Titanic's Kelvin Sounding Machine

By Bob Read, D.M.D.

Introduction

Since antiquity, ships have needed to gauge the depth of the water within which they were navigating. For most of history, that was accomplish by the hand thrown sounding lead. With the advent of steam ships which had deeper drafts and traveled faster, a solution was required to overcome the deficiencies of the hand thrown lead when used aboard these new ships. This article will examine the Kelvin sounding machine which was invented to address the deficiencies of the hand thrown sounding lead. Major aspects of the structure and function of this machine will be examined.

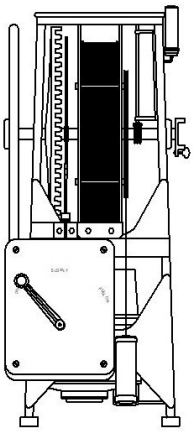
History

In 1876, Sir William Thomson (later Lord Kelvin) patented an improved sounding machine. Between 1903 and 1906 Lord Kelvin worked with the Royal Navy to develop the Mark IV sounding machine. This machine was patented in 1907 by Kelvin and James White Ltd. One of the improvements in this 1907 patent was that it had an electric motor to rewind the sounding wire and lead. Some refer to this machine as a "Kelvite" sounding machine. In 1913, Lord Kelvin's company became Kelvin, Bottomley & Baird Ltd. It was only after this reorganization that the term "Kelvite" was adopted. The Mark IV machine continued in use with only minor modifications into the 1960s.

Structure

This article will only describe the major components of the 1907 Mark IV patent of Lord Kelvin's sounding machine. At the end of this article is an appendix which contains the original 1907 patent. It has more details than will be described here.

The sounding machine had a framework in which was suspended a reel on which the sounding wire was wound. Outside the frame was a hand operated brake wheel which slowed the movement of the wire wheel. Under the wire reel was a motor which was geared to the wire reel to turn it to rewind the sounding wire after it had reached the sea bed. A junction box had a speed control lever. On top of the frame was a dial which indicated depth up to 300 feet. There were handles which could be attached to the brake wheel and the wire reel axle on the opposite side so that the sounding wire could be rewound manually if necessary. A multi-view drawing of the Kelvin Mark IV sounding machine is shown in Figure 1.



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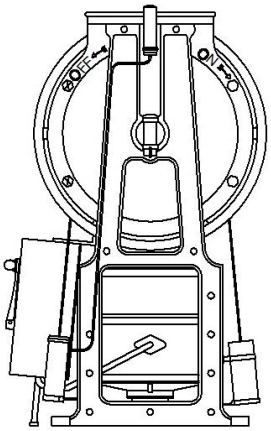

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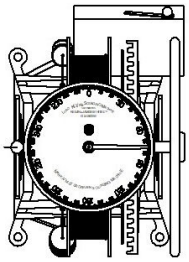
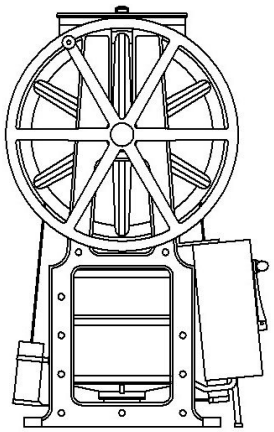


plan



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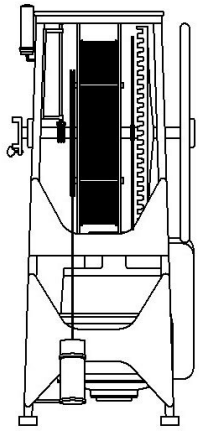

inboard

Figure 1

Kelvin Mark IV Sounding machine

Auxiliary Equipment

The sounding machine required auxiliary equipment to be able to perform the sounding procedure. So that the sounding wire could be kept far enough away from the side of the ship and not foul the propellers, a 30-foot sounding spar was used. The spar was no more than 5-1/2 inches at its greatest diameter. At its inboard end, the spar had a gooseneck fitting which fit in an eye on the forward, outboard bulwark of the boat deck. To maintain the spar in a horizontal position which was parallel to the water surface, there was a band on the outboard end of the spar. This band had two lateral eyes and an upper eye. To these eyes were attached a fore and after guy and a topping lift.

The sounding machine was bolted to the deck and had a fixed electrical connection for the motor and the dial light. The sheave on the sounding spar for the sounding wire was a specialized unit known as a "carrier". This carrier unit is shown in Figure 2.

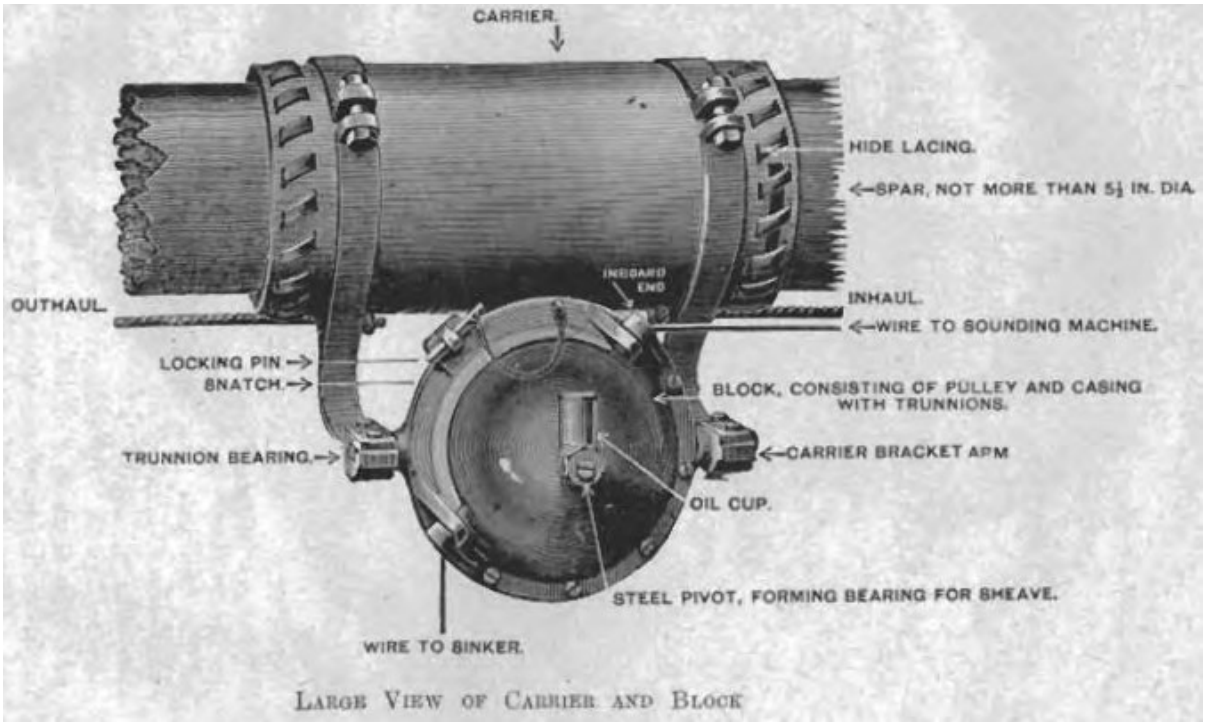

Figure 2

Carrier unit on sounding spar

This carrier was slipped over the inboard end of the sounding spar before the spar was attached to the bulwark. The carrier was moved to its outboard position and back again by means of an inhaul and an outhaul line which traveled through a sheave morticed into the end of the sounding spar. After the carrier was attached to the spar, the sounding wire was fed through an opening in the bulwark and through the sheave of the carrier. The sounding lead was then attached to the sounding wire.

Figure 3 shows a plan view of the forward, port area of *Titanic's* boat deck before the sounding machine and auxiliary equipment is rigged.

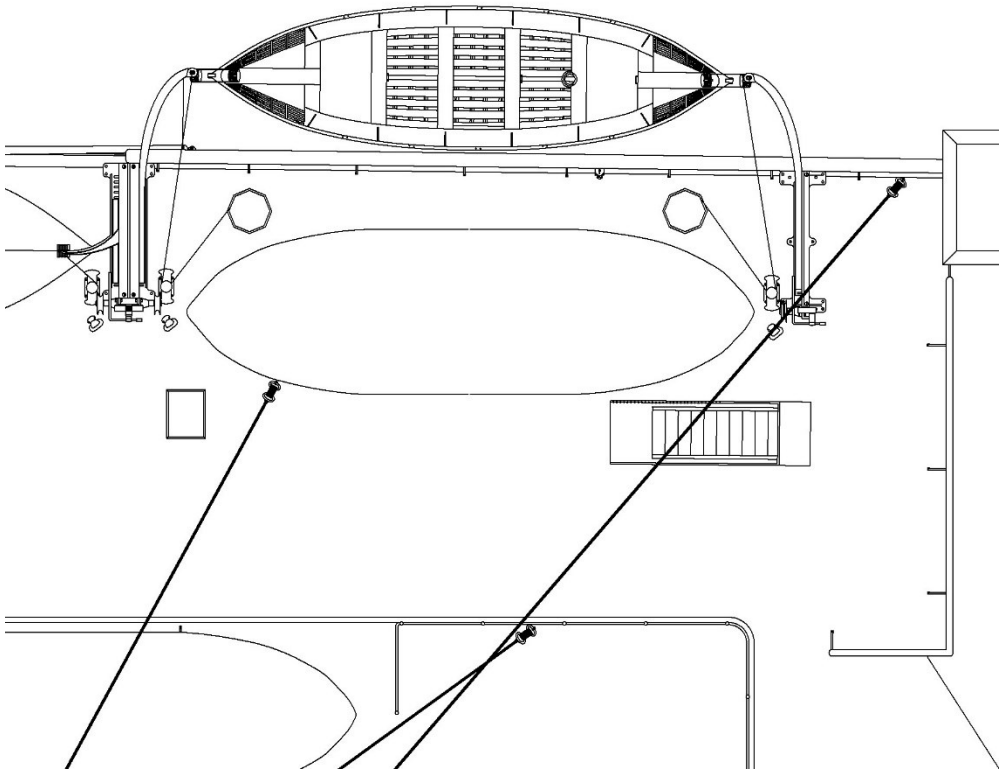

Figure 3

Plan view of forward, port boat deck area prior to rigging sounding machine

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Figure 4 is a plan view of the sounding machine rigged for operation.

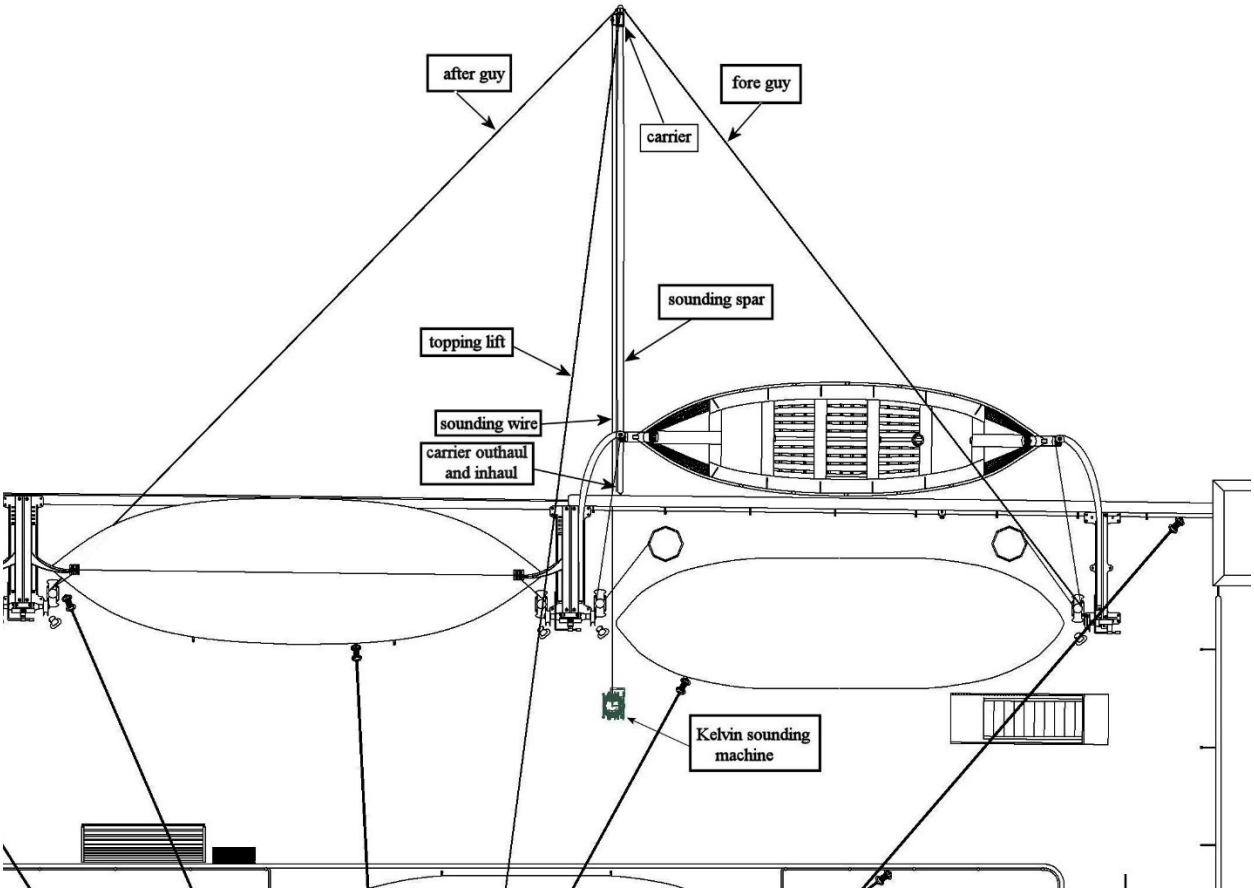

Figure 4

Plan view of sounding machine rigged for operation

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Figure 5 is an elevation view from aft looking forward showing the sounding machine rigged for operation.

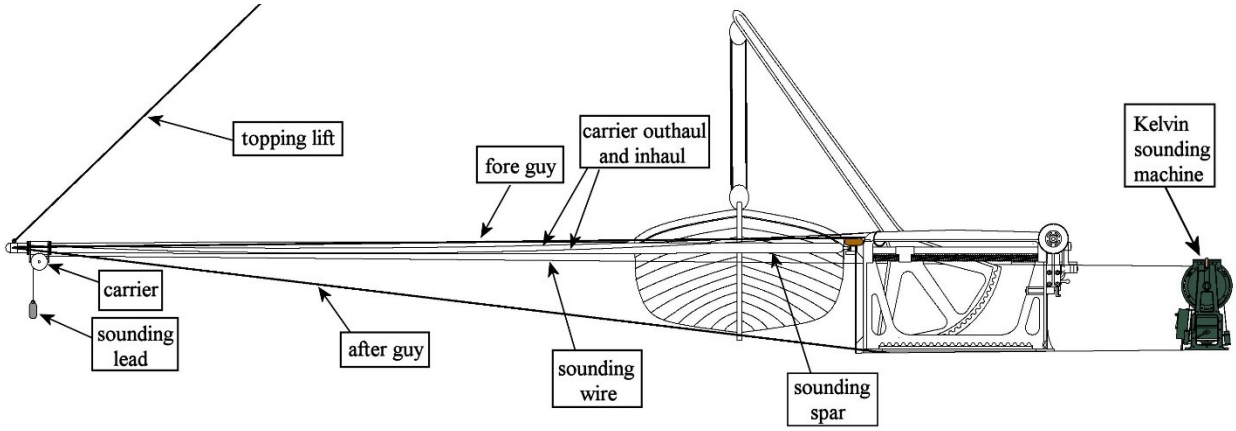

Figure 5

Elevation view from aft looking forward showing sounding machine rigged for operation

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Figure 6 is an elevation view from outboard looking inboard showing the sounding machine rigged for operation.

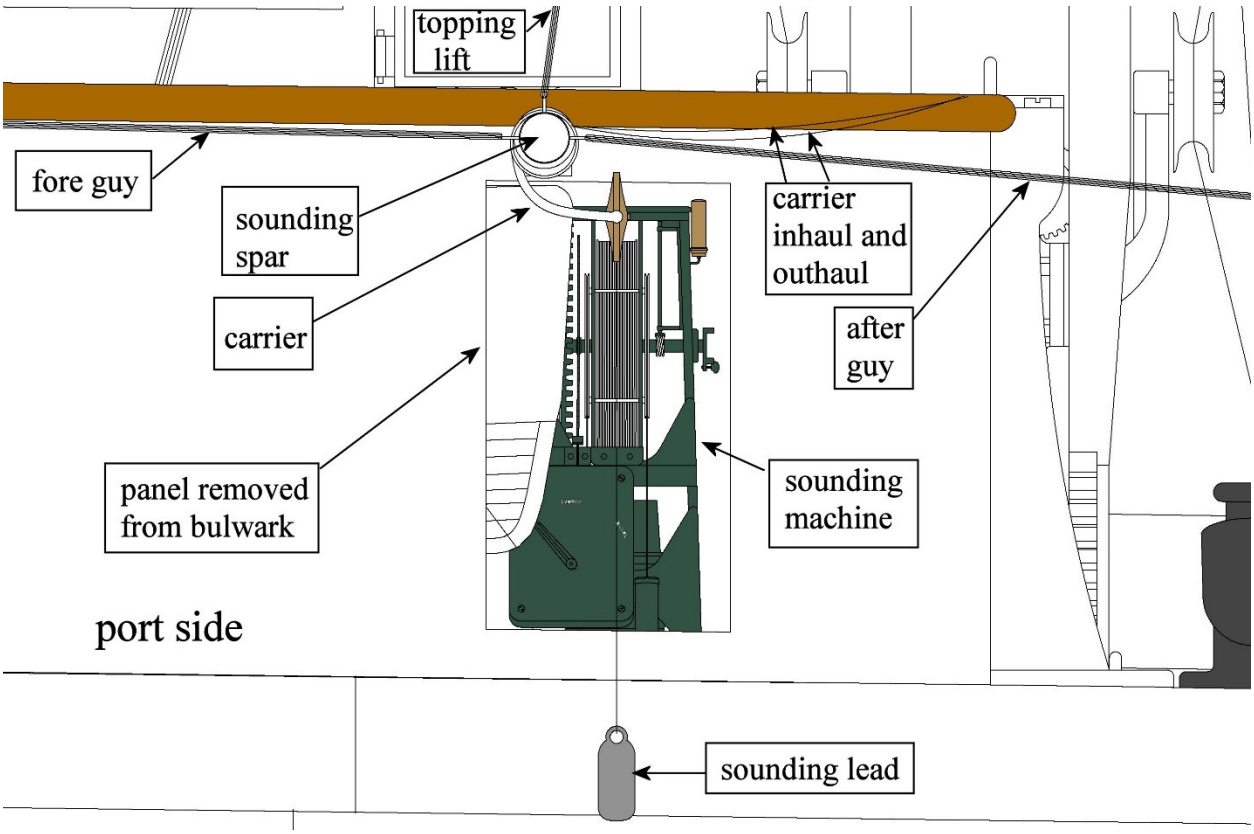

Figure 6

Elevation view looking inboard at sounding machine rigged for operation

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Figure 7 is an elevation from outboard looking inboard showing the toping lift rigged through one of the painters' line sheaves. The fore and after guys are belayed to boat bitts.

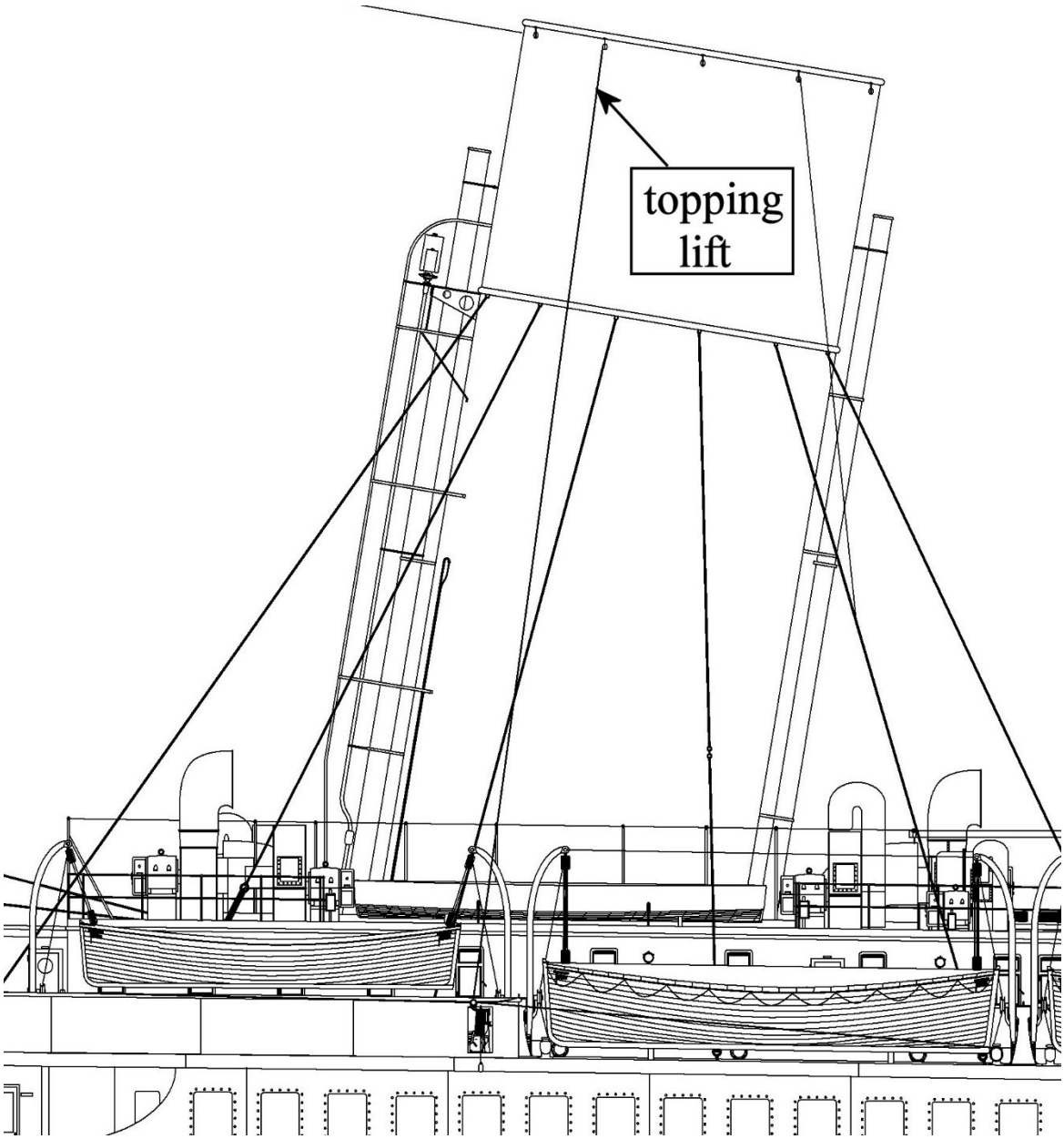

Figure 7

Elevation looking inboard showing rigging of topping lift

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Operation

All of the steps involved in the operation of the sounding machine will not be described here. An appendix is included at the end of this article which gives operational steps in greater detail.

Once the machine and the auxiliary equipment are rigged for operation, at least two crewmen operate the machine as is shown in Figure 8.

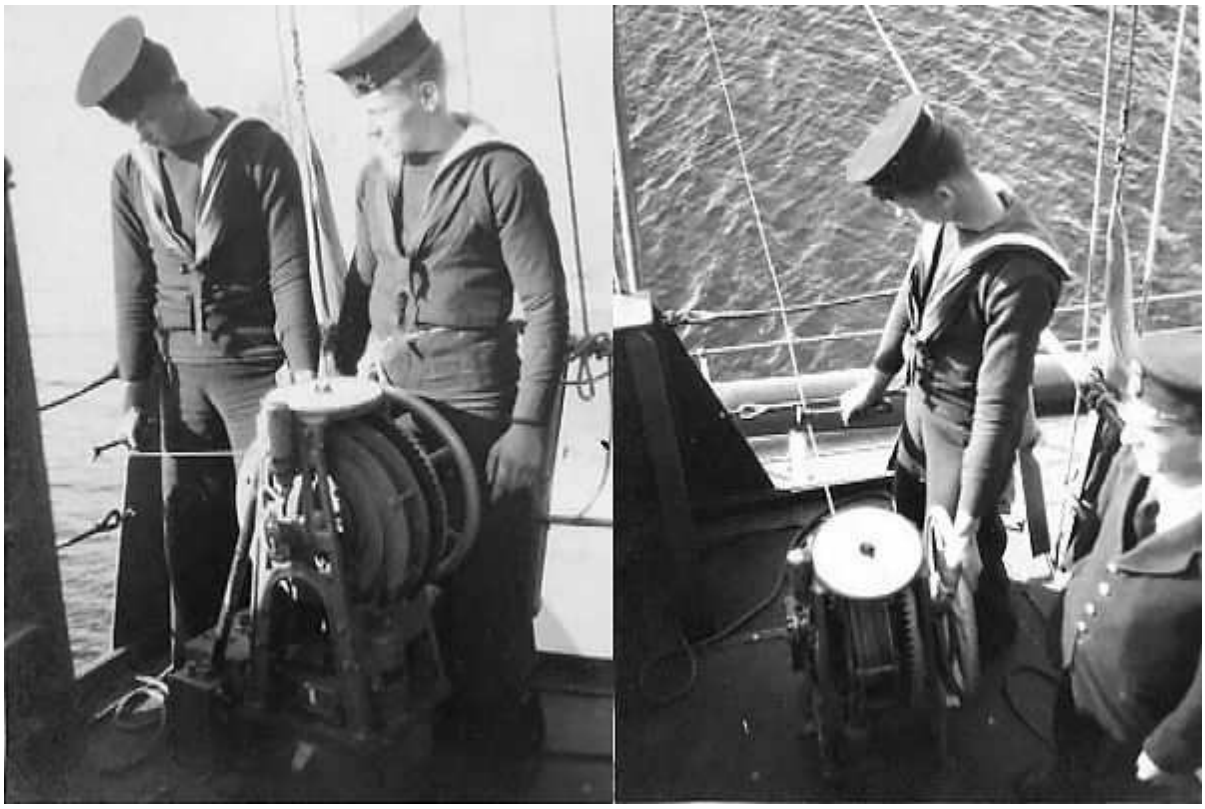

Figure 8

Crewmen operating the sounding machine

The sounding lead is lowered to just above the surface of the water. When the order is given to "let go", the brake on the sounding machine is released and the sounding lead begins to sink. The brake operator keeps one hand on the brake and in the other hand he has a "feeler" which he holds on the sounding wire. When he feels the wire go slack with the feeler, he applies the brake. Figure 9 shows a "feeler".

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Figure 9

Feeler

The other crewman then reads the depth indicated on the dial atop the sounding machine. Figure 10 shows the dial marked in feet.

Figure 10

Dial of sounding machine marked in feet

The reading is conveyed to the officer of the watch. The sounding machine operator then rewinds the sounding wire with the motor until it is ready to take another sounding.

Use of the Sounding Machine

The sounding machine can be used in any depth or at any ship's speed usually up to 18 knots. However, the hand lead is usually used to take depth soundings in relatively shallow pilotage waters and at relative slow speeds. The sounding machine can be used to verify the accuracy of the hand lead if needed. The sounding machine is usually used outside of pilotage waters and within anchorage waters to verify the ship's position with regard to depth charts and to verify the depth before dropping anchor.

Chemical Sounding Tubes

A very accurate means for depth soundings involved the use of chemically treated tubes. In this method a glass tube was lined with a chemical coating. There was water at the bottom of the tube. The tube was attached just above the sounding lead. As it descended, increasing water pressure forced the water to rise within the tube. As the rising water in the tube contacted the chemical coating, it caused the chemical coating to change color. When the chemical tube was retrieved, the depth was determined by measuring the height that the water had risen in the tube by observing where the chemical coating had changed color. Figure 11 shows a chemical sounding tube.

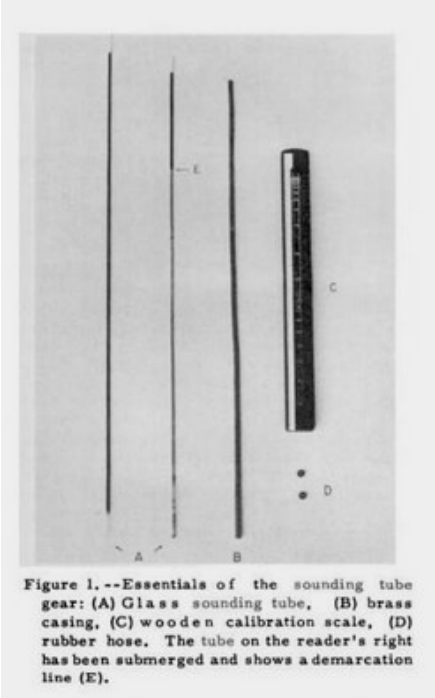

Figure 1.--Essentials of the sounding tube gear: (A) Glass sounding tube, (B) brass casing, (C) wooden calibration scale, (D) rubber hose. The tube on the reader's right has been submerged and shows a demarcation line (E).

Figure 11

Chemical sounding tube

The chemical sounding tubes gave a more accurate depth reading than the sounding machine lead. The sounding machine's accuracy was influenced by the speed of the ship. The officer of the watch had to take the depth reading given to him and enter it into a table which had various ship speeds. The table used a calculation to compensate for the ship speed. By using a chemical sounding tube, a more accurate reading could be compared to the table results to calibrate the machine's readings. The chemical sounding tube reading could also be used to verify the readings obtained with the hand-held sounding lead. The chemical sounding tubes were expensive so were only used to verify depth readings obtained by other means.

Conclusion

This article has sought to explain the structure and operation of the Kelvin Mark IV sounding machine. The details were only broadly outlined. For more specific information, two appendices follow. The first is the original 1907 patent of the Kelvin and James White Ltd. Mark IV motorized sounding machine. The second is from the Bluejackets Manual/United States Navy (1917 edition).

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Appendix I

1907 British Patent of the Motorized Kelvin Mark IV Sounding Machine

N° 26,132 **A.D. 1906**

Date of Application, 19th Nov., 1906

Complete Specification Left, 13th June, 1907—Accepted, 14th Nov., 1907

PROVISIONAL SPECIFICATION.

"An Improvement in connection with Navigational Sounding Machines especially for Flying Soundings".

We, WILLIAM THOMSON, BARON KELVIN OF LARGS, Scotland, FRANCIS WOOD CLARK, Foreman, and KELVIN & JAMES WHITE, LIMITED, all of 18, Cambridge Street, Glasgow, Scotland, Scientific Instrument Makers, do hereby declare the nature of this invention to be as follows:—

In carrying our invention into practice, we take an ordinary sounding machine, or by preference, the sounder as described in the Patent of Lord Kelvin and Kelvin & James White, Limited, No. 20813 A.D. 1905, and increase its size so as to allow room for an electric motor to be placed vertically below the wire reel. On the spindle of the motor aforesaid, we fix a bevelled pinion wheel designed to gear into a large wheel which is keyed on the spindle carrying the wire reel and brake arrangement, as described in the specification of the patent referred to above: the size and pitch of said bevel gearing being such as to bring the speed of winding to what is safe and convenient. By this method, we construct the machine so that it can either be used by the hand with the handles, or by an electric motor, and simplify and reduce the number of movements necessary to the aforesaid two methods of working.

Our method of doing this is by substituting for the brake catch a pawl mounted on the frame of the sounding machine, and designed to work on teeth cut on the brake wheel, which is mounted on the spindle with screw action as described in the patent already referred to. This pawl prevents the brake wheel from being turned in the direction of the wire being payed out. Thus, when the spindle is turned by the handles in the direction for running out, the brake is released, and when the handle is turned in the winding-in direction, the tension of the wire puts on the brake, and the pawl lifts free of the teeth.

To avoid the danger that would be caused by handles flying round when the machine is being wound in rapidly by the motor, we fix a controlling wheel on the spindle, of the same diameter as the handles. This wheel has a smooth round outside edge, so that it can be conveniently grasped by the hand. To release the brake, all that is necessary is to turn the wheel in the direction of the wire running out and then give attention to the feeler pin with one hand, and place the other on the switch or starter. Immediately the bottom is touched, the motor current is to be switched on. The requisite guidance of the wire on the wheel may be by a piece of oily canvas held in the hand. One man can work the machine easily and call out the length of wire used on touching the bottom; or the officer on the bridge can see the dial so that it is unnecessary to have more than one man at the machine unless tubes or depth recorders are being used.

For working by handles, the motor is disconnected. One handle is fixed on as in our machines hitherto in use; the other is fixed on to a similar mounting attached to the controlling wheel described above.

Dated this 17th day of November, 1906.

BOTTOMLEY & LIDDLE,
154, St. Vincent Street, Glasgow.
Chartered Patent Agents.

[*Price 8d.*]

An Improvement in connection with Navigational Sounding Machines.

COMPLETE SPECIFICATION.

"An Improvement in connection with Navigational Sounding Machines, especially for Flying Soundings."

We, WILLIAM THOMSON, BARON KELVIN OF LARGS, Scotland, FRANCIS WOOD CLARK, Foreman, and KELVIN & JAMES WHITE, LIMITED, all of 18, Cambridge Street, Glasgow, Scotland, Scientific Instrument Makers, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:—

The machine embodying the improvements is a development of the Patent of Lord Kelvin and Kelvin & James White Limited, No. 20813 A.D. 1905. The conditions provided to maintain the constant egress of the wire for a given speed of the ship are the same as in the previous machine, and the wire runs out in the same way.

In order that our invention may be properly understood and readily carried into effect, we have hereunto appended one sheet of drawings, of which

Figure 1 is a front elevation and part vertical section of our improved navigational sounding machine.

Figure 2 is a side elevation of the same.

In carrying our invention into practice, we take an ordinary sounding machine, such as that described in the Specification of Patent No. 20813 A.D. 1905, and increase its size so as to allow room for an electric motor *b* to be placed vertically below the wire reel *c*. On the spindle b^1 of the motor *b* aforesaid, we fix a bevelled pinion wheel *d*, designed to gear into a large wheel d^1 which is keyed on the spindle c^1 carrying the wire reel *c* and brake arrangement, as described in the specification of the patent referred to above; the size and pitch of said bevel gearing *d*, d^1 being such as to bring the speed of winding to what is safe and convenient. By this method, we construct the machine so that it can either be used by the hand with the handles, or by an electric motor *b*.

To avoid the danger that would be caused by handles flying round when the wire is being wound in rapidly by the motor, we fix a controlling wheel *h* on the spindle, of the same diameter as the handles. This wheel *h* has a smooth round outside edge, so that it can be conveniently grasped by the hand. To release the brake, all that is necessary is to turn the wheel in the direction of the wire running out and then give attention to the feeler pin with one hand by pressing it on the wire, and place the other hand on the handle of the switch or starter *i*. Immediately the bottom is touched, the controlling wheel is turned in the direction for hauling, the brake-catch is released, and the motor current is switched on to haul in at full speed. The requisite guidance of the wire on the wheel may be given by a piece of oily canvas held in the hand. One man can work the machine easily and call out the length of wire used on touching the bottom; or the officer on the bridge can see the dial so that it is unnecessary to have more than one man at the machine, unless tubes or depth recorders are being used.

For working by handles, the motor is disconnected. One handle is fixed on as in our machines hitherto in use; the other is fixed on to a similar mounting attached to the controlling wheel *h* described above.

An Improvement in connection with Navigational Sounding Machines.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that we are aware of our prior Patent No. 9853 A.D. 1903, and we are also aware that it has been proposed to have a motor driven winch in which the motor drives through spur gearing and we make no specific claim for such but what we do claim is:—

1. In navigational sounding machines constructing the frame and increasing the size thereof so as to accomodate an electric motor designed to be placed vertically below the wire reel; and mounting on the spindle of the motor a bevelled pinion wheel gearing into a large wheel keyed on the spindle which carries the wire reel and brake arrangement, substantially as and for the purposes hereinbefore described and illustrated on the accompanying sheet of drawings.

2. In navigational sounding machines mounting on the spindle a controlling wheel of the same diameter as the handles or nearly so, and having a smooth circumferential edge which can be conveniently grasped by the hand, in order to avoid danger that would be caused by the handles flying round when the machine is being wound in rapidly, substantially as and for the purposes hereinbefore described and illustrated on the accompanying sheet of drawings.

3. The general arrangement and combination of parts operating substantially as and for the purposes hereinbefore described and illustrated on the accompanying sheet of drawings.

Dated this 12th day of June, 1907.

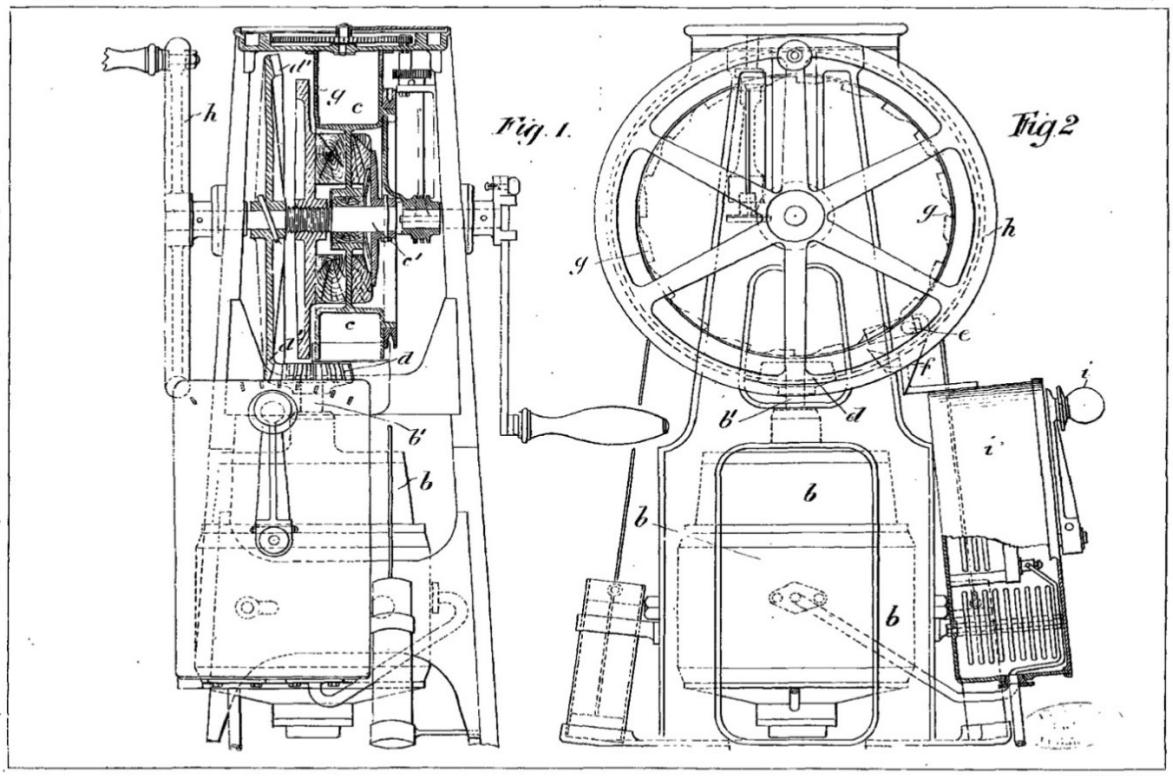
BOTTOMLEY & LIDDLE
154, St. Vincent Street, Glasgow.
Chartered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

A.D 1906 Nov. 19. № 26,132.
BARON KELVIN & *others'* COMPLETE SPECIFICATION.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale]



Malby & Sons, Photo-Litho

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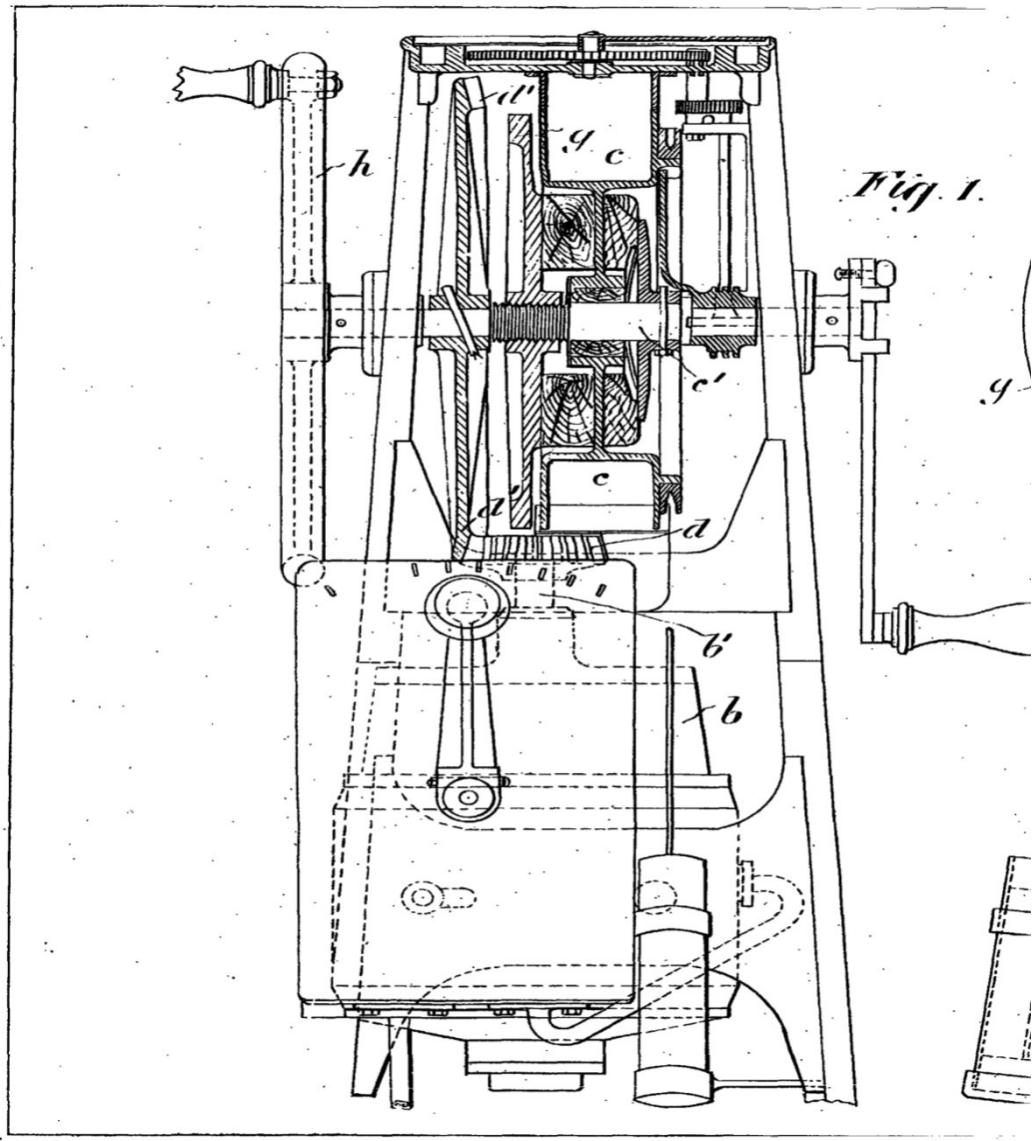
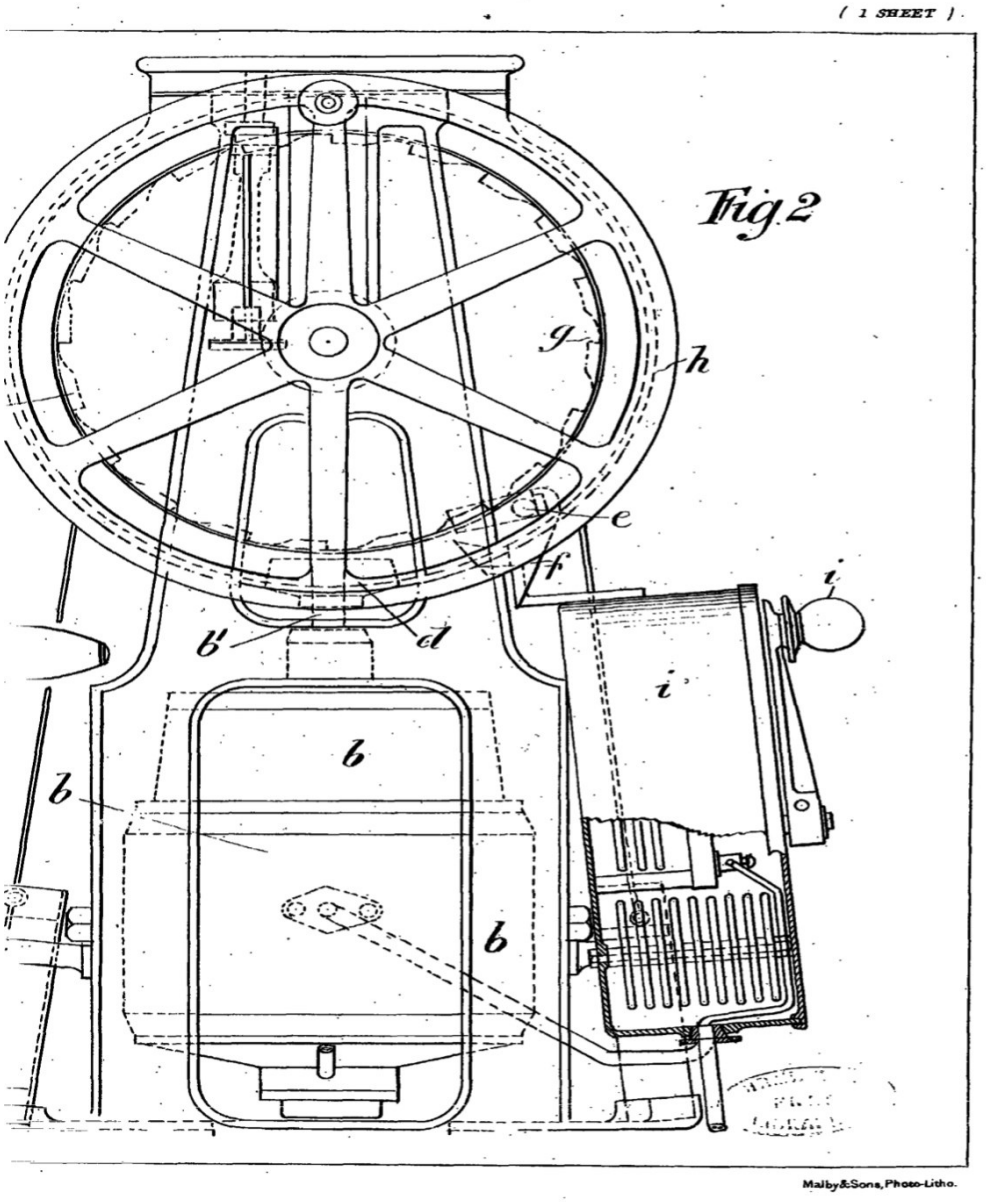


Fig. 1.



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Appendix II

Excerpt from The Bluejacket's Manual/United States Navy (1917 edition)

12. Describe the important features of the latest type of the KELVIN (THOMPSON) SOUNDING MACHINE.

The machine should be fixed on the spar deck in the vicinity of the fore bridge so that the working of the machine is under the general supervision of the officers on the bridge.

The wire is kept clear of the ship's side by a spar, which should be from 30 to 40 feet long according to the size of the ship.

The spar should not be over 5½ inches in diameter; it should taper slightly to both ends.

The heel is fitted with a gooseneck and clamp to an awning stanchion, or with a swivel bolt to the ship's rail. For convenience in shipping and unshipping, the heel must admit of its being guyed forward or aft, and also of its being topped up or lowered down.

The other end of the spar should be fitted with a band and three lugs. A topping lift, to support the spar in a horizontal position, is secured to the lug at the upper part of the band, and a fore guy and an after guy secure to lugs on the fore side and after side of the band. When in use, the spar is held in a horizontal position at right angles to the fore and aft line of the ship by the topping lift and guys.

A small sheave is fixed in a mortise at the outer end of the spar just within the band previously mentioned. A line is rove through the sheave hole to serve as an outhaul for hauling the carrier or traveler out on the spar. One end is secured to the brackets of the carrier, and the other end is brought inboard to a cleat near the heel of the spar. The sounding wire itself serves as an inhaul; but if a separate inhaul is desired, the other end of the outhaul will serve.

If possible the heel of the spar should be secured at such a height above the deck as to be 3 or 4 inches above the top of the wire drum of the machine.

The position of the machine should admit of the men having good footing; it should be in view of the bridge. It need not necessarily be out close to the side of the ship. The machine should be placed so that the spindle of the wire drum is at right angles to the longitudinal axis of the spar. Even if the heel of the spar cannot be secured above the level of the top of the wire drum, a very slight movement of the machine to either side will ensure that the wire leads clear to the block on the carrier.

Before the deck plates of the machine are finally screwed down, care must be used to see that the wire will run out without chafing against the side of the spar, or any fittings, or the sides of own drum. The wire must run out as nearly as possible parallel to the spar.

To Ship the Spar.—Place the carrier over the heel end of the spar; and with the spar in a fore-and-aft position, secure the gooseneck into its socket. Then by tending the topping lift and guy ropes, it is easily swung out into position for use.

The topping lift should reeve through a block secured aloft, so that the topping lift will make a large angle with the spar.

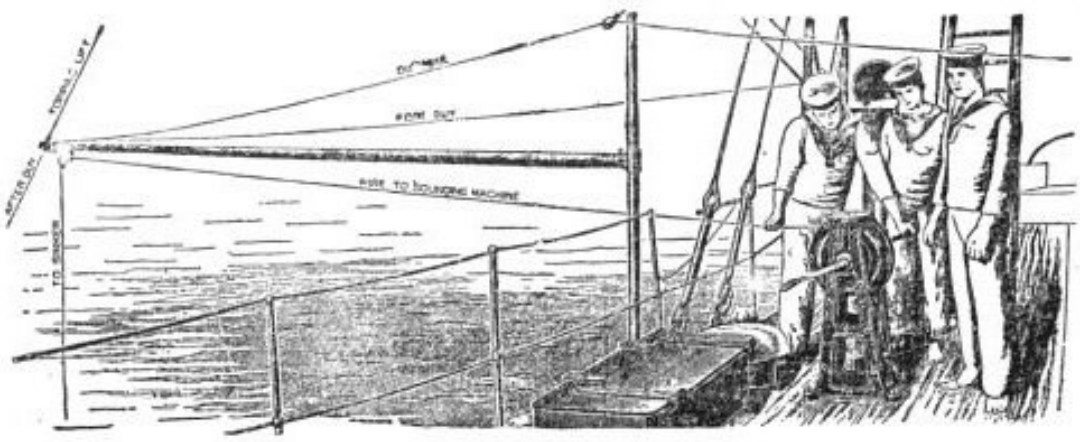

Plate 5.
SOUNDING FROM THE FORE BRIDGE—WIRE RUNNING OUT.

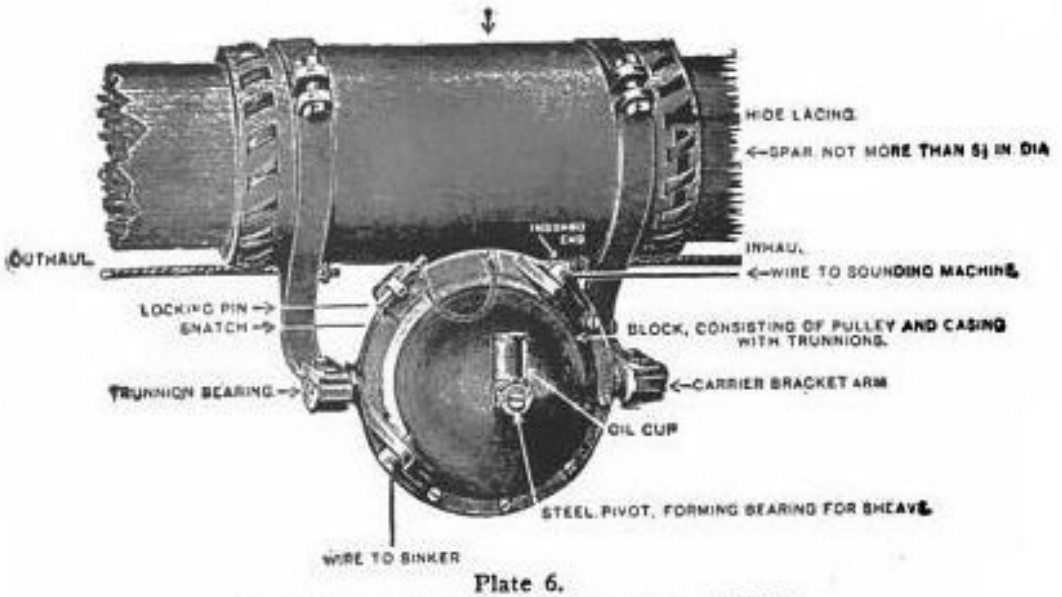

Plate 6.
LARGE VIEW OF CARRIER AND BLOCK.

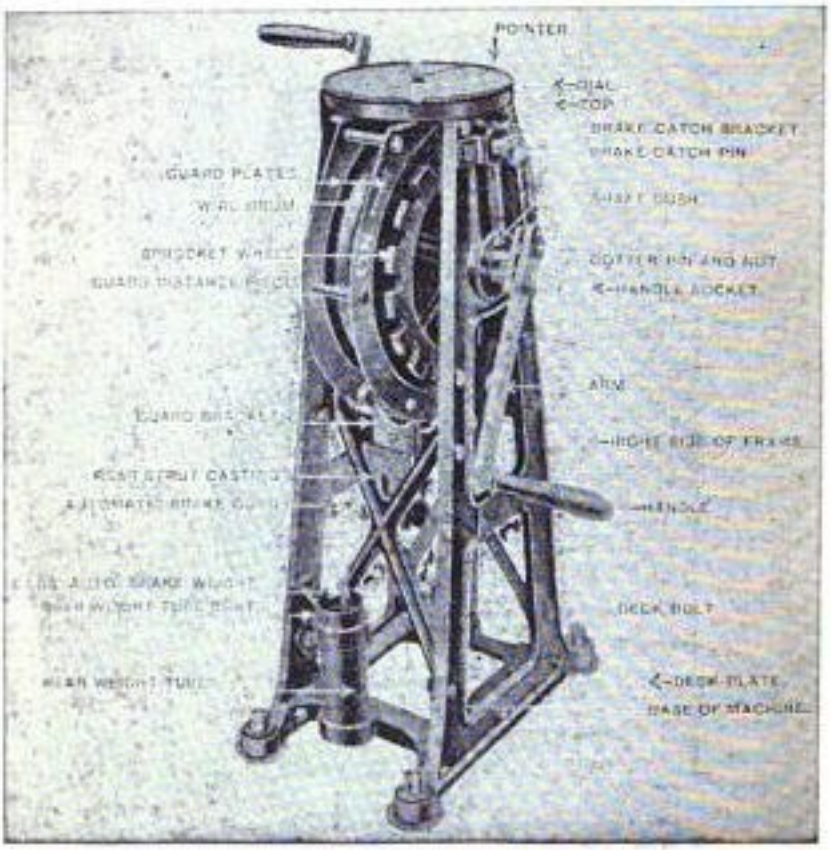

Plate 7.

LORD KELVIN'S NEW SOUNDING MACHINE.

Mark IV.—Hand Driven.

POSITION OF BRASS GUARD TUBE.—The stray line between the sinker and the wire should not be less than 9 feet long. The brass guard tube should be seized on it, 3 feet above the shank of the sinker.

SWIVEL BETWEEN WIRE AND STRAY LINE.—The connection between the hemp and the wire should be a swivel, to prevent turns passing into the wire when the lead is struck by the top of a wave and set spinning, as sometimes happens.

AUTOMATIC BRAKE.—An important feature of the new machine is the "Automatic Brake," consisting of a cord passing over a "V" shaped groove on the side of the drum. The cord is attached to weights working in tubes; it is adjusted as follows: Attach the cord to the heavy weight (6 pounds); pass it over the groove and secure it to the 1-pound weight; so that, when the heavy weight is resting on the bottom of the tube at the back of the machine, the 1-pound weight hangs about 1 to 1½ inches from the bottom of the tube at the front of the machine. The cord may be wet or dry without making any difference in the working of the brake; it may be kept oiled with advantage to prevent its rotting. In renewing this cord, care must be taken to use the same quality and diameter as the original. The groove also should be kept free from rust or dirt. A 6-pound weight will answer up to speeds of 13 knots. If, at higher speeds, it shows a tendency to jump out of its tube, the 10-pound weight should be substituted. Four 1-pound weights are supplied, to be added to the 6-pound weight if found necessary. Once adjusted, the automatic brake requires no attention. The automatic brake prevents the wire drum from over-running, and ensures that the resistance against the wire, when running out, is always constant for all speeds of the ship. This causes the length of wire run out for the same speed of the ship to be the same for the same depth, provided that the following points are attended to:

(a) That when releasing the main brake at the order "let go," it is given one complete turn in the contrary direction to "heaving in" on the handles; this must be done smartly.

(b) That sinkers of the same shape and of exactly the same weight are always used.

(c) That the same length and size of stray line is always used, that the swivels are identical, and that the guard tube is seized on in the same place.

(d) That the same brake weight is in use; because at a given speed a 10-pound weight would not permit the wire to run with as much velocity as the 6-pound weight.

This property of constant resistance against the wire running out for all speeds is a most valuable feature. When soundings are being taken continuously, and the ship is steaming at a constant speed, a change of depth is at once indicated by a less or greater amount of wire run out.

When in pilotage water, entering or leaving harbor, at speeds which render it difficult or impossible to get bottom with the hand lead and line, the machine should be kept constantly going, as a check on the hand lead, and for information as to a change of depth. Steaming in 20 fathoms of water at a speed of 10 knots, soundings can easily be obtained continuously once a minute, and in 10 fathoms once every half minute.

It is important that the number of fathoms of wire run out should be noted at the instant the wire slacks, and not after the brake has been applied, as a few fathoms of wire may run out during the operation of applying the brake.

CARE OF SOUNDING MACHINE.—The machine must be kept clean and well oiled. When the machine is not in use, the main brake must never be left set up. The "V" groove of the automatic brake must be kept clean and free from clogged oil, dirt or dust, and no cutting substances such as bath brick or emery must ever be used in cleaning it. The brake weights and their tubes must be kept clean; the tubes should be wiped out before sounding, and the weights oiled slightly to ensure that they move easily in the tubes. The brake cord should be frequently examined for signs of wear and changed if necessary.

CARE OF SOUNDING WIRE.—When sounding and heaving in the wire, it must be carefully guided on the drum, using a piece of oiled canvas to protect the hand. A reel and fittings for attaching it to the machine are supplied so that the wire can be conveniently wound off for occasional examination or oiling. On arrival in port, the wire should be wound off to the spare reel, and then back on to the drum of the machine; during this process, the wire should be oiled over and examined for faults. If kinks occur in the wire, cut the wire at the fault and splice it.

TO SPLICE THE WIRE.—Let the ends of the wire overlap for about 3 feet in the case of strand wire, and 4 feet in the case of piano wire. Lay the parts up slackly and put temporary stops on to keep them from untwisting. Wax some sailmaker's seaming twine, and put a whipping over the twisted parts of wire taking care that the ends of the wire do not project through the whipping. Two men can put on the whippings at once by commencing in the middle and working towards the ends. When each whipping is an inch beyond the end of the

wire, cut its ends off about 2 inches long, lay them along the wire and cover them by another whipping commenced on the single wire or strand just beyond them and worked towards the center and finished close against the ends of the original whippings. Old splices should be examined to see that the ends of the wire have not worked through the whippings. If so, they must be mended, because a projecting end of wire may cause a foul on the drum.

TO TAKE SOUNDINGS.—A petty officer and two men are sufficient, but an extra man is desirable when steaming fast and there is much strain on the wire. The petty officer takes the soundings, two men heave in, and the third guides the wire evenly on to the drum and occasionally relieves one of the men on the handles. The sinker being attached to the wire, ship the handles, put the sinker over the side, and let the wire off gently by turning the handles, snatch the wire in the block of the carrier, run the carrier out by the outhaul and belay it. Let the sinker down until it is almost touching the water, push home the brake catch and set the pointer on the dial to zero. The petty officer now eases the main brake gently until it will just hold the wire from running, and holding the handle of the machine with one hand, presses the feeler pin gently on the wire with the other, and notes the exact position of the handle. To "let go" he rapidly revolves the handle one turn in the direction contrary to "heaving in," and keeps his eye on the pointer while the wire is running out; the instant the wire slacks, he reads off the number of fathoms of wire out and applies the main brake; he then stands clear and lets the other men heave in. The leadsman winds with his left hand, and guides the wire on the drum with a piece of oily waste or canvas in his right hand. The brakesman winding with both hands, watches the counter from time to time during the winding in; and when the swivel or link is 5 fathoms from the fairlead, he calls out "hand the lead." The petty officer instantly leaves the machine and releases the outhaul. The brakesman then winds slowly in until the lead reaches the ship's side. The petty officer then takes the lead on board, examines the arming for specimen of bottom, and prepares the arming for a fresh cast.

WHEN CHEMICAL TUBES ARE USED, one of the brass guard tubes is lashed to the rope between the wire and the sinker, about 3 feet from the end of the wire. Before taking a cast, the petty officer in charge places a glass tube with the open end down in the guard tube and puts the cap on. When the guard tube is brought on board, care should be taken to keep it right

side up. If it is turned on its side or upside down, the water will run up in the glass tube and produce a bad mark. The petty officer takes out the glass tube, and applies it to the scale with the closed end against the brass plate at the top of the scale. He reads off the number of fathoms shown on the scale by the lowest part of the red coating.

DIRECTIONS FOR TAKING THE MACHINE TO PIECES are found in a pamphlet issued by Messrs. John Bliss & Co., agents for Kelvin, Bottomley & Baird, Ltd., Glasgow, Scotland. The plates and text in relation to the Mark IV Sounding Machine are here reproduced through the courtesy of Messrs. John Bliss & Co.