the end of the rope.

The paying out of the anchor cable could now be commenced. The anchor capstan gradually wound the cable off the roller. At the first stations a start was made with four turns round the capstan roller, this number being increased later, but the chance of kinking was so great, in view of the short distance from capstan roller to cable roller, that it was thought better to keep the number of turns constant ; this number was fixed at six. Up to 1500 metres the cable would not slip off the shell-shaped side so that a heavy fender had to be constructed and fastened to the base of the capstan and this compelled the cable to glide off towards the cylindrical part of the reel. Moreover, oil and grease were frequently applied at that point.

Later on, the paying out did not require much power and the braking arrangement of the cable roller even had to be used. Owing to the very slight eccentricity of this brake disc, the braking was effected with short jerks which became particularly powerful and dangerous at great depths.



Shears Stopper.

Continual attention had to be paid to the position of the coupling discs of the anchor capstan to prevent sticking. A watch was continually present at one of the two revolution counters to keep the chief officer posted about the length of cable paid out, so that he could decide as to the advisability of manœuvring. When much cable had been paid out, the steam supply to the capstan was cut off and the cable ran out of its own accord turning the capstan with it. If it had to be stopped for any reason, this was effected by tightening up the brake of the cable roller and immediately afterwards closing the cable clamp as well.

The original construction of this clamp was not sufficiently strong ; teeth of crown wheels broke and the cable — which was itself very smooth — slipped through it. Shearstoppers had to be resorted to, two heavy ones behind each other ; lengths of thin mooring chain also had to be used, but to make this hold, the cable had to be wrapped in jute.

It was found that although the horizontal stem roller revolved satisfactorily, it showed grooves 2 to 3 mm deep, probably caused by the twisting of the cable. A loud report was heard when the cable fell back into such a groove after having run out when the ship sheered. These jerks on the cable, as well as those when the cable was eased along the capstan roller, were not absorbed by an accumulator.

At first the ship was slowly manœuvred by means of the engines before the anchors touched bottom ; when, however, it was found at one of the stations that the anchors had fallen practically on top of one another and the cable showed kinks, notwithstanding that the vessel had drifted very much during the anchoring, it was concluded that, owing to the great resistance of the cable in the water, this cable was not dragged along the bottom but more drawn up, this effect being more noticeable according as the depth increased. When the ship was steady, the grounding of the anchors could be observed on the manometer ; when she was pitching, the indicator was continually in motion and the moment could not be determined.

When finally the necessary length of cable had been paid out, steam was once more applied to the capstan and the shears hauled over ; brake and clamp were then also applied at once and if necessary stoppers added. When anchoring in shallower water it was sufficient to cause the cable to run out more slowly by applying the brake and to stop, after which the clamp could be closed.

Lying at anchor. When the ship was lying at anchor a few more metres of cable were veered out from time to time to prevent its weakening at the comparatively sharp turn over the horizontal stem roller. When anchoring in comparatively shallow water there is more chance of the cable becoming taut, as a result of its lighter weight. If a high swell occurs it may become more necessary than at great depths to decide to veer out more cable.

When the ship is steady but a swift current is running very jerky readings of the manometer may indicate dragging anchors or the stretching of coils in the anchor cable lying on the bottom.

Raising the anchor. When winding in it was found that the boat steam engine could not revolve quickly enough to allow the cable coming from the anchor capstan which was working at full pressure to be wound tightly. This was the principal factor in determining the speed at which the anchor could be raised. Whereas 2000 metres could be veered out per hour when anchoring, the length of cable wound in did not exceed 1600 metres at the commencement and 1800 metres at the end of the manœuvre.

An adjustable transmission would have been very useful.

When the friction between anchor cable and capstan roller was not sufficiently great, this roller slipped under the cable from time to time, upon which the boat steam engine and the cable roller stopped. The friction was then increased by sprinkling chalk on the roller ; when the cable again began to grip the roller great care had to be taken that the cable roller was also revolved at once. Twelve men were then required to set this roller in motion again.

The lubrication of the anchor capstan required a great deal of attention ; sometimes, when very much cable was out it was found that running hot could not be prevented by the use of oil and grease, in which case ample quantities of soapy water were applied. On one occasion, when as a result of special circumstances the operation had to be carried out at great speed and the lubricants caught fire, the fire extinguishing line was run over the capstan.

Later on at all the stations work was stopped for five minutes after every hour's winding in.

A watch was now also placed at the revolution counter to give warning of the moment when the anchors were raised ; when the ship was not pitching this moment could be observed on the manometer.

During the winding in of the cable at the last station at great depth it was found that many strands of a splice had got loose ; they were cut off.

The revolution counter was read when the first mud was noticed on the cable. Sometimes the sand had affected the cable very much ; at the third station it appeared as if the ship had lain at anchor in front of a sweep at about 100 metres more than the echo depth.

Great care had to be exercised when the clamp on the cable came up to the stem roller. When this first clamp had been removed the cable and chain (with shoulder block) were wound at the same time by means of the capstan and boat winch. The 200 kilo anchor was transferred to the derrick with the aid of a Weston tackle and remained hanging there till the end of the weighing manœuvre. By means of the capstan the light anchor was then brought to the stem roller.

This moment was of interest to the geologist because a denizen of the sea bottom was sometimes found in the hollow of the small anchor, whereas a bottom sampler had not been able to secure anything at the same place on account of the bottom having been worn smooth by the current.

Final remarks. The upkeep of the equipment did not call for a great deal of attention. The cable, which when received and when being wound on to the roller was practically soaked in linseed oil, hardly rusted at all. When being wound in, the cable was dried by two men and before being wound on the roller it was smeared with a mixture of linseed oil and rosin.

Not only was the roller of the anchor capstan chalked to increase the friction but chalk was also rubbed into the vertical counting discs.

The cable had continually to be kept free of the stem ; when lying at anchor, it necessary by giving some turns to the rudder or by slowly manœuvring with the engines.

At none of the anchoring stations did the anchors drag, so that the behaviour of the ship under such circumstances is not known. The ship will probably swing round side-on to the wind only when a strong wind is blowing and not much cable is "out". The cable itself acts as a heavy drift-anchor ; when the wind was blowing 6 to 7 metres per second the ship only veered round when no more than 500 metres were out.