DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

APPARATERNE OG DERES BRUG

AF

C. WILLE,

KAPTEJN I MARINEN.

MED ET TITELBILLEDE OG 21 TRÆSNIT.

CHRISTIANIA.

GRØNDAHL & SØNS BOGTRYKKERI.

1882.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

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THE APPARATUS, AND HOW USED.

BY

C. WILLE,
CAPTAIN OF THE ROYAL NAVY.

WITH A FRONTISPIECE AND 21 ILLUSTRATIONS.

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Apparaterne og deres Brug.

Indhold.

Som nævnt i min Afhandling om Nordhavs-Expeditionens Oprindelse og Rejser blev det, da Expeditionens Iværksættelse var besluttet, overdraget mig at anskaffe de til Udførelse af de forskjellige Slags Iagttagelser og andre Arbejder nødvendige Apparater. Under min Rejse til England i 1875 anskaffedes saaledes flere Apparater og Instrumenter efter de fra tidligere Expeditioner anerkjendte Modeller. I Løbet af Vinteren 1875—76 udførtes de øvrige Apparater og andre Sager ved norske Verksteder efter de af mig opgivne Tegninger og Betingelser, ligesom jeg organiserede og jevnlig udførte Apparaternes Anvendelse ombord.

Til Grund for den følgende Afhandling, hvis Indhold er angivet ovenfor, er lagt de udførlige Rapporter om Ap-

The Apparatus, and How Used.

Contents.

The Government having resolved to despatch a Scientific Expedition to the Northern Seas, I undertook, as already stated in my account of the origin and cruises of the Norwegian North-Atlantic Expedition, at the instance of the Directors of the Geographical Survey, to procure the various instruments and appliances wherewith it would have to be furnished. Several of these, tested and approved by the experience of former Expeditions, I had constructed in England, from models, when visiting that country in 1875. The remaining apparatus, together with all minor implements requisite for the equipment of the vessel, were made at Norwegian workshops, in the winter of 1875, myself furnishing the designs, and stipulating the conditions on which the work was supplied. Moreover, on the captain devolved the duty of placing and arranging the apparatus, and, as a general rule, of superintending their use on board.

This descriptive exposition, the contents of which have been given above, is in the main an abstract of the special paraterne og deres Brug, som jeg navnlig i 1876 men ogsaa de følgende Aar indsendte til Direktionen for den geografiske Opmaaling. Fremstillingen er imidlertid bleven for en Del omarbejdet og udvidet, hvad der navnlig gjælder Kapitlet om Navigationen. Efter Professor Mohns Ønske er ogsaa medtaget de af ham, tildels til andre Øjemed, gjorte Studier over Loddernes Udløbshastigheder, over Varigheden af Lodninger og Skrabninger, over Vandloggens Theori og over Kronometrenes Gang, hvis Resultater finde sin naturlige Plads i denne Afhandling. Professor Mohn har ligeledes ydet værdifulde Bidrag til Udarbejdelsen af de denne Afhandling ledsagende Tegninger.

Skibet.

Det til Expeditionen lejede Dampskib, "Vøringen,"[1] var bygget af Træ, og var 35^m (140 n. F.) mellem Perpendiculærerne, 7^m (22$^1/_2$ n. F.) bredt, stak 4^m (13 n. F.) agter og maalte Brutto 344 Tons. Maskinen var paa 55 nominelle Hestekræfter og gav, med et Kulforbrug af 2 Tønder i Timen, Skibet en Fart af 7$^1/_2$ til 8 Knob i roligt Vejr. Besætningen bestod af Chef, 2 Officierer, 2 à 3 Styrmænd, 1 Baadsmand, 1 Tømmermand, 8 helbefarne og 8 halvbefarne Matroser, 2 Maskinister, 6 Fyrbødere, 1 Messekok, 1 Skibskok og 1 Tjener.

"Vøringen" viste sig at være et usædvanlig godt Søskib, og afgav i alle Dele tilstrækkelig Plads, uden at der dog kunde siges at være Rum tilovers. Under Expeditionerne var det, som Fig. 1 viser, foruden med de almindelige Stag- og Gaffelsejl, tillige rigget med Topsejl paa begge Master. Stængerne, der det første Aar (1876) vare ganske korte, forlængedes, saavelsom Topsejlene, 0.^{m}5 (1$^1/_2$ Fod) i 1877 for at skaffe større Sejlareal, men dette var alligevel for lidet til under almindelige Omstændigheder at bruges alene. Heldigvis indtraf der intet saadant Uheld ved Maskinen, at Expeditionen var henvist udelukkende til Sejlenes Brug. De gjorde imidlertid ofte god Nytte saavel ved Manøvrer som til at hjelpe paa Farten. Ved Skibets Udrustning var forøvrigt ikke gjort Regning paa dets Egenskaber under Sejl. Kulboxerne (Fig. 4 *k*) vare udvidede med en Del af Lasterummet under Mellemdækket, saa at de rummede indtil 1400 Tønder, en Forsyning, der var fuldt tilstrækkelig for den længste Tid, som Expeditionen holdt Søen.

Fig. 2 i Forbindelse med Fig. 1 viser de forskjellige Apparaters Plads paa det øverste Dæk. Midten af dette indtages af en Overbygning eller Hytte, hvis Dæk er frem-

[1] Opkaldt efter Vøringfossen i Hardanger.

Reports on the Apparatus and how to work them, drawn up by the author for the Directors of the Geographical Survey, chiefly in 1876, but also in the two following years. Meanwhile, the subject-matter has been carefully revised, and in part expanded, more particularly as regards the section that treats of navigating the ship. At the suggestion of Professor Mohn, Director of the Meteorological Institute, I have incorporated divers investigations, instituted by him partly for other purposes, on the velocity of the sounding-lead, the duration of soundings and dredgings, the theory of the water-log, and the rates of the chronometers, the results of which may be given an appropriate place in this division of the General Report. Furthermore, for not a few of the illustrations I am wholly, or in part, indebted to the pencil of Professor Mohn.

The Ship.

The S. S. "Vøringen,"[1] the vessel selected for the Expedition, was built of wood, had a length of 144 feet between the perpendiculars, 23$^1/_2$ feet beam, and measured 344 tons gross weight. Her engines were of 55 horse power, nominal, and propelled her in calm weather at the rate of from 7$^1/_2$ to 8 knots an hour, with a consumption of 430 pounds of coal. The ship's complement consisted of the captain, 2 chief officers, 2 mates (on the last cruise there was a third mate), the boatswain, the carpenter, 8 able and 8 ordinary seamen, 2 engineers, 6 firemen, a steward, the ship's cook, and one servant.

The "Vøringen" proved an excellent sea-boat, and afforded sufficient accomodation, though it cannot be said there was room to spare. She carried on the three cruises of the Expedition (see Frontispiece), exclusive of the usual fore-and-aft sails, a top-sail on either mast. The topmasts, which were rather short, I had lengthened a foot and a half for the second cruise, in 1877, as also the top-sails, to give greater spread of canvas; but this was still insufficient for working the ship under all plain sail. Fortunately, no such accident occurred to the engine or the screw as would have left the sails our only resource. Yet they often stood us in good stead, no less in handling the ship than to increase her speed. For the rest, the qualities of the "Vøringen" as a sailing-vessel had not been taken into account when equipping her for the Expedition. The dimensions of the coal-bunkers (Fig. 4 *k*) were increased, by encroaching on the hold below the orlop-deck, to admit, if necessary, of stowing about 150 tons, a supply amply sufficient for the longest cruise the Expedition would undertake.

Figs. 1 and 2 show together the general arrangement of the apparatus on the upper deck. The middle portion of the latter was occupied by a roundhouse, of which

[1] Named after the "Vøringfos," a celebrated waterfall in Hardanger.

Fig. 1.

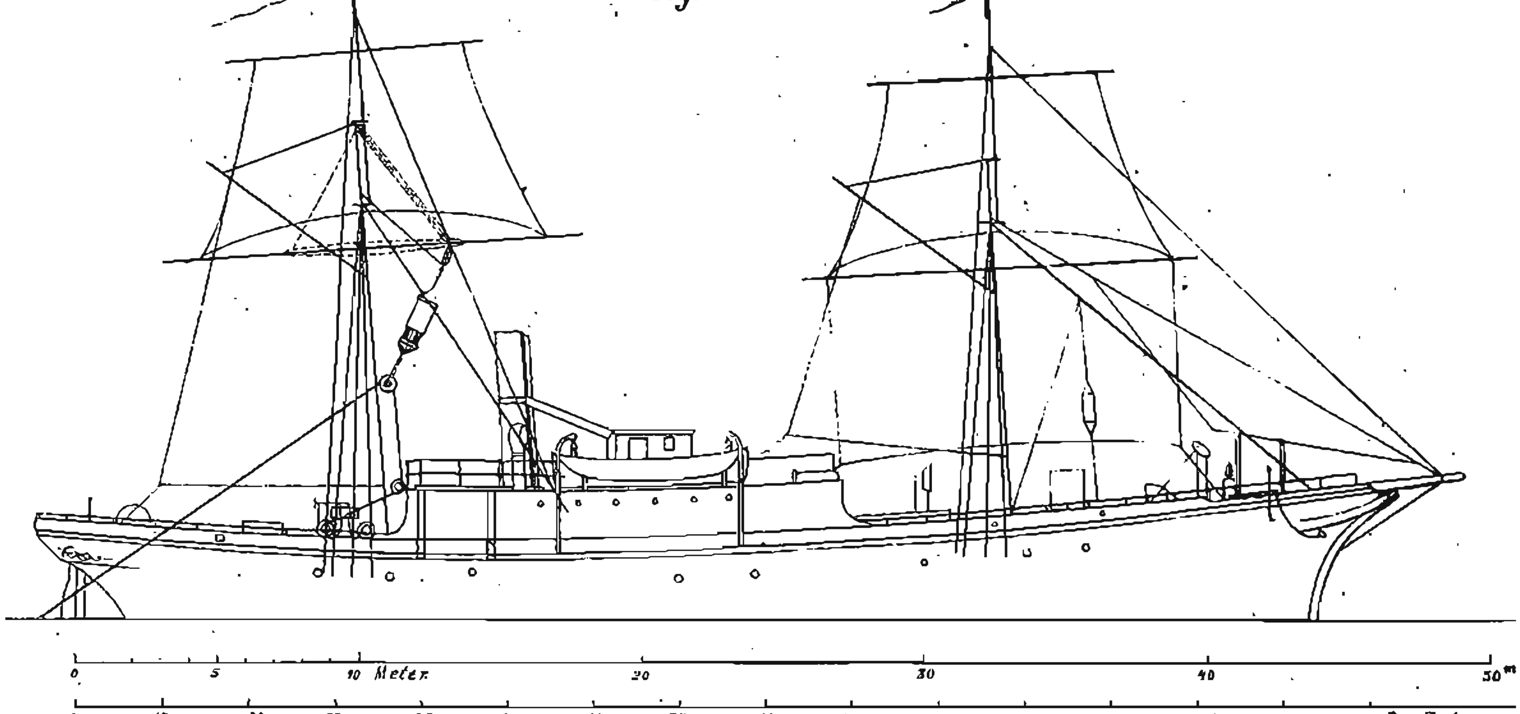


Fig. 2.

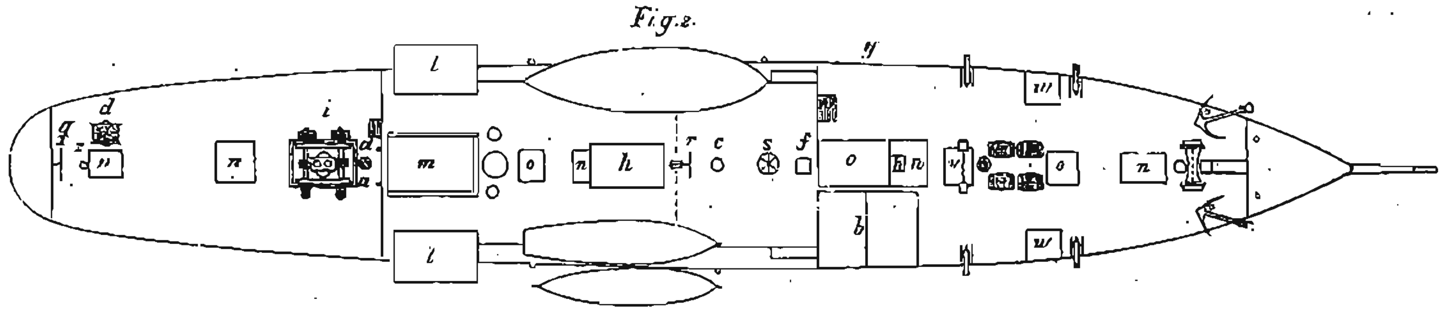


Fig. 3.

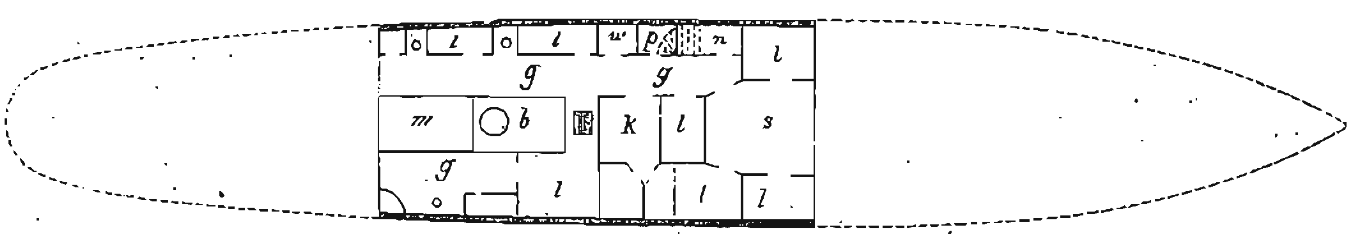
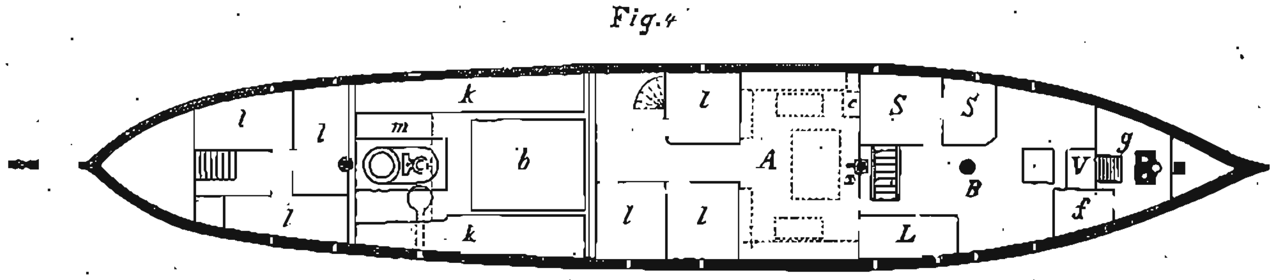


Fig. 4.



stillet i Fig. 2 og Indredning under Læ i Fig. 3. Agtenfor Fokkemasten stod en almindelig *Dampwinch* (Fig. 2 *v*), der ved Hjælp af en Kjettingkabellaring kunde benyttes til Ankerhivning. Forrenfor Hytten om Styrbord var opslaaet af Planker en *Binge* (*b*) med 2 Afdelinger, der tilsammen rummede indtil 6000 Favne *Skrabetoug*, og i denne laa Touget klart og luftigt. Paa Fordækket var ligeledes i 1877 og 1878 anbragt 4 *Falconetter*, der med Rapperter og andet Tilbehør velvillig blev udlaant til Expeditionen fra Bergens Værft.

Paa *Hytten* var anbragt en af Skibets *Baade* om Styrbord og udenfor denne hang i Daviderne en Skjækte. Om Bagbord stod Expeditionens store Livbaad, 8.m5 (27 Fod) lang, 2.m3 (7 Fod) bred og 1.m3 (4 Fod) høj i Stevnene. Midskibs i Forkant stod Stativet med Balancebordet til *Fox-Cirkelen* (*f*) og agtenfor Skylightet til Spisesalonen (*s*) stod *Standardkompasset* (*c*) og *Styreapparatet* (*r*). Rathjulet bevægede med Drev den lavere liggende Ratstamme, og i Tandkronen om denne laa Bugten af Kjettingen, der gik gjennem almindelige Skildpadder først ud i Borde, derefter langs Hyttetaget, saa ned paa Agterdækket og agterover langs dette, og endelig gjennem Skildpadder i Borde agterud og paa Rorpinden, der viste agterover. Paa Grund af denne lange Ledning virkede Apparatet langsomt. I 1876 var Kjettingen smekrere og virkede agterud med dobbelt Part paa Rorpinden, i hvis Ende der var tilsvarende Blokke. Den blev let slak og var tilbøjelig til at komme i Uorden. I 1877 anbragtes en sværere Kjetting, der virkede direkte paa Rorpinden, hvorved de nævnte Ulemper hævedes. Det blev aldrig nødvendigt at ty til Vererattet agter (*q*). Lige agtenfor Styreapparatet blev i 1877 opsat et *Bestikhus* (*h*). Paa begge Sider af Hyttedækket og i Agterkant af samme var udbygget *Loddelroer* 3.m1 (10 Fod) lange og 1.m9 (6 Fod) brede (Fig. 2, *l*, Fig. 14 og 21), forsynede med Jernrækverk og støttede med Stræbere mod Skibssiden. I Agterkant af Hytten og paa begge Sider af midtskibs var anbragt "antifriction" *Fodblokke* (Fig. 2 *a*, Fig. 14 og 21), der vare hukede i lange Øjebolte, som løb ned langs Agterkanten af Hytten og gjennem Dæksbjelken.

Paa *Agterdækket* strax agtenfor Stormasten stod *Indhivningsmaskinen* (Fig. 2 *i* og Fig. 5). Den var leveret fra Nylands mekaniske Verksted i Christiania. Den dobbelte vertikalt staaende Højtryksmaskine paa 8 Hestes Kraft drev rundt en under samme langskibs liggende Axel, der forrenfor og agtenfor Krumtapperne var forsynet med to Skruer uden Ende. Disse greb i Tandhjul (Diameter 0.m47 = 1 Fod 6 Tom), der havde svære horizontalt og tverskibs liggende Axler, 2.m37 (7 Fod 6½ Tom.) lange, og paa Nokkerne af disse udenfor Lagerne i Ramverket var Tapperne indsmøgede og fæstede med Kiler. Tapperne om Styrbord, der brugtes til Indhivningen af Skrabetouget,

Fig. 2 represents the roof and Fig. 3 the interior fittings. Abaft the foremast was a *Steam-winch* (Fig. 2 *v*), which, when connected with a chain-messenger, would serve for heaving the anchor. In front of the roundhouse, on the starboard side, had been fitted up a spacious and well-ventilated *Locker* (*b*), with two compartments, affording room for stowing away 6000 fathoms of *Dredge-rope*, ready for immediate use. On the forecastle had been mounted, for the cruises in 1877 and 1878, 4 howitzers, kindly lent to the Expedition, along with the carriages &c., from the Royal Dockyard at Bergen.

The roof of the roundhouse, on the starboard side, supported one of the ship's *Boats*, alongside of which, suspended on davits, hung a small skiff. On the port side was placed the lifeboat of the Expedition, 28 feet long, 7 feet beam, and 4 feet deep in the stems. In the forepart, amidships, stood the foot of the balance-board for the Fox-circle (*f*), and abaft the mess-room skylight (*s*) were the *Standard-compass* (*c*) and the *Steering-apparatus* (*r*). By means of cogwheels, the motion of the steering wheel was transmitted to the barrel: and round the latter, over a toothed wheel, lay the bight of the chain, which, on being rove through cheek-blocks in the ship's side, was carried along the roof of the roundhouse down along the after-deck, and then, through cheek-blocks in the ship's side, right aft on to the tiller. With so long a lead, the working of the apparatus proved somewhat slow. On the first cruise, in 1876, the chain had been of smaller size, and rove double on the tiller, through corresponding blocks at the end; hence it easily got slack, and was apt to kink. In 1877, therefore, we substituted a stouter chain, which led singly to the tiller, and were thus able to remedy the defect. On no occasion had we, however, been compelled to have recourse to the spare wheel aft (*q*). Immediately abaft the steering-apparatus, was a small deck-house (*h*), put up in 1877, containing the log-slate, charts, &c. From both sides of the roof of the roundhouse, and from its after extremity, projected *Sounding-bridges*, 10 feet long by 6 feet wide (Fig. 2 *l* and Figs. 14, 21), with an iron railing, and supported by stays against the ship's side. At the after end, and on both sides, of the roundhouse, there were antifriction *Blocks* (Fig. 2 *a*, and Figs. 14 and 21), hooked to long eye-bolts extending down along the after-bulkhead of the roundhouse and thence through the nearest deck-beam.

On the *After-deck*, immediately abaft the mainmast, was placed the the *Donkey-engine* for hoisting the dredging and sounding gear (Figs. 2 *i* and 5), made at the Nyland Works, Christiania. This double-cylinder, high-pressure, vertical engine, of eight horse-power nominal, imparted a rotary motion to a shaft extending fore and aft beneath it, and provided with a pair of endless screws, one before and one behind the cranks. These screws bit into cog-wheels (diameter 1 foot 6½ inches), fixed on stout horizontal shafts, 7 feet 9½ inches long, lying athwartships; and to the ends of these shafts, which projected beyond the bearings on the frame, were fixed the drums, firmly secured var $0.^{m}41$ (1 Fod 4 Tom.) lange og $0.^{m}42$ (1 Fod 4 Tom.) i Diameter. Tapperne om Bagbord, der brugtes til Indhivning af Lodlinen, vare $0.^{m}41$ lange og $0.^{m}73$ (2 Fod 4 Tom.) i Diameter. Alle 4 Tapper havde 5 Furer eller Rifler. Afstanden mellem forreste og agterste Tappecentrer var $1.^{m}14$ (3 Fod 7.6 Tom.). Tapperne blev saaledes drevne samtidig rundt med lige Hastighed og samme Vej. Maskinen viste sig særdeles hensigtsmæssig, idet den arbejdede sikkert og kraftigt, kunde baade hale og fire, uden at man behøvede at skifte Linen paa Tapperne, og man undgik

by keys. The drums on the starboard side, for hauling in the dredge-rope, had a length of 1 foot $4^1/_4$ inches, and were 1 foot $4^1/_2$ inches in diameter; those on the port side, for bringing in the sounding-line, had a length of 1 foot $4^1/_4$ inches, with a diameter of 2 feet $4^7/_8$ inches. The 4 drums had each of them 5 flutes, or grooves. Between the foremost and hindmost pair of drums, measured from centre to centre, the distance was 3 feet $9^5/_{16}$ inches. Hence it is obvious, that the drums would revolve simultaneously, with equal velocity and in the same direction. The donkey-

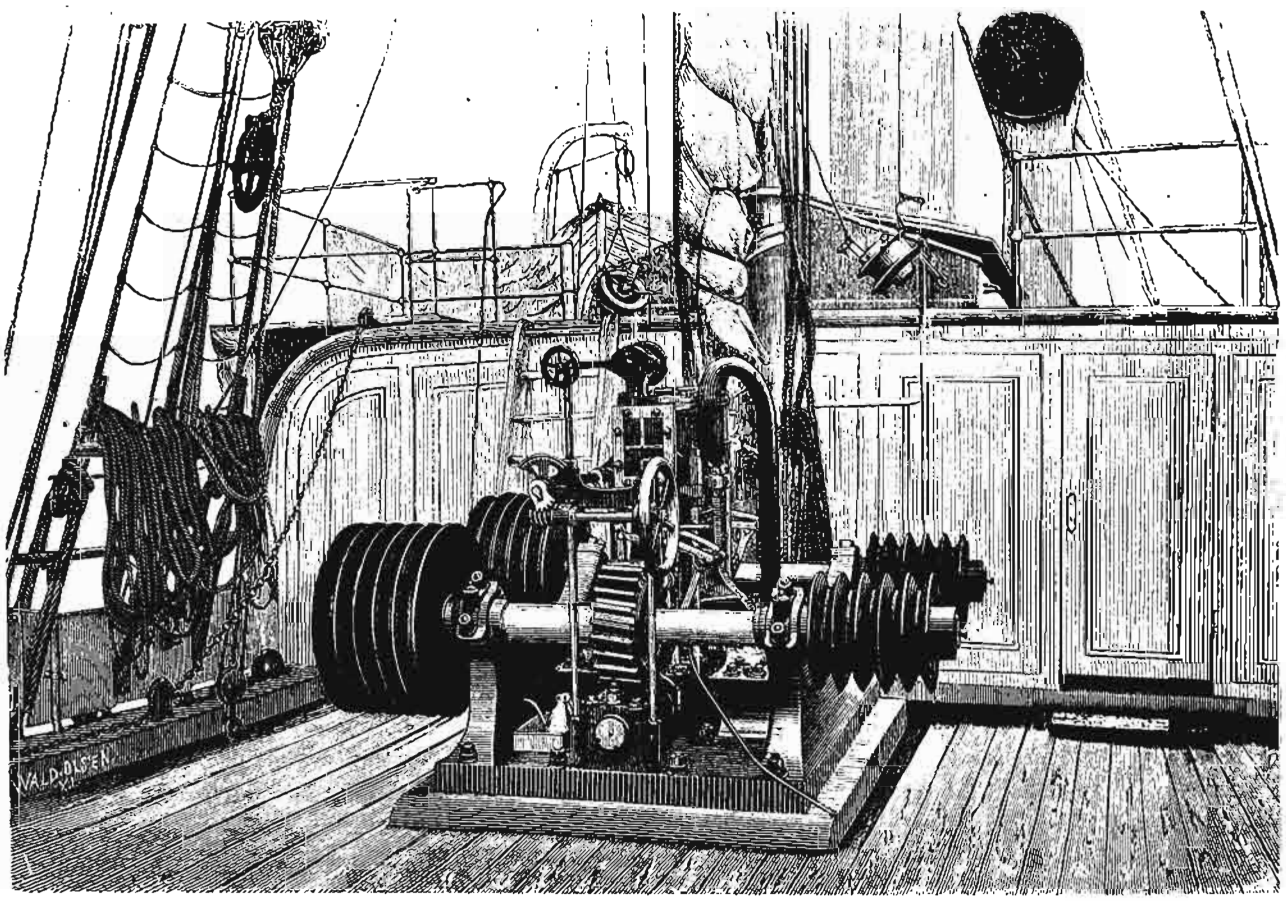


Fig. 5.

Skrændsningen, der følger med Indhivning paa én konkav Tap. De store Tapper om Bagbord tog ind 100 Favne (183 Meter) af Lodlinen i 3 Minuter, og de smaa om Styrbord 100 Favne af Skrabetouget i 6 à 7 Minuter.

I Begyndelsen blev den brugte Damp fra Højtrykscylinderne ledet i en Slange over Dækket og ud over Skibssiden om Styrbord. Da Dampen ved dette Arrangement jevnlig blæstes ind over Dækket og generede, sattes et Kobberrør som Dampskorsten ret op bag Stormasten, hvorved den nævnte Ulempe hævedes.

engine proved a most efficient little machine, working with surprising steadiness and ease; we could haul in or pay out the line without having to shift it on the drums, and there was no surging, which cannot be avoided when the drum is concave. The large drums on the port side delivered 100 fathoms of sounding-line in 3 minutes, and the small ones on the starboard side, 100 fathoms of dredge-rope in 6 or 7 minutes.

On the first cruise, the waste steam escaped through a hose on deck over the starboard side of the vessel; but being with this arrangement, frequently blown back, to the inconvenience of those on deck, the following year a copper steam-pipe was put up abaft the mainmast to get rid of the nuisance.

Ved Siden af agterste Luge var anbragt om Bagbord en Rulle (Fig 2 *d*, Fig. 13 og 14), paa hvilken der kunde oprulles indtil 3000 Favne (5500ᵐ) Lodline. I 1876 havde vi en Reserve-Rulle om Styrbord, men denne blev aldrig benyttet.

I Fig. 2 er forresten *n* Nedgangskapper, *o* Skylighter, *m* Maskin-Skylightet, *h* Lufthat, *w* Waterclosets.

Fig. 3 viser Apteringen af *Rummet i Hytten*. *gg* ere Gange paa begge Sider, *s* Spisesalong, *k* Kabys, *l*, *l*, *l* . . . Sovelugarer, *n* Nedgang til Mellemdækket, *p* Sterrids, *m* Maskin-Skylightet, *b* Kjedlen.

Baade forrenfor og agtenfor Maskinen blev lagt *Mellemdæk*. Apteringen af dette er vist i Fig. 4. *A* er Arbejdssalonen, der indtager Skibets hele Bredde. Den var i 1876 noget mindre, idet Forskuddet stod 0.ᵐ6 (2 Fod) længere agter og der var her saavelsom i Lugarerne med Hensyn til Maling og Udstyr anvendt den største Sparsommelighed. Midt under Skylightet, der var anbragt i Skibets Storluge, stod Zoologernes Bord. Meteorologen havde sit Bord om Bagbord og Kemikeren sit om Styrbord. I Figuren betegner *c* om Bagbord Kronometerskabets Plads. Midskibs paa Forskuddet hang Søbarometret. *l*, *l*, *l* . . . ere Sovelugarer, 3 foran og 3 agtenfor Maskinen. Fra Carljohansværns Verft erholdtes udlaant Chiffonierer, Vaskevandstole, Feltstole samt fornødent Køjetøj til Lugarer og Mandskab, men Rammekøjerne i Lugarerne blev senere paa Turen ombyttede med Slingrekøjer af Træ, som Tømmermanden forarbejdede. Erfaringen fra det første Aar viste, at det var nødvendigt at anvende noget mere Bekostning paa Indredningen, navnlig med Hensyn til Lys og Luft. Kemikerens Arbejde generede ofte de øvrige Herrer, ligesom Skibslugten var en stor Plage, naar Vejret ikke tillod Luftning gjennem Skylightet. Til 1877 Aars Togt blev der derfor gjort flere Forbedringer. Forskuddet i Arbejdssalonen flyttedes 0.ᵐ6 (2 Fod) længere forefter. Om Styrbord indrettedes paa Banjerne (*B*) særskilt Laboratorium (*L*) for Kemikerne, med Indgangsdør fra Salonen. Denne blev ordentlig malet med lysgrøn Farve og Gulvet blev tættet og trukket med Voxdug. Langs Forskuddet opsattes en Luftrende (*h*) af 0.1ᵐ (1 Kvadratfods) Tversnit, der ledede frisk Luft ned i Salonen (Fig. 2 *h* og Lufthatten, Fig. 1, der kunde vendes mod Vinden). Den slette Luft førtes ud gjennem et Blikrør, der fra Gangen udenfor Lugarerne gik over Kjedlen (*b*) og op forrenfor Skorstenen. Skuddet paa Forkant af Dampkjedlen (*b*) blev gjort dobbelt og den i Mellemrummet staaende varme Luft givet Afløb paa lignende Maade. Lugarerne agterud havde ogsaa en lignende Ventilationsindretning. Samtlige Lugarer og Banjerne, hvor Folkene laa i Hængekøjer, havde Ventiler i Skibssiden, saaledes som man ser af Fig. 4 og Fig. 1. Lugarerne bleve trukne med hvidt Tapetpapir og Gulvet klædt med Voxdug. De vare meget rummelige og tørre, men varme, naar der var Fyr paa Kjedlen og noget mørke. Varmeledningen, som det første Aar kun bestod af et Jernrør, der var ledet gjennem de forskjellige Rum, blev forsynet med Aftapningskraner og særskilte Dampovne af Kob-

Alongside the aftermost hatchway, on the port side, was placed a large, strong reel (Fig. 2 *d*, and Figs. 13, 14), which held 3000 fathoms of sounding-line. In 1876, we had a spare reel on the starboard side; but it was never used.

Explanation of Fig. 2: — *n* companion hatchways; *o* skylights; *m* skylight over engine-room; *h* ventilator; *w* waterclosets.

Fig. 3 shows the arrangement of the *Deck below the Roundhouse*: — *gg* passages on both sides of the ship; *s* messroom; *k* cooking-range; *l*, *l*, *l* . . . cabins; *n* companion-ladder to orlop-deck; *p* pantry; *m* skylight over engine-room; *b* boiler.

An *Orlop-deck*, fitted up as shown in Fig. 4, had been laid fore and aft from the engine. The common work-room, *A*, occupies the whole breadth of the ship. The first year of the Expedition it was a trifle smaller, the foremost bulkhead being 2 feet farther aft. Amidships, under the large skylight, for which an opening had been cut in the main-hatch, was placed the zoologists' table; another, that of our meteorologist, stood on the port side; and on the starboard side a third, for the chemical work done on board. In Fig. 4 *c*, on the port side, is shown the case for the chronometers. Amidships, from the foremost bulkhead, was suspended the marine barometer. In the same figure *l*, *l*, *l* . . . are a row of cabins, 3 on either side of the engine, fore and aft. From the Royal Dockyard of Carljohansværn the Expedition procured cabin furniture, such as chests of drawers, washing-stands, camp-stools, &c., and the necessary bedding both for the cabins and the sailors' hammocks; but in place of the canvas berths we afterwards substituted wooden swinging-berths, made on board by the carpenter. The experience of the first year's cruise, showed some additional outlay for remedying defects in the general arrangements below deck, in particular those connected with light and ventilation, to be highly desirable. Unsavoury smells emitted during the chemical work, would hang about the room, and the foul air from the bilge proved a great nuisance in weather that did not admit of ventilating through the skylight. Divers improvements were accordingly effected before commencing the cruise in 1877. We had the dimensions of the work-room increased, by moving the foremost bulkhead 2 feet farther forward. On the starboard side of the orlop-deck (*B*), a separate laboratory (*L*), opening into the work-room, was fitted up for the chemical work to be done on board. The work-room got a good coating of light-green paint; and after filling up the chinks, the floor was covered with oil-cloth. Along the foremost bulkhead we put up a ventiduct (*h*), 1 foot square, down which an uninterrupted current of fresh air found its way into the work-room (Fig. 2 *h*; Fig. 1 represents the moveable top of the ventilator, which could be turned in any direction to catch the wind). To get rid of the vitiated air, a tin pipe was laid along the roof of the passage extending past the cabins, being carried thence over the boiler (*b*), and up the front of the funnel. Moreover, there being now a double bulkhead afore the boiler (*b*), like provision was made for the escape of ber i hvert Rum. I Fig. 4 er endvidere *S*, *S* Styrmændenes Rum, *f* Fyrbødernes, *g* Kabysen for Mandskabet, *v* Vandtank, *b* Kjedlen, *m* Maskinen, *k* Kulboxerne.

the heated air between the two partitions. For the cabins aft, too, we adopted this mode of ventilation. Each compartment, as also the orlop-deck, where the crew slung their hammocks, had bull's eye windows (Figs. 4 and 1). The cabins were all of them papered white, and had their floors covered with oil-cloth. They were very commodious, and dry withal, but somewhat dark, and with the steam up, rather close, from their proximity to the boiler. The warming-apparatus, which on the first year's cruise had consisted merely of an iron pipe extending from compart-

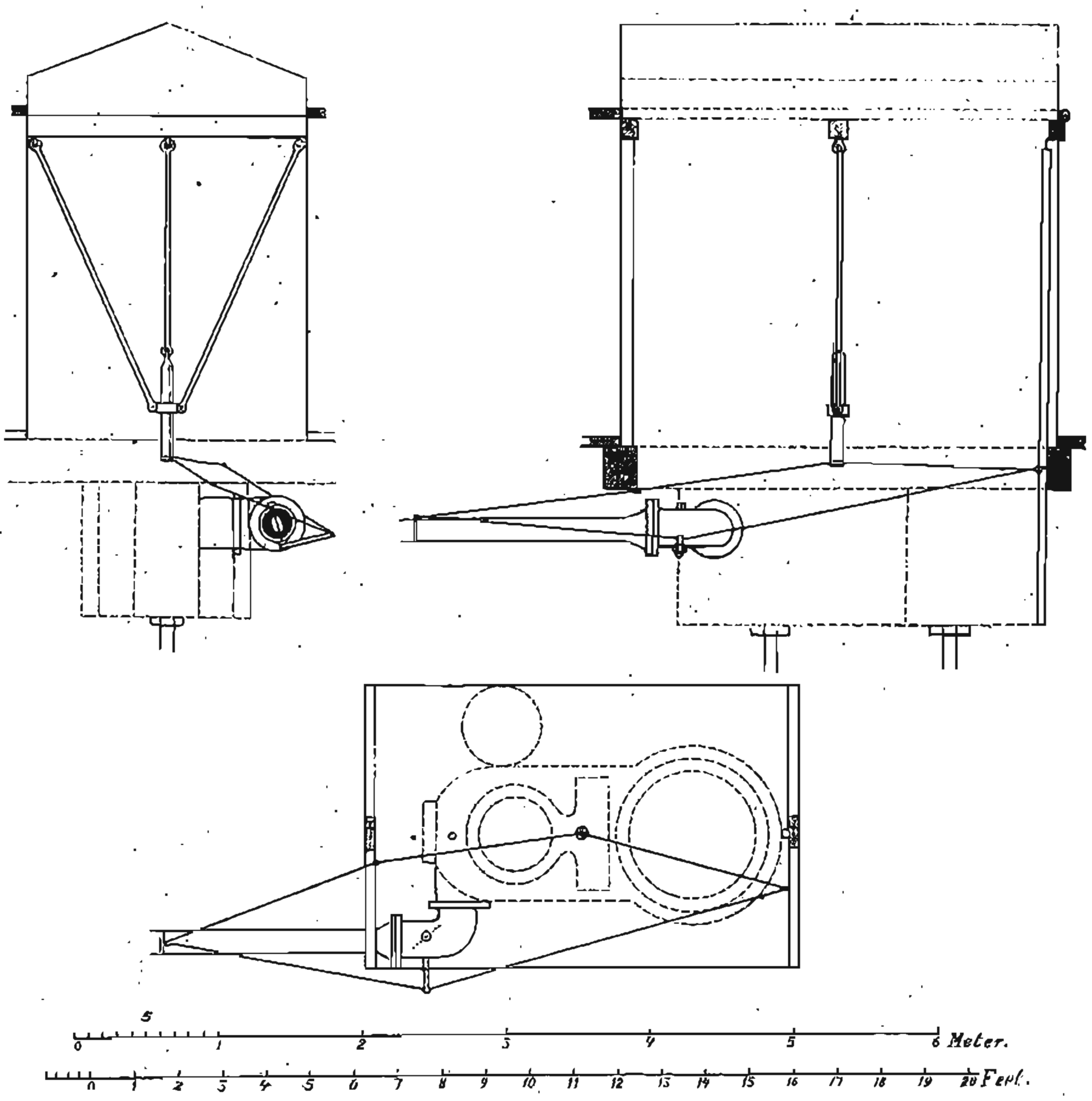


Fig. 6.

ment to compartment throughout the vessel, was now provided with stopcocks for turning on the steam into copper receptacles, or stoves, as they are called, of which each room and compartment had one. Fig. 4 also represents the mates' cabin (*S*, *S*), the firemen's compartment (*f*), the ship's galley (*g*), the water-tank (*v*), the boiler (*b*), the engine (*m*), and the coal-bunkers (*k*).

Samtidig med Skibet skal jeg omtale *Petersens Pendel-Regulator*, Fig. 6. Som bekjendt er det en stor Ulempe,

In my description of the ship and her equipment I must not omit to mention *Petersen's Pendulum-governor* (Fig. 6).

naar Skruefartøjer skal gaa ret mod eller ret undaf Vinden i høj Sø, at Skruen til enkelte Tider kommer ud af Søen, eller i alle Fald saa høit op i Vandet, at den tager en saadan Fart, at der let kan opstaa Havari i Maskinen. Erfaring lærte, at "Vøringen" klarede sig bedst i høi Søgang, naar den blev lagt med Stevnen ret mod Søerne, men naar Bølgetoppen havde passeret Skibets Midte, faldt Bougen ned i Bølgedalen og Skruen, som derved løftedes op i Vandets Overflade, slog da saa haardt, at Maskinisten stadig maatte staa med Throttlevalven i Haanden og bremse. Næstcommanderende, Premierlieutenant Petersen, fandt da paa at hænge op et af de store Lodder, der brugtes til Loduingerne, af 112 Pd.s Vægt, under Maskinskylightet, med Forstøtning til Siderne, saaat det blot kunde svinge frem og tilbage i Skibets Diametralplan. I den nedre Ende var fastgjort 2 Snore, der løb gjennem Kouse, en forrenfor Maskinen (over Kjedlen) og en agtenfor samme (i Maskinskylightet) noget ud i Borde, og begge Snore var med de nedre Ender fastgjorte i Haandtaget til Throttlevalven.

Idet Skibet nu faldt ned med Bougen, svingede Loddet forefter, trak derved i den agterste Snor og lukkede Throttlevalven. Naar Skibet atter rejste sig, faldt Loddet tilbage og aabnede igjen for Dampen ved Hjelp af den anden Snor. Grændserne for Loddets eller Ventilens Bevægelser i begge Retninger reguleredes ved et Par paa den agterste Snor fæstede Tværstykker af Træ, der stoppede op imod den agterste Kous i Maskinskylightet.

Gjennem dette enkle Arrangement udførte Loddet den for Maskinisten saa besværlige Tjeneste med Bremsningen, og bedre end han kunde, da Loddet følger Skibets Bevægelser sikkrere end Maskinisten kan. Med fuld Fart hjalp ikke Loddet, da Slideskabet og Cylinderen indeholdt for meget Damp selv efter Throttlevalvens Lukning; men da Maskinisten heller ikke kan gjøre mere end at lukke, er man i dette Tilfælde ved Omstændighedernes Medfør nødt til at regulere til mindre Fart.

Lodning.

Lodderne. Naar Dybden ikke antoges at være over 1000 Favne, anvendtes det saakaldte Rør-Lod. Til Lodning paa større Dyb brugtes Baillie-Maskinen.

Rør-Loddet (Fig. 7) er af Bly $0.^{m}77$ (2 Fod $5^{1}/_{2}$ Tom.) langt, $0.^{m}078$ (3 Tom.) tykt og vejer 56 Kgr. (112 Pund). Det har i den nedre Ende et i en Messingmuffe indskruet Jernrør $0.^{m}23$ (9 Tom.) langt, $0.^{m}052$ (2 Tom.) bredt til Optagning af Prøver af Bunden. Dette Rør har i den øvre Ende nogle Huller for at Vandet kan slippe ud, naar Bundprøven trænger ind nedenfra, og i den nedre Ende en Butterfly-Ventil, der aabner sig opad, og som hindrer Bund-

It is a well-known drawback with screw-vessels steaming head or stern to wind in a heavy sea, that of the screw being at times either wholly lifted out of the water, or at least brought so near the surface as to cause it to revolve with a rapidity that cannot but expose the engine to serious damage. In rough weather, the "Vøringen" was found to behave best with her head to the sea; but when the crest of a wave had passed the middle of the ship, she would plunge her bows into the trough of the sea, and the screw, being then proportionally raised, tore round with such critical violence at the surface of the water that the engineer had to be constantly on the alert, ready at any moment to shut the throttle-valve and cut off the steam. Observing this and the trouble it entailed, Lieutenant Petersen, our second in command, hit upon the ingenious device of suspending as a governor under the engine-room skylight one of the heavy leaden sinkers, weight 112 lbs., which he made to swing right fore and aft. At the bottom end of the sinker were fastened two lines, rove through thimbles, one before the engine (over the boiler), and the other abaft it (on the engine-room skylight), a little to the port side, the other two ends being made fast to the hand-lever of the throttle-valve.

Now, when the vessel pitched, the sinker swung forward, and, pulling upon the afterline, closed the throttle-valve; on her again rising, the sinker swung back, opening the steam-passage by its drag on the other line. The motion both of the sinker and of the valve was kept within proper limits by two cross-pieces of wood on the after line, fixed one on each side of the after thimble.

By this simple arrangement, the engineer was relieved from the troublesome duty of throttling, which the sinker performed even more effectually, following the motion of the vessel with far greater nicety than the most watchful eye. At full speed, our pendulum-governor was of no avail, the valve-casing and the cylinder then containing too much steam, even with the throttle-valve closed; however, as the engineer can do no more than cut off the steam, in that case there is nothing for it but to reduce the speed.

Deep-sea Sounding.

When the depth was supposed not to exceed 1000 fathoms, we used the tube-lead, as it is called. For sounding in greater depths the Baillie machine was employed.

The *Tube-lead* (Fig. 7), 2 feet $6^{1}/_{2}$ inches long by 3 inches thick, is of lead, and weighs 112 lbs. At the lower end it has a brass box, into which is screwed an iron tube, 9 inches long by 2 inches in diameter, for bringing up samples of the bottom. This tube has the upper end perforated with a number of holes, to allow of the water passing out above on the sample of the bottom pressing in from beneath, and is furnished at the lower end with a butterfly valve, openprøven fra at skylles ud af Røret under Ophalingen. Naar Røret er afskruet, kan et Sidestykke tages ud, hvorved Bundprøven kommer tilsyne med sine naturlige Lag og kan undersøges foreløbig, førend den bringes paa de dertil bestemte Opbevaringskar.

ing inwards, to prevent the washing out of the sample on its journey to the surface. The tube screwed off, the sample within, as it lies *in situ*, may, by removing a slip from the side, be disclosed for preliminary inspection, before being taken to the receptacles in which it is stored

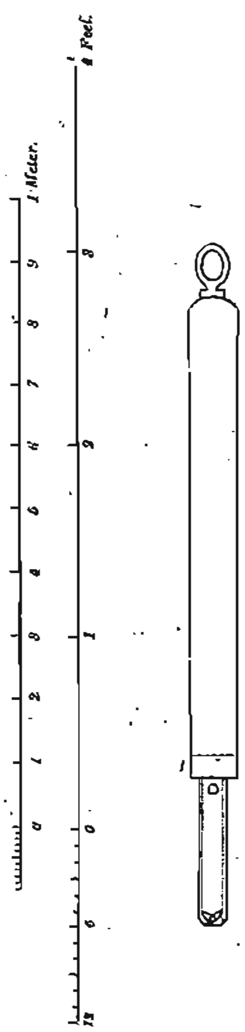


Fig. 7.

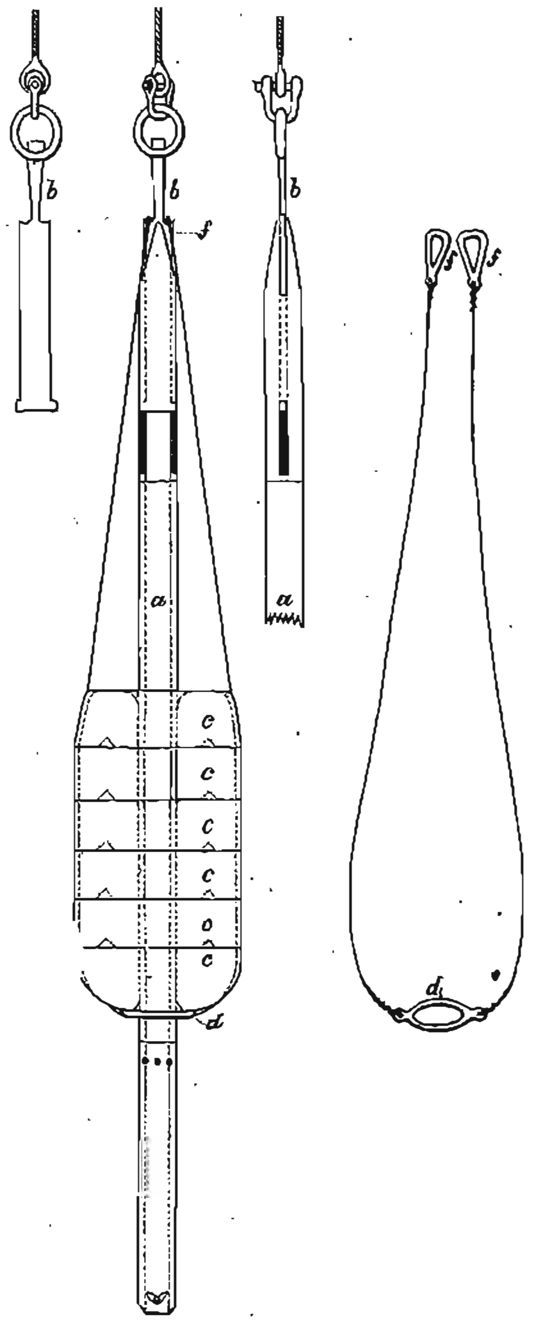


Fig. 8.

Baillie-Maskinen (Fig. 8) bestaar af et 1.m75 (5 Fod 7 Tom.) langt, 0.m061 (2 1/8 Tomme) bredt Rør, *a*, hvis øvre Del er af Messing og tilspidset. I Spidsen er en Gjennemskjæring, og længere nede i Flugt med denne en

The *Baillie Sounding-machine* (Fig. 8) consists of a tube *a*, 5 feet 9 inches long by 2 1/8 inches in diameter, the upper portion of which is of brass, bevelled away to a long rounded slope. At this end it has a slot, Aabning paa hver Side. Stykket b, der har en Bredde, som er noget mindre end Røret a's indvendige Diameter, er indsat i dette saaledes, at Knasterne ved b's nedre Ende kommer frem i Sideaabningerne, og Stykket b kan saaledes bevæges op og ned, fra at Knasten støder an mod Overkant til den støder an mod Underkant af Aabningen. I sidste Tilfælde er b ganske skjult inde i Røret med Undtagelse af Ringen. I den nedre Ende af Røret a er anbragt den samme Indretning til Optagning af Bundprøve som paa Rør-Loddet.

Til Maskinen hører Jernlodderne c, c, c, af hvilke hvert har en Vægt af omtrent 27 Kilogram (55 Pd.). De ere korte Cylindre af støbt Jern med et Hul i Midten af noget større Diameter end Røret a's og med Knaster paa Oversiden samt tilsvarende Fordybninger paa Undersiden og desuden en Fure paa begge Sider, der ligger i Knasternes og Fordybningernes Plan. Naar det ene Lod stables ovenpaa det andet, danner deres Furer en fortløbende Rende. Underlod og Overlod har særskilt Form, som Figuren viser, idet det første er kugleformig afrundet paa Undersiden, for at gjøre mindre Modstand mod Vandet, og det sidste er noget konisk.

Naar Baillie-Maskinen skal rigges, bruges en større cylindrisk Træblok med et Hul i Midten. Over dette lægges Ringen d, der er af Støbejern, med isatte Jerntraade, og man stabler nu Lodderne ovenpaa, saa mange som man anser fornødent for med Sikkerhed at kunne angive Øjeblikket, da Loddet slaar i Bund. Derefter sættes Røret a gjennem Hullerne i Lodderne og Træblokken, Stykket b løftes op, Jerntraadene lægges i Jernloddernes Sidefurer, og Ringene f hukes paa de øvre Afsatser paa b. Naar man nu løfter op i Lodlinen, der er hexet fast til Ringen i Stykket b, hænge Lodderne paa Afsatserne paa Stykket b, og Røret a hænger med Overkant af Sideaabningerne paa Knasterne ved den nedre Ende af b, som i Figuren. Naar Maskinen støder mod Bunden, bliver det løst hængende Rør a drevet op og trykker med sin øvre koniske og afrundede Del Ringene f ud af Afsatserne paa b. Derved er Forbindelsen mellem Jernlodderne og Lodlinen ophævet. Lodderne med Ringen d, Jerntraadene og Ringene f falde ned og blive liggende paa Havbunden, medens Røret a og Stykket b bringes op til Overfladen, naar Lodlinen hives ind.

Der blev anvendt indtil 8 Lodder af samlet Vægt 216 Kilogram (432 Pd.). Røret, der hales op, vejer kun 17.5 Kilogram (35 Pd.).

Baillie-Maskinen viste sig at være et udmærket Apparat, idet Lodderne hver eneste Gang, den brugtes, gik af Røret, om end Bunden var noksaa blød. Den eneste Van-

and farther down, in a line with the latter, two other openings, one on either side. The piston-iron b, not quite equal in width to the inner diameter of a, being so fitted into the tube that the studs at its lower extremity correspond with the aforesaid slots, or openings, can accordingly work up and down within those limits. When the studs are at the bottom of the slots, the piston-iron b is just within the brass or upper end of the tube, the ring only by which the instrument is shackled to the sounding-line being then above it. For bringing up samples of the bottom, the lower end of the tube has an arrangement similar to that at the bottom of the tube-lead.

To the machine belong a number of sinkers c, c, c, weighing each about 55 pounds, — short cast-iron cylinders, with a hole through the middle slightly exceeding in diameter the tube of the instrument, and toothed and notched so as to fit into one another and make one mass, also having a groove on either side in the same plane with the notches. The top and bottom sinkers differ in shape, the former being slightly conical, and the latter having the lower end spherically rounded, to diminish the resistance and thus increase the velocity in descending.

The Baillie machine was placed for adjustment on a cylinder of wood, having a hole through the middle somewhat greater in diameter than that of the tube a. Over the bore of the cylinder is placed a cast-iron ring d, with iron wires attached; and upon the ring are piled a number of sinkers, sufficient to determine the exact moment at which the instrument reaches the bottom. The lower part of the tube a is next passed through the sinkers into the wooden cylinder beneath; and after drawing out the piston-iron b, the wires, forming a sling, are laid in the groove along the sides of the sinkers, and the rings f hooked upon the shoulders of the piston. Now, on the instrument being hung to the sounding-line by the ring of the piston-iron, the sinkers will depend, on the iron-wire sling, from the shoulders of b, and the tube a from the lower studs that retain the piston-iron in position, the brass cylinder being pulled down the entire length of the slots, as shown in the figure. When the tube and the weights touch the bottom, the brass cylinder is pushed upward the length of the slots, and its top rim striking against the rings f, the sling is slipped off the shoulders of the piston-iron. The sinkers, being thus deprived of their support, drop, carrying with them the ring d, the wires of the sling, and the rings f, down the tube a, which, on hauling in the line, comes up alone, with the piston-rod and a sample of the bottom.

For some soundings we used as many as 8 sinkers, weighing together 432 pounds. The weight of the tube is only 35 pounds.

The Baillie machine proved an excellent apparatus, the weights being without exception detached from the tube, however soft the bottom. The only difficulty skelighed var Udfiringen over Rækken og ned i Søen, thi ved Slag mod Skibssiden kunde Jerntraadene løsne og Lodderne tabes. Man firede den derfor saa hurtig som muligt ned i Vandet, hvor dens Svingninger under Fartøjets Bevægelser lettere kunde dæmpes og gjøres uskadelige.

Lodlinerne, der var leverede af Rebslager Timm i Christiania, var af fineste Sort italiensk Hamp, 2.cm6 (1 Tomme) i Omkreds, voxede og glatstrøgne. De holdt ved anstillet Prøve en Vægt af 750 Kilogram (1500 Pd.). De viste sig særdeles gode, og der blev brugt kun en Line hver Sommer. Linen blev mærket for hvert hundrede Favne med omviklede og paamerlede Stykker Flagdug af forskjellig Farve. De første 20 Favne var dobbelt Part med Kous og Hex til Loddet. I 1876 var Lodlinen inddelt i *norske* Favne, og de første 100 Favne havde Lædermærker for hver 10 Favne. I 1877 og 1878 var Lodlinen inddelt i *engelske* Favne og de første 200 Favne opmærkede for hver 10de Favn. Opmærkningen foretoges ombord, idet der med Tommestok blev sat Mærker i Dækket for en Længde af 5 Favne, hvilke ogsaa senere brugtes, naar Linen blev eftermaalt og rettet.

Som anført, havde vi ingen Sprængning af Lodlinen foraarsaget ved at Baillie-Maskinens Lodder ikke gik af Røret. Som Bevis paa Lodlinens Godhed kan anføres, at den under Lodningen en Gang, medens den altsaa var i fuld Fart, gik i Hus i Loddeblokken, idet denne ikke drejede sig hurtigt nok ind i Planet mellem Linens Parter. Uagtet det voldsomme Ryk og det snevre Rum, hvori Linen blev kneben ind i Blokken, over tildels skarpe Kanter, holdt den uden at lide Skade. Den eneste Sprængning af Lodline fandt Sted i 1877 paa Turen nordenfor Tromsø, idet Lodlinen, som under Indhivningen var kommen under Fartøjets Bund, blev grebet af Skruen og sprængt. Ved at fire et Lod i slak Bugt ud fra Stevnen og med Enderne af Linen langs hver af Fartøjets Sider hale det agterud, lykkedes det vagthavende Officer, Capt. Grieg, at fiske Lodlinen, der havde kastet sig om Propelleraxen saa vidt, at den ikke sank; derved reddedes flere Thermometre og de af dem registrerede Bund-Temperaturer.

Accumulatoren bestaar af en Samling Kautschuk-Stroppe (Fig. 9), hver bestaaende af 2 sammenføjede Strenge af 2cm (3/4 Toms) Tykkelse. I hver Bugt er en Træ-Kous med Stjert, og Strengene holdes sammen om Trækousene ved tynde Kautschuk-Ringe. Stroppene ere ordnede mellem 2 stærke Træskiver, 0m.442 (1 Fod 5 Tom.) i Diameter og 0m.045 (1.7 Tom.) tykke, med ligesaamange smaa Huller som der er Stroppe. Stjerten tages gjennem Hullerne og samles om en svær Kous, saaledes at Stroppene blive jevnt stive. Fig. 10 viser Lodde-Accumulatoren. Den be-

lay in lowering the instrument: bumping against the ship's side was apt to disengage the sling, and thus occasion the loss of the sinkers. We therefore got the machine as quickly as possible into the water, where the swinging motion given to it by the rolling of the vessel could produce no injurious result.

The *Sounding-lines*, supplied by Mr. Timm, ropemaker of Christiania, were of the best Italian hemp, 1 inch in circumference, with a breaking strain of 1500 pounds, and well waxed and smoothened. They proved of excellent quality, one amply sufficing for a whole cruise. The lines were graduated into hundreds of fathoms by attached slips of different coloured buntine, wrapped round the surface. Each was rove double the first 20 fathoms, and provided with a thimble and a shackle, by which to make fast the sounding-machine. For the first year's cruise, in 1876, the line was graduated into Norwegian fathoms, and had slips of leather at every 10 fathoms of the first hundred; but for the two remaining cruises, in 1877 and 1878, we substituted English measure, graduating the first two hundred fathoms of the line into tens of fathoms. The line was graduated on board, 5 fathoms having been previously measured out along the deck with a foot-rule. These five-fathom intervals served, too, as a reliable standard when re-measuring and adjusting the line.

As stated above, the weights were detached at every sounding with the Baillie machine; and hence we never had the line carry away from their failing to drop off on the instrument striking the bottom. Meanwhile, the excellence of its quality came on one occasion to be severely tested. When running out with full velocity, the line suddenly caught in the sounding-block, which had not readily adjusted itself to the direction taken by the former on its rapid passage out. But, though brought up in this way with a violent jerk, and jammed besides into the block, partly, too, against sharp edges, the line was strong enough to stand the strain uninjured. The only sounding-line that parted was one used in 1877, on our cruise north of Tromsø. We were hauling in the lead, when it got underneath the ship's bottom, fouled the screw, and was broken. By lowering a weight over the bows in a slack bight, and then, with the ends of the rope extending one along either side of the vessel, hauling it aft, the officer of the watch, Captain Grieg, succeeded in fishing the sounding-line, which had twisted round the screw-shaft just sufficient to keep it from sinking, and thus recovered several thermometers, along with the temperatures they had registered at the bottom.

The *Accumulator* is built up of a number of straps (Fig. 9), each composed of 2 vulcanised india-rubber springs, three-quarters of an inch thick, joined lengthwise. In each of the loops is fixed a wooden thimble, with a lanyard, and the springs are kept together by means of thin india-rubber rings. The straps are kept free from one another and equably taut, by stretching them between a couple of strong wooden disks, 1 foot 5½ inches in diameter and 1¾ inch thick, bored with a hole for every strap, the lanyards being rove through the holes and brought staar af 15 Stroppe. I den nedre Kous hænger Loddeblokken, der er af Jern, forsynet med Hvirvel, Axe, der løber paa Friktionsruller og to Arme med Hængsler til Styring af Lodlinen. Den øverste Kous hukes i et Topreb, der senere skal beskrives, og det hele Apparat hænger,

together round a large thimble. Fig. 10 represents the Sounding-accumulator, composed of 15 straps. To the lower thimble is hung the cast-iron sounding-block, provided with a swivel, an axle revolving on antifriction rollers, and two hinged arms to act as fairleaders for the line. The upper

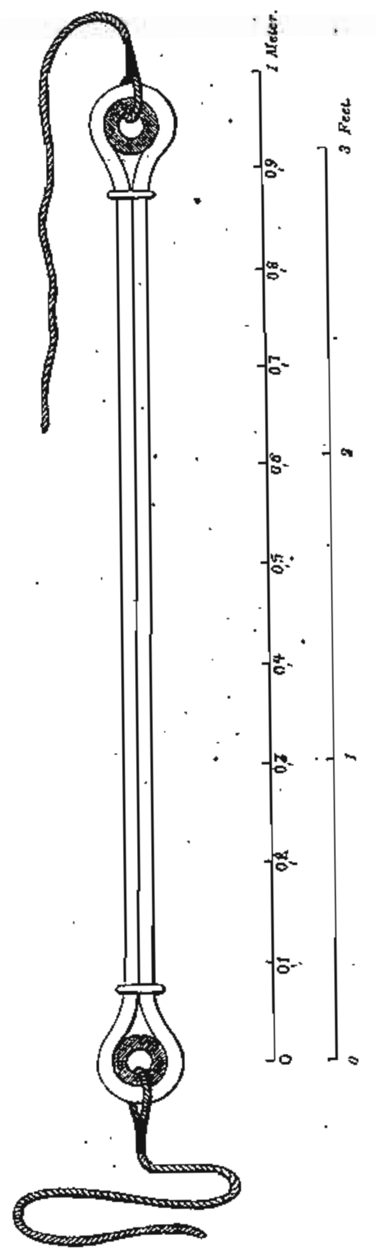


Fig. 9.

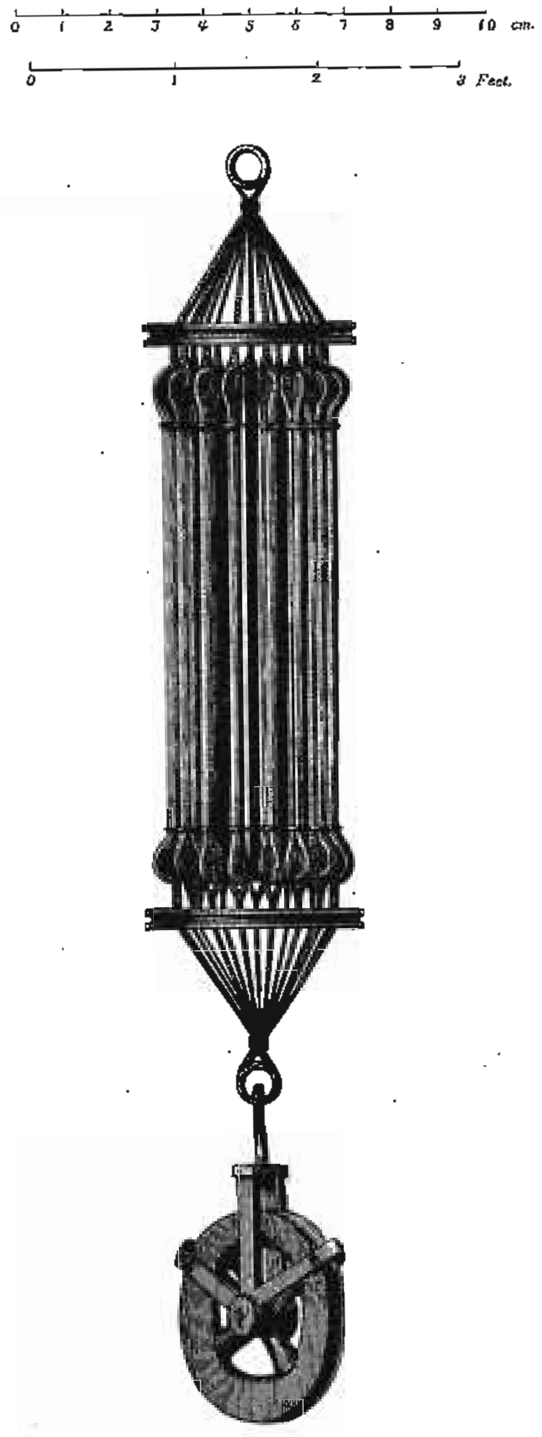


Fig. 10.

naar det er i Virksomhed, under Bagbords Storraa-Nok.

Hensigten med Accumulatoren er at kompensere Skibets Bevægelser op og ned i Søen, saaledes at Lodlinen

thimble is hooked on to a pendant, which will be afterwards described. When in use, the apparatus hangs suspended from the port main-yard-arm.

The most important function of the accumulator is to take off the suddenness of the strain on the line when ikke bliver udsat for pludselige Ryk. Udvidelsen af Accumulatorens Stroppe tjener ogsaa til at angive Størrelsen af den Kraft, som gaar paa den.

Ved Afvejning i Land fandtes den Vægt, der svarede til hver Fods Udvidelse af en enkelt Strop, og derefter opsattes nedenstaaende Tabel, der dog selvfølgelig kun angiver omtrentlige Værdier. En Accumulator med 30 Stroppe brugtes til Bundskrabningerne.

Længde. Fod.	1 Strop.	15 Stroppe.	30 Stroppe.
	Vægt i Pund.		
3	0	0	0
4	40	600	1200
5	61	915	1830
6	76	1140	2280
7	90	1350	2700
8	101	1515	3030
9	111	1665	3330
10	122	1830	3660
11	132	1980	3960
12	143	2145	4290
13	153	2295	4590
14	162	2430	4860
15	173	2595	5190
16	185	2775	5550
17	198	2970	5940
18	213	3195	6390
19	230	3450	6900

Ved $20^1/_2$ Fods Længde blev Stroppen sprængt.

Da Loddeblokken vejer sine 50 Pd., den største Loddevægt, som ovenfor anført, var 470 Pd., hvortil kommer Vandhenterens Vægt, ser man, at Accumulatoren, paa hvilken der i dette Tilfælde gik en Kraft af noget over 1000 Pd. før Lodderne kom i Vandet, ikke blev meget anstrengt i Forhold til hvad den kunde bære. Under Loddets Synken gaar der ikke stor Kraft paa Accumulatoren, derimod bevirker Lodlinens lange Overflade en saa betydelig Friktion mod Vandet under Ophalingen fra større Dybder, at Accumulatoren kan strækkes ud 0.m2 til 0.m3 (en halv til en hel Fod.)

Kautschukstroppene taaler godt Fugtighed, men angribes af fedtagtige Stoffe og lider vel ogsaa ved stadig Udsættelse for Vind og Vejr. Saasnart Lodningen var forbi, blev vistnok Accumulatoren strax firet ned i Vandet, men det kunde ikke altid undgaaes, naar den var udhalt under Raaen til Brug, at den for en kortere Tid kom i Røgen fra Skorstenen. Den i 1876 brugte Accumulator kunde ikke bruges den følgende Sommer. I 1877 anbragte jeg til Forsøg omkring Stropperne en Serk af Sejldug, der blev fastspigret rundt Kanten af øverste Træskive (se Fig. 1, Skrabe-Accumulatoren, og Titelbilledet samt Fig. 14) og var af samme Længde som Stroppene i Hvile. Ikke usandsynligt paa Grund af denne Beskyttelse holdt Accumulatorerne sig saa godt, at de kunde benyttes i 1878, dog i den sidste Tid forstærkede med nogle nye Reserve-Stroppe.

the vessel is rolling or pitching; but it is also valuable as indicating roughly the amount of the strain, by the greater or less extension of the straps.

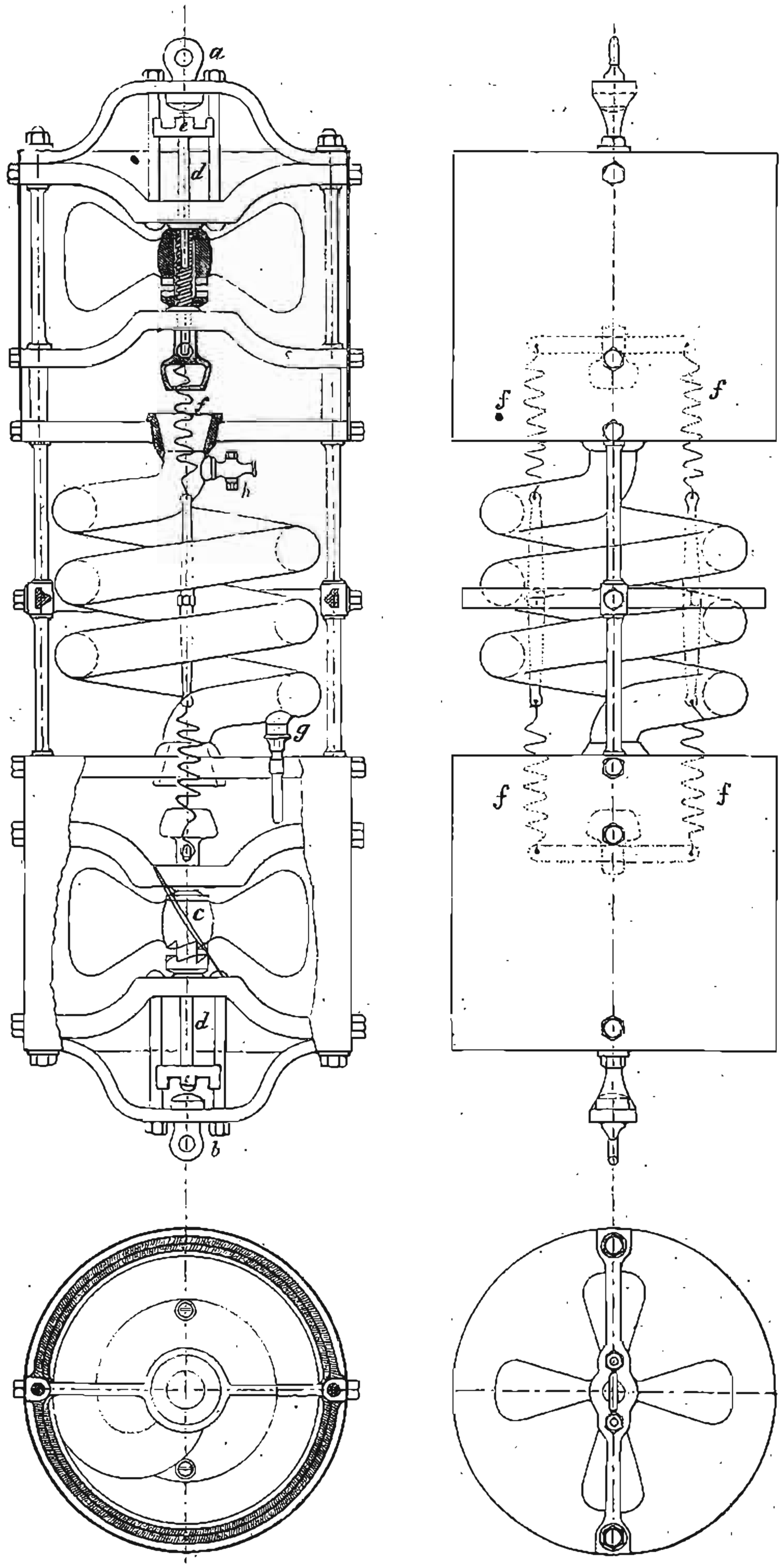
By weighting one of the straps, I had found, before the Expedition left Norway on the first cruise, the amount of strain corresponding to its extension, for every successive foot. The results, which of course cannot but represent approximate values, are given in the following Table. An accumulator with 30 straps was used with the dredging-gear.

Length of Strap. Feet.	1 Strap.	15 Straps.	30 Straps.
	Weight in Pounds.		
3	0	0	0
4	40	600	1200
5	61	915	1830
6	76	1140	2280
7	90	1350	2700
8	101	1515	3030
9	111	1665	3330
10	122	1830	3660
11	132	1980	3960
12	143	2145	4290
13	153	2295	4590
14	162	2430	4860
15	173	2595	5190
16	185	2775	5550
17	198	2970	5940
18	213	3195	6390
19	230	3450	6900

At twenty feet and a half the strap broke.

The weight of the sounding-block being 50 pounds, and that of our heaviest set of sinkers, as stated above, 470, to which must be added the weight of the water-bottle, the accumulator, which accordingly had to bear a strain of but little more than 1000 pounds before the sinkers reached the water, was not exposed to any severe test, considering the great strength of the straps. During the downward passage of the lead, there is very little strain on the accumulator; but when hauling in, the friction of one or two miles of cord in the water is so considerable, that the accumulator will be frequently stretched from half a foot to a foot.

The india-rubber springs stand wet and moisture well; they are, however, injuriously affected by grease and all kinds of fatty substances, and probably, too, suffer from continued exposure to wind and weather. Immediately after sounding, the accumulator was lowered into the shrouds; but when triced under the yard-arm for use, it was not always possible to keep it out of the smoke from the funnel. The accumulators provided for the first year's cruise, in 1876, had to be rejected on the next. To remedy this drawback, I tried, in 1877, the experiment of nailing round the rim of the upper disc a protective covering of canvass, of the same length as the unstretched straps (see Fig. 1, Dredge-accumulator, Frontispiece, and Fig. 14). Owing, probably, to this simple expedient, the accumulators kept in so good a condition as to admit of our using them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f

Thermometre. — De Dybvandsthermometre, der benyttedes paa vor Expedition, vare Casella-Millers, Buchanans (Kviksølvpiezometer) og Negretti og Zambras, den ældre og den nyere Model. Desuden gjordes Forsøg med Vand-Piezometre til Kontrolbestemmelser for de maalte Dybder. Alle disse Instrumenter ville blive beskrevne af Professor Mohn i hans Afhandling om Dybvands-Temperaturerne.

Vandhenter. — Paa vor Expedition anvendtes hovedsagelig den af mig dertil konstruerede, i Fig. 11 i $^1/_8$ af den sande Størrelse fremstillede Vandhenter. Instrumentet, der blev prøvet i Christiania før det blev antaget, blev brugt under den hele Expedition, saavel paa de større som paa mindre Dyb. Da Kemikeren havde stillet Fordring paa 5 Liter Vand, blev Apparatet meget stort, hvilket vistnok ikke generede Indhalingen i mærkelig Grad, men det gjorde det noget tungvindt at haandtere paa Dæk.

Vandhenteren er i Figuren fremstillet færdig til Udfiring. Tampen af Lodlinen hexedes i øverste (*a*) og Loddet i nederste Øjebolt (*b*). Under Udfiringen strømmer Vandet frit gjennem det, for Pladsens Skyld, spiralformig bøjede Rør, der var af Kobber og indvendig fortinnet. Samtidig løftes Propellerne op, saa at Taggerne i Underkant af Propelbosset *c* kommer klar af Taggerne i Muffen om Ventilstangen, og om de ikke skulde komme ganske klare, sker Propellens Omdrejning med Skraaplanerne, saaat Muffen og den gjennem samme gaaende Ventilstang *d* bliver staaende stille. Naar derimod Instrumentet under Indhivning bevæges opad, trykker Vandtrykket Propellerne ned, de drives rundt den anden Vej og tager Muffen med sig. Ventilstængerne, der styres af Tverstykkerne *e* og Ventilerne, der ere overtrukne med Kautschuk, skrues da mod Ventilsæderne i Enden af Røret, og naar de er næsten lukkede, glipper den sidste Skruegjænge i Ventilstangen ud af Skruegjængerne i Muffen og Spiralfjædrene (*f*) klappe da Ventilen i, og holder dem lukkede under Resten af Indhivningen, medens Propellerne og Mufferne gaa løse rundt den glatte Del af Ventilstangen og saaledes frembyde meget liden Modstand. Instrumentet lukkede sig efterat være indhalt 6 à 7 Favne. Skjærmene om Propellerne beskytter disse, saa at Instrumentet uden Skade kan ligge paa Bunden.

Da man ønskede at konstatere, om der var Overskud af Luft i de dybere Vandlag, blev der over Svikhullet (*g*) paa Røret paaskruet et gjennemboret Laag, og dette blev forenet med et i den ene Ende lukket Glasrør ved Hjælp af et Stykke Kautschukslange. Naar Vandet under Nedfiringen strømmede ind i Vandrøret, løb det ogsaa ned i

the year after (1878), strengthened, however, on the latter part of the cruise with a few spare straps.

Thermometers. — Of deep-sea thermometers, the Expedition was provided with the Miller-Casella, Buchanan's (mercury-piezometer), and Negretti & Zambra's (on the original and the improved construction.) Experiments were also made with water-piezometers, to control determinations of depth. These instruments will all be described by Professor Mohn, in his Memoir on the deep-sea temperatures.

The Water-Bottle. — For collecting water both from the bottom and intermediate depths, we made chief use, on each of the three cruises, of an instrument devised by myself, and tested in Christiania previous to the departure of the Expedition. Fig. 11 represents this water-bottle, one-eighth of the actual size. The apparatus having, as stipulated by Mr. Svendsen, chemist to the Expedition, to bring up 5 litres of waters, it was of course rather bulky; but this, though it made the instrument somewhat cumbersome to handle on deck, did not materially impede the heaving in.

In the figure, the water-bottle is shown ready to let go. The end of the sounding-line is shackled to the upper eyebolt (*a*), and the lead to the lower (*b*). On the downward journey, the water passes freely through the tube, which is of copper, tinned on the inside, and which, to save space, had been given a spiral form. Now, the pressure of the water will lift up the propellers, enabling the cogs in the under surface of the boss (*c*) to get clear of the cogs in the bush, through which passes the rod of the valve (*d*); and if not quite clear, the propeller will revolve *with* the inclined planes, the bush and the valve-rod remaining stationary as before. On the other hand, when the instrument, on being hauled in, is given an upward motion, the pressure of the water will force down the propellers, and they will then revolve in the opposite direction, carrying along with them the bushes. The valve-rods, which cannot revolve, being kept in position by the cross-pieces (*e*), will then, together with the valves, covered with india-rubber, be screwed against the valve-seats. When the valves are well-nigh closed, the last twist of the screw on the rod of the valve will slip out of the corresponding twist of the screw on the bush, and the spiral springs (*f*) instantly press down the valves and prevent the enclosed sample of water from escaping, the propellers and the bushes being left to revolve independently round the flush portion of the rods, thus affording very little resistance on the passage to the surface. The instrument closes on being hauled in 6 or 7 fathoms. The shields round the propellers serve to protect them from damage when the instrument is lying on the bottom.

With a view to ascertain whether the proportion of air were really greater in the deeper strata of the ocean, a perforated cover was screwed over the spigot-hole (*g*), and connected, by means of a short piece of india-rubber hose, with a glass tube, sealed at one end. Now, when the water on the downward passage of the instrument entered

Glasrøret, af hvilket saaledes den atmosfæriske Luft blev udjaget. Naar Instrumentet kom ombord, endevendtes det, saaledes at Kranen h kom ned og Glasrøret op. Man bevægede nu Vandhenteren lidt frem og tilbage med den øvre Ende, og hvis der havde været Overskud af Luft, maatte denne have arbejdet sig op, og vist sig i Toppen af Glasrøret. Dette viste sig imidlertid i ethvert Tilfælde fuldt af Vand lige til Tops, og blev derfor i den senere Tid ikke paasat.

Til mindre Dybder, og naar man ikke behøvede at standse Udfiringen, benyttedes en mindre Vandhenter konstrueret af Professor *Ekman* i Stockholm. Dette Apparat er fremstillet i Fig. 12. Det bestaar af en i begge Ender aaben Cylinder c, der har en Brem rundt om den øvre Kant. Denne Cylinder løber op og ned langs tre[1] Styrestænger d, hvis øvre Ender er forbundne med et Tværstykke, og de nedre Ender er fæstede til en Bund, der har en med Fedt eller Guttapercha fyldt Udskjølpning rundt om, i hvilken Cylinderens nedre Kant passer. I denne Bund er ogsaa en Udtapningskran. Fra Midten af Bunden staar op en Stang, der bærer en Skive med Kanter af ombøjet Kautschuk, og som lukker Cylinderen foroven, naar den er sluppet ned. I denne Skive er et Svikhul, lukket med en Prop. Cylinderen hukes med en Sliphage a i det øvre Tværstykke mellem Stængerne, og denne Hage holder da Cylinderen oppe, medens Apparatet løftes over og langs Skibssiden, men naar man lader det falde i Vandet, løftes Cylinderen lidt af Vandtrykket under Bremmen og Sliphagen falder ned. Vandtrykket holder da Cylinderen fremdeles oppe, saalænge Instrumentet synker raskt, men idet man standser Udfiringen eller ved Bunden, falder den ned og indeslutter Vandet. Hagen b griber fat under Bundstykket og hindrer Cylinderen fra at løfte sig mere, naar den engang er faldt ned.

[1] I Figuren er for Tydeligheds Skyld kun tegnet to.

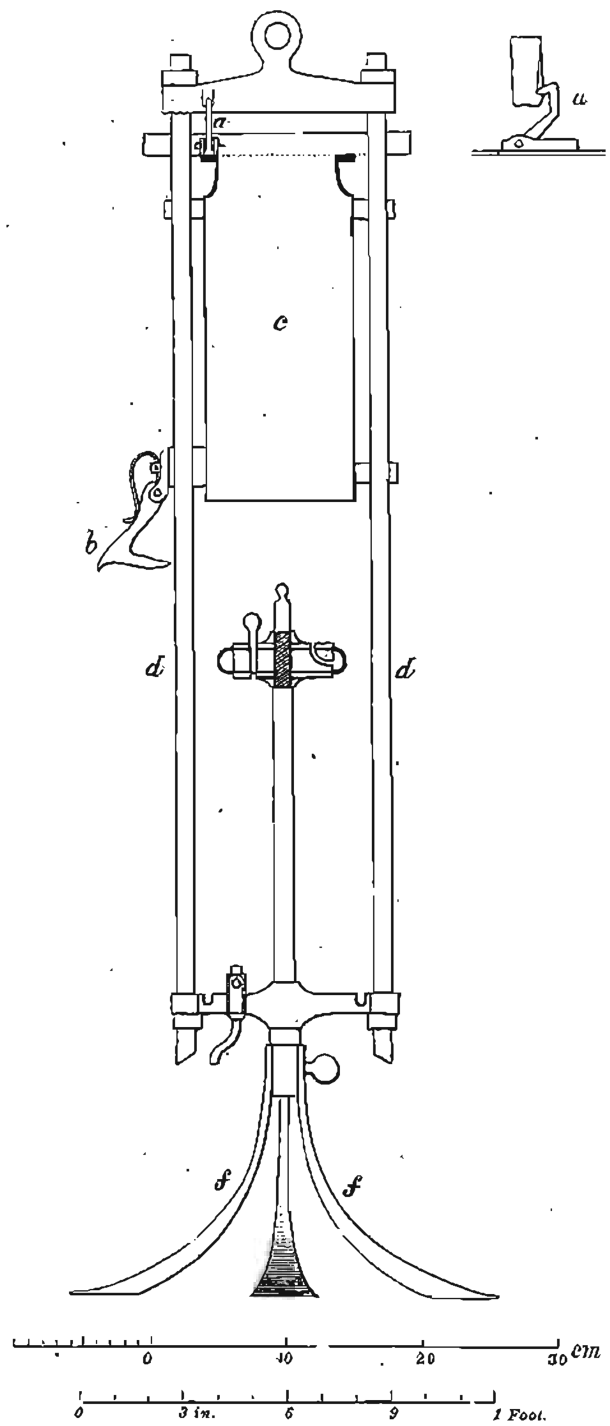

Fig. 12.

the spiral copper tube, it also flowed into the glass tube, expelling the atmospheric air. So soon as the instrument came on board, it was inverted, the stopcock (h) pointing down and the glass tube up. The upper end of the apparatus being then moved gently backwards and forwards, the surplus of air, had any such existed, must obviously have forced its way upwards, and have appeared, in the form of bubbles, at the top of the glass tube, which, however, was invariably found to be full of water; and hence we ceased to attach it when the fact would no longer admit of doubt.

For moderate depths, and when not obliged to check the line in veering out, we used a smaller water-bottle, constructed by Professor *Ekman* of Stockholm. This instrument is represented in Fig. 12. It consists of a brass cylinder (c), open at both ends, and with a flange round the upper rim. The cylinder slides up and down 3[1] metal guides, the upper ends of which are connected by a beam, the lower end being fixed to a circular bottom-piece, having a grooved rim filled with grease or guttapercha, into which the cylinder fits. The bottom-piece is also provided with a stopcock; and, projecting upwards from the centre, extends a stout rod, bearing a metal disk, the rim of india-rubber, which serves to close the top end of the cylinder, on the latter having slid down the guides. In the disk is a spigot-hole, stopped with a plug. The cylinder is attached to the beam, between the guides, by means of a slipping-hook (a), which keeps it suspended when lifting the apparatus and lowering it over the ship's side; but on its reaching the water, the pressure against the under surface of the flange slightly raises the cylinder and slips it off the hook. Meanwhile, the pressure of the water will retain the cylinder at the top of the instrument, the descent being sufficiently rapid; but on checking the line, or the instant the machine touches the bottom, it will slide down and shut in a sample of

[1] To avoid apparent complexity, only two of the guides are shown in the figure.

De nedentil paasatte Jernblade *f* stoder mod Bunden og hindrer, at Kranen bliver fyldt med Mudder. Til vort Brug anbragtes istedetfor disse en fast Jernstang med Øjebolt i den nedre Ende, i hvilken Ror-Loddet indhexedes. Apparatet rummede 2 Liter Vand.

Under de før antydede Omstændigheder er Apparatet særdeles hensigtsmæssigt og Tætningen paalidelig, men kommer noget i Vejen under Nedfiringen, maa hele Operationen gjøres om igjen, og dertil kommer, at Bremmen tilligemed øverste Lukningsskive frembyder en ikke uvæsentlig Modstandsflade under en længere Indhivning.

Forberedelser til Lodning. Lodlinen, 3000 Favne lang, var oprullet paa den agterud om Bagbord i Dækket fastskruede Dækrulle, der sees i Fig. 1, 2 og 14. I Fig. 13 er denne vist tydeligere. Rullens Bom var 0.m627 (2 Fod) lang, 0.m157 (6 Tom.) tyk og af Træ. De cirkelformede Sideflader var af tykke, galvaniserede Jernplader, paa den indre Side plane, paa Ydersiderne forstærkede ved dobbelte Lag af Jernplader. Deres Diameter var 1.m098 (3 Fod 6 Tom.) og deres Kanter var afrundede, saa at de frembød en glat, ringformig Flade af omtrent 2.cm6 (en Tommes) Diameter. Paa Bagbord Side var anbragt en Svejv af 0.m31 (1 Fods) Længde med Træhaandtag. Stativets trende Dele var nedentil forbundne med Jernstænger, og det hele hvilede paa et Par langskibs løbende Bjælker, gjennem hvilke Stativet var skruet fast til Dækket.

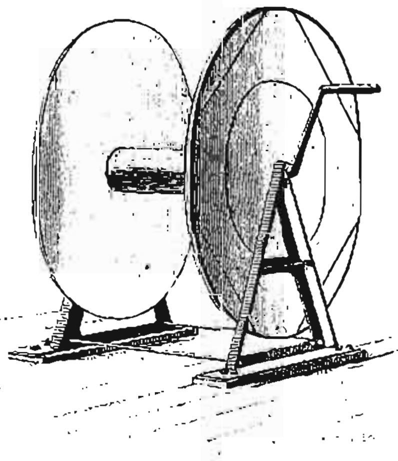
Fig. 13.

Tampen af Lodlinen toges fra Rullen og manedes gjennem Fodblokken paa Agterkant af Hytten (Fig. 14.) Denne Blok var lidt mindre end Loddeblokken, og Skiven solid, men forøvrigt af samme Konstruktion som denne. Derfra manedes Lodlinetampen videre gjennem Loddeblokken, der hang under Accumulatoren. Accumulatoren var i sin øvre Ende fæstet til et *Topreb*, hvis anden Ende var fastgjort over Godset paa Storsalingen (Fig. 14.) Med en firskaaren Tålje haledes nu Accumulatoren ud paa sin Plads under Bagbords Storraa-Nok. Storraaen brasedes saaledes, at Accumulatoren kom omtrent for Midten af Loddebroen, og blev i denne Stilling forstøttet med Braser, Toplenter og Rakke. Lodlinen ihexedes øverste Øjebolt i Vandhenteren, eller Ringen i Rørloddet, eller Ringen i Røret til Baillie-Maskinen, efter Omstændighederne. Benyttedes Willes Vandhenter, hexedes Rørlod eller Baillie-Maskinen i dennes nederste Øjebolt. Disse Forberedelser blev truffet, medens Fartøjet endnu var i Gang. De følgende Manøvrer, der udførtes dels for at holde Fartøjet saavidt muligt paa Plads under Lodningen, dels for at faa

water. Once down, the cylinder is kept in position by a hook (*b*), which catches on the under surface of the bottom-piece. The iron fenders (*f*) at the lower end of the instrument serve to protect it when striking the bottom, and prevent mud or rubble from fouling the stopcock. In lieu of the fenders, we substituted an iron rod, having at the lower end an eye-bolt, to which the tube-lead was attached. The apparatus brings up about 2 litres of water.

Properly used, the Ekman water-bottle gives every satisfaction. There is no leakage; but should any mishap occur in veering, the whole operation will have to be repeated; moreover, the flange of the cylinder and the disk at the top offer considerable resistance in hauling up the instrument.

Preparations for Deep-sea Sounding. — The sounding-line — length 3000 fathoms — was wound on the port side of the after-deck on a large, strong reel, secured by screws (Figs. 1, 2, and 14) to the deck. Fig. 13 conveys a clearer idea of the arrangement. The barrel of the reel was of wood, 2 feet 3 3/4 inches long by 6 3/16 inches in diameter, the two terminal disks being of thick, galvanized sheet-iron, strengthened on the outer surface by a double plating of the same material. They measured 3 feet 7 1/4 inches in diameter, and were rounded at the circumference, so as to give them a smooth annular rim, about an inch broad. At the port end, the reel had an iron lever-arm, 1 foot in length, with a wooden handle. The two supports of the frame were connected underneath by means of iron stays, the whole apparatus being made to rest on a couple of beams running fore and aft, through which the frame was screwed to the deck.

The end of the line was run off the reel and rove through the leading-block on the after part of the round-house (Fig. 14.) This block was a trifle smaller than the sounding-block and had a solid sheaf, though in other respects similarly constructed. From thence the line was rove through the sounding-block, which hung beneath the accumulator. This apparatus was attached to a strong pendant, made fast above the gear of the main cross-trees (Fig. 14), and by means of a gun-tackle purchase hauled out under the port main yard-arm, the yard being trimmed so as to bring the accumulator as near as possible abreast of the sounding-bridge, and kept in position by the braces, topping-lifts, and trusses. The line — according to the nature of the operation — was next shackled to the upper eye-bolt of the water-bottle, the ring of the tube-lead, or the ring of the tube of the Baillie machine. When using Wille's water-bottle, we hung the sounding-instrument — the tube-lead or the Baillie machine — to the lower eye-bolt. These preparations were made with the vessel steaming ahead; the subsequent manœuvres, for keeping the ship in position

Loddet i Bund, udførtes samtidig med Fartøjet og med Apparaterne paa Dæk.

Manøvre med Fartøjet. Ved Ankomsten til Loddestationen lagdes Fartøjet med Stevnen ret imod Vinden og stoppedes. I denne Stilling søgte man nu at holde

and for sinking the lead to the bottom, we carried out together, handling the vessel and the deep-sea apparatus simultaneously.

Handling the Ship. — On arriving at a sounding-station, the vessel was put head to wind and her way deadened. In this position we tried to keep the ship as

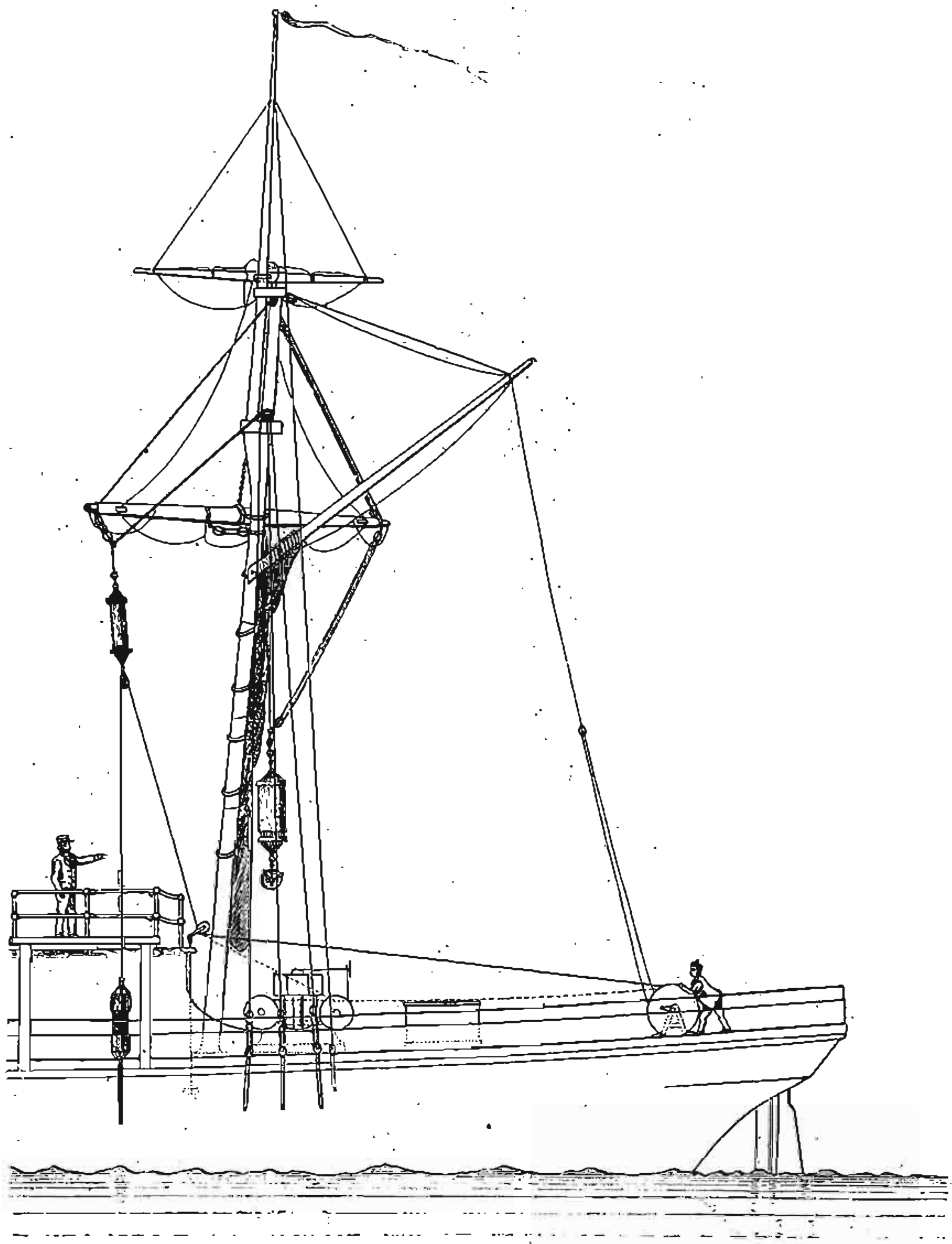

Fig. 14.

det paa samme Plads hele den Tid, Loddet behøvede for at komme til Bunds. Ved afvexlende at lade Maskinen gaa langsomt forover, naar Fartøjet begyndte at sakke, og stoppe, naar Lodlinen begyndte at vise agterover, opnaaedes i Regelen Hensigten, idet Skruevandet gav tilstrækkeligt Tryk,

near as possible stationary during the passage of the lead to the bottom. By alternately starting the engine as soon as the vessel had got sternway and stopping when the line began to point aft, we generally managed to gain our object, the water thrown back by the screw acting on the rudder til at Roret kunde virke og benyttes til at støtte for Affald til den ene eller den anden Side. I løj Bris sattes undertiden bakt Fortopsejl, hvorved opnaaedes større Modstand mod Skruens Virkning, saaledes at Maskinen kunde gaa hurtigere forover og med mindre eller ingen Afbrydelse, hvorved Styringen blev saameget mere virksom. Desuden kunde Fartøjet ogsaa styres ved at brase Topsejlet.

Naar Vinden var meget svag, Søen rolig og Dybden ringe, kunde Lodningen udføres ved at lægge Fartøjet tvers paa Vinden med Lodlinen til Luvart.

Med stiv Kuling og høj Sø var det selvfølgelig nødvendigt at anvende stor Paapasselighed for at kunne holde Skibet i den rigtige Stilling med Stevnen mod Vinden. Det var under saadanne Omstændigheder ofte ikke muligt for Rorgjængeren med det langsomt virkende Styreapparat at undgaa, at Bougen faldt af til den ene eller til den anden Side. Et begyndende Affald til Styrbord kunde i Regelen standses med Styrbord Ror og et Par Slag fuld Fart forover, der kunde give Roret Drejningskraft, uden at Skibet begyndte at skyde over Stevn. Hjalp ikke dette, gaves derpaa fuld Fart agterover, hvorved Skruen drejede Agterskibet til Styrbord — denne Grund var væsentlig bestemmende for at lade Lodningen foregaa om Bagbord — og fjernede dette fra Lodlinen, og derefter fuld Fart forover med Styrbord Ror, indtil man fik Stevnen op i Vinden igjen og Lodlinen lodret.

Besværligere blev Manøvren, naar Skibet, uagtet al anvendt Forsigtighed, faldt med Bougen Bagbord ud over Linen. Dersom det da ikke lykkedes ved enkelte Slag forover og agterover og Skiftning af Roret at faa Vinden ind om Bagbord, saa man med Fart forover og Styrbords Ror kunde komme op i Vinden med Linen klar af Siden, var der intet andet at gjøre end med afvexlende fuld Fart forover og agterover at dreje Skibet helt rundt om Lodlinen Bagbord over, indtil man atter kom op med Stevnen mod Vinden, og Linen visende lodret.

Man kunde ogsaa i ikke altfor svær Sø med Fordel lægge Agterenden mod Vind og Sø, og med Lodlinen til Luvart holde Fartøjet paa Plads med Skruen gaaende agterover, idet Agterenden i saadant Fald altid søger op imod Vinden.

Lodning med Rør-Lod. Loddet (med Vandhenter) løftedes, saasnart Skibets Fart var standset, ud over Loddebroen, og firedes, idet en Mand drejede Svejven paa Rullen, omtrent en Favn ned. Dybvandsthermometerne sattes fra Loddebroen fast paa Lodlinen. Ved Rullen stod 2 Mand, med Læderhandsker paa Hænderne, paa hver sin Side af denne og trykkede med Magt paa Sidefladernes afrundede Kanter. Alt var nu færdigt til at „Lade gaa". Idet den kommanderende Officer fra Loddebroen gav Ordren: „Lad gaa"! slippedes Svejven paa Rullen løs, Loddet og Lodlinen tog Fart, og Rullen drejede sig rundt. Det er dette Øjeblik, der er fremstillet i Fig. 14. De to Mænd med Læderhandskerne regulerede ved sit Tryk paa Rullen Bevægelsen saaledes, at den blev saa jevn som muligt, hvad der

with sufficient force to give steerage way and prevent the ship from falling off. In a light wind we sometimes set the fore topsail aback, and thus, by occasioning greater resistance to the action of the screw, enabled the engine to work quicker a head and with little or no interruption, which made the steering more effective. The ship could be steered, too, by bracing the topsail.

If there was very little wind and no sea, we could sound, in comparatively shallow water, with the vessel laid beam to wind and the line to windward.

In a stiff breeze and with a heavy sea running, great care and attention were obviously needed to keep the ship in position with her head to the wind; nay, the helmsman, owing to the necessarily tardy action of the steering-gear, found it impossible to prevent her from now and again paying off. If she fell off to starboard, we generally managed to bring her up by putting the helm a-starboard and starting the engine ahead, a few strokes of the screw being sufficient for the rudder to act, without getting way on the ship. This failing, we gave her full speed astern, upon which the action of the screw, bringing the stern of the vessel to starboard, kept it clear of the sounding-line (the certain result of this manœuvre was indeed our main reason for carrying on the sounding operations from the port side), and then steamed full speed ahead till the ship was again head to wind and the line pointed right up and down.

When the vessel, in spite of every precaution, had fallen off with her head to port across the line, the difficulty of bringing her to was much greater. In that case, if we failed by a few strokes of the screw ahead and astern, and by shifting the helm, in getting the port side to windward, so as, on starting the engine ahead, with the helm a-starboard, to bring the ship head to wind and clear of the line, our only resource lay in working her head to port round the line, by steaming full speed alternately ahead and astern, till we had again got her head to wind, with the line right up and down.

In comparatively moderate weather, we found it a good plan to lay the ship stern to wind and sea, with the line to windward, and keep her in position with reversed engines, the stern then invariably working up against the wind.

Sounding with the Tube-lead. — As soon as the vessel had lost her headway, the lead (with the water-bottle attached) was lifted over the sounding-bridge, and then lowered about a fathom, a man turning the handle of the reel. The deep-sea thermometers were fastened to the line from the bridge. Two men, their hands protected by leather gloves, stood one on either side of the reel, and pressed against the annular rim of the sheet-iron disks. Everything was now ready for the operation. At the moment the officer in charge, from his station on the sounding-bridge, gave the word to let go, the man grasping the handle of the reel let go his hold, and the lead immediately dropped, dragging after it the line, which, in running out, caused the reel to revolve. This is the stage of the operation reer af Vigtighed for Nøjagtigheden af den følgende Beregning af Dybden. Det Stykke af Lodlinen, der er mellem Rullen og Fodblokken, maa altid have en passende Stramning, saat Linen ikke under Bevægelsen slaar Bugter, der kunde bringe den til at kaste sig om en eller anden fremstaaende Gjenstand og derved foraarsage Havarier eller en pludselig Standsning af Lodlinens Bevægelse. Denne Bremsning fordrer derfor baade Opmerksomhed, Kraft og Øvelse.

I 1877 forsøgte jeg en mekanisk Bremse paa Rullen, men den viste sig upraktisk og anvendtes kun nogle Gange. Naar Skibet løfter sig paa Søen, rives Linen af Rullen med stor Kraft, og naar det atter sænker sig, formindskes Loddets Drag, ja ophæves undertiden næsten for et Øjeblik. Disse uafladelige Forandringer føles strax, naar man bremser med Haand, og med nogen Øvelse vænner man sig til at bremse netop det nødvendige, men med den mekaniske Bremse viste det sig ugjørligt at følge Forandringerne, der ikke føltes gjennem Apparatet.

Ved Dybder, der ikke oversteg 900 til 1000 Favne, mærkedes bedst, at Loddet slog i Bund, derved, at man lod Linen løbe ganske løst gjennem Haanden, og man følte da en pludselig Aftagen i Udløbshastigheden. Man kunde ogsaa tydelig se det derved, at Linen mellem Fodblokken og Rullen lagde sig pludselig flad ned paa Dækket. Saasnart over 700 Favne var ude, var den Bremsning, der udfordredes for at holde Linen stram, kun ringe. I nogle faa Tilfælder, i hvilke der blev loddet paa 1100 til 1200 Favne med Rørlod alene, viste det sig, at det ikke var muligt at iagttage det Øjeblik, da Loddet kom i Bund. Linen vedblev at løbe ud paa Grund af sin egen Vægt med en Hastighed, der ikke var synligt forskjellig fra den Hastighed, hvormed den løb med Loddet som Tillægsvægt. Under saadanne Omstændigheder loddedes om igjen med Baillie-Maskine, dersom det ansaaes fornødent at faa et nøjagtigt Lodskud. Med Rørlod og Willes Vandhenter sammen kunde der faaes gode Lodskud paa over 1100 Favne, som et Forsøg paa Station 247 viste. Her gav nemlig Baillie-Maskinen 1120 Favne, medens Rørlod med Vandhenter gav 1124 Favne.

Bestemmelse af Dybden. Da Lodlinen for de større Dyb kun var mærket for hver 100 Favne, maatte det nøjagtige Favnetal søges ved særegne Observationer og Beregninger. Den fra først af brugte Fremgangsmaade var følgende. I det Øjeblik, Loddet gik i Vandet, og naar et Hundrede-Favne-Mærke gik i Vandet, raabtes „Nu" og Klokkeslettet noteredes i Loddejournalen paa nærmeste Sekund. Forat give Noteringerne større Sikkerhed, varskoedes af Folkene ved Rullen altid i Forvejen „Mærke", naar et af Mærkerne gik af Rullen. I det Øjeblik Loddet var i Bund, raabtes „Bund" og det tilsvarende Klokkeslet noteredes. Af Rækken af de under hverandre noterede Klokkeslet toges første Differents. Disse Tal stige med Dybden, idet Udløbshastigheden aftager med Længden af den gjennem Vandet løbende Lodline. Dernæst beregnedes

presented in Fig. 14. The two men with leather gloves endeavoured, by pressing upon the reel, to keep the motion as uniform as possible, this being an essential condition for accurately computing the depth. When veering, the line between the reel and the leading-block must be kept sufficiently taut, to prevent its running out in bights, that might catch on some projecting object, and thus occasion damage, or possibly a sudden stoppage of the line. Hence, skilful braking requires care, practice, and physical strength. In 1877 I tried a mechanical brake; it proved, however, inefficient, and was used only a few times. When the vessel heaves, the line is run off the reel with great violence, and on her plunging into the trough of a sea, the drag of the lead becomes greatly diminished, nay, for a moment may be taken off altogether. These constant alternations are instantly felt when the braking is done by hand; and with some little practice, the brakesmen can calculate to a nicety the needful amount of pressure, whereas with the mechanical brake we found it impossible to follow the changes, which could not be felt through the machine.

In depths not exceeding 900 or 1000 fathoms, the best way of determining the exact moment when the lead struck the bottom, was to let the line run loosely through the hand, when a sudden dismimishment of velocity would be felt. Nay, it could be distinctly *seen*, the line between the leading-block and the reel becoming all at once slack and dropping down on the deck. Having veered to a depth of 700 fathoms, there was no great need of braking to keep the line taut on the remainder of the downward journey. In some few instances, when sounding in from 1100 to 1200 fathoms with the tube-lead alone, we found it impossible to tell exactly when the lead touched the bottom. The line went on running out by its own weight only, and moreover, with a velocity that did not sensibly differ from that given it by the additional weight of the lead. Hence, when accuracy of measurement was the chief desideratum, we had to sound again, and with the Baillie machine. Sent down along with Wille's water-bottle, the tube-lead gave good results, as shown at Station 247. Here, the Baillie machine indicated a depth of 1120 fathoms, and the tube-lead used with Wille's water-bottle, 1124.

Determination of Depth. — The line for deep-sea soundings being graduated into hundreds of fathoms, the exact depth had in each case to be computed from special observations. Our mode of procedure was, at first, as follows:— The moment the lead entered the water, as also one of the slips of bunting on the line, an officer called out, and the time to a second was entered in the sounding-journal. To attain greater accuracy, the brakesmen had to give timely notice for every slip of bunting run off the reel; the instant the lead struck the bottom, the officer gave the word, and the time was entered in the journal. From the series of entries was computed the first difference, or set of intervals. These figures increase with the depth, the velocity diminishing with the length of the line running out through the water. The second difference of the series

2den Differents af Rækken, hvilken, fraregnet de uundgaaelige mindre Variationer i Udløbshastigheden, viste sig at være paa det nærmeste constant. Med denne anden Differents beregnedes Størrelsen af Tidsintervallet for Udløbet af det sidste observerede Hundredefavnemærke til det næste Mærke, inden hvilket 100 Favne-Interval altsaa Loddet kom i Bund. Ved Hjælp af dette Tal og den mellem Udløbsøjeblikket for det sidst observerede Hundrefavnemærke og Øjeblikket for „Bund" forløbne Tid beregnedes ved simpel Proportion, hvor mange Favne der vare udløbne mellem de tilsvarende Øjeblikke. Denne Længde, tillagt Numeret for sidste observerede Mærke, bliver Lodskuddet eller Dybden.

Som Exempel anføres her et Uddrag af Loddejournalen, der tillige viser dennes Indretning.

No. 129.		Dato	1877 Juni 20
		Bredde	67° 40'.5 N.
Klokkeslet	4h 30m p. m.	Længde	6° 42' E. Greenw.
Vind	NE.	Lufttemperatur	5°.9
Styrke	3	Overflade do.	6.8
Vejr	Skyet.	Dybde	709 e Fv.
Sø	NE. 4	Bund	Brun Ler
Vægt	112 Pd.	Karakter	Godt.

Favne.	Tid.			Interval.		2den Diff.
	T.	M.	S.	M.	S.	Sec.
Lad gaa	4	46	30	1	11	
100		47	41	1	13	2
200		48	51	1	30	17
300		50	24	1	42	12
400		52	6	1	55	13
500		54	1	2	3	8
600		56	4	2	9	6
700		58	13	0	15	
Bund		58	28			

For Intervallet 700 til 800 Favne beregnes Udløbstiden til $2^m\ 9^s + 6^s = 2^m\ 15^s = 135^s$. Altsaa faaes Proportionen:

$135^s : 100$ Favne $= 15^s : 11$ Favne.

Efter dette skulde Dybden være 711 Favne. Ved Udmaaling af det Stykke af Lodlinen, der var i Vandet i det Øieblik, Loddet slog i Bund, over 700 Favne, efter den nedenfor beskrevne Methode, fandtes 9 Favne, altsaa Dybden 709 Favne, som opført i Loddejournalen.

Nøjagtigheden af Tidsintervalmethoden beror, som man ser, ganske paa den Grad af Jevnhed i Bevægelsen, som kan tilvejebringes ved Bremsningen. Resultatet tiltrænger derfor en Kontrol ved andre Methoder, saaledes som det stadig blev gjort paa vor Expedition. Ved at sammenligne Resultaterne af de forskjellige Methoder viser det sig, at Tidsintervalmethoden næsten altid giver for store Tal.

was calculated from the first, and the figures thus obtained, if we except all minor variations in velocity, proved very nearly constant. From the second difference was computed the interval that would have elapsed, had the depth been sufficient, ere the slip of bunting next in succession to that last run off could have entered the water, and within which the lead had accordingly reached the bottom. Then, with the figure thus found and that denoting the time between the moment when the last slip of bunting reached the water and that at which the lead struck the bottom, was computed, by simple proportion, the odd number of fathoms, which, added to the length on the slip last run off the reel, gave the true sounding, or depth.

The following is an extract from the sounding-journal, showing its mode of arrangement.

No. 129.		Date	1877 June, 20th.
		Lat.	67° 40'5 N.
Time	4.30 p. m.	Long.	6° 42' E.
Wind	NE.	Temp. of Air	5°9
Force	3	Do. of Sea	6°8
Weather	Cloudy	Depth	709 Fathoms.
Sea	NE. 4	Bottom	Brown Clay.
Weight	112 pounds	Character	Good.

Fathoms.	Time.			Interval.		2nd Diff.
	h.	m.	s.	m.	s.	s.
0	4	46	30	1	11	--
100	4	47	41	1	13	—
200	4	48	54	1	30	2
300	4	50	24	1	42	17
400	4	52	6	1	55	12
500	4	54	1	2	3	13
600	4	56	4	2	9	8
700	4	58	13	0	15	6
Bottom.	4	58	28			

Now, the interval from 700 to 800 fathoms is found to be 2m 9s + 6s = 2m 15s = 135s; and hence

135s : 100 fathoms : : 15s : 11 fathoms.

This would make the depth 711 fathoms. Measuring by the method described below the part of the line which, in addition to the 700 fathoms, had run out when the lead struck the bottom, we get 9 fathoms, and thus a depth of 709 fathoms, the depth entered in the sounding-journal.

As regards the accuracy of the method of computation by time-intervals, it is obvious that this must be wholly dependent upon the degree of uniformity attainable in braking. The results will have in each case to be tested by some other method; and this was invariably done on the Norwegian Expedition. On comparing together the results of the different methods, the figures obtained

En anden Methode var at tage Tidsintervaller under Indhivningen af Lodlinen, idet man lod Indhivningsmaskinen gaa saa jevnt som muligt. Herved fik man bestemt det Tidsrum, Maskinen brugte for at tage ind 100 Favne saavelsom det Tidsrum, den med samme Hastighed tog ind Overskuddet over sidste Hundredefavnemærke, og Længden af det sidste kunde saaledes bestemmes ved simpel Proportion. Med jevnt Damptryk og jevn Damptilførsel til Maskinen, hvilke er lettere at holde end jevn Bremsning især i urolig Sø, giver denne Methode gode Resultater. Dens Resultater antoges, naar den anvendtes med de nævnte Forudsætninger, som de definitive, forsaavidt ikke den i det følgende beskrevne Methode kom til Anvendelse. De Lodskud, som i 1876 falde paa Dybderne mellem 100 og 300 Favne, beregnedes udelukkende efter den sidst beskrevne Methode.

Den tredie Methode, der er den sikreste, indførtes først i 1877. Idet Loddet løftedes af Bunden, viste Virkningen af dets Vægt sig paa Accumulatoren, der pludselig strakte sig noget ud. En Mand, som stod klar ved agterste Spiltap, greb i dette Øjeblik paa givet Signal med den ene Haand om halende Part af Linen over Midten af Tappen, og fulgte med Linen, idet denne rulledes op paa Rullen, agterover en paa Dækket afsat Længde af 3 Favne. Naar han kom til agterste Mærke, slap han Linen og raabte „En". Næste Mand greb da fat om Linen ved Tappen, og naar han kom til agterste Mærke, raabte han „To" o.s.v. Idet det sidst udløbne Hundredefavnemærke kom i Vandskorpen varskoedes „Stop". Den søgte Længde af Lodlinen fandtes saaledes ved direkte Udmaaling med en Nøjagtighed af en Brøkdel af en Favn.

Ved de mindste Dybder, for hvilke Lodlinen var mærket for hver 10de Favn, bestemtes det enkelte Favnetal i Regelen ved direkte Udmaaling, dels alene, dels som Control for Tidsintervaller med Indhivningsmaskinen.

Lodning med Baillie-Maskinen. Denne blev gjort i Stand paa Agterdækket lige agtenfor Hytten som før forklaret. Saasnart de nødvendige Forberedelser med Lodlinen og Accumulatoren, de samme som ovenfor beskrevne, var færdig, hexedes Lodlinen til Ringen i Baillie-Maskinen eller til øverste Øjebolt i Vandhenteren og i dette Tilfælde nederste Øjebolt i Vandhenteren til Ringen paa Røret. Linen stivhaltes og lagdes rundt Tapperne paa Indhivningsmaskinen. Med denne løftedes nu, naar Fartøjet var stoppet, det hele over Rækken mellem Hytten og Storvantet (Fig. 14) og firedes ned i Vandet for ikke at komme i Svingning og Berøring med Skibssiden under Fartøjets Bevægelser. Dybvandsthermometrene fastgjordes derefter paa Linen 1 à 2 Favne over Vandhenteren eller Lodderne, hvorpaa man med Indhivningsmaskinen udfirede raskt 200 eller 300 Favne. Maskinen standsedes, Stopper paasattes i Forhaand paa Hyttedækket, Linen kastedes af Spiltapperne og rulledes

from computation by time-intervals almost always proved too high.

Another method practised was to measure time-intervals during the winding in of the line, due care being taken to regulate with the greatest nicety the working of the donkey-engine. We could thus determine both the time required for bringing in 100 fathoms and that needed for hauling in the surplus portion of the line run out after the last 100 fathom slip had reached the water, the length of which was then computed by simple proportion. With an equable steam pressure and an equable supply of steam, which is much easier to keep up, more especially in a rough sea, than uniform manual braking, this method will give good results; and hence, when carefully obtained, we regarded such as final, save when the method described below was also had recourse to. The soundings taken in 1876 that embrace depths from 100 to 300 fathoms, were computed exclusively by this method.

The third method, which is the most trustworthy, was not adopted till 1877. On the lead being lifted from the bottom, its weight tells upon the accumulator, which instantly yields a little to the strain. Then, at a given signal, a man, stationed for the purpose at the after drum of the donkey-engine, laid hold of the line as near as may be above the middle of the drum, and while the leading part was being wound on the reel, went aft with it for a distance of 3 fathoms, which had been marked off on the deck, and thereupon let go, calling out as he did so — „One"! Another man then caught hold of the line above the drum, went the same distance aft, and cried — „Two"! and so on in like manner. The instant the 100 fathom slip last run out appeared above the surface of the water, a man called out — „Stop"! Thus, by actual measurement, we found the length of the line within a fraction of a fathom.

Soundings in shallower water, for which the line was graduated into tens of fathoms, we generally determined by direct measurement, whether taken as independent operations or as a means to test the accuracy of the time-intervals registered when heaving in the lead.

Sounding with the Baillie Machine. — As previously stated, this instrument was got ready for use on the after-deck, just abaft the roundhouse. After arranging, in the manner described above, the sounding-line and the accumulator, we shackled the former either to the ring of the Baillie machine or to the upper eye-bolt of the water-bottle, the lower eye-bolt being in the latter case attached to the ring of the tube. The line was now hauled taut and passed round the drums of the donkey-engine. Then, having deadened the ship's way, we hoisted, by means of the donkey-engine, the whole of the gear over the railing, between the roundhouse and the main shrouds (Fig. 14), and lowered it into the water, to prevent the machine from oscillating and from bumping against the side of the vessel. The deep-sea thermometers were next made fast to the line, 1 or 2 fathoms above the water-bottle or the weight, after which we rapidly veered 200 or 300 fathoms fast paa Rullen agterud, hvor 2 Mænd stode færdige til at bremse. Derpaa kommanderedes „Lad gaa"! og Lodningen udførtes som ovenfor for Rør-Loddet beskrevet.

Udfiringen af Baillie-Maskinen til 200 eller 300 Favnes Dyb, før man lader gaa, er nødvendig paa Grund af den store Vægt, Lodlinen har at bære, og som vilde gjøre det umuligt med de havende Bremsemidler at kunne regulere Linens Bevægelse. De 200 til 300 Favne Lodline, der ved Operationens Begyndelse allerede er i Vandet, giver saamegen Friktion, at det er Bremserne muligt, om end med Anstrængelse, at holde Rullens og Linens Bevægelse under Kontrol.

Ved Lodning paa større Dyb er det ikke saa let at iagttage det Øjeblik, da Loddet naar Bund, som ved mindre Dybder. Linen lægger sig ikke ned i Dækket, men vedbliver at løbe fra Rullen, efterat Loddet er i Bund, med en Hastighed, der ofte kun er lidet mindre end under Loddets Synken. Ved med udelt Opmærksomhed at følge Linens Fart, navnlig dens Bevægelse gjennem Loddeblokken under Accumulatoren, har man imidlertid et næsten altid sikkert Middel til at observere Øjeblikket, naar Loddet slaar i Bund: man ser da nemlig Blokskivens Rotationshastighed pludselig formindsket. En første Kontrol har man strax deri, at Slakken af Lodlinen nu kan hales ind med Haandmagt, medens det, saalænge Loddet løber, i Regelen vil vise sig ugjørligt ved Haandmagt at standse Bevægelsen. Den sædvanlige Kontrol med Notering af Klokkeslet for hvert Hundredefavnsmærke, som gaar i Vandet, anvendtes jevnlig. Den sidste Kontrol havdes endelig deri, at Accumulatoren i det Øjeblik, Lodrøret (og Vandhenteren) løftedes af Bunden, tydelig strakte sig ud. Fra dette Øjeblik begyndte man, som ovenfor beskrevet, at maale Favnetallet over sidst udløbne Mærke. Naar Øjeblikket, da Loddet slog i Bund, var utvivlsomt at iagttage paa den udløbende Line, viste Methoden med Tidsintervaller for hver 100 udløbne Favne sig ulige paalideligere ved Baillie-Maskinen end ved Rørloddet.

Exempel.

No. 354.	Dato 1878 August 11.
	Brédde . . . . . 78° 1′ N.
Klokkeslet . . 4h 40m p. m.	Længde . . 6° 54′ E. Greew.
Vind . . . . . N.	Lufttemperatur 3°.0.
Styrke 3	Overflade do. 4°.5
Vejr . . . . . Skyet	Dybde . . . . . 1343 e. Fv.
Sø 3	Bund . . . . Biloculin - Ler
Vægt . . . . . 315 Pd.	Karakter . . . . Meget godt.

of line with the donkey-engine. The engine was now stopped, the fore part of the line secured with a stopper to an eye-bolt on the deck of the roundhouse, and the after part removed from the drums and tightly wound on the reel aft, where a couple of men stood ready to commence braking. The word being now given to let go, the operation was carried out in the manner described above for sounding with the tube-lead.

Veering the apparatus 200 or 300 fathoms preparatory to letting go, was indispensible with the Baillie machine, owing to the great strain upon the sounding-line, the motion of which would otherwise have been impossible to regulate with the means of braking at our disposal. The friction of the 200 or 300 fathoms of line in the water at the beginning of the operation, enable the brakesmen, though with some little exertion, to command the revolutions of the reel and the motion of the line.

When sounding in greater depths, it is by no means so easy as in water comparatively shallow to tell the exact moment at which the lead touches the bottom. The line will not drop flat on the deck, but go on running off the reel, even after the lead has reached the bottom, and with a velocity but very little inferior to that it had during the descent of the lead. Meanwhile, by closely noting the speed of the line, in particular where it passes through the sounding-block below the accumulator, we have, in the great majority of cases, a sure means of accurately determining the moment when the lead strikes the bottom, the rotation of the sheaf of the block becoming instantly slower. Moreover, the slack part of the line can then be readily brought in by hand, whereas so long as the lead is sinking, it will, as a rule, be found impossible to check its motion by physical strength alone. The usual mode of measurement, by noting down the exact time at which each of the 300 fathom slips entered the water, was frequently adopted. As a final resort, we had the test afforded by the visible extension of the accumulator the instant the sounding-tube and the water-bottle were lifted from the bottom. We then, as stated above, immediately began to measure off the number of fathoms run out after the last slip had entered the water. Provided the arrest of the weight at the bottom could be accurately determined by observing the velocity of the line, the method of measuring by time-intervals, for every 100 fathoms run out, was found to be far more trustworthy with the Baillie machine than with the tube-lead.

Extract from the Sounding-journal.

No. 354.	Date 1878 August 11th.
	Lat. . . . . . 78° 1′ N.
Time . . . . . . 4 40 p. m.	Long. . . . . 6° 54′ E.
Wind . . . . . . N.	Temp. of Air 3°. 0.
Force . . . . . 3.	Do. of Sea 4°. 5.
Weather . . . . Cloudy	Depth. . . . 1343 Fath.
Sea 3	Bottom . . . Biloculina Clay.
Weight . . . . 315 pounds	Character. . Very good.

Favne.	Tid.		Interval.		2den Diff.
	M.	S.	M.	S.	S.
200	16	32			
300	17	27	0	55	10
400	18	32	1	5	3
500	19	40	1	8	9
600	20	57	1	17	2
700	22	16	1	19	3
800	23	38	1	22	19
900	25	19	1	41	—5
1000	26	55	1	36	2
1100	28	33	1	38	1
1200	30	12	1	39	4
1300	31	55	1	43	
Bund	32	44	0	49	

Med det beregnede Interval 1m 47s for Længden 1300 til 1400 Favne findes for det observerede Interval af 49s en Længde af 46 Favne, eller den udledede Dybde 1346 Favne. Ved den nøjere Eftermaaling fandtes 1343 Favne. Paa 78° 2′ N. 6° 44′ E fandt den Svenske Expedition med „Sofia" den 14de August 1868 en Dybde af 1350 Favne. „Sofias" paaværende Plads var omtrent 2 Kvartmil W for „Vöringens", og da Bunden fra Spitsbergen af her skraanede nedad mod Vest er Overensstemmelsen mellem begge Expeditioners Lodninger efter al Sandsynlighed endnu større, end de ovennævnte Tal udtrykker.

Lodlinens Ophaling. Efterat Loddet var kommet i Bund, gaves de medsendte Dybthermometre Tid til at antage det omgivende Vands Temperatur, og derpaa lagdes Lodlinen om Tapperne paa Indhivningsmaskinen. Dens Visning sees af de prikkede Linier i Fig. 14. Fra Fodblokken gik Linen først til agterste Spiltap, derfra frem og tilbage gjennem begge Tappers Furer og endelig paa Rullen. Ophalingen begyndte, og under denne rulledes Lodlinen strax op paa Rullen, saaat den altid var klar til næste Lodskud. Maalingen af Dybden under Ophalingen er ovenfor beskrevet. Indhivningen gik jevnt, og Maskinen bragte 100 Favne Line hjem i Løbet af 3 Minutter.

Naar Loddet nærmede sig Vandskorpen, skede Indhivningen langsommere. Thermometerne toges af Linen, under fornøden Stands i Indhivningen, eftersom de kom over Rækken paa Loddebroen, og tilsidst toges Vandhenter og Lod ind paa denne, hvor de hexedes af. Vandhenteren endevendtes og tømtes af Chemikeren. Bundprøven undersøgtes først, som den laa i Lod-Røret og dens Art noteredes i Loddejournalen. Derpaa toges den ud af Røret og bragtes paa Flasker eller Glas, som forsynedes med Stationens Nummer paa Etiketten. I 1876 brugtes Selters-vand-Flasker med Korkeprop, i 1877 og 1878 cylindriske Glas, ca. 10cm høje og brede, der lukkedes med Pergament-

Fathoms.	Time.		Interval.		2nd Diff.
	m.	s.	m.	s.	s.
200	16	32			
300	17	27	0	55	10
400	18	32	1	5	3
500	19	40	1	8	9
600	20	57	1	17	2
700	22	16	1	19	3
800	23	38	1	22	19
900	25	19	1	41	—5
1000	26	55	1	36	2
1100	28	33	1	38	1
1200	30	12	1	39	4
1300	31	55	1	43	
Bottom	32	44	0	49	

The interval computed for 1300 to 1400 fathoms being 1m. 47s., the interval last observed, 49s., will correspond to a length of 46 fathoms, which, added to 1300, gives a depth of 1346 fathoms. By actual measurement, as described above, we got 1343 fathoms. The Swedish Expedition with the "Sophia," sounding on the 14th of August, 1868, in lat. 78° 2′ N., long 6° 44′ E., registered a depth of 1350 fathoms. The position of the "Sofia" was about two miles to the west of that of the "Vöringen;" and as the sea-bed shelves from the shores of Spitzbergen in a westerly direction past this locality, the agreement shown by the soundings of the two Expeditions is probably even greater than expressed by the above figures.

Heaving in the Line. — The lead having reached the bottom, sufficient time was allowed for the deep-sea thermometers to assume the temperature of the surrounding water, after which the sounding-line was passed round the drums of the donkey-engine, as shown by the dotted lines in Fig. 14. From the leading-block, the line was first led to the after drum, then passed backwards and forwards along the grooves of both drums, and finally on to the reel. Thereupon the heaving in commenced, the line, as it came up, being wound on the reel, ready for the next sounding. Our mode of determining the depth when heaving in the lead has been already described. The line was brought in at the uniform rate of 100 fathoms in 3 minutes.

On the lead nearing the surface of the water, the speed of the donkey-engine was reduced. The needful stoppages, too, were made to detach the thermometers as they came over the rail of the sounding-bridge; and finally, the water-bottle and the lead were taken in here and unshackled. The water-bottle was immediately inverted and emptied of its contents, whereas the sample of the bottom was first inspected *in situ*, and its nature registered in the sounding-journal, previous to being taken out of the tube, from which it was transferred to bottles or jars labelled with the number of the observing-station. On the first cruise, in 1876, we used corked soda-water bottles, but in papir. Bundprøverne overleveredes derpaa til Kemikernes Varetægt.

Loddernes Udløbshastigheder. Efter de i Loddejournalen indeholdte Data gives her nogle Resultater af Studier over Loddernes Bevægelse under Lodningen.

Rørlod. Som tidligere bemærket, var Lodlinens første 200 Favne inddelt med Mærker for hver 10 Favne. Paa Station 375 gjordes et Forsøg til Bestemmelse af Linens eller Loddets Udløbshastigheder under de første 200 Favnes Udløb, idet Tidsøjeblikkene for hvert 10-Favne Mærkes Gaaen i Vandet noteredes, under det at Bremsningen paa Rullen søgtes holdt saa normal som muligt. Resultatet af dette Forsøg indeholdes i den følgende Tabel.

Favne.	Tid fra „Lad gaa".		Interval.	Hastighed. Favne pr. Sek.
0	0.m	0s		
10		6	6s	1.67
20		12	6	1.67
30		15	3	3.33
40		19	4	2.50
50		25	6	1.67
60		32	7	1.43
70		37	5	2.00
80		44	7	1.43
90		50	6	1.67
100		57	7	1.43
110	1	4	7	1.43
120	1	11	7	1.43
130	1	19	8	1.25
140	1	27	8	1.25
150	1	34	7	1.43
160	1	42	8	1.25
170	1	51	9	1.11
180	1	59	8	1.25
190	2	7	8	1.25
200	2	16	9	1.11

Man ser af Rubrikken „Hastighed i Favne pr. Sek.", at Hastigheden, hvormed Loddet synker, der er lig Nul i det Øjeblik, man „lader gaa", i Begyndelsen er voxende, men naar sit Maximum allerede ved 25 Favnes Dyb, og derpaa er den gjennemsnitlig aftagende med Dybden, idet Linens Friktion i Vandet samtidig med at Bremsningen er lettere at regulere, bevirker en større Modstand mod Bevægelsen.

Af Iagttagelser af Udløbstiderne for 100 Favnemærkerne paa en større Række Stationer findes som gjennemsnitlige Værdier de i den følgende Tabel opførte Tal:

1877 and 1878 cylindrical glass jars, about 4 inches high and wide and covered at the top with strong vellum paper. When ready for storing, the samples of the bottom were left in charge of the chemist to the Expedition.

Velocity of the Lead. — In this Section we give some results obtained by investigating the rate of descent from the data registered in the sounding-journal.

The Tube-lead. — As previously stated, the line was graduated for the first 200 fathoms into lengths of tens of fathoms. At Station 375, we sought to determine the absolute rate of descent down to a depth of 200 fathoms, by registering the exact moment at which each of the ten-fathom slips entered the water, striving the while to keep the braking as uniform as possible. The following Table shows the results of the experiment.

Fathoms.	Time.		Interval.	Velocity. Fath. pr. Sec.
0	0.m	0s		
10		6	6s	1.67
20		12	6	1.67
30		15	3	3.33
40		19	4	2.50
50		25	6	1.67
60		32	7	1.43
70		37	5	2.00
80		44	7	1.43
90		50	6	1.67
100		57	7	1.43
110	1	4	7	1.43
120	1	11	7	1.43
130	1	19	8	1.25
140	1	27	8	1.25
150	1	34	7	1.43
160	1	42	8	1.25
170	1	51	9	1.11
180	1	59	8	1.25
190	2	7	8	1.25
200	2	16	9	1.11

We see from a glance at the column headed "Velocity, in fathoms pr. second," that the rate of descent, which at the moment of letting go is nil, tends at first to increase, soon however reaching its maximum, at a depth of 25 fathoms, after which it begins, and as a rule continues, to decrease with the depth, the augmenting friction in the water, along with increased facility of braking, together occasioning greater resistance to the downward motion of lead and line.

The figures in the following Table are deduced from the intervals, timed at a number of Stations, for every hundred-fathom slip that successively entered the water, and represent the average rate of decent.

Favne.	Tid fra „lad gaa".	Interval.	Hastighed Favne pr. Sek.
0	0m 0s		
100	55	0m 55s	1.82
200	2 12	1 17	1.29
300	3 42	1 30	1.11
400	5 18	1 36	1.05
500	7 6	1 48	0.92
600	9 7	2 1	0.83
700	11 15	2 8	0.78
800	13 29	2 14	0.75
(900)	(16 10)	(2 41)	(0.62)

For Intervallet 800—900 Favne haves kun en Observation.

De her fundne Hastigheder slutter sig meget godt til de ovenfor fundne, efter hvilke Gjennemsnitshastigheden mellem 0 og 100 Favne er 1.82 og mellem 100 og 200 Favne 1.28. Man ser endvidere, at Loddets Hastighed er stadig aftagende med Dybden. Udjevner man paa grafisk Vej Hastighederne i den første Tabel og slutter denne Række til den anden, der beror paa flere Iagttagelser, saaledes at Tidsintervallerne i den sidste beholdes, saa faar man et Billede af Rørloddets Bevægelse saaledes som Kurverne R i Fig. 15 og 16 viser. Fig. 15 viser de til de forskjellide Tider udløbne Længder af Lodlinen, og Fig. 16

Fathoms.	Time.	Interval.	Velocity Fath. p. Sec.
0	0m 0s		
100	55	0m 55s	1.82
200	2 12	1 17	1.29
300	3 42	1 30	1.11
400	5 18	1 36	1.05
500	7 6	1 48	0.92
600	9 7	2 1	0.83
700	11 15	2 8	0,78
800	13 29	2 14	0.75
(900)	(16 10)	(2 41)	(0.62).

For the 800—900-fathom interval we have only one observation.

The velocities thus determined agree pretty well with those previously found, which average 1.88 between 0 and 100 fathoms and 1.28 between 100 and 200 fathoms. Moreover, the rate of descent decreases steadily with the depth. Now, if we equalize, in a diagrammatic form, the velocities given in the first Table, and adjust that series to the second, retaining the time-intervals of the latter, as based on a greater number of observations, we shall have figured before us the descent of the tube-lead, as represented by the curves R, R, in Figs. 15 and 16. Fig 15 shows the lengths of sounding-line run out during succes-

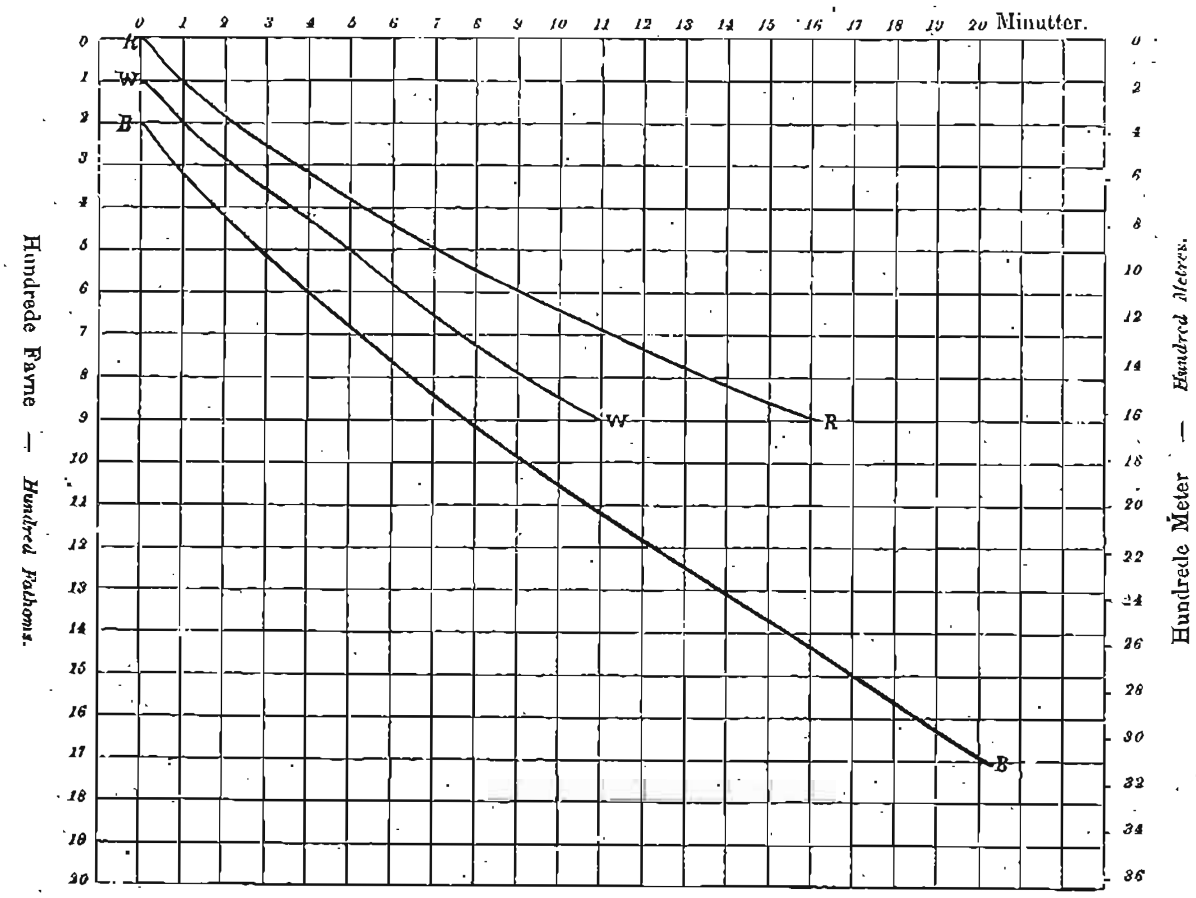

Fig. 15.

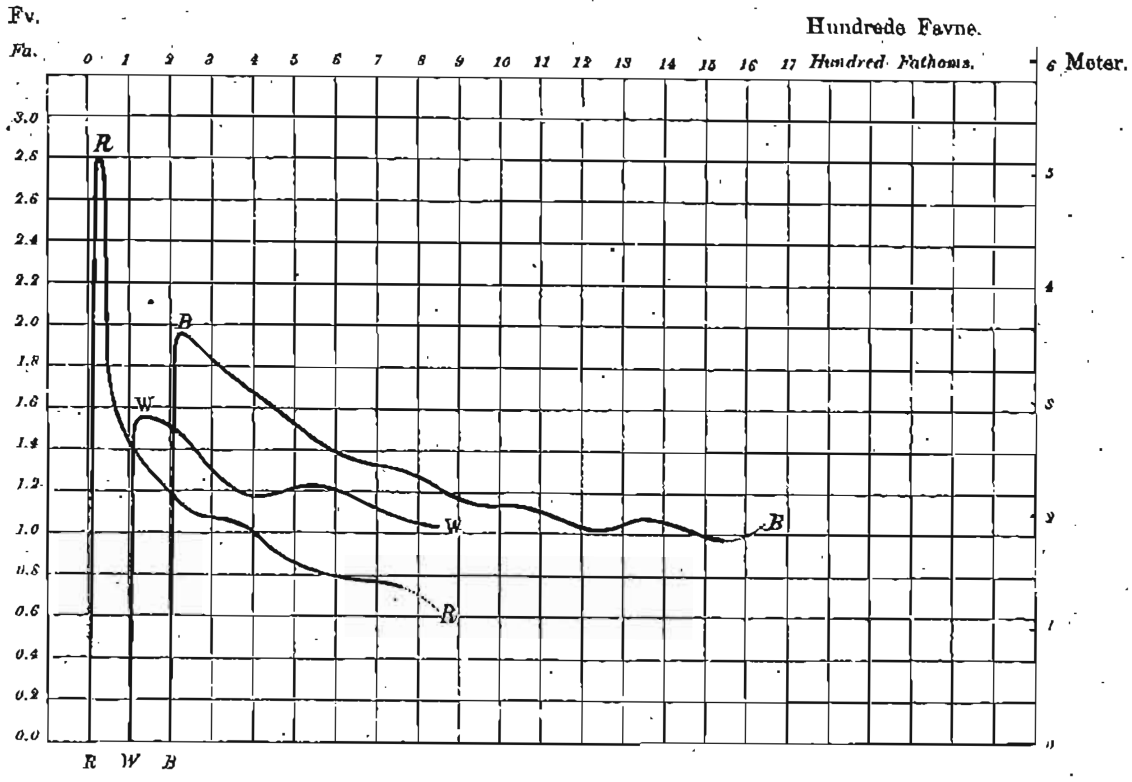

Fig. 16.

Hastighederne, udtrykt i Favne pr. Sekund, i de forskjellige Dybder. I den første Del af Fig. 16, fra 0 til 200 Favne, er Hastighederne afsat for hver 10de Favn, regnet fra 5 Favne af, i den sidste Del er Hastighederne afsat for hver 100 Favn, regnet fra 250 Favne af.

Rørlod med Willes Vandhenter. Nedenstaaende Tabel viser Synkningen af Rørloddet med Willes Vandhenter, fra 100 Favnes Dyb af, til hvilken Dybde det blev udfiret fra Indhivningsmaskinen, før man „lod gaa". Iagttagelserne hidrører for Størstedelen fra 1876.

Favne.	Tid fra „lad gaa".		Interval.		Hastighed. Fv. pr. Sek.
100	0ᵐ	0ˢ			
200	1	4	1ᵐ	4ˢ	1.56
300	2	14	1	10	1.43
400	3	36	1	22	1.22
500	5	0	1	24	1.19
600	6	22	1	22	1.22
700	7	46	1	24	1.19
800	9	18	1	32	1.09
900	10	55	1	37	1.03

Fra det Øjeblik, da man „lader gaa", i hvilket Hastigheden er Nul, voxer den raskt til et Maximum, og er siden gjennemsnitlig aftagende med Dybden. Tabellens Resultater er fremstillet grafisk i Figg. 15 og 16 ved Kurverne W. Man ser, at den Hastighed, med hvilken

sive intervals; and Fig. 16 the rate of descent, in fathoms pr. second, at the different depths. In the left part of Fig. 16, from 0 to 200 fathoms, the velocities are given for tens of fathoms: in the right part of the figure, for hundreds, beginning with 250 fathoms.

The Tube-lead with Wille's Water-bottle attached. — The following Table shows the rate of descent of the tube-lead when sent down along with Wille's water-bottle, beginning at 100 fathoms, to which depth the apparatus were sunk with the donkey-engine before being cast off. The observations date chiefly from 1876.

Fathoms.	Time.		Interval.		Velocity Fath. pr. Sec.
100	0ᵐ	0ˢ			
200	1	4	1ᵐ	4ˢ	1.56
300	2	14	1	10	1.43
400	3	36	1	22	1.22
500	5	0	1	24	1.19
600	6	22	1	22	1.22
700	7	46	1	24	1.19
800	9	18	1	32	1.09
900	10	55	1	37	1.03

From the moment of casting off, when the velocity is nil, the rate of descent rapidly increases up to a maximum, and then, as a general rule, decreases with the depth. The results set forth in the Table are represented diagrammatically, by the curves W, W in Figs. 15 and 16. It is obvious

Loddet slaar i Bund, er mærkelig større, naar Vandhenteren er paa, end med Rørloddet alene.

Baillie-Maskinen. Den følgende Tabel er Middelresultater af Forsøg med Baillie-Maskinen, med en total Belastning fra 142 til 182 Kilo (285 til 365 Pd.), gjennemsnitlig 171 Kilogram (342 Pd.), efter et større Antal Iagttagelsesrækker.

Favne.	Tid fra „lad gaa."	Interval.	Hastighed Favne pr. Sek.
200	0m 0s		
300	0 51	0m 51s	1.96
400	1 48	0 57	1.76
500	2 50	1 2	1.60
600	3 59	1 9	1.46
700	5 12	1 13	1.37
800	6 27	1 15	1.33
900	7 48	1 21	1.23
1000	9 15	1 27	1.16
1100	10 43	1 28	1.14
1200	12 16	1 33	1.08
1300	13 53	1 37	1.03
1400	15 27	1 34	1.07
1500	17 5	1 38	1.02
1600	18 46	1 41	0.99
1700	20 20	1 34	1.06

Kurverne B i Figg. 15 og 16 viser Tabellens Resultater.

Sammenligner man Kurverne i Fig. 16, saa ser man strax, hvorledes det tungere Lod slaar i Bund med en større Hastighed end det lettere, og Nødvendigheden af tungere Lod til de dybere Lodskud fremtræder med Styrke. Figuren viser tydelig, hvorledes Rørloddet alene kommer til kort paa Dybder over 1000 Favne, saaledes som Erfaringen har vist.

Et fælles Træk for alle tre Hastighedskurver er deres bølgeformige Løb paa større Dybder. Dette forklares ved Bremsningens Ujevnhed. Bremsningen paa Rullen er paavirket af Søgangen, idet den falder lettere at regulere i roligt Vejr end i uroligt, naar Fartøjet løfter og sænker sig og derunder snart rykker i Linen, snart gaar med dens Bevægelse. Men Ujevnheden i Bremsningen er vistnok ogsaa af fysiologisk Natur. Under den første Del af Loddets Udløb bremser Folkene paa Rullen med friske Kræfter og udelt Opmerksomhed. Figuren viser i den tilsvarende Del af Hastighedskurverne den største Regelmæssighed. Saa bliver Bremserne trætte og mindre agtpaagivende. Lodlinen begynder at slænge op og ned og til Siderne paa Vejen fra Rullen til Fodblokken. Et „brems ordentligt" fra den kommanderende Officiers Mund bringer atter Regelmæssighed i Bevægelsen, men denne afløses igjen af Virkningen af Træthed under det fortsatte anstrængende Arbejde og saa fremdeles. Disse Perioder i Hastigheden

that the velocity of the lead when it strikes the bottom is perceptibly greater with the water-bottle attached than without.

The Baillie Machine. — The following Table gives the mean results computed from an extensive series of soundings with the Baillie machine, the total sinking-weight, which varied from 285 to 365 pounds, having averaged 342 pounds.

Fathoms.	Time.	Interval.	Velocity Fath. pr. Sec.
200	0m 0s		
300	0 51	0m 51s	1.96
400	1 48	57	1.76
500	2 50	1 2	1.60
600	3 59	1 9	1.46
700	5 12	1 13	1.37
800	6 27	1 15	1.33
900	7 48	1 21	1.23
1000	9 15	1 27	1.16
1100	10 43	1 28	1.14
1200	12 16	1 33	1.08
1300	13 53	1 37	1.03
1400	15 27	1 34	1.07
1500	17 5	1 38	1.02
1600	18 46	1 41	0.99
1700	20 20	1 34	1.06

The curves B, B in Figs. 15 and 16, are constructed from the results set forth in this Table.

A glance at the curves in Fig. 16, shows that the heavier the lead the greater will be its velocity on reaching the bottom; and hence the need of increasing the sinking-weight for deeper soundings. The diagram clearly discloses the untrustworthiness of the tube-lead as a sounding-instrument for depths of more than 1000 fathoms, thus confirming the result of experience.

A common feature distinguishing the three curves of velocity is their sinuous course in great depths. This must be ascribed to want of uniformity in braking. The said operation is disadvantageously affected in a seaway, the revolutions of the reel being easier to regulate in calm than in rough weather, when the vessel heaves and sinks, now dragging after her the line, and now following its motion. Meanwhile, the cause of irregular braking is in part, no doubt, physiological. The men, who come to their work fresh, brake at first with skill and undivided attention. This is evident from the diagram, which exhibits greatest regularity of form in the corresponding portion of the curve of velocity. After a time, the brakesmen get tired, and in consequence less attentive. The sounding-line is jerked up and down and sideways on its passage from the reel to the leading-block. By an encouraging word, the officer in charge can, indeed, for a time, restore regularity to the braking; but soon the effects of lassitude, brought falder nu vistnok ikke i ethvert Tilfælde paa samme Tid eller rettere samme Dybde, men Kurverne antyder, saaledes som ogsaa de grafisk opsatte Kurver for de enkelte Lodninger viser, at der er en vis Regelmæssighed i Ujevnhederne, saaledes at disse falder nogenlunde omkring samme Dybdetal ved de forskjellige Tilfælder.

Den Tid, som behøves til at tage et Lodskud er væsentlig afhængig af Lodskuddets Dybde. Efter Skibsjournalen, i hvilken anførtes Klokkeslettene for Lodningens Begyndelse, naar Fartøjet stoppede, og for dens Afslutning, naar der atter sattes i Gang igjen, eller naar en anden Operation, som Temperaturrække eller Skrabning, begyndte, findes ved en statistisk Beregning, at i Gjennemsnit krævede et Lodskud paa

100 Favne	20 Minutter.
500 —	40 —
1000 —	1 Time.
1500 —	1 Time 30 Minutter.
2000 —	henimod 2 Timer.

eller i Almindelighed

Tiden for et Lodskud $= 20^m + 5^m \times \frac{(\text{Dybden i Fv.} - 100)}{100}$.

Denne Tid forbruges omtrent saaledes som følgende Skema viser.

Dybde i Favne	100	500	1000	1500	2000
Vægt af Lod i Pund	112	112	285	350	365
	Minutter.				
Stopning af Fartøjet. Forbered. til Lodning	10^m	10^m	10^m	10^m	10^m
Udfiring til 300 Favne à 3 Minutter pr. 100 Favne	0	0	9	9	9
Paasætning af Stopper, Linen taget fra Indhivningsmaskinen til Rullen	0	0	3	3	3
Udløbstid til Bunds efter Fig. 15	1	7	9	17	25
Thermometrenes Accomodation, Lodlinens Skiftning fra Rul til Spil	8	5	5	5	5
Indhivning à 3 Min. pr. 100 Favne	3	15	30	45	60
Ialt	22	37	66	89	112
Ovenst. Formel giver	20	40	65	90	115
Forskjel	+2	−3	+1	−1	−3

on by the unintermitting exertion, are again apparent, to be again counteracted for a still shorter interval, and so on *de novo*, to the end of the operation. True, these periodical deviations in velocity do not occur in every case precisely at the same time, or rather at the same depth, but the curves here given, as also those diagrammatically constructed for each individual sounding, indicate a certain regularity in the inequalities, and a tendency to occur at about the same depth in all cases.

The Time required for Sounding depends mainly on the depth. From data in the ship's log-book, comprising the time at which each sounding commenced, — viz. when the vessel was stopped, — and that of its termination, when she again went ahead, — or the time at which some other operation, such as dredging or taking a serial temperature, was begun, we found, by direct computation, the time each sounding occupied to average as follows: —

100 Fathoms	20 Minutes.
500 —	40 —
1000 —	1 Hour.
1500 —	1 Hour 30 Minutes.
2000 —	Nearly 2 Hours.

Hence a sounding occupied $20^m + 5^m \times$ (the depth in fathoms —100): 100; and this interval passed very nearly as set forth in the following tabular statement.

Depth in Fathoms	100	500	1000	1500	2000
Sinking-weight in pounds	112	112	285	350	365
	Minutes.				
Stopping vessel and preparing for sounding	10^m	10^m	10^m	10^m	10^m
Veering 300 fathoms of Line, at 3 min. pr. 100 fathoms	0	0	9	9	9
Putting on stoppers and shifting Line from drum of donkey-engine to the reel	0	0	3	3	3
Time required for reaching bottom, according to Fig. 15	1	7	9	17	25
Time for Accomodation of the Thermometers, and for shifting Line from the reel to drum of donkey-engine	8	5	5	5	5
Heaving in at 3m. pr. 100 fathoms	3	15	30	45	60
Total	22	37	66	89	112
The above formula gives	20	40	65	90	115
Difference	+2	−3	+1	−1	−3

Paa Norhavsexpeditionens trende Undersøgelsesrejser toges nedenstaaende Lodskud. Til at betegne Bundens Beskaffenhed er anvendt følgende Forkortelser:

b — blaa,	blk — sort,	br — brun.
c — grov,	cl — Ler,	d — mørk,
f — fin,	g — Singels.	gn — grøn,
gy — graa,	h — haard,	m — Mudder.
oz — Slik,	r — Fjeld,	s — Sand,
sft — blød,	sh — Skjæl.	st — Sten.
B. cl — Biloculin-Ler.		y — gul.

On the three exploring cruises of the Norwegian North-Atlantic Expedition, the following soundings were taken. The abbreviations given below denote the nature of the bottom.

b — blue.	blk — black.	br — brown.
c — coarse.	cl — clay.	d — dark.
f — fine.	g — gravel.	gn — green.
gy — grey.	h — hard.	m — mud.
oz — ooze.	r — rock.	s — sand.
sft — soft.	sh — shells.	st — stones.
B. cl — Biloculina clay.		y — yellow.

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
2	61° 10.'	6° 32.' E	653	672	1229	s & cl
3	61 5	5 15 E	600	618	1130	do.
4	61 5	5 14 E	550	566	1035	s. cl. g
5	61 6	5 12 E	490	504	922	s. cl
6	61 6	5 9 E	205	211	386	r
7	61 6	5 11 E	200	206	377	r
9	61 30	3 37 E	200	206	377	cl
10	61 41	3 19 E	214	220	402	oz. cl
11	61 47	3 9 E	225	232	424	cl
12	61 53	3 0 E	217	223	408	cl
13	61 58	2 54 E	221	228	417	cl
14	62 4	2 45 E	220	226	413	cl
15	62 10	2 36 E	215	221	404	cl
16	62 24	2 17 E	215	221	404	r
17	62 33	2 4 E	280	288	527	r
18	62 44	1 48 E	400	412	753	cl
19	62 23	2 50 E	220	226	413	cl. s
20	62 16	3 8 E	213	219	400	cl
21	62 14	3 28 E	183	188	344	cl. s
22	62 13	3 41 E	125	129	236	cl. s
24	63 10	5 58 E	87	90	165	s. cl
26	63 10	5 16 E	230	237	433	s. cl
	63 7	5 17 E	87	90	165	r
27	63 6	5 18 E	85	87	159	r
28	63 10	5 11 E	385	396	724	s. cl
29	63 10	5 7 E	385	396	724	s. cl
30	63 10	5 4 E	390	401	733	s. cl
31	63 10	5 0 E	405	417	763	s. cl
32	63 10	4 51 E	418	430	786	s. cl
33	63 5	3 0 E	510	525	960	cl
34	63 5	0 53 E	570	587	1073	oz
35	63 2	1 12 W	1000?	—	—	cl
	63 7	1 26 W	1050	1081	1977	cl
36	62 15	4 34 W	144	148	271	st
37	62 28	2 29 W	670	690	1262	s. cl
38	63 1	3 58 W	198	204	373	r
40	63 22	5 29 W	1180	1215	2222	s. cl
41	63 37	7 10 W	677	697	1275	cl

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
42	63° 2.'	10° 17.' W	256	264	483	r
43	63 11	13 32 W	514	529	967	s
44	63 8	14 0 W	820	844	1543	r
45	63 28	12 58 W	370	381	697	r. cl
46	63 51	12 5 W	250	257	470	s. cl
47	64 13	11 14 W	185	190	347	r
48	64 36	10 22 W	290	299	547	s. oz
49	65 0	9 25 W	425	437	799	s. cl
50	65 26	8 24 W	555	571	1044	cl
51	65 53	7 18 W	1130	1163	2127	B. cl
52	65 47	3 7 W	1808	1861	3403	B. cl
53	65 13	0 33 E	1495	1539	2814	B. cl
54	64 47	4 24 E	584	601	1099	B. cl
55	64 38	10 22 E	90	93	170	r
56	64 39	10 11 E	173	178	326	s. cl
57	64 39	9 59 E	156	161	294	cl
58	64 39	9 49 E	215	221	404	s. cl
59	64 39	9 38 E	162	167	305	s. cl
60	64 40	9 30 E	115	118	216	h. cl
61	64 40	9 19 E	115	118	216	h. cl
62	64 41	9 10 E	105	108	198	h. cl
63	64 41	9 0 E	90	93	170	r
64	64 42	8 50 E	56	58	106	r
65	64 42	8 39 E	60	62	113	r
66	64 43	8 30 E	85	88	161	s. cl
67	64 44	8 19 E	116	119	218	s. cl
68	64 44	8 9 E	128	132	241	cl
69	64 45	8 2 E	124	128	234	cl. s
70	64 45	7 53 E	126	130	238	cl. s
71	64 45	7 46 E	128	132	241	s. cl
72	64 46	7 37 E	133	137	251	s cl
73	64 46	7 28 E	129	133	243	s. cl
74	64 47	7 20 E	128	132	241	s. cl
75	64 47	7 13 E	141	145	265	s. cl
76	64 47	7 4 E	145	149	272	s. cl
77	64 48	6 54 E	145	149	272	s. cl
78	64 48	6 45 E	151	155	283	s. cl
79	64 48	6 36 E	151	155	283	s. cl

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
80	64° 48.'	6° 26.' E	140	144	263	cl
81	64 49	6 17 E	151	155	283	cl
82	64 49	6 7 E	170	175	320	
83	64 49	5 58 E	180	185	338	cl
84	64 49	5 49 E	215	221	404	cl
85	64 50	5 39 E	294	303	554	br. cl
86	64 50	5 30 E	370	381	697	cl
87	64 2	5 35 E	484	498	911	cl
88	64 1	5 53 E	345	355	649	cl
89	64 1	6 8 E	185	190	347	r
90	64 1	6 21 E	199	205	375	s. cl
91	64 0	6 32 E	185	190	347	gy. cl
92	64 0	6 42 E	173	178	326	cl
93	62 41	7 8 E	153	158	289	sft. cl
94	59 8	4 38 E	142	145	265	cl
95	60 42	4 14 E	170	175	320	cl
96	66 8	3 0 E	782	805	1472	B. cl
97	66 2	4 21 E	663.5	683	1249	cl
98	65 56	5 21 E	377	388	710	cl
99	65 51	6 25 E	207	213	390	cl
100	65 43	7 29 E	188	194	355	cl
101	65 36	8 32 E	216	223	408	cl
102	65 32	9 10 E	205	211	386	cl
103	65 30	9 37 E	187	193	353	cl
104	65 28	9 56 E	157	162	296	cl
105	65 26	10 13 E	141	145	265	s. cl
106	65 24	10 33 E	172	177	324	cl
107	65 21	10 44 E	167	172	315	cl. g
108	66 6	11 1 E	123	127	232	s. cl
109	66 10	10 41 E	175	180	329	s. cl
110	66 12	10 30 E	154	159	291	cl
111	66 15	10 21 E	152	157	287	s. cl
112	66 16	10 10 E	134	138	252	cl. s
113	66 18	10 0 E	119	123	225	cl. s
114	66 18	9 51 E	116	120	219	cl. s
115	66 20	9 41 E	128	132	241	cl. s
116	66 21	9 30 E	117	121	221	cl. st
117	66 23	9 20 E	137	141	258	cl. s
118	66 26	8 59 E	137	141	258	cl. s.
119	66 28	8 40 E	163	168	307	cl
120	66 30	8 20 E	184	190	347	cl
121	66 33	7 59 E	186	192	351	cl. sh
122	66 36	7 40 E	195	201	368	cl. s
123	66 39	7 19 E	239	246	450	cl. st
124	66 41	6 59 E	340	350	640	cl
125	67 52	5 12 E	680	700	1280	cl
126	67 49	5 33 E	709	730	1335	br. cl
127	67 47	5 54 E	694	715	1308	cl
128	67 43	6 21 E	668	688	1258	cl
129	67 40	6 42 E	689	709	1296	br. cl
130	67 38	7 3 E	669	689	1260	cl
131	67 35	7 26 E	772	795	1454	sft. br. cl
132	67 33	7 48 E	927	954	1745	br. cl
133	67 30	8 10 E	862	890	1628	br. cl
134	67 29	8 20 E	853	878	1606	cl
135	67 27	8 31 E	835	860	1573	cl
136	67 25	8 47 E	593	610	1116	h. cl. g
137	67 24	8 58 E	438	452	827	h. cl
138	67° 18.'	9° 9.' E	179	184	336	c. s. cl
139	67 14	9 25 E	170	175	320	cl. s. st
140	67 10	9 42 E	191	197	360	cl. s
141	67 6	9 59 E	186	192	351	cl. s
142	67 2	10 17 E	173	178	326	cl. s
143	66 58	10 33 E	183	189	346	cl.
144	66 53	10 50 E	178	183	335	cl. s st
145	66 49	11 7 E	192	198	362	cl. s
146	66 45	11 22 E	175	180	329	cl. s. st
147	66 49	12 8 E	138	142	260	sft. cl. s
148	67 27	13 25 E	146	150	274	cl
150	67 11	13 21 E	183	189	346	cl
151	67 15	13 4 E	123	127	232	r
152	67 18	12 46 E	121	125	229	sft. cl
153	67 22	12 29 E	118	122	223	s. cl
154	67 26	12 14 E	76	78	143	r
155	67 35	11 46 E	70	72	132	r
156	67 40	11 26 E	87	90	165	r
157	67 45	11 7 E	103	106	194	r
158	67 49	10 49 E	99	102	187	d. cl. s
159	67 54	10 30 E	115	118	216	s. g. sh
160	67 58	10 11 E	272	280	512	r. cl
161	68 3	9 53 E	575	592	1083	f. s. cl
162	68 23	10 20 E	772	795	1454	br. cl
163	68 22	10 30 E	670	690	1262	br. cl
164	68 21	10 40 E	443	457	836	gy. cl s
165	68 46	10 51 E	1428	1470	2688	B. cl
166	68 40	11 40 E	394	406	742	cl
167	68 37	12 2 E	77	79	144	r
168	68 39	11 51 E	431	444	812	br. cl
169	68 36	12 53 E	70	72	132	r
170	68 32	13 18 E	65	67	123	r
171	69 18	14 29 E	624	642	1174	br. cl
172	69 12	14 47 E	79	81	148	r
173	69 14	14 43 E	233	240	439	r
174	69 16	14 38 E	327	337	616	cl. st
175	69 17	14 35 E	403	415	759	cl. g
176	69 18	14 33 E	521	536	980	cl
177	69 25	13 49 E	1402	1443	2639	br. cl
178	69 29	12 26 E	1533	1578	2886	B. cl
179	69 32	11 10 E	1561	1607	2939	B. cl
180	69 39	9 55 E	1549	1594	2915	B. cl
181	69 45	8 43 E	1549	1595	2917	B. cl
182	69 51	7 30 E	1636	1684	3080	B. cl
183	69 59	6 15 E	1661	1710	3127	B. cl
184	70 4	9 50 E	1503	1547	2829	B. cl
185	70 3	13 37 E	1442	1485	2716	B. cl
186	69 56	14 18 E	1378	1418	2593	B. cl. st
187	69 51	14 41 E	1297	1335	2441	br. cl
188	69 43	15 29 E	1151	1185	2167	br. cl
189	69 41	15 42 E	835	860	1573	br cl.
190	69 41	15 51 E	845	870	1591	br. cl. s
191	69 44	16 26 E	242	249	455	sh. st. s
192	69 46	16 15 E	630	649	1187	s. cl
193	69 44	16 54 E	45	46	84	r
194	69 43	17 16 E	28	29	53	r
195	70 55	18 38 E	104	107	196	st. cl
196	71 2	18 3 E	118	122	223	cl. s

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
197	71° 7.'	17° 28.' E	134	138	252	r	256	70° 8.'	23° 4.' E	218	225	411	gn. cl
198	71 13	16 52 E	219	226	413	r	257	70 4	23 2 E	155	160	293	gy. cl
199	71 18	16 17 E	510	525	960	r	258	70 13	23 3 E	223	230	421	gn. cl
200	71 25	15 41 E	602	620	1134	br. cl	259	70 49	25 59 E	78	80	146	r
201	71 31	15 28 E	628	647	1183	br. cl. s	260	70 55	26 11 E	123	127	232	cl
202	71 31	14 40 E	780	803	1468	cl	261	70 47	28 30 E	123	127	232	cl
203	71 31	13 54 E	875	901	1648	br. cl. st	262	70 36	32 35 E	144	148	271	cl
204	70 57	13 34 E	1230	1266	2315	B. cl	263	70 44	34 14 E	117	121	221	cl
205	70 51	13 3 E	1250	1287	2354	B. cl	264	70 56	35 37 E	84	86	157	sft. cl
206	70 45	14 36 E	1212	1248	2282	B. cl	265	71 18	34 49 E	102	105	192	h. cl
207	70 33	15 50 E	1079	1111	2032	B. cl	266	71 27	35 39 E	126	130	238	sft. cl
208	70 21	16 57 E	656	675	1234	br. cl. st	267	71 42	37 1 E	144	148	271	cl. st
209	70 19	17 9 E	122	126	230	r	268	71 36	36 18 E	126	130	238	cl. s
210	70 17	17 20 E	133	137	251	r	269	72 11	36 40 E	134	138	252	gn. cl
211	70 15	17 31 E	125	129	236	s. cl	270	72 27	35 1 E	132	136	249	br. cl
212	70 12	17 41 E	138	142	260	s. cl	271	72 38	33 50 E	155	160	293	gn. cl
213	70 23	2 30 E	1710	1760	3219	B. cl	272	73 11	33 3 E	110	113	207	cl. s
214	70 39	0 0	1700	1750	3200	B. cl	273	73 25	31 30 E	191	197	360	gn. cl
215	70 53	2 0 W	1617	1665	3045	B. cl	274	73 46	31 16 E	177	182	333	cl
216	70 58	3 40 W	1196	1231	2251	s. cl	275	74 8	31 12 E	143	147	269	gn. cl
217	71 0	5 9 W	805	829	1516	B. cl	276	74 5	27 39 E	214	220	402	gn. cl
218	71 1	6 0 W	940	968	1770	B. cl	277	74 3	25 43 E	218	225	411	gn. cl
219	71 2	6 51 W	773	796	1456	B. cl	278	74 1	22 27 E	223	230	421	gn. cl
220	71 2	7 26 W	1238?	1275?	2332?	?	279	74 15	20 48 E	77	79	144	st. sh. cl
221	71 2	7 35 W	1030	1060	1938	r	280	74 10	18 51 E	34	35	64	r
222	71 2	7 46 W	635	654	1196	r	281	74 3	17 18 E	112	115	210	r
223	70 54	8 24 W	68	70	128	blk. cl. s	282	73 53	15 36 E	444	457	836	sft. gn. cl
224	70 51	8 20 W	92	95	174	blk. s	283	73 47	14 21 E	745	767	1403	br. cl
225	70 58	8 4 W	189	195	357	blk. cl. s	284	73 1	12 58 E	777	800	1463	br. cl
226	70 59	7 51 W	330	340	622	blk. cl. s	285	73 6	11 56 E	995	1024	1873	br. cl
227	71 13	7 33 W	1010	1040	1902	br. cl	286	72 57	14 32 E	434	447	817	gy. cl
228	71 12	8 9 W	906	933	1706	r	287	72 52	15 19 E	242	249	455	gy. cl
229	71 12	8 55 W	711	732	1339	br. cl	288	72 46	17 50 E	209	215	393	br. cl
230	71 16	9 10 W	830	854	1562	br. cl	289	72 41	20 18 E	213	219	400	gn. cl
231	71 21	9 23 W	1002	1032	1887	br. cl	290	72 27	20 51 E	185	191	349	cl. s
232	71 10	8 48 W	758	780	1426	br. cl	291	71 54	21 57 E	188	194	355	gy. cl
233	71 8	8 46 W	563	580	1061	br. cl	292	71 20	22 59 E	210	216	395	gy. cl
234	71 6	8 38 W	251	259	474	blk. cl. s	293	71 7	21 11 E	92	95	174	s. cl
235	70 59	8 55 W	95	98	179	r	294	71 35	15 11 E	619	637	1165	sft. br. cl
236	70 58	9 2 W	151	156	285	blk. s. cl	295	71 59	11 40 E	1078	1110	2030	B. cl
237	70 41	10 10 W	255	263	481	br. s. cl	296	72 15	8 9 E	1399	1440	2633	B. cl
238	70 13	10 54 W	821	845	1545	B. cl	297	72 36	5 12 E	1243	1280	2341	B. cl
239	69 35	11 13 W	1020	1050	1920	B. cl	298	72 52	1 51 E	1457	1500	2743	B. cl
240	69 2	11 26 W	975	1004	1836	B. cl	299	73 10	2 14 W	1327	1366	2498	B. cl
241	68 41	10 54 W	1087	1119	2046	B. cl	301	74 1	1 20 W	1636	1684	3080	B. cl
242	68 36	8 40 W	1003	1033	1889	B. cl	302	75 16	0 54 W	1928	1985	3630	B. cl
243	68 32	6 26 W	1345	1385	2533	B. cl	303	75 12	3 2 E	1166	1200	2195	B. cl
244	68 28	4 17 W	1895	1951	3568	B. cl	304	75 3	4 51 E	1686	1735	3173	B. cl
245	68 21	2 5 W	1948	2005	3667	B. cl	305	75 1	7 56 E	1545	1590	2908	B. cl
246	68 14	0 6 E	1546	1592	2911	B. cl	306	75 0	10 27 E	1296	1334	2440	B. cl
247	68 5	2 24 E	1088	1120	2048	y. cl	307	74 58	12 10 E	1181	1216	2224	B. cl
248	67 56	4 11 E	756	778	1423	B. cl	308	74 57	12 43 E	1104	1136	2078	B. cl
249	68 12	6 35 E	1033	1063	1944	B. cl	309	74 57	13 18 E	1035	1065	1948	br. cl
250	68 10	9 20 E		1150?		y. cl. g	310	74 56	13 50 E	977	1006	1840	br. cl
251	68 6	9 44 E	616	634	1159	br. cl	311	74 55	14 25 E	872	898	1642	br. cl
253	I Skjærstadfjorden		255	263	481	gy. cl	312	74 54	14 53 E	639	658	1203	gy. cl
254	67° 27.'	13° 25 E	139	143	262	b. cl	313	74 55	15 49 E	198	204	373	gy. cl
255	68 12	15 40 E	331	341	624	b. cl	314	74 55	15 21 E	494	509	931	gy. cl

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315	74° 53.′	15° 55.′E	175	180	329	h. cl. s
316	74 56	16 29 E	125	129	236	b. cl
317	74 56	16 52 E	96	99	181	d. gy. cl
318	74 56	17 39 E	53	55	101	d. gn. cl
319	74 57	18 22 E	44	45	82	r
320	74 57	19 8 E	30	31	57	r
321	74 56	19 30 E	24	25	46	r
322	74 57	19 52 E	20	21	38	r
323	72 53	21 51 E	217	223	408	br. gy. cl
324	73 47	20 48 E	226	233	426	gy. cl
325	74 2	20 30 E	87	90	165	d. gn. cl
326	75 31	17 50 E	119	123	225	d. cl
327	75 39	16 33 E	183	188	344	gn. cl
328	75 42	15 39 E	194	200	366	gy. cl
329	75 45	14 45 E	193	199	364	d. cl
330	75 48	13 54 E	431	444	812	d. cl
331	75 51	13 5 E	772	795	1454	red cl
332	75 56	11 36 E	1116	1149	2101	B. cl
333	76 6	13 10 E	727	748	1368	B. cl
334	76 12	14 0 E	392	403	737	d. cl
335	76 17	14 39 E	174	179	327	d. cl
336	76 19	15 42 E	68	70	128	h. cl
337	76 23	16 43 E	19	20	37	r
338	76 19	18 1 E	142	146	267	r
339	76 30	15 39 E	36	37	68	r
340	76 31	14 40 E	56	58	106	cl
341	76 32	13 53 E	115	118	216	r
342	76 33	13 18 E	508	523	956	d. gy. cl
343	76 34	12 51 E	722	743	1359	cl

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344	76° 42.′	11° 16.′E	988	1017	1860	d. cl
347	76 40	7 47 E	1388	1429	2613	B. cl
349	76 30	2 57 E	1445	1487	2719	B. cl
350	76 26	0 29 W	1638	1686	3083	B. cl
351	77 49	0 0 W	1593	1640	2999	B. cl
352	77 56	3 29 E	1638	1686	3083	B. cl
353	77 58	5 10 E	1295	1333	2438	B. cl
354	78 1	6 54 E	1305	1343	2456	B. cl
355	78 0	8 32 E	921	948	1734	cl
356	78 2	10 19 E	107	110	201	b cl.
357	78 3	11 18 E	121	125	229	gn. cl
358	78 2	9 46 E	90	93	170	cl. g.
359	78 2	9 25 E	404	416	761	b. gy. cl
360	78 47	6 58 E	409	421	770	h
361*	79 8	5 28 E	879	905	1655	B. cl
362*	79 59	5 40 E	446	459	839	b. cl
363	80 3	8 28 E	253	260	475	b. cl
364	79 48	10 50 E	189	195	357	sh
365	79 34	11 25 E	72	74	135	d. gy. cl
366	79 35	11 17 E	59	61	112	d. gy. cl
367*	78 44	7 46 E	520	535	978	cl
368*	78 43	8 20 E	306	315	576	b. cl
369*	78 42	8 53 E	84	87	159	st. cl
370*	78 48	8 37 E	106	109	199	gy. cl
371	78 8	13 46 E	191	197	360	gy. cl
372	78 9	14 7 E	125	129	236	d. cl
373	78 10	14 21 E	117	120	219	d. cl
374	78 16	15 33 E	58	60	110	d. cl
375	75 30	15 3 E	198	204	373	d. cl

* Paaværende Plads usikker, muligens 4′—6′ sydligere.

Position doubtful; possibly from 4 to 5 Miles farther South.

Temperatur-Rækker.

Til Undersøgelse af Temperaturen i forskjellige Dybder paa samme Station toges Temperatur-Rækker. Disse udførtes i Regelen saaledes: Rørloddet hexedes i Lodlinen, og lige ovenfor Loddet fastgjordes et Dybvandsthermometer, ganske som ved Lodning. Indhivningsmaskinen udfiredes 100 Favne, og Thermometer No. 2 gjordes fast i Lodlinen fra Loddebroen. Atter udfiredes det andet 100 Favne og Thermometer No. 3 paasattes Linen. Paa denne Maade anbragtes 5 a 6 Thermometre paa Linen med 100 Favnes Afstand og sænkedes ved Udfiring fra Indhivningsmaskinen til de Dybder, i hvilke man vilde maale Temperaturen. Naar alle Thermometre havde faaet Tid til at accommodere sig, haledes Linen ind med Maskinen. Der stoppedes saa lang Tid, som var nødvendig for at løse Thermometrene fra Linen, efterhvert som de kom op. Der lagdes megen Vind paa jevne Bevægelser under disse Operationer, for ikke at udsætte Indexthermometrene for pludselige Ryk eller Stød. I høj Søgang maatte der benyttes megen Forsigtighed ved Thermometrenes Aftagning af Linen. Fartøjet laa i Regelen, som ved Lodning, med Stevnen mod Søen, men man kunde ikke altid holde Lodlinen saaledes, at den kunde naaes med Haanden fra Loddebroen. Linen maatte da bringes ind til Broen ved Hjælp af en Baadshage, der maatte gribe Linen *under* Thermometret for ikke at komme til at berøre dette.

Temperaturrækkerne udførtes kun meget faa Gange ved at lade Linen løbe ud fra Rullen, da dens Standsning let medførte Ryk, som ialfald Indexthermometre ikke maa udsættes for.

Temperaturrækker paa Dybder mindre end 50 Favne udførtes ofte med Haandlod og Haandline, der havde Mærker for hver 5 eller 10 Favne.

Temperaturrækkerne toges i Almindelighed strax efter et Lodskud. Flere Gange blev der dog efter Lodskuddet arbejdet med Skrabe eller Trawl, naar saadant faldt belejligere, og Temperaturrækken toges da efter at disse Arbejder var færdige. Paa denne Maade er det gaaet til, at Temperaturrækkens paaværende Plads undertiden er lidt forskjellig fra Lodskuddets.

Varigheden af en Temperaturrække er naturligvis forskjellig efter Antallet af Dybder, hvori Temperaturen tages og efter Dybdernes Størrelse. En Statistik, taget af Skibsjournalen, viser, at der til *Lodskud og Temperaturrække* medgik omtrentlig:

Paa et Dyb af 100 Favne	30 til 50 Minutter.
- - - - 500 —	1 Time 40 —
- - - - 1000 —	2 Timer 30 —
- - - - 1500 —	3 —
- - - - 2000 —	3 — til 3 Timer 30 Minutter.

Serial Temperatures.

For determining the temperature of the sea in different depths at the same observing-station, we took series of temperatures. Our mode of operation was generally as follows: — After shackling the tube-lead to the sounding-line, we attached, just above the weight, a deep-sea thermometer, precisely as for ordinary soundings. Then, 100 fathoms of line were veered out with the donkey-engine, and Thermometer No. 2 made fast, from the sounding-bridge, at the first hundred-fathom slip, after which we veered another 100 fathoms, and attached Thermometer No. 3 to the line at the second slip. In this manner, as many as 5 or 6 thermometers were made fast to the sounding-line at intervals of 100 fathoms, and sent down to register the temperature in the desired depths. So soon as the thermometers had had time to take the temperature of the surrounding water, we started the donkey-engine and began hauling in the lead, stopping, as each of the thermometers came up over the rail of the bridge, to detach it from the line. Very great importance was attached to uniformity of motion pending these operations, so as not to expose the index-thermometers to any sudden jerk or shock. In a heavy sea, we had to be specially careful when taking the thermometers off the line. The ship generally lay head to sea, as she did during the descent of the lead; nevertheless, we sometimes found it impossible to keep the line within reach from the sounding-bridge, in which case it was got in with a boat-hook, care being taken to hook the line below the thermometer, and thus avoid coming in contact with the latter.

Only a few serial temperatures were taken by letting the line run out of itself, the necessary stoppages in that case easily occasioning jerks, to which the index-thermometers, at least, must not be exposed.

At depths of less than 50 fathoms, serial temperatures were frequently taken with the hand-lead, the line being graduated into fives or tens of fathoms.

As a rule, we took our serial temperatures immediately after sounding. On several occasions however, the dredge or trawl was worked in preference, the serial temperatures being in that case deferred till we had terminated those operations. This accounts for the position in which certain of the serial temperatures were taken differing slightly from that of the soundings.

The time required to take a serial temperature will obviously depend alike on the depth and the number of temperatures. Data obtained from the ship's log-book show the time occupied in taking a sounding and a serial temperature to have averaged as follows: —

For a Depth of 100 Fathoms	from 30 to 50 minutes.
- - — - 500 —	1 hour 40 minutes.
- - — - 1000 —	2 hours 30 —
- - — - 1500 —	3 —
- - — - 2000 —	from 3 hours to 3 hours 30 minutes.

I de dybere Lag, under 600 Favne, toges sjælden Temperaturrækker, da Vandets Temperatur her kun varierede fra 0° til —1°,5.

At depths exceeding 600 fathoms we seldom took serial temperatures, the temperature in the deeper strata varying only from 0° to — 1°,5.

Bundskrabning.

De Apparater, som brugtes til at hente Dyr op fra Havbunden, var Skraber, Svabere og Trawls.

Skrabe. -- Dette Apparat var gjort efter engelsk Mønster. Skrabemunden bestaar af en smedet Jernramme, hvis Længde er omtrent 7 Gange saa stor som Bredden. Til denne er fæstet en Pose eller Sæk, og det hele drages langs Havbunden, idet Munden med sin nederste lange Læbe afskraber det øverste Lag af denne og dermed de deri værende Sødyr.

Af *Skraber* for større Dyb havde vi 3 Størrelser. Paa den største, fremstillet i Fig. 17, var Læbernes Længde 1m.25 (4 Fod), paa den mellemste 0m.94 (3 Fod) og paa den mindste 0m.78 (2½ Fod). Paa alle 3 var Formen af *Skrabemunden* den samme. Med den oprindelige Form, som Skraberne havde, da de kom fra England, fandt vi, at de tog for Lidet af Bunden, og selv efter lang Skrabning var der altid meget lidet i dem. Medens Expeditionen laa i Thorshavn i Begyndelsen af Juli 1876 og udbedrede den

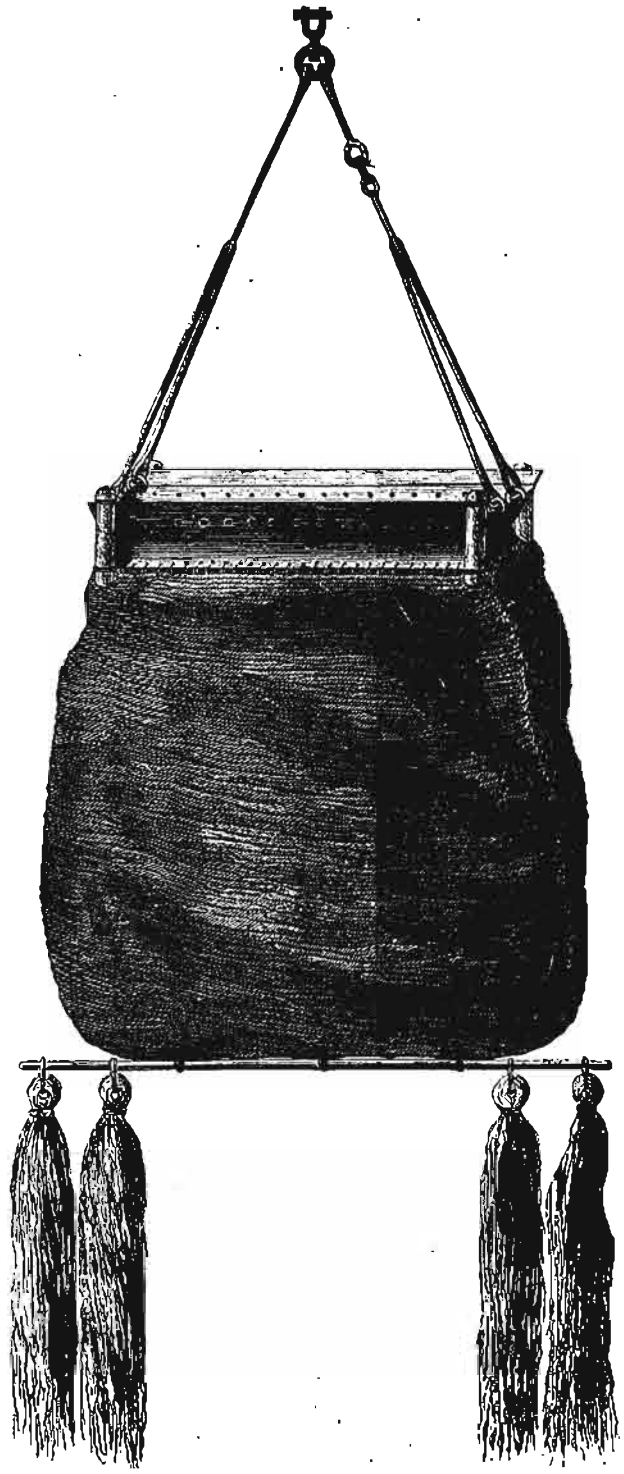

Fig. 17.

Dredging.

The apparatus employed on the Expedition for bringing up animals from the bottom of the sea comprised the dredge, the trawl, and swabs.

The Dredge. — This instrument was on an English pattern. The frame is of hammered iron, the length at the mouth being to the width as 7 to 1. From the frame is suspended a bag, into which, on the dredge being dragged over the bottom, the long nether lip of the mouth will scrape in the substance of the surface, along with the marine animals it contains.

For greater depths, we had dredges of three different sizes. In the largest (Fig. 17), the length of the lips, or scrapers, was 4 feet, in that of medium size 3 feet, and in the smallest 2½ feet. The shape of the *mouth* was the same in all three.

These instruments, which had been made in England for the Expedition, did not, we found, as originally constructed, bring up a fair sample of the bottom; the freight was invariably small, even after protracted dredging. We therefore, when refitting at Thorslidte Søskade, benyttede vi Anledningen til at give Læberne en hensigtsmæssigere Form, idet der udenpaa den oprindelige Læbe paaklinkedes tyndere Jernlæber, der rakte 3.9 cm. (1½ Tomme) frem foran de gamle. Mundingen blev herved ogsaa noget videre, da de nye Læber havde en divergerende Stilling udad, foruden at Læberne blev skarpere. I Fig. 17 ser man dem afbildet. Denne Anordning viste sig strax som en Forbedring. Det hændte dog undertiden, at Læberne greb altfor dybt, saaledes at Skraben i kort Tid fyldte sig med Bundmaterialet, istedetfor kun at skumme det Øverste af dette af og først efter længere Tids Skrabning at fylde Sækken. Denne Ulempe hævedes dog snart ved Anbringelsen af et Par korte Træmejer, som er viste i Figuren, paa begge Sider af Skrabens Jernramme. Mejerne var 4 til 5 Centimeter (1½ til 2 Tommer) brede og af lidt større Længde end Jernrammens Højde, paa Ydersiden og for begge Ender afrundede, og fastgjorte henimod sine Ender med Surringer dels til Jern-Hanefoden dels til den Kant af Skraberammen, hvor Sækken var fastsyet. Forenden rakte ganske lidt foran (i Figuren over) Læbernes Yderkant.

Sækken var af Kokostougverk, lagt som Matte. Den var syet til Skrabens Jernramme paa dennes Under- eller Bagside, og desuden sammensyet paa Siderne som vist i Figuren, saaledes at den let kunde aabnes og Indholdet lægges frit i Dagen.

Skraben var, saaledes som Figuren viser, forsynet med en *Hanefod*, i hvilken Skrabetouget blev fastgjort. Hanefoden var af Jernstænger, med dobbelt Part i den Skraben nærmeste Del, og fæstet til Skraberammen med stærke Ringe, der gik gjennem Huller i denne og gjennem Hanefodens Øjebolt. Den ene Side af Hanefoden bestod i Forhaand af 2 Dele, der endte i Øjebolte, som var forbundne med en Fangning af Skibmandsgarn. Denne var beregnet paa at springe, dersom Skraben stødte paa en større Hindring paa Havbunden, som kunde holde den fast, naar begge Hanefodens Arme trak i Skraben. Med alene den ene Arm som Drag, kunde man i mange Tilfælde gjøre Regning paa at faa Skraben halet rundt Hindringen og løs.

Til Sækkens Bund var fastgjort en Jernstang, til hvilken, ud imod dens Ender, nejedes 2 *Svabere* paa hver Side. Disse Svabere var af heglet Hamp, noget over 1m (3 Fod) lange. Mange Dyr, som ikke eller i lidet Antal kom ind i Skrabesækken, hang fast ved Svaberne, der saaledes var, for visse Dyrearter, et udmærket Fangstapparat.

Enkelte Gange, paa meget ujevn Bund, hvor man vilde risikere at faa Skraben iturevet, brugtes Svabere alene, fæstede til en Jernstang, der med Hanefod var fæstet til Skrabetouget.

havn in the beginning of July 1876, took advantage of the opportunity afforded to modify the construction of the apparatus, with the object of remedying the above-mentioned defect, in which we succeeded, by rivetting on to the outer surface of the scrapers another, but thinner pair (Fig. 17), projecting an inch and a half beyond the former. In this way greater width was given to the mouth of the dredge, the additional pair of scrapers being made to diverge from each other; moreover, they had sharper edges. Our modification turned out a decided improvement. Now and again, however, the scrapers would cut too deep, and soon fill the dredge-bag with matter from the bottom, instead of skimming off a thin layer from the surface and gradually freighting the apparatus. But this drawback we got rid of by fixing to the frame of the dredge, as shown in the figure, a couple of wooden runners, one on either side. These runners had a width of 1½—2 inches, and slightly exceeded in length the height of the frame: they were rounded on the outer side and at both ends, and were lashed, near their extremities, to the iron crow-foot, and to the end of the dredge-frame from which the bag depended. The fore part projected a very little beyond the edges of the scrapers.

The *Dredge-bag* — of strong cocoa-nut matting — was suspended from the lower end of the frame, and fastened together at the sides in such manner as to admit of being readily opened to expose its contents.

The dredge, as shown in the figure, was made fast to the dredge-rope by means of a *crow-foot*, consisting of iron rods, two-armed in the part nearest the dredge, and attached to the dredge-frame by strong iron rings, that passed through holes in the frame and through the eyes of the crow-foot. One arm of the crow-foot was in two parts terminating in eyebolts, connected together by a stop of spunyarn, so that in case the dredge got jammed among rocks and stones, a strain less than sufficient to break the dredge-rope would part the stop, alter the position of the dredge, — which would then be attached to the rope by only one arm of the crow-foot, — and probably enable it to free itself.

To the bottom of the dredge-bag was attached a long tranverse iron bar, with a couple of "swabs," or rather bunches of teazed-out hemp, about 3 feet in length, fastened at each of the free ends. Animals that never entered the dredge-bag, or, at best, but rarely and few in number, came up again and again on the tangles, which seem to be singularly well adapted for the capture of certain kinds of marine animals.

Once or twice, on a bottom exceptionally rugged, involving the risk of the dredge being torn or broken, we sent down the tangles alone, attached to an iron bar, which by means of a crow-foot was made fast to the dredge-rope.

Af *Trawls* havde vi 2 Slags, begge leverede af Dr. J. Hearder & Son i Plymouth, nemlig Otter-Trawl og Bom-Trawl,

Of *Trawls* we had two kinds, viz. the Otter-trawl and the Beam-trawl, both furnished by Dr. I. Hearder & Son of Plymouth.

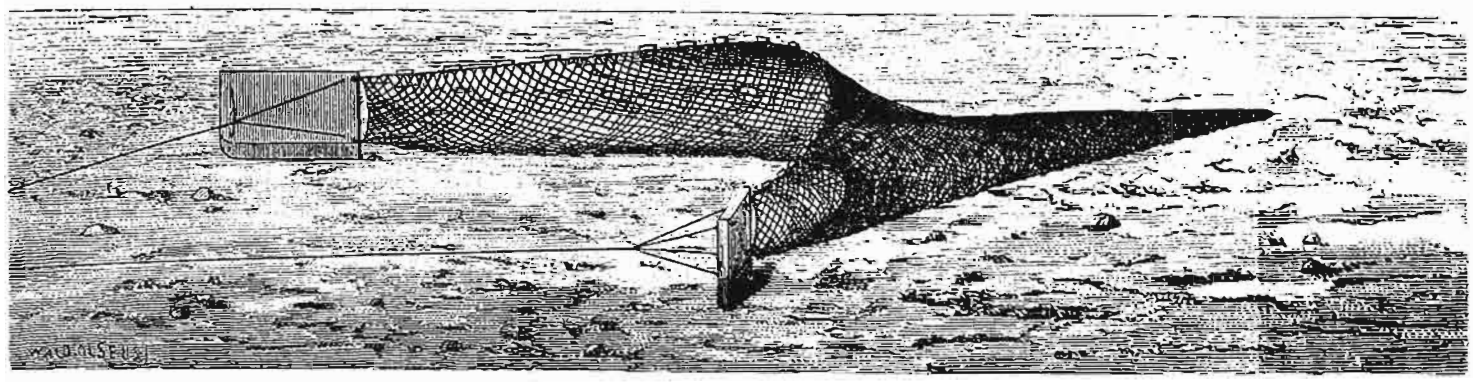

Fig. 18.

Otter-Trawlen (Fig. 18) er nærmest et Fiskeapparat og ikke særdeles meget skikket til zoologisk Brug: Det bestaar af et Net, der er aabent foran og bagtil snevrer sig sammen til en Spids. Til Netmundingen er fastgjort 2 Ottere eller firkantede Træplader. 0.m63 (2 Fod) høje, hvis Underkanter er belastede med Jernmejer. Enderne af Hanefoden, der forbinder Skrabetouget med Trawlen, er fastgjort til Stropper paa Indersiden af disse Ottere, saaledes at de under Farten ved Vandtrykket skjærer ud til hver Side. Overkanten af Netmundingen holdes oppe ved Korkstykker, medens Underkanten er belastet med Blystykker. Netmundingen er 7m.5 (24 Fod) bred mellem Otterne, og Posens hele Længde er 6.m3 (20 Fod).

Naar Otterne skal komme i Stilling, maa dette Apparat gives saa stor Fart gjennem Vandet, at det paa Grund af Tougets Visning paa større Dybder er udsat for at løftes fra Bunden.

The *Otter-trawl* (Fig. 18) is properly a fisherman's apparatus, and not very well adapted for scientific purposes. It consists of a long conical bag of cord-netting, to the mouth of which are attached two "otters," or quadrangular pieces of wood, 2 feet square, each weighted on the lower part with an iron runner. The ends of the crow-foot connecting the trawl with the dredge-rope are secured to straps on the inner side of the otters, in such manner as will cause the latter, when in motion, to sheer out, or diverge, from the action of the water. The top side of the mouth of the net is kept in position by pieces of cork, the under side being weighted with rolls of sheet-lead. The length of the trawl-bag is 20 feet, and its width at the mouth, measured between the otters, 24 feet.

To give the otters the right position, the trawl must move through the water with a rapidity that, by reason of the oblique direction of the dredge-rope, will easily cause the apparatus to be lifted from the bottom.

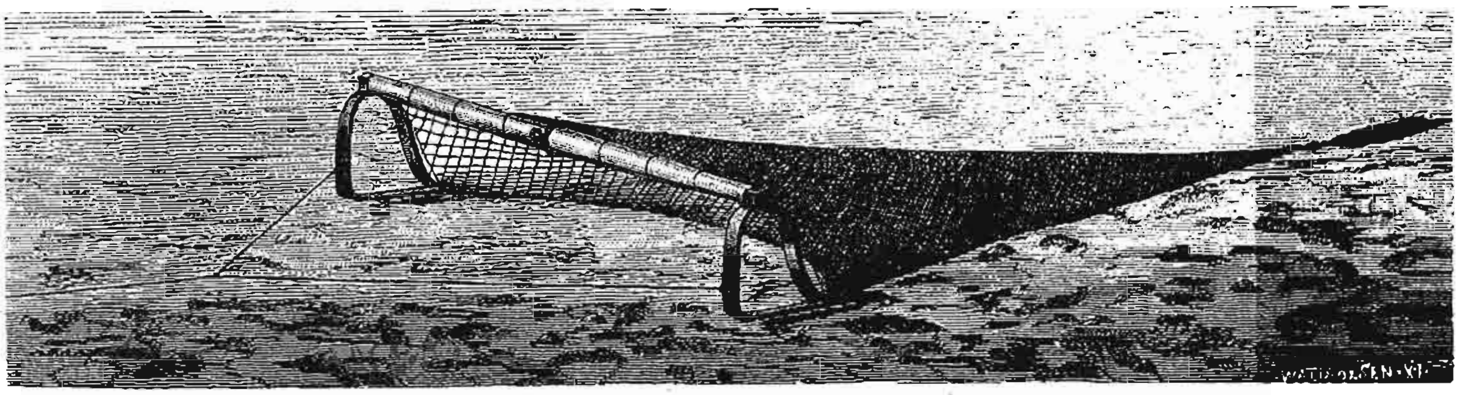

Fig. 19.

Bom-Trawlen (Fig. 19) bestaar af et poseformet, mod Bagenden spidst indsnævret Net, hvis Mundings Overkant er fastgjort til en, 4.m7 (15 Fod) lang, rund Bom af Træ, paa hvis firkantede Ender er indsnøget Jernmejer, 0m.8 (2½ Fod) høje, paa hvilke Apparatet kjøres langs Havbunden. Trawlens Længde fra Midten af Bommen til Spidsen af Nettet er 6m.5 (21 Fod). Den med Blystykker belastede, noget slakke Underkant af Netmundingen er i sine Ender fæstet til Mejernes Underdel og slæber langs Bunden mellem disse, idet den graver mere eller mindre dybt ned i Bundens Materiale. Gjennem en Hanefod af Tougverk, der er fæstet i Øjebolte paa Forkant af Jernmejerne, staar Trawlen i Forbindelse med Skrabetouget. Til Mejerne og til Netspidsen fæstedes ofte Hampsvabere.

Maskerne i Nettet var oprindelig temmelig aabne, saaat det kun kunde holde større Gjenstande tilbage, medens mindre Dyr og det fine Slam gik igjennem. Efter Professor Sars's Ønske blev derfor Spidsen af Nettet foret med finmasket Garn, saaledes at det kunde holde fint Slam. Med denne Forbedring var efter vor Erfaring Bom-Trawlen et udmærket Bundskrabningsapparat. Den fangede baade under hurtigere og langsommere Bevægelse langs Bunden og tog ikke alene Fiske og andre Dyr, der bevæger sig frit i Nærheden af Bunden, men den skummede ogsaa det øvre dyrholdige Bundmateriale af, ja tog endog Stene og det store, indtil 50 Kilograms (100 Pd.) Vægt ind i Nettet.

Bom-Trawlen havde i sin oprindelige Skikkelse ogsaa den Fejl, at hele Systemet kunde svinge sig rundt i Vandet under Udfiringen, og Apparatet kunde saaledes undertiden falde paa Ryggen, med Bommen ned, paa Havbunden. Denne Mangel blev rettet af Skibsfører Grieg ved at hænge et Lod i slak Bugt mellem Mejerne. Fig. 20 viser dette Arrangement. Naar Trawlen begynder at helde fra den rigtige Stilling, i hvilken den blev sendt ud, afslakkes den Del af Touget, der var fast i den Mej, som var nederst. Loddet trak i den anden Part alene og drog den Ende, som var øverst, ned til samme Højde som den anden.

Til *Skrabetoug* brugtes 5 centimeters (2 Toms) Toug de første 2000 Favne og 6.5 centimeters (2½ Toms) i Agterhaanden. Begge Slags var af bedste Sort russisk Hamp, og Prøvetrosserne besigtigede og prøvede ved Carl-Johansværns Værft.

Forberedelser til Bundskrabning. — Disse begyndte i Regelen strax efter at man var færdig paa Bagbord Side med Lodning eller Temperaturrække.

For at compensere Virkningen af Skibets og Skrabens Bevægelse paa Strammingen af Skrabetouget, navnlig for at undgaa farlige pludselige Ryk, var Skrabetouget vist gjennem en Blok, der hang i en *Accumulator*. Skrabeaccumulatoren var meget større end Loddeaccumulatoren. Den havde 30 Stropper, af samme Slags som de ved Lodningen benyttede. Træskiverne, gjennem hvilke Tougstjerterne gik, havde en Diameter af 0m.605 (1 Fod 11½ Tomme) og en Tykkelse af 0m.050 (1.9 Tomme). Skrabeblokken var af

Fig. 19 represents the *Beam-trawl* used on the Expedition. A conical netted bag is suspended by one side from a round beam of wood 15 feet in length, to the square ends of which are fixed iron runners, 2 feet and a half high, that support the apparatus when riding over the bottom. The length of the trawl, measured from the middle of the beam to the apex of the bag, is 21 feet. The lower side of the mouth of the net, weighted with rolls of sheet-lead, hangs loose, and is fastened at either end to the bottom part of the runners, between which it drags along the sea-floor, scooping up more or less of solid matter. This trawl is attached to the dredge-rope by means of a rope crow-foot, lashed to eyebolts on the fore part of the iron runners. We often fastened hempen tangles both to the runners and to the end of the bag.

The commercial trawl, as furnished by the English maker, had a rather wide-meshed bag: and hence it brought up none but comparatively large bodies, small animals and fine mud being washed through. At the instance, therefore, of Professor Sars, the bottom of the bag was lined up to a certain height with yarn netting, sufficiently close to retain the finest mud. With this slight modification, we found the beam-trawl a most efficient instrument, whether quickly or slowly worked; it not only secured fishes and other marine animals that occur near the bottom, but skimmed off a thin layer of the surface: nay, it would take in stones, some of them weighing as much as 100 pounds.

In its original form, the beam-trawl was apt moreover to capsize in the water and reach the bottom with the beam down. Captain Grieg remedied this defective tendency by suspending one of the cast-iron sinkers in a slack bight between the runners. This arrangement is shown in Fig. 20. So soon as the trawl begins to incline from the right position given it at the commencement of the operation, the part of the rope made fast to the runner then deepest in the water will get slack, and the weight accordingly act only upon the runner at the opposite end of the beam, pulling it down to a level with the lower one.

The *Dredge-rope*, samples of which had been examined and tested at the Royal Dockyard of Carljohansværn, was of the best Russian hemp. The 2000 fathoms next the dredge were 2 inches in circumference, the remainder had a circumference of 2½ inches.

Preparations for Dredging. — As a rule, the gear was got ready immediately after taking — on the port side — a sounding or a serial temperature.

With a view to take off the suddenness of the strain on the rope caused by the scraping of the dredge or the motion of the vessel, the rope was rove through a block suspended to an *accumulator*. The accumulator provided for the dredge exceeded considerably in size that used with the sounding-machine. The number of straps was 30, and the wooden disks through which the lanyards passed had a diameter of 1 foot 11¼ inches and a thickness of 2 inches. The dredging-block was of iron, similar in con-

Jern og forøvrigt af lignende Konstruktion som Loddeblokken. Skiven, der var solid, havde en Diameter at 0m.521 (1 Fod 8 Tommer), en Tykkelse af 0m.15 (5³/₄ Tomme), og Furens Dybde var 0m.079 (3 Tommer). Skrabeaccumulatoren hang paa Styrbord Side, *i et Topreb*, hvis ovre Ende var fastgjort til Stormasten over Godset. Fig. 14 viser Accumulatoren hængende i Styrbords Vant, hvor den havde sin Plads, naar den ikke benyttedes til Skrabning.

Skraben eller Trawlen gjordes klar paa Agterdækket mellem Nedgangskappen til Lugarerne og Kappen ved Siden af Dækrullen (Fig. 1, Fig. 2, Fig. 14). Skrabetouget, der laa i sine Binger (Fig. 2, b) agtenfor Fokkemasten, og som i Tampen havde Kous og Hex, toges gjennem en Kasteblok paa Fokkemasten (se Fig. 20), derfra over Hytten og gjennem Kasteblokken i Accumulatoren, og hexedes i Hanefoden til Skraben eller Trawlen. Paa Skrabetouget var indsmøget en Pokkenholts Dor eller Kous med en lang Stjert. Dens Plads var mellem Skrabeblokken og Skraben (Trawlen). Accumulatoren udhaltes med firskaaren Talje (Fig. 14) paa Plads under Styrbords Storraanok. Raaen brasedes saaledes, at Accumulatoren hang omtrent midt ud for Loddebroen. (Fig. 1, Fig. 20). Da der ved Skrabningen kunde gaa stor Kraft paa Raaen saavel nedad som indad, var den paa Styrbord Side faststøttet, foruden ved Toplent, Rakke og Braser, ogsaa ved en Talje som Extra-Toplent og en Støttalje paa Bagbord Side, som Fig. 14 viser.

Manøvrerne ved Bundskrabning var ikke meget forskjellige, enten man brugte Skrabe eller Trawl. For Tydeligheds Skyld skal de her særskilt beskrives, forsaavidt nødvendigt er.

Bundskrabning med Skrabe. — Skibet sattes med fuld Fart op mod Vinden med denne lidt ind om Styrbord. Naar det var kommet i godt Sig, standsedes Maskinen, Skraben løftedes ud over Rækken med Haandmagt og kastedes i Vandet. Forud ved Fokkemasten stod en Mand, med Læderhandsker paa Hænderne, færdig til at fire ud paa Skrabetouget, assisteret af en anden Mand, der ved Hjælp af en Haandspage holdt Touget klart til at løbe fra Kveilen i Bingen. Strax Skraben var i Vandet, kommanderedes: „Fir"! og man firede langsomt paa Skrabetouget, saa man kunde se, om alting var klart. Naar Skraben var agtenfor Skruen, sattes denne atter igang til 4 Knobs Fart, som Maskinisten holdt jevn ved at observere Vandloggen. (Se nedenfor). Man firede nu, med jevnlige Anhold, for at holde Touget og Apparatet strakt, stadig under samme Kurs, som da Skraben kastedes overbord. Naar 200, 300 eller 400 Favne, efter den mindre eller større Dybde, var udfirede, standsedes atter, Touget haledes ved Hjælp af Kousen og Stjerten ind til Hakkebrættet, og der paasattes en Trætærs ved Hjælp af Skibmandsgarnsurring, agtenfor Kousen. Der sattes atter i Gang med samme Kurs og Fart, og man sejlede ud den hele Touglængde, der ansaaes fornøden, nemlig mindst det dobbelte af Dybden og for mindre Dybder mere.

struction to the sounding-block. The sheaf, which was solid, had a diameter of 1 foot 8½ inches and a thickness of 6 inches: the depth of the groove was 3 inches. The accumulator used for the dredge hung — on the starboard side — in a *pendant*, the upper end of which was secured to the mainmast above the rigging. Fig. 14 represents this accumulator as it hung suspended in the starboard shrouds when not in use.

The dredge and the trawl were got ready on the after-deck, between the companion-hatchway to the cabins and the hatchway alongside of the reel (Figs. 1, 2, and 14). The dredge-rope, which at one end had a thimble and shackle, was rove from the lockers (Fig 2 b) in which it lay coiled abaft the fore-mast, through a snatch-block on the mast (Fig. 20), carried from thence over the roof of the roundhouse and through the snatch-block of the accumulator, and then shackled to the crow-foot of the dredge or trawl. Between the dredging-block and the dredge (or trawl) a thimble of lignum vitæ, with a lizard, was slipped on to the dredge-rope. The accumulator was triced up under the starboard main yard-arm by means of a guntackle purchase, the yard being trimmed so as to bring the accumulator nearly abreast of the sounding-bridge (Figs. 1 and 20). As the strain, inwards as well as downwards, to which the yard was exposed when dredging, might be very considerable, it was secured, not only by braces, lifts, and trusses, but also, on the starboard side, by a purchase, as a preventer-lift, and on the port side, by a rolling-tackle, as shown in Fig. 14.

Dredging and Trawling from the "Vøringen." — Both operations were conducted very much alike. We shall, however, for the sake of perspicuity, describe our mode of working each of the two instruments.

Working the Dredge. — We steamed full speed ahead, with the wind a little on our starboard bow. So soon as the vessel had got sufficient headway, the engine was stopped, the dredge lifted by hand over the railing and dropped into the sea. At the foremast, a man with thick leather gloves stood ready to pay out the dredge-rope, which another kept clear with a handspike as it ran out from the coil in the locker. On the dredge entering the water, the word was immediately given to veer, when the paying out commenced, — slowly, however, to make sure that all was right. So soon as the dredge was clear of the propeller, the vessel again went ahead, steaming at a uniform rate of 4 knots, which the engineer was enabled to keep up by frequent reference to the water-log (see below). Meanwhile, we kept steadily veering, while taking care, by frequent holding on to the rope, that the length run out should be properly taut, and steering the course given to the ship when the dredge was put over. After paying out, according to depth, 200, 300, or 400 fathoms, we again stopped, hauled in the rope to the taffrail by means of the lizard and thimble, and fastened, below the latter, with spun-yarn, a wooden toggle to the rope. Starting again (same course and speed), we next ran out the whole length of rope deemed necessary for the operation. —

Farten standsedes. Med Stjerten haledes Skrabetouget atter ind til Hakkebrættet og holdtes inde med Bugten af en Ende. Til Stjerten i Pukkenholtskousen fastgjordes en efter Dybden afpasset Vægt, hvortil brugtes 3 eller 4, til de større Dybder 6 af Baillie-Maskinens Lodder, der vejede 27 Kilogr. (55 Pd.) hver. Man slap Tampen af Enden, væltede Vægten overbord, og denne løb da med Kousen nedover langs Touget, indtil den standsedes af den paasatte Trætærs. Dette kunde føles, naar man holdt Haanden paa Touget.

Skibet laa nu stille, medens Lodder og Skrabe sank. Vi regnede, efter flere Forsøg, at der behøvedes 12 Minutter for at Skraben skulde synke 100 Favne. Skrabens (eller rettere Trawlens) og Loddernes Synkning er anskue-

not less than double the depth, nay for smaller depths even more.

The engine was now stopped, after which we hauled in the dredge-rope, as before, to the taffrail, and kept it up in a bight of rope's end. With the lizard was then made fast to the wooden thimble a weight proportioned to the depth, consisting of 3 or 4, and for the deepest dredgings, of as many as 6 of the sinkers of the Baillie sounding-machine, weighing each 55 pounds. We now, after letting go the rope, tilted the weight overboard, which spun down along it till stopped by the wooden toggle. The shock of its arrest was distinctly perceptible to a person who had his hand on the rope.

The vessel was now kept stationary, while the weight and the dredge were sinking. After some experience, we calculated the time required for the dredge to sink 100 fathoms, to be about 12 minutes. Fig. 20 will

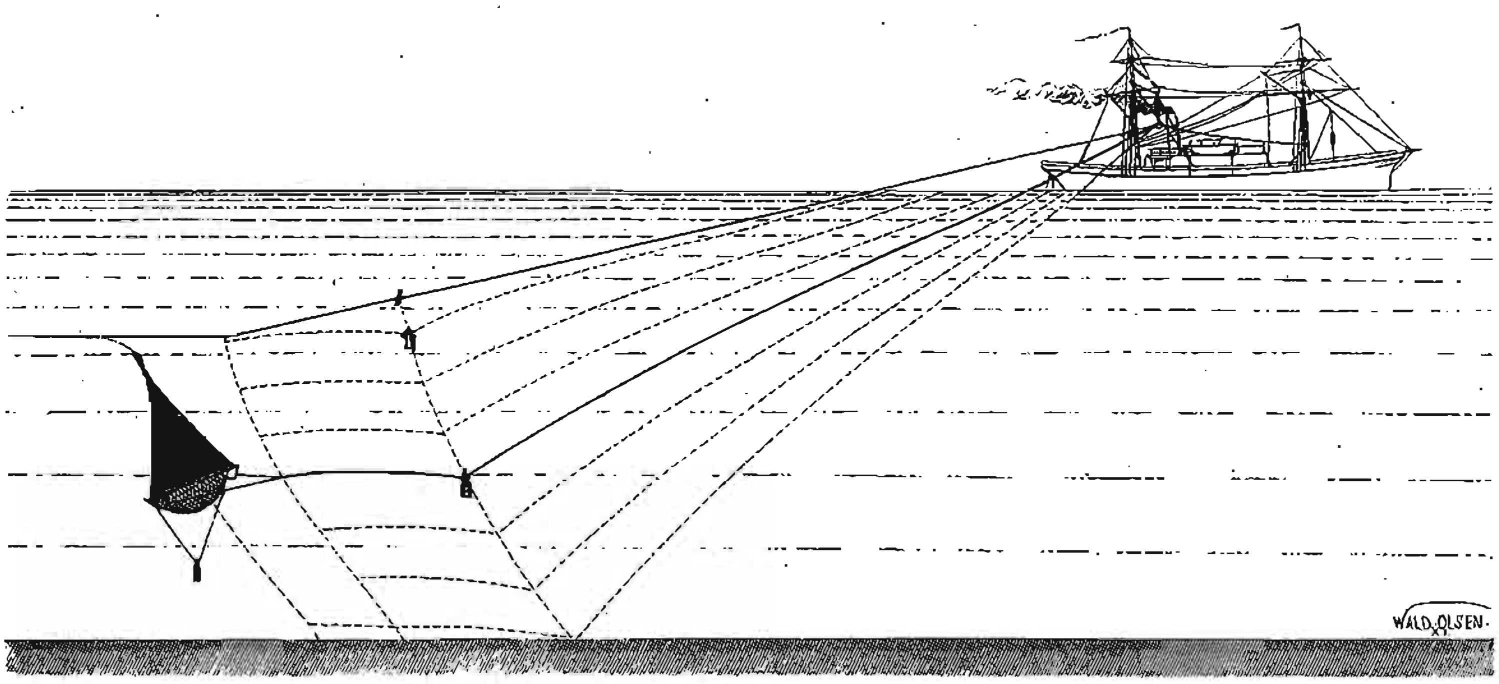

Fig. 20.

liggjort i Fig. 20. Den i Figuren antagne Dybde er 1300 Favne, følgelig er Skib og Trawl tegnet i forstørret Maalestok. De prikkede Linier viser Loddernes, Skrabetoughexens og Trawlbommens Bane under Synkningen, under Forudsætning af, at Trawlen synker med en Hastighed, der er lidt mindre end den, hvormed Lodderne nærmer sig Bunden. Idet Lodderne naar Bund, svæver endnu Trawlen i Vandet, og det sidste Stykke af dens Bane vil være næsten lodret. Erfaring viste, at Trawl og Skrabe med den brugte Fremgangsmaade i Regelen uden Vanskelighed kom i rigtig Stilling paa Bunden. Er Skrabens (Trawlens) Synken meget langsommere end Loddernes, vil den falde lodret ned paa Bunden med sin tunge Ende foran. Er derimod dens Syn-

give an idea of the descent of the dredge, or rather of the trawl. The supposed depth in the diagram being 1300 fathoms, the vessel and the trawl are of course on a much larger scale. The dotted lines represent the lines of descent of the weight, the shackle, the dredge-rope, and the beam of the trawl, — assuming the trawl to sink more slowly than the weight. When the weight strikes the bottom, the trawl has still some distance to travel, and the last part of its line of descent will be well-nigh perpendicular. We found that, when worked in the manner described above, both trawl and dredge could as a rule without difficulty be made to reach the bottom in the right position. If the dredge or trawl descend much more slowly ken ligesaa hurtig som Loddernes eller hurtigere, vil den komme til Bunds med en horizontal Component i sin Bevægelse, hvilket vistnok vilde være det sikreste Middel til at den blev klar under den følgende Bundskrabning.

Saasnart Skraben antoges at have naaet Bund, kastedes Touget los forud og Bugten bragtes agterover, lagdes ind i Fodblokken (a, Fig. 2) i Agterkant af Hytten og derpaa om Spiltapperne om Styrbord, saaledes som Fig. 1 viser.

Med 1, $1^1/_2$ og 2 Knobs Fart og samme Kurs som tidligere blev nu Skraben trukket henover Havbunden, idet Vægten i Forhaand holdt den første Del af Touget ned, saa at Draget blev horizontalt eller næsten horizontalt, og Skrabemunden ikke let løftedes fra Bunden. Under Skrabningen maatte man stadig have Opmærksomheden henvendt paa Accumulatoren. Dens Udvidelse og pludselige Sammentrækning igjen angav, naar Skraben tog Tag og atter slap Bunden, og selvfølgelig angav den ogsaa, naar Skraben satte sig fast. Naar Accumulatoren i dette Tilfælde havde udvidet sig saa meget, at man i den lave Stilling, som Loddeblokken indtog, ikke vilde have mere Kraft paa Touget, kommanderedes "Fir"! og Maskinisten ved Indhivningsmaskinen, som for dette Tilfældes Skyld altid stod klar, reverserede Maskinen og firede ud, paa samme Tid som Skibets Fart standsedes. I Regelen fik man Skraben løs ved at hive ind igjen paa Touget. Stod Accumulatoren stadig paa samme Mærke, antydede dette som oftest, at Farten var for stor, og at baade Vægt og Skrabe slæbtes gjennem Vandet fri af Bunden. For at have et Varsko, naar Accumulatoren pludselig udvidede sig over den tilbørlige Grændse, fastgjordes undertiden en Line med den ene Ende i Accumulatoren og med den anden i Damppiben, der saaledes peb, strax Accumulatoren blev for lang.

Skrabningen fortsattes ofte indtil et Par Timer, forend man begyndte *Indhivningen*. Under denne var Farten standset, og man lod Skibet drive tilbage. I Regelen foregik Indhivningen hurtigere end Skibet drev, saa at Touget viste klart ud i Læ. I modsat Fald gik man rundt med Fartøjet, lagde sig paa Læ Side af Touget og drev da tilsidst over Skraben.

Med fuld Fart paa Indhivningsmaskinen tog den ind 100 Favne i 6 à 7 Minutter. Var Skraben meget tung, maatte der hives langsommere. Eftersom Touget kom ind, haledes det fra Spillet over Hytten forefter og blev atter opskudt klart i Bingen forud. Dette var et meget anstrængende Arbejde, navnlig naar Indhivningen, som enkelte Gange Tilfældet, gik uden Stands i 4 til 5 Timer.

than the weight, it will fall vertically, with the heavy end foremost. If, on the other hand, its rate of descent be equal to or exceed that of the weights, it will, on reaching the bottom, have a horizontal component in its motion, — which is pretty sure to keep it from clogging during the ensuing operation.

So soon as the dredge, by our calculation, had reached the bottom, the rope was cast off forward, the bight brought aft, rove through the leading-block (a, Fig. 2) on the after part of the roundhouse, and then passed round the starboard drums, as shown in Fig. 1.

Steaming ahead at the rate of 1, $1^1/_2$, or 2 knots, on the same course as before, the dredge was pulled along the bottom, the tension of the motion of the vessel not however acting immediately upon it, but dragging forward the iron sinkers, which by their great weight serve to keep the direct traction horizontal, or nearly so, and thus prevent the mouth of the dredge from being readily lifted up. In dredging we had to keep our attention constantly fixed on the accumulator. Its extension and sudden contraction was a sure sign that the dredge was working properly, and of course the accumulator also told us when the dredge had fouled the bottom. A great and increasing strain upon the rope, pulling down the block and seriously stretching the accumulator, showed the dredge to have stuck fast, in which case we gave the word to veer, and an assistant engineer, who always stood ready for that purpose, reversed the donkey-engine and paid out the rope, the ship's way, too, being immediately deadened. By hauling in the rope we generally succeeded in extricating the dredge. Sometimes, the accumulator would remain stretched at the same point, and this we as a rule found to indicate that the speed of the vessel was too great, both weight and dredge being dragged through the water clear of the bottom. To give notice of any sudden stretching of the accumulator beyond the safe limit of extension, we hit on the expedient of fastening one end of a line to the apparatus and the other to the steam-whistle, which in that case would sound on the elastic bands running out too far.

Dredging from the "Vöringen" was frequently carried on for a couple of hours before *heaving in*. During the latter operation the vessel drifted before the wind. The rope being in the majority of cases brought in at a rate exceeding the drift of the ship, pointed leeward. If not, we steamed the vessel round, to get the rope to windward and drift over the dredge.

Working at full speed, the donkey-engine brought in 100 fathoms of dredge-rope in 6 or 7 minutes. When the dredge had got a very heavy freight to bring up, we heaved at a slower rate. As the rope came in, we hauled it from the drum of the engine over the roof of the roundhouse, and thence forward into the locker, where it was again coiled ready for the next operation. This was very fatiguing work indeed, particularly when the engine, as was

Naar Lodderne kom op, haledes Bugten af Touget ind til Loddebroen, hvor Vægten blev afstukken. Et godt Mærke paa, at Skraben havde været i Bund, var det, naar Lodderne var overtrukne med Bundler. Naar Skraben kom op, ihukedes et Takkel fra Gaffelen, og med dette løftedes den ind over Agterdækket.

Bundskrabning med Otter-Trawl. Naar man havde faaet denne klar ud i Søen, saa at Otterne skar ud og Nettet slæbte klart efter, foregik Operationerne som med Skrabe. Apparatet var imidlertid vanskeligt at faa klart til Bunds. Det behøvede en større Hastighed under Skrabningen, tog ikke meget af Bunden med og kom ikke sjælden uklart op. Det brugtes derfor efterhaanden mindre og blev det sidste Aar ganske fortrængt af Bom-Trawlen.

Bundskrabning med Bom-Trawl. Fra Agterdækket løftedes Bom og Mejer ud over Rækken ved en Jolle fra Gaffelen. Denne Jolle var fastgjort med en Tærs til en Strop paa Midten af Bommen. Dette gjordes, medens Skibet havde fuld Fart forover. Naar Bommen var kommen i den rette Stilling udenfor Rækken, standsedes Maskinen, Nettet kastedes ud, og man rykkede Tærsen ud ved en deri fastgjort Stjert, hvorefter Udfiringen af Skrabetouget begyndte. De videre Manøvrer var de samme som med Skraben, kun maatte Farten under Skrabningen være mindre, for at Trawlen skulde holde sig i Bund. En større Fart antoges at være hensigtsmæssig til at fange Fiske og anvendtes oftere en kortere Tid efter den egentlige Bundskrabnings Afslutning.

Naar Bomtrawlen kom op fuld af Bundler i hele sin nedre Del, maatte særegne Foranstaltninger til for at faa den ind paa Dækket, dels paa Grund af dens Længde dels paa Grund af dens Vægt, der var for stor til at dens nedre Ende kunde løftes ind med Haandmagt. Den fyldte Trawl havde Form af en Tragt, hvis Spids var udvidet til en Kugle af en Meters (3 Fods) Diameter. I dette Tilfælde sloges Stropper om selve Trawlnettet saa langt nede som muligt, og i disse hukedes Talje fra Gaffelen. Naar Trawlen med denne var løftet saavidt, at kun den nederste kugleformede Del var i Vandet, firedes ned under denne en "Indretning", bestaaende af en tyk Jernring, indvendig udforet med et meget stærkt Tougnet og som hang i 3 Ender, i hvilke man halede ombord under Indløftningen. Denne Sikkerhedsindretning, hvis Hensigt nærmest var at forhindre, at Trawlnettets nedre Ende skulde revne, naar den kom ud af Vandet, idet den bar en Del af Trawlnettets Vægt, var til stor Betryggelse og Hjælp ved at faa Trawlen ombord. Det hændte os ikke nogen Gang, at Trawlen aabnede sig selv under Indholdets Tryk; men før Indretningen kom i Brug, vovede vi ikke at hale Trawlen ombord, førend en stor Del af det fine Bundslam var udslemmet ved Trawlens Svingninger i Vandet.

often the case, had to be kept going for 4 or 5 hours at a stretch.

On the weights coming up, the bight of the rope was hauled in to the sounding-bridge, where they were severally detached. If covered with clay, it was a sure sign that the dredge had been at the bottom. When the dredge appeared, we hooked a tackle on to it from the gaff, by means of which the apparatus was got in on the after-deck.

Working the Otter-Trawl. — Once properly in the water, with the "otters" sheering out to either side, and the bag behind horizontally extended as the instrument was pulled along after the vessel, we worked the otter-trawl precisely as the dredge. The apparatus was, however, apt to foul before reaching the bottom, greater speed being requisite to work it; besides, it failed to secure a satisfactory sample of the bottom, and came up frequently foul. Hence, on discovering these drawbacks, we came to use it less; and on the last cruise it was entirely superseded by the beam-trawl.

Working the Beam-Trawl. — The beam and runners were hoisted over the railing of the after-deck by means of a whip from the gaff, secured with a toggle to a strap on the middle of the beam, — the vessel steaming ahead the while at full speed. So soon as the beam had been given the right position for letting go, the engine was stopped, the bag pitched out, and the toggle pulled off the strap by means of a lanyard, to which it was attached. This done, we began veering the rope. The remainder of the operation was the same as with the dredge, saving the speed, which we had to reduce lest the trawl should be lifted off the bottom. For catching fish, some increase in speed was presumed to be of advantage, and frequently tried as a wind-up to the bottom-trawling.

If the beam-trawl came up with the whole of the lower part filled with clay, special provision had to be made for getting it in, partly on account of its length, and partly owing to its great weight, which would not admit of lifting in the lower part by hand. With the bag full of clay or mud, the trawl had the shape of a cone, expanded at the apex into a sphere, 3 feet in diameter. A bight of rope was passed round the trawl-net as low down as possible, and a purchase hooked on from the gaff. Then, after hauling up the apparatus till the only part left in the water was the spherical extremity of the bag, we lowered under the latter a contrivance consisting of a thick iron ring, having the opening covered with strong cord netting, and the shank firmly secured to 3 stout hempen ropes, by which the apparatus was lifted over. This precautionary device, the main object of which was to prevent the trawl-bag, on its leaving the water, from bursting at the bottom while partially supporting the net and its contents, proved a safe and most efficient expedient for getting the instrument on board. On no single occasion did the bag give way from the pressure of its freight, whereas previous to our adoption of the contrivance, we had never dared to haul in the apparatus till

I Begyndelsen fulgte vi den efter "Challenger"-Expeditionen givne Anvisning med Hensyn til Manøvren, at sejle ud den hele Tougłængde i Læ og lade Skraben trækkes af Skibet, eftersom dette drev for Vinden. Det er ogsaa rimeligt, at denne Maade maa benyttes, naar Skrabningen skal udføres fra store og fuldkrafts Skibe, som ikke kan gaa saa langsomt for Maskinen, som Skrabningen fordrer. Dersom der Intet kommer ivejen, er det forsaavidt ligegyldigt, hvilken Vej man vælger, men i modsat Fald taber man meget baade i Tid og Arbejde. Naar man skraber under Gang mod Vinden, kan man regulere Farten efter Ønske og standse en Stund, hvis man frygter for at Farten har løftet Skraben fra Bunden. Driver man i Læ af Skraben, bestemmes Farten af Vind og Strøm, og tror man, det gaar for hurtigt, maa man fire ud Toug til Overflod, hvilket senere atter skal hales ind. Sætter Skraben sig fast, og man er til Luvart, behøver man ikke at fire mere end nogle faa Favne, indtil Farten er standset, og kan derefter strax begynde at hive ind, eftersom Skibet driver ned mod Skraben. Er man derimod i Læ, maa der fires ud en Mængde Toug, før man kommer paa Kurs og kan begynde at gaa op mod Skraben.

At faa Skraben løs igjen, naar den har sat sig fast, kræver ofte en besværlig og langvarig Manøver, der desuden ikke altid lykkes. Man maa hive ind til næsten op og ned og derefter søge at trække den løs den modsatte Vej af den, man skrabede, da den gik sig fast. Da ukjendt Strøm ofte kan være tilstede, nødes man gjerne til at gjøre mange Forsøg. Lykkes disse ikke, staar det sidste Middel tilbage, at kaste Touget til en Pullert, gaa forover i Maskinen med fuld Kraft og enten rykke Skraben løs eller sprænge Touget.

Det første Aar forsøgte vi et Par Gange at fæste Otter-Trawlen efter Skraben, men dette viste sig ikke videre hensigtsmæssigt. Naar man skraber, er Farten saa langsom, at Otter-Trawlen slæber langs Bunden som en Bundt Linegods, og sætter man Fart paa, saa at Otterne kan skjære ud til Siderne og holde Trawlmundingen aaben, løfter Skraben sig fra Bunden og gaar med sine paahængte Svabere et kort Stykke foran Trawlaabningen. Den vil saaledes rimeligvis bortskræmme den Fisk, der muligens ellers kunde være fangen.

Paa Expeditionens Rejser faldt der naturligvis adskillige mislykkede Kast med Skrabe og Trawl. Det hændte, at Apparatet ikke kom i Bund, at det blev itureven i Bunden eller satte sig fast, at Skrabetouget sprang under Ind-

a considerable portion of the finest mud had been washed out, by allowing the trawl-bag to swing backwards and forwards in the water.

Dredging from the "Vöringen" was carried on at first in the way adopted on the "Challenger" Expedition — viz. by paying out to leward the due amount of rope, the dredge being then pulled along by the drift of the vessel. This is perhaps the only feasible method in dredging or trawling from large ships of full power, which cannot reduce their speed to the rate required for such operations. True, if all goes well, it is upon the whole immaterial which way is selected; but should, on the other hand, a mishap occur, a serious loss of time and labour will inevitably result. Dredging head to wind, the speed of a steamer may be regulated at pleasure, and her way immediately deadened should there be reason to believe the dredge is off the bottom. When drifting to leeward of the dredge, the speed will be dependent on the wind and the force and direction of currents, and if too high, an extra amount of rope has to be veered, which, of course, must afterwards be hauled in again. Should the dredge foul with the ship to windward, only a few fathoms will have to be veered before stopping the engine, after which the heaving in may be at once commenced, keeping pace with the ship as she drifts down upon the dredge. On the other hand, the ship being to leeward, a very considerable quantity of rope will have to be veered before she can be brought head to wind and steam up to the dredge.

To extricate the dredge when jammed fast at the bottom, is frequently a very difficult matter, involving hours of unremitting exertion, not always accompanied by a successful result. The rope must be hove in till nearly right up and down, attempt being made to extricate the dredge by hauling in a direction contrary to that in which it was moving when the mishap occurred. Moreover, the action of unknown currents will, by complicating the expedients adopted, often protract this laborious work. Should each in turn fail, there is nothing for it but to make fast the rope to a bollard head, and then, steaming full speed ahead, either free the dredge by sheer force or break the rope.

On the first cruise of the Expedition, by way of experiment, we sometimes made fast the otter-trawl behind the dredge, and worked both together; but this arrangement was not found to answer. With amply sufficient headway for dredging, the otter-trawl will drag along the bottom like a heap of cordage; and if, on the other hand, the speed be increased, to make the otters diverge and keep the mouth of the trawl open, the dredge, with its hempen tangles, will be lifted off the bottom and move along a short distance in front of the trawl-bag, scaring away probably many animals, in particular fishes, that might otherwise be captured.

Not every cast of the dredge and trawl was, of course, successful. Sometimes, the apparatus would fail to reach the bottom, or if there get broken, or jammed between rocks or stones; then again, we had the dredge-rope part.

hivningen, at Skrabeposen eller Trawlnettet lagde sig foran Aabningen og tilstoppede denne. Det første Aar brugtes mest Skrabe, hvortil tildels det uheldige Vejr var Grunden, enkelte Gange Ottertrawl og sjælden Bomtrawl. Det andet Aar kom Bomtrawlen i Brug ved Siden af Skrabe, medens Ottertrawlen heller ikke sjælden benyttedes. Det tredje Aar var Bomtrawlen vort Hovedapparat, som da var forsynet med alle de ovenfor nævnte Forbedringer, og brugtes overalt, selv paa de største Dybder, hvor Bunden var jevn og blød. Paa ujevn og haard Bund fik Skraben sin Anvendelse, hvorimod Ottertrawlen ikke blev benyttet.

Naar Skraben eller Trawlen var kommet ombord, begyndte Zoologernes og deres Assistenters Arbejde. Før Apparaterne kom ombord, fyldtes to store Baljer agterud med Søvand ved Hjelp af Donkeyen (en Hjælpepumpe i Maskinen). Til Sigtning af det optagne Bundmaterial brugtes et Sæt runde Sigter, hvert bestaaende af 3 saadanne, den ene staaende inde i den anden. Den underste Sigt havde en Diameter af $0.^{m}365$ (1 Fod 2 Tom.), den mellemste af $0.^{m}33$ (1 Fod 1 Tom.) og den overste af $0.^{m}284$ (11 Tom.) Paa alle 3 var Kantens Højde $0.^{m}087$ ($3^{1}/_{3}$ Tom.) Maskerne var dannede af Kobbertraade og Aabningen mellem dem var paa den nederste Sigt $0.^{mm}3$ til $0.^{mm}5$, paa den mellemste $1.^{mm}5$ og paa den overste $2.^{mm}$ (1 Linie). Sigterne var forsynede med opstaaende Haandtag paa begge Sider.

Naar Skraben kom ombord, afkappedes først Svaberne og derefter blev den firet ned paa Dækket. Sømmen i Sækken blev opsprættet paa begge Sider, og den losnedes ligeledes fra Jernrammen paa den Side, som laa op. Sækkens Overdel toges af, og Indholdet laa afdækket klart til at tages under Behandling. Fiske, Stene og større Gjenstande udtoges strax til Opbevaring og nærmere Bestemmelse. Med en Øse, hvis Bund var af Metalnet, toges af Assistenterne en Portion af Bundmaterialet op i den øverste af et Sæt Sigter. Dette sænkedes ned i Vandet i en af Baljerne, Sigterne bevægedes op og ned, frem og tilbage, indtil det fine Slam var udslemmet, hvorpaa alle Sigters Indhold undersøgtes af samtlige Zoologer. Naar Skrabesækkens hele Indhold paa denne Maade var undersøgt, skylledes Sækken ren med en Vandstraale fra Donkeyen og gjordes klar til senere Brug. Svabernes Indhold udtoges af Zoologerne, et Arbejde, hvortil der i de fleste Tilfælde maatte benyttes Sax. Af saadanne havdes et større Antal i Reserve.

Trawlens Indhold af Bundmateriale tømtes paa Dækket derved, at man løste op Sammensnøringen i Enden af Bunden.

Den Tid, som en Bundskrabning tager, er væsentlig afhængig af Dybden, foruden naturligvis af den Tid, hvori den egentlige Bundskrabning foregaar. En Statistik herover,

when heaving in the gear, and the bag of the dredge or trawl was apt at times to twist round and clog the mouth of the instrument. On the first cruise, in 1876, partly because of the boisterous weather, we made chief use of the dredge, working the otter-trawl occasionally; the beam-trawl was seldom sent down. On the second cruise, both the beam-trawl and the dredge were in constant use, and we also worked the otter-trawl with comparative frequence. On the third and last cruise, the beam-trawl, with the various modifications before described, had come to be our principal apparatus; indeed, we used it exclusively in every locality, even at the greatest depths, on a smooth and soft bottom. Where the bottom was hard and rugged, we had recourse to the dredge. Of the otter-trawl, no use whatever was made in 1878.

So soon as the dredge or trawl was hauled on deck, our naturalists and their assistants set to work. Shortly before the apparatus was got in, two large tubs on the the after-deck were filled with sea-water by means of the steam-pump. For sifting the contents of the bag, we had a set of 3 sieves, fitting freely one within the other The third or bottom sieve had a diameter of 1 foot 2 inches; the second of 1 foot 1 inch; and the first of 11 inches. The depth was the same in each — $3^{1}/_{3}$ inches. These sieves were made of copper wire, the bottom sieve with 0.02 inch meshes, the second with 0.075 inch meshes, and the first with 0.1 inch meshes. Each sieve was provided with a pair of vertical iron handles.

Having hauled the dredge over the railing, the first thing we did was to cut off the hempen tangles, and then lower the apparatus on deck. After ripping open the seam of the bag, the netting, on the side lying up, was detached from the frame, and the top part of the bag removed, thus exposing the contents. Fishes, stones, and all larger bodies were at once laid aside, to be stored for subsequent examination. With a ladle having the bottom of brass wire netting, the assistants transferred to the top sieve part of the sample of the bottom brought up in the apparatus. The set of sieves were then moved gently up and down — from side to side — in one of the tubs of water, till the fine mud or ooze had passed through each, after which the three naturalists carefully examined the sieves in succession. When the whole contents of the dredge or trawl had been sifted and examined, the bag of the apparatus was thoroughly rinsed, by directing on to it a jet of water from the steam-pump, and then put by ready for use. The delicate organisms brought up on the hempen tangles had mostly to be clipped out with short scissors, of which there was an ample supply.

For emptying the trawl, we had a contrivance by means of which the bottom of the bag was made to unlace, and the contents could thus be deposited on deck without inverting the apparatus.

The time occupied in a dredging is mainly dependent on the depth, but of course to a considerable extent also on the length of the interval devoted to working the inudregnet af Skibsjournalens Opgaver over Klokkeslettet, da Skrabe (Trawl) blev sat ud, da Lodderne blev slupne, da man begyndte Bundskrabningen, da den endte, og Indhivningen begyndte, og da Skraben (Trawlen) kom op igjen, viser, at en Skrabning paa 100 Favnes Dyb gjennemsnitlig tog $1\frac{1}{2}$ Time, paa 500 Favnes Dyb $4\frac{1}{2}$ Time, paa 1000 Favnes Dyb $7\frac{1}{3}$ Time, paa 1500 Favnes Dyb $10\frac{1}{2}$ Time. Eller, udtrykt ved en Tilnærmelsesformel, kan man sige, at Tiden for en Bundskrabning =

$$1.5 + (\text{Dybden} - 100\ \text{Fv.})\ 0.654\ \text{Timer.}$$

Denne Formel giver for en Dybde af 2000 Favne en Tid af 14 Timer. Forresten kunde Tiden for en Bundskrabning paa en vis Dybde være temmelig forskjellig, eftersom Manøvren gik mere eller mindre heldig. Var Trawlen meget tung f. Ex., maatte der hives langsommere ind. I 1878, da Trawlen mest var i Brug, varede gjerne selve Skrabningen længere end tidligere (2 Timer mod $1\frac{1}{2}$ Time), og Trawlen var ofte meget tung. Det viser sig af vor Statistik ogsaa, at Varigheden af den hele Operation gjennemsnitlig i 1878 var større end i 1877.

Overfladenet. Foruden de ovenfor beskrevne Fangstredskaber brugtes ogsaa meget hyppigt af Prof. Sars et Overfladenet, som bestod af en omtrent 1 Meter (3 Fod) lang Pose af fin Kammerdug, spids i den ene Ende, og aaben i den anden, der var fæstet til en Ring af Messingtraad. Til denne blev fastgjort i Hanefod en smækker Line. Naar der ved Ankomsten til en Arbejdsstation blev kommanderet "Sagte", udkastedes Nettet, og det slæbte efter Skibet under den aftagende Fart. Undertiden blev det ogsaa blot kastet ud fra Fartøjet under Stilleliggen og strax indhalet.

Navigering.

Til Expeditionen var anskaffet et Admiralitets-*Kompas* fra England. Dets Plads var, som tidligere anført, strax forenfor Bestiklugaret paa Hytten (Fig. 2 c). Dets *Deviation* bestemtes ved Svingning af Skibet, i 1876 i Husø, i 1877 i Husø, ved Røst og i Vestfjorden, i 1878 i Bergen, paa Kysten af Øst-Finmarken nær Vardø, udenfor Sørøen ved Hammerfest, paa Ishavet vestenfor Beeren Eiland, under Beeren Eiland, under Spidsbergens Sydkap, under Grønlandsisen paa $76\frac{1}{2}$ Grads Bredde. Observationerne blev beregnede efter Archibald Smiths Methode strax efter, at de var tagne, og Resultaterne anvendte til Bestemmelse af Kursen. De benyttede Værdier af Misvisningen toges af de norske, britiske og danske Søkarter, naar Misvisningen ikke var bestemt ved vore egne Observationer.

strument when down. Reference to the ship's logbook, in which were recorded the details of every operation, comprising the moment at which the dredge (or trawl) was put over, that at which the sinkers were let go, the actual dredging was commenced and terminated, when the heaving in began, and when the apparatus was hauled on deck, — shows the average time to have been as follows: — At a depth of 100 fathoms, 1 hour 30 min.; at a depth of 500 fathoms, 4 hours 30 min.; at a depth of 1000 fathoms, 7 hours 20 min.; and at a depth of 1500 fathoms, 10 hours 30 min. Or, expressed by an approximate formula, the time required for a dredging =

$$1.5 + (\text{the depth} - 100\ \text{fathoms})\ 0.654\ \text{hours.}$$

For 2000 fathoms, this formula will give 14 hours. Meanwhile, the time a dredging would occupy at any given depth, was found to vary not a little according to the greater or less success attending the operation. And moreover, if the trawl had got an exceptionally heavy freight, the rate of heaving in had to be reduced. In 1878, when chief use was made of the beam-trawl, we as a rule kept the apparatus longer at the bottom than on the two preceding cruises, and it often came up very heavy. It appears, too, from the entries in the log-book, that the average duration of a cast of the trawl in 1878 was greater than in 1877.

The Tow-Net. — Among the apparatus for prosecuting zoological work was a tow- or surface-net, of which Professor Sars made frequent use. It consisted of a conical muslin bag, 3 feet deep, attached to a stout brass ring, which, by means of a crow-foot, was made fast to a line of suitable thickness. Shortly before our arrival at an observing-station, after the ship's way had been deadened, Professor Sars cast out the tow-net, which was pulled along after the vessel till she stopped. Sometimes, he merely threw it over and hauled it in when there was no way on the ship.

Navigating the Ship.

An Admiralty-compass had been procured from England for the Expedition. Its place, as previously stated, was just forward of the chart-room on the roundhouse. The deviation of the instrument we determined by swinging the ship, — in 1876 at Husø; in 1877 at Husø, at Røst, and in the Vestfjord; in 1878 at Bergen, off the coast of East Finmark (near Vardø), off Sørøen (near Hammerfest), in the Arctic Ocean (west of Beeren Eiland), off South Cape, Spitzbergen, and off the Greenland ice-barrier, in lat. 76° 30′ N. Immediately on being taken, the observations were computed by Archibald Smith's method, and the results employed for shaping the ship's course. The variation was taken from the Norwegian, British, or Danish charts, when not previously determined by our own observations.

I 1876 anvendtes, foruden den almindelige *Log* med Flyndre og Line, ogsaa Masseys Patentlog. Denne viste sig ikke synderlig hensigtsmæssig paa Grund af de hyppige Standsninger, og et Par Exemplarer gik i Skruen og tabtes. Der savnedes ogsaa god Lejlighed til at kontrollere dens Nøjagtighed. I 1877 indsattes den af Premierlieutenant *M. Petersen* arrangerede *Vandlog*, hvis Anordning

On the first cruise, in 1876, we used Massey's patent log, as well as the common log with logchips and line. The first instrument, however, did not answer well, owing to the frequent stoppages; and on one or two occasions it fouled the screw, and was lost. Moreover, we had no good opportunity whereby to test its accuracy. In 1877, the "Vøringen" was furnished with a *water-log*, the inven-

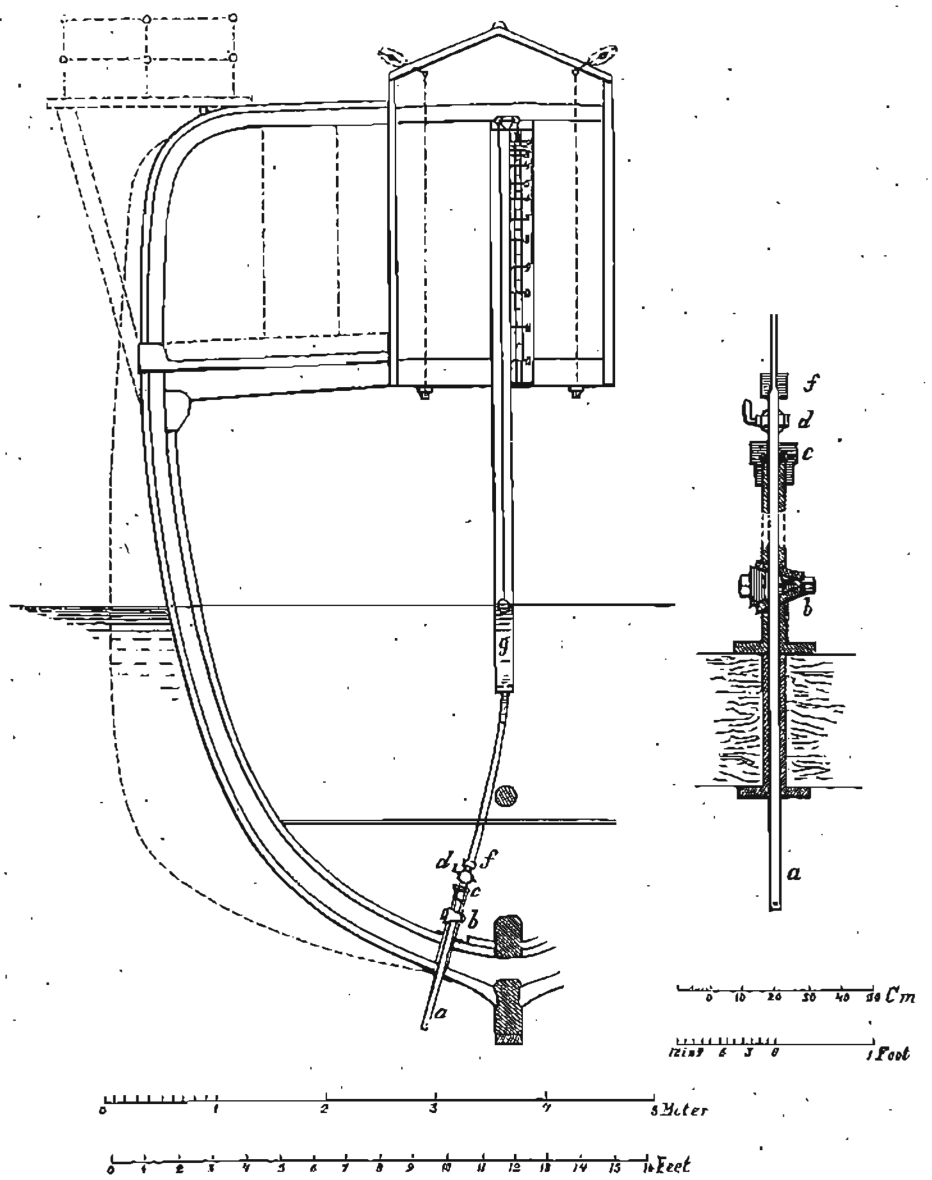

Fig. 21.

ombord i "Vøringen" sees af Fig. 21, der viser et Tversnit af "Vøringen" gjennem den agterste Del af Maskinrummet, seet forfra agterover. Vandloggen har følgende Indretning.

Paa et bekvemt Sted i Maskinrummet bores et Hul i Skibsbunden og føres med et 1 Toms Rør. Over dette anbringes med Flens Røret *b* (se den lille Figur) saaledes, at Aabningen i dette danner en Fortsættelse af Hullet i Bunden. Paa Midten af dette Rør er en konisk Kran og omkring dets øvre Ende er Skruegjænger til Pakningsringen *c*. Gjennem Røret *b* og Hullet i Skibsbunden nedsættes Røret *a* saa langt, at den lille Aabning i dets nedre Ende,

tion of Lieutenant *M. Petersen*. Fig. 21, representing a transverse section of the after part of the engine-room, as seen looking aft, shows the arrangement of the water-log on board.

In some convenient spot in the engine-room, a hole was bored in the ship's bottom to receive a one-inch metal tube, having fixed on to its top end the flange of the tube *b* (see small Figure), in such manner that the bore of the latter would form a continuation of the hole in the ship's bottom. This tube had a conical stop-cock, and its upper extremity screw-threads fitting into the gland *c*. The tube *a* was passed through the tube *b* and the hole in the ship's der forøvrigt er lukket, kommer omtrent 0.m5 (20 Tommer) under Skibsbunden og visende ret forefter. Denne Afstand fandt vi var den hensigtsmæssigste. En mindre Afstand bragte Hullet for nær det af Skibsbunden medslæbte Vand, en større Afstand rønnede for meget paa det fritstaaende Rør under større Fart. Pakningsskruen *c* tilskrues. Ovenfor *c* bør Røret *a* have en mindre Kran *d*. Fra *a*'s øvre Ende gaar et tyndt Blyrør til Stigerøret *g*, der har omtrent 10cm (4 Tommers) Diameter. Dette maa placeres midtskibs, vertikalt og saa lavt, at dets nedre Ende er godt under laveste (nederste) Vandlinies Plan. Det er forsynet med Blænde, for at ikke Vandet under Skibets Bevægelse skal pumpe i Røret. I dette Stigerør er anbragt en Flyder, fra hvilken der gaar en Snor over en Metalrulle paa Toppen af Røret, derfra over en anden Rulle paa Toppen af Skalaen, og Tampen er stukket gjennem et lidet Blylod, der vandrer mellem to tynde Messingstænger langs Skalaen, og som fæstes til Snoren ved at man trykker ind en liden Trækile nedenfra i det Hul, gjennem hvilket Snoren er trukket.

Under Skibets Fart forover trykkes Vandet op i Stigerøret, og eftersom Flyderen kommer højere, synker Loddet langs Skalaen. Saasnart Farten er bleven jevn, staar Loddet uforandret paa samme Højde paa Skalaen, hvor Fartens Størrelse da kan aflæses i et Øjeblik.

Vandloggen er, som man ser, en speciel Anvendelse af *Pitot*'s *Rør*. Kaldes den Højde, hvortil Vandet stiger i Stigerøret over det Niveau, det indtager, naar Fartøjet ligger stille, *h*, Skibets Hastighed *v*, Tyngdens Acceleration *g* og er *M* en Coefficient, saa har man[1]

$$h = M\frac{v^2}{2g}.$$

Coefficienten *M* har efter Dubuats Forsøg en Værdi, der er større end 1, men bliver mindre, naar Hastighederne bliver større, uden dog at naa Enheden. Ved en Hastighed af 1.m8 pr. Sekund fandtes $M = 1.08$.

Ved Vandloggen, saaledes som den er indrettet af Lieutenant Petersen, er Coefficienten *M* sat lig 1. Rigtigheden eller Tilstrækkeligheden af denne Antagelse til ethvert praktisk Brug tilsøs, selv paa lange Rejser, er godtgjort ved den Anvendelse, Apparatet har havt paa "Vøringen" under 1877 og 1878 Aars Expeditioner og under dens Gang i Fragtfart paa Østersøen og Spanien, hvor lange Strækninger er udsejlede uden Afbrydelse. Endvidere har det samme Resultat vist sig af Vandloggens Anvendelse paa Oplodningsdampskibet "Hansteen" hvert Aar siden 1875 og paa Korvetten "Nornen" paa et Togt til Vestindien.

[1] Bresse, Cours de mécanique appliquée. Seconde partie, p. 335.

bottom, till the small aperture at its lower end, which for the rest was closed up, had been made to project about 20 inches beneath the bottom of the vessel, while pointing straight forward. This we found, by repeated experiment, to be the right distance. If diminished, it would bring the aperture too near the water carried along by adhesion to the ship's bottom; and if increased, it would, with greater speed, expose the projecting tube to a serious strain. The gland *c* has now to be screwed on. A little above the gland, the tube *a* should have a smaller stopcock *d*. From the top of *a* a slender leaden pipe led to the upper tube *g*, which had a diameter of nearly 4 inches. This tube must be given a vertical position amidships, and far enough down to bring its lower extremity well below the level of the lowest load water-line. It was provided with a blind, to prevent the water from pumping in the tube by reason of the motion of the vessel. In this upper tube there was a float, from which a line passed first over a brass roller at the top of the tube and then over another at the top of a graduated scale, the end of the line being rove through a small leaden weight that played against the scale between two slender brass rods, and was made fast to the line by inserting from below a small wooden wedge into the opening through which the former passed.

Now, on the ship moving ahead, the water will be forced into the upper tube and the weight descend along the scale as the float rises. So soon as the speed has become uniform, the weight will keep stationary, at the same point on the scale, and the rate may then be read off at a glance.

The water-log is obviously a special adaptation of *Pitot's tube*. Let *h* be the height to which the water in the upper tube rises above its level when the ship is stationary; *v* the speed of the vessel; *g* the acceleration of gravity; and *M* a coefficient, — we shall then have the formula[1]

$$h = M\frac{v^2}{2g}$$

The coefficient *M* has, according to Dubuat, a value greater than 1, which decreases however with the increasing velocities, though without reaching unity. For a velocity of 1.8m pr. second, the value of *M* was found to be 1.08.

For the water-log on Lieutenant Petersen's construction, the coefficient *M* is put equal to 1. And this is practically correct, even for comparatively long voyages, as shown from experience derived on the cruises of the "Vøringen" in 1877 and 1878, and on her voyages in the freight-trade to the Baltic and to Spain, very considerable distances having then been run at a stretch. Equally favourable results have been obtained, too, by the use of the water-log (since 1875) on board the Coast Survey steamer "Hansteen," and on a cruise of the steam-corvette "Nornen" to the West Indies. Now, supposing the coef-

[1] Bresse, Cours de mécanique appliquée. Seconde partie, p. 335.

Sættes Coefficienten M lig 1, Kvartmilen lig $^1/_{60}$ af en Ækvatorsgrad og g lig $9.^m810$ (50° N. Br.), saa faar man den følgende Tabel for Skalaens Inddeling.

ficient M to equal 1, a mile to equal $^1/_{60}$ of an equatorial degree, and g to equal 9.810^m (in lat. 50° N.), we have the following series of figures for graduating the scale.

Fart. (Speed.)	Skala. (Scale.)			Fart. (Speed.)	Skala. (Scale.)		
Kvartmil i Timen. (Miles an Hour.)	Meter. (Metres.)	Norske Fod. (Norw. Feet)	Eng. Fod. (Eng. Feet.)	Kvartmil i Timen. (Miles an Hour.)	Meter. (Metres.)	Norske Fod. (Norw. Feet.)	Eng. Fod. (Eng. Feet.)
1	0.014	0.043	0.044	7	0.663	2.114	2.176
2	0.054	0.172	0.178	7.5	0.761	2.427	2.498
2.5	0.085	0.270	0.278	8	0.866	2.761	2.842
3	0.122	0.388	0.400	8.5	0.978	3.117	3.209
3.5	0.166	0.529	0.544	9	1.096	3.495	3.597
4	0.217	0.690	0.711	9.5	1.222	3.894	4.008
4.5	0.274	0.874	0.899	10	1.354	4.314	4.441
5	0.338	1.079	1.110	10.5	1.492	4.756	4.896
5.5	0.410	1.305	1.343	11	1.638	5.220	5.373
6	0.487	1.553	1.599	11.5	1.790	5.706	5.873
6.5	0.572	1.823	1.876	12[1]	1.949	6.213	6.395

Vil man efterse, om Røret gjennem Bunden er i Orden, stænges Kranen *d*, Pakningsstykket *f* afskrues, og Blyrøret bøjes noget til Side; man løsner paa Pakningsringen *c*, Røret *a* løftes op, indtil dets nedre Ende har passeret Kranen paa Røret *b*, hvorefter denne afstænges, og Røret *a* kan løftes helt op og eftersees.

Ved Brugen af Vandloggen maa to Ting haves i Erindring:

1) at Skalaens Nulpunkt eller rettere Snorens Længde fra Flyderen til Vægten, der tjener til Viser paa Skalaen, retter sig efter Skibets Dybgaaende, og

2) Fejlen, der foraarsages ved stadig Krængning.

Med Hensyn til det første Punkt, reguleres dette lettest derved, at man standser Skibets Fart, udtager Trækilen og flytter Loddet paa Nul. Det hele kan udføres i nogle Minutter. Ved de hyppige Stopninger, som Lodning og Skrabning foranledigede, kunde vi paa Nordhavs-Expeditionen altid holde Vandloggen skarpt justeret. Paa Sejlskibe vil Forbruget ombord ikke saaledes forandre Dybgaaendet, som paa Dampskibe, men man bør dog imellem foretage et Par nøjagtige Logninger med den almindelige Log og Uhr, for at kontrollere Vandloggen og eventuelt justere den paany.

[1] Ved 80° Bredde med $g = 9.^m830$ bliver Skalastregen for 12 Miles Fart 1.945 Meter, altsaa kun 4^{mm} forskjellig fra Tabellens. For de mindre Hastigheder bliver Forskjellen forholdsvis mindre.

To ascertain whether the tube passing through the ship's bottom be in order, the stopcock *d* is turned back, the gland *f* screwed off, and the leaden tube bent a little aside; then, after partially unscrewing the gland *c*, the tube *a* is lifted up till its lower extremity is just clear of the cock of the tube *b*, and when this too has been turned back, the tube *a* may be taken out and examined.

When using the water-log, two things must be borne in mind, viz. —

1) That the position of zero on the graduated scale, or rather the length of the line from the float to the weight which plays against the scale, is regulated by the draught of the ship; and

2) The heeling error.

As regards the first source of error, the index is best regulated by stopping the vessel, and then, after taking out the wooden wedge, placing the weight at zero. This may be done in a few minutes. With the frequent stoppages involved in sounding and dredging on the North-Atlantic Expedition, we could always manage to keep the water-log accurately adjusted. In sailing-vessels the draught is not of course as in steamers affected by the consumption of coal: but now and then the speed should nevertheless be closely determined with the common log as a means of testing the results of the water-log, and, if necessary, of adjusting that instrument anew.

[1] In lat. 80° N., where $g = 9.830^m$, the division on the scale denoting a speed of 12 knots will correspond to 1.945^m, and thus exhibit a difference of only 4^{mm} as compared with the figures in the Table. For less velocities, the difference will be proportionally reduced.

Med Hensyn til det andet Punkt, Krængningsfejlen, da kommer denne i Betragtning kun ved større og stadig Krængning. Slingringernes Virkning er næsten ganske hævet ved Hullets Tranghed og Blænderen. Antages at Stigerøret staar midskibs og vertikalt, naar Skibet ligger paa ret Kjøl, og sættes den lodrette Afstand fra Havniveauet til det Punkt, om hvilket Fartøjet drejer sig, naar det begynder at krænge, lig x, regnet positiv fra Havniveauet nedad mod Kjølen, samt Krængningsvinkelen i og den under denne Krængning paa Skalaen aflæste Fart v', saa har man, idet de tidligere Benævnelser h og v beholdes:

$$v'^2 = 2g\left(\frac{h + x}{\cos i} - x\right) = \frac{2gh + 2gx}{\cos i} - 2gx =$$

$$\frac{v^2 + 2gx\,(1 - \cos i)}{\cos i}$$

$$v^2 = v'^2 \cos i - 4gx \sin^2 \frac{i}{2}$$

x, v og v' maa regnes i samme Enhed (Meter, Fod), Tidsenhed er Sekundet. 1 Kvartmil i Timen svarer til 0.5153 Meter pr. Sekund.

Den følgende Tabel giver en Oversigt over Resultaterne efter denne Formel. Den er beregnet for en Krængning $i = 20°$, og efter Værdierne af $x = 0$, $x = +1^m$ og $x = -1^m$.[1]

[1] Værdien af x kan findes, naar man krænger Fartøjet, medens det ligger stille, og observerer Krængningsvinkelen i samt Længden o af det Stykke, Vandets Overflade har flyttet sig fra det oprindelige Niveau i Røret. Ligger Niveauet under Krængningen højere, det er over Nulpunktet (Loddet paa Tal paa Skalaen), er x positiv, ligger det lavere (Loddet ovenfor Nulpunktet paa Skalaen), er x negativ. Formelen er:

$$x = o\,\frac{\cos i}{2\sin^2 \frac{i}{2}}$$

Ex. $i = 20°$, $o = 0.^m05$, $x = 0.^m770$.

Den negative Værdi af x lig en hel Meter er medtaget som Regneexempel for at vise Virkningen af en saadan, omendskjønt den ikke vil forekomme i Praxis.

The other source of error, viz. heeling, may be ignored altogether, save when the heeling is both great and continuous. The effect of rolling on the water-log will, as a rule, be almost wholly counteracted by the narrowness of the aperture of the tube, and by the blind. Supposing the upper tube, placed amidships, to have a vertical position when the ship is on an even keel, then, if x be the length of the perpendicular from the level of the sea to the point about which she turns on beginning to heel, — assumed positive from the level of the sea towards the keel, — i the heeling-angle, and v' the speed, as read off on the scale with the vessel at that angle, we have, h and v denoting as before, —

$$v'^2 = 2g\left(\frac{h + x}{\cos i} - x\right) = \frac{2gh + 2gx}{\cos i} - 2gx =$$

$$\frac{v^2 + 2gx\,(1 - \cos i)}{\cos i}$$

$$v^2 = v'^2 \cos i - 4gx \sin^2 \frac{i}{2}$$

The value of x, v, and v' must be taken in the same unit of measure (metre, foot). The unit of time is a second. One mile an hour corresponds to 0.5153 metre pr. second.

The following Table gives the results obtained by this formula, taking 20° as the angle of heel, and with the values $x = 0$, $x = +1^m$, and $x = -1^m$.[1]

[1] The value of x may be found by heeling the ship when stationary, and then observing the angle of heel i, together with the distance o, through which the water in the tube has moved from its original level. If the level in heeling be higher, i. e. above zero (the weight within the divisions of the scale), the value of x will be positive; if lower (the weight above zero), x will be negative. The formula is as follows: —

$$x = o\,\frac{\cos i}{2\sin^2 \frac{i}{2}}$$

Example: $i = 20°$, $o = 0.^m05$, $x = 0.^m770$.

The negative value of x put equal to a whole metre, is introduced merely by way of example, to show its *possible* effect, the case never occurring in practice.

Krængning 20°. *Angle of Heel* 20°.

Observeret Fart. (Observed Speed.) Kvartmil i Timen. (Miles an Hour.) v'	Virkelig Fart. (Actual Speed.) $x = 0$ v	Corr. (Corr.)	Diff. f. 1 Kvartmil. (Diff. for 1 Mile.)	v Kvartmil i Timen. (Miles an Hour.) $x = + 1^m$ v	Corr.	$x = -1^m$ v	Corr.
12.0	11.6	—0.4	0.03	11.4	—0.6	11.8	—0.2
9.0	8.7	—0.3	0.03	8.5	—0.5	9.0	0.0
6.0	5.8	—0.2	0.03	5.4	—0.6	6.2	+0.2
4.0	3.9	—0.1	0.03	3.3	—0.7	4.4	+0.4
3.0	2.9	—0.1	0.03	2.0	—1.0	3.6	+0.6
2.5	2.4	—0.1	0.03	1.2	—1.3	3.2	+0.7
2.2	2.1	—0.1	0.03	0.4	—1.8	3.0	+0.8
2.177	2.1	—0.1	0.03	0.0	—2.2	3.0	+0.8
1.0	1.0	0.0				2.3	+1.3

Man ser, at Krængningsfejlen, selv med en saa stor Krængning som 20°, for de større Farter kun udgjør Brøkdele af en Knobs Fart. Svinger Fartøjet om et Punkt i eller nær Vandliniens Flade, er Krængningsfejlene i ethvert Tilfælde meget smaa.

Anderledes stiller Forholdet sig, dersom Stigerøret ikke staar midtskibs. Der kommer da under Krængning en ny Korrektion til, som bliver positiv for Krængning til den ene Side og negativ for Krængning til den anden, og hvis Størrelse voxer med Stigerørets Afstand fra Diametralplanet.

Efter vor Erfaring viste Vandloggen sig særdeles hensigtsmæssig og holdtes med største Lethed i Orden. Et Blik ned i Maskinskylightet var nok til at observere Skibets Fart i Øjeblikket. Maskinisten kunde under Skrabning og Trawling holde Skibet gaaende med den befalede Fart. Til Reduktion af de observerede Vindretninger og Vindhastigheder til sande kræves Skibets Hastighed i Observationsøjeblikket. Denne observeredes paa Vandloggen, der saaledes er et udmærket nautisk-meteorologisk Apparat.

Astronomiske Observationer. Da Expeditionen færdedes paa høje nordlige Bredder om Sommeren, var der ikke Tale om at observere andre Himmellegemer end *Solen* til Bestemmelse af Skibets paaværende Plads. Observationerne gjordes med flere *Sextanter*, der altid var godt verificerede, og hvis Indexfejl stadig blev kontrolleret. Sammenlignende Observationer med forskjellige Sextanter gav altid godt overensstemmende Resultater. Observationspladsen var i Regelen Hyttedækket. I Solobservationernes Udførelse og Beregning deltog, foruden jeg selv og Skibsofficiererne Petersen og Grieg, Professor Mohn og Hr. Tornøe. Solhøjder maaltes til alle Dagstider, naar der var Anledning. I 1878 iagttoges oftere Midnatsolen. Det var kun yderst faa Dage, paa hvilke der manglede Observationer.

It is evident that, with greater speed, the error involved in heeling, even at an angle of 20°, will amount to only a fraction of a mile. And if the point about which the vessel turns lie in or near the plane of the water-line, the error will be generally very small.

The case, however, is different in the event of the upper tube not being amidships. Another correction, positive with a heel to the one side, negative with a heel to the other, will then be needed for computing the speed, and the effect of the heeling will increase with the distance of the upper tube from amidships.

So far as our experience went, we had every reason to be satisfied with the water-log; it answered excellently, and was easy to keep in order. A glance down the engine-room skylight sufficed to tell the ship's speed. Hence, in dredging or trawling the engineer could keep the vessel at the exact rate required. For reducing observations of the wind's direction and velocity to their true value, the speed of the vessel at the moment of observation has to be found. Now, this we took from the water-log, which accordingly proved an excellent instrument for meteorological work at sea.

Astronomical Observations. — The North-Atlantic Expedition having to cruise in high northern latitudes during the summer season, observations of other celestial bodies than the sun for determining the ship's position were of course out of the question. The altitudes were taken with several sextants, accurately verified; the index-error, too, being determined for each separate observation. The results of comparative observations with different sextants never failed to exhibit satisfactory agreement. Our post of observation was, as a rule, the roof of the roundhouse. Besides myself and the ship's officers, Mr. Petersen and Mr. Grieg, Professor Mohn and Mr. Tornøe also assisted in taking the observations and computing their results. Solar altitudes were taken at all hours of the day; nay, on the last cruise, in 1878, we

Kronometrene stod i et Skab i Arbejdssalonen om Bagbord (Fig, 4, c). De blev optrukne hver Morgen og derpaa indbyrdes sammenlignede.

I 1876 havdes 3 Kronometre ombord, et af Kullberg, et af Mewes og et af Frodsham. Det første, der ved den paa Bergens Observatorium af Hr. Åstrand foretagne Undersøgelse før Rejsen viste den jevneste Gang, blev benyttet som Hoveduhr.

I 1877 og 1878 havdes 4 Kronometre ombord, nemlig foruden de 3 nævte. et af Reid, der var Skibet tilhørende. Dette Kronometer viste en saa fortræffelig jevn Gang, at det benyttedes som Hoveduhr de 2 sidste Aar.

Kronometrenes Stand blev bestemt, først paa Bergens Observatorium (undtagen Reid) og senere hovedsagelig ved de telegrafiske Tidssignaler fra Christiania. Disse Signaler gives fra Observatoriet i Christiania hver Onsdag Morgen Kl. 8 Formiddag og hver Søndag Morgen Kl. 9 Form., *Greenwich* Middeltid, til samtlige norske Telegrafstationer. Signalerne gives paa Observatoriet direkte efter Normalpendelen. Der telegraferes hver Gang 3 Signaler, hvert bestaaende af et enkelt Slag fra Nøglen paa Morses Telegrafapparat, nemlig $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$ og $8^h\ 1^m\ 0^s$ om Onsdagen og $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$ og $9^h\ 1^m\ 0^s$ om Søndagen. For at skille mellem Signalerne betegnes de henholdsvis med 1, 2 og 3 dobbelte Slag strax efter Signalet. Paa Modtagelsesstationen, hvor man indfinder sig med sit Kronometer eller Observationsuhr, høres Signalerne kort og skarpt paa Morses Apparat.

Ved 15 Par korresponderende Solhøjder paa Huso (4° 36′ 57″ øst f. Greenwich) fandt Prof. Mohn den 10de Juni 1876 Kronometret Kullberg $0^h\ 38^m\ 43.3^s$ foran Greenwich Middeltid.

Under Expeditionens Ophold i Reykjavik toges af Lieutn. Petersen og mig den 1ste August 1876 14 Par korresponderende Solhøjder paa en Plads, der ligger omtrent 200 Alen østenfor Kirken. Ifølge velvillig Meddelelse fra Chefen for det Kgl. Danske Søkaart-Archiv, Hr. Kommandør *Rothe*, er, ifølge saavel ældre som nyere Iagttagelser, Længden af et Punkt, der ligger 600 Alen vestenfor Kirken

21° 54′ 46″ W. Greenwich.

Vor Observationsplads ligger saaledes ca. 800 Alen øst for dette Punkt, hvilket, da Bredden er 64° 9′, svarer til 38″ i Længde, og Længden af vor Observationsplads bliver saaledes 21° 54′ 8″ W. Greenwich eller i Tid:

	$1^h\ 27^m\ 36.^s5$
Kronometrets Stand for Stedets Middeltid fandtes	$2^h\ 6^m\ 55.^s7$ foran
altsaa dets Stand for Greenwich Middeltid	$0^h\ 39^m\ 19.^s2$ foran

frequently observed the sun at midnight. The days on which no observations could be taken were very few indeed.

The *Chronometers* we kept in a cupboard in the workroom, on the port side (Fig. 4. c). They were wound up every morning, and duly compared.

On the first cruise, in 1876, we had 3 chronometers, — one by Kullberg, one by Mewes, and one by Frodsham. That by Kullberg, which, previous to the departure of the Expedition, Mr. Åstrand, Director of the Bergen Observatory, had found to have the most uniform rate of the three, was our principal timekeeper in 1876.

In 1877 and 1878 there was a fourth chronometer, one of Reid's, belonging to the ship. This instrument having a remarkably uniform rate, we made it our chief timekeeper on the two last cruises.

The error of each chronometer was first determined at the Bergen Observatory (saving that of the Reid), and afterwards chiefly by comparison with the time-signals telegraphed from Christiania. The observatory of that city transmits these signals every Wednesday morning at 8 a. m. and every Sunday morning at 9 a. m., *Greenwich* mean time, to all Norwegian telegraph-stations. The time is taken at the observatory direct from the standard-clock. Three separate time-signals, each consisting of a single click, are telegraphed, from the key of Morse's apparatus, at intervals of one minute, viz.: — Wednesdays, at $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$, and $8^h\ 1^m\ 0^s$; Sundays, at $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$, and $9^h\ 1^m\ 0^s$. To distinguish between the signals, they are respectively indicated by double clicks, 1, 2, and 3, following after the signal in the order of succession. At the receiving station, where the observer stands by with his chronometer or hack-watch in hand, the signals come sharp and distinct from Morse's apparatus.

From 15 pairs of equal solar altitudes, taken at Huso (long. 4° 36′ 57″ E.) on the 10th of June 1876, Professor Mohn found the error of Kullberg's chronometer, on Greenwich mean time, to be $0^h\ 38^m\ 43.^s3$ fast.

During the stay of the Expedition at Reykjavik, Lieutenant Petersen and myself took 14 pairs of equal solar altitudes, at a point about 140 yards east of the cathedral. From information kindly furnished by Commodore *Rothe*, Hydrographer to the Royal Danish Navy, it appears that the longitude of a point 410 yards west of the church, has been found, by earlier as well as recent observations, to be —

21° 54′ 46″ W.

Our post of observation was thus about 550 yards east of this point, which corresponds, the latitude being 64° 9′, to 38″ in longitude. Hence, our post of observation was in

Longitude 21° 54′ 8″ W., or in time	$1^h\ 27^m\ 36.^s5$
Error of chronometer on mean time of place	$2^h\ 6^m\ 55.^s7$ fast;
therefore on Greenwich mean time	$0^h\ 39^m\ 19.^s2$ fast.

I nedenstaaende Tabeller er givet en Oversigt over Hovedkronometrets Stand og Gang under vor Expedition.

1876. Kronometer Kullberg.

Dag.	Stand foran Gr. Middelt.	Daglig Acceleration.	Sted.
Mai 30	0h 38m 37.s8	0.s66	Bergens Observatorium.
Juni 10	38 43.3	0.50	Husø. Corr. Højder.
Juni 26	38 59.6	1.02	Kristiansund. Tel. Sig.
Aug. 1	39 19.2	0.54	Reykjavik. Corr. Højder.
Aug. 20	39 33.6	0.76	Namsos. Tel. Sig.

Sammenstilles de Værdier af Kronometrets Stand, som er benyttede ombord, med de som følger af Tabellens Tal ved ligefrem Interpolation, saa finder man, at den største Forskjel falder den 22de Juli, da den brugte Stand er 39m 21s og den efter Tabellen fundne 39m 14s. Forskjellen er 7s i Tid eller 1.'75 i Bue af Parallelgraden. Da Bredden her var mellem 63° og 64°, bliver Fejlen i Storcirkelbue 0.'78, en saa liden Størrelse, at vi i vore Opgaver over Skibets (Stationernes) paaværende Plads har beholdt de under Rejsen bestemte Værdier af Bredder og Længder. Den næststørste Afvigelse mellem den benyttede og beregnede Værdi af Kronometrets Stand findes den 13de August, da den er — 5s, hvilket svarer til en Afstand af 0.6 Kvartmil.

1877. Kronometer Reid.

Dag.	Stand efter Gr. Middelt.	Daglig Retardation.	Sted.	
Maj 23	0h 7m 23.s0	0.s90	Bergen.	Tel. Sig.
Juni 24	7 54.0	0.97	Bodø.	do.
Juli 11	8 10.0	0.94	Tromsø.	do.
Juli 22	8 21.2	1.02	Tromsø.	do.
Aug. 12	8 39.5	0.86	Bodø.	do.

Ved Ankomsten til Bodø den 23de Juni var den beregnede Stand af Kronometret 7m 51s, og den af Verifikationen den følgende Dag udledede 7m 53s, altsaa en Forskjel af 2s, der paa 67° Bredde svarer til en Afstand af 0.2 Kvartmil. Ved Tilbagekomsten fra Jan Mayen beregnedes Observationerne ombord den 9de August udenfor Lofoten med en Kronometerstand af 8m 39s. Den efter Verifikationen i Bodø den 12te August bestemte Stand er 8m 36.s7. Forskjellen, 2.s3, svarer til en Afstand af 0.2 Kvartmil.

1878. Kronometer Reid.

Dag.	Stand efter Gr. Middelt.	Daglig Retardation.	Sted.	
Juni 23	0h 15m 4.s5	1.s00	Hammerfest.	Tel. Sig.
Juli 10	15 19.0	0.85	do.	do.
Juli 28	15 36.5	0.97	do.	do.
Aug. 28	16 6.8	0.98	Tromsø.	do.

Den 7de Juli, da sidste Observation toges Dagen før Tilbagekomsten til Hammerfest paa første Tur, regnedes

In the following Tables are set forth the error and rate of our chief chronometer.

1876. Kullberg's Chronometer.

Date.	Chron. Fast on G. M. T.	Gaining daily.	Place.
May 30	0h 38m 37.s8	0.s66	Bergen Observatory.
June 10	38 43.3	0.50	Husø. Equ. Altit.
June 26	38 59.6	1.02	Christiansund. Tel. Sig.
Aug. 1	39 19.2	0.54	Reykjavik. Equ. Altit.
Aug. 20	39 33.6	0.76	Namsos. Tel. Sig.

By comparing the assumed values of the error of the chronometer with those deduced, by simple interpolation, from the figures in the Table, the greatest difference is found to have occurred on the 22nd of July, the assumed error having been 39m 21s as against 39m 14s, the error determined from the Table, — a difference of 7s in time, or 1.'75 in arc of parallel of latitude. The latitude was between 63° and 64°, which reduces the error, in arc of great circle, to 0.'78, an error so small that we did not hesitate, when recording the position of the ship, to retain the latitudes and longitudes determined on the cruise. The next greatest difference between the observed and computed error occurred on the 13th of August; it was 5s, which corresponds to 0.6 of a nautical mile.

1877. Reid's Chronometer.

Date.	Chron. Slow by G. M. T.	Losing daily.	Place.	
May 23	0h 7m 23.s0	0.s90	Bergen.	Tel. Sig.
June 24	7 54.0	0.97	Bodø.	do.
July 11	8 10.0	0.94	Tromsø.	do.
July 22	8 21.2	1.02	Tromsø.	do.
Aug. 12	8 39.5	0.86	Bodø.	do.

On our arrival at Bodø, June 23rd, the computed error of the chronometer was 7m 51s, whereas the error found next day by verification amounted to 7m 53s, making a difference of 2s, which, on the 67th parallel of latitude, corresponds to a distance of 0.2 of a nautical mile. When returning from Jan Mayen, observations taken on the 9th of August, off Lofoten, were calculated with an assumed error of 8m 39s. The error found by verification at Bodø on the 12th of August was 8m 36.s7. The difference, 2.s3, corresponds to 0.2 of a nautical mile.

1878. Reid's Chronometer.

Date.	Chron. Slow by G. M. T.	Losing daily.	Place.	
June 23	0h 15m 4.s5	1.s00	Hammerfest.	Tel. Sig.
July 10	15 19.0	0.85	do.	do.
July 28	15 36.5	0.97	do.	do.
Aug. 28	16 6.8	0.98	Tromsø	do.

For our last observation on the first cruise of the Expedition, taken July 7th, the day before returning to ombord med Kronometerstanden $15^m\ 18.^s8$. Efter Verifikationen den 10de i Hammerfest skulde Standen være $15^m\ 16.^s4$. Forskjellen, $2.^s4$ svarer, da Bredden var 72°, til en Afstand af 0.18 Kvartmil.

Den 24de Juli, da Expeditionen kom tilbage til Hammerfest fra den anden Tur, regnedes ombord med Kronometerstanden $15^m\ 31^s$. Den efter Signalerne den 28de Juli korrigerede Stand er $15^m\ 32.^s6$. Forskjellen, $1.^s6$, svarer, da Bredden er 73°, til en Afstand af 0.12 Kvartmil.

Den 24de August, da sidste Observation toges paa Tilbagerejsen fra Spidsbergen til Tromsø, regnedes Standen af Kronometret ombord til $16^m\ 2.^s0$. Efter Verifikationen den 28de i Tromsø skulde den være $16^m\ 3.^s0$. Forskjellen, $1.^s0$, svarer, da Bredden var $74\frac{1}{2}$°, til en Afstand af 0.06 Kvartmil.

Tager man Hensyn til Usikkerheden af Størrelsen af Kimmingdalingen — vi regnede med en konstant Værdi for alle fra Hyttedækket tagne Solhøjder — der beror paa Horizontalrefraktionen, og til Virkningen af Irradiation til at gjøre den iagttagne Solradius mere eller mindre for stor, eftersom Solbilledet ses mere eller mindre lyst, kan vel den sandsynlige Fejl af en paa Søen maalt Solhøjde neppe sættes under ± 1′. Da i Regelen nedre Solrand maaltes, gjør Irradiationen de maalte Højder for smaa. Bredderne for store ved Middag, for smaa ved Midnat, Timevinklerne for store paa Vestsiden, for smaa paa Østsiden, østlige Længder for store paa Vestsiden, for smaa paa Østsiden, vestlige Længder for smaa paa Vestsiden, for store af Observationer paa Østsiden.

Saa ofte Anledning gaves, og det paa ganske faa Undtagelser nær i Regelen hver Dag, og særlig ved Ankomsten til en Arbejdsstation, korrigeredes Bestikket ved Observationerne. Disse beregnedes altid (undtagen Meridianhøjder) med 2 vilkaarlige Bredder eller, naar de var nær Meridianen, med 2 vilkaarlige Længder. Nautical Almanacs Tabeller benyttedes. Stedlinien blev afsat i Kartet som en ret Linie mellem de 2 saaledes bestemte Punkter. Ved Hjælp af den imellem 2 Observationer udsejlede Kurs og Distance bestemtes den paaværende Plads i hver af Stedlinierne. Stationernes Bredde og Længde bestemtes saaledes af mig og indførtes i Loddejournalen. Bestik og Observationer svarede i Regelen meget godt. Under Skrabning og Trawling blev vi imidlertid altid sat ud af Bestik, da det var vanskeligt at holde Rede paa Kurser og udløbne Distancer under disse Manøvrer.

Efter det ovenfor anførte om vore Kronometres Gang og om den sandsynlige Fejl af en maalt Solhøjde fremgaar det, at vore Værdier for Stationernes Bredde og Længde har en sandsynlig Fejl af mellem 1 og 2 Minuter. For den største Dels Vedkommende overstiger Fejlen ikke synderlig 1 Minut.

Hammerfest, we assumed the error of the chronometer to be $15^m\ 18.^s8$. From the verification at Hammerfest on the 10th, it was found to have been $15^m\ 16.^s4$. The difference, $2.^s4$, corresponds on the 72nd parallel of latitude to 0.18 of a nautical mile.

When returning to Hammerfest on the second cruise, we assumed the error of the chronometer for an observation taken July 24th to be $15^m\ 31^s$. Corrected at Hammerfest on the 28th by comparison with the time-signals, it proved to have been $15^m\ 32.^s6$. The difference, $1.^s6$, corresponds, in latitude 73°, to 0.12 of a nautical mile.

On the 24th of August, when returning from Spitzbergen to Tromsø, we assumed the error of the chronometer to be $16^m\ 2.^s0$. Verified at Tromsø on the 28th, it was found to have been $16^m\ 3.^s0$. The difference, $1.^s0$, corresponds, in latitude 74° 30′, to 0.06 of a nautical mile.

If we consider the difficulty of determining the dip of the horizon, a constant value was assumed for all solar altitudes taken from the roof of the roundhouse, — depending as it does on horizontal refraction, and also take into account the effect of irradiation in magnifying to a greater or less extent the diameter of the sun, according as the solar disk appears more or less luminous to the eye of the observer, the probable error of a solar altitude taken at sea can hardly be put at less than ± 1′. The altitude of the lower limb having as a rule been observed, the effect of irradiation would make the measured altitude too low, the latitude too high at noon, too low at midnight, the hour-angles too great west, too small east, the results for longitude east too high on the west side, too low on the east side, for longitude west too low on the west side, too high on the east.

Whenever opportunity offered, which, as a rule, was almost every day, and in particular on arriving at a sounding-station, we corrected our dead-reckoning by means of observations. These were always computed (excepting only meridional altitudes) with two optional latitudes, or, when taken near the meridian, with two optional longitudes. The Tables used were those of the Nautical Almanac. The line of equal altitudes was marked out on the chart as a straight line between the two points thus determined. The ship's position on each of the lines of equal altitudes was computed from the course and the distance run between the observations. I thus determined the latitude and longitude of the observing-stations, and entered the results in the sounding-journal. The dead-reckoning and the observations exhibited in general satisfactory agreement. Meanwhile, we were invariably out of our reckoning after working the dredge or trawl; to calculate the day's work correctly is next to impossible with such operations in hand.

From what has been stated above concerning the rate of our chronometers and the probable error of an observed solar altitude, it is evident that the values for the latitude and longitude of the observing-stations will have a probable error of from 1 to 2 minutes. For the greater part of them, the error will not much exceed a minute.

Der findes imidlertid blandt vore Stationer nogle, hvor Usikkerheden af den paaværende Plads gaar op til 5 à 6 Minuter, nemlig udenfor den nordvestlige Del af Spidsbergen, nordenfor 78° Bredde. Efterat den paaværende Plads var bestemt ved Solobservationer saavel Formiddag som Eftermiddag, viste det sig, da vi fik Land i Sigte, at Resultatet af Pejlinger af Nordpynten af Pr. Charles Foreland gav en 5′ til 6′ sydligere Plads end Solobservationerne. Men Aarsagen viste sig ogsaa i en stærk Hildring, der krævede en anden Værdi for Kimmingdalingen end den normale, som var benyttet. Under saadanne Forhold er paaværende Plads umulig at bestemme med vanlig Nøjagtighed efter Solobservationer, selv om man laa for Anker og observerede Højder i alle Azimuther, thi Horizontalrefraktionen vil variere med Retningen og med Dagstiden paa en ganske uperiodisk Maade, der er umulig at bringe i Regning. Et lignende Exempel paa Virkningen af Hildring havde vi om Morgenen den 10de August 1877 udenfor Lofoten. Maaling af Horizontalvinkler mellem kjendte Punkter gav Fartøjet en paaværende Plads, der laa i en betydelig Afstand fra den Stedlinie, som en over den østlige, falske Horizont maalt Solhøjde gav.

Til Slutning skal jeg nævne, at Expeditionen var udrustet med Apparater til at maale Strøm i Overfladen og paa Dybet. Disse kom ikke til Anvendelse, først fordi Vejret det første Aar var saa særdeles ugunstigt, og senere fordi de andre Arbejder, som skulde udføres, krævede al vor Tid og ikke turde forsinkes af Operationer, om hvilke det altid maatte være tvivlsomt, hvorvidt noget brugbart Resultat kunde erholdes. Bestemmelser af Strømmen i Overfladen efter den almindelige nautiske Methode lod sig ikke, undtagen i yderst faa Tilfælde, udføre paa vor Expedition, da Sejladsen under Skrabning, som nævnt, umuliggjorde et skarpt Bestikhold.

Meanwhile, for some of our observing-stations, the possible error of the ship's position amounts to from 5 to 6 miles, viz. those off the north-western extremity of Spitzbergen, in latitude from 78° to 80° N. After determining the ship's position by observations of the sun's altitude, taken before as well as after noon, we found, on sighting land, the bearing of the northern promontory of Prince Charles' Foreland to give a point from 5 to 6 miles farther south than that determined by the solar altitudes. This, however, was obviously the result of mirage: and hence our constant value for the dip of the horizon would not serve. Under such circumstances it is impossible, were the ship at anchor even and the altitudes observed in all azimuths, to determine her position with the usual accuracy by observations of the sun, since the horizontal refraction according to the direction and the time of day will not vary periodically, and its true value cannot be taken into account. A similar instance of the effects of mirage occurred on the morning of the 10th of August 1877, off Lofoten. By measuring horizontal angles between known objects, we found the ship's position to be a considerable distance from the line of equal altitudes marked out from observations of the sun above the eastern delusory horizon.

Finally, I must not omit to mention that the Expedition was provided with instruments for determining both surface and deep-sea currents. These apparatus, however, were not made use of, — at first owing to the very unfavourable weather we encountered on the opening cruise, and afterwards to avoid impeding the chief exploratory work by operations from which it was anything but certain that practical results would be obtained. Nor had we, save in a very few cases, opportunity of determining the surface-current in the usual nautical way, the effect of dredging and trawling, as stated above, inevitably putting us out of our reckoning.

Translated into English by John Hazeland.

CIRCULAR

from the *Editorial Committee* of

The Norwegian North-Atlantic Expedition.

The "General Report of the Norwegian North-Atlantic Expedition" is published in parts, each Memoir being distributed immediately on its leaving the press.

The General Report will comprise the following Memoirs: —

Capt. Wille, R. N. (Narrative of the Expedition — Description of the Apparatus, how constructed and used — Magnetical Observations).

Professor H. Mohn (Meteorology — Deep-sea Temperatures — Motion of the Sea — Astronomical, Geographical, Geological Observations).

Mr. H. Tornøe (Amount of Air in Sea-Water — Amount of Carbonic Acid in Sea-Water — Amount of Salt in Sea-Water).

Mr. L. Schmelck (The Salts in Sea-Water — Investigation of Bottom-Samples).

Professor G. O. Sars *(Crustacea — Pycnogonida — Tunicata — Bryozoa — Hydrozoa — Spongozoa — Rhizopoda — Protophyta).*

Drs. Danielssen & Koren *(Holothurida — Echinida — Asterida — Crinoida — Gephyrea — Anthozoa).*

Mr. H. Friele *(Mollusca — Brachiopoda).*

Dr. G. A. Hansen *(Annulata).*

Mr. R. Collett (Fishes).

The publication of the Report, for which a grant of money has been obtained from the Norwegian Storthing, is conducted in conformity with the directions of His Norwegian Majesty's Government, on whose behalf the Editorial Committee have the honour of presenting Hr. Professor F. A. Smitt ..... with the accompanying Part, the title of which will be found overleaf. The Committee make free to request, that on the publication of scientific works by your Institute, you will kindly remember the scientific institutions and the *savants* of this country with which and with whom you may have been brought into connexion. Of the more important public libraries in Norway, we have been