MANUAL OF SUBMARINE MINING

PART II.

Office Copy

MANUAL

OF

SUBMARINE MINING.

PART II.

DRILL BOOK.—PART II.

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MANUAL

OF

SUBMARINE MINING.

PART II.

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DRILL BOOK – PART II

PREFACE

PART II of the Revised Submarine Mining Manual deals generally with the practical work of Submarine Mining Afloat.

It has been considered desirable to include instructions as to the method of keeping the working records of a Submarine Mine Defence, and the state of preparation and system of identification of the *matériel*.

A glossary of certain nautical terms is given to assist those under instruction. The information is mainly taken from Dixon Kemp's Manual of Yacht and Boat Sailing, by permission of the Author.

PREFACE

Paris, 11 of the Second Quinzaine of Messidor, Second Republic.

It has been considered desirable to include in this volume, as in the previous one, a few pages on the Second Republic.

I propose to devote a fourth volume to the Empire, and the fifth and last will be devoted to the Restoration and the Monarchy of July.

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CHAPTER I.

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Row-boats—Rowing and Management of Small Boats.

The rowing-boats commonly used in the submarine mining service are :—

Cutters Pinnaces	Double-banked boats.
Gigs Whale-boats Dinghies	Single-banked boats.

Drawings and Specifications have been prepared for cutters, gigs and dinghies, to govern future supplies.

The approved design for a cutter shows a boat 30 ft. long by 8 ft. 1 in. beam and 2 ft. 8½ in. depth, fitted for 12 oars. Cutters.

These boats are used for conveying men and stores from place to place, for laying out marking buoys and small charges, as junction-box boats when more suitable boats are not available, and for various other duties.

There are some pinnaces still in the service, which form useful junction-box boats, except in very rough water or strong tides. When fitted with a derrick and a hand crab they can be used to Pinnaces.

underrun cables and light E.C. mines. These boats are stronger and heavier built than cutters.

Gigs. The gigs supplied are 22 ft. by 5 ft. 6 in. by 2 ft. 2 in., and are fitted for four oars.

They are provided also with a mast and dipping lug sail. These boats are used for sounding, laying marking buoys, and other light work in the mine-field, as well as for transport duties, and superintendence.

Whaleboats. These boats, which for many purposes are to be preferred to gigs, exist at some stations. They vary in length from 24 ft. to 27 ft.; the longer boats pulling five oars and the shorter four.

Dinghies. These boats are of various sizes and shapes, the approved pattern being 14 ft. by 5 ft. 2 in. by 2 ft. 2 in., fitted for three oars, but generally using only two.

These boats are of the greatest use in submarine mining work, and in the mine-field; every steamer should have one, either on the davits or laying off within hail. While work is going on, the boat should not be sent far away from the steamer. In the event of "man overboard," a foul under the joggle, or a cable in the screw, a dinghy on the spot may save much valuable time, or avert a possible disaster.

Weights of boats. The following are the approximate weights of Service boats empty:—

Feet.		Cwt.	Feet.		Cwt.
42	Pulling Launch ..	75	22	Gig	7
32	Pinnace	43	27	Whaleboat ..	$7\frac{1}{2}$
30	Cutter	$18\frac{1}{2}$	25	.. „ ..	7
28	„	17	14	Dinghy	$4\frac{1}{2}$
24	Gig	$7\frac{1}{4}$			

Stores for Rowing-boats used in the Submarine Mining Service.

Stores.	12 Oar'd, 30-ft. Cutter.	10 Oar'd, 25-ft. Cutter.	Gig.	Whaleboats.	Wherry.	Dinghy.	Remarks.
Oars, Ash ... 14-ft.	8	...	...	...	...	...	
Oars, Ash ... 12-ft.	4*	10*	5†	6†	5†	2	* 2 spare, 2 stroke. † 1 spare.
Oars, Ash ... 10-ft.	2‡	2‡	4	4	1‡	...	‡ Bow Oars.
Sculls or Paddles, 8 to 9 feet	...	...	...	...	...	2	
Hooks, Boat ... 6-ft. Stave ...	1	1	1	1	1	1	
Hooks, Boat ... 12-ft. Stave ...	2	2	...	...	...	...	
Fenders ... Rope	12	10	...	...	17	...	
Fenders ... Leather ...	...	...	4	5	4	1	
Baller's Boat	1	1	1	1	1	1	
Buoy, Life, and Line ...	1	1	...	...	...	...	
Anchor, 2 cwts.	1	1	...	...	...	...	
Cable, 2-in., 10 fms. ...	1	1	...	...	...	...	Carried as required.
Painter, 4 fms., 3-in. rope ...	1	1	...	...	...	...	
Painter, 4 fms., 2-in. rope ...	...	...	1	1	1	1	
Beaker, Water, 5 galls. ...	1	1	...	...	...	...	Carried as required.

Rowing and Sculling.

All submarine miners must be taught to row and scull. The instruction in rowing is commenced in a cutter, after which the men should learn to row in gigs and dinghies.

During the course of rowing drill the men should be taught the meanings and application of common nautical terms, and the care and management of small boats. The proper management of boats under various conditions of wind and sea can only be fully learnt by experience, but a good deal may be done during a course of instruction towards teaching men some of the main rules of conduct in small boats, such as those relating to trim, behaviour in boats—both under sail and oars—coming alongside, towing, rowing in a seaway, landing on a beach, shoving off from a beach, hauling boats up and down slips, mooring, &c.

The meanings of the following nautical terms should be explained to men under instruction in rowing :— Meanings of nautical terms (*see* Appendix III).

Construction of boats.—Hull, bow, stern, counter, quarter, bilge, beam, draught, free board, topsides, gunwale, stem, keel, keelson, sternpost, dead-wood, floor, bottom boards, ribs or timbers, planking, carvel-built, clinker-built, diagonal-built, thwart, stretcher, rowlock, poppet, crutch, painter, sternfast, step of mast, rudder, tiller, yoke, yoke-lines.

Terms descriptive of position.—Ahead, astern, abreast, port, starboard, on the bow, on the quarter, abeam, athwartships, aboard, awash, weather, lee, aft, forward, amidships.

Oars.—Handle, loom, blade, sculls, paddles, shipping and unshipping oars.

Anchors.—Casting and weighing anchor. Flukes, crown, shank, stock, washer, forelock or key, ring. Catheading or "catting" anchor.

Method of making fast or bending on warp and buoy line to anchors.

Moorings.—Method of mooring with bridle and buoy-rope. Continuous moorings or "trots" for a number of small boats. Mooring with two anchors and cables. Picking up moorings.

Tides and currents.—Flood and ebb tide—duration of flow in each direction. Spring and neap tides. "Full and change." "Mean high water springs" (M.H.W.S.). "Set" of current. Velocity—how measured.

Care of Boats.

At all stations a well-qualified man should be detailed to look after the small boats. He should be made responsible that all the stores are kept in good order and ready for immediate use, and should report at once all damages and deficiencies.

Housing and mooring boats.

Boats should always be kept in a boat-house if possible; if kept afloat for any length of time, they are liable to become foul and water-soaked, and consequently heavy to pull.

Boats which are too heavy to haul up and down slips constantly, should be hauled up on a beach from time to time to be cleaned,

and should be allowed to remain for some time hauled up, so that they may dry thoroughly before they are painted. If exposed to a hot sun while hauled up, they should be covered with a tarpaulin or old sail, the air being allowed free access to the hull both inside and out.

Boats can be quickly and easily taken out of the water by means of the cranes on the pier-head. If there are no ring bolts in the keel for the purpose, it is well to sling the boat in two strong canvas slings. Stout wooden spreaders, slightly longer than the beam of the boat, should be used to keep the slings from crushing in the top sides, and the slings should be kept from drawing together by lashings made fast to the ring bolts in the stem and stern post.

Where there is no boat house, or there is insufficient accommodation for all the boats, some of them may conveniently be hauled up to davits on the pier, placed clear of the working frontage. It is well to construct roofs over these davits to protect the boats from the sun, or to make canvas covers for the boats.

Hauling boats up and down slips and beaches.

Men should be taught to exercise care in hauling boats up and down slips and beaches; to keep them on an even keel, and put rollers under them when possible. These precautions will save the keel and bilges from injury and a lot of unnecessary labour. Never hoist a boat in davits, or haul her up a slip, with weights or water in her.

Moorings for small boats.

It is generally necessary to lay down moorings for junction-box boats and cutters in constant use. Where there are a good number of boats to be moored, "trots" may be laid down. A "trot" consists of a length of heavy chain securely anchored or made fast at each end. At sufficient intervals along this chain, lighter chains of a length equal to twice the depth of water at M.H.W.S. are made fast. These chains or "bridles" are raised by means of coir buoy lines made fast to watch-buoys made of light wood or out of small kegs or oil drums. Where single moorings are used, it is well to introduce a short piece of heavy chain between the sinker and light chain (about 2 fathoms); this will allow the boat to ride easily in a sea to a short scope of chain without jerking and straining. The bridle chain should in all cases be "parcelled" with old canvas where it chafes on the gunwale or fair lead. In some places it is advisable to padlock the chain when made fast. All moveable stores should be removed from moored boats, and they should be visited at least once a day.

Rowing, Drill.

Rowing drill.

Instruction in rowing should commence in a double-banked boat, and be continued afterwards in single-banked boats. The details of the drills differ slightly, owing to the fact that the oars in single-banked boats are not tossed, and are usually fitted with lanyards, which allow of the oars being swung alongside the boat instead of being "boated" or "laid in," as in a double-banked boat.

The following is the drill to be observed in cutter rowing.

It will be seen that many of the words of command are *cautions*, or for use with crews under instruction:—

FALL IN, CREW OF FIRST (or Second, &c.) CUTTER.

(For crews under instruction only.)

The instructor (coxswain) will fall in the crew in two ranks and number off. Nos. 1 are bow-men, and the highest numbers are "strokes." The front rank will be "starboard oars," and the rear rank "port oars." Each man must know his place in the boat.

MAN THE FIRST (&c.) CUTTER.

The boat keepers bring the boat alongside; the crew take their places in the boat, bringing with them such stores as may be required, sit down on the thwarts, and wait for orders from the coxswain.

The outer bow-man will cast off and coil down the painter, and then assist to fend off, the inner bow-man holding on with his boat-hook.

The inner stroke-oar uses the stern boat-hook, and the remainder of the crew see their oars clear (the stroke-oars being nearest to the side of the boat), and, unless ordered to the contrary, unship their poppets.

UP OARS.

The crew get hold of their oars, and, watching the stroke-oar, toss them together, placing the handles on the bottom boards between their feet, every oar upright, blades "fore and aft," outer hand just below the leather, "mid-ship" hand as low as possible, body upright.

Note.—This is the position in "Tossed oars."

SHOVE OFF.

Bow-men shove the bow of the boat off, toss their boat-hooks upright, wait a pause, boat them together, sit down, take in fenders, unship poppets, and then toss their oars together. The remainder of the crew take in fenders at the word "shove off," the inner stroke oarsman keeps the stern clear, lays in boat-hook with hook aft, sits down, and tosses his oar.

DOWN.

All the oars are lifted together about a foot, and let fall quietly with blades flat on the water, the looms being kept clear of the gunwale; the oars are brought quietly into the rowlocks, and are held horizontally, square with the boat, and feathered.

Note.—This is the position of "Laying on oars." It may sometimes be necessary to "down" oars before the bow-men and stroke have tossed their oars, or to "down" oars on one side of the boat before the other.

Give Way Together.

(By Numbers. For crews under instruction only.)

"*One.*" Lean aft, straighten the arms, turning the knuckles down as the blade goes forward (*i.e.*, towards the stem of the boat), bringing it square with the water; all oars to be parallel with the stroke oars, blades just clear of the water.

"*Two.*" Dip the blade in the water, and pull the loom towards you, falling back at the same time, back and arms straight; drop the elbows and wrists on arriving at the end of the stroke, taking the blade out of the water, and come to the position of "Laying on oars."

Note.—A pause of about three seconds is to be made between each order until all the crew understand feathering their oars; as they improve, the interval will be lessened. Time taken from port stroke-oar. This word of command may be varied as follows:—"Give way, port," or "Starboard," or any named oar.

Stand By to Lay on Your Oars (a caution).

(Followed by—Oars.)

Complete the stroke, and come to the position of "Laying on oars."

Stand By to Toss Oars (a caution).

(Followed by—Toss Oars).

Each man bears down smartly on his oar with his midship hand, causing it to jerk out of the rowlock, and brings his oar to the position of "Toss oars."

Note.—If oars are to be laid in, the order "Toss oars" will be followed by "Lay in your oars," when they will be laid down quietly in rotation from forward, blades flat and pointing forward, and the poppets will be shipped.

Stand By to Hold Water (a caution).

(Followed by—Hold Water.)

Oars to be held perfectly steady, square with the boat, all the blades nearly upright and same depth in the water.

Note.—Used for checking the boat's way. For crews under instruction, the practice should be commenced from position of "Laying on oars."

Back Water, All.

(By Numbers. For crews under instruction only.)

"*One.*" At the word "*one,*" lean back a little, bringing the handle of the oar close to the chest, blade clear of the water, and square with it.

"*Two.*" Drop the blade in the water, pushing the handle aft

by bringing the body upright, and return to the position of "Laying on oars."

Note.—This word should not be given without previously checking the boat's way. With crews under instruction, the practice should be commenced from the position of "Laying on Oars." The command may be varied as follows:—"Back water, port," or "Starboard," or any named oars.

STAND BY, BOWS (a caution.).
(Followed by—Bows.)

The bow-men will look towards each other, toss their oars together, wait a pause, lay in their oars, ship poppets, out fenders, stand up on head sheets facing the bow with tossed boat-hooks, ready to fend off. Remainder of crew "out fenders" with outer hands.

Note.—This command must be given so that the operation is completed before the next word of command is given. With trained crews the "caution" is usually omitted.

WAY ENOUGH.

The crew finish their stroke and give one more; the port stroke gives the word "Up," when the oars are all tossed together and laid in quietly, and poppets shipped. The stroke oarsman nearest to landing-place stands up and attends stern boat-hook.

Note.—With crews under instruction, or in case of difficulty in reaching the landing, the coxswain, instead of giving the word "Way enough," may give the caution "Stand by to lay on your oars," followed by "Oars," and such other words of command as may be required.

Rowing in Single-banked Boats.

Men will be instructed in single-banked boats, such as whale-boats and gigs, after learning to row in cutters. In these boats the oars are never tossed, and are generally fitted with lanyards, in which case the oars are "swung" alongside, instead of being laid in to the boat when going alongside a vessel or landing place.

It is usual not to fit the bow oar with a lanyard in any case.

The alterations necessary in the word of command and detail of drill are as follows:—

SHOVE OFF.—The oars are swung from alongside as the boat gets clear; "bow" gets his oar out as soon as he has laid in his boat-hook and sat down.

GIVE WAY TOGETHER.—As in cutters.

TOSS OARS.—Omitted.

LAY ON YOUR OARS, HOLD WATER .., BACK WATER .. } With "Cautions," same as in cutters.

BOW.—"Bow" lays in his oar without tossing it, and proceeds as in cutters.

WAY ENOUGH.—Stroke looks forward over his shoulder and gives the word "swing" instead of "up." The handles

of the oars are allowed to go forward, blades in the water; each oarsman, leaning backwards and outwards, passes the handle forward with his midship hand.

Note.—Oars may be swung at any time, when passing through a narrow place or close to an object. The caution "stand by to swing oars," should then be given in good time.

When the oars are laid in, the crutches should be taken inboard.

A boat must never be left alongside a gangway, but as soon as the crew have got out, the boat-keepers* must drop her into her proper position. The tiller must be taken out and laid inboard.

Dinghies.—Men must be exercised in the management of dinghies. Two men should be able to row a dinghy on a straight course, and bring her alongside a vessel or pier without a coxswain. Men should also be taught to scull with a pair of sculls or paddles, and to scull with one oar over the stern.

Salutes in Military Boats.

The following are the rules for saluting to be observed in military boats (Q. Reg., Section III, 38 A.);—

(1.) When an Officer is in the boat—

Rank.	When passing	Under oars.	Meeting at landing-place or alongside ship.
Field Officers ...	Admiral or General	"Lay on Oars," Officer salutes.	Crew "Eyes Front," Officer and coxswain salute.
Field Officers ...	Other naval and military Officers, if senior.	Officer salutes ...	Officer salutes.
Officers below rank of Field Officer.	Admiral or General	"Toss Oars," Officer salutes.	Crew "Eyes Front," Officer and coxswain salute.
Officers below rank of Field Officer.	Commodore | Colonel ... Captain ... | Lieut.-Colonel	"Lay on Oars," Officer salutes.	Crew "Eyes Front," Officer and coxswain salute.
Officers below rank of Field Officer.	Other Officers of either Service whom they know to be senior.	Officer salutes ...	Officer salutes.

(2.) When no Officer is in the boat—

When passing	Under oars.	Meeting at landing-place or alongside ship.
Admiral ... | General Officer Commodore | Colonel. Captain ... | Lieut.-Colonel.	"Toss Oars," coxswain salutes.	Crew "Eyes Front," coxswain salutes.
All other Officers	"Lay on Oars," coxswain salutes.	Crew "Eyes Front," coxswain salutes.

NOTE—In boats fitted with crutches, oars are never to be tossed, but the salute should be given by laying on oars.

* Two of the crew detailed for the purpose.

(8.) In steamboats, engines are to be stopped in those cases in which, in pulling boats, oars are tossed; engines are to be eased in those cases in which pulling boats "lay on" oars.

(4.) Laden boats, or those towing or in tow, are not to toss or lay on their oars.

(5.) Coxswains of boats under oars or sails, when an Officer is in charge, only salute at landing-places.

(6.) Salutes in boats under oars or sails are to be made sitting down; in other cases, standing up.

(7.) Boats laying off on their oars are to salute as above, but the bow-men will salute as well as the coxswain.

(8.) Boat keepers salute standing up in the ordinary manner.

(9.) For a royal salute, the crew toss oars and stand up (in double-banked boats only).

General Instructions, and Hints on the Management of Small Boats.

Silence is always to be observed in boats, unless orders are given to the contrary.

When getting into a small boat, step on the bottom boards amidships, and sit down at once.

Do not sit on the gunwale, or stand on the thwarts. The crew take their places first, and passengers and officers last; officers and passengers disembark first. The senior officer gets in last, and lands first.

Oars are not to be tossed going alongside a vessel at sea or under way, but must be thrown out of the rowlocks, blades forward, and boated at once; and, on leaving, blades to be lifted clear of the gunwale, the oars being brought aft into the row-locks at the order "Out oars." In boats fitted with crutches, the oars can be taken in after they are swung fore and aft by passing the handles forward inside the boat, when the oars can be lifted out of the crutches if desired.

Boats' crews learning to pull are to have their thwarts changed, so that they may learn to row on both sides of the boat, and the duties of stroke and bow oars.

When pulling, the crew should incline the eyes rather to the blades of the oars in front of them, to ensure time being well observed. Men should not be allowed to look carelessly about or stare at the stern sheets.

Masts should always be lowered before going alongside a vessel at sea or under way. Sailing boats.

If a sail does not set properly, shifting the strop a few inches in or out on the yard will often correct it. If carrying too much weather helm, shift all the weight a little aft; if lee helm, a little forward.

Never belay a sheet, and always keep the halyards clear.

Sail should not be hoisted in an open boat until every man is seated on the bottom boards as close down as possible. Standing up in a boat under sail on any account is undesirable. In lowering the sail, always haul down on the luff, and as the sail spills in lowering it should be gathered in by the hands to leeward. No one is on any account to move in the boat without orders.

It is better to reef than to sail a boat on her side with a whole sail. When reefing a lug sail with an inexperienced crew, it is better to lower the sail right down, take in the reef or reefs, and hoist up again. With a good crew, the reef can be taken in with the sail lowered only enough to allow of the men hooking on the tack and sheet to the reef cringles without standing up, the boat being under way all the time. The tack and sheet should be secured before the reef points are tied up. In shaking out a reef, always cast off the reef points before starting tack or halyards; in this way very little time need be lost in either operation.

Shoving off.

"Shove off" forward first, unless it is necessary to back out. Never shove off from both ends of a boat at the same time.

In getting afloat from a beach, launch the boat on an even keel at right angles to the water line, keeping one or two men in the stern to keep her from broaching to, with boathooks or *reversed* oars. Do not try and shove a boat off by main force with oars blades downwards, as it is bad for both the boat and the oars. When the boat is afloat astern the passengers and crew should get on board, the bow men being left ashore to shove off more, if necessary. If the water is shoal for some way out, the boat must be walked out by the crew until fairly afloat.

If there is any sea coming in on the beach, it is often advisable to launch a square-sterned boat bows first. If any difficulty is apprehended in getting a boat off, the anchor may be dropped some way out before landing. The boat can then be warped out and kept from broaching to while the oars are being got out.

Landing through surf.

Landing through a heavy surf should not be attempted with an inexperienced crew. A whaleboat steered with an oar is the best service boat for such work.

When a boat is left on a beach, she should be hauled up high and dry if the tide is rising. A man should always be left with a boat to keep her afloat on a falling tide and to look after her generally.

When landing on a rocky shore with any sea on, the boat should be backed in, the rudder unshipped, and those landing should watch their opportunity to jump out at the right moment. The crew should keep the boat from bumping with their oars.

Trim.

"Trimming" a boat consists in disposing the weights to the best advantage in a fore and aft direction, and this varies very much under different circumstances; for instance, in rowing down the wind, a boat will generally steer and pull better if she is trimmed a little "by the stern"—that is, if the weights are moved a little aft of their usual position; but when rowing against the wind she will be difficult to pull and steer in this state, and must be trimmed a little "by the head" (or "by the bow"). When rowing across the wind, carelessness in trimming the boat may throw all the work on the oars on one side of the boat, especially in a short broad boat like a dinghy; thus, if the boat is much by the stern, the wind will tend to blow the bow round and throw all the work on the lee oars. In a dinghy the lee oar should generally be the bow oar.

The weights in a boat should be concentrated as much as

possible in the centre. A boat will ride lighter in a seaway with the weights amidships than if they are distributed all over her or collected in the bows and stern. A boat under the latter conditions will plunge heavily, stop dead, and drench everyone on board, whereas the same boat with the weight collected in the middle as much as possible will ride easily, rising quickly to the sea, and throwing up little water.

The art of trimming a boat under sail to the best advantage must be learned by experience.

Rowing in rough water.

Men who have become fair oars in smooth water often find themselves unable to pull in a seaway. It is then necessary to adhere less to catching the water together, but to feel the water with the oar before putting the weight on, to feather high, and to avoid stiffness generally. The stroke must be slower than in smooth water, and advantage must be taken of the periodical intervals of comparatively smooth water to get way on the boat.

Steering.

Never put the helm "hard over" at first; begin gently, until the boat gathers turning way, and then put it over harder. This allows the boat to turn without stopping her way. In making a sharp turn help the rudder with the oars; this may be done in several ways. Do not back water unless it is necessary to turn a boat in the shortest possible space. It will generally suffice to stop rowing or "hold water" on one side, or if speed is an object and the turn not very sharp, to "give way" on one side and "pull easy" on the other.

Scull-holes and sculling.

It is advisable to have scull holes or crutch sockets in the stern of all row-boats, as it is often desirable to be able to use an oar over the stern for propulsion or steering.

Gigs and dinghies can be rowed, on an emergency, with one oar from the after thwart, the rudder being kept against the oar by means of the yoke lines.

Sculling with one oar over the stern should only be used for very short distances.

Bringing a boat alongside.

As a general rule, bring a boat alongside a vessel with her bow in the same direction as the vessel's bow. In large boats make a good sweep, and give plenty of room coming alongside, especially in a strong tideway. Knock as little paint off as possible, and get the boat astern or hauled up as soon as she is clear of her crew. Remember, that laden and heavy boats carry their way much longer than when empty or light, and make allowance accordingly, especially when running into a camber or on to a hard beach with a fair wind.

If the vessel is under way, the oars are "boated" at once without tossing; the boat is kept parallel to the vessel, and is either dropped down or brought up alongside. The vessel should heave a line into the boat, the bowman taking a quick turn round the bow thwart, and holding on ready to cast off, or ease out, if desired; the boat can now be "sheered" alongside by the use of the rudder or an oar over the stern. It may be necessary to take the line round the second thwart from the bow to make the boat steer easily*.

* NOTE.—This should not be attempted with an inexperienced bow-man and coxswain.

Towing.

A short broad boat like a dinghy is best towed with a short painter. In a sea-way or when going fast, it is advisable to use two painters, one made fast to each quarter of the towing vessel.

Inexperienced men should not be allowed to remain in small boats when towed fast. Men sitting in towed boats should sit rather aft, so that the boat is "by the stern." If it is necessary to tow with a long painter the weights should move further aft, or if the boat is empty, some ballast may be required in the stern to keep her from broaching to, or ranging about from one quarter to the other.

To get into a towed boat while under-way, haul the boat short up under the counter, the crew get in one at a time, moving aft at once as they do so, and sitting down, the painter is then eased out gradually so that no jerk is brought on the boat. Careless easing out of the painter may cause an upset, strain the boat, or jerk a man overboard. *If the boat is to be cast off*, the bowman is not to move forward to get in the painter until it is cast off and clear of the vessel. This should only be done by experienced men.

A good hand should be told off to look after towed boats (especially when stopping, going astern, and starting), to keep tow ropes out of the screw, fend off, and ease out painters, &c.

When starting out from a pier with several boats in tow, they should be brought up alongside and made fast bow and stern, with painter and sternfast, until the steamer is fairly on her course, when they can be eased off astern. When coming in to a pier, it will usually save delay to ease down, and bring the boats alongside in a similar manner.

When a number of junction-box boats are being towed out to the mine-field, it will save time to tow the first boat alongside, if the weather admits of its being done. While No. 1 boat is getting hold of the junction-box buoy, No. 2 boat can be brought alongside, and so on. Where the boats are capable of raising the boxes without assistance, it is better to drop them one by one as the buoys are reached, each boat being "sheered" by its coxswain so as to get as near the buoy as possible. The steamer should "slow" as she approaches each buoy.

Large boats, when towed, should be steered; small boats should generally be towed with a short painter close up. Heavier and bigger boats in a sea-way require long tow-ropes to prevent damage from over-running, besides which the elasticity of a long rope takes up the sudden jerks due to the uneven motion in a sea-way.

When towing laden or large boats, the tow-line should be made fast sufficiently far forward in the towing vessel to allow of her being steered properly. Towing alongside with large vessels is only admissible in smooth water. It is frequently advisable to bring a towed vessel alongside the tug on entering smooth water in a crowded harbour, as it is much easier to make sharp turns under these circumstances, and at the same time a great deal of room is saved.

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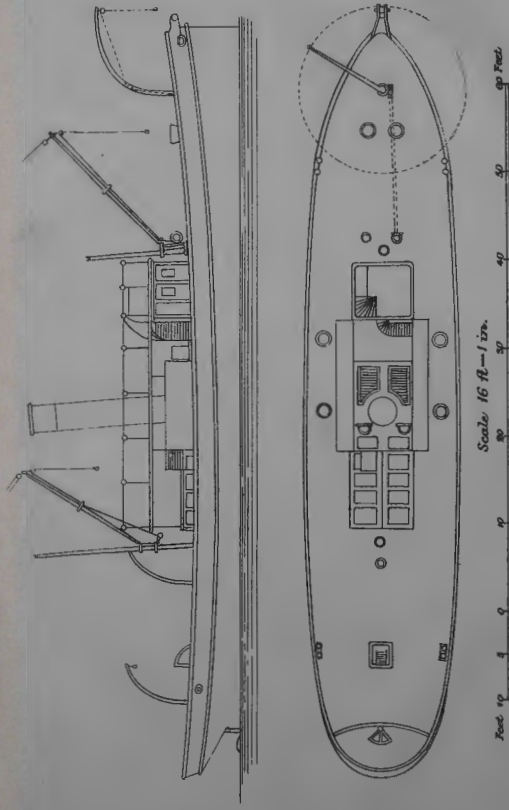
* *See* duties of deck-hands, p. 23.

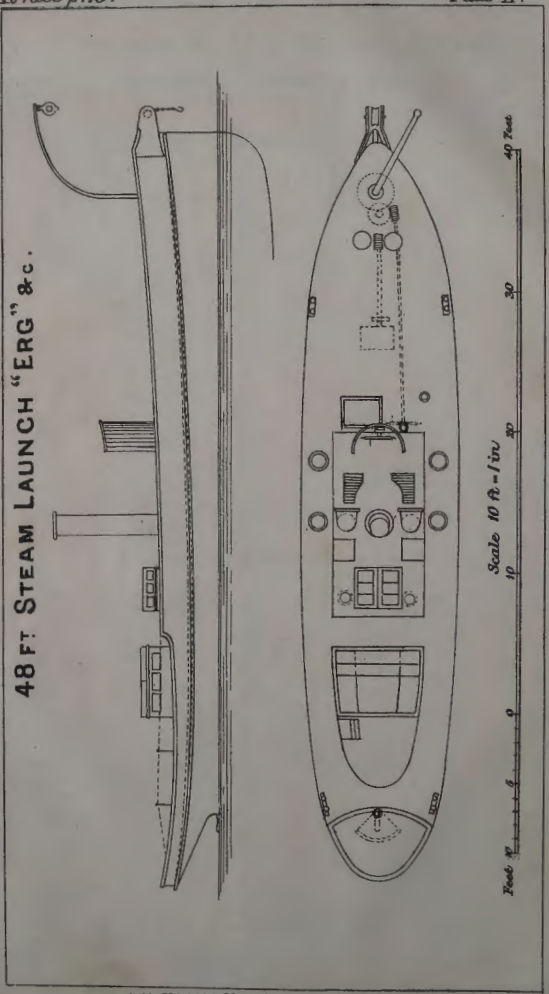
DESIGN FOR 80 FT MOORING STEAMER. "GENERAL SKINNER" &c.



Judd & Co Ld Lith. 73 & 74, Farringdon Rd & Doctors' Commons M30. 8. 80

"Nautilus" = 67' x 14' draws 4'. 6" to 6'

"Isabel" 50' x 12'. 6" draws 4'. 11"



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CHAPTER II.

STEAMERS AND OTHER SUBMARINE MINING VESSELS.

CONTENTS.

Establishment of steamers and boats.—Arrangements for supply and repair of vessels.—Description of various steamers, boats, and appliances.—Hired vessels; requirements and fittings.—Table giving characteristics of steamers and launches.—Crews required.—Duties of crew.—Fire regulations.

An establishment of steamers and other vessels and boats of special design has been provided at each submarine mining station, its size being regulated by the strength and importance of the defences, and the facilities that may exist for reinforcing the establishment by means of local vessels suited for the work.

The usual establishment would consist of the following vessels and boats, which would be required for ordinary peace operations, and for instructional work.

1 Submarine mining mooring steamer.
1 Steam launch.
1 Lighter.
3 Junction-box boats (either pinnaces or boats of special design).
2 Cutters.
3 Dinghies.
1 Gig, or whaleboat.

At some stations the establishment of boats is larger than this, and in most cases arrangements are made for hiring local steamers in case of emergency. At certain stations some of these hired vessels are taken each year for short periods of training, so that the special fittings may be placed on board, and the masters, crews, and men may become familiar with their work. Tug steamers would also be hired when required, and also launches for despatch-boat work; these vessels would require no previous alteration.

Arrangements for supply and repair of vessels.

Submarine mining vessels and boats were formerly supplied and kept in repair by the Admiralty, but this work is now undertaken by the War Office. The Admiralty, however, still repair vessels where practicable, and make periodical inspections of boilers and machinery on foreign stations; they also supply tugs free of cost at Home Ports when they can be spared.

The principal characteristics of the different types of submarine mining steamers are given in Table A, and Plates I and II are illustrations of the latest types of "mooring vessel" and "launch" approved for the Service.

Detailed drawings of the vessels supplied to each station should be kept at that station.

The mooring steamers in the Service vary considerably in size. The "Miner" class are 65 ft. by 15 ft., and draw about 6 ft. of water, and the "Gordon" class are 95 ft. by 17 ft. 6 in., drawing about 8 ft. aft. these vessels being employed in the more exposed ports; they were designed with special reference

(*a*) to manœuvring power,
(*b*) to capability of carrying a considerable number of mines at one time.

The manœuvring power is obtained by the adoption of Mr. White's "turn-about" principle of construction, which gives these vessels remarkable steering powers when going either ahead or astern, although the vessels are provided only with single screws. They are, moreover, excellent sea boats; one of them sailed to China, and behaved extremely well in very rough weather during the voyage.

The large deck space, and arrangement of masts and derricks, render it possible to stow a large number of mines, with their moorings and cables on deck, and to get them over the side for laying out as required. The number of mines thus stowed will depend to some extent on the state of the weather and local circumstances, for it will not be in all cases advantageous to take a large number of mines on board at the same time, even if the weather is fine enough to allow of its being done in safety.

Trials in smooth water show that 20 E.C. mines can be embarked at the same time on board one of these vessels and afterwards laid out, the operations being performed easily in a working day of 8 hours, with one squad slinging and another laying out.

80 foot class. In later designs the length has been reduced to 80 ft., the beam varying from 17 ft. to 18 ft., and the "turn-about" principle has been abandoned in favour of twin screws, which, while they give good manœuvring power, allow of locomotion in the event of one screw getting foul or disabled. These vessels have good deck space, and are all provided with the means of slinging mines stowed on deck.

In some cases this is effected by means of steam cranes or derricks only, and in rigged vessels additional facilities are afforded by means of masts and booms, the falls being worked by the forward steam capstans.

These vessels cost much less than those of the "Gordon" type.

"Miner" class. The "Miner" class, of which there are 15 in the Service, were originally unprovided with means for lifting over the side mines or sinkers stowed on deck in the after part of the vessel.* Several of these vessels have, however, lately been altered considerably. The chart-house has been moved forward of the funnel, where its roof and extensions form a bridge for the coxswain and officer in charge. Two large davit-derricks have

* Mines stowed in the after part of the vessel can be hauled along the deck to the bow derrick by placing them on junk mats to which a rope, taken round the capstan, is made fast.

been provided, one forward and one aft, worked by worm and pinion gearing, and vertical capstans have been substituted for the old steam winch. A "horn" has also been substituted for the old joggle, and some other minor alterations effected.

In all the foregoing vessels accommodation is provided for officers and crew.

Steam launches.

There are 12 42-ft. naval steam-launches in the Service, some of which were specially built for the work. These boats are useful for many kinds of submarine mining operations, but their want of speed is a great drawback. They are capable of laying out and picking up the lighter kinds of E.C. mines with rapidity in smooth shallow water, if the store-ship is close to the mine-field. They can also lay out group-cables and junction-boxes, and have been used with advantage as "mobile" junction-box boats. These boats, being only half-decked, cannot be used in rough water, but their capabilities in this respect for transport work is greatly increased by fitting them with turtle-back awnings or hoods, one forward to protect the boiler and engines, and one aft to protect the passengers or stores in the stern sheets.

The latest design for a launch (Plate II) is a boat 48 feet long between perpendiculars, with an overhanging counter, 11 ft. 2 in.* beam, and drawing 4 feet 6 inches aft. These vessels are decked all over, the engines and boiler being protected by a raised steel casing. A good deck forward of the engines is provided for laying out and picking up mines and cables. A davit-derrick and two vertical steam capstans are fitted in the fore part of the vessel. The boats are diagonal built in two thicknesses of teak, the bulwarks (2 feet high) and rail being of steel.

There is a small cock-pit and cabin aft.

These boats are fitted with twin-screws and surface-condensing compound engines, which are designed to give a speed of 9 knots. They are designed to lay out and pick up E.C. mines in moderately smooth water, and at the same time to be used for transport and despatch work when required. It is intended that nearly all the mining work should be done forward of the funnel.

Junction-box boats.

There are some naval pinnaces in the Service which are specially fitted for use as junction-box boats. They vary in length from 28 to 36 feet, and are fitted with joggle, derrick, and hand-crab, so that they contain the means for raising junction-boxes, and light E.C. mines. These boats are very strongly built, and are most useful for landing the ends of main and shore end cable, for putting down moorings, and as diving boats. These boats, and also the 42-ft. pulling launches which are provided at some stations, can carry a few mines, as "store-ships," in smooth water.

Special junction-box boats.

A good number of specially built junction-box boats have been provided for the Service. They are decked fore and aft, with a central well, over part of which cover is provided for opening and closing the junction-box, and for protecting the crew and telephones from the weather. These boats have a joggle at each end, which ships in-board when not in use.

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* Increased to 12' in later designs.

Cleats are provided for making fast cables. These boats are short and broad, and very buoyant, consequently some care is required in towing them at high speed. They are better adapted for work in enclosed waters than in the open sea. In deep water, and when the junction-box is heavy, it is well to raise the latter with the steamer's gear, and place the boat under the box.

Store lighters.

Most stations are provided with at least one store lighter, and in time of emergency it would generally be very easy to supplement them by hired vessels, admirably suited for the duties they would have to perform.

These store lighters are employed as follows:—Several groups of mines are run down to the pier and shipped on board, the sinkers for these mines being generally kept stored in the hold. The vessels can then be hauled away from the pier so that the laying-out steamers can "sling" both from the pier and the lighter. If the conditions of weather and sea are favourable, the store ships can be taken to the mine fields, where the mines can be rapidly transhipped to the laying out vessels.

The big derrick and steam crab of the lighter are very efficient in rapidly transferring mines to the laying-out vessels.

As these vessels are often lying by for some time without use, the falls and guys of the derricks should be very carefully attended to and tested, so that they may not become rotten. It is well to rig a "Burton" tackle to the masthead of each derrick for easing weights down to any required position on deck, close to the foot of the mast.

Special fittings, capstans and winches.

The lifting arrangements in submarine mining vessels are very varied in character. The older vessels were provided with steam winches, which are now replaced by vertical capstans. Two of these capstans are generally provided, one of them being fitted for taking an expanding drum for laying out and under-running short lengths of cable. These drums are now being tried in the form of a removable frame 2 ft. 6 in. in diameter, which can be shipped at pleasure on one of the capstans.

Vertical capstans allow of a horizontal "lead" to a rope or chain in any direction, and this gives the power of raising weights on the forward and after derricks of masted vessels, and of applying power to make a direct "lift" over the gunwale on either side.

These capstans are worked by small auxiliary engines, fixed to the underside of the deck,* close to them, and controlled by levers placed in a convenient position on deck.

Derricks.

Derricks are usually in the form of large davits, capable of being traversed by hand or steam power through a complete circle. In the older boats the derricks were controlled by means of guys. Davit derricks are now being fitted in the after part of those vessels not rigged with masts.

The masted vessels are provided with boom derricks, which have a good sweep and a high lift. These boats are consequently able to sling weights off piers and store ships with their own appliances, which is a great advantage in many cases.

* In future these engines will be placed on the flooring of the hold.

The older boats are fitted with joggles over the bows, containing two sheaves, each capable of taking 4 in. rope. Horn joggles, containing one large roller about 8 in. wide and 6 in. diameter are now provided in new vessels, so that connecting boxes and shackles may pass easily over them. Joggles and horns.

Fair leads, with horizontal and vertical rollers, are fitted on the rail on each bow for paying out and getting in cables, &c. Fair leads, cleats, &c.

Iron cleats are fitted all along the bulwarks so that mines and sinkers can be slung at any part of the vessel. These cleats are capable of taking 4 in. rope.

Ring bolts are provided in suitable places for attaching snatch blocks, through which falls are given a fair lead to the capstans or winches.

It is convenient to fix on the bridge a chart table, or box, with a glass top, for the protection of the mine field plan, also a box for the protection of binoculars and sextants in rough or wet weather. Chart tables, &c.

Fitting out Hired Vessels.

The steamers suitable for submarine mining work at any port fall naturally into two classes.

(1) Those suitable for most submarine mining operations with the addition of a few fittings.

(2) Those required only as tugs and despatch boats, and perhaps eventually as guard and picket boats.

Vessels of the first class will nearly always be single screw boats, generally deeper and narrower than our own vessels, and sometimes possessing considerable power and speed. At some ports small steam lighters are obtainable, and these vessels are generally provided with a steam winch and derrick, the boom of which works aft over a large hatchway, the engine and boilers being right aft. Such vessels require only a joggle and a few cleats to turn them at once into very useful boats for submarine mining purposes, as they can be used either for laying out mines, or as store-ships, carrying a large number of mines in their holds.

The smaller tugs, 60 to 90 feet long, can usually be turned into very efficient "miners," with little trouble and expense. These vessels generally steer well enough for submarine mining purposes, and are provided with a forward wheel, and communication with the engine-room. They may be wooden or iron vessels. If the bulwarks, stanchions, and rail are of wood, it will be easier to attach the cleats and joggle. In Plate III is given an illustration of a form of cleat that has been found very suitable for such vessels. There should be a clear deck-space forward, and this can usually be obtained by removing any skylights or companion hatchways, and covering each opening with a low flat hatch. The windlass and bitts, if right forward must also be removed, but the pawl-bitt may be found of use as a support for a derrick mast or davit to work over the joggle. If the vessel has a foremast, a derrick boom, working forward, may be found more useful, and easier fitted than a davit-derrick.*

*This derrick boom need not plumb over the joggle; in many cases the boom would be of an unwieldy size, and would not pass under the forestay; "fair-leads" on each bow are sufficient.

The strength of the deck and rail should be seen to; the former may be strutted up from the keelson, and extra stanchions may be required for the proper support of the rail when heavy mines are slung. A clear gangway of at least 3 ft. 6 in. is desirable between the bulwarks and the casings over engines and boiler. This will allow of mines being dragged from aft into position for slinging on either bow. For this purpose rope mats about 2 ft. 6 in. square have been found very useful.

Cleats. Iron cleats, unless previously provided for use, take some time to make, and require a good deal of time to fit properly. Where wooden stanchions exist, it is better to fix cleats as shown in Plate III, fig. 4. Where the bulwarks are of iron, wooden stanchions may be fitted between rail and covering board, to which cleats and cavels can be attached. The stanchions may be recessed as in fig. 2, to form the thumb cleat, the cavel being attached in a countersunk slot above.

Joggle. The joggle may be formed out of an old davit, the head being opened out to take the roller sheave. Ears, projecting above and forward of the sheave, should be provided to keep cables and chains from slipping off the latter when a side strain comes on them. Very good work can be done with fair leads fixed on each bow, no joggle being used on account of cramped space forward, forestay, &c.

Derrick. There should be no difficulty in finding a suitable derrick, and fitting it up on board. Most large steamers are usually fitted with handy little derricks for shipping their anchors, which would answer very well for submarine mining purposes. In Plate III is given an illustration of the manner in which an old "miner's" derrick has been fitted to a hired boat.

Steam winch. A steam winch capable of lifting 2 tons should be fitted a few feet aft of the derrick. The steam connection with the boiler, if above the deck, should be well protected with a wooden covering.

Much time will be saved on an emergency, if all these fittings are placed on board in peace time, although they are removed when the vessel is not in use. It has been found that vessels which have been so fitted can be prepared for service again in about 10 hours.

Every station should have some special fittings ready for attachment on an emergency.

Paddle-wheel steamers have been successfully used for submarine mining.

FITTINGS FOR HIRED VESSELS.

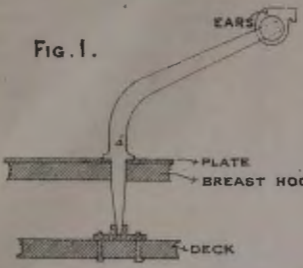


FIG. 1.

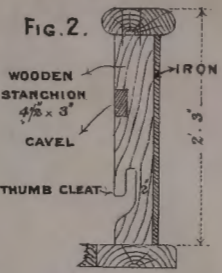


FIG. 2.

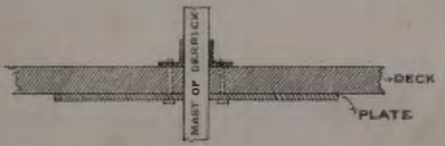
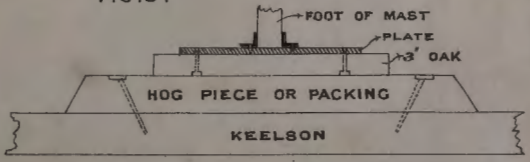
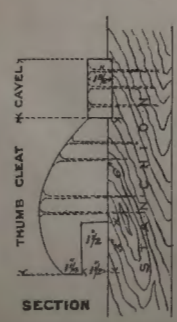


FIG. 3.





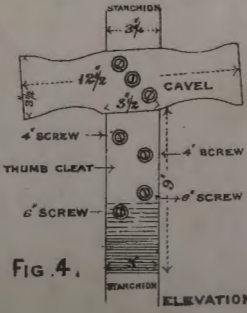


FIG. 4.

Judd & Co Lith. 73 & 75, Farringdon Rd & Doctors' Commons

TABLE OF SUBMARINE MINING VESSELS.

Class of Type of Vessel.	No.	Material of Hull.	Tons Displacement.	Dimensions. Length between perpendiculars.	Breadth extreme.	Mean Draft.	Propelling Machinery. Type.	I.H.P.	Date of Completion.	Speed	Mining Machinery.	Remarks.
				ft. in.	ft. in.	ft. in.				knots.		
"Miner"	15*	Iron ...	81	65 0	15 0	5 8	High-Pressure Surface Condensing Twin Screw.	110 to 140	76–79	7 to 8	Steam Winch 1	Numbered 1 to 15.—No. 7 belongs to Indian Government, Nos. 3, 4, 6, 8, 10, 13, 14, have been improved and altered.* See foot note.
"Gordon"	6	Steel ...	125	95 0	17 6	7 10	C.S.C. Single Screw, fitted with forced draught arrangements.	320	84–85	12	Steam Capstans 2 Davit Derrick 1	White's double rudder system, fitted with masts and sails, and large wooden derricks.
"Sir R. Fletcher"... ...	3	Iron and Steel.	100	78 10	15 6	6 3	C.S.C. Twin Screw.	189	87	9·8	Steam Cranes 2 Steam Capstans 2	The "Empress" is included in this class.
"Sir Francis Head" ...	4	Steel ...	134	80 0	17 6	7 0	C.S.C. Twin Screw.	220	89	9·5	Steam Cranes 2 Steam Capstans 2	
"General Skinner" and "Napier of Magdala."	2	Steel ...	144	80 0	18 0	6 8	C.S.C. Twin Screw.	300	91	10·5	Steam Capstans 2 Davit Derrick 1, with hand screw traversing gear.	Two masts with wood derrick boom fitted on each.
Steam Launch "Volta."	1	Wood, top sides of Steel.	25	45 0	11 2	4 5	C.S.C. Twin Screw.	90	89	8·5	Steam Crane 1 Steam Capstan 1	Bottom coppered.
Steam Launches "Ohm," "Erg," "Farad," "Ampere," "Watt," "Joule," "Dyne."	7†	Wood, top sides Steel.	26	48 0	11 2	4 5	C.S.C. Twin Screw.	90	90	9·0	Steam Crane 1 Steam Capstan 1	"Ohm" is arranged to stoke boiler from forward end, all others from after end. Bottom coppered.
Steam Launch, 42-ft. Naval	12	Wood ...	25	42 0	11 9	4 —	Double Cylinder non-condensing Twin Screw.	36	...	5 to 6	... ...	Some of these launches only were specially built for S.M. Service.
Steam Launch "Primrose"	1	Wood ...	25	58 8	9 8	4 0	C.S.C. Single Screw (double rudder).	150	84	13		
Steam Vessel "Nellie" ...	1	Iron ...	70	58 0	14 0	5 6	Single Screw	70	Bt. in 78	6 to 7	1 Steam Winch	New boilers and engines and overhauled, July 87.

* NOTE.—Extensive alterations have been carried out to some of these boats, viz., chart house and bridge placed forward of funnel; two 11′ derricks fitted winch removed and 2 steam capstans substituted; after skylight removed; new horn joggle, propeller, and propeller guards, &c.

† 9 more launches are under construction in which the beam is increased to 12 ft.; draft 4 ft. 3 in.

Crews of Submarine-mining Vessels.

The personnel of a submarine-mining steamer consists of the "military mechanist" coxswain, the deck-hands and the engine-room staff.

Military mechanist coxswains.

For the important duty of taking charge of, and handling, the larger natures of mooring-steamers, a special class of seamen has been enlisted. These men are entrusted with very important and responsible duties which are set forth in greater detail under the heading of "Duties of Crews of Mooring-steamers." The following numbers should generally suffice for the efficient working of the larger steamers under normal conditions:—

Mooring steamers.

Military mechanist (coxswain)		1
Deck-hands		2
Military mechanist (engine-driver) ..	Engine-room staff	1
Engine-driver		1
Stoker		1
Cook and cook's mate (only when the crew live on board)		1
	Total ..	7

When work in the mine-field is going on, it is desirable to ship another engine-driver in those vessels fitted with steam cranes, so that one of the engine-room staff may be available for operating them and the capstans.

It is also desirable, under these circumstances, to provide a dinghy crew of two men, in order that the deck-hands may not be taken away from their proper duties. These extra men should assist the deck-hands when not required for the boat, and should be capable of taking their places on an emergency.

The cook should be capable of giving assistance on deck when required.

At foreign stations, where natives are employed both on deck and in the engine-room, it is generally necessary to increase the numbers of deck-hands and stokers.

Hired vessels.

When hired steamers are employed for submarine-mining work, the civilian crews should, if possible, be engaged also. The crews of such vessels of 80 or 100 tons displacement usually consist of a master, mate and boy on deck, and one engine-driver and one stoker below. When employed in the mine-field, it may often be desirable to supplement these crews, *e.g.*, by placing on board a dinghy crew, or an extra engine-room hand to assist in working the steam-crab.

Launches.

The normal crew for a twin-screw steam launch is:—

Coxswain	1
Deck-hand	1
Engine-driver	1
Stoker	1

When the steam lifting appliances are in use, and long hours are being worked, another engine-driver may be sent on board, and it may be desirable to have a second deck-hand under these circumstances. Where the work is light, the duties of the deck-hand can be performed by the coxswain and stoker.

Lighters.

These vessels, which may be used either in the mine-field or as an auxiliary to pier-heads, require the following crew when work is going on:—

1 N.C.O. in charge.
7 men on deck to work guys, buttons, hook ropes, and falls.
2 men below when sinkers and mines are stowed in hold.
1 engine-driver.
1 stoker.

Duties of Crews of Submarine-mining Vessels.

Military mechanist coxswains.

(1) The military mechanist coxswain will be held responsible to the officer in charge of the submarine-mining defences of the port for the safety, efficiency and cleanliness of the vessels, boats and stores placed in his charge. He is not responsible for the state of the engines and engine-room, but the orders for getting up steam, executing repairs to engines and boilers, and reports connected with their condition will pass through him, in order that he may be duly acquainted with everything concerning the efficiency of his charge.

(2) He will draw and account for all consumable stores used on or about his vessel, with the exception of those required for the engine-room department.

(3) He will see that all vessels and boats in his charge are

The oil used in all lamps on board is to be rape seed (colza). Paraffin oil is not to be employed.

properly, and should direct the attention of his crew to the circumstances of the collision as corroborative evidence. Should his vessel be so injured as to be in danger of sinking he will make every effort to keep her afloat, or to beach her if necessary.

(5) He will see that proper discipline is maintained on board his vessel, and that the orders issued for the purpose are duly obeyed. Any breach of these orders should be reported immediately to the officer in charge.

(6) He will see that the vessel is washed down every morning and the bilges pumped out. The latter should be opened up and cleaned at least once a month.

(7) He will see that the brass work is kept clean and bright, and that any paint rubbed off is renewed as opportunity offers.

(8) He will see that the cabins, chart room, and men's quarters are clean and tidy, and will allow none but officers to use the former.

(9) He should remain on the bridge while navigating narrow channels and anchorages, and when going alongside vessels or piers.

(10) He will take every opportunity of instructing the deck-hands in their duties in steering and managing the vessel under steam, in the rules of the road at sea, &c., so that they may be able to take charge of the vessel in an emergency, or as a relief.

(11) He will frequently inspect and test all running gear and

Lighters.

These vessels, which may be used either in the mine-field or as an auxiliary pier-head, require the following crew when work is going on:

1 N.C.O. in charge.
7 men on deck to work guys, burtons, hook ropes, and falls.
2 men below when sinkers and mines are stowed in hold.
1 engine-driver.
1 stoker.

Duties of Crews of Submarine-mining Vessels.

Military mechanist coxswains.

(1) The military mechanist coxswain will be held responsible to the officer in charge of the submarine-mining defences of the port for the safety, efficiency and cleanliness of the vessels, boats and stores placed in his charge. He is not responsible for the state of the engines and engine-room, but the orders for getting up steam, executing repairs to engines and boilers, and reports connected with their condition will pass through him, in order that he may be duly acquainted with everything concerning the efficiency of his charge.

(2) He will draw and account for all consumable stores used on or about his vessel, with the exception of those required for the engine-room department.

(3) He will see that all vessels and boats in his charge are properly moored or secured, and that riding and other lights are properly trimmed, lit, and fixed, when required.

(4) In the event of any vessel coming into collision with a vessel under his charge, he will, if possible, obtain the name and port of such vessel, and also that of her owner; if the collision occurs after dark he will ascertain that his lights are burning properly, and should direct the attention of his crew to the circumstances of the collision as corroborative evidence. Should his vessel be so injured as to be in danger of sinking he will make every effort to keep her afloat, or to beach her if necessary.

(5) He will see that proper discipline is maintained on board his vessel, and that the orders issued for the purpose are duly obeyed. Any breach of these orders should be reported immediately to the officer in charge.

(6) He will see that the vessel is washed down every morning and the bilges pumped out. The latter should be opened up and cleaned at least once a month.

(7) He will see that the brass work is kept clean and bright, and that any paint rubbed off is renewed as opportunity offers.

(8) He will see that the cabins, chart room, and men's quarters are clean and tidy, and will allow none but officers to use the former.

(9) He should remain on the bridge while navigating narrow channels and anchorages, and when going alongside vessels or piers.

(10) He will take every opportunity of instructing the deck-hands in their duties in steering and managing the vessel under steam, in the rules of the road at sea, &c., so that they may be able to take charge of the vessel in an emergency, or as a relief.

(11) He will frequently inspect and test all running gear and

rigging, and will report at once any deficiency or damage affecting them, or the ground tackle, boats and equipment.

(12) Should the miner under his charge be away from her moorings any night, he will see that she is securely anchored in a proper depth of water, and out of the ordinary course of vessels, that a sufficient scope of chain is paid out, boats properly secured, and the riding lights properly displayed. When away from moorings one of the crew is to be always on deck keeping watch.

(13) If under weigh after dark, he will see that the proper lights are displayed and burning brightly, viz.: On a staff at the forepart of the vessel, a height above the hull of not less than 12 feet, a "bright white light," showing through 10 points of the compass on each side of the miner's bow; on the starboard side a "green light," showing through 10 points of the compass from right ahead to 2 points abaft the beam; on the port side a similar "red light." If towing, a second white light, 4 feet above and similar to the first above-mentioned white light to be hoisted.

(14) He will send in daily, by 9 a.m., a report, on the form given below (Form Y), to the Division Officer Submarine Mining, R.E., in which any failure to comply with these orders will be recorded, and the reason given. He will also mention in this report anything of a special nature that has happened during the past 24 hours, affecting the vessels under his charge.

FORM Y.

Daily Report of N.-C.O. in charge of Submarine-mining Steamer

Date 189

SIR,

I have to report the orders for the care of the vessels under my charge were complied with during the past 24 hours, except as reported below.

The riding lights were properly trimmed, filled with oil, fixed in position, and lighted at sunset. They were taken down at a.m. and were then*

The dinghy was hauled up in the davits at p.m.

All lights and fires were extinguished at p.m.

The fire regulations were strictly complied with. The "Fire Stations" were last practised on the p.m. The decks were washed down and the vessels pumped dry by a.m. The men under my charge were all present and correct.

Special report of any deviation from regulations, or occurrence affecting the vessels under my charge:—

N.-C. Officer in charge.

*Alight or not alight.

Particular care must be exercised in steaming through minefields, so as to avoid submerged mines and buoys. Submarine mining vessels, when passing through a minefield, should proceed at not greater than half-speed, unless there are urgent reasons to the contrary.

nds.

give each man some special charge, *e.g.*, to one man charge of sail-locker, ropes, and submarine-mining gear kept on board; to another the care of lamps, boats, bridge, and brass work; to another the cleaning ont of cabin and chart-room, &c.

The men should also be given definite stations when under way, one being stationed aft to look after boats in tow, to keep ropes, cables, and buoys out of the propellers, and to tend the stern-fast and fender. One hand forward tends bow-fast and fender, heaves throw-lines, supplies spun-yarn stops when required, and sees that all gear required for work is ready for use; he also washes away mud and dirt before it gets trampled into the deck. He should have a supply of clean sand ready to sand the decks when necessary.

[*Note.*—After a heavy day's submarine-mining work, the squads should assist to wash down and tidy the vessel before going ashore.]

The deck-hands should take a pride in the appearance of their vessel, and should make use of every opportunity to repair damages, to point and splice ropes, mend fenders, &c. They should also be ready to instruct men under instruction, by practical illustration as to the proper way to heave throw-lines, belay ropes, to make knots and hitches, &c. They should in like manner take every opportunity of learning how to steer and manœuvre the vessel under steam, how to heave the lead, the rules of the road at sea, the pilotage of the port, and the appearance of buoys, leading marks, and beacons.

When there is a hand on board for cooking he should be made responsible for the cleanliness of the men's quarters and mess-kit, the closing of ports when under way, and he should be ready to give assistance on deck when required.

Engine-room staff.

The special duties of the engine-room staff are laid down in "Regulations and Instructions relating to the Machinery and Boilers of Submarine-mining Vessels." The engine-driver in charge of a vessel's machinery should draw and account for the stores required for his work. He should make all reports through the coxswain in charge of the vessel. The driving of steam capstans and derricks should, when possible, be done by the engine-room staff.

General.

To maintain cleanliness and tidiness in a vessel it is essential that there should be a place for everything, and that everything should be in its place. Ropes, lashings, boat-hooks, and fenders must be returned to their proper berths when not in use, and not left lying about the decks. Each man should make up his own hammock or bunk, and stow away his clothes in his locker.

Standing orders for each station.

At each station, standing orders, based on the foregoing instructions, should be placed on a board in each submarine-mining vessel, together with any other extracts from local orders and regulations, which may affect the proper working of the vessel.

See S.M.M. Circular to 417

Deck-hands.

The deck-hands are, under the coxswain, responsible for the cleanliness and tidiness of the vessel, and for the performance of all work on deck.

It is well to detail the several hands for special duties, and to give each man some special charge, *e.g.*, to one man charge of sail-locker, ropes, and submarine-mining gear kept on board; to another the care of lamps, boats, bridge, and brass work; to another the cleaning out of cabin and chart-room, &c.

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See S.M.M Circular No 417.

"position-finder."—Rules for use of instrument.—Accuracy and speed of method.—Mine alignments.—Laying mines or buoys by this method.

(v.) *Fixing unknown positions by two or more Sextant Angles and Station Pointer.*—Method not applicable to finding pre-determined positions.—Use in special cases.—Double sextant.—Method of plotting position.—Station pointer.—(For errors see Appendix H).—Conditions necessary for accurate work.—Several points should be chosen for observation to employ with these conditions.

(vi.) *Laying out Marking-buoys.—Sounding.*—Lead and lead-line.—Marks on line.—Another method.—Sounding rods.—Sounding in swift currents.—Sounding book.—Tide gauge.

This chapter deals with the details of plans and charts connected with submarine mine defences, and of the various methods which are usually employed in carrying out the surveys, and in finding the positions of mines, junction-boxes, and buoys.

General Scheme of Defence.

General scheme of defence.

The submarine mine defences of a port having to be considered and designed in connection with the artillery and floating defences, it is necessary, before the details of the former are drawn out, to treat the defence as a whole from a tactical point of view, remembering the many considerations connected with the traffic of the port, the character of the attack to be provided against, and the means available, both in *matériel* and *personnel*.

General plan of defence or small scale.

The first step to be taken, therefore, is the preparation, on a small scale, of a chart showing the general arrangements for the defence by all arms, both by land and water, as detailed further on for A chart.

This plan, which will be generally prepared in the first instance at the War Office, after consultation with the Admiralty, will be forwarded to the station for the observations of the General, or other Officer Commanding, who will consider what alterations are desirable, from a local point of view, in the general arrangements, as well as in the special disposition of the mines. The latter involves to a great extent, questions of pilotage and naval requirements, therefore the local naval and harbour authorities should be consulted.

After a careful study of the proposed defence, any alterations considered desirable will be submitted, with full explanations of the reasons for such alterations; and, when the plan is finally approved, the detail survey work connected with the submarine mine defence may be commenced. Alterations in the disposition of the mines will usually be confined to those due to small changes in the alignments, necessitated by the desire to take advantage of existing marks, or to avoid foul ground.

Plans and Charts.

When carrying out the detailed survey of the mine-field, the following plans should be generally prepared for all ports defended by submarine mines:—

A Plan.

A.—Plan of the whole defence, giving all possible information in a condensed form; scale 3 to 8 inches to a mile.

In this plan copies of which are required for the use of the officers commanding the defence and other branches of the Service, the mine-field areas only are indicated, and not individual mines, but it must give all information required for the proper tactical working of the defence under one hand. These plans should therefore show:—

(1.) Commanding officers' stations, with telephone, telegraph, and visual signalling arrangements;

(2.) Arcs of fire of various batteries, with limitations of fire under specified circumstances;

(3.) Arrangement of search-lights and fixed beams; those used in connection with artillery fire should be distinguished from those used purely for the mine defence. The arcs of training should be very clearly defined;

(4.) Manœuvring ground and moorings of guard-boats in tactical positions, previously determined with the R.N.

The foregoing information may frequently be recorded on the Admiralty charts, but if this cannot be done, the plans must give all the hydrographical details necessary. Transcripts of portions of these plans, when finally approved, should be prepared for the information of Artillery officers commanding different sections of the defence, but a wise discretion should be exercised, so that, while the intelligent action of subordinate commanders must not be hampered by a want of needful information, any really confidential matter may not unnecessarily be widely distributed.

B Plan, scale $\frac{1}{2500}$ to $\frac{1}{4800}$, record of existing state of defence area.

B.—Plan of each mine-field, giving the accurate position of survey marks, beacons, lighthouses, prominent natural alignments, lightships, fairway buoys, datum marks, shoals, test rooms, and observing stations, pivots and arcs of training of guns, electric light emplacements and engine houses, underground electric cable channels of all sorts, existing submarine cables, soundings (in feet) reduced to mean high water springs, set and velocity of tides, &c.

This plan will not be used for charting the positions of mines, cables, and alignments, which are liable to considerable modifications from time to time, but will be kept as a record of the existing state of the mine-field and its surroundings. From this plan, which may be of an unwieldy size for out-door work, tracings or copies of portions can be made as under.

C Plan. Details of submarine-mining defences.

C.—Plans of each mine-field, copied or traced from B, will be prepared, showing the position of every alignment post, mine, junction-box and cable, as laid down in the authorised plan of defence. The depth of water (M.H.W.S.) at each mine will be shown on these plans, also the position of leading marks, buoys for friendly channel, obstructions and boat mines, moorings for guard-boats, and all the details connected with the submarine

mine defence. It is convenient to record on these plans the actual form and colouring of alignment poles, and all cross intersections, sextant angles, or actual measurements necessary for the rapid buoying or finding of charted positions.

D Plan, for use in laying-out vessels.

D.—Transcripts of adequate portions of C should be prepared for use in the mine-field. These charts should contain all the information required for laying out mines, junction-boxes, &c.; they may be drawn on waterproof paper, or in such a way that they may stand rough usage and wet weather.

E Diagrams.

E.—Diagrams, for use in junction-box boats, should be prepared, showing the distribution of the cables and cores. These may be conveniently drawn on waterproof paper, a complete set being provided for each junction-box boat, and laying-out steamer.

F Alignment marks.

F.—Diagrams of alignment marks on shore for the use of the alignment party.

G Friendly channel.

G.—A plan of the friendly channel, on a large scale, should be prepared, giving the leading marks and the details for mooring the channel buoys.

Diagrams on a large scale should also be drawn out, showing the disposition of the cables where they enter the sea.

The details in D, E, and F, may be recorded in note-books, made of waterproof paper if necessary. Waterproof ink for use with these books can be made from the following recipe: shellac 2 ozs., borax 1 oz., water 18 ozs., boil together, and add aniline dye (Judson's) as required, for colour.

Preparation of Large Scale Plans of Mine-fields.

The general scheme of defence and arrangement of mines having been finally determined, the preparation of the large scale plans B and C will be at once proceeded with.

Scales.

The scales on which these plans are drawn will vary at different stations. If the plans are enlarged from 6-inch maps, a scale of $\frac{1}{5000}$, or 12 inches to a mile, is convenient. If 25-inch maps ($\frac{1}{2500}$) are available, this scale, or one of $\frac{1}{5000}$, may be more convenient. If the position-finder is used, a scale of $\frac{1}{1000}$ must be used for the firing table, although a plan on a scale of $\frac{1}{5000}$ may be used with this instrument for survey purposes if the altitude is over 200 feet.

Where plans on these scales do not exist, it will be necessary to prepare them by one of the following methods:—

(1.) Actual survey from a carefully measured base line.

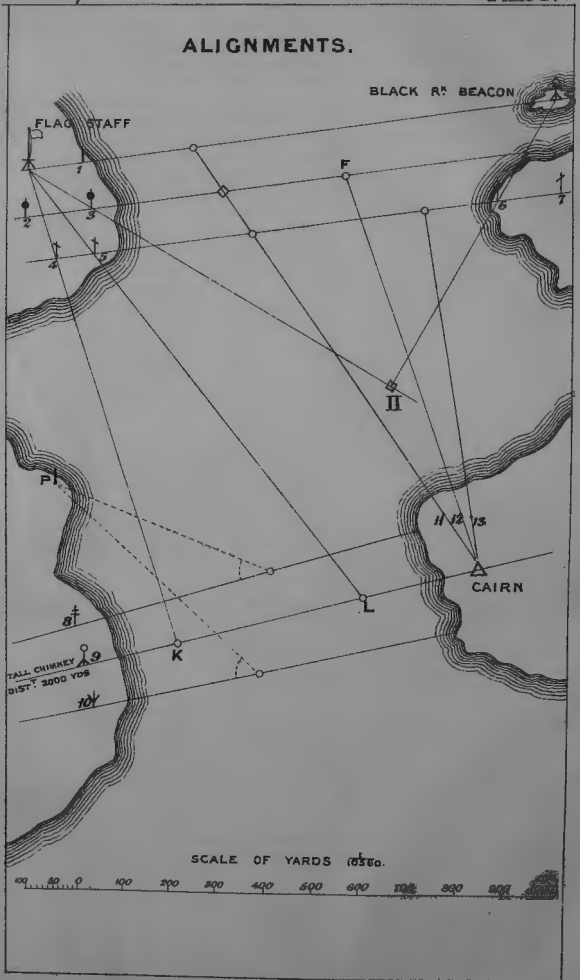
(2.) Triangulation from existing triangulation stations, the reduced horizontal distance between them having been ascertained,

(*a*.) By reference to records of original survey;

(*b*.) By careful measurement from the largest scale plan obtainable.

The first method, if unavoidably necessary, must be carried out as carefully as possible, in accordance with the well-known rules governing such operations. Measuring tapes and chains must be checked, and a standard of length laid down. It will, however, generally be possible to work from points by the second method.

If it is not possible to obtain the reduced distances between



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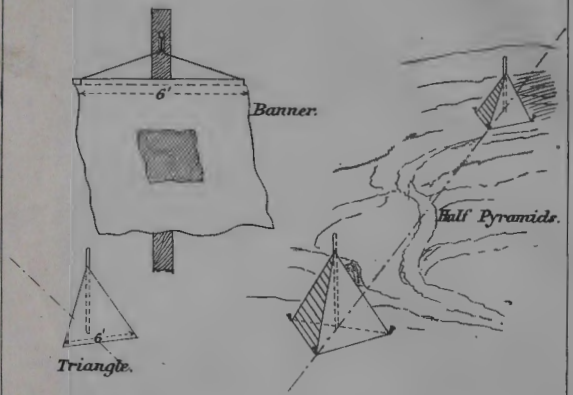
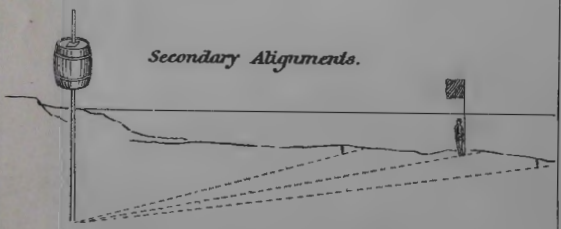
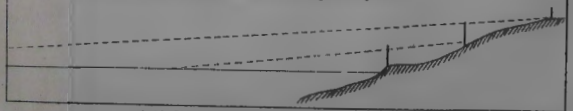
ARTIFICIAL ALIGNMENT MARKS.







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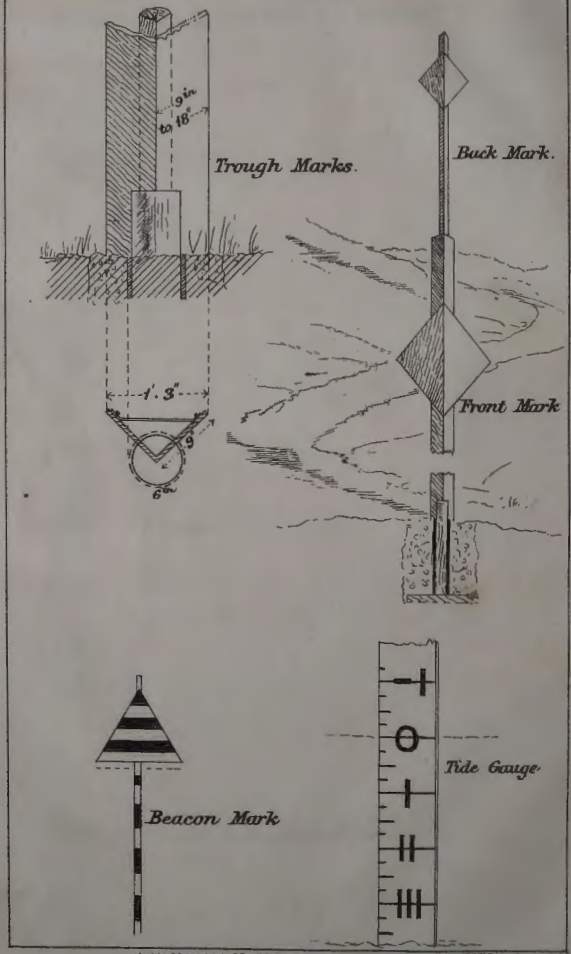
ARTIFICIAL ALIGNMENT MARKS.



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these points from original records, measurement from existing plans may be resorted to, provided the probable error does not exceed 1 in 500. To ensure the greatest possible amount of accuracy by this method, the plan should be on the largest scale obtainable, the stations about 2,000 yards apart, and the scale engraved on the plan used for measurement.

Local surveys.

In many cases good plans prepared by Local Harbour Trusts, or similar bodies, will be found to exist, and every effort should be made to obtain them for reference, if not for use.

Preparation of plan B.

The preparation of the plan B will, in most cases, be a matter of compilation; recording on one large scale drawing the information contained in existing plans of different scales. It is of great importance that such a chart, containing a record of the actual state of the defence area and of all the permanent defence works, on the same scale as the detailed submarine mine charts, should exist. The position of local triangulation stations should be recorded on this plan, but submarine mining alignment marks, which are liable to alteration, need only be shown on the submarine mining charts.

Triangulation stations.

In selecting the stations for the triangulation, it may be necessary to include more ground than is actually required for the submarine mining chart alone, in order to fix properly the defence works required for plan B. Some of the stations should, if possible, be on or near some of the principal alignments for mines.

It is desirable to take angles to distant well-defined objects beyond the limits of the plan. These bearings, or their prolongations, when laid down thereon, will often give valuable alignments and cross intersections with existing alignments, and save a good deal of time and material in putting up poles.

Alignments.

Alignments are of three descriptions:—

(1.) Natural and permanent;

(2.) Artificial;

(3.) Combination of (1) and (2).

In most places, plenty of permanent conspicuous objects will be found, which will either give suitable alignments by themselves, or can be used in conjunction with artificial marks to give alignments or cross intersections.

Plate IV illustrates the use that may be made of permanent and artificial marks in arranging alignments. Two existing objects, a flagstaff and a beacon, are selected as suitable and convenient marks for determining the direction of one main alignment; a single artificial mark, No. 1, completes it. The alignments 2—3, and 4—5—6—7 are set off by actual measurement from flagstaff, J.

The positions of the marks 3, 4, 5, 6, may be capable of adjustment along these alignments, so that they may fulfil a double purpose; thus the flagstaff and 5 give a cross bearing for the M.D.J.B., L. Similarly, the alignments, flagstaff, 3, and Black Rock beacon, 6, mark the position of the M.J.B., H.

The alignments passing through the marks 8, 9, 10, are not parallel. This is due to the selection of a conspicuous distant object as a back mark common to the three alignments. In this

illustration, the mark 9 is aligned between the chimney and the cairn, and the positions of 8 and 10 are easily found by actual measurement from 9.

By this means, one permanent back mark is made to fulfil the office of three artificial marks, with a consequent saving of material and gain in accuracy.

Base, or distance between marks.

The base, or distance between alignment marks, should, if possible, be at least one-eighth to one-tenth the distance to the furthest mine. When a distant back mark is selected, the base will frequently exceed the distance to the furthest mine; but in misty or thick weather the back mark may be invisible, in which case temporary back marks may be required. The positions of these should be marked, so that they may be erected without any delay. The probable errors due to short base are alluded to under the heading, "Buoying Positions in the Mine-field."

Permanent marks.

Permanent marks, such as cairns, leading marks, datum piles, tall chimneys, gables, &c., have several advantages over artificial marks. They are always standing, do not show the position of mines to strangers, and, as they are generally fixed by triangulation, ensure very accurate work.

Requirements of alignment marks.

The first requisite of alignment marks is visibility under all ordinary conditions of work; the second, that they should be so placed as to give accurate results. The marks, therefore, should be of considerable size, and of such form and colouring as to be visible from the most distant part of the alignment under working conditions of light and background.

Forms of marks (*see* Plates V, VI).

The following forms may be used under different circumstances:—

(*a*) Poles, with or without flags or arms.
(*b*) Planks.
(*c*) Planks at right angles to each other.
(*d*) Triangles or half pyramids of timber or timber and canvas.
(*e*) Cairns of stones, whitewashed.
(*f*) Lights and smoke.

(*a*) Poles of different colours to suit the background are frequently used for short distances. These poles may be fitted with arms, discs, triangles, flags or other devices for rendering them visible. If flags are used it is well to make them in the form of banners, about six feet square. In calm weather the banner hangs down and displays its full area, and if there is a breeze, serves, by its fluttering motion, to denote very efficiently, the position of the pole carrying it.

(*b*) Planks present a much larger area to view than poles, for the same weight, and are cheap and effective marks.

(*c and d*) Lighter planks at right angles to each other, in the form of a V-shaped trough, make excellent marks. The dimensions of the trough can be varied according to the surroundings. In some places the "trough" mark will be high and narrow, in others low and broad. The latter form can be made very light, so that it can be folded flat and easily transported. As one side of the mark is

certain to be illuminated to a greater extent than the other, the intersection of the two planes on the alignment is very visible. If the sun is likely to be vertically over, or a little behind, the mark, it can be sloped back in the plane of the alignment, or the mark can be constructed in a semi-pyramidal form of timber and canvas. The principle of constructing marks in the form of a solid, the planes of which shall be illuminated to different degrees, is capable of many variations. Thus, where high poles, or beacons of large dimensions, are used for long alignments, the erection of an ordinary bell tent round the foot of each pole would probably render the marks distinguishable when they would otherwise be invisible.

(*e*) Whitewashed cairns of stones, or obelisks, form good marks for similar reasons.

(*f*) Lights and smoke may be used for alignment marks. Old paint tins, filled with junk and pitch, can be used for the latter purpose, the tins being suspended from the poles or marks. The datum marks for the position-finders may often be used as alignment marks. When specially erected, they should be sloped sideways, a few degrees from the vertical; this gets over the difficulty of estimating the true water-line in a dead calm, when the mark is reflected in the water.

Colouring of marks.

The colouring of marks is mainly a question of light and background. In some cases red is a good colour to use, *e.g.*, where the background is a white cliff. Against a sky line black is generally the best colour. Where planks are used it is desirable to have them painted white on one side and black on the other, so that they can be reversed if necessary. As a rule white is the best colour for general use.

If possible, marks should be erected on a north in preference to a south, shore in northern latitudes, as this will ensure the maximum illumination. Every effort should be made to render alignment marks visible under all working conditions, and, with this object, the marks should be kept in good repair and well painted.

Arrangement of marks (Plate V).

If possible, marks should be so arranged that they partly cover each other when viewed from all parts of the alignment. It is evident then that where the shores are steep the marks must often be of considerable height, and it may sometimes be necessary to erect three, or more, to ensure their covering each other, and to keep them within reasonable limits of height.

Identification of marks.

Alignment marks should be easily identified from the water, and should correspond in form and colouring with the sketches of them drawn on the mine-field charts. It is convenient to fix cross-bars at different angles with the horizon when there is any danger of confusion, those on the front poles being usually placed half way up, and those on the back poles at the top. Discs are often used to distinguish junction-box alignments.

Marks for sextant observation.

Marks used for sextant observation should be as low down as possible, and much at the same altitude, to obviate error and undue tilting of the instrument.

Permanent footings for marks (Plate VI).

The positions of survey and alignment marks should be permanently marked on the ground. A convenient method, which provides at the same time a socket for the pole or mark when up, is to sink a 6-in. pipe 4 ft. long in the ground, bedding it in concrete, and covering it with a flat stone * bearing the requisite inscription. The iron socket pipes may be dispensed with, by using a slightly tapered wooden core about 4 ft. long, round which the concrete socket is formed; the core is provided with a handle for turning it round and withdrawing it. A hole should be bored down the centre of the core, so that it may be plumbed truly vertical.

Record of marks.

A list of all marks should be prepared, and they should be periodically inspected (not less than once a quarter), and any defects made good. This list should be kept with the submarine mining records.

Buoying Positions in Mine-fields.

Buoying mine-field.

The main survey having been completed, as described in the foregoing pages, it may be necessary to undertake a regular hydrographical survey of the mine-fields and adjacent waters. In this case special arrangements will have to be made for taking the soundings, either by working along alignments; taking simultaneous theodolite observations from three or more stations as each sounding is taken; working by actual measurement from buoys accurately moored by three or four anchors; by means of the position-finder; or by means of double sextant-angles. It is desirable in any case to check, by careful observation, the position of a few buoys laid by any of the various methods about to be described, so that no doubt may exist as to the accuracy of that employed.

Selection of method.

In selecting the method to be pursued, the advantages and disadvantages of each must be carefully considered in connection with local conditions, and the "probable errors" of a few cases should be carefully worked out before any particular method is definitely decided on.

A method, quite accurate and applicable in one case, may be very inaccurate in another. It may often happen that each and every method might be used at the same place with advantage, and, in most cases, it will be advisable to check the results obtained, by frequently laying out the same buoys and charting the results by the position-finder or simultaneous observation of three or more azimuth instruments.

Methods in general use.

The following methods for buoying or finding positions in the mine-field are generally employed:—

1. Cross-intersection of two alignments.
2. One alignment and sextant angle.
3. Actual measurement.
4. Position-finder and one alignment.
5. Combinations of the above.

* A wooden plug kept in place by means of a set-screw through the iron pipe answers well for this purpose.

Intersection of two Alignments.

Probable Errors.

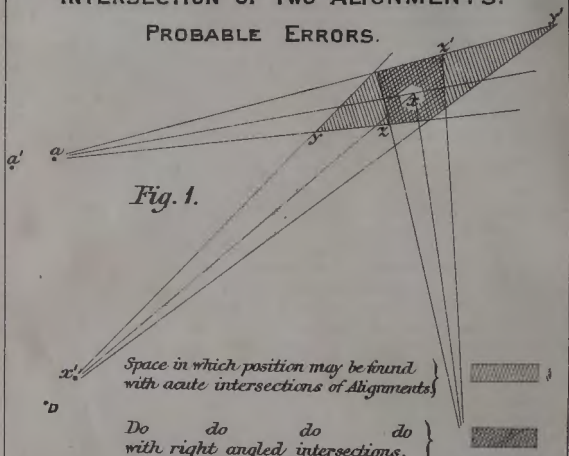
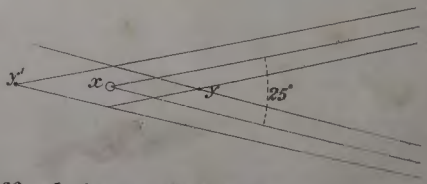


Fig. 1.

Example, Fig. 2.



Marks 1000 yards from x. 200 ft. apart.

Angle of intersection 25°.

Assumed error in alignment of centres of marks 2 ft. (made up of errors in Survey, erection of marks, and in Minefield)

Maximum error in laying $x\frac{1}{y} = 140'$.

Scale $\frac{1}{2500}$.

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(i.)—Intersection of two Alignments.

Plate IV. illustrates the method of finding positions by means of the intersections of alignments. Where the positions are disposed in several rows more or less parallel, the intersection of one cross-alignment may often be arranged to mark a position in each row. It is well to avoid the multiplication of alignment marks as much as possible. This may frequently be arranged for when the mine positions are being planned out.

Where it is necessary to provide for a considerable number of cross-alignments to give the necessary intersections, a back or front mark common to each such alignment may often be employed with advantage. The positions of the marks for such cross-intersection may be marked, where the distance to the mine-field is not too great, by pickets, at which banderols, or other suitable marks, are held up when a mine or buoy is being laid. The positions of these pickets may be fixed by theodolite or plane-table, preferably by the former. *See* Plate V.

When a plane-table is used for this purpose, it may be set up at any convenient place, its position being found by interpolation from other fixed points.

Where Watkin's Position-finder is used for giving intersections with other alignments, the pickets may be either in front of or behind, the mark erected over the instrument according to circumstances.

The angle at which the alignments cross each other should not be less than 30°, unless the distances are very small (under 500 yards), and the distance between poles at least one-eighth of this. Figs. 1 and 2, Plate VII, illustrate unfavourable conditions for the use of cross-alignments, and show what large errors may arise in ordinary practice by using the method under these conditions. Angle of intersection of alignments.

In fig. 1 the distance a between main alignment marks is 200 ft., one fifteenth of ax, 1,000 yards. The distance bx, between secondary alignment marks, is 200 ft., also one fifteenth of distance x.

Suppose that, in laying out, the centres of the marks $a'a$ and bx are not exactly aligned, but are each two feet out in opposite directions, an error which might easily occur with indistinct marks on steeply falling ground, added to small inaccuracies of survey), and that the angle of intersection of alignments at x is 25°, then, from the diagram, it will be seen that the mine or buoy might be laid at y or y', or about 140 ft. from the true position.

If an error of only 1 ft. in aligning the posts were made, the error in position would be half of this amount.

If the angle of intersection of the alignments in this example be 90°, the errors in laying xz are reduced to 42 and 21 ft., for errors in alignment of 2 ft. and 1 ft. respectively. This example shows the necessity of checking results obtained by this method by independent observations.

The use of two alignments, therefore, may cause considerable inaccuracy from :—

(a) Shortness of base.

(*b*) Slight inaccuracies in setting out the alignments.
(*c*) Small inaccuracies in working in the mine-field
(*d*) Small angles of intersection, which are usually smallest at the most distant mines.

These sources of inaccuracy may frequently be cumulative, and lead to bad results in practice.

When marking buoys or mines are being laid out by this method, the marks for individual mines or buoys are erected, as required, by signals from the laying-out steamer to an alignment party on shore. This saves the expense and confusion which would arise from having a permanent mark for each mine; it introduces, however, a source of error and delay in practical work, as mistakes may be made, both in reading the signals and in erecting the mark on the proper spot, and the officer in the laying-out vessel, is, to a great extent, dependent on others for the speed and accuracy of his work.

When there is much work going on, and two or three steamers are in the mine-field, great care must be taken to obviate confusion and mistakes by the alignment party.

In a large mine-field, two or three secondary alignment stations would be required for this purpose, as well as to fulfil the conditions of accurate work already indicated.

The cross intersection method may be very advantageously used for fixing a few important positions in a distant mine-field, from which other positions can be found by the method of actual measurement. For this purpose long bases and good intersections (from 50° to 130°) are desirable.

The importance of exercising great care in erecting alignment marks and in checking their direction, can hardly be insisted on too strongly. It is therefore desirable, when the marks are erected, to independently survey the alignments, prolonging them to the opposite shore when practicable, and to compare the results so obtained with the aligments as originally laid down on the chart, before the marks were put up.

(ii.) *One Alignment and a Sextant Angle.*

This method of finding the position of a buoy or mine is very convenient. It is capable of giving great accuracy if properly applied. A consideration of the diagrams in Plates VIII, IX, X, and of the following remarks, will show the conditions necessary for getting accurate results. Where the method is relied on for finding positions in a mine-field, individual cases should be worked out in the office, to see whether the conditions referred to are fulfilled.

The required positions, *x*, *y* (figs. 1, 2, 3, 4, &c.) on any alignment *a b* can be found by moving along it until the angles ϕ, ϕ', subtended by the marks *p a*, *p r*, correspond with their previously determined values. The sextant is set to read these angles, and the observer moves along the alignment until the two marks come together in the horizon glass.

Similarly, the position of the observer at any moment on a given alignment can be ascertained by reading the subtended angle, and plotting the position afterwards on a plan.

One alignment and Sextant Angle.

Fig. 1.

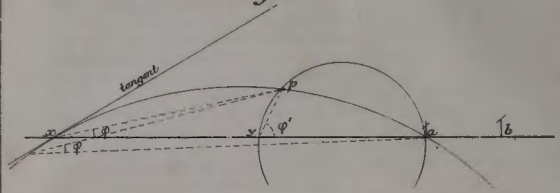


Fig. 2.

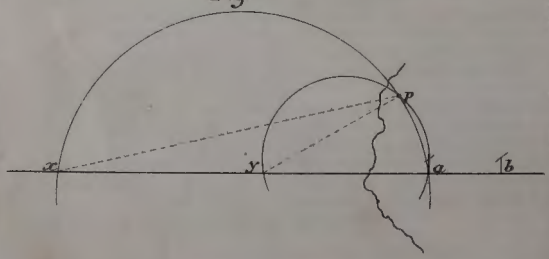
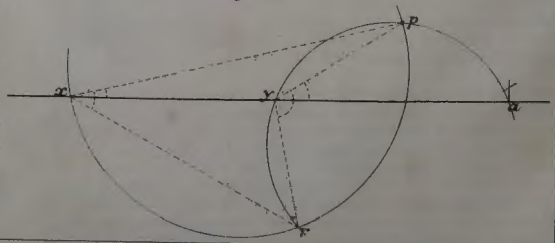


Fig. 3.



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To get accurate results, it is evident:—

(1.) That the alignment should cut the segment of the circle containing the angle as normally as possible.

(2.) That the observer should be accurately on the plotted alignment at the moment of intersection with the segment especially when the angle of intersection is oblique, and the circle is large. (*See* fig. 1.)

(3.) That the angular variation should be rapid.

(4.) That the marks p, a, b, r, should correspond accurately with their plotted positions on plan, and that they should be visible, and suitable for sextant observation.

(5.) That there should be no doubt about the value of the angles, ϕ, ϕ'.

With regard to the 1st condition, it will be seen from figs. 1, 2, and 4, that the marks p, a, should be fairly equidistant from any point on the alignment, the position of which is required to be fixed. In fig. 1, where p is much nearer than a to the working part of the alignment, the intersection is bad at x, although good at y. In this case, the segment of the circle continues to make worse and worse intersections as the distance from a increases, and where the probable errors in alignment are also increasing. In fig. 4 the intersections get bad at y, where the errors in alignment should be small. This is a much better arrangement than that in fig. 1.

In fig. 2 the intersections are good all along the alignment.

2nd Condition. Fig. 6 illustrates this condition: shortness of base, small errors in survey, or in truly aligning the centres of the marks, may throw the observer many feet to the right or left of the true alignment. If the segment of the circle (cc) containing the angle cuts the alignment at an oblique angle, as in the diagram, the position may be found at y or y'. Assuming in addition, small errors in the computation of the angle, and in "letting go," the position may be finally found at z or z'. Comparing this "probable error" under unfavourable conditions, with that worked out for the cross-intersection of two alignments, it is found that xz is 85 feet, where the base ab is 200 feet, ax 1,000 yards, and the angle axy 25°. Where the angle axy is 90° or thereabouts, the error is reduced to 34 feet, nearly all of which is due to faulty alignment.

3rd Condition. The angle should change rapidly as the observer moves along the alignment. This angular variation should be at least 1 minute per yard, and more if possible. In fig. 2, the positions of the marks p, and a, are such as to give good intersections all along the alignment, but the angular variation at the outer portion of the latter will be slow, owing to the small distance between p and a. To obviate this objection, a mark r, (fig. 3) may be chosen on the other side of the alignment from p. The intersections will be just as good, and the angular variation will be very much more rapid.

The distance xy in figures 2 and 3 is 1,400 yards on a scale of 2 in. to a mile, and the angle pyq is 18° larger than pxa, giving an average variation of ·77 minute per yard. In fig. 3, where

the angles are taken to p and r, the average variation is 3 minutes per yard.

When both marks are off the alignment, the observer cannot himself see whether he is on or off it, and must trust to the coxswain, but any slight error in alignment will be of small account in view of the rapid angular variation and excellent segmental intersection obtained.

The marks p, r (fig. 5) may sometimes be on one side of the alignment, and good intersections and fairly rapid variation will be obtainable over part of it, viz., from x to y. From y to y' the angular variation is bad, and the alignment is actually a tangent to the segment at s, so that the method is worthless along this portion of the line. It will be seen that at the points y', x', pr subtend the same angles as at x, y, the intersections are good, and the angular variation is rapid. This then is an ambiguous case which should not be lost sight of. If the points p, r, are used for giving angles to parts of the alignment to the right of the figure, it will be seen that there may be four points, x, &c., at which the angle will be the same. It is evident therefore that this phase of the method may lead to bad results, unless care is taken in working out particular cases beforehand. Over the bad portions of the alignment, yy', positions might be found by the method of cross-intersection, which would be unsuitable for positions near x.

4th Condition.—The errors due to faulty alignment have already been noticed. The positions of p, r, would generally be fixed by triangulation, and should therefore be accurately known. These marks should be at a low altitude if possible, and much on the same level, to facilitate observation and obviate error. Where the marks are broad, and the base is short, the centres of the marks should be clearly visible.

5th Condition.—The values of the angles ϕ may be measured by means of the station-pointer, which is virtually a protractor reading to 1′ of arc. The instrument is, however, liable to errors, and unless these are accurately known, the value of the angles should be checked by calculation, especially when the angular variation is slow.

Warming sextant.

To avoid condensation of vapour on the lenses and mirrors of the sextant, it is well to warm it in the engine room before commencing work.

Working on long alignments.

Fig. 7 illustrates the application of some of the foregoing principles to a long alignment. The latter is marked on both sides of the channel, so that, over a good portion of it, it is possible to work in either direction.

From x to z, facing the marks cd, the angles are taken to pr; from z onwards the points a, b are used, from z, facing towards ab, positions can be found by using c, d, as points for observation.* The intersections are good all along the working part of the alignment.

Working to a vertical,

In certain cases the point p might be vertically under the point a, where the alignment ab is marked out on the summit of a high

* See Appendix II.

ONE ALIGNMENT AND SEXTANT ANGLE CONT?

Fig. 4.

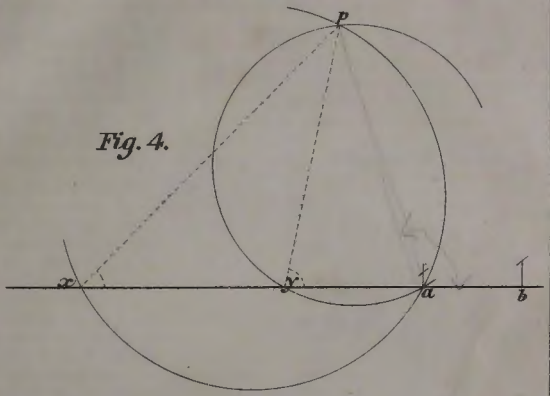
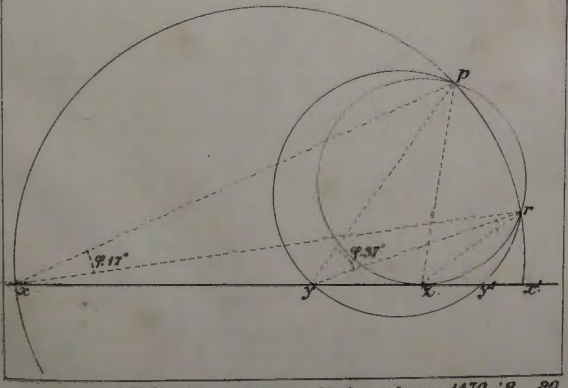


Fig. 5.



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One Alignment and Sextant Angle cont?

Fig. 6.

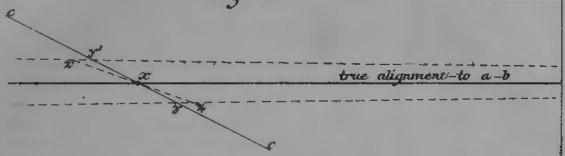
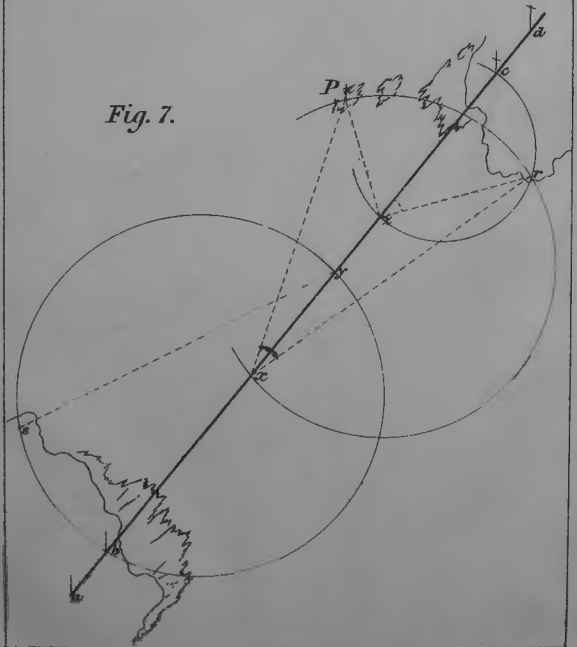


Fig. 7.



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cliff. Fair angular variation could then be obtained for a distance of 800 yards if the distance *ac* were 250 feet. instead of a horizontal base.

The advantages of this system of finding positions in a mine-field may be summed up as follows:—

(1.) It is very accurate when properly applied.

(2.) It is rapid, if the coxswain and observer are well practised in their work.

(3.) There is absence of confusion, and economy of men and material, in comparison with other methods, owing to the absence of signalling and reduction in alignment party and marks.

The positions of mines, buoys, and soundings found by this method should be plotted by position-finder when practicable, as a check on the work, and to obviate the risk of laying two mines at the same spot.

(iii.) *Actual Measurement.*

Finding positions in the mine-field by actual measurement may often be resorted to with advantage—

(1.) When the channel to be buoyed is narrow;

(2.) When good alignments cannot be obtained;

(3.) From carefully laid marks at long distance from the shore;

(4.) For very accurate work in connection with experiments;

(5.) In exceptional cases at night time.

The measurement may be made either on the surface of the water, or along the bottom.

Measurements along the surface are difficult if the intervals exceed 100 yards, and are seldom practicable at this distance if the tide is at all strong. They are easily carried out in smooth still water of small depth by running measuring lines between boats moored by three or four anchors.

A long alignment may be divided up into sections of 400 or 500 yards by large marking buoys, the positions of which are checked by independent observations, and the intermediate buoys laid by measurement along the surface from these large buoys. It is convenient to use coir or grass rope when measuring on the surface, as it does not sink, and is light to handle and to haul taut.

The following modification of the method may be used for rapidly buoying out an alignment when the positions so buoyed are at even distances apart. The laying-out steamer tows a boat after her by means of a stout tow-rope of such a length that the distance from the centre of the boat to a selected spot in the laying-out steamer is equal to the required interval between each buoyed position. The steamer, with the boat in tow, proceeds along the alignment, and drops the first buoy by observation or cross-bearing. As the boat comes abreast of this buoy, a signal is made to the laying-out steamer, and another buoy is dropped, and so on.

Care must be taken that the interval is correctly kept, as any error is multiplied by the number of buoys laid. The boat, if small, may use a sea anchor, or drag a piece of timber to keep the tow rope taut. An independent measuring line may be used

to find the proper spot on the laying-out steamer, from which to drop the buoys, after the tow rope is stretched out, and the steamer is proceeding at her normal rate of speed.

Where mines are laid in very advanced positions at considerable distance from the shore, it may often be practicable to mark the positions of the junction-boxes with some degree of accuracy, and from these positions to measure off to the mine positions of the group on compass bearings or distant landmarks.

When there is a sufficient rise and fall of tide, the most satisfactory and accurate method of laying out mines for experimental purposes is to take the measurements on the bottom at low water when the tide has receded. In most cases, this is not practicable, and then the measurements can either be made with measuring lines on the surface, or by stretching chains on the bottom. Very accurate work can be done by the latter method by sending down divers to stretch out the chains and place the mines or sinkers. Small measurements on the surface can also be very accurately made by using a framework of timber from which to suspend charges.

Well-stretched rope must be used for measuring lines, which should be of sufficient size to stand the considerable strains unavoidable in surface work without stretching or parting.

The ropes should be marked when wet, and with a good strain on them.

The errors occurring by this method are due to inaccuracy in fixing the position of the starting-point from which measurements are taken, incorrect measuring lines, and inaccuracy in keeping to the proper alignment. Where the starting-point is a buoy, or a boat hanging to a buoy, the first error may be considerable, so that it is generally advisable to take precautions, either for getting the starting-point into position by laying out one or two anchors in the proper direction, or to fix the actual position of the starting-point, at the time the strain comes on the measuring line, by means of independent observations.

The errors due to the lines should be trifling, when the measurements are made from several independent starting points.

The error in alignment may or may not be serious. If the alignment is being run for any distance by surface measurement from a point where there is no possibility of erecting marks, a buoy or boat should be moored some distance out in the proper alignment, by compass bearing taken from the starting-point.

The direction of the alignment should then be checked from each fresh starting-point. The advantages of the method of actual measurement depend on the conditions under which it is used. It is capable of giving great accuracy, and in smooth water, where the tides are not very strong, can be carried out with considerable rapidity. The disadvantages of some of the methods described, are apparent where the tides are very strong, and the water very deep. Accuracy is then impossible without a considerable expenditure of time and trouble in mooring boats and buoys. Another disadvantage of the method arises from the fact that, if buoys are removed or lost, the measurements may have to be taken all over again from the starting-point.

(iv.)—By means of the Position Finder.

In many places position-finders can be very advantageously used for the survey of mine-fields and for laying out mines.

The long range instrument will take in a semi-circular area of which the radius is 1,700 yards on a scale of $\frac{1}{3500}$, and 3,400 yards on a scale of $\frac{1}{7000}$. It will fix with sufficient accuracy any point on the surface of the water within this area, provided:— Survey of mine-field.

(*a*) The altitude of the instrument is at least 5 ft. for every 100 yards (60 ft. for 1000 yards, &c.).*

(*b*) This altitude is capable of being exactly found at any moment.

The latter condition is best fulfilled by providing one or more datum marks within the field of view of the telescope, and as far off as possible (not less than 800 yards).

These datum marks should have a water line at all states of the tide, and their distance on plan from the vertical axis of the instrument should be accurately known.

This method is preferable to using the height scale and a tide gauge, but for work at night, the latter method would generally be necessary, so that the readings of the height scale for different readings of the tide gauge should be checked and compared with results obtained from observations to the datum marks. Given these conditions, the instrument can be used to draw an accurate plan of the coast-line at high and low water, and to fix on this plan the positions of all buoys or mines laid out within its field of view. The positions of alignments can also be traced by keeping the cross hairs fixed on the water-line at the stem of a vessel proceeding along them.

From the above, it is evident, that if time were of great importance, the preliminary survey of a mine-field might be confined simply to the computation of the distance on plan between the datum mark and the centre of the instrument. The remainder of the work can be carried out by means of the instrument itself and a few measurements on shore.

As a rule, however, there will be time to carry out the survey in its entirety, and as the datum distance, to which the instrument works, is calculated from this survey, there should be no discrepancy in the plans drawn by both methods.

The following rules (Appendix II, S.M. Circular 308), have been drawn up for the use of the instrument in fixing positions in the mine-field. Finding positions.

(1.) An alignment pole is placed in the socket over the centre of the position-finder.

(2.) The pointer is moved to the position of the buoy to be laid, and the telescope is depressed *by the adjusting screw under the vertical pivot*, until the position for a front alignment can be given.

(3.) The front alignment mark is then erected. This should be 1½ inches to the right of the point seen, to allow for

* NOTE.—It is very desirable to get twice these altitudes, if possible, especially if the water is rough.

the telescope of the position-finder being that much to the left of the pivot of the instrument.

(4.) The "miner" runs in on the alignment, and the observer takes his datum and then follows the bow water-line of the vessel, and causes a flag to be waved by an assistant. The vessel should run in slowly, and as the pointer of the position-finder is just coming on the proper position, the flag is lowered, at which signal the buoy is dropped from the bow.

(5.) In cases where great accuracy is desired, it can be obtained by laying small marking buoys by this method, and tracing a small sketch of their actual and intended positions, from which the necessary corrections can be made in laying the mines or buoys. Such a tracing should have a scale, and a north point or an alignment on it, as a guide to the direction of the error.

(6.) The "miner" can lay buoys with equal accuracy running to alignments which do not pass through the observing station, in which case no alignment poles are necessary at the latter place, the moment of intersection being signalled by some instantaneous visual method.

(7.) The prolongations of alignments, courses of friendly channels, &c., can be plotted by tracing the path of a properly steered vessel with a pencil on the chart of the position-finder, and this plan will be found of great value in selecting and plotting natural alignments in the mine-field, which may materially lessen the labour of erecting artificial alignment marks.

It will be seen that these rules treat of two distinct methods of fixing positions by the aid of this instrument. The method described in the first five rules requires no alignment marks, except the two erected temporarily at the observing station. This gives great freedom in the design of the mine-field, and the mines may be echeloned and disposed in all sorts of ways, without reference to the rigorous limitations imposed by other methods of fixing positions.

The accuracy and speed of this method will depend a good deal on the possibility of giving the mobring-steamer a sufficiently good alignment to work on. This should be taken into consideration in selecting the site of the observing station. If there is not room in front of the instrument to get a good enough base, the mine mark may be put up behind the instrument, in which case special arrangements will have to be made for "laying back" to its proper position. It will probably be possible, in most cases, to align a front mark as described in Rule 3, and on this and the central mark a back pole of sufficient size, and at a sufficient distance, can be aligned.

In some cases it may be desirable to put up an instrument merely for the survey and buoying of the mine-field by this method, in which case the consideration of the adequacy of the alignment bases would become of importance in selecting the site.

If the base or distance between the alignment marks is so short

that the mooring-steamer has a difficulty in keeping to the true alignment, the flag for signalling the proper moment for dropping the mine or buoy may also be used to show the vessel which way to steer; thus, when the flag is held upright, the vessel is on the alignment; if the vessel is off it, the flag is sloped to a corresponding degree to the side towards which she must steer, and is brought upright as the vessel comes back again on the line. This method is also applicable in other cases where the alignment is long and the base short, and a theodolite or firing arc can be used instead of the position-finder, in which case the position of the mine *on the alignment* is ascertained by other means.

One great advantage of this method is, that all errors in laying* are immediately known, both in magnitude and direction, and the necessary corrections can be made at once.

For very rapid work, when time is of great importance, the positions of junction-boxes might be found by this method, the mines being laid by actual measurement, or by eye, round the junction-box boat.

The second method, indicated in Rule 6, is simply a modification of the cross-alignment method, but is not liable to its errors, as these are instantly detected on the chart of the position-finder.

(v.) *Fixing Unknown Positions by Two or more Sextant Angles and Station Pointer.*

The following method is not applicable for finding predetermined positions in the mine-field; but, given a few prominent marks, the positions of which are known on plan, the relative positions of a great number of other points, either on land or sea, can be rapidly found with very fair accuracy by means of this method, if it is rightly applied. Not applicable to finding pre-determined positions.

To fix the position of a large number of soundings taken over an extensive area, by any of the methods already described, involves a number of skilled assistants, or the marking out of many carefully surveyed alignments, or the erection of position-finders, &c. The method under consideration may therefore be of great use in certain cases for making a rapid series of preliminary soundings, when time is of great importance, or where skilled observers, or theodolites are not available. If single sextants only are available, it is well to have two observers taking simultaneous observations. If there is only one observer, he should be provided, either with two single sextants, or a double sextant. May be very useful in special cases.

The method of procedure is to measure at any point the angles subtended by three or more fixed objects, the positions of which on plan are accurately known. If the observations are taken from a boat she should be stationary while the observations are being taken, unless the latter are taken simultaneously, or great accuracy is not required. Increased speed and accuracy will, of course, be obtained by having two or more observers at work at the same time. As a general rule in such operations, soundings would be taken at the same time as the sextant observations. Method of procedure.

* *E.g.*—Laying two mines in the same place!

Plotting the position.

The positions of the various points from which observations are taken can be plotted in three ways:—

(i.) By describing geometrically the segments of the circles, containing the observed angles, passing through the fixed points and intersecting at the unknown position.

(ii.) By laying off the angles on tracing paper, which is moved about on the plan, until the lines containing the angles pass through the fixed points.

(iii.) By means of the "station-pointer," an instrument specially designed for this purpose. (*See* Appendix—Sextant and Station-pointer.)

The accuracy of this method of fixing positions depends on the following considerations:—

Any errors, either in the original observation of the angles or in setting them off on the station-pointer, or in the position of the objects observed to, or in the plan, may pass undetected. It is therefore desirable to take a third angle to a fourth object, which can be used as a check on the positions obtained by the other two angles. By doing this, three combinations of angles can be used, and a close approximation to the true position should be obtained.

It may be, that though no error has been made in the observation, and the chart is quite accurate, the third angle, laid off from the plotted position obtained from the first two angles, will not pass through the fourth object; this will arise from improper selection of the first three objects, a subject of great importance, and one in which there is, at first, great liability to make mistakes.

An examination of figs. 1–7, Plates XI, XII, will show the effect of different positions of the observed objects on the accuracy of the method.

In fig. 1 the observer x is situated on the circle that passes through all three objects, A, B, C, therefore x may be anywhere on the segment of the circle AxC.

Figs. 2 and 3, in which the circles cut each other at very acute angles, are examples of "bad fixes." It is evident that in these cases an observation to a fourth object, such as D, fig. 1, would have solved the difficulty.

To avoid "bad fixes," avoid choosing objects of which the centre one is the most distant.

Good results will be obtained—

(*a.*) When the observer is inside the triangle formed by the three objects, but sometimes the angles may be awkwardly large for observation (fig. 4).

(*b.*) When the observer is outside, if—

(1.) The centre object is nearer than either both or one of the others, and each angle is not less than 40° (fig. 5);

(2.) The three objects are nearly equidistant from the observer and each angle is not less than 70° (fig. 7);

(3.) One angle is small and the other large, provided always that in the smaller angle the outer object is much more distant than the centre one (fig. 6).

A good and practical rule, when under way, is, that either one

TWO SEXTANT ANGLES AND STATION POINTER.

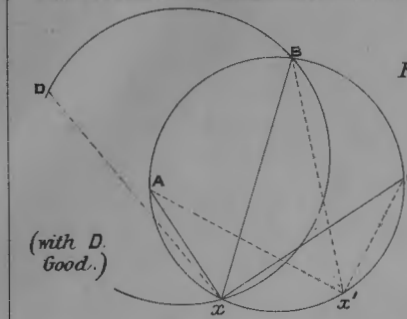


Fig. 1.

Useless

(with D. Good.)

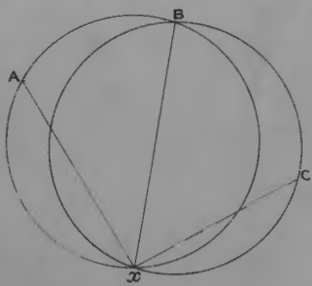
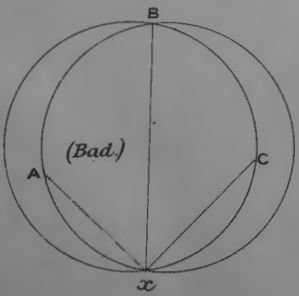


Fig. 2.
(Bad.)

Fig. 3.



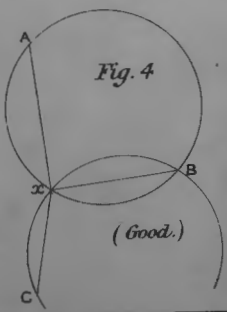


Fig. 4

(Good.)

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Two Sextant angles and Station Pointer cont?

Fig. 5.

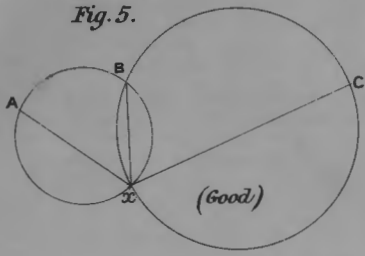


Fig. 6.

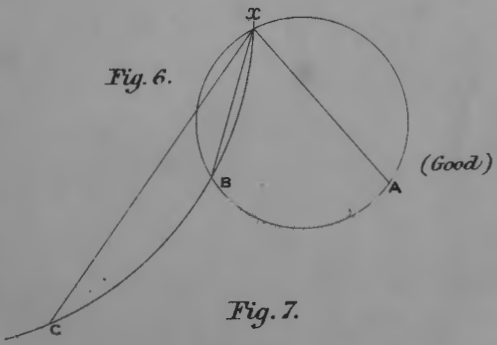
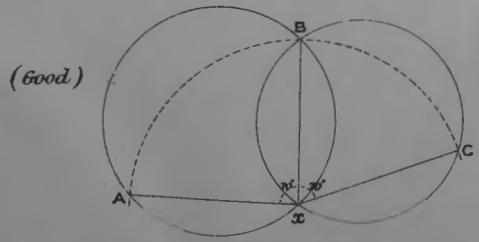


Fig. 7.



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of the angles should be altering very rapidly, or that both should be altering moderately rapidly. This should always be borne in mind when using the same points for several consecutive observations, as a change of position may have brought the observer nearer and nearer to the circumference of the circle containing all the points. The moment the centre object becomes the furthest, the "fix" is to be avoided.

(NOTE.—Extracted from Admiralty Memorandum on "Use of Station-pointer," 1886).

For these reasons it is well to have several points to observe to, and to select the most suitable points for fixing positions in different areas of the field, before going out to work.

(vi.) *Laying out Marking Buoys.*

Laying out marking buoys can be done much more easily, quickly, and accurately, than laying out mines when marking buoys have not previously been laid, owing to their being so easily let go, and to the fact that there is no cable to take to a junction-box afterwards.

For this reason, it is sometimes desirable to lay marking buoys before laying mines, especially where the mines are moored at close intervals. The errors in laying the former can be estimated, either by position-finder or in the mine-field, and allowed for in laying the mine. The sinkers used for marking buoys should only be sufficiently heavy to keep the buoy from shifting. The buoy-lines should have as little slack as possible, so that they may ride nearly over the sinker. If the buoys are intended to remain out for some time, stronger and heavier gear will be required than if they are merely laid out and taken up again the same day. It is a great convenience to be able to weigh marking buoys in row-boats, and, for this purpose, the gear should be as light as possible. 56 lb. weights and half hundredweight sinkers are issued for this purpose, one or more being used as required, and for strong tides mushroom sinkers of 1¾ cwt. The marking buoys in the Service are described in Part I.

When marking buoys or mines are being laid by any system which involves a visual signal made from shore, an appreciable delay occurs in giving the command and in letting go. With mines this delay has been found to be from 1½ to 2 seconds, so that for great accuracy of work the mine or buoy should be a corresponding distance astern of the part of the vessel observed If the stem, water-line is observed, the sinker should be about 15 feet or 20 feet from the bow.

When working on cross alignments, or by sextant angle and one alignment, the Officer or N. C. O. giving the order to let go, should be about 6 feet forward of the sinker.*

Sounding.

Soundings should be taken at the position of every mine and junction-box in the mine-field, in addition to any other soundings which may be necessary for the correction of old charts or the

*NOTE.—This direction applies to cases where great accuracy is required.

verification of the depths in "friendly channel." These soundings should be taken at least twice, preferably near high and low water, when the tide is slack, and if the results, when reduced to zero of the tide gauge (the level of high water at ordinary spring tides) agree fairly well, the mean may be taken as the correct depth.

The position of each sounding is found by one of the methods already described. In some cases it may be found convenient to sound without laying marking buoys; in others it may be more convenient and quicker to lay out marking buoys first, and sound afterwards. Two boats working together can do very rapid work in this way, one laying buoys and the other sounding.

By laying a buoy before, or at the time of sounding, it is very easy to check by the position-finder, or other means, the accuracy of the work, and to record the true position of each sounding as actually taken.

If no position-finder be available for this purpose, the positions of the buoys can be verified by observations from the shore with theodolite and plane table, or by sextant observations taken from the buoys themselves to suitable marks on shore. In each case the buoy lines should be hove in taut over the bows of a boat, so that they are fair up and down. Care must be taken to use a sinker that will not drag, or to drop the boat's anchor up-stream to take most of the strain. When this is done, the boat can be sheered over the buoy by keeping the anchor warp over the port or starboard bow, as the case may be, using the rudder at the same time.

Such accuracy as this will, however, only be necessary where the depth of water changes very rapidly. Where observations are taken from several points on shore, it will be necessary to arrange simple flag signals, so that simultaneous observations may be taken at the moment the buoy line is fair up and down. Calm water is necessary for accurate work of this kind. This may often be obtained in the early morning.

Sounding lead.

The weight of the sounding lead used must depend upon the depth and velocity of the tide; it would be better, in any case, not to use a lighter lead than one of 9 or 10 lb., and this weight will be effective in currents not exceeding 2 knots, and depths of not more than 14 fathoms. For currents of 2 or 3 knots and depth of 14 fathoms a lead of 14 or 15 lb., and for currents of 5 knots, with depths of 20 fathoms, a lead of 28 lb. weight will be required. If possible, soundings should be taken at slack tide.

Lead line.

Great care must be taken in the preparation and marking of the lead line. It will be advantageous if a line that has already been in use a short time can be procured and re-marked, but if new line has to be used, it should be well stretched and wetted, and allowed to dry again, these operations being repeated two or three times, until the newness is, to a certain extent, got out of the line; the marks should then be put on when the line is thoroughly wet, and if it is always well soaked before commencing sounding its length will be found not to vary very much; while sounding, it should, however, be constantly checked by means of fathoms marked by copper nails driven along the length

of the deck of the surveying vessel, and the necessary corrections made in the soundings taken.

The recognised marks for the hand lead line are as follows:— Marks on the lead line.

2 fathoms, leather, with two ends;
3 ,, ,, ,, three ends;
5 ,, white calico;
7 ,, red bunting;
10 ,, leather, with a hole in it;
13 ,, blue serge;
15 ,, white calico;
17 ,, red bunting;
20 ,, strand, with two knots in it.

1, 4, 6, 8, 9, 11, 12, 14, 16, 18, and 19 fathoms should be marked by pieces of leather, on which the number of fathoms should be stamped, and every foot between each fathom should be marked by a smaller piece of leather.

When the depth of water is known within reasonable limits, it is not necessary to use the Service lead line marked in fathoms and feet. A piece of well-knotched line is wetted and measured off to a convenient mean depth in round numbers of feet, say at 40 ft. from the lead. The defect or excess in the sounding is then measured off by means of a measuring rod, or a scale of feet marked with copper tacks on the gunwale. Another method.

This gives the depth at once in feet.

The precautions necessary in checking this line are, of course, the same as with the Service line.

Where the depth of water is under three fathoms, and very accurate work is required, as in deepening a channel, a sounding rod, marked in feet and inches, and weighted at one end, is preferable to a lead line. Sounding rods.

It is difficult to sound very accurately in the ordinary manner in strong tides and deep water. The best course to pursue under these circumstances is to bring the surveying vessel to a dead stop, 30 or 40 yards above the position of the sounding, and to allow her to drift over it with the lead hanging right down, nearly to the bottom. As the vessel reaches the position the line is allowed to run out, and the sounding is taken as accurately as in a still pond. This principle is also applicable to laying out mines under similar circumstances. Sounding in swift currents.

The following is a convenient form in which to record soundings. It can be ruled off in a note book and the results copied into a record book afterwards. Sounding book.

No. of Sounding.	Position.	Time.	Sounding.	Tide Gauge.	Sounding reduced to M.H.W.S.	Remarks.
		H. M.	ft. in.	ft. in.	ft. in.	
1	Mine 21	3 17	42 6	7 6	50 0	
2	F. J. B.	3 24	41 3	7 9	49 0	
3						

Name.
Rank.
Date.

Tide gauge.

If a tide gauge has not previously existed at the station, one must be constructed and fixed, reading downwards from high water mark of ordinary spring tides, which will be the O of the tide gauge. The best way of fixing the level of the O will be to observe, as often as possible, the height to which the tides rise on the days near each new and full moon, taking note of the direction and force of the wind, and attendant circumstances on each occasion; these observations may be made while the preliminary survey work on shore is being carried out, and, by means of them, a fair estimate can be formed of the level to which an ordinary spring tide will rise. This method will often be found preferable to taking a datum from a chart or similar source. The tide gauge should be marked with figures cut out of sheet copper, 6 in. high, the centre of the figure corresponding with the reading to which it refers. See Plate VI.

When soundings are going on, a man is stationed at the tide gauge, to record the readings at short intervals of time, (say every ten minutes). His watch must agree with that used in the mine-field. A curve can be plotted from these data, showing the reading of the gauge at any moment, and from this the mine-field soundings are reduced to zero of the tide gauge.

CHAPTER IV.

LAYING LAND, SHORE-END, AND MULTIPLE CABLES.

CONTENTS.

Land cables often desirable where test-rooms are some distance from the shore.—Connecting pits generally required where shore-end cable is used.—Spare cores in land and shore-end cables.—Seldom desirable to carry the mine-field cables into the test-room without a break.—Spare cores to be provided in such cables.—Identification of cores and cables.—Cable trench.—Connecting pits to be placed in a safe position, and well concealed, covered by rifle-fire; diagrams of connections of cores to be prepared.—Cables to be well concealed between high and low water.—Cable cuts.—Use of shore-end cable, it should run out to four fathoms at low water.—Landing shore-end cable.—Treatment of outer ends.—Anchoring connecting-boxes.

Multiple cables may sometimes be laid out permanently.—Arrangements to be perfected for getting cables quickly out of tanks.—Laying from drums and from cable-lighter.—Weight of drums and cables.—Laying over bow and stern.—Brakes.—Stoppers.—Laying two cables at same time.—Buoying track of cables.—Alignments.—Charting position of cables as laid.—Slack.—Laying from and to the shore.—Laying from the coil.

Land and Shore-end Cables.

Where test-rooms and observing stations are at some distance from the shore, it is generally advisable to lay down land cables to a connecting pit constructed in a safe sheltered position close to the water. These cables should contain about 30 per cent. more cores than are actually required for the service of the mine-field, to allow for casualties and the use of additional mines.

In some cases the connecting pit may be unnecessary, the land cables being carried on without a break to connecting or junction-boxes securely anchored a short distance from the shore.

Where shore-end cable is used, it will be necessary, as a rule, to bring the inner ends to a connecting pit, in which the joints with the land cables are made. These shore-ends should contain the same number of cores as the land cables, *minus* those required for "earths."

In few cases will it be possible or desirable to carry the mine-field main cables into the test-room without a break, although at first sight it might appear to be the best arrangement.

In few places is it possible to lay out the main cables permanently, therefore it is desirable to take steps for shortening this operation as much as possible by laying down the land cables as far as they will go, *i.e.*, either to a connecting pit close to the water's edge, or out a short distance into deep water. Local conditions will determine which of these courses to adopt; where the water is deep close inshore and there is not much difficulty in landing in all weathers, and the foreshore is not exposed for a long distance between high and low water, it will often be desirable to terminate the land cables at a connecting pit above high-water mark, and this mode of procedure will save an insulated joint in every core. On the other hand, where there is a difficulty in landing, or the foreshore dries for a good distance between high and low water, it is best to carry the land cables out to a point where the laying-out steamer can bring the ends of the main cables at all states of the tide. The cables must in either case be securely trenched, or covered, down to low water mark, spring tides. In ordinary soil the cables should be buried 5 feet deep: this can be done carefully in peace time, and affords another reason for the statement that it is generally inadvisable to carry in the main cables to the test-room without a break. It is also evident, that where the land cables are buried at such a depth, it is necessary to provide a large percentage of spare cores to provide for casualties, and to avoid having to open up the trench to lay new cables. In those cases where it is feasible to run the main cables into the test-room without a break, one spare core at least should, if possible, be left in each multiple cable, to provide for casualties or possible additions to the defences. It is presumed that in such cases there will only be a small amount of trenching required, so that extra cables can be quickly laid; but at the same time it is of the greatest importance to leave a spare core available in every multiple junction-box.

Identification of cores.

In those cases where the main cables are made up of two or more sections, some of which are laid down permanently, the numbering of the cores, as figured on the terminal battens of the test-rooms, should be adhered to up to the point where the mine-field cables are joined on; *i.e.*, to the connecting pits on shore, or the connecting boxes in deep water. The terminal battens, therefore, must have terminals for the spare cores in the land cables; these, and their "shore-end" extensions also, which contain the same total of cores *minus* "earths," are identified by the numbers of the cores they contain, as figured on the terminal batten in the test-room. This method of identification is necessitated by the fact that all sorts and descriptions of cables may be used for the land connections, and also by the fact of there being a number of spare cores used, which allows of a change of connection being made at the connecting pit, in the event of a core of the land cable going bad.

Cable trench.

The cable trench should be as little exposed to hostile fire as

possible, a circuitous route to the shore being followed if necessary to obtain cover. In ordinary soil the trenches should be 5 feet deep, unless complete protection is given by the features of the ground. In hard rocky ground the trench should be at least 18 inches deep.

Connecting pits.

The connecting pits already referred to should be placed in a very safe position near high water, and should be suitably covered with an iron door, the whole being concealed where not under fire. The pit and landing place of the cables should be well covered by rifle and machine-gun fire at close range. The pit should be of good size, and should be so arranged that there may be no difficulty or confusion in making the electrical joints between the cables. Clear diagrams of the connections should be made, and the labelling of the cores must be very clear and distinct.

The concealment of the cables between high and low water mark must be carefully attended to; where the shore is rocky the cables may often be placed in natural fissures, or channels may be cut for them, the cables being afterwards concreted in, or covered with large boulders.

Cable cuts.

Cables have sometimes to be led straight into a work from deep water. In these cases the cable cut, or tunnel, should emerge just below low-water springs, and in the least exposed situation; an outlet or shaft must be provided to carry off the compressed air in the cut, due to the rise of tide and surge of the waves, otherwise the damp salt air will most probably be driven into the test-room. Where shore-end cable is led ashore in this manner, care must be taken to avoid sharp turns and narrow passages, and ring bolts must be provided in suitable places for hooking on tackles for hauling it along. A chain should be kept passed through the cable, out for the purpose of hauling cable-ends in or out.

Use of shore end cable.

Shore-end cable is sometimes required in rocky and exposed situations, and especially on shingle beaches, where the action of the waves soon destroys the armouring of lighter forms of cable. The connecting boxes at the outer ends should be in four fathoms of water at low tide. The use of "shore-end" may often allow of a much shorter route being taken to the mine-field, and thus save a great deal of cable and undue resistance in the firing circuit. This cable weighs about 13 tons per knot in air, or 13 cwt. per hundred yards.

Landing shore-end cable.

The landing of this cable may be easily effected in the following manner:—The position of the outer end of the cable having been previously buoyed, the mooring steamer or lighter is anchored or moored so that she will lie over the position of the buoy. A stout warp is passed ashore and stretched taut. The shore-end cable is then passed ashore by means of cutters and pinnaces, which are hauled along the warp stretched from the steamer to the shore. Each boat takes in about 30 or 40 yards of cable, which is not paid out until the last boat has stretched the cable from the laying-out steamer, when each boat in succession, counting from the steamer, stretches out her portion. The slack in the last boat is hauled up by a party on shore, and at low water the cable is buried. If the length is short, it is well

to carry out the operation at high water; if it is long, it may be better to do it at low water, with a strong working party on shore to walk the cable up the beach and lay it in its proper position, and cover it up.

Treatment of outer and of shore-end cables.

It is necessary to make careful arrangements, so that the connecting or junction-boxes at the outer ends of shore-end and short multiple cables shall be easily got at, and also, especially where there are a great number of cores, that the cables do not get mixed up and foul of each other. Such cables are very apt to get silted up, and if they get foul as well, will be very difficult to raise and renew. The outer ends, therefore, must be well separated, and must be raised from time to time to prevent their getting silted over.

The conditions under which these ends are laid out vary considerably. In some cases the junction of the mine-field cables may be made at the end of a pier or mole, the boxes being raised by means of tripping lines or chains made fast to the pier head. In other cases, the ends of the shore-end cable must be securely anchored in deep water, so that the multiple cables can be joined on at any moment.

In the latter case it may sometimes be convenient to have short lengths of ordinary seven-core cable attached to the ends of the shore-end cable for convenience in raising. This may often be necessary where, as in some cases, some of the group cables start at once from the ends of the shore-ends. The connecting or multiple junction-boxes at the outer ends of such cables should be anchored by chains to sinkers moored 20 or 30 yards apart, the positions of these sinkers being found by actual measurement or cross-alignments. It will generally be inconvenient to buoy each cable-end, in which case the tripping lines for each box may be led to a large, centrally-moored buoy, or the boxes may all be connected together by a chain made fast to sinkers at either end of the line of boxes, this chain being raised either by grappling or by means of a tripping-line led ashore to a fastening above high-water mark, or to a buoy at one end of the line (*see* Plate XIII). Chain pennants should be led from the connecting boxes to the long chain (*see* Plate XIII, fig. 2), so that any one of them may be raised without disturbing the others. In either case each shore-end or group of shore-ends is provided with a sinker and anchor-chain capable of mooring the junction-box boat when in use.

Where there is a liability to movement of silt or shingle, the boxes should be periodically raised to prevent their getting buried. Special steps will have to be taken to prevent vessels anchoring over these cables.

Laying out Multiple Cables.

Multiple cables may, in some cases, be kept laid out permanently. This will not be possible, however, where they pass through recognised anchorages, and in this case it is necessary that every arrangement should be perfected for getting the cables transferred from their place of storage in the tanks or ponds on board the laying-out vessels in the least possible time.

ARRANGEMENT OF "SHORE ENDS" OF CABLE.

Fig. 1.

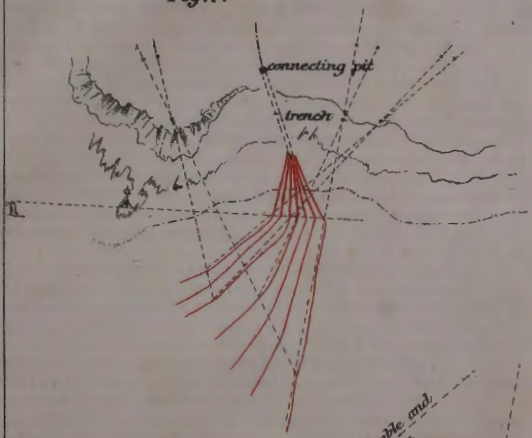
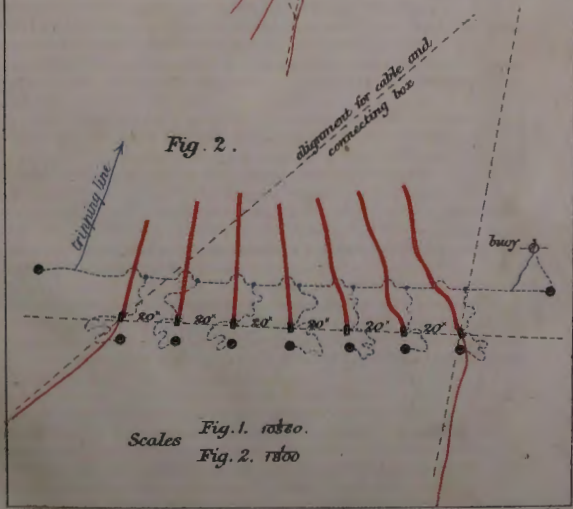


Fig. 2.



Scales *Fig. 1.* 1/2520.
Fig. 2. 1/600

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The operation of coiling cables out of tanks on to drums is a tedious one, and where the tank or pond accommodation is limited, it is almost impossible to exceed a certain rate of work, although it is one of the operations that can be carried on at night. Multiple cables are generally laid from drums, especially when they are at all worn. New cable that has never been on a drum is often laid, even in long lengths, from a carefully-made coil, a snatch-block being suspended over the centre of it, through which the cable runs out clear. Battens should be placed between each layer of the coils. The cable may be coiled in a launch or lighter towed alongside, or on the laying-out steamer's deck.

The large iron drum (Part I., plate LXI.) takes 1,000 yards of multiple cable, and any excess can be laid from a coil which is paid out first.

Where the large wooden drums are available, it is easier and better to lay multiple cables, 1,100 to 2,100 yards in length, from them, and not to make a joint. If the iron drums only are available, it may be necessary, in the case of long cables, to use two drums, and make a joint when half way.

Cable tanks on board a lighter.

A method of laying multiple cables straight from tanks constructed in a lighter is now under trial. In this case the cable will pass from the coils through a snatch-block suspended over the centre of the tank.

The drums and their stands may be mounted on trucks, and, when the cables are wound on, run down to the pier for embarkation in the steamer. The weights to be lifted by the cranes can be roughly approximated from the following table:—

Nature of Drum.	Drum.	Stand.	Cable-weight per 100 yards.		
			S.A.	4-core a.	7-core a.
	cwt.	cwt.	cwt.	cwt.	cwt.
Iron, horizontal { large...	10	5			
Iron, horizontal { small ...	3	2	1¼*	2½	4
Wooden, horizontal { large...	13	8½			
Wooden, horizontal { small ...	8½	6			

Multiple cables may be laid out from drums over the bows or over the stern.

The method adopted will depend chiefly on the arrangement of the deck space of the laying-out vessel, and the number of cable drums on board.

In no case should the cable drum be placed right in the stern of the vessel. If it cannot be placed about 20 feet from the taffrail, it can be placed forward of the funnel, even when the cable is paid out over the stern. In this case the cable should be led down the side over which it will naturally tend to pay out when laying across a tideway.

The cable should lead from the top of the drum, and this must

* Circuit closer cable about 2½ cwt. per 100 yards.

be seen to when putting the drum into its stand. The latter must be securely lashed down or shored up, and must be so fixed that the brakeman faces in the direction the cable pays out.

Brakes. The brake of the drum must be looked to before starting, and a handspike or hauk of timber should be kept handy for applying as a brake under the rim of one of the end plates, if necessary. This forms a very efficient brake for the large wooden drums, which are unprovided with strap brakes.

Stoppers. A stopper should be kept ready to make fast the cable, in case it is necessary to stop or change direction.

If a turn has to be made while laying, the engines should be slowed and some slack paid out to enable the vessel to turn easily and quickly. The slack can then be hauled taut when the turn is made by keeping a stopper on the brakes on. If the cable appears to be running out too fast, the brake must be applied, and if the steamer has not made a turn sharp enough, so that there is a danger of the cable not reaching the desired spot, the engines should be slowed down and a stopper applied to the cable, so that some of the slack lost in the turn may be pulled across the corner.

Any strain of this nature tends to slew the laying-out vessel, and makes it hard to steer her properly, so that where sharp turns have to be made in a tideway, the cable must be humoured to suit the turning powers of the steamer.

Where the tide is not very strong, the cable may be led through one of the roller fair leads, or over the bow goggle. There is then less danger of fouling the screw.

Laying two cables at once. Two main cables leading for a good distance in the same direction may be laid out at the same time, if tide and sea are favourable, by towing a lighter or launch alongside, one cable being paid out from each vessel.

The shorter cable should be placed in the towed vessel, which is anchored at the spot where the cables diverge. This plan ensures these two cables coming up quite clear, but is not suitable in a strong tide, or when there is any sea or roll on.

Buoying track of cables. Where there are many multiple cables running for a considerable distance together, and also where turns have to be made, it is desirable to lay out buoys at the turns, and also in the direction which the cables should take, so that they may not be laid on top of one another.

Alignments for cables. It is also advisable in many cases to put up alignment poles marking the directions in which the main cables should be laid, for some distance from the shore.

Charting position of cables. In every laying-out steamer, a record of the order in which cables are laid should be kept, and also a position-finder chart of the actual courses of the cables as laid, so that in case of a "cross" or foul in under-running, the cables may be recognised without difficulty.

Slack. The amount of slack required in main cables will differ in accordance with local conditions and the method of laying out. In strong tides and deep water more slack is required than where the tides are weak and the water shoal. Again, cables laid from drums require less slack than those laid from coils, and

the proportion of slack in short should be greater than in long cables.

The following formula should provide sufficient slack in most cases :—

Let m = measured distance on plan,

$$\text{Length required} = m + \frac{m}{x} + 50 \text{ yards.}$$

For swift currents and deep water $x = 20$.

For weak currents and shoal water $x = 40$.

The following table gives the lengths of cables worked out by different rules :—

Measured Distance on Plan.	Swift Tides.	Weak Tides.	Old Rule, M. D. $m + \frac{m}{10} + 20$.
3000	3200	3125	3320
2000	2150	2100	2220
1000	1100	1075	1120
500	575	562	570

Laying from, and to, the shore.

When laying cables from the junction-box inwards, the slack cable remaining over will have to be put overboard just where all the cables converge together, and if there are many cables, this may cause fouling and trouble. This slack will not be inconvenient if the cable is landed, but in those cases where it is joined on to permanent cables and shore-ends, the question of its disposal in the best way must be considered.

If it is inconvenient to have all the slack near the shore, it is still more so to have it all at the junction-box, but in the latter case it is possible to dispose of the slack a little distance from the junction-box.

The slack cable remaining over should not be cut off, as the cable may be required in another position. When laying from the junction-box inwards, (which is the preferable method in strong tides and deep water), the sinker is first laid in its accurate position, and the boat is made fast to it. It is advisable that this boat's anchor should also be laid out in a direction in prolongation of the main cable, so that the boat and sinker may not be dragged out of position by the strain on the main cable at starting.

A 5-cwt. sinker may sometimes be required on the main cable, 80 yards from the junction-box. This length of 80 yards is slung over the side of the vessel in 3 coils, consisting of about 7 turns each, and the sinker (lashed to the cable by 1-inch rope passed through all the lugs) is slung with a lowering line in the ordinary manner. The laying-out steamer passes the junction-box and end of cable into the boat, and proceeds to stretch out the 80 yards of cable in the proper direction, taking care not to drag the boat out of position in the operation.

The sinker is lowered out, and let go at the proper moment, and the vessel steams on her course.

On arriving near the shore, the steamer anchors, and disposes of the surplus cable by making it up into a neat coil, which is lowered overboard without stops. If the cable is to be landed,

of course this is unnecessary. In the latter case the steamer gets as close in as possible before anchoring, and the cable end is passed ashore in boats, as described for shore-end cable. A warp, passed from the steamer to the shore, much facilitates the operation.

If the cable has to be connected to a previously laid shore-end or short length of multiple cable, a second junction-box boat will be required.

The boat at the outer end of the cable may be dispensed with sometimes, but great care will then be required not to drag the box out of position.

Laying outwards.

If the cable is laid outwards from the shore to junction-box, the slack cable not used up should be disposed of before the sinker on the main cable (if used) is let go.

It may be desirable, in this case, to lay a marking buoy by actual measurement for this sinker, especially if the cable makes a sharp turn at the spot.

When laying multiple cables across a strong tide, they should always be paid out from drums, and the laying-out vessel should go at a good speed. She should keep well on the up-stream side of her proper course, as the cables get carried away very much by the current, especially if the water is deep.

Laying from the coil.

When multiple cable is laid from the coil, it is desirable to coil it down carefully on the laying-out vessel's deck, and not to hoist a previously made coil on board. A good clear deck is required.

With short lengths, the coils may be thrown overboard by hand by a detachment placed round the outside of the coil. The speed of the vessel should not exceed three knots. The detachment for this work should consist of old practised hands, for on them will largely depend the successful laying of the cable without fouls or kinks. Cables laid from coils require more slack than those laid from drums. It is well, therefore, to stopper the cable from time to time, and tauten it out along the bottom if there is any fear of its not lasting out. Inexperienced men are apt to throw the coils overboard with great freedom, and use up much more cable than is required.

Various methods of mooring dormant junction-box buoys over the outer ends of permanently laid main cables are being tried. Those giving the most satisfactory results are described under "Junction-box Moorings."

To face p. 55.

JUNCTION BOX MOORINGS.

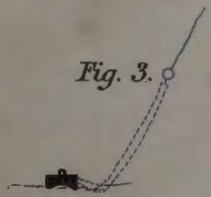


Fig. 3.

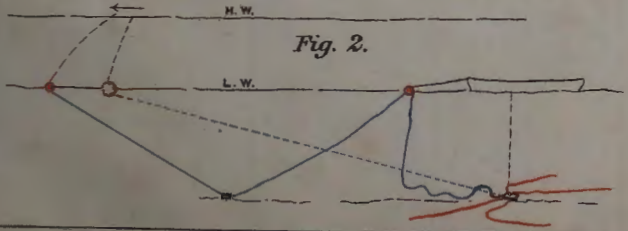


Fig. 2.

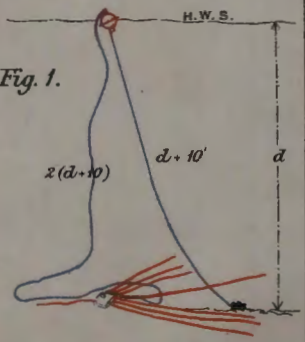


Fig. 1.

Judd & Co. Lith. 73 & 75, Farringdon Rd & Doctors Commons 1470. 8. 90

CHAPTER V.

JUNCTION-BOX MOORINGS.

CONTENTS.

Junction-boxes are generally buoyed in peace time.—Buoys must be removed in war.—Dormant buoys may be used for main cables.

Two Methods of Mooring Junction-boxes in Use.—Description of the two methods, with directions respecting moorings, buoys, &c.—Experience must determine which method is most suitable at different stations.

Mooring the Junction-box Boat.—Precautions necessary in strong tides.—Boat to be allowed to ride in natural position.—Use of cables in keeping position.—Use of "stream" mooring in deep water.—Sinkers on main cable sometimes desirable. Lowering the box overboard.—Raising the box.—Sailing and "mobile" junction-box boats.

Dormant Junction-box Buoys.

Junction-box Boat's Crews.—Stores.—Duties.—Management of boat.—Safety of crew.

Junction-box Moorings.

Junction-box moorings serve the double purpose of anchoring the end of the main or group cable with its junction-box, and of mooring the junction-box boat when the box is raised for the purpose of connecting cables or testing mines.

During peace operations the junction-box is generally buoyed, in order that it may be raised when desired. When the mines are all laid out, however, buoys are not required, nor are they allowable in time of war, as they show unmistakeably the position of the mine groups. When the buoys are removed the boxes can be raised by grappling, or under-running, the main or group cables; dormant junction-box buoys may be used, especially in connection with permanently laid main cables, as described later on in this chapter.

There are two descriptions of junction-box moorings in use. Two methods of mooring junction-boxes.

In the first method (see Plate XIV, fig. 1), the buoy is attached by a wire mooring-line to a sinker, and a second line is led from the top of the buoy to the junction-box. The boat rides to the buoy and raises the box by means of the tripping-line.

This method necessitates a large buoy of sufficient buoyancy to support two wire rope lines in all tides and weathers. In rough water, a buoy of this description strains and jerks at the sinker very much, so that, if damage to the moorings is anticipated, it is desirable to introduce a length of heavy chain between the sinker and mooring-line (fig. 3), to deaden the jerking action both to the buoy and boat. In strong tides the two lines are apt to twist up and foul, and, where the rise and fall of tide is fairly large, there is some danger of the buoy riding to the box instead of to the sinker, unless care is taken to lower the box near the latter (*see* Plate XIV, fig. 2).

If the buoy is removed, the top of the mooring-line should be attached to the box, and the top of the box-line should be stopped to the main cable as far back as it will reach, after the manner of a tripping-chain.

Length of mooring and box-lines.

The box-line is usually twice the length of the mooring-line to ensure the buoy always riding to the sinker; but even this length would not be enough if the box were lowered under the faulty conditions shown in Plate XIV, fig. 2. The mooring-line should evidently be as short as possible—10′ longer than the depth at H.W.S. should generally be sufficient.

Another method.

The second description of mooring is illustrated in Plate XV. Here the buoy is as light as possible. It is attached by means of a coir, or other light, strong line, to a tripping-chain, by means of which the weight of the box and cables is raised. The box is attached to a sinker by another chain called the mooring-chain, which serves to moor the boat when the box is raised.

The buoy used may be light and inexpensive. It has merely to support the weight of the buoy-line, which is practically negligible if of coir rope. Any sort of buoy may be used provided it is watertight and has sufficient buoyancy.* Small wooden breakers, like those used for yachts' moorings, oil drums, and wooden buoys have given good results.

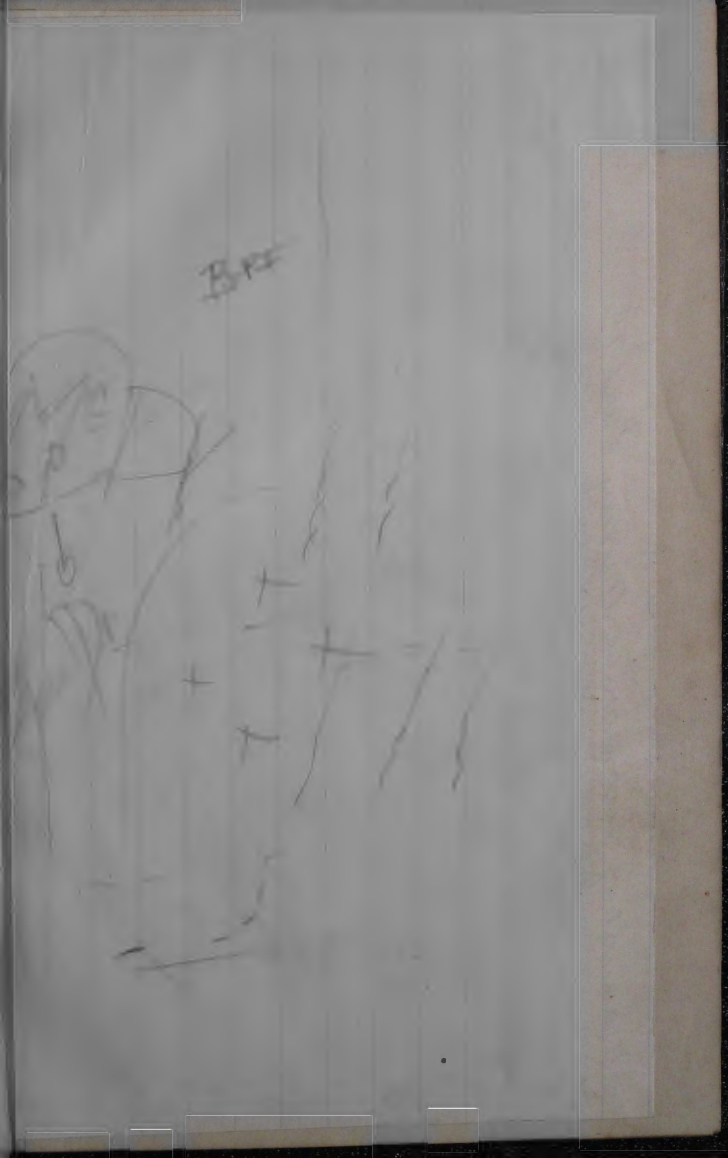
In very strong tides and deep water it may be necessary to use two buoys, or even a large buoy and a wire rope tripping-line. If the buoy used is too large and heavy to pick up and put in the boat a slack bight of the buoy-line should be made fast to the top of the buoy to catch hold of. The lower end of the bight should be made fast about 10 feet down the buoy-rope, so that the latter may be hauled in without having to lift the buoy. The long piece of tripping-chain between the buoy-line and box obviates any chance of damage to the box and cables from the straining and jerking of the buoy.

The buoy-line should be 10 feet, and the tripping-chain 20 to 30 feet longer than the depth at H.W.S. The length of the mooring chain should be equal to $\frac{1}{3}$d.

In this description of mooring there is nothing to foul if the box is lowered carefully, and not thrown overboard.

When the buoy is removed the buoy-line should be taken away

* NOTE.—Where the bottom is rocky, the buoy-lines of coir rope may be cut equal to the depth at low water, so that the buoy will have to support the weight of some of the chain at high water.



Defence Office
11/11/98
98/32

Submarine Mining Circular No 48.

Junction Box Moorings.

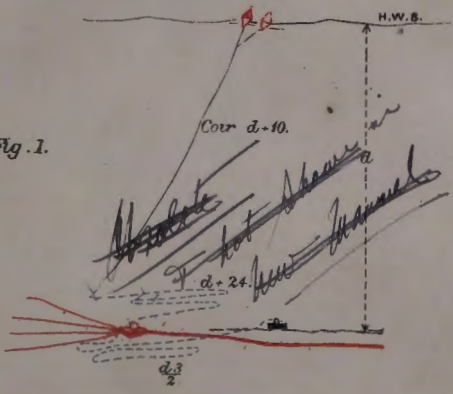
War Office
London S.W.
2nd Sept, 1898.

1898
E/764.

M has been at certain stations been found of advantage to substitute a single length of 3½" chain, attached to a 25" steel spherical, or old pattern circular, buoy, for the upper chain, light line and marking buoy described on page 56 and shown on Fiji Plate XI in "Submarine Mining Part II.

JUNCTION BOX MOORINGS.

Fig. 1.



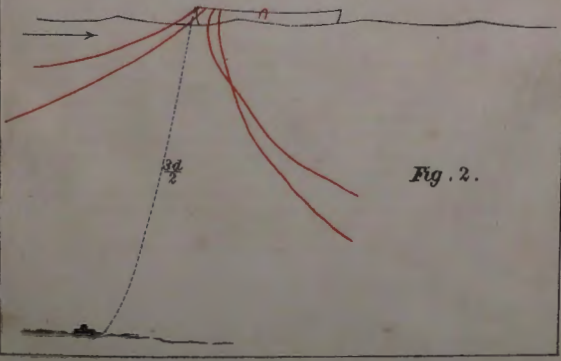


Fig. 2.

Judd & Co Ltd Lith 73 & 75, Farringdon Rd & Doctors' Commons

To face p. 57.

Plate XVI.

Function-box boat keeping position in deep water and strong wind and tide by means of an auxiliary sinker laid in proper direction

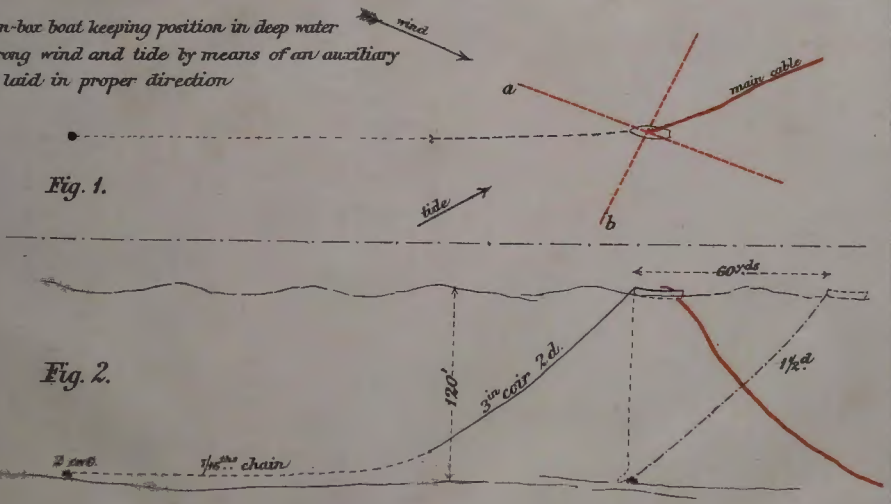


Fig. 1.

Fig. 2.

Judd & Co Ltd Lith. 73 & 75, Farringdon Rd & Doctors Commons 1870. B. 301.

at the same time, the tripping-chain being stopped to the main cable as far back as it will reach.

In most cases a 7 or 8½-cwt. sinker will be sufficiently heavy to moor the junction-box boat. In strong tides of 3 knots and upwards, 11½-cwt. sinkers should be used. Weight of sinker.

Experience will determine which of these methods is the better suited to particular stations. At some places, it may be found that the light buoys and lines do not stand, or that they get stolen; and at others, that the two wire ropes attached to the same buoy twist up and get foul. In all cases, however, it should be remembered that once the mines are down, and in good order, group junction-box buoys at all events should be removed as soon as possible.

A junction-box boat must lie close to the proper position of the junction-box in order that the cables may reach to her. She must therefore moor short up to the sinker if she has not mine cables on board to which she can ride. In strong tides or winds all the cables should come in over the bows within six feet of the stem, and the boat should be allowed to ride to the cable which leads away nearest to the direction in which she heads. If no cable leads approximately in this direction, she may ride to two cables, one on each bow. Mooring the junction-box boat.

When there is much wind or sea, the boat cannot be moored very short, or she will be liable to swamp.

In deep water, under any circumstances, the boat is bound to range a good deal if there are no cables on board leading in the proper direction. Under these circumstances an auxiliary sinker of 2 or 3 cwt., or the boat's anchor, may be laid out in such a position that the boat can ride easily over the proper place. Plate XVI illustrates this, the depth being 120′ and the sea rough.

When the cables *a*, *b*, are laid, the boat will be able to ride to them, and the sinker can be picked up. The boat should be allowed to show which way she will ride before the auxiliary sinker is laid. In this example, if the boat were riding to the junction-box mooring-line of a length 1½ times the depth of water, she would be 60 yards from her proper position. For such cases it would be very difficult to provide in any other manner. When riding short up to the sinker, care must be taken to ease out the mooring-line from time to time as the tide rises.

A sinker is sometimes placed on the main cable about 80 yards from the junction-box. The boat can, if necessary, keep her position by lying by the main cable to this sinker. Sinker on main cable.

Junction-box boats should be allowed to ride as far as possible in their natural position, bow on to wind and sea, or tide. If the tide turns while the box is on board—a contingency to be avoided if possible—the boat must not be allowed to turn with the cables made fast, or a nest of foul cables will be the result; they must be moved round the boat one by one until she can take up her proper position.

Before the box is lowered overboard, the N.C.O. in charge must get his boat into the proper position, so that the box may lie near the mooring sinker. This can be done by hauling in on the mooring-line (or chain), or the main cable. It is usual to test a group of E.C. mines with the box just immersed over the side before Lowering the box overboard.

lowering away, in order to detect any short circuit or fault due to the closing of the box. When this is finally lowered away, it must be paid out carefully until it touches the bottom.

Raising the box.

It is well to be able to raise the box and to get it on board with the crew and gear of the junction-box boat. It is, however, frequently a great saving of time to get the box up with the mooring-vessel's appliances, and to place the boat under it, especially where the water is deep.

Sailing junction-box boats.

It is a great convenience for boats to be able to move about from one junction-box to another without any help, and to raise the boxes themselves. Sailing junction-box boats are being tried, and so far have proved most satisfactory, as they are quite independent of the steamers when there is any wind, and a purchase to the mast-head enables them to raise the box with great ease.

The old 42-foot steam launches make very good junction-box boats of the "mobile" type. They can not only move from one box to another themselves, but can tow other boats about the mine-field as well. In many cases, their want of speed renders them unfit to take an active part in laying out mines.

Dormant Junction-box Buoys.

Floating junction-box buoys are in most cases inadmissible where multiple cables are laid out for long periods. They are liable to be sunk or stolen, and to cause obstruction unnecessarily. If the cables are short, they may be under-run from the shore, or from a point where it is safe to attach buoys to them. In some cases, especially where the cable is long, it is more convenient to attach a dormant buoy to the junction-box at the outer end of it.

Requirements.

The requirements of such an arrangement are as follows:—

(*a*) It must remain efficient for long periods without damage to cable or box, and the buoy must come up clear when the link is fired.

(*b*) It must be easily and quickly replaced in its normal dormant state, for the conditions of traffic may frequently render it undesirable to leave the buoy on the surface, even for a short time.

(*c*) The buoy, when dormant, must be below the deepest vessel using the channel, at all states of the tide.

Plate XVII.

Plate XVII illustrates the method which, so far, appears to best fulfil these requirements.

Fig. 1 shows the process of laying down the buoy, and fig. 2 the general arrangement of the system.

The multiple junction-box is connected to a heavy sinker, as already described, by means of a $\frac{7}{8}$-th mooring chain. The buoy-line to the box is of 1½-in. or 2-in wire rope, in length equal to 3½ times the depth of water.*

The buoy, a special steel buoy or c. c. case, is attached to a 5 cwt. sinker by means of an explosive link attachment, adjusted to keep the top of the buoy 30 feet under the surface at low water. A "link-cable" of the same length as the buoy-line is

* Six feet of chain is placed between the buoy and end of buoy-line to save chafing the latter.

DORMANT JUNCTION BOX BUOYS.

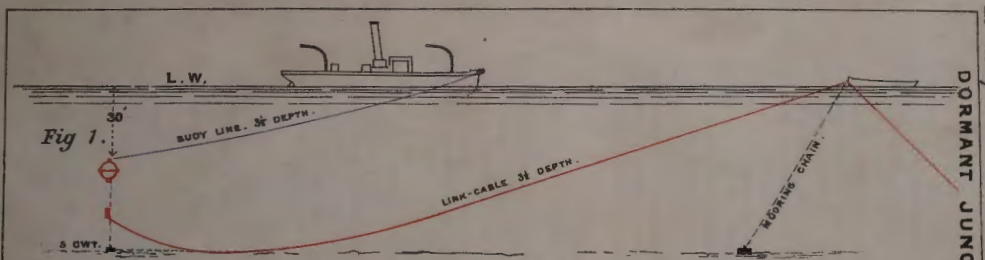


Fig 1.

STEAMER AFTER LAYING BUOY TAKING BUOY-LINE TO J. B. BOAT.

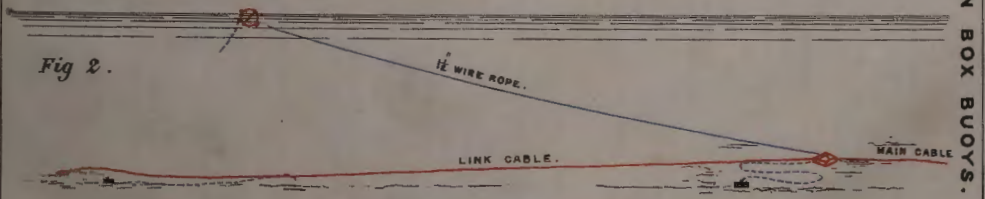


Fig 2.

LINK FIRED — BUOY WITH END OF BUOY-LINE FOR PICKING UP BOX.

Judd & Co. Lith. 73 & 75, Farringdon Rd. & Doctors' Commons 1870. B. 80

led from the junction-box to the link, a tripping-chain being attached to this cable and the link-sinker in the ordinary way. The link cable should consist of a piece of 4-core, or two single core cables stopped together, so as to provide a metallic circuit for the test and firing current.

An "earth" return should not be used unless there are not two cores available in the multiple cable for the link circuit.

Slinging the dormant buoy.

The sinker and buoy are slung in the same manner as a dormant mine, the link cable, which is paid out first, being arranged in long coils outside the laying out steamer. The buoy-line is coiled down on board.

Laying out. *See* Plate

*The link cable, the end of which is passed into the junction-box boat, is paid out from the steamer until it is stretched out in the required direction, the buoy and sinker are lowered away in the same manner as a dormant mine. The buoy-line is then taken back to the boat and made fast to the box. This ensures the buoy coming up clear, as the buoy-line is laid out the last thing.

Replacing link.

To render the buoy dormant again it is only necessary to take out a new explosive link, under-run the link-sinker, replace link between buoy and sinker, lower away, and under-run the buoy-line back to the boat to see that it is all clear.* While this operation is being carried out, the steamer must take care not to drag the junction-box boat.

Damage to the box and multiple cable by the movement of the buoy is obviated by attaching the latter to a sinker at some distance off the box, and the work of replacing the link is carried on clear of the junction-box boat, and can be effected at any time while the box is raised by any boat capable of weighing a 5-cwt. sinker. A steam launch is the handiest boat for the work.

When the buoy is raised for protracted work in the mine-field, the long buoy rope and large buoy may be replaced, if desired, by a shorter line and a light floating buoy.

In other cases, it may be necessary to render the buoy dormant every time the junction-box boat is removed.

Two other methods of mooring these buoys are under trial, but do not appear to fulfil the requirements laid down so satisfactorily as the method just described.

Junction-box Boats, Crews, Management, &c.

Crew.

The success and speed of extended "laying out" operations depend to a large extent on the efficiency of the junction-box boat crews. The number specially trained in this work should provide at least three good men for each boat, supposing the maximum number of boats to be in use at the same time. If a fourth man is required, *e.g.*, in cases where the tides are strong or the lifts are heavy, he should be a good boatman, although not necessarily trained in the special duties of junction-box boat work. The crew will usually be in charge of a N.C.O., who should be thoroughly conversant with both the electrical and seafaring duties in the boat.

Stores.

The following stores should be taken out in a junction-box

* Caution.—The link cable should not be connected to the main cable until the buoy is laid out.

boat. The N.C.O. or man in charge must see himself that the stores are on board in a serviceable state before starting. An inventory of the stores required should be kept in the boat.

1 life buoy with line attached.
1 life belt for each of the crew.
1 bucket with bucket rope attached.
1 mop.
1 baler (if there be no pump).
1 long boat hook.
4 oars and crutches.
2 large signalling flags (white and blue).
2 stoppers.
6 short lengths of 2-in. rope for stoppering.
1 buoy, small, marking.
2 throw-lines of 1½-in. rope, each 12 fms.
An anchor and warp should be carried if the boat is to work at "shore ends," or on a lee-shore.
1 jointers' box, complete.
30 yards No. 16 B.W.G. iron wire.
1 plan or note book of waterproof paper, showing arrangement of cables in grips, connections of cores, marks for fixing position, telephone connections, &c.
1 note book and pencil.
1 telephone arrangement, complete.
Leads.
Copper labels for branch cables.

A spare M.D.J.B. should, if possible, be taken to the mine-field, either on board one of the mooring steamers, or in the boat detailed to look after the junction-box boats.

Duties. The junction-box boats are under the orders of the test-room, and must carry out its orders with implicit obedience. They must not take independent action without reference to the test-room.

When towing, the N.C.O. in charge must see that his boat is trimmed by the stern. He must not allow the whole crew to get into her nose to make fast a tow rope. When cast off by the steamer, he must get his box on board without delay, and see that the cables are arranged so that they lead clear, and that at the same time the boat is riding easily in her natural position.

It is the duty of the N.C.O. in charge to pay particular attention to the cables, both in laying out and picking up. In the first case he must see that the cables are led in on the proper side, and that the box is lowered away carefully; in the second to have the cable ready for the laying-out steamer, and to see, as far as possible, that it is clear of all the other cables and of the J. B. moorings; this can be tested by hauling up the cable as far as it will come.

He will detail one hand to heave a throw-line to the steamer, every time she passes one to the boat; and another hand to stand ready with a boat-hook to catch the throw-line if it goes wide.

When the box has been washed, it is taken in-board, the cables are hauled up a little to relieve the strain, and stoppered. In strong tides or winds the cables should all come in close to the bow.

The cover of the box should then be removed, the inside cleaned, and communication established with the test-room. The labels should be examined, and defective ones replaced.

The crowns, leads and joints should be carefully examined and any faults at once reported to the test-room.

When mines are being laid out, the N.C.O. in charge, should ascertain the number of the mine when the cable is passed to him, and inform test-room when it is connected on.

He should, when mines are being picked up, ascertain which mine cable is next required, so that it may be all ready when wanted.

When he receives the order to close the box he should at once get up flag signalling connection with test-room. It is well to test the closed box *in the boat*, by making earth on the cover, to discover metallic contact, before it is tested overboard. When the box is lowered overboard for the final test before lowering away altogether, there should not be any outside strain on the box, so that it may readily be lifted in-board again if necessary.

When in this position the N.C.O. in charge should see that all the cables are leading clear.

The box must be carefully lowered away until it takes the bottom. It must be lowered near the mooring sinker in all cases. When a light buoy is used it should be hauled on board when the box is up. If a large buoy is used, too heavy to get on board, it should not be allowed to bump against the side of the boat.

All the crew should be constantly on the alert for signals from test-room, and boats in the mine-field, and station calls of flag stations should be well known to all hands.

When the box is finally lowered, the crew should clean down and tidy up the boat.

Safety of Boat and Crew.

The N.C.O. in charge must satisfy himself that the pump (if there is any in the boat) is in working order before starting for the mine-field.

He must also see that the life-buoy is easily accessible, and that the life-line is attached to it.

He should see that the life-belts are serviceable, and that they are so placed as to be accessible at a moment's notice. He should order the crew to put on the life-belts if he considers it necessary.

If possible, the men employed in junction-box boats should be able to swim.

CHAPTER VI.

SLINGING AND LAYING OUT MINES.

Contents.

General.—Success in "laying out" depends much on the care exercised in "slinging."—Large steamers can carry a good number of mines—not always a good plan.—No definite rule can be laid down on this point.—Slinging from lighter moored in mine-field.—Not practicable in launches if there is any sea.—Generally advisable to transfer some mines to a lighter, even if she is not taken to mine-field.—Position of mine when slung.—Stores used in slinging and laying out mines.—Lowering lines, &c.—Description of the process of slinging an E. C. mine.—Slinging drills.—Coming up to the position of the mine and manœuvring the vessel during "laying out."—Marking and watch buoys,—Illustration of above remarks.—Points to be attended to in letting go mines.—Cable to be clear and passed to boat with a throw line.—Dormant mines.—Drills for laying out E. C. mines on Fork system.

Observation mines—generally laid in "lines" of 2, 3, or 4.—Precautions to be observed in slinging.—Weights to be balanced as much as possible.—Mines to be slung on up-stream side.—Slinging a line of mines.—Watch buoys to be attached to the two end mines.—Laying out lines of mines.—Ground mines—usually in about 50 feet of water.—Lay at slack tide—low water if possible.—Buoyant lines of mines difficult to lay in over 70 feet of water with accuracy.—Points to be attended to in laying out lines of mines.—Drill for same.

Slinging and Laying out Mines.

Success in laying out mines rapidly, and without fouls and delays, will depend to a great extent on the forethought exercised in slinging them over the side of the mooring steamer.

General.

The large steamers can carry a good many E. C. mines slung over the side, but it is doubtful if this is a good arrangement. Very good detachments are required to prevent fouls and confusion, smooth water is necessary, and the hands of the officer in charge are tied to a great extent as to the order in which the mines shall be let go.

It is better generally only to sling from two to four mines at a time, even in a large steamer, and if circumstances render it advantageous to carry more mines on board, to sling them as required with the vessel's own derricks; in which case two squads of men may be employed in slinging and laying mines alternately. It is not advantageous to carry many mines on board, unless the submarine-mining pier is a good way off, or unless it is too rough to bring out a store-ship to the mine-field.

These conditions are always varying, so that what is best on one day, or at one port, will not do at all on another day, or at another port. The efficiency of the detachments, and also that of the coxswain, the state of the sea and weather, and the handiness of the mooring steamer, are some of the many variables to be taken into account.

If mines are slung from a store-ship or lighter, the latter should be anchored in the smoothest water obtainable within reasonable distance of the mine-field. If the store-ship is fitted with two derricks, they should be arranged to work clear of each other. In smooth water, when it is practicable to sling the mines with the store-ship derricks, the mine case can be slung on one derrick, and the sinker on the other; the mooring line and tripping chain being shackled on all ready for the laying-out steamer; when she arrives alongside, all that has to be done is to pass the lowering lines through the rings and shackles, the branch cable and tripping chain being passed on board at the same time. The arrangement of mooring line, cable, and tripping chain, over the side, can be done as the vessel proceeds to the position of the mine. If there is any roll on, the mine should be taken from the store-ship with the mooring steamer's derrick,* otherwise there is great risk of accident while the mine is being got into position on the steamer's side.

Where there is a great rise and fall of tide, it is also a good plan to transfer the mines from the pier head to a store-ship or lighter, from which they are taken by the laying-out steamers as required, even if the store-ship is not taken out to the mine-field. The transference of some of the mines to a lighter may also considerably expedite "slinging" and "laying out," when there are two or more steamers at work, especially if the pier head is at all cramped, or the cranes are few in number, or the water shoal at low tide.

Position of mine when slung.

The position of the mine in a fore and aft direction, and the side on which it is to be slung must be considered. The former is only of importance when there are two mines slung on the same side. When there is only one mine slung on a side, the sinker is slung near the bow, the mine and circuit closer coming next in order, at intervals of 10 or 15 feet. The *side* on which the mine is slung is generally of importance, unless there is no wind or tide to speak of; the mine should preferably be slung on the side which will cause it and the cable to go clear of the vessel after the word "let go," otherwise it may be necessary to

* If a masted vessel.

"come astern" after laying, so as to get mine and cable on the other side of the vessel.

Stores used in Slinging and Laying Out Mines.

Lowering lines.

Sinkers and mines are lowered away by means of "lowering lines," which are also used to secure them when slung over the ship's side.

The sinkers or mines may be slung in the bight of the line, in which case they are lowered from one end of the line, the other being made fast on board. This only throws half the weight of the mine or sinker on the running part.

Buoyant mine-cases are usually slung in this manner, with "short" lowering lines, or lowering ropes, about six fathoms in length.

Longer lowering lines used in this manner are, however, sometimes used, even for sinkers and ground mines. Lowering lines are made of $\frac{3}{4}$-in. or $3\frac{1}{2}$-in. rope. Care must be taken that the rope can pass freely through the ring or shackle on the weight to be lowered, and a little grease may be put on the rope near the nip of the ring or shackle, to ensure the weight starting at once. This grease should not extend to the running part in-board, or the weight may take charge.

Lowering lines should be of soft laid white rope, so that they may be easily belayed, and run freely round the cleat when wanted to. Hard rope, especially when wet, is difficult to belay, and runs very badly on the cleat.

The working load for 3-in. rope in good condition is 9 cwt., and its breaking strain 3 tons, and for $3\frac{1}{2}$-in. rope the working load is $12\frac{1}{4}$ cwt., and its breaking strain 4 tons. When used as described, the safe working load for the doubled 3-in. rope is, therefore, 18 cwt.; but care must be taken that the shackle or ring at the nip is smooth and of good size, so that it may not cut the rope.

Lowering hooks.

When sinkers and mines are not let go "by the run," but are lowered to a considerable depth before "letting go," it is better to use single lowering lines fitted with "lowering hooks." The latter hold the weight only so long as a continuous strain is thrown on them, and at once disengage when this strain is removed, either by the weight being taken by the mooring line or the ground. These lowering lines should be of 4-in. rope, if the weights to be lowered exceed $12\frac{1}{4}$ cwt. All forms of lowering hooks are fitted with safety keys, or catches, which must be released on the command "stand by to lower away." Lowering hooks will usually be employed with ground cases and dormant mines (both sinker and case).

The best form of lowering hook, however, will not prevent the sinker turning round and round while being lowered, and twisting up the rope and mooring line.

This can only be prevented, (1) by seeing that the lowering line is *well stretched* before it is used, by a strain at least equal to half its breaking weight; (2) by lowering away very smartly, so that the sinker has not time to turn round.

Four-inch rope is generally used with lowering hooks, but this

size is only necessary for the 500-lb. and 600-lb. ground mines. This rope requires large cleats, of which it is well to use two, passing the rope under one and making fast on the other. Its breaking strain is 5⅓ tons, and safe load 16 cwt.

Lowering hooks are hardly required except for ground mine-cases. All mines having buoyant cases can be let go by means of short lowering lines. Mine-cases can be slung a foot to 18 inches higher out of the water by using lowering lines instead of lowering hooks, and this is a great advantage in most cases.

When the water is deep, care must be taken that the mooring line and tripping chain are arranged so that they may run out quite clear; this is best done by taking plenty of room in slinging.

Short lashings.

Three-fathom lengths of 2-in. rope are used in slinging mines to keep them out of the water until just before laying. They are made fast to the cleats in the same manner as short lowering lines or head lashings. With the heavier natures of mines these lashings should be of 3-in. rope, so that they may be certain to hold them in the event of the lowering line parting. Another precaution to be taken, especially when there is any sea on, is to pass the tripping chain round a cleat as near up to the weight as possible.

Chain Slings.

Chain slings consisting of three or four 4 ft. "legs" radiating from a central ring, and provided with hooks at the ends, are very useful for slinging and disembarking mines rapidly. By using two legs spherical cases can be slung with the axis horizontal, clear of the water.

Rope mats.

Mats about 2 ft. 6 ins. square, made of unstranded tarred rope, have been found very useful for transporting mines stowed in the after part of a vessel to positions forward, where they can be slung out-board by means of the derrick. These mats should have a couple of beckets or eyelet holes worked in them for attaching a hauling rope to. These mats are found specially useful in the case of vessels unprovided with after derricks, or when it is desired to do all the laying out forward, or when the state of the weather is such as to prevent many mines being slung at the same time.

Slinging E. C. Mines.

The mooring steamer lies alongside the pier or store-ship in such a position that the mine-case or sinker may be dropped by the crane into the proper place just outside the gunwale. The weight is lowered so that the lowering hook or line may be passed through the shackle on the side lug of sinker or ring of attachment chain, the weight being steadied and hauled into position by means of a hook rope manned by a sufficient number of men on board the mooring steamer. In masted steamers a "Burton tackle," made fast aloft, is very handy for this purpose, and requires fewer men to work it than a hook rope.

It is often best to sling the mines off the pier or store-ship with the vessel's own gear, one reason being that in anything of a seaway it is much safer to do so, and another that the weight can be slung on the further side, if required. The derrick

of the mooring steamer may be fixed by means of the guys over the proper position of the weight when slung, and the latter dragged into position by means of the derrick tackle, the fall of which is taken round the steam capstan. In these cases the hook rope is worked from the store-ship or pier.

Plates XVIII, XIX, XX, and XXI illustrate the method of slinging the various parts of E. C. mines. The sinker, or ground mine-case, is so placed that there is a sufficient space forward of it for flaking the tripping chain and part of the branch cable over the side between it and the joggle, to which the long link at the end of the tripping chain is made fast with a single spun yarn stop. The chain and branch cable over the side are similarly secured at the requisite intervals. Not more than two returns of the chain should be secured by one stop. The buoyant mine-case, with mooring line, is then slung 10 or 15 feet aft of the sinker, in the bight of a short lowering line of 3-in. rope, about 6 fathoms in length. This line is passed through a shackle or ring attached to the case or to the upper attachment chain of a buoyant mine-case. The "foot," or mouth end, of the case is secured in the same way with a short lashing called the "foot lashing," so that it may not drag in the water if the steamer has any distance to go, or the water is rough. If there is a circuit-closer case, it is slung in a similar manner, aft of the mine-case. It may sometimes be necessary to sling the mine and circuit-closer case off the pier in one load, where the drop is greater than the length of the upper mooring line. For this purpose it is convenient to have a chain sling with four legs, each about four feet long, radiating from a large ring, the end of each leg being fitted with a good sized hook. This sling is also handy for quickly unloading vessels, especially when a steam crane is in use. The mooring line is shackled on to the centre lug of the sinker, and the cable is then slung on board, together with the tripping chain, the latter being shackled to a side lug of the sinker. The circuit-closer cable and mooring line are hung in short coils over the side of the vessel between sinker and mine by means of spun yarn stops, which snap one after the other as the mine is let go. If the water is very deep, and the mine is let go "by the run," the bight of mooring line and cable may be stretched out aft outside the vessel.

The cable is coiled down in the approved place, either forward or aft, and care must be taken that it is arranged to pay out so that it shall not work under the bottom and get foul of the screw. It is well to put a stopper on the branch cable where it comes on board, to prevent its being run away with by the tripping chain.

Branch cables, paid out from coils, should be recoiled, if necessary, after slinging, so that they may run out clear.

The larger natures of E. C. mines should not, as a rule, be laid out from launches.

Slinging mines from inboard.

The masted mooring steamers are provided with appliances for slinging mines and sinkers at convenient places over the side. The "burtons" referred to on page 65 take the place of hook ropes, and render the operation quite simple, even in a seaway. The

Text face p. 66.

100 lb E. C. Mine on Steam Launch.

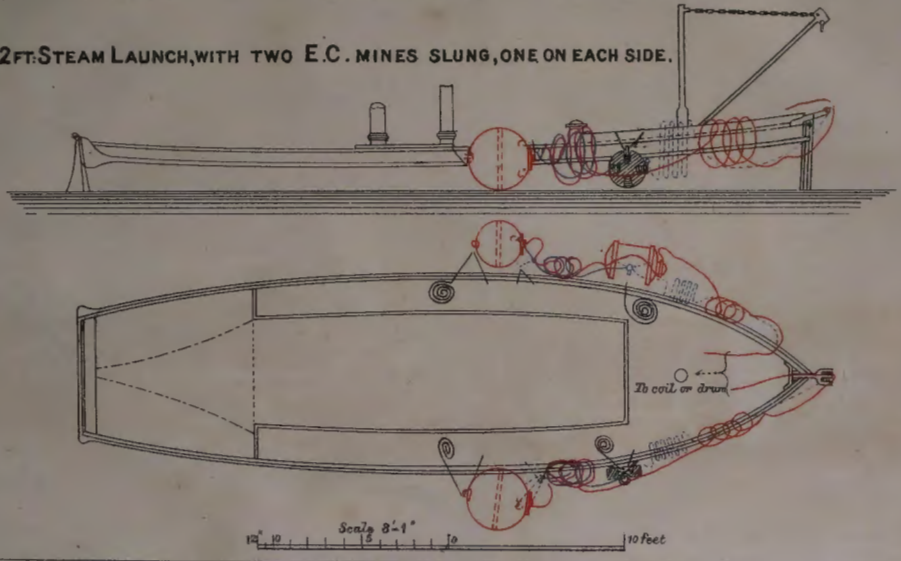
Plate XVIII.

500 lb: Buoyant E.C. Mine, with C.C. on "Miner."

To face p. 66.

. Dormant E. C. 100 lb. Mine on Steam Launch.

42 FT: STEAM LAUNCH, WITH TWO E.C. MINES SLUNG, ONE ON EACH SIDE.



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same principle can be applied to the bow derricks of un-masted steamers in the following manner: a single block is made fast to the top of the derrick mast, or to the central part of a davit derrick; the hook rope is then rove through this block and hooked into the weight, which can then be lowered into position, even if the end of the derrick plumbs some feet outboard. Derricks provided with guys can be lashed in position during the operation.

SLINGING MINES.

Stores Required.

Stores required.

1 lowering line (fitted with lowering hook, if required) per mine.*
1 lowering rope per mine (or "head" lashing).
6 lashings per mine.
1 marlinespike.
1 hook rope.
1 axe.
1 flag.
Spun yarn.

They should form part of the equipment of the vessel which lays the mines.

No vessel to carry less than proportion of stores required for 4 mines.

The party called the "laying-out vessel party" consists of 1 N.C.O. and 6 men. They work in conjunction with a second party of 1 N.C.O. and 6 men who work at the crane, and are known as the "crane party."

Duties of Numbers.

Slinging drill.

No. 1 commands, points out the cleats to be used for each mine.

No. 2 slings sinkers and ground mine cases, shackles on mooring lines and tripping chains to them when necessary.

No. 3 assists No. 2.

No. 4 slings buoyant mine cases and circuit-closer cases, secures mooring lines and cables stopped to them.

No. 5 assists No. 4.

No. 6 stops tripping chain and cables ready for paying out.

No. 7 has charge of hook rope, and assists No. 6.

The whole of the numbers assist in getting the different parts of the mine into position, and in stopping mooring lines, tripping chains, and cables in position ready for laying out.

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* Squads will be exercised in laying mines with and without lowering hooks.

Coming up to the Position of the Mine in Laying-out Vessel.

The manner in which the laying-out vessel is brought up to the position of the mine, and is subsequently manœuvred in the process of laying the branch cable to the junction-box boat, will depend altogether on the following conditions:—

(i.) Method of finding the position of the mine.
(ii.) Strength, set, and state of tide, and force and direction of wind.
(iii.) Side on which the mine is slung.
(iv.) The nature of the laying-out vessel.

(i.) *Method of Finding the Position of the Mine.*

The various methods of finding any required position in the mine-field have been fully described in Chapter III, "Survey of Mine-field."

It merely remains to consider how these methods are applied in practice for laying-out single mines and their branch cables.

Cross intersection.

The cross intersection of two alignments allows of considerable freedom of action, as the laying-out vessel can work along either alignment, and marking buoys should be rarely required.

Sextant angle and one alignment.

When the position is found by a single alignment and sextant angle, mines can still be laid in many cases without marking buoys. It will be a convenience to have the alignment marked on both sides of the channel if possible, and two angles for each mine, so that the laying-out vessel can work in either direction along the alignment.

Marking buoys hamper the laying-out vessel to some extent, take a certain time to lay down and pick up, and in strong tides and deep water do not mark the position very accurately, and are apt to get swept under the surface. Nevertheless, in many cases, it will be found advantageous to use them, where the method of finding the position is that of a single alignment and sextant angle.

Actual measurement.

When the mine positions are found by actual measurement from a junction-box boat a long distance from the shore, it would in most cases be necessary to lay marking buoys.

Position-finder and one alignment.

When using this method, mines might often be laid without marking buoys, as the position of the junction-box boat would be a good guide for estimating the proximity of the laying-out vessel to the position. In many cases, however, the strength and direction of wind and tide, the position of the mine in relation to the latter and the junction-box, and the course of the laying-out vessel would render it advantageous to buoy the position of the mine before laying it.

It must be remembered, however, that rapidity of work wou in many cases be the first consideration, so that, provid fair accuracy could be obtained without their use, marking buo should not be employed, if they in any way delayed the work completing the defences. An inspection of the Position-find Chart would show at once if it were necessary to re-lay any he mines.

(ii.) *Strength, set, and state of Tide, and force and direction of Wind.*

If the tide is at all strong, it may be used to help the laying-out vessel to reach the junction-box after the mine is laid, the bows being kept up-stream, and the cable leading clear over one bow. In working along an alignment across a tideway, it is necessary to keep the head of the vessel up-stream, unless marking buoys are used. In very strong tides and deep water, and where the bottom is uneven, accuracy of laying is best obtained by bringing the vessel to a dead stop 20 or 30 yards above the proper position, and allowing her to drift over it with the sinker lowered to its full extent; the vessels can then either drift down to the junction-box, or steam up-stream towards it, according to circumstances. Tide.

If the state of the tide is such that the mine or circuit-closer cases are near the surface, care must be taken not to drift over them after they are let go, and watch buoys should be attached to the mine or circuit-closer cases, so that the laying-out vessel may keep clear of them subsequently. Watch buoys.

In many cases the wind may be of more importance than the tide, its strength and direction may be such as altogether to change the conditions of laying-out, and to necessitate coming up to the position of the mine in quite a different way from that which would otherwise be employed. For instance, if the wind were strong and against the tide it might quite prevent the laying-out vessel from drifting down on the junction-box boat in the manner just described, and might necessitate the use of a marking buoy to allow the vessel to come up to the position of the mine in such a manner that she might steam straight to the junction-box boat afterwards. Wind.

(iii.) *The side on which the Mine is slung.*

This will generally be of importance, especially when the cases are near the surface at the time of laying. It is desirable that when the mine is let go, it and the cable should not drag under the vessel owing to the set of the tide. This consideration will affect, in many instances, the manner in which the laying-out vessel is brought up to the position of the mine and is subsequently manœuvred.

(iv.) *The nature of the laying-out Vessel.*

The size and handiness of the laying-out vessel are of importance, inasmuch as the large steamers [illegible] make sharp turns in a tideway, nor can [illegible] e branch cable to help [illegible] y to drag the mine [illegible]ssels like launches [illegible] to assist them in [illegible] junction-box boat. [illegible]going remarks on [illegible]f 4 E. C. mines are [illegible]ner, all four being [illegible]XIII. The plans Illustration of above remarks.

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The manner in which the laying-out vessel is brought up to the position of the mine, and is subsequently manœuvred in the process of laying the branch cable to the junction-box boat, will depend altogether on the following conditions:—

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The various methods of finding any required position in the mine-field have been fully described in Chapter III, "Survey of Mine-field."

It merely remains to consider how these methods are applied in practice for laying-out single mines and their branch cables.

Cross intersection.

The cross intersection of two alignments allows of considerable freedom of action, as the laying-out vessel can work along either alignment, and marking buoys should be rarely required.

Sextant angle and one alignment.

When the position is found by a single alignment and sextant angle, mines can still be laid in many cases without marking buoys. It will be a convenience to have the alignment marked on both sides of the channel if possible, and two angles for each mine, so that the laying-out vessel can work in either direction along the alignment.

Marking buoys hamper the laying-out vessel to some extent, take a certain time to lay down and pick up, and in strong tides and deep water do not mark the position very accurately, and are apt to get swept under the surface. Nevertheless, in many cases, it will be found advantageous to use them, where the method of finding the position is that of a single alignment and sextant angle.

Actual measurement.

When the mine positions are found by actual measurement from a junction-box boat a long distance from the shore, it would in most cases be necessary to lay marking buoys.

Position-finder and one alignment.

When using this method, mines might often be laid without marking buoys, as the position of the junction-box boat would be a good guide for estimating the proximity of the laying-out vessel to the position. In many cases, however, the strength and direction of wind and tide, the position of the mine in relation to the latter and the junction-box, and the course of the laying-out vessel would render it advantageous to buoy the position of the mine before laying it.

When marks on the shore are invisible, owing to fog or other cause, some accuracy can be obtained in laying mines round a junction-box boat by using the vertical height of the mast, or a pole in the boat, a sextant, set to the proper angle, being used in a launch which drops marking buoys round the boat. Direction is given in this system by compass bearing, or by the relative position of other buoys in the minefield. In some cases actual measurement may take the place of the mast and sextant angle.

(ii.) *Strength, set, and state of Tide, and force and direction of Wind.*

If the tide is at all strong, it may be used to help the laying-out vessel to reach the junction-box after the mine is laid, the bows being kept up-stream, and the cable leading clear over one bow. In working along an alignment across a tideway, it is necessary to keep the head of the vessel up-stream, unless marking buoys are used. In very strong tides and deep water, and where the bottom is uneven, accuracy of laying is best obtained by bringing the vessel to a dead stop 20 or 30 yards above the proper position, and allowing her to drift over it with the sinker lowered to its full extent; the vessels can then either drift down to the junction-box, or steam up-stream towards it, according to circumstances. Tide.

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In many cases the wind may be of more importance than the tide, its strength and direction may be such as altogether to change the conditions of laying-out, and to necessitate coming up to the position of the mine in quite a different way from that which would otherwise be employed. For instance, if the wind were strong and against the tide it might quite prevent the laying-out vessel from drifting down on the junction-box boat in the manner just described, and might necessitate the use of a marking buoy to allow the vessel to come up to the position of the mine in such a manner that she might steam straight to the junction-box boat afterwards. Wind.

(iii.) *The side on which the Mine is slung.*

This will generally be of importance, especially when the cases are near the surface at the time of laying. It is desirable that when the mine is let go, it and the cable should not drag under the vessel owing to the set of the tide. This consideration will affect, in many instances, the manner in which the laying-out vessel is brought up to the position of the mine and is subsequently manœuvred.

(iv.) *The nature of the laying-out Vessel.*

The size and handiness of the laying-out vessel are of importance, inasmuch as the large steamers cannot make sharp turns in a tideway, nor can they make use of the branch cable to help them to turn, on account of the liability to drag the mine out of position. On the other hand, small vessels like launches can turn quicker, and can use the branch-cable to assist them in doing so, and to sheer in a tide-way towards the junction-box boat.

Plates XXII and XXIII illustrate the foregoing remarks on coming up to the position of the mine. A group of 4 E. C. mines are to be laid out on the X system from a large steamer, all four being slung at the same time, as shown in fig. 1, Plate XXIII. The plans Illustration of above remarks.

in red in fig. 2 indicate the probable position of the laying-out steamer when laying to marking buoys, or by cross intersections in a slack tide. The plans in blue indicate the positions of the vessel when the tide is strong enough to allow of its being utilized in laying out the branch cable to the junction-box. It will be observed that in no case does the vessel drift over the mine and cable after "letting go."

Plate XXIII shows a slightly different arrangement of slinging and laying out. In this case, all the mines might be laid by the method of a single alignment and sextant angle without marking buoys. It will be seen that, in order to obviate any chance of a foul screw, the vessel has to go astern immediately Nos. 2 and 3 mines are let go. This method of manœuvring the steamer requires more skill on the part of the officer in charge and the coxswain, than that illustrated in red in Plate XXII, when a direct course for the junction-box is steered.

Laying by eye.

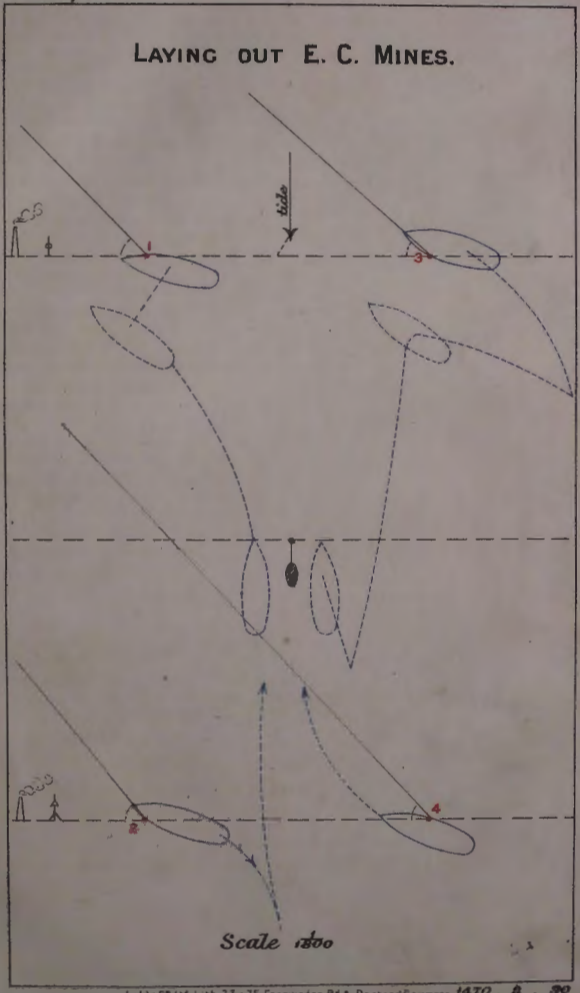
There are many expedients in laying E. C. mines whereby the necessity of using marking buoys can be obviated, while, at the same time, rapidity and fair accuracy is obtained. For instance, the position of any of the mines in Plate XXII can be found by means of a sextant angle and alignment in the ordinary manner. At the same moment, some object (K) on shore is found to be in line with the junction-box boat; the laying-out vessel can then come in on this temporary alignment, and drop the mine when crossing the permanent alignment. If a watch buoy is attached to this mine (say No. 1), No. 3 can be laid by eye, with the alignment, the junction-box boat, and No. 1 mine, to assist in forming a correct judgment of the proper position.

Laying out E. C. mines.

The mooring steamer should be brought up to the position of the mine at a slow speed; in some cases, she will have to come to a dead stop. At the word "stand clear," the engines should be stopped by the coxswain, if this has not previously been done. The drill details the duties of the various numbers when actually laying a mine. No. 1 must himself see that everything is clear for letting go. The chief points to be attended to are the casting off of all preventer lashings, that the tripping chain is all clear, and not likely to catch in a cleat or fair lead when running out, that lowering hooks are unkeyed, also that there is a stopper on the end of the chain, (or cable near the end of the chain), to prevent it running away with the cable. No. 1 must also see that his axe is handy in case of emergency, such as a man being carried overboard in a bight of cable, a lashing or lowering line jamming, &c. A deck hand or spare number must be told off with a boat hook to keep cables, mine cases, buoys, &c., clear of the screw. Too much attention cannot be paid to this point by all concerned.

The lowering away of the mine or sinker requires some practice. Inexperienced men should not be told off to lower 600-lb. ground mines until they have had practice with lighter weights. When these mines are lowered into the water, half their weight is taken off, but an extra strain is thrown on the lowering line by the rush of water on the case.

In taking the turns off the cleat one hand or foot should be



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LAYING OUT E. C. MINES.

Fig. 2.

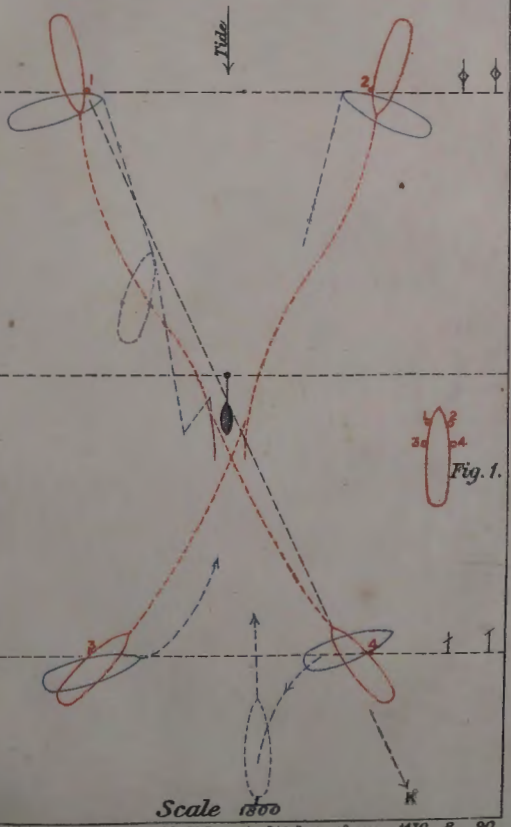

Fig. 1.

Scale 1800

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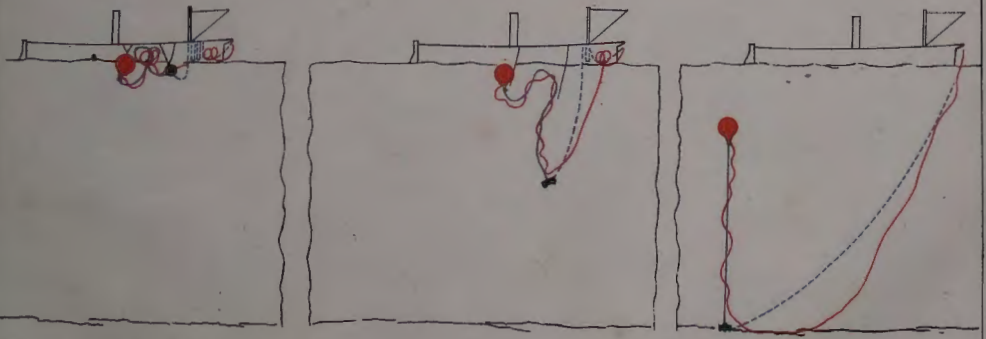
To face p. 71.

LAYING OUT E. C. MINE WITH SHORT LOWERING LINES.



"Lower away the sinker to the mark"

"Let go"

"Mine laid."

Plate XXV.

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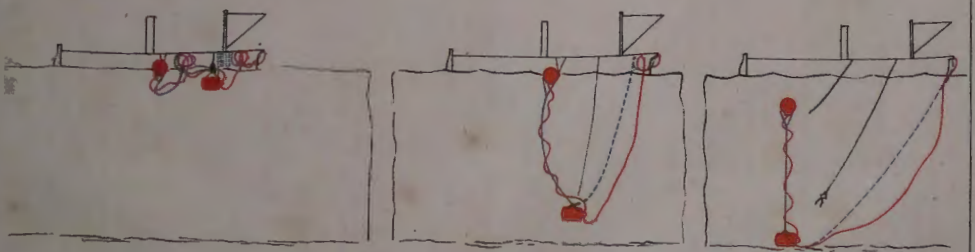
To face p. 71.

LAYING OUT E.C. MINES WITH LOWERING HOOK.



Commencing to lower away "to the mark".

Mine or Sinker lowered "to the mark".

Just after letting go.

Scale ⅛th.

Plate XXV

Judd & Co's Lith. 73 & 75, Farringdon Rd & Doctors Commons 1870. A. 867

used to jam the underneath turn, while the upper one is taken off, and while lowering away, the men must take plenty of room and not get their hands near the cleat. The line should not be paid out in jerks, and if the weight is taking charge, a quick half turn round a neighbouring cleat will stop it. If the rope and cleat are slippery it is better to use two cleats than a complete turn round one cleat, or turns may be taken round the capstan.

Lowering away "to the mark."

Ground mine-cases lowered with lowering hooks should be eased out within a couple of fathoms of the bottom before they are let go. The simplest way to ensure this is to measure off on the lowering line from the belayed part on the cleat a length, two fathoms less than the depth of water at the time of laying, and mark the spot with a piece of spun yarn. The line will be eased out till this mark is on the cleat, at the word "Lower away No. to the mark."

Letting go.

In commencing to overhaul lowering lines (including those sometimes called "head lashings"), care should be taken to grasp the rope just beyond the gunwale, so that if any sudden strain should come upon the rope, the fingers may not be jammed. The rope must not be grasped too far from the gunwale, as there might then be risk of the man being jerked overboard.

from the vertical cable drum. The slack cable should be paid out near the mine, and not near the junction-box boat.

In any case the end of the cable is cleared and led up to the bow that will be nearest to the boat, and a throw line is made fast to the end of it by means of a stopper hitch (or magnus hitch with an extra half-hitch near the crown), so that the cable end may be passed into the boat without going alongside.

Cables laid from drums must be run off them in good time, so that the throw line may be beat on. A buoy should be kept ready to make fast to the throw line if required. The steamer should pass close to the boat on the leeward or downstream side, to obviate any chance of a foul.

Dormant mines.
Plate XX.

Dormant mines are slung in a similar manner to ordinary E. C. mines, but the mine has usually to be nearer to the sinker, to allow of the link attachment being shackled on.

For dormant mines it is well to select cases provided with a top lug, through which the lowering hook is passed. The sinker must be lowered gently until the weight is taken by the short mooring line and link. The mine-case and sinker are then lowered together, until the sinker is fairly near the bottom. This applies equally to dormant buoys.

These mines should be lowered carefully to the bottom to prevent any chance of the link breaking, as they are usually 30 feet under water at all times of tide, they should be lowered away with 4½in. ropes and lowering hooks. The bight of mooring line and circuit closer cable should not be allowed to go overboard until the mine and sinker are lowered, so that it may not get under the latter, and prevent the mine rising on the explosion

used to jam the underneath turn, while the upper one is taken off, and while lowering away, the men must take plenty of room and not get their hands near the cleat. The line should not be paid out in jerks, and if the weight is taking charge, a quick half turn round a neighbouring cleat will stop it. If the rope and cleat are slippery it is better to use two cleats than a complete turn round one cleat, or turns may be taken round the capstan.

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The 500- and 600-lb. ground cases should be lowered carefully, so that they may not take charge.

Plate XXIV shows an E. C. mine being let go from a 42-ft. launch, short lowering lines being used, and Plate XXV shows an E. C. mine, with ground case, being laid out with a lowering hook.

The mine having been let go, the engines should not be started again until it is seen that mine and cable are clear of the screw; the steamer then proceeds slowly to the junction-box boat, the cable being paid out from coils, either from the bow or stern, or from the vertical cable drum. The slack cable should be paid out near the mine, and not near the junction-box boat.

In any case the end of the cable is cleared and led up to the bow that will be nearest to the boat, and a throw line is made fast to the end of it by means of a stopper hitch (or magnus hitch with an extra half-hitch near the crown), so that the cable end may be passed into the boat without going alongside.

Cables laid from drums must be run off them in good time, so that the throw line may be bent on. A buoy should be kept ready to make fast to the throw line if required. The steamer should pass close to the boat on the leeward or downstream side, to obviate any chance of a foul.

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These mines should be lowered carefully to the bottom to prevent any chance of the link breaking; as they are usually 30 feet under water at all times of tide, they should be lowered away with 4-in. ropes and lowering hooks. The bight of mooring line and circuit closer cable should not be allowed to go overboard until the mine and sinker are lowered, so that it may not get under the latter, and prevent the mine rising on the explosion

of the link. The bight should be paid out with a lowering line as the mine is lowered, from a position some distance aft of the mine case.

Laying out Mines on the Fork System.

Drill. The party will consist of 1 N.C.O. and 6 men, under the command of an officer or senior N.C.O., who will give the executive words of command.

Duties of Numbers.

No. 1 superintends his party, repeats the words of command given by the officer in charge, sees that the various numbers perform their duties correctly. At the word "Stand by to lower away," sees that lowering hooks are unkeyed, and proper lashings cast off. At the word "Lower away to the mark," sees that lowering lines are properly eased off. At "Stand clear," sees that all men are standing clear of all running gear, stations himself with the axe near the weight, and sees that all goes clear at the word "Let go."

No. 2 takes up position by ground mine or sinker. At the word "Stand by to lower away," unkeys lowering hook and casts loose lashings. Then assists No. 3.

No. 3 takes up position by ground mine or sinker. At the word "Stand by to lower away," prepares to lower away. At the word "Lower away to the mark," he lowers away gradually to the amount ordered. If the lowering hook has disengaged itself he overhauls and coils down. If the weight be still on the lowering line he will, at the word "Let go," cast the lowering line smartly off the cleat, overhaul when clear, and coil down.

No. 4 takes up position by buoyant mine case. At the word "Stand by to lower away," casts off the foot lashing and makes ready to let go the head lashing, which he lets go at the word "Let go."

No. 5 takes up position by C.O. case. At the word "Stand by to lower away," casts off foot lashing, and makes ready to let go head lashing. At the word "Let go," he lets go, overhauls, and coils down.

No. 6 sees that tripping chain and cable pay out properly, cutting stops if necessary, then attends to branch cable.

No. 7 assists No. 6.

All the numbers assist in paying out the cable as soon as they have performed the above duties.

Slinging Lines of Mines.

Observation mines are generally laid out in lines of two, three, or four.

When slinging a line of heavy mines, the stability of the mooring steamer must be considered, because a heavy list to one side is at all times inconvenient, on account of the mine cases dragging in the water; and may be dangerous if there is any sea on in the mine-field, or from the exposure of the crown of the boiler furnace. The weight of a line of four 500-lb. buoyant mines with sinkers, tripping chain and intermediate cables is

about 5¼ tons, and of a line of four 600-lb. ground mines, nearly 5 tons; steps must therefore be taken to balance the weights by slinging two mines on each side, or by slinging more mines on the further side. Plate XXVI, fig. 1, shows a line of four 600-lb. ground mines slung on a mooring steamer of the Gordon class; Nos. 1 and 2 on the port side, and Nos. 3 and 4 on the starboard side, the intermediate cable and chain between 2 and 3 being brought round the stem and stopped under the joggle. The cable drum is put in the stern and helps to trim the vessel. At no time can there be an excess of weight of more than two mines (about 2½ tons) on one side, and this can only occur for the short interval of time between laying Nos. 2 and 3 mines. This excess of weight, however, should rarely occur, as before No. 2 is let go, No. 3. will have been lowered into the water, thereby losing half its weight. As a rough rule, the excess of weight on one side should not exceed 2½ tons in large vessels, and 1 ton in launches. It has been found that a weight of 3 tons on one side gives a list of 8° to a vessel of the Sir Francis Head type.

The advantages of this method of slinging are, that the mines can be kept well forward so that they are away from the screw, and that plenty of room can be taken between each mine.

The disadvantages are, (1) that it may be necessary to swing the miner to sling the mines, (2) that in laying out across a strong tide, the cables, chains, and lowering lines, of two of the mines are bound to drag under the bottom of the vessel, so that if there is any hitch in the operation of laying out, there is a great chance of getting a foul screw.

Another method of slinging, obviating these disadvantages to a great extent, is illustrated in Plate XXVII, fig. 1, which shows a line of four 500-lb. buoyant mines, slung on an 80-ft. miner. Three of the mines are slung on one side, and the last mine, on the other bow, where it could be placed by the steamer's derrick without swinging. Another mine is shown as slung on that side to reduce the list. This arrangement allows of plenty of room between each mine for the intermediate cables and chains, and after No 4 is let go, the cable can be passed round the bow so as to pay out clear. Of course, this method of slinging is equally applicable to the line of ground mines shown in Plate XXVI. The single mine should be slung first and laid out last.

Plate XXVIII shows a line of four ground mines slung on the same side of the vessel, which should be balanced by a total weight of 2½ tons slung on the other side.

Slinging lines of mines.

The mines are slung in the same manner as E. C. mines. Buoyant mine-cases are best slung with short lowering lines, but ground mines, and the sinkers of buoyant mines, are usually lowered away with lowering hooks. The tripping chain is flaked over the side forward of the sinker or mine-case, and must be secured by spun yarn stops at intervals of about 20 feet along the chain. These stops must be strong enough to check the chain from running out by its own weight, but should part easily when the weight of the mine comes on them. The successful laying of a line of mines often depends on the care with which the intermediate chains and cables are arranged and stopped.

The intermediate cable between each mine is hung over the side in 3 or 4 small coils, each of which is secured by a spun yarn stop. It is well to take a turn with the tripping chain of each mine round a cleat close to the mine, in case the lowering line should carry away. This turn must, of course, be cast off at the word "Stand by to lower away."

Watch buoys should be attached to the two end mines of lines of mines after slinging—one number should be detailed to see that these buoys pay out clear and that they do not foul the lowering lines.

Laying out Observation Mines.

Lines of mines must generally be laid across the tide, therefore it is desirable to lay them when it is slack or slacking. The majority of the mines should, if possible, be slung on the up-stream side of the boat, which should not exceed a speed of 3 knots while the mines are being let go.

Laying out a line of ground mines.

Plate XXVI, fig. 2, illustrates the laying of a line of ground mines with long lowering lines and hooks. No. 1 has just been laid, the lowering line is being hauled on board again, while No. 2, having been lowered "to the mark," is being let go as No. 3 is slowly eased down. As each mine is lowered, it takes down with it some of the tripping chain and cable. The stops should be so placed, and of such strength, that the chain and cable do not run out in a heap as the mine is lowered, but are stretched out by the steamer before reaching the bottom.

Large ground mines are not used in depths greater than 60 feet. The depth of water at the time of laying will usually be less than this, so that there is little difficulty in laying out these mines at the proper intervals.

Laying out lines of buoyant mines.

In Plate XXVII, a line of buoyant mines is shown as being laid out on an even bottom in 70 feet of water in one operation.

It will be observed that the intermediate tripping chains must be 120 feet long to get the mines 100 feet apart on the bottom. No. 1 mine is laid; No. 2 has just been let go, its sinker having been lowered away when No. 1 mine-case was let go; No. 3 sinker is being lowered away smartly, so that the tripping chain may be stretched out before No. 3 case is let go; No. 4 mine is on the port side of the vessel.

In depths over 70 feet, or in strong tides, or where the bottom is very uneven, it is a difficult matter to lay these mines out in a string in one operation, so that they shall be at the same time properly spaced and at the right depth. Also, in depths of 100 feet and over, it is a difficult operation to pick up these mines when connected up in the ordinary manner (*vide* plate CXXIII, Part I.).

Other methods of laying buoyant lines of mines in very deep water are being tried, with a view of overcoming these difficulties.

One method which has so far given satisfactory results is as follows:

The intermediate cables are cut to a length of three times the depth of water, so that there is plenty of slack between each mine.

The tripping chains are cut to a length of d + 24 ft., and are stoppered to the intermediate cables as with E.C. mines, and do not stretch from sinker to sinker. The end mine is laid by observation, or to a buoy, as usual. The moment for letting go the remaining mines is found by means of a distance line, which is attached to the watch buoy on the end mine and allowed to run out from a coil in the stern of the mooring steamer. The "distance line" should be of grass or coir rope, and the marks on it should allow for the distance apart of the sinkers as they are slung on the vessel's sides. The plan has been tried in 90 feet of water, the mines being very accurately spaced.

The Royal Navy lay down the rule that when laying lines of mines across a tide-way a marking buoy should be previously laid for each mine position. Buoys can be laid very accurately by means of a distance line of grass rope attached at the proper intervals to the rope itself. The sinkers should either be let go by hand at the proper moment, or the distance line can be arranged to release buoy and sinker at the same instant.

Before laying a line of mines to buoys laid in this manner, the distance line should be removed. The buoys should have plenty of buoyancy, and the mooring lines should be little longer than the depth of water. The lines of mines, connected up in the manner just described, should be laid on the down-stream side of the buoys.

It is of the utmost importance to know the exact position of the end mines. This is best done by attaching watch buoys by means of light coir lines, which will float until dragged down. The last foot or two of the buoy-line next the mine may be of strong spun yarn, so that the buoy and line may be recovered by breaking it when the position of the mine has been observed. It is not safe to trust to any other method of noting the position, as mines may be dragged some distance after being let go.

The buoy-line must be led clear away from the lowering line, and one man should pay it out taut as the mine is lowered, throwing the buoy as far away from the vessel's side as he can when the mine is let go.

The chief points to be attended to in laying out a line of mines when once slung, are, to take plenty of time about it, to see that everything is clear for running out, and to lower each mine in succession at the proper time.

Ground mines should be lowered away gradually "to the mark" as the previous one is let go, so that the intermediate chain and cable may be gradually stretched out; at the same time care must be taken not to hold on to the lowering line too long, or the mine may be dragged along the bottom. To obviate this, the first mine is sometimes let go "by the run," the remainder being lowered away as usual.

Laying out buoyant lines of mines correctly is one of the most difficult operations in submarine mining work. Low water, slack tide, is the best time to lay these mines. Squads should be practised frequently at this work, beginning with short lines of two mines. The mines should always be called No. 1, No. 2, &c., in the order in which they are let go, quite irrespective of what their real numbers may be in the mine-field. The men will then

get quite familiar with the operations consequent on each order.

The orders for a line of ground mines will then run as follows:—

Lower away No. 1 to the mark—(pause)—No. 1 mine let go, and Lower away No. 2 to the mark—(pause)—No. 2 mine let go, and Lower away No. 3 to the mark, &c.; and for a Buoyant line of Mines, with short lowering lines: Lower away No 1 sinker—(pause)—No. 1 mine let go, and lower away No 2 sinker—(pause)—No. 2 mine let go, and lower away No. 3 sinker, &c.

Laying Out Mines on the Line System.

Drill for lines of mines.

The party will consist of 1 non-commissioned officer and 2 men per mine, under the command of an officer or senior non-commissioned officer, who will give the executive words of command.

Duties of Numbers.

No. 1 superintends his party, repeats the words of command given by the officer in charge, sees that the various numbers perform their duties correctly. At the word "stand by to lower away," sees that the lowering hooks are unkeyed, and proper lashings cast off. At the word "lower away to the mark," sees that lowering lines are properly eased off. At "stand clear" sees that all men are standing clear of all running gear, stations himself with the axe near the weight, and sees that all goes clear at the word "let go."

No. 2 For Line of Ground Mines. Takes up position by No. 1 mine. At the word "stand by to lower away," he unkeys lowering hook and casts off lashings, then assists No. 3 till the lowering hook disengages itself.

For Line of Buoyant Mines. At the word "stand by to lower away," unkeys lowering hook, casts off foot lashing of No. 1 mine, assists No. 3 until lowering hook disengages, then makes ready to let go head lashing, which at the word, "No. 1 mine let go," he lets go, overhauls, and coils down.

No. 3 takes up position by No. 1 mine or sinker. At the word "stand by to lower away," he prepares to lower away. At the word "lower away to the mark," he lowers away gradually to the amount ordered. If the lowering hook has disengaged itself, he overhauls and coils down. If the weight be still on the lowering line, he will at the word "No. 1 mine let go," throw the lowering line smartly off the cleat, overhaul when clear, and coil down.

No. 4 performs the same duties as No. 2 for No. 2 mine.

No. 5 performs the same duties as No. 3 for No. 2 mine.

No. 6 and 7 the same for No. 3 mine, and so on.

All numbers assist in paying out the cable as soon as they have performed the above duties.

Raising Mines.

The steamer receives the end of the cable from the junction-

To face p. 76.

LAYING OUT GROUND LINE OF MINES IN 50FT. OF WATER.

1 and 2 port side; intermediate cable and chain between 2 & 3 taken round bow outside & under joggle. "No 2 let go", "Lower away No 3 to the mark".

Fig 2.

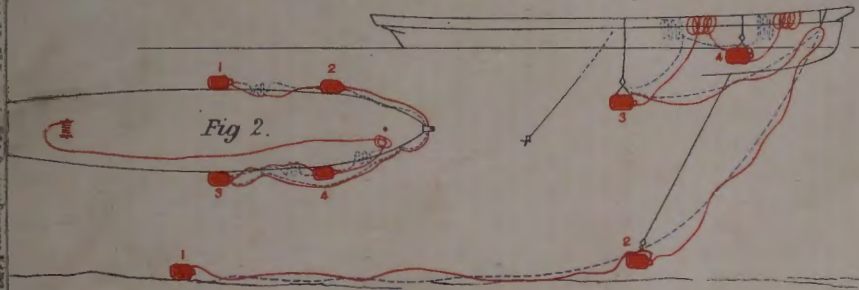


Plate XXVI

To face p. 76.

SLINGING AND LAYING OUT BUOYANT LINE OF MINES FROM 80 FT: MINER IN 70 FT: OF WATER, EVEN BOTTOM, AND SLACK TIDE

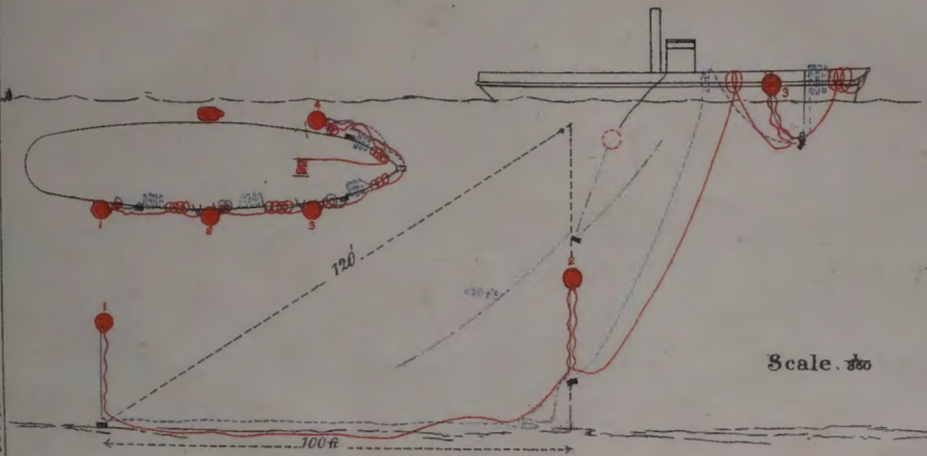
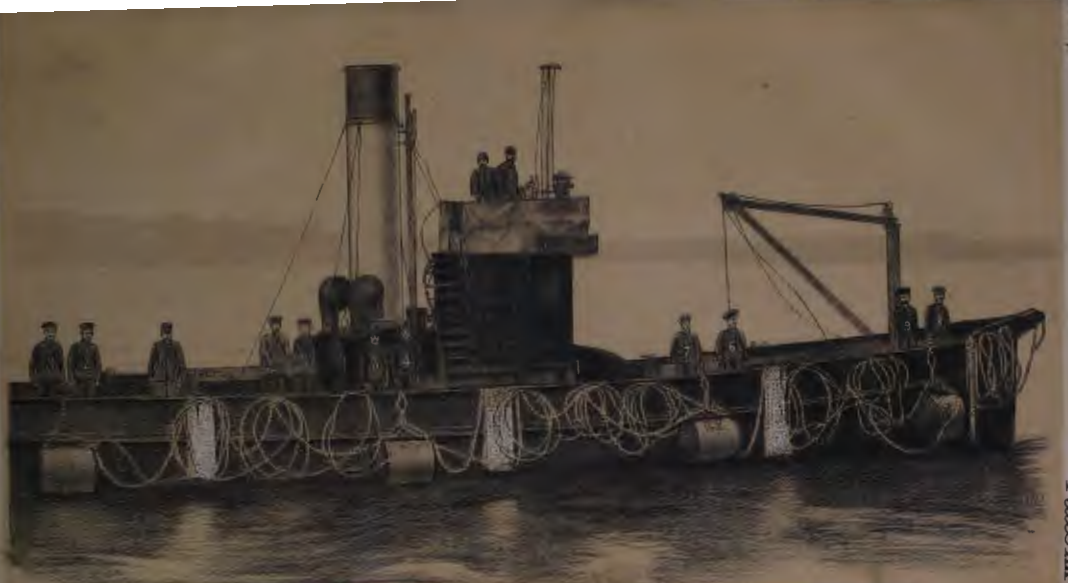


Plate XXVII.

Judd & Co.ˢ Lith. 3 & 5 Farringdon Rd & Doctors Commons 1870 & 80

Face p. 76.



Line System–4–500 lb. Ground Mines on "Sir Francis Head."

box boat by means of a throw-line, and at the same time heaves a throw-line back to the boat in exchange. If more than one mine in a group is to be raised, it is well to begin with the mine last laid out, as the cable is then more likely to come up clear.

The cable is laid over the joggle or fair lead, and is coiled down in a convenient place or on an expanding drum. The vessel must be manœuvred by the coxswain so that the cable comes up easily; she must not be allowed either to over-run the cable or get broadside on to the lie of it. The cable should not be hauled in by means of the steam crab unless all other means fail, and then a rope, stoppered to the cable, should be passed round the barrel or drum and not the cable itself.

As soon as the end of the tripping chain is reached the four-fathom length of chain is shackled on if required, and is passed four times round the barrel of the crab or capstan, and the mine-case or sinker is hauled up to the joggle, the stops on the tripping chain being cut as soon as possible. The cable must be carefully kept clear of the chain while the weight is being raised.

A stopper is kept loosely on the tripping chain at this time in case of anything parting.

When the weight is up, the derrick tackle is hooked in so that it may be lifted in board. Where vertical capstans are used it is well to stopper the tripping chain and remove it from the barrel *before* putting on the derrick fall to the latter. The capstan engine then works in the proper direction suited to the "lead" of the slide valves, and all chance of a foul tripping chain is avoided. The practice of passing the fall of the derrick tackle round the drum the reverse way to the tripping chain is not to be recommended.

As soon as the sinker or ground mine-case is on deck, the fall of the tackle is used to get the mine or circuit closer-case on board. The latter should be secured by one hand as soon as it appears. To get hold of it quickly in a seaway is difficult, and much time is often lost in trying to hook on the block of the derrick fall. A 2-in. wire rope pennant, fitted with a stiff long backed hook at one end, has been used with satisfactory results; the pennant is fitted with a couple of eyes for hooking on the block when the mine is caught. The hook at the end of the pennant is hooked either into the top lug or the attachment chain; the whole pennant is about 5 feet long.

As soon as the complete mine is on deck, the sinker is rolled aft, the mine slid aft on a sleigh or paunch mat, and the cable coil is neatly stowed on top of the case. If there are many mines to be raised it is well to have a few extra hands on board to shift the mines and help to coil down cables.

E. C. mines should be raised at an average rate of 12 to 15 minutes per mine.

Raising mines in hired vessels.

Very good work can be done in raising mines in hired vessels. Joggles are not a necessity, and are often impracticable in these boats. A good fair lead on one bow does very well, and a gaff rigged to the foremast with a topping lift and fall replaces the derrick. In many places steam lighters are used, in which the foremast is right forward, and there is a tall derrick working aft

over a big cargo hold; in these vessels the mines can be picked up over the side without any joggle or fair lead; the cable is coiled down in the hold, and the sinker is raised in two or more lifts by the fall of the derrick, which usually gives a lift of 25 or 30 feet. The tripping chain can be made fast to the hook by means of a Blackwall or man-harness hitch. The sinker and mine are lowered away into the hold as soon as they come on board, out of the way.

Raising from the mine end.

A mine when awash is often picked up from the mine. The best way is to pass a chain running-noose over the case and allow it to drop down to the sinker, then jerk the noose tight and haul up. The noose is formed by shackling the long link to the standing part, the pin of the shackle being through the long link. This noose or "snotter" is of great use in many cases as an under water stoppering arrangement.

Raising lines of mines.

The tripping chains of lines of ground mines are arranged so that each mine can be detached without disturbing the continuity of the chain. Screw shackles should be used if possible. No special difficulty is presented by the operation.

Raising Mines.

Drill for raising mines.

The party consists of 1 N.C.O. and 6 men.

Duties of Numbers when under-running.

No. 1 commands.

No. 2 receives end of cable from J.B. boat, works in the bow in under-running the cable.

No. 3 works just aft of No. 2.

No. 4 works just aft of No. 3.

No. 5 } Assist in coiling down cable.
No. 6 }
No. 7 }

Duties at Mine.

No. 1 commands.

No. 2 hands end of tripping chain to No. 6, keeps cable and tripping chain from jamming, has charge of hook of derrick tackle, unshackles mooring lines and tripping chains.

No. 3 stoppers cable or tripping chain when required, keeping a stopper loosely on the tripping chain whilst the weight is being raised, so arranged that he can tighten it at any moment.

No. 4 has charge of port guy, coils down cable, secures cases.

No. 5 has charge of starboard guy, coils down cable, secures cases.

No. 6 has charge of 4-fathom length and tripping chain at the crab; cuts stops of tripping chain.

No. 7 has charge of end of fall of derrick tackle, and assists at the crab.

Duties when disembarking Mines.

No. 1 commands.

No. 2 hooks block of lifting tackle into weights to be disembarked.

No. 3 assists No. 2.

No. 4 } Assist No. 7.
No. 5 }

No. 6 disembarks tripping chain, prepares branch cable for disembarking,

No. 7 has charge of hook rope, guides weights with it when being disembarked.

CHAPTER VII.

SIGNALLING.

CONTENTS.

Indispensable for submarine mining.—Classification of signallers.—Militia and Volunteer signallers.—Miscellaneous signals.—Speed.—Accuracy.—Principles of visual signalling.—Method of communication.—Sending to two or more stations at once.—Expert signallers.—Apparatus and method of use.—Large flags.—Small flags.—The lime light.—Constituent parts of.—Oxygen gas.—To trim the lamp.—To obtain the light.—Range.—The hand lamp.—Telescopes.—Arrangement of lenses.—Signalling by sound.—Flag drill.—Beginners.—Practice with recording instruments.

Signalling indispensable for submarine mining.

A simple and efficient system of signalling is indispensable for submarine mining operations, and it should be available for use at all times between working parties, whether on shore or at sea.

The conditions under which submarine mining signalling is carried on, differ altogether, in most cases, from those which obtain in army signalling.

As a rule there is only one man sending or receiving, so that messages cannot be written out in the manner prescribed for army messages. Again, it is necessary that as many men as possible should be trained to send and read simple messages. This necessitates a low standard of speed for the majority, in comparison with that laid down for the specially trained and selected signallers of the Army. A higher standard of proficiency is, however, expected from a small proportion of the men, who should, in the time available for practice in signalling, be trained to the highest possible standard, so that they may be able to communicate, if necessary, with the signallers of the Army or Navy.

Classification of signallers.

For signalling purposes the N.C. officers and men of submarine mining companies are classified as follows:—

Expert signallers	Class A.	Men borne on the list of trades as "signallers."
	Class B.	Men reaching the standard of "Expert Signalling," viz., 5 words per minute with large flag.
Ordinary submarine mining signallers		Men who can send and receive accurately at a rate of 4 words per minute.
Men possessing no signalling qualifications.		All those failing to reach the standard of ordinary S.M. signallers.

The percentage of the last-named class should be small, and every effort should be made to keep it as low as possible.

Militia and volunteer signallers.

The conditions of training and practice of volunteer and militia submarine miners are such as to render it necessary to specialize the work of individuals to a greater extent than is desirable or necessary in the case of the regulars. Signallers in these branches of the Service should be carefully selected with a view of obtaining considerable efficiency from a few. Having obtained this result every facility should be given to the remainder to acquire the art as soon as they are proficient in their other S. M. duties. The specialized signallers should qualify as "experts," and should attain a high standard of excellence.

Miscellaneous signals.

It will be observed that the miscellaneous signals for "ordinary" signallers are reduced to the smallest possible number, and the "method of communication" contains only what is absolutely required for the short unwritten messages that form the great bulk of those used in submarine mining operations.

"Expert" signallers are required to possess a more extended knowledge of the miscellaneous signals, the methods of sending written messages with prefixes, &c.

Speed.

The standard of speed for sending and receiving, *words*, is much lower than that to which army signallers have to conform. The reduction in speed should be due more to the length of the *pauses* between individual letters and words than to a reduction in the speed at which the letters themselves are signalled. If the men get accustomed to send and read the *letters* when signalled at a comparatively high speed, the acceleration of the rate of reading *words*, due to a gradual reduction of the length of the pauses, is merely a question of practice.

Accuracy.

The standard of accuracy for ordinary S. M. signallers is that known as "fairly accurate," in the Manual of Army Signalling (p. 76 *et seq.*), that is to say, 93 per cent. of the letters in two "test" groups must be read correctly.

An example of a test message is given on page 86 (Manual of Army Signalling). It is formed by selecting at random the letters of three alphabets and forming them into 20 subdivisions of unequal length. This message only contains 78 letters, but is considered equal to a message of 20 ordinary words of an average length of 5 letters.

The standard for "expert" signallers is that known as "accurate," *i.e.*, 95 per cent. of the letters must be read correctly.

The total number of mistakes allowed in the two test groups is therefore—

For "fairly accurate"	..	..	11
For "accurate"	..	..	8

Principles of Visual Signalling.

Dots and Dashes.

The system of visual signalling has but two simple elements, called a dot and a dash, and these are combined in groups to make up the signals necessary to form an alphabet.

The dot is taken as the unit, and the dash represents three times the length of the dot.

The pause between each complete sign or letter should be made equal to a dash or three units, and that between words is double, *i.e.*, six units.

Good signalling depends upon the accuracy with which the correct lengths of dots and dashes and the separating intervals and pauses are maintained. Whatever the rate of signalling may be, these relative lengths should be strictly adhered to.

The alphabet in use is that invented by Morse. It is constructed so that the letters of most frequent occurrence in the English language are represented by the shortest symbols, and no letter requires more than four of the elements for its composition.

The following table shows the Morse alphabet and the few miscellaneous signals adopted into the system of Army Signalling :—

Alphabet.

A	·—	N	—·
B	—···	O	———
C	—·—·	P	·——·
D	—··	Q	——·—
E	·	R	·—·
F	··—·	S	···
G	——·	T	—
H	····	U	··—
I	··	V	···—
J	·———	W	·——
K	—·—	X	—··—
L	·—··	Y	—·——
M	——	Z	——··

Numeral Signs.

1	·————	6	—····
2	··———	7	——···
3	···——	8	———··
4	····—	9	————·
5	·····	0	—————

Miscellaneous Signals.

The only mark of punctuation to be used is the full stop, viz. (.), ·– ·– ·– III

Preparative and Erasure, – – – – – – – – –, &c.

(*A continued succession of dots.*)

The PREPARATIVE SIGN is used when communicating with two or more stations in sight, to call their attention before sending a message. It is also used to call the attention of an unknown station. To acknowledge this sign the receiving station should give, instead of the "General Answer," its distinguishing letter or letters (without the prefix P), and repeat this till the next signal is begun. When used at other times, to be answered by the General Answer.

This sign is also the ERASURE SIGNAL. It is used to erase a word or group that has been wrongly sent. It should, in this case, be answered by the Erasure.

Stop – · – · – · – · –, &c.

(*A continued succession of dashes.*)

The STOP denotes the end of a message when sending to two or more stations, and the previous signal, the "preparative," has commenced it.

General answer, – · –, a T or *dash*.

Repeat – · – · – · – · (sometimes called I M I; but the signal is given continuously, not as three letters). It is never used alone, but is immediately followed by the word preceding the doubtful words.

Signaller's indicator, · – · – · – (commonly called A A), preparative to the abbreviations on page 86*, should only be used when a message has been commenced. It is answered by the indicator.

The CIPHER SIGN, – · – · – · – · – · – (CC), is used before and after cipher groups. It is answered by the General Answer.

The BREAK SIGNAL, – · – · (II), is used between the address and the text of a message, and after the text if the name and address of the sender are to be signalled.

The signal · – · – · – · (VE, but sent as one group, not as two letters) denotes the completion of a message.

The OBLITERATOR, · – · – · – · – · – · – (commonly called W W). This sign is used to erase everything that has been signalled in a message, and differs from the Erasure Signal which erases only a word or group that has just been wrongly sent; it should be answered by · – · – · – · – · – · –, the Obliterator.

Method of Communication.

"Ordinary" signallers are required to know— Method of communication.

(*a.*) The Morse alphabet;

(*b.*) The "preparative" sign;

(*c.*) The "general answer;"

(*d.*) The "stop" sign;

(*e.*) The "erasure" and "answer to erasure;"

(*f.*) The station sign P (· – – · –), followed by the distinguishing letter of the station.

* Manual of Instruction in Army Signalling.

In submarine mining work there are usually a good number of "stations" in view of each other at the same time. To avoid confusion, therefore, it is necessary that each "station" and boat should have a distinguishing letter, which should be known to all hands. The mode of communication will then be as follows:—

PA has a message for PK.

(1.) PA signals PK, PK, PK, &c., until PK replies with the "general answer."

(2.) Then follow the words of the message, each word being acknowledged by the "general answer."

If the receiving station does not understand a word, it stands fast, making no sign, and the sending station repeats the word.

If the sending station makes a mistake in sending a word, it immediately signals the "erasure," and the receiving station answers by "erasure."

(3.) After the last word of the message, the sending station sends the "stop" sign; the receiving station sends "general answer," and RD communication ceases.

Sending to two or more stations at once.

When a message has to be sent to two or more stations at the same time, or to a station with no distinguishing letter, the "preparative sign" is signalled until all the receiving stations have answered. This answer is made by each station signalling its distinguishing letter (without the prefix P), and repeating this until the next signal is begun.

"Expert" signallers are required to have a more extended knowledge of the miscellaneous signals, and the methods of sending and receiving written messages, for which see Appendix I, Royal Engineers Corps Memorandum, No. 584, and the Manual of Army Signalling.

Apparatus and Method of Use.

Flags.

From the fact that flags are visible, but not fully exposed except when in motion, the short and long flashes are made by the motion of the flag instead of by the appearance and obscuration of the object.

When signalling a letter, say R (. — .), the flashes representing it should be made in one continuous wave of the flag, taking particular care that no pause is made when at the normal position. Thus, to make R, wave the flag from *a* (Plate XXIX, fig. 1), to *b* (fig. 2), back to *a* (fig. 1), and without any pause down to *c* (fig. 3), slight pause at *c* (*vide* instructions for making a dash) back to *a* (fig. 1), then, without pause, to *b* (fig. 2), and back to the normal position *a* (fig. 1).

A pause equal to the length of a dash should be made at the normal position *a* (Plate XXIX, fig. 1), between each letter of a word, or group of letters. When the word or group is finished the flag pole is lowered, and the flag gathered in with the left hand.

A slight pause should be made at the normal position, before commencing a word or group.

FLAG SIGNALLING.

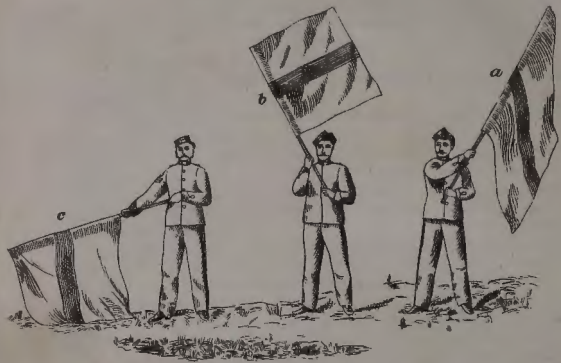


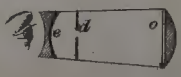
Fig. 3. *Fig. 2.* *Fig. 1.*

TELESCOPES & FIELD GLASSES.

DIAGRAMS SHOWING ARRANGEMENT OF LENSES.

Fig. 4

Fig. 5



Judd & Co Ltd Lith. 73 & 75, Farringdon Rd & Doctors Commons

In receiving a message, the flag should be lowered and gathered in until required for answering.

In order to keep the flag always exposed while moving it across the body to form the flashes, the point of the pole should be made to describe an elongated figure of 8 in the air.

The pole should be kept as upright as possible while in motion, the point never being allowed to droop to the front. This must be particularly attended to after signalling a dash.

When two or more dashes come together in a letter, some signallers are apt to shorten the waves by not bringing the flag back to the normal position between each dash.

This habit must be carefully guarded against, as it spoils otherwise good signalling, destroying the idea of time, without which it is impossible either to send or read correctly.

When signalling to a station the flagman should stand square with it, so that the motions of the flag may be at right angles to the visual line between the two stations.

The large flags are 3 feet square, made of a sort of muslin. They are of two colours, viz., white with a blue horizontal stripe, for use with a dark background, and dark blue, for use with a light background. The pole is 5 feet 6 inches long, 1 inch in diameter at the butt, and tapering to $\frac{3}{8}$ inch at the top.

Small Flags.—These are of the same material as the large ones, but 2 feet square, and with a pole 3 feet 6 inches long, $\frac{3}{4}$ inch in diameter at the butt, and tapering to $\frac{1}{4}$ inch at the top.

The drill with these flags is the same as that described for the others, except that the hands must be held higher and closer together, with the arms nearly straight, the left hand not to be lower than the chin. The tendency to allow the elbows to rest on the chest must be strictly guarded against.

The distance at which signals made with these flags can be read, and therefore their value in saving signallers the labour of using the larger flags, depends on their being waved through a wide circle. It is therefore essential that signallers should be drilled to use them correctly. They should be waved well over the head. With clear sending and under favourable conditions these flags can be read with the ordinary Service telescope at distances up to 12 miles.

The Lime Light.

This light is derived from a pencil of lime raised to a white heat by means of an oxy-hydrogen flame. It is obtained by causing a jet of oxygen gas to pass through the flame of a spirit lamp on to the end of the pencil.

The apparatus consists of the following parts:—

1. The body of the lamp.
2. Obscuring shutter with key.
3. The spirit chamber.
4. The pencil-holder.
5. The tripod.
6. Gas and pressure bags.
7. Gas tubing.

1. The body of the lamp has an opening in front to take the

carriage containing the lens arrangement for emitting parallel rays. This consists of two plano-convex lenses, each 3 inches in diameter, placed about half-an-inch apart, with the convex surfaces towards one another, so that both the plane surfaces are outwards, and it is immaterial which end of the carriage is screwed into the opening. There is a hole in the back of the lamp to receive the pencil-holder. The lamp has also a perforated cap, a hinged door, and a handle.

2. Obscuring shutter and key. Between the light and the lens is a metal disc, which is raised and lowered to expose and shut off the light by means of the key on the outside of the lamp. This key is covered with ivory or other non-conductor of heat. It is acted on by a spring outside the lamp, which maintains the shutter in the obscuring position.

3. The spirit chamber has a burner in the middle for a cotton or sponge wick. Along the top of it is fixed a conducting pipe for the gas, which terminates in a nozzle projecting into the spirit flame. There are also two pins attached to chains, which serve to fasten the body of the lamp securely to the top of the spirit chamber. A sighting tube is fixed on the spirit chamber.

4. The pencil-holder is a metal claw for holding the lime pencil.

5. The tripod or stand is the same as that of the heliograph.

6. The gas bag is made of waterproof material, and will contain about 3¼ cubic feet of oxygen gas. It has a tap and a nozzle to which the tubing is attached. The pressure bag is of canvas, and should have from 12 to 14 lb. of sand or earth put into it on the spot just before being required for use.

7. The tube is of elastic indiarubber, ⅜ inch internal diameter, and connects the gas bag tap with the conducting pipe passing outside the spirit chamber. The tap is turned on full when the gas is required (the pressure bag having first been placed on top of the gas bag), and the supply of gas to the burner is then regulated by another tap on the conducting pipe immediately above the nozzle which receives the tubing.

N.B.—The lime pencil should be removed from the holder when the signalling is concluded.

Oxygen Gas.—The oxygen gas is obtained from a mixture in the following proportion (by weight), viz.:—

Chlorate of potash	3
(Granulated) binoxide of manganese ..	1

The binoxide of manganese is not a source of oxygen, but its presence facilitates the decomposition of the chlorate of potash.

To make the gas, put about 1 lb., or about two-thirds of a pint, of the above mixture in the retort, and place it on a fire having previously screwed the cap tightly home.

The fire should be a slow one, made of wood, not of coal, which injures the retort. On no account should a fierce fire be allowed.

Before placing the retort on the fire, the tap of the gas bag should have been opened and connected by means of a piece of elastic tubing to that part of the wash bottle marked "out," and a separate piece of tubing, attached to that part of the wash

bottle marked "in," is held in the hand, and as soon as the gas begins to come it is connected to the tube of the retort.

NOTE.—The retort must be thoroughly dry, and the potash well mixed with the manganese.

The gas will now pass through the wash bottle to the bag.

Shortly after the retort has been placed on the fire, steam will be given off, but it is easily distinguished from the oxygen by holding a piece of burning wood (without flame) to the tube of the retort, when, if oxygen is passing, a brilliant white flame will be produced.

The wash bottle should be about half full of cold water.

The tubing and the wash bottle should be blown through before use, to make sure that all is clear.

If the gas comes too freely the retort should be taken off the fire, but should be placed in a warm position near it, and replaced when necessary.

Not more than 1 lb. of the mixture for making the gas should be put into the retort at a time. The gas from 1 lb. of the mixture will fill two bags. When the gas has ceased, the retort should be removed from the fire and allowed to cool; when cool, it should be washed out with water and placed on the fire to dry ready for use again.

To Trim the Lamp

1. Remove the body of the lamp from the spirit chamber by taking out the pins which secure it, and lifting it off.

2. Unpin the gas-pipe and take it off. Take a piece of cotton wick about 7 inches long, and thick enough to well fill the holder without packing it too tightly. Lay the strands carefully together. Insert the wick into the holder, without twisting the strands. Cut the wick nearly flush with the top of the holder but leaving a few strands projecting ¼ inch just where the gas-pipe enters the holder. Re-fix the gas-pipe, bedding the nozzle in the projecting strands of the wick so that it may be wrapt in flame when the spirit is lighted. Now press the strands in front of the nozzle right and left of the orifice, forming a little channel to give free passage to the jet of gas. It is most important that these points should be carefully attended to, for a very slight obstruction to the jet of gas or any excess of flame will mar the light.

3. Fill the chamber with the spirit of wine.

4. Replace the body of the lamp on to the spirit chamber, taking care that the oxygen jet points towards the lime pencil-holder.

To obtain the Light.

1. Light the spirit lamp.

2. Place a lime pencil about 1 inch long in the holder, the end next to the lens having been cut or rubbed flat at right angles to the longer axis of the pencil; put the pencil in position, and allow it to heat in the spirit flame for a short time.

3. Connect the gas bag by a piece of indiarubber tubing to the conducting pipe in front of the spirit chamber.

4. Place the pressure bag on top of the gas bag.

5. Open the tap of the gas bag.

6. Turn on the tap of the lamp and adjust the lime pencil by moving the holder backwards or forwards, by a twisting motion, till the jet of gas impinges on the end of the lime pencil, and regulate the oxygen tap till just sufficient gas passes through to raise the end of the pencil to an intense white heat.

The intensity of the light depends on the exact proportion of the two gases in the flame that is brought to bear on, and to completely cover, the end of the pencil. In making this adjustment the signaller should look at the reflected image in the lens. If the end of the pencil is dark, it is evident that the gas flame does not strike it. In this case either the pencil is too far back, or there is not enough gas turned on, or it may be that the pencil is too far forward, and that the gas strikes the bottom of it. If the end of the pencil is bright, but with a dark spot in the middle, it is too far forward or there is too much gas turned on. If the upper part be dark and the lower bright, the pencil is too far forward. If the reverse be the case, it is too far back. If it be found impossible to get a good light by any adjustment of the pencil and the supply of oxygen gas, the fault lies probably in the supply of hydrogen from the spirit flame; there is either too much or too little, *i.e.*, the wick is too high or too low. Particular care must be taken not to have too much flame.

When everything is in order, the end of the pencil should be about $\frac{1}{10}$ inch in rear of the centre of the wick, no flame should strike against the chimney, and the reflected image seen in the lens should be a disc of bright light of uniform intensity without a shadow or spot over it.

It remains now to provide that the greatest possible amount of this light shall reach the distant station. This is done by adjusting the lens so as to bring it into proper focus. Place any object about 18 feet in front of the lamp, and adjust the focus until the smallest possible circle of light is obtained. This will generally be about 18 inches in diameter for the above distance.

The light is now ready for use.

In this description of the necessary points to be attended to in the adjustment of the lamp, it is taken for granted that the gas-pipe has been properly bored and bent so as to throw the jet of gas in the right direction, that is, on the centre of the face of the pencil. This adjustment requiring great nicety should be tested before the issue of the lamp, and the signaller should on no account be allowed to tamper with the gas-pipe.

To maintain a good light when signalling, constant attention must be paid to the lime pencil, 1st, to see that it is kept in a proper position with relation to that of the oxygen jet; and 2nd, to watch whether it is cracking; if so, it generally crumbles away and must be replaced, as speedily as possible, by a new pencil. The supply of gas must be carefully regulated when in use, and economised as much as possible when not signalling. The direction of the lamp must also be attended to, to see that it is always kept on to the receiving station. The alignment is obtained by means of the sighting tube, or pinkets, as described below.

The gas bag tap remains turned on so long as there is any gas in the bag. During a cessation of work the tap at the lamp should be turned off, and the pressure bag removed. When it is required to work the lamp again the pressure bag should be placed on the gas bag before turning on the tap at the lamp.

The range of this light exceeds 20 miles in England.

When practicable the direction of the distant station should be fixed as accurately as possible by day, and marked with pickets. The tops of these pickets must be in exact line between the proposed position of the lamp at night and the distant station.

When aligning the lamp by means of the sighting tube, which is fixed to the top of the spirit chamber, the signaller looks through the pin-hole at the rear end, and turns the lamp until the distant light is brought fully into the field of the tube.

The Hand Lamp.

This lamp is an ordinary bullseye with a flat double 1½ in. wick fed by colza or other vegetable oil. Mineral oil must not be used. It is provided with a disc. A key on the outside opens or obscures the light.

The wick should be placed with its edge turned towards the bullseye. Care must be taken not to stop the supply of air to the lamp through the air-holes at the bottom.

The stand for this lamp consists of a tripod, the legs of which fit into each other. It has a metal knob with studs which fit into the base of the lamp.

Telescopes.

It is not only necessary that signallers should thoroughly understand the use of field-glasses and telescopes, but they ought further to be able to clean the lenses when required, and to replace them in their proper position. To enable them to do this, diagrams, showing the arrangements of the lenses in each of these instruments are given in fig. 4, Plate XXIX.

The portion of the telescope A B forms the eye-piece, consisting of an object-glass *c*, a diaphragm *d*, an amplifying lens *a*, a field-lens *f*, another diaphragm *d*, and eye-lens *e*. The object-glass of the telescope is shown at O. This glass consists of two lenses, one a thin double convex lens, and the other a thicker plano-concave lens. One convex surface of the former fits into the concave surface of the latter. Care must be taken to replace these lenses so that the thicker one has its plane or flat surface towards the eyes, while the thin lens is outside towards the distant object. The curves of the lenses are exaggerated to show clearly the side that should be turned towards the eye E when replacing them in the tubes.

Field Glasses.

The arrangement of lenses shown in fig. 5, Plate XXIX, consists of an object-glass *o*, diaphragm *d*, and an eye-piece *e*.

It is well to remember that in replacing the object-glass of a telescope or field-glass the curved side should always be turned from the eye towards the object to be viewed.

The glasses should be cleaned with chamois leather or blotting

paper, and should be removed from the tubes as seldom as possible. The interiors of the tubes of telescopes and field-glasses are purposely blackened and must not be cleaned. In opening out a telescope the tubes should be slightly twisted round, not drawn out straight, and the same should be done in shutting up a telescope.

Signalling by Sound.

Signals may also be made by sound with bugles, fog-horns, steam-whistles, &c. They may be made with short and long calls, representing dots and dashes, or, with any instrument that will give two notes, they may be given with a higher note representing a dot, and a lower note representing a dash. Where the signals are given with one note the time must exactly correspond with that laid down in the above instructions.

Flag drill will be practised in accordance with "Manual of Instruction in Signalling."

1st Exercise—

On the Command "*Fall in,* NUMBER BY THREES."	If the Squad numbers 10 and under. Fall in at right angles to the wind in single rank, flags at the order gathered in at the right side and number off by threes.
On the Command "PREPARE FOR FLAG DRILL."	Nos. 2 and 3 turn about, and on the word "March," No. 2 takes 6 paces to the rear, halt and front; No. 3 takes 12 paces to the rear, halt and front. *It is optional to the Instructor to turn his Squad Half-right, or in any direction according as the wind may be blowing.*
On the Command "FALL IN—NUMBER."	If the Squad number 20 or more, fall in in two ranks, files 2 paces apart and number.
On the Command "PREPARE FOR FLAG DRILL." "MARCH."	The whole turn about, except the right file front rank and on the word "March." The Left files front rank take 6 paces, halt and front. The Right files rear rank take 12 paces, halt and front. The left files rear rank take 18 paces, halt and front.
On the Command "PREPARE TO SIGNAL."	The flag pole is brought diagonally across the body, pointing upwards to the left. The right hand grasps the pole 8 inches below the flag, which should be gathered in and held in the hollow of the left hand. The right foot is separated from the left 12 inches to the right. *Care should be taken that in this position the Signaller does not hold the flag too high—about the middle of the body being high enough.*

On the Command "READY."

Raise the pole smartly with the right hand until it is in line with the left shoulder, seize the butt of the pole with the left hand opposite the centre of the body. In this position the left elbow should be close in to the side, the left forearm square with the wrist rounded outwards, and held 6 inches from and 6 inches in front of the centre of the body. The right hand will still remain 8 inches below the flag, but without constraint.

The pole should be held high enough to see underneath the flag when in motion.

In this the normal position the flag pole should make an angle of 25°, with a vertical line through the centre of the body.

Before proceeding any further the Instructor should pay strict attention to the Signallers in this position. He should see that the right hand is not held too high, that the left hand is not cramped into the body, that the flag is kept to the angle of 25°, that the Signaller does not lean back on the heels but slightly forward, and that the flag pole is not allowed to droop to the front or rear.

DOTS BY NUMBERS.

Wave the flag from the normal position to the corresponding position on the opposite side of the body.

On the Command "ONE."

Strict attention should be paid in this practice to the way the Signaller forms his dot.

1st. That he describes a curve in the air with the flag pole, and does not bring it straight from left to right, which causes the flag to wrap round the pole.

2nd. That the left elbow is kept close in to the body.

On the Command "TWO."

Bring the flag back to the normal position.

These motions should be constantly practised before the Signaller is allowed to make the two combined.

On the Command "1 DOT."

Wave the flag from the normal position to a corresponding position on the opposite side of the body, and back to the normal position without any pause.

Care should be taken that the Signaller in making the dot, makes the point of the pole describe an elongated figure of 8 in the air.

When the dot is made correctly then practice making 2 dots, 3 dots, and then a succession of dots, seeing that no pause is made when coming back to the normal position, so that the wave is continuous.

On the Command "STEADY."

Return to the normal position.

DASHES BY NUMBERS.

Wave the flag from the normal position till the point of the pole nearly touches the ground (on the opposite side of the body), the right arm

On the Command "ONE."

straight, wrist rounded outwards, the left elbow close into the side, and the left hand not allowed to drop or come across the body.

The Signaller should be taught to keep his eyes straight to the front, and on no account to let them follow the motion of the flag, also to keep his body perfectly upright, and not lean over to his right in making the dash.

On the Command "TWO."

Bring the flag back to the normal position smartly, in a straight line, and not with the curved motion.

Care should be taken to guard against the tendency to bring the flag too far back over the left shoulder. It should stop at the angle of 25°.

On the Command "1 DASH."

Wave the flag from the normal position till the point of the pole nearly touches the ground on the opposite side of the body (straighten the right arm), make a slight but distinct pause, and back to the normal position.

A succession of dashes should then be practised, but no pause made at the normal position after each dash.

On the Command "STEADY."

Return to the normal position.

In signalling, the point of the pole should not be allowed to droop to the front or rear.

It is good practice to teach the Signaller to make his dashes with the right arm alone, keeping the left behind the back.

In signalling two or more dashes, the Signaller is apt to cut his dashes short.

This should be strictly guarded against.

Constant practice of dashes by numbers is the best way to obviate this.

Too much attention cannot be given when instructing Signallers to the importance of making the dots and dashes perfectly by numbers, if allowed to cut either short, they will invariably make very bad senders, and consequently their signalling will be hard to read.

The Signaller in being taught to make a letter should make that letter quickly, and on no account slowly, or pausing between the elements, which tend rather to make the Signaller slow throughout.

When instructing, each letter must be made sharply and a longer pause allowed between letters; this is the better way of teaching, as it gives the Signaller a more correct idea of time.

There is only one TIME common to all signalling, and this TIME should be taught and acquired from the commencement.

2nd Exercise { "*One dot*, E" / "*One dash*, T" / "*Dot dash*, A" / &c., &c. } Executive words of command.

NOTE.—As soon as the class begin to know the letters, the executive word should be changed to "*Signal* E," "*Signal* A." &c &c.

"*Order flags.*"
"*Stand at ease.*"
"*Stand easy.*"
"*Attention.*"

3rd Exercise { "Signalling groups on the word 'commence'" (a caution). "T.F.R.M., *commence.*" / On this word the squad will (1) assume the normal position, (2) signal the letters named, (3) return to the position of attention.

Small Flag.

The drill with these flags is the same as with the large, except on the command

"READY." Bring the flag across the body as with large flag, the left hand in line with the chin, right arm below the eyes, both elbows free from the body, flag pole grasped firmly but not tightly, and both wrists turned outwards.

NOTE.—*In making the dash, the point of the pole should cut just below the right shoulder, and no lower, and the arms should not be allowed to drop.*

Beginners may also be taught the symbols by means of the hand lamp, which is a very good method. The lamp need not necessarily be lit, and, if used at short distances, the men can be taught to read by *sound* and *sight* simultaneously. By this means, the importance of the element of *time* in Morse signalling is impressed on the men. The lamp can also be used, of course, for teaching by *sound* alone, or by *sight* alone. The use of the lamp also permits of men being taught at night, when flag drill is out of the question.

Where recording instruments are available, practice with them is a very valuable aid to visual signalling. By the use of the recorder, the learner realizes the tendency to make the intervals between the dots and dashes composing a word incorrectly, more especially the tendency to lengthen unduly the interval succeeding a dash.

APPENDIX I.

WORKING RECORDS AND PREPARATION OF STORES.

The mine-field having been surveyed, the necessary plans and charts prepared, and the scheme of defence finally approved, the details for and of the preparation of the necessary stores for the submarine mining defence will be recorded in the books and forms authorised for the purpose.

It is necessary to divide the submarine mining records at the station into two distinct branches:—

(1.) Reference records.
(2.) Working details.

Reference records.

(1.) *Reference Records.*

These may be divided into store records (*a*), and defence records (*b*). Both are required for reference, but are liable to changes and alterations of different characters.

(*a*) *Store records* include ledgers, vouchers, establishment of stores, remains and inspection returns, lists of vessels and boats with their stores, record of weight and tests of loaded mines, stores issued or allotted to test-rooms, observing stations, &c., records of cable tests.

(*b*) *Defence Records* will show the actual or proposed distribution of the stores necessary for each mine-field, their state of preparation, and the scheme of mobilization. They include the following plans and papers:—

Survey Records, including triangulation, soundings, field books, details connected with alignment marks and ownership of land.

Confidential plans of defence. (Plans A, B, and C, *see* page 27.)

All confidential documents connected with scheme of defence, such as proposed modifications; stores required to complete authorised scheme; buildings required for the same; detailed account of boats, cables, electric light gear, &c., obtainable locally; standing orders for mobilization; detail, plan, and account of "friendly channel."

Mine-field record books, containing the details and forms necessary for preparing the stores for each mine-field, as well as a record of their state of preparation.

Fitting room records, containing details of the fitting and testing of all defence apparatus, junction-boxes, detonators, disconnecting fuzes.

Stores used for practice and instruction should be separated, if possible, from the other stores, and separate records should be kept for practice mine-fields. (This does not, of course, refer to lowering lines, lashings, buoys, &c.)

(2.) *Working Details.*

These are required for distribution to those in charge of the various operations connected with the laying out of the S. M. defences, and will consist of copies and abstracts from the necessary reference records. Thus, some of the details will be copied out into note books or on inventory boards, and others will be better given in the form of diagrams or plans. For use out of doors and on the water, waterproof paper and ink is recommended (the latter can be made from Judson's dye mixed with a little shellac and borax). Diagrams, not necessarily to scale, should be freely used for illustrating junction-box connections, disposition of cables in tanks and trenches, method of storage of mines and apparatus, &c.

The working details to be prepared are as follows:—

(1.) *Connecting up*, order of getting out, and details connected with main, group, and branch cables. Details of each mine.

(2.) *Slinging.* Notes as to the arrangements found to be most suitable for expeditiously getting the mines on to the laying-out steamers with full complement of men and boats.

(3.) *Laying out.* Working charts will be required for each laying-out vessel, showing appearance of alignment marks, and method of finding the position of each mine; also a book containing general orders for conducting the operations and a record of work done each day.

(4.) *Junction-box boats.* Note books with diagrams of connections in every box in the mine-field, and details for getting up communication with the test-room. List of stores to be carried in the boat.

(5.) *Alignment diagrams*, and orders for alignment party.

(6.) Test-rooms and observing stations will require diagrams of the disposition of batteries and cores; orders for testing and for routine in action; plans of mine-field; forms for recording system and general tests; diaries and note books; lists of all stores issued to them.

State of Preparation of Submarine Mining Defences.

The preparations made in peace time should be pushed as far as possible, so that the work to be done to complete the mine defences at the last moment may be a minimum; constant practice in peace time in laying out portions of the defence will tend to still further lessen the time required for this. Much will depend, however, on the system on which the stores are prepared, and the steps taken to record the state of preparation, and the scheme of mobilization.

Mine-field record book.

With the object of securing an uniform method in preparing and recording the state of preparation of the defences, the mine-field record book will be used at all stations in conjunction with the other books and forms already detailed.

A separate book will be kept for each mine-field so that there may be no confusion.

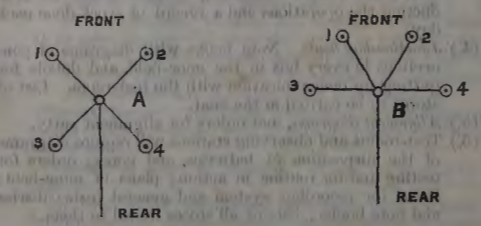
The forms hitherto used for the preparation of mines and cables have been modified, and where necessary are placed on the right hand pages of the book, the left hand pages being left blank for descriptive remarks and diagrams.

Fitting records.

The details of apparatus, relays, detonators, and disconnecting fuzes, electrical and hydraulic tests, are not recorded in this book. All this information will be afforded in the "Fitting Records," which should be kept in the fitting room, and which will show the existing state of preparation, and record of periodical tests, both electrical and hydraulic. These forms must be very carefully prepared and kept up, and the periodical tests must be made under the immediate supervision of an officer, who will be held responsible for their correctness.

Identification of Stores.

E.C. Mines.—The electro-contact mines will be divided up into groups known as A, B, C, &c. The letter I will not be used. With four mines to a group, this will provide for 100 E.C. mines. If there are more than that number of E.C. mines, the lettering of groups will continue AA, BB, &c. The individual mines of a group will be known as A_1, B_2, C_3, &c. The mines should be similarly numbered in each group according to their arrangement in the mine-field. Thus,—



This arrangement will tend to simplify matters and reduce the chances of mistakes in the junction-box boats. The labels for branch cables of E.C. mines need only bear the numbers 1, 2, 3, 4, and these labels will be put on in the junction-box boat when the cable is passed in by the laying-out steamer.

Observation Mines.—These mines will be known simply by their numbers. The numbering will commence at 200 or 300, well beyond the total number of E.C. mines, so that there may be no possibility of confusion.

The *lowest number* in each line of mines is to be the end mine containing the relay.

Cables and Cores.—All the cores leading from the terminal battens in test-rooms and observing stations, whether for mine-field or telegraphic purposes, will be numbered consecutively in Arabic numerals, no two cores bearing the same number. This system of identification will continue to the end of the core as permanently laid. In the case of land and shore-end cores leading from the test-room to the mine-field, this numbering will be reproduced at the connecting pit or in the connecting boxes at the end of the shore-end cable. From these points the mine-field cables may be said to commence, and these are identified differently. For instance, there may be 80 cores leading from the terminal battens of a test-room, of which 60 are led to a connecting pit near high water. Here 4 of the cores might be allotted to earths, the other 56 being connected to "shore-end" or short pieces of multiple cable, leading to connecting boxes in deep water. Of these 56 cores, 14 (say), are contained in two spare cables, and of the other 42, 39 are required for the mine-field and 3 for telegraphic purposes. All these cores will bear their numbers, 1 to 60, at the places where they terminate, whether in the connecting pit, or in the connecting or junction-boxes at the ends of the "shore-end." The cables carrying these cores will be identified as "land 1–7," "shore-ends 15–21," &c., the connecting or junction-boxes at their outer ends bearing similar marks; diagrams should be prepared showing the disposition and identification of all cores in connection with test-rooms and observing stations, and should be kept hung up in these places, corrected to date.

Main Multiple Cables will be numbered I., II., &c., as also the junction-boxes at their outer ends. Individual cores of these cables will be known as I. 5, II. 4, III. 7, &c.

Group Cables of E.C. mines, whether single or multiple, will be identified by the capital letters of the groups to which they belong, the individual cores of multiple group cables for dormant mines being known as F 1. 2. 3. 4.; G 1. 2. 3. 4.; &c. The multiple disconnecting junction-boxes and their buoys will bear the capital letters of the groups to which they belong.

Branch Cables are known by the numbers of the mines to which they lead. All branch cables should be labelled with their proper *lengths*; the identification label for each mine of a group should be put on in the junction-box boat.

Cables for link circuits will be labelled "link," together with the identification mark of the mines to which they lead.

Alignments.—Permanent marks should as a rule be known by their names, and artificial marks and their bearings by numbers.

Apparatus, mooring lines, and *disconnectors* will bear the identification marks of the mines to which they belong.

Apparatus will be stored in the condition laid down in Part III. Each apparatus is to be fitted carefully into its own mine when loaded, to see that it fits properly, and that no undue cross strain is brought on the eye-pipe when the mouthpiece is screwed down. A mark should be made on both case and

mouthpiece to ensure the latter being screwed down in the proper position after priming.

Apparatus for positive mines (odd numbers) will be marked with a + sign in addition to the number of the mine; *negative apparatus*, with a — sign. *The mouthpieces of positive mines* should be painted *black*. *Mooring lines* should be stamped with their lengths and mine numbers. *Circuit closer cables* should bear labels showing length and number of mine, and should, if cut, be stored together in bundles of groups. Interchangeable branch cables for E.C. mines will be marked with their lengths; those of equal lengths will be stored together. *Tripping chains* may either be stored with their mines or in heaps of equal lengths, each chain being labelled with its true length. Chain of different sizes must not be mixed up.

Guncotton, intended for mines which are not stored loaded, should be so arranged and labelled in the magazine, that no delay or confusion may arise when the mines are ordered to be loaded.

The state of preparation of test-rooms, observing stations, electric light engines and installations, will be dealt with in detail in the chapters referring to these subjects.

Connecting up the Defences for Laying Out.

For this purpose it is necessary to provide those in charge of the various operations with "details for connecting up." These details are abstracted from the mine-field record books into note books, which should be previously prepared, so that there may be no delay in assembling the various parties. It is a good plan to provide a small "inventory" or "tally" board for each group, on which the details necessary for connecting up the group are written. These boards should be hung up in the case store.

The order in which the cables and mines are to be laid out must be well thought out and recorded, and the gear should be arranged, as far as possible, in accordance with this plan, which should provide for contingencies of weather, &c.

The greatest delay may generally be expected to arise in connection with the cables, especially when the main cables are not laid out. The officer or N.C. officer in charge of the party getting out cables, must have full information as to the disposition of the cables in the tanks or ponds, and also as to the order in which they are to be got out. He should also be responsible for the junction-box moorings in connection with each main or group cable, and see that the cable, complete with its junction-box, sinkers, buoy, mooring and buoy line, is delivered over. The necessary details for each main and group cable may be conveniently recorded on a page of Army Book 136, under the following headings:—

Identification number or letter.
Class of cable; length; where stored.
Junction-box, where stored.
Mooring line and buoy line, lengths and where stored.
Buoy, identification and place of storage.
Sinkers required.

The "Mine-field Record Book" and the Store Records will furnish all this information.

Mines.—The officer in charge of the connecting-up parties must also have the details for getting his gear assembled. This information may be conveniently recorded for each mine on a double page of Army Book 136, under the following headings :—

No. of mine, group, and system of connecting up.
No. of mine case; circuit closer; mooring lines.
Tripping chain, length, and where stored.
Cable, length, and where stored.
Sinker, weight.
T. box or explosive link, where stored.
Watch buoy and line (if required).
No. in order of connecting up, &c.

The mine and circuit closer will be delivered over to him sealed up, he has merely to draw in addition the branch, circuit closer, and intermediate cables, mooring lines, tripping chains, sinkers, explosive links, and watch buoys, as required.

In the loading shed, those mines not previously completed will be loaded as rapidly as possible, the apparatus *belonging to the mine* being fitted in from time to time as the loading proceeds. The dry primer should not be inserted into the apparatus until the loading of the mine has been satisfactorily completed.

The operations to be performed in the fitting room and testing pit must necessarily take some time, as the dry primers have to be inserted into the envelopes, after which the proper electrical tests have to be made. This work, as well as that of getting cables out of the pond, can be carried out by night, if necessary.

On shore the operations to be first undertaken are completing the loading, priming, and testing apparatus, and getting out cables, while, in the mine-field, the cables are being laid as fast as possible, alignments put up, and positions of junction-boxes, &c., buoyed. In many cases, it may save time to buoy the positions of some of the mines to be laid during the first day's work. The friendly channel (*see* pp. 26, 27) must be marked out the first thing before any E.C. mines are laid.

APPENDIX II.

THE SEXTANT AND STATION POINTER.

The Sextant.

The sextant is a portable instrument capable of measuring in any plane the angle subtended at the eye of the observer by any two distant objects. If the angle be greater than 120°, two observations are required, but for angles less than this only one rapid observation is necessary. The plane of the instrument must be made to coincide with the plane containing the observer's eye and the observed objects. This requires some practice, and is the only difficulty in the use of the instrument.

Sextants are made in several forms, but the principles involved are the same in each form of instrument, and may be readily understood from the following description. (See Plate XXX.)

I and H are two mirrors called respectively the index mirror and the horizon glass, and these are accurately set at right angles to the plane of the instrument, which corresponds in this illustration with the surface of the paper. H, the horizon glass, has either the top or bottom half of its surface silvered, the other half being transparent. This glass is permanently fixed in position, and is capable of a fine adjustment, by means of screws, in a horizontal and vertical plane. The index mirror, I, rotates about an axis set at right angles to the plane of the instrument, and attached to it is the "index arm" and vernier V, which moves over a graduated arc on which the angles are read off.

It is evident that when the two mirrros H and I are exactly parallel a ray of light from an object X will pass through the transparent half of H, and be reflected back from I on to the silvered half of H, so that an observer looking through a small eye-hole at I would see the direct and reflected image of X coinciding in H. When the mirrors are in this position, the zero of the vernier on the "index arm" coincides with the zero of the graduated arc.

To measure the angle between X and another object P, to the *right* of X, the mirror I is slowly turned, and when in its proper position it is evident that the ray of light from P will be reflected from I on to the silvered portion of H, so that the observer at I will see the image of P in the silvered portion of H coinciding with the image of X as viewed directly through the transparent portion of the same glass. The angular movement of I is measured by the movement of the "index arm" on the

THE SEXTANT.

PROOF.

Angle PIQ = angle QIX
angle of incidence =
angle of reflection –
Also angle ZIX = YIQ
Take away common
part XIY and angle
YIZ = angle XIQ = half
angle subtended by
X and P at eye :–

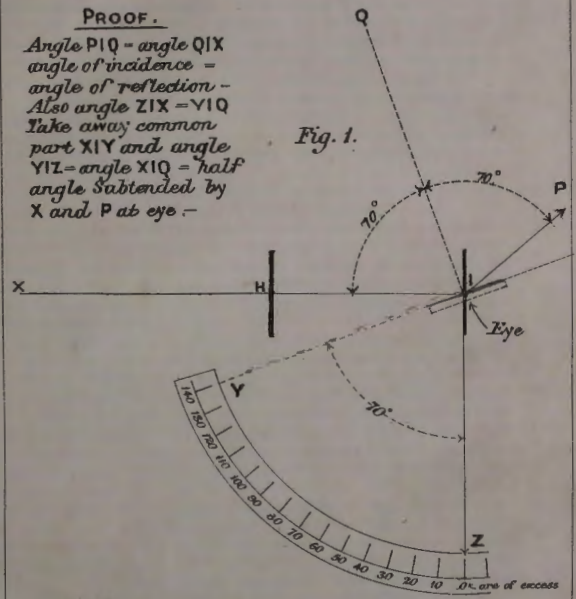
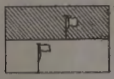


Fig. 1.

Fig. 2.

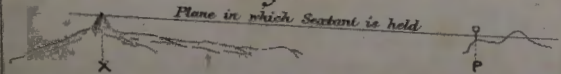


View in Horizon Glass with index error.

Fig. 4.

X & P coinciding in Horizon Glass

Fig. 3.



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graduated arc. It will be observed that, owing to the double reflection of the object P, the index mirror and arm only move through *half* the real angle XLP, so that an angular displacement of 70° measures an angle of 140°, and the graduated arc is divided up accordingly. If the object P were to the *left* of X, at P¹, the angle would be measured either by turning the sextant slightly round so that P¹ is seen by direct vision through H, X being the reflected object, or by turning the sextant upside down, when P¹ would still be the reflected object.

In this illustration the eye of the observer is supposed to be coincident with the centre of the index mirror I. This is not the case practically, but it does *not* affect the principle involved, and when the reflected object is over 600 yards away the small error due to this fact is inappreciable.

This small error due to the observer's eye not coinciding with the centre of the index mirror is called "parallax." Parallax.

It is evident that if the two mirrors H and I are not exactly parallel when the pointer of the index arm is at zero of the graduated arc, the direct and reflected images of the object X will not coincide. The two images may then appear as in fig. 2, the reflected image being, in this illustration, above, and slightly to the right of the real image. Index errors.

The horizon-glass is provided with two adjustments for correcting this error, and in some patterns of instrument a special key is supplied for turning the adjusting screws. By turning one screw the images will be brought to the same *level* in the horizon-glass, and by the other screw the horizon-glass is slightly turned, so that the images coincide. If the sextant shows an index error of this kind when directed on a well-defined object more than half-a-mile distant, it is well to correct the error at once, or to get it done by an instrument-maker.

If this cannot be done, the error must be recorded by moving the index arm until the images overlap (for the *up-and-down* error cannot be corrected by this means), and reading off the error on the graduated arc. It will be observed that the latter is graduated on *both* sides of the zero point. The small portion of the arc so graduated is called the "arc of excess," and if the zero of the vernier is on this arc when the direct and reflected images of the object are brought into coincidence, the reading on this arc will have to be *added* to all subsequent angles taken, and if the index error is in the other direction, its amount will have to be *subtracted* from other angles. It is evident that it saves trouble and chance of mistakes to have *no* index error.

The naked eye cannot read divisions smaller than $\frac{1}{40}$th of an inch with accuracy, so that where smaller divisions than this have to be read it is necessary to use a "vernier" and a magnifying lens. The vernier.

The index arm of all sextants is provided with these adjuncts, which enable the observer to read with accuracy very small angular divisions. Thus, if the index arm of a box sextant were three inches long, the length of a degree on the scale would be very nearly $\frac{1}{20}$th of an inch, and such an instrument, by means of a vernier and magnifying lens, reads to minutes, or $\frac{1}{60}$th of this,

or to $\frac{1}{3600}$th of an inch. The larger marine sextants read to 10 seconds of arc.

The vernier is a subsidiary scale, each division of which differs by a very small amount from the length of a unit division of the primary scale on the graduated arc. This "very small amount" of difference is the limit of accuracy of reading possible. The principle is as follows:—If any number of divisions of the primary scale, say three, be taken for the length of the vernier, and this length is divided into four equal parts (one part more than the primary scale), each of these vernier divisions will be smaller than each of the primary divisions by $\frac{1}{4}$th. (*See* Plate XXXI, fig. 1.) In fig. 2, the zero, or ↑ of the vernier is seen to be between the fifth and sixth division of the primary scale, and the second division of the vernier corresponds with one of the divisions of the primary scale, so that the reading is 5 4ths, or $5\frac{1}{2}$.

Now, the primary scales or graduated arcs of small sextants and of station pointers are divided into unit divisions of $\frac{1}{6}$ degrees, so that if there were no vernier it would be necessary to guess at the odd minutes if the ↑ of the index arm were anywhere between two of these divisions. It is required to read to single minutes, or $\frac{1}{60}$th of the unit divisions on the primary scale. This will be done if a length equal to 29 of these units is taken for the vernier, and this length is divided up into 30 parts; each division of the vernier then differs from a unit division by $\frac{1}{30}$ of its length, or 1 minute. Such a scale and vernier are shown in fig. 3, Plate XXXI. The reading on the scale is done as follows (*see* plate). The ↑ of the vernier lies between 1° 30′, and 2°; passing the eye and magnifying lens along the vernier scale, it is seen that the fifteenth division of the vernier corresponds with a division mark in the primary scale; it is, of course, the only one that does so correspond; the reading is, therefore, 1° 30′ + 15′ = 1° 45′. Fig. 4 is an illustration of the scale and vernier of a large sextant, reading to 10 seconds. The unit division of the primary scale is $\frac{1}{12}$th of a degree, or 10 minutes. In this case the vernier has to read to $\frac{1}{60}$th of the primary division, so 59 divisions of the primary scale are taken and divided into 60 divisions for the vernier. The reading of the latter in the figure is obviously—

↑	20°	30′	0″
Vernier		2′	30″
	20°	32′	30″

Verniers are sometimes constructed in which its divisions are slightly *larger* than the primary divisions, and in these cases the verniers read in the opposite direction to the scale. Such verniers are not often met with.

Use of the Sextant in Submarine Mining.

Before the sextant is used afloat, the observer should become thoroughly conversant with its use on shore. Angles subtended by different objects at different altitudes should first be read, and then the observer should set the index to some predetermined reading, and practice moving along an alignment at

VERNIERS.

Fig. 1.

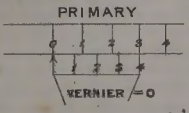


Fig. 2.

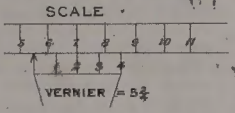


Fig. 3. *Vernier of Box Sextant, reading to 1 min:*

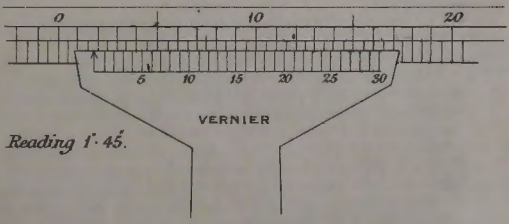
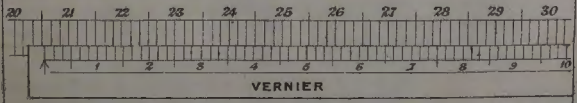


Fig. 4. *Vernier of Marine Sextant, reading to 10 sec:*



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a walk until he brings another object in coincidence with the alignment marks. This should be practised with the converging mark to the *right* and then to the *left* of the alignment, and also with marks at slightly different altitudes. The operator should then be practised in a row-boat in smooth water, and lastly in a steamer, with some motion on. In submarine mining, the sextant is nearly always used to find a pre-determined position on a given alignment. It is of some importance to know *which* alignment post to bring into coincidence with the converging mark in the event of the steamer being a little off the true line.

It will be safest, in such a case, to bring the alignment mark which is most nearly the same distance away as the converging mark into coincidence with the latter.

It is a good plan to warm the sextant in the engine-room before work, as this prevents, to a great extent, a condensation of vapour on the mirrors, which would otherwise greatly increase the difficulty of observation. This condensation can also be mitigated by polishing the surfaces of the mirrors well with a piece of chamois leather.

When taking a marine sextant out of its box, it should be grasped by the central frame, and taken up square. It should not be held by the mirrors or graduated arc. If the telescope is not used, the plain eye-piece should be inserted in its place.

The Double Sextant and Station Pointer.

Double sextant.

The double sextant consists of two sextants fitted one immediately above the other, and combined together in a portable form. There is only one eye-hole, but in all other respects, each sextant is complete in itself, and can be used as an ordinary single sextant. The two horizon-glasses revolve concentrically one immediately above the other; a small space on the lower part of the upper mirror and a similar space on the upper part of the lower mirror being left for direct vision, and the remainder silvered over. The upper mirror works in conjunction with an index arm and graduated arc on the upper side of the instrument, and the lower mirror with a similar arm and arc on the lower surface. The upper mirror reflects objects to the right of the observer, the lower one those to the left, while through the unsilvered portion the central object is seen direct.

Station pointer.

The station pointer is a circular protractor provided with three radial arms, two movable and one fixed, the bevelled edges of which radiate from the centre of the instrument. The movable arms are fitted with clamping screws, slow motion screws, and verniers reading to one minute of arc. The radial arms are provided with lengthening pieces which can be screwed on when required. It is better not to use these when the instrument is merely used as a protractor, but they are often required when it is used as a "station pointer."

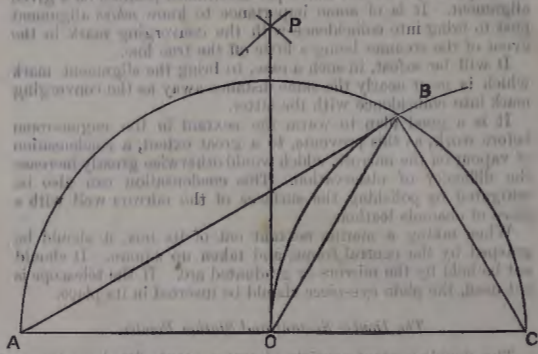
Errors of instruments.

The instrument is liable to two sources of error.

(1.) Imperfect centreing of the arms or graduation of the scale. The errors from this cause will vary for different angles, and should rarely exist.

(2.) Error in the zero of the verniers, or index error. This error will be constant for all angles.

All instruments should be tested to find the values of these errors from time to time. The following method should suffice for practical purposes.



The triangle ABO constructed in the semi-circle ABC, whose radius is about 15 inches, contains angles approximately of 30°, 60°, and 90° at A, C, and B.

The angles at A, B, and C are measured very carefully, with one leg of the station pointer. The excess or defect of the sum from 180° divided by 3 gives the mean error of each angle. This mean error is added to or subtracted from each angle, as the case may be. The same course is followed with the other leg of the instrument, and the corrected angles are compared together. If no mistake has been made, and there is only an index error in the instrument, the corrected angles, as obtained from each limb, will agree very closely. If there is a discrepancy, the work must be checked again, to find whether the error occurred in measurement.

Example of index error test:—

Right Leg.		Corrected Angle.
BAC 90° 17′ − 15′⅝	=	90° 01′⅜
ABC 90° 12′ − 16′⅝	=	89° 56′⅜
ACB 60° 18′ − 15′⅜	=	60° 02′⅝
180° 47′		180° 00

mean error ⅜′ = 15′⅜.

LEFT LEG.

Observed Angle.	Mean Correction.		Corrected Angle.
BAC 29·51	+ $10\frac{1}{3}$	=	30·01$\frac{1}{3}$
ABC 89·47	+ $10\frac{1}{3}$	=	89·57$\frac{1}{3}$
ACB 59·51	+ $10\frac{1}{3}$	=	60·01$\frac{1}{3}$
179·29			180·00

mean error $\frac{2}{3}=10'\frac{1}{3}$.

The angles of the triangle $\overline{ABC}$ should be correct within two or three minutes, if it is carefully constructed and of large size. If the discrepancies in the measured angles are uniform, the error will be merely an index one, involving the addition or subtraction of a fixed number of minutes in all cases. Should the discrepancy vary considerably for each angle measured, *e.g.* if the angles at A, C, and B measure 30° 10', 60° 25', and 90° 35', an error in centreing or graduation is apparent, and another instrument should be obtained." The angles POA, POC, BOA, AOC should also be measured as a check on the work.

In handling a station pointer it should never be lifted by the legs, but by the body or circle. If the angle observed on the right is too small to be set off by the right leg, set the left leg to this small angle, and, treating the left leg as the central one, bring the right leg round the circle until the index stands at the sum of the two angles observed.

APPENDIX III.

GLOSSARY OF CERTAIN NAUTICAL TERMS.

A.

Abaft.—A relative term used to denote the situation of an object or point that is astern of another.

Abeam.—At right angles to a vessel's broadside or keel; opposite to the vessel's centre of length

Aboard.—Inside a ship, or on the deck of a ship.

Abreast.—Synonymous with "Abeam." Side by side. To Breast.—To come abreast.

Accommodation Ladder.—A side ladder with platform for boarding vessels.

A Cock Bill.—The position of an anchor hanging by its ring to the cat-head.

Adrift.—Floating with the tide. Generally, driving about without control. Also a vessel is said to be adrift when she breaks away from her moorings, warps, &c. The term is also applied to loose spars rolling about the deck, sheets or ropes which are not belayed, &c.

Afloat.—The state of being water-borne after being aground. To be on board ship.

Aft.—An abbreviation of abaft, generally applied to the stern; to launch aft is to move a spar or anything else towards the stern. To haul aft the sheets is to bring the clew of the sail more aboard by hauling on the sheets.

After End.—The stern end of a vessel or anything else, or the end of anything nearest the stern of a vessel.

Ahead.—Forward; in advance of.

Aloft.—Up the mast; overhead. "Aloft there!" is a manner of bailing seamen who may be aloft on the mast, tops, yards, &c.

Alongside.—By the side of the ship.

Amidships.—The middle part of a ship. The middle part of anything. To put the helm amidships is to bring it in a line with the keel. Generally, the word has reference to the middle fore-and-aft line of the ship, and to the middle athwartship part of a ship.

Anchor.—Anchors are made of all sizes and shapes, but those used in the Service are of the old familiar pattern.

An anchor consists of the "flukes" (or flues), which catch and hold in the ground; the "crown," where the shank

joins on to the fluke arms; the "ring," a fixture in the end of the shank; and the "stock," which works in a socket in the shank, and is kept in position by means of the "fore-lock," or key.

The anchor is "stocked" when the stock is keyed up in position at right angles to the plane of the flukes.

For small boats, anchors should weigh 1 lb. per foot of length of boat.

The anchor in general use in a vessel is called the "bower" anchor. A "kedge" anchor is smaller and lighter than the "bower" anchor, and is used for light work; it is not, as a rule, heavy enough for a vessel to ride to, except temporarily and in fine weather.

Anchor Buoy.—A buoy made fast by a buoy line to the crown of the anchor. It serves to show the position of the anchor, and, by means of the buoy line, the flukes can be tripped out of the ground in the event of their having caught in rocks, old moorings, cables, &c. It is always well to have a buoy and buoy line if the ground is foul, or there is any chance of catching a telegraph or S. M. cable. Sometimes the buoy is dispensed with, and the buoy line is stopped lightly back along the anchor cable; this is called "scowing" the anchor.

Anchor Cable.—The chain or warp made fast or "bent on" to the ring of the anchor. A chain cable is generally divided into lengths of 12½ fathoms connected by shackles, so that the amount of cable out can always be seen at a glance, and the cable can be quickly disconnected at several points. This is done when a vessel is moored by two anchors and cables; the latter are connected together by means of a "mooring swivel" outside the vessel, and one part of cable is led inboard. If this is not done when a vessel is moored for any time, the cables get twisted up into the condition known as "foul hawse." The cables for kedge anchors and for small boats' anchors are generally of rope, but when anchoring on rocky ground, 3 or 4 fathoms of chain should be inserted between the anchor and warp to save the latter from being cut by the rocks. "Coir" is the best for small boats. It is sometimes necessary to "slip the cable," in which case it should invariably be buoyed. Care must be taken to bend on the buoy line outside the hawse pipe. The "bitter end" of the cable is generally made fast to the keel-son by means of a slip link. The cable should, when worn, be turned end for end.

Anchor Light.—Or "riding light." The white light suspended in the bow of a vessel "riding" at anchor.

Anchors, to.—When about to anchor everything should be ready, cable "bent on," also the buoy line and buoy, if used, the anchor either on the rail or hanging by a slip line (called the "cat-fall") at the cathead. The anchor should not, as a rule, be "let go" until the vessel has sternway in the direction she will ride; this ensures the fluke being dragged into the bottom and prevents its being "tripped" by the

bights of cable; enough cable should be ranged on deck to allow the anchor just to reach the bottom when let go; after this is done and the vessel has way in the required direction, the cable is "veered" or "paid" out as required, turns being taken round a bollard, the bitts, or windlass. In ordinary weather and tides three times the depth of water is sufficient "scope" to pay out. In strong winds or sea, very much more is necessary. Sometimes it may be necessary to "run out the kedge" to hold the vessel. This is done from a boat in which a sufficient length of warp is coiled to allow her to reach the proper position for the anchor. A vessel is said to be "moored" when she puts down two anchors. These are generally placed up and down stream so that the vessel rides to one anchor on the flood, and to the other on the ebb tide.

Anchor, to "bring home" the.—To drag it along the bottom; generally caused by having too little chain out, or "scope."

Anchor, to cat the.—To hoist it up to the cathead.

Anchor, to trip the.—Generally speaking, to get it out of its proper holding position. It may be done by a vessel swinging to tide or wind when riding to a single anchor.

Anchor, to weigh.—To raise the anchor off the ground. The anchor is said to be "hove short" when the chain is up and down, just before it is "tripped."

A-peek or peak.—An anchor is said to be a-peak when the cable has been so much hove in as to form a line with the fore-stay; "hove short" so that the vessel is over her anchor.

Apron.—A piece of timber fitted at the fore end of the keel at its intersection with the stem and up the stem.

Astern.—Towards the stern. To move astern; to launch astern; to drop astern. An object or vessel that is behind another vessel or object.

Athwart.—Transversely, at right angles to fore and aft; across the keel. Athwart-ship is thus across the ship from one side to the other. Athwart hawse is when one vessel gets across the stem of another.

Avast.—Stop, cease, hold, discontinue. As, avast heaving (stop heaving), avast hauling (stop hauling), &c.

Awash.—Level with the surface of the water.

A-weigh.—Said of the anchor when it is a-trip, or broken out of the ground. The anchor is weighed when hove up to the hawse pipe.

B.

Bale.—To throw water out of a vessel or boat by buckets or balers.

Barrel.—The part of a capstan, windlass or winch round which the cable or rope is wound whilst heaving. Sometimes termed the drum.

Beach.—A shore. To beach is to lay ashore to strand.

Beam.—A timber that crosses a vessel transversely to support the deck. The breadth of a vessel. "Before the beam" is forward of the middle part of a ship. The wind is said to be

before the beam when the ship makes a less angle than 90° with the wind. A beam wind is a wind that blows at right angles to a vessel's keel. "Abaft the beam" is towards the stern.

Bear, to.—The direction an object takes from a ship expressed in compass points, or by points in the vessel; as in reference to another vessel she bears S.E. or W.S.W., &c., or on the port bow or weather bow, port beam or weather beam, port quarter or weather quarter, &c., or two points on the weather bow or port bow, &c.

Bear a hand, there.—An admonition to hurry.

Belay, To.—To make fast a rope or fall of a tackle. In hauling upon a rope the signal to cease is usually, "Belay!" or "Belay there!" "Belay that!" or "Avast hauling! Belay!"

Below.—A general term for the under-deck space. To go below is to descend from the deck to the cabin, or to under the deck. A seaman always goes "below," and never "downstairs."

Bend.—To fasten a rope to another; to fasten a rope to a spar; to bend a sail to a yard, &c. A knot, a mode of fastening a rope to a spar, &c.

Berth.—The situation of a ship when at anchor. A place to sleep in: a cabin. Employment.

Bight.—A loop or part of a rope doubled so as to form a loop, thus ⌒. The deepest part of a bay.

Bilge.—The round in a vessel's timbers where they begin to approach a vertical direction.

Bill Boards.—Pieces of wood fitted to the bow of a vessel to protect the plank from the fluke of the anchor.

Binnacle.—A case wherein the compass is contained.

Bitts.—Stout pieces of timber fitted in the deck to receive the bowsprit; also stout pieces of timber fitted in the deck by the side of the mast to which the halyards are usually belayed.

Blade.—The flat part of an oar.

Bluff Bowed.—Very full bowed, thus ⊐.

Boat Chocks or Skids.—Pieces of wood with a score in them to take the keel of boats when they are lifted in upon deck, &c.

Boat Keeper.—The man left in charge of a boat when the other part of her crew go on shore.

Boat's Crew.—Men told off to always man a particular boat, such as the gig, cutter, or dinghy.

Body.—Part of a vessel's hull, as fore-body, middle-body, and after-body. A vessel is said to be long-bodied when the tapering of the fore-and-aft lines are very gradual; short-bodied, when the fore-and-aft lines taper very suddenly; a long body thus means a great parallel length of middle-body.

Bollard.—A short timber to fasten ropes and warps to.

Bottom.—Usually understood as the part of a vessel below the bilge.

Bow.—The forepart of a vessel; forward of the greatest transverse section. In taking bearings an object is said to be on the bow if its direction does not make more than an angle of 45° with the line of the keel

Bower Anchor.—The anchor in constant use.

Bow Fast.—A warp for holding the vessel by the bow.

Breast Fast.—A warp fastened to a vessel amidships to hold her.

Breast-hook.—A strong ⩥ shaped wood knee used forward to bind the stem, shelf, and frame of a vessel together. Breast-hooks are also used in other parts of a vessel. They are now frequently made of wrought iron.

Bridles.—The parts of moorings to hold on by; many ropes gathered into one.

Bring Up.—To come to anchor.

Broadside On.—When a vessel moves sideways, or when she is approached by an object at right angles to her broadside.

Bulkheads.—The athwartship partitions which separate a vessel in compartments, cabins, &c. Fore-and-aft partitions are also termed bulkheads.

Bull's Eye.—A block without a sheave, and with one hole in it. They are usually iron bound.

Bulwark.—The side of a vessel above the deck.

Bunk.—A bed or place to sleep in in a cabin.

Burton.—A tackle composed of two single blocks; a double Spanish burton consists of two single and one double block.

Butt.—The joining or meeting of two pieces of wood end-ways. Butt and butt means that two planks meet end to end, but do not overlap.

By the Head.—When the vessel is trimmed or depressed by the head, so that her proper line of flotation is departed from.

By the Stern.—The contrary to being by the head.

C.

Cable.—A rope or chain by which a vessel is held at anchor. The length for a cable according to the Admiralty is 120 fathoms.

Cable's Length.—A measure of one-tenth of a sea mile, 608 feet, or 101 fathoms, or 203 yards.

Careen.—To heel, to list, to lean over.

Carry Away.—The breakage of a spar, rope, &c.

Carvel Built.—Built with the plank flush edge to edge, and the seams caulked and payed.

Catch a turn.—To take a turn quickly with a rope round a belaying pin, or bitt, or cavel.

Cathead.—Timber or iron projection from the bow of a vessel by which the anchor is hoisted up to the rail, after it has been weighed to the hawse pipe.

Caulking.—Driving oakum into the seams of a vessel.

Cavel.—(Sometimes spelt "Kavul," or "Kevel").—Stout pieces of timber fixed horizontally to the stanchions or bitts for belaying ropes to.

Chain Locker.—The compartment in the hold of a vessel, wherein the mooring chain is stowed.

Chain Pipe.—Iron pipe on the deck through which the cables pass into the lockers.

Chock-a-block.—Said of two blocks when, in hoisting or hauling, the two blocks of a tackle are brought close together. Generally when two things are brought so close together that they cannot be got closer.

Cleats.—Pieces of wood or iron, with one or more arms fastened to spars, &c., for belaying to, or to prevent ropes slipping, &c.

Clench Work.—(Spelt also "Clencher," "Clincher," and sometimes "Clinker").—In boat building when the edges of the planks overlap, forming lands.

Coal, Stowage of.—It is usual to allow 40 cubic feet per ton for the stowage of coal in bunkers.

Coamings.—A raised frame fitted to and above the deck for the hatches, skylights, &c., to rest upon. Sometimes wrongly spelt "combings."

Come Up.—Generally to slack up. Whilst hauling on the fall of a tackle and the order comes, "Avast hauling there," the hand that has to belay sings out, "Come up behind," all hands instantly release the fall, so that the one who has to belay may catch the turn round the belaying pin or cavel without "losing any."

Conning.—Directing a steersman in the use or management of the helm. Telling him how to steer.

Copper Bottomed.—The bottom of a ship sheathed with copper.

Copper Fastened.—Fastened with copper bolts and nails.

Counter.—The projecting part of a vessel abaft the sternpost.

Course.—Direction; the direction in which a vessel moves; the direction from one point to another point which a vessel has to reach.

Covering Board.—The outside deck plank fitted over the timber heads. See "Plank sheer."

Craft.—A vessel; also used in the plural, thus a number of craft, or a lot of craft, means a number of vessels.

Crown of an Anchor.—The part of an anchor where the arms are joined to the shank.

D.

Davits.—Strong iron arms used for hoisting boats, &c.

Dead Wood.—The solid wood worked on top of the keel forward and aft.

Derrick.—A kind of crane.

Dipping Lug Sail.—A sail hoisted by a halyard and mast hoop traveller. The sail is set to leeward of the mast, and the tack is usually fast to the stem or on the weather bow. In tacking or gybing the sail has to be lowered and the yard shifted to the other side of the mast.

Double-banked.—When men sit on the same thwart to pow oars from different sides of a boat.

Double Block.—A block with two sheaves.

Douse or Dowse.—To lower away suddenly, to take in a sail suddenly.

Drag, to.—To scrape the bottom, to search the bottom with grapnels.

Draught of Water.—The depth of a vessel to the extreme underside of the keel, measured from the load water line.

Drift.—To float about with the tide or current.

Drift.—The distance between two blocks of a tackle, or the two parts of one thing.

E.

Ease Away.—The order to slacken a rope, &c.; to ease off a sheet, to ease up a sheet, are synonymous terms, and mean to slacken.

Ebb.—The receding of the tide.

End for End.—To shift a spar, rope, &c., by reversing the direction of the ends.

End On.—Said of a vessel when she has an object bearing in a line with the keel directly ahead of the bow. On approaching a mark or buoy it is said to be end on if it is directly ahead of the vessel, the bowsprit will then point to the object, hence it is sometimes said that an object is "right on for the bowsprit end."

Entrance.—The fore part of a vessel, the bow. A good entrance into the water means a long well-formed bow.

Even Keel.—Said of a vessel when she is not heeled either to port or starboard, also when her keel is horizontal, that is when she is so trimmed that her draught forward is the same as aft.

Eyes of Her.—The extreme fore end of the ship near the hawse pipes, which are the "eyes of her."

Eye Splice.—The end of a rope turned in so as to form an eye.

F.

Fair Lead.—When the fall of a rope leads fairly without obstruction from the sheave hole. Also a "lead" made for a rope through a sheave hole or through any other hole.

Fairway.—The ship's course in a channel. The navigable channel of a harbour as distinct from an anchorage in a harbour. A harbour-master's duty is to see that the fairway is kept clear, and that no vessels improperly anchor in it. A fairway is generally buoyed.

Fake, A.—One of the rings formed in coiling a rope. The folds of a cable when ranged on deck in long close loops. To fake is to arrange in folds.

Fall.—The loose end of the rope of a tackle, the hauling part of a tackle.

Falling Tide.—The ebbing tide.

False Keel.—A piece of timber fitted under the main keel to deepen it, or protect it when taking the ground.

Fast.—Made fast by belaying. (*See* "Breast Fast," "Bow Fast," "Quarter Fast.")

Fastenings.—The bolts, nails, &c., by which the framing and planking of a vessel are held together.

Fathom.—A sea measure of six feet. To fathom a thing is to arrive at the bottom of it, to understand it.

Feathering.—Turning an oar on its blade as it comes out of the water.

Fender.—A sort of buffer made of rope, wood, matting, cork, or other material, to hang over the side of a vessel when she is about to come into contact with another vessel or object

Fend Off.—To ward off the effects of a collision by placing a fender between the vessel and the object which is going to be struck.

Flood Tide.—The rising tide, contrary to ebb.

Floors.—The bottom timbers of a vessel.

Flowing Tide.—The rising tide, the flood tide.

Flukes.—(Pronounced "flues" by seamen). The barb-shaped extremities of the arms of an anchor.

Flush Deck.—When the deck has no raised or sunken part.

Fly.—The part of a flag which blows out; the opposite side to the hoist; the halyards are bent to the hoist.

Foot.—The lower edge of a sail.

Fore.—Front; contrary of aft; the forward part.

Fore-and-Aft.—Running from forward aft, in a line with the keel.

Fore-body.—The fore part of a ship which is forward of the greatest transverse section.

Forecastle.—The space under deck before the mast, allotted to the seamen.

Fore Foot.—The foremost part of the keel at its intersection with the stem under water.

Foremast.—The mast which occupies the most forward position in a vessel.

Fore Peak.—The forecastle, a space decked over forward in a small boat to stow gear in.

Foul Anchor.—When an anchor gets a turn of the cable round its arms or stock; when embedded among rocks, &c., so that it cannot be readily recovered. Also a pictorial anchor with a cable round the shank, &c.

Foul Berth.—When two vessels that are anchored or moored have not room to swing without fouling each other. If a vessel is properly moored, and another fouls her berth, she is held liable for any damage which may ensue.

Foul Bottom.—A rocky bottom; also the bottom of a ship when it is covered with weeds, &c.

Foul Hawse.—When moored, if the cables get crossed by the vessel swinging with the tide.

Frames.—The timbers or ribs of a vessel.

Frapping.—A rope put round the parts of a tackle or other ropes which are some distance apart, to draw them together and increase their tension, or prevent them overhauling.

Freeboard.—The side of a vessel which is above water.

Full Aft.—When a vessel is said not to taper sufficiently aft.

Full and Change.—*See* "High Water."

Full Bowed.—The same as "Bluff Bowed."

G.

Garboard.—The strake of plank next above the keel into which it is rabeted and bolted.

Gather Way.—When a vessel begins to move through the water, under the influence of the wind on her sails, or under the influence of steam. (*See* "Steerage Way.")

Girt.—To moor a vessel so that she cannot swing by tide or wind.

Give Way.—The order to a boat's crew to commence rowing, or to pull with more force or more quickly.

Gooseneck.—An iron jointed bolt used to fix the end of booms to the mast, &c.

Granny Knot.—An insecure knot which a seaman never ties, but which a landsman is sometimes seen to do when trying his hand at reef-knots.

Grapnel.—A grapling iron with four claws, used to moor small boats by or to drag the bed of the sea.

Gratings.—Open woodwork put in the bottoms of boats, in gangways, &c.

Grounding.—The act of getting aground or taking the ground as the tide falls.

Ground Tackle.—The moorings, anchors, chains, &c., used in securing a vessel.

Gudgeons.—Metal eye bolts fitted to the stern post to receive the pintles of the rudder. (*See* "Braces.")

Guy.—A rope used to steady a support or spar.

H.

Halyards, or Haulyards, or Halliards.—Ropes for hauling up sails, yards, &c., by.

Hand over Hand.—Hauling on a rope by one hand at a time, and passing one hand rapidly over the other to haul. A very rapid way of hauling, hence anything done rapidly is said to be done "hand over hand."

Handsomely.—Steadily; with care. Not too fast, nor yet too slow, but with great care; cleverly. As "Lower away handsomely."

Hanging Knee.—Knees that help to keep the beams and frame together; one arm is bolted to the under side of a beam, the other to the frame.

Hatches or Hatchways.—Openings in the deck.

Hatchway Coamings.—The raised frame above the deck upon which the hatches or hatch covers rest.

Haul.—To pull on a rope.

Hawse Pipes.—The pipes in the hawse holes in the bow through which the cables pass.

Head.—The fore part of a vessel. The upper part of a sail. "By the head" means pressed or trimmed down by the head in contradistinction to "by the stern." To head is to pass ahead of another vessel.

Head Way.—When a vessel moves ahead through the water.

Heave.—To bring a strain or drag upon a capstan bar, purchase, &c. To throw, as "heave overboard."

Heave Ahead.—To draw a vessel ahead by heaving on her cable, warp, &c.

Heave Short.—To heave on the cable until the vessel is over the anchor, or the cable taut in a line with the fore stay, so that with another heave, or by the action of the sails, the anchor will be broken out of the ground.

Heel.—The lower after end of anything, as heel of the keel, heel of the mast (the fore part of the lower end of a mast is called the toe), heel of a yard, heel of the bowsprit. The amount of list a vessel has. (See "List.")

Helm.—The apparatus for steering a vessel, usually applied only to the tiller.

Helm, to Port the.—To put the helm or tiller to the port side, and thereby bring the vessel's head round to starboard. If a wheel is used besides a tiller, the action of turning the wheel to port brings the vessel's head round to port, as the tiller is moved by the chains to starboard. Thus with a wheel, when the order is given to port, the wheel is turned to starboard.

Helm, to starboard the.—To put the tiller the way opposite to port.

Helm, to steady the.—To bring the helm or tiller amidships after it has been moved to port or starboard, as the case may be.

High Water.—Full and Change.—On all coast charts the time of high water at the full moon and new moon is set down, the time of high water at the full moon and new moon always occurring at the same hour throughout the year; therefore, if the time of high water at full and change (new moon) is known, and the age of the moon, the time of high water for any particular day can be roughly calculated, about 25 minutes being allowed for each tide.

Hitch.—A mode of fastening a rope. There are many kinds of "hitches," such as Blackwall hitch, timber hitch, clove hitch, rolling hitch, &c. A hitch is also a short tack or board made in close-hauled sailing.

Hogging Piece.—A piece of timber worked upon top of the keel to prevent its hogging or rising in the middle.

Hoist.—The length of the luff of a fore-and-aft sail, or the space it requires for hoisting. The hoist of a flag is the edge to which the roping is stitched.

Hold.—The interior of a ship; generally understood to mean the space in which cargo, &c., is stowed away.

Holding Water.—Resting with the blades of the oars in water to check a boat's way, or stop it.

Hull.—The ship, as distinct from her masts and rigging.

J.

Junk.—Old rope; also old salt beef, as tough and hard as old rope or oak; also a Chinese ship.

Jury.—A makeshift or temporary contrivance, as jury mast, jury

rudder, jury bowsprit, &c., which may be fitted when either has been lost or carried away.

K.

Kedge.—The smallest anchor a vessel carries, used for anchoring temporarily by a hawser or warp. To kedge is to anchor by the kedge, or to carry the kedge anchor out in a boat, and warp ahead by it.

Keel.—The fore-and-aft timber in a vessel to which the frames and garboard strake are fastened.

Keelson or Kelson.—An inside keel fitted over the throats of the floors.

Kevel or Cavel.—Large pieces of timber used for belaying ropes to, such as the horizontal piece which is bolted to the stanchions aft to belay the main sheet to.

Knees.—Pieces of timber or iron shaped thus ⌊, used to strengthen particular parts of a ship. A hanging knee is the one fitted under the beams, a lodging knee is a knee fitted horizontally to the beams and shelf, or to the mast partners, or deck beams. Floor knees are V-shaped, like breast-hooks.

Knot.—A geographical mile, or sixtieth part of a degree, termed also a sea mile, or nautical mile. The Admiralty knot or mile is 6,080 ft., a statute mile is 5,280 ft. A sea mile = 1·1515 statute mile; a statute mile = ·86842 sea mile.

L.

Lay of a Rope.—The way the strands of a rope are laid up.

Lee.—The opposite side to that from which the wind blows.

Lend a hand here.—An order to a person to assist.

Lights.—*See* "Side-lights."

Lines.—A general term applied to the drawing or design of a vessel as depicted by fore-and-aft lines. A vessel is said to have fine lines when she is very sharp fore-and-aft.

List.—A vessel is said to have a "list" when she leans over on one side owing to the way her cargo or ballast is disposed.

Load-water-line.—The line of flotation when a vessel is properly laden or ballasted.

Loss her Way.—Said of a vessel when she loses motion, or gradually comes to a stop.

M.

Make Fast.—To securely belay a rope, or join two ropes.

Meet, to.—To meet a vessel with the helm, is after the helm has been put one way, to alter her course, to put it the other way to stop the course being altered any further. This is also called "checking the helm."

Moor.—To anchor by two cables.

Mousings.—Yarns wound round hooks to prevent them becoming detached.

N.

Neap Tides.—The tides which occur between new and full moon; spring tides being at or near the new and full moon.

Nip.—A short bight in a rope, such as the part that goes round a sheave, &c.

O.

Overhaul.—To overtake another vessel; to loosen the parts of a tackle; to ease up; to slacken or free the fall of a tackle; to slacken or "lighten up" a rope.

P.

Painter.—A rope spliced to a ring-bolt in the bow of a boat to make fast by.

Parcel.—To cover a rope with strips of canvas, painted or otherwise. The canvas is wound round the rope and stitched, or "sewed" with spun yarn.

Pay.—To run hot pitch and tar, or marine glue, &c., into seams after they are caulked.

Pay Out.—To veer or slack out chain or rope.

Pendant.—A stout rope to which tackles are attached.

Pintles.—The metal hooks by which rudders are attached to the gudgeons.

Planking.—The outside skin of a vessel; plank laid on the frames or beams of a vessel, whether inside or outside.

Plank Sheer.—The outside plank at the deck edge which covers in the timber heads, and shows the sheer of the vessel. The same as covering board.

Port.—The left-hand side; the opposite to starboard. Formerly also termed larboard.

Preserving a Boat.—All small boats, if possible, should be hauled out of water or beached when not in use. Varnish preserves the wood from water absorption better than paint. Whenever the varnish becomes worn, the boat should be recoated.

Preventers.—Additional ropes, stays, tackles, &c., used to prevent spars being carried away if their proper stays give out. A preventer is also any rope or lashing used to prevent something giving way.

Punt.—A small boat or dinghy.

Purchase.—A tackle; any contrivance for increasing mechanical power.

Q.

Quarters.—That part of a yacht or ship nearest the stern.

R.

Rabbet or Rebate.—An angular channel or groove cut in the keel, stem, or sternpost, &c., to receive the edges or ends of the plank.

Rasking.—A rope or seizing used to lash the parts of a tackle together by taking several turns, so as to keep them from

running through the blocks, whilst the fall is cast off for some purpose, or whilst one hand belays the fall.

Rail.—The timber fitted on to the heads of the bulwark stanchions. Called also "top rail."

Rake.—To lean forward or aft from the vertical, as raking masts, raking sternposts, raking stem, &c.

Range.—Scope. To range is to arrange; to range the cable, to place a lot on deck in fakes ready for veering out. To give a range of cable is to veer out enough in letting go the anchor to bring the vessel up without causing much strain to come on the bitts. To sail near to, as to range up to windward, to range up alongside, to range along the coast, &c.

Reef.—To shorten sail by reefing. Also to shorten a spar, as to take a reef in the bowsprit.

Reef Band.—A strip of canvas sewn across the sail in which the eyelet holes are worked to receive the reef points.

Reef Cringles.—The large cringles in the leeches of sails through which the reef pendants are rove, and tacks or sheets hooked.

Reef Points.—Short pieces of rope attached to sails to secure the folds rolled up when reefing.

Render.—To slacken or ease up. A rope is said to render when it slackens without warning.

Reeve.—To put a rope through a hole of any kind.

Ribs.—The frames or timbers of a ship or boat.

Ride.—To rest at anchor, or to be held by an anchor.

Riding Light.—The white globular lantern hung on the forestay of vessels when riding at anchor.

Rig.—The arrangement of a vessel's spars, rigging, and sails, as schooner rig, cutter rig, lugger rig, &c. To rig is to fit the spars with rigging, &c. To rig out is to fit out.

Right-hand Rope.—Rope laid up or twisted with the sun.

Rising Floor.—Distinct from flat-floored, or flat-bottomed; sharp-bottomed.

Risings.—Stringers fitted inside small boats to strengthen them and support the thwarts.

Round in.—To haul in a rope.

Round Turn.—To pass a rope twice round a pin or cleat so as to make a complete circle.

Rowlocks.—The fittings on the gunwale to receive the tholes or crutches for the oars.

Ruff or Roove.—A small ring or square plate placed over copper nails before clinching in boat-building.

Running Rigging.—The parts of the rigging made to overhaul or run through blocks, as distinct from that set up by lanyards, shackles, &c.

S.

Scope.—Length or drift of rope or cable.

Screens.—The wood shelves and screens, painted red for port side and green for starboard, in which a vessel's side-lights are carried. (*See* "Side-Lights.")

Scull.—A short oar used with one hand. To scull is to propel a boat by working an oar over the centre of the transom on the principle of the screw.

Scuppers.—Apertures cut in the bulwarks or waterways to clear the deck of water.

Sea, a.—A wave. A heavy sea is when the waves are large and steep. When a quantity of water falls aboard a vessel, it is said that "she shipped a sea."

Seaworthy.—In every respect fit to go to sea.

Seizing.—A way of securing a bight of rope by a lashing so as to form an eye, or of securing any parts of ropes together.

Selvagee Strop.—A strop made of spun yarn laid up in coils and marked.

Serve.—To cover a rope with spun yarn called "service."

Set.—To hoist or make sail. This word is sometimes improperly confused with "hait," in reference to the way a sail stands.

Set of the Tide.—Direction of the current.

Sheathing.—The copper sheets put on the bottom of a vessel.

Sheer.—The fore-and-aft curve of a vessel's deck or bulwarks.

Shelf.—A strong piece of timber running the whole length of the vessel inside the timber heads, binding the timbers together; the deck beams rest on and are fastened to the shelf.

Shoe.—A cupe or chain by which the lower after corners of sails are secured.

Shift the Helm.—To move the tiller from one side to the other; thus, if it is put to port, an order to shift the helm means put it to starboard.

Shift of Wind.—A change of wind.

Ship, to.—To put anything in position. To engage as one of the crew of a vessel. To ship a sea, to ship a oar, to ship a seaman, &c.

Ship Shape.—Done in a proper and unimpeachable manner.

Side Kelsons.—Stout pieces of timber fitted fore-and-aft on either side of the keel.

Side-Lights.—The red (port) and green (starboard) lights carried by vessels when under way. Small boats during bad weather are not required to have their side-lights fixed, but must always have them ready on deck on their proper sides ready to show. Open boats must carry lights, and if the usual side-lights are not used they must have lanterns fitted with green and red slides to show when required. Steam vessels and steam launches, in addition to the *usual* side-lights, must carry a white light at the masthead, or on the funnel.

Steam vessels, when towing, must carry two white lights (vertically) at the masthead. All vessels, when at anchor, are required to exhibit after sundown a white light at a height not exceeding 20 ft. above the hull. This light must be visible one mile, and show all round the horizon. It is usual to put the light on the forestay. Pilot vessels carry a white masthead light, and exhibit a "flare up" every

fifteen minutes. Fishing vessels and open boats, when riding to nets, carry a white light and show a flare up occasionally. If drift netting, a fishing boat must carry two red lights vertically. A ship which is being overtaken by another ship must show a white light or flare up over her stern. Previous to 1847 there had been no regulation as to the carrying of lights; the custom being for ships to exhibit a light over their sides when approaching each other at night; but, in 1847, the Admiralty were empowered to make regulations respecting lights, and steamers were ordered to exhibit a white light at the masthead, a green light to starboard, and a red light to port, and vessels at anchor a bright light. And sailing ships were ordered to show, when required, a green light on the starboard side, and a red to port. As between steamships and sailing vessels, the latter were required to present a light to the former where there was any danger of collision. The Admiralty Court acted upon the Admiralty Rules. The Order in Council issued in pursuance of the Act, and dated June 29, 1848, and the Act 1852, re-affirmed the former regulations as to steamers, and recommended all sailing vessels to be provided with red and green shaded lanterns, and lights to be shown on the port or starboard bow, according to the side a vessel might be approaching. Section 295 of the Merchant Shipping Act, 1854, confirmed the powers of the Admiralty to the same extent as before. The Merchant Shipping Act, 1862, did not alter the law with respect to steamers, but made it compulsory on sailing ships to keep their side-lights fixed instead of displaying red or green lights by hand lamps.

Signal of Distress.—An ensign hoisted jack downwards.

Skin.—The outside or inside planking of a vessel.

Slack.—Not taut. To slack up a rope or fall of a tackle is to ease it.

Slack Tide.—The tide between the two streams when it runs neither one way nor the other. There is high water slack and low water slack.

Slip.—To let go, as to slip the cable.

Snatch Block.—A block with an opening in the shell so that a rope can be put over the sheave without reeving it.

Splice.—To join the ends of rope together by interweaving the untwisted strands. An eye splice is formed by interweaving the untwisted end of a rope in the lay of the strands.

Spring.—A warp, or hawser, or rope.

Starboard.—The right-hand side. The opposite to port.

Steerage Way.—When a vessel moves through the water so that she can be steered. In simply drifting or moving with the tide a vessel has no steerage way on, and cannot be steered; therefore steerage way means that a vessel, relatively to the water, moves ahead and passes through the water.

Stem.—The timber at the fore end of a vessel into which the ends of the plank are butted. To stem is to make headway, as against a current.

Step.—A piece of timber or metal to receive a vessel's mast, &c. To step is to put a thing into its step.

Stern Board.—A movement of a vessel sternwards.

Stern Way.—Moving astern; to make a stern board.

Stern Post.—The strong timber to which the rudder is hung.

Stern Sheets.—The seat in the aft end of a boat. Sometimes the three-cornered bottom board is termed the stern sheet. This board in a gig is usually a wood grating. In small fishing boats the stern sheet is the platform on which the fisherman coils away his nets, lines, &c.

Stiff.—Not easily heeled; having great stability.

Stock of an Anchor.—The cross bar near the shackle.

Stopper.—A rope or lashing used to prevent a rope or chain surging or slipping, as cable stopper, rigging stoppers, &c. The latter is usually a short piece or rope put on as a kind of racking to prevent the rigging or its tackles rendering. A stopper is sometimes put on with a hitch. (See "Racking.")

Strake or Streak.—A breadth of plank.

Stranded.—Said of a rope when one or more of its strands have burst. Cast ashore.

Stringers.—Strengthening strakes of plank or iron inside a vessel's frame.

Sweeps.—Large oars.

Swivel Hook.—A hook that revolves by a pivot inserted in a socket and clinched.

T.

Tackle.—An arrangement of ropes and pulleys for increasing power; a purchase. (Pronounced "tay-kel" by sailors.)

Taffrail.—The continuation of the top rail round the after end of the counter.

Tail block.—A block with a tail or piece of rope stoppered to it, for making fast the block instead of a hook.

Tail on.—An order to take hold of a rope and help haul.

Taunt.—Tall, high, towering.

Taut.—Tight; stretched as tightly as possible.

Thimble.—A ring, pear-shaped or circular, with a groove outside for ropes to fit in. When the thimble is pear-shaped it is usually termed a "heart thimble" or "thimble heart." These thimbles are used for the eye splices in ropes, whilst circular thimbles are mostly used for the cringles of sails, &c.

Tholes.—Pins fitted into the holes in rowlocks for oars to work in.

Thumb Cleat.—Pieces of wood put on spars, &c., to prevent ropes or strops from slipping.

Thwarts.—The transverse seats in a boat.

Tidal Harbour.—A harbour that can only be entered on certain stages of the tide.

Tiller.—The piece of timber inserted in the rudder head for steering, usually termed the helm.

Tiller Lines.—The lines attached to the tiller to move it by

Tiller Ropes.—The ropes attached to the short tiller when a wheel is used for steering.

Timbers.—The frames or ribs of a vessel.

Top Rail.—The rail fitted on the stanchions as a finish to the bulwarks.

Topsides.—That part of a vessel above the wales; now sometimes understood as the part between the water line and deck, or the freeboard.

To Whip.—To bind the ends of rope with twine to prevent their fraying.

Transom.—The frame at the sternpost of a vessel. In boats, the transverse board at the stern, which gives shape to the quarters, and forms the stern end of the boat.

Traveller.—An iron ring, thimble, or strop, which travels on a spar, bar, or rope.

Trim.—The position of a ship in the water in a fore-and-aft direction. To trim a vessel is to set her in a particular position by the head or stern. The term is sometimes erroneously used to represent the shifting of ballast transversely. To trim the sails is to sheet and tack them so that they are disposed in the best manner possible in relation to the direction of the wind.

Trucks.—The wooden caps fitted on the upper mastheads to reeve the signal halyards through.

Turk's Head.—A knot made to finish off the end of a rope.

Turn.—A circle made by a rope round a pin, &c. "Turn O!" is an order to belay. To catch a turn is to put the fall of a tackle or part of any rope round a belaying pin, stanchion, &c.

Turn of the Tide.—When the tide changes from flood to ebb, or the contrary.

Twice-laid Rope.—Rope re-made from old rope. A term of reproach for articles of inferior quality.

Two-blocks.—Said when a tackle has been used so that its two blocks come close together. (See "Chock-a-block.")

U.

Unbend.—To cast loose a sail from its gaff, yard, &c. The opposite of bend.

Underrun.—To follow up a rope, chain hawser, or cable, by hauling it in from a boat which moves in the direction that the cable, &c., is laid out.

Under the Lee.—Sheltered from the wind by the sails of another vessel. Under the lee of the land, sheltered from the full force of the wind by the land.

Under Way.—Moving through the water under the influence of the wind, steam, or oars. Sometimes wrongly written "under weigh."

Unmoored.—With anchors a-weigh. A vessel is also said to be "unmoored" when she is riding to a single anchor, as, to be moored, two anchors must be down.

Unreeve.—To haul out a rope from a hole, &c.

Unship.—To remove a thing from its lodgment. The opposite of "to ship."

Upper Strake.—The top strake running round a vessel at the deck edge under the covering board, usually stouter than the general planking, and almost always of hard wood to better hold fastenings.

V.

Varnish.—Black Japan: lamp black, 1 oz.; bitumen, 2 ozs.; acetate, ½ oz.; lead, ½ oz.; Turkey umber, ½ oz.; Venice turpentine, 12 ozs.; boiled oil. Dissolve the oil in turpentine, powder the other ingredients, and stir in gradually. Simmer on slow fire ten minutes.

Copal varnish: copal, 30 ozs.; drying linseed oil, 18 ozs.; spirits of turpentine, 50 ozs. Briskly fuse the copal; heat the oil to close on boiling point, and pour it hot on the copal; mix thoroughly; allow the mixture to cool a little, and add the turpentine; mix thoroughly. When cool, strain for use.

A quick-drying varnish: copal (fused), 7 lbs.; hot linseed, ½ gall.; hot turpentine, 1½ galls. Carefully stir and boil together.

Oak varnish: 7 lbs. pale resin dissolved in 2 galls. oil of turpentine.

Varnish for metals: powder 1 lb. of copal, and dissolve in 2 lbs. of strongest alcohol. A very quick-drying varnish.

Varnish for iron: mastic (clear grains), 10 lbs.; camphor, 5 lbs.; sandarach, 15 lbs.; elemi, 5 lbs. Dissolve in sufficient alcohol.

Black varnish or polish for iron: resin, 4 ozs.; lamp black, 2 ozs.; beeswax, 3 ozs.; shellac, 2 ozs.; linseed oil, 1 qt. Boil together one hour, and then stir in ½ pint turpentine.

Tar varnish for iron: coal tar, 1 pt.; lamp black, 1 oz.; heel ball, ½ oz.; spirits turpentine, ½ pt.; beeswax, 1 oz. Dissolve the heel ball and beeswax in the turpentine, add the lamp black and tar, warm and mix it thoroughly. This mixture should be applied hot.

Tar varnish for wood or iron: coal tar, 1 gall.; oil of vitriol, 2 oz; mix thoroughly, and add ½ pt. of turpentine, mix and apply immediately. This dries quickly, and only quantities sufficient for use should be made.

Varnishing a bright Boat.—Oil the planks, &c., and when the oil is dried in put on two coats of copal varnish. If size is used instead of oil, the varnish will peel off. To clean off varnish take a mixture of soda (2 lbs.), soap (1 lb.), boiled together; it will remove varnish from spars, &c. It should be used hot.

Veer.—To pay out chain. Veer is also used in the sense of wearing or gybing. The wind is said to veer when it changes in direction with the sun. To back when it changes against the sun. The wind is said to veer when it draws more aft. To haul when it comes more ahead.

Veer and Haul.—To slacken up a rope, and then haul on it suddenly, in order that those who are hauling on it may acquire a momentum. Pulling by jerks.

Vessel.—A name for all kinds of craft, from a canoe to a three-decker.

W.

Waist.—The middle part of a vessel's decks.

Wake.—The peculiar eddying water that appears after a ship has passed. Vessels are said to leave a clean wake that do not cause waves to form astern.

Wall Knot.—A knot formed at the end of a rope by unlaying and interweaving the strands.

Wall Sided.—Up and down sides of a vessel, that neither tumble home nor flare out.

Wash Strake.—A strake, fixed or movable, of plank fitted to the gunwale of an open boat to increase her height out of the water.

Watch.—An anchor buoy or mooring buoy is said to watch when it keeps above water.

Watches.—The divisions of time for work on board a vessel. The crew of a ship is divided for this work into two watches, port and starboard, each watch being alternately on deck, excepting in emergencies, when both watches may be called on deck. Watches are thus divided: from 8 p.m. to midnight is the "First Watch"; from 4 a.m. to 8 a.m. is the "Morning Watch"; from 8 a.m. to noon is the "Forenoon Watch"; from noon to 4 p.m. the "Afternoon Watch"; from 4 p.m. to 8 p.m. the two "Dog Watches."

Water Ballast.—Water carried in tanks or breakers as ballast. The tanks or breakers should be either full or empty.

Water Borne.—Not resting on the ground, but being in the condition of floating.

Water Logged.—The condition of a vessel when, although her hold is full of water, she does not sink, owing to the buoyant nature of her cargo, or from other causes.

Waterproofing.—Boil 12 oz. of beeswax in 1 gallon of linseed oil for two hours; paint the cloth with this mixture twice or thrice. Colour as required.

Way.—Motion through the water, as under way, head way, stern way, steerage way, lee way, &c.

Ways.—Balks of timber arranged in a kind of shute to haul vessels up on, or to launch them off.

Weather.—The windward or "breezy" side of an object. The side on which the "weather" is felt; not to leeward. To weather is to pass on the windward side of an object. In cross tacking the vessel "weathers" another that crosses ahead of her. To weather on another vessel is to gain on her in a windward direction by holding a better wind than she does; to eat her out of the wind.

Weather Tide or Weather-going Tide.—The tide that makes to windward, or against the wind.

Wheel.—Used to give motion to the rudder by chains which

pass over a barrel, and lead through blocks to the tiller. When the tiller points *forward*, the chain is put *over* the barrel first; when the tiller points *aft*, the chain is put *under* the barrel first.

Whip.—A purchase consisting of one single block. A pennant vane.

Whip, to.—To bind the ends of rope with twine to prevent their fraying.

Wings of a Ship.—That part of a ship below water near the load line.

Y.

Yard.—A spar used to extend a sail.

Yarn.—A yarn is generally understood to mean one of the parts of a strand of a rope. The strands of old rope are separated, and used as stops for temporarily securing sails when rolled up, &c. A narrative, a tale, a long story, or discourse.

Yaw.—When a vessel's head flies from one direction to another; generally when a vessel does not steer a straight or steady course.

Yoke.—The lower cap on the masthead. It is cut out of solid wood, and either strengthened by an iron plate over the whole of its top, or an iron band round its entire edge. The cross-trees are fitted on the yoke. A yoke is also the cross-bar put on the rudder-head of small boats, to which lines, termed yoke lines, are attached for steering.

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