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DEEP-SEA SOUNDINGS

IN THE

NORTH PACIFIC OCEAN

U. S. HYDROGRAPHIC OFFICE.

No. 51.

DEEP-SEA SOUNDINGS

IN THE

NORTH PACIFIC OCEAN,

OBTAINED IN THE

UNITED STATES STEAMER TUSCARORA,

COMMANDER GEORGE E. BELKNAP.

WASHINGTON:
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1874.

DEEP-SEA SOUNDINGS IN THE NORTH PACIFIC OCEAN.

OBJECT OF THE CRUISE, AND THE ROUTES EXAMINED.

In the Spring of 1873, the United States steamer Tuscarora, Commander George E. Belknap, was detailed for the purpose of finding a practicable route for a submarine cable between the United States and Japan.

Nothing more was contemplated than an examination of the bed of the ocean to ascertain its profile on the northern and southern routes between those countries; the time allotted not permitting a thorough examination for scientific purposes.

Specimens of the bottom, however, were obtained with all soundings, and serial temperatures, when practicable; the surface and under currents were also ascertained when the circumstances would allow.

The Tuscarora arrived at the navy-yard, Mare Island, Cal., June 27, 1873, when the work of preparing her for the sounding cruise was commenced. A portion of the battery was landed, a chart-house was erected on deck, and such sounding-machines and stores were supplied as could then be furnished. These preparations were completed in the early part of August, and the vessel proceeded on an experimental trip off San Francisco, to test the working of the machines, and to remedy any defects that might be discovered, before commencing to run a line of soundings.

Eleven casts were made on this trip with both machines, which determined the superiority of Sir William Thomson's machine and piano-wire over the steam reel and rope. The vessel then returned to the navy-yard; and, after such alterations and improvements in the sounding-machines and instruments were made as were suggested by experience, she proceeded to the Straits of Juan de Fuca to commence the first line of soundings on the great-circle route from Cape Flattery to Japan.

This line was commenced September 17, and the great-circle route was followed as nearly as the winds and currents would permit. Thirty-four casts were made, the last in latitude 53° 58′ N., longitude 153° 00′ W., when the vessel was compelled to return for coal to Victoria, Vancouver Island. On account of the lateness of the season, it was determined to defer the completion of this line until the following year; and it being deemed desirable to ascertain the continental outline, or the commencement of the ocean-bed proper, of the west coast of the United States, the vessel left the Straits of Juan de Fuca October 17, and commenced running lines of soundings off and on shore between Cape

Flattery and San Francisco. Eight lines were run between those places, and eighty-three casts were made, the vessel arriving at San Francisco on the 6th of November. Leaving there on December 20, the lines of soundings off and on shore were continued to San Diego, at which place the vessel arrived December 30; eight lines having been run and fifty-eight casts made.

The line of soundings on the southern route between California and Japan was commenced at San Diego, the vessel leaving there January 6, 1874, touching at Honolulu, Hawaiian Islands; Port Lloyd, Bonin Isles, and arriving at Yokohama, Japan, on the 22d of April. Sixty-two casts were made between San Diego and Honolulu; fifty-nine, between Honolulu and Port Lloyd; and fourteen, between Port Lloyd and Yokohama, making a total of one hundred and thirty-five casts on the southern route.

On the 8th of June, the line of soundings on the great-circle route from Yokohama to Cape Flattery was commenced; but after making fifteen casts, such great depth of water, over 4,600 fathoms, was found in the Japan stream, that it was deemed an impracticable route for a submarine cable, and the vessel returned to the coast to commence a new line of soundings on a great-circle route beginning near Point Komoto. After eighteen casts were made on this line, the water was again found too deep, and the vessel was headed for the Kurile Islands, and an inshore line of fourteen casts was run back toward Yokohama.

Being short of coal, the vessel proceeded to Hakodadi, Japan; and it was then determined to abandon the great-circle route, and to complete the line along the coasts of the Kurile Islands to Cape Lopatka, and from there across the Behring's Sea to the Aleutian Islands.

The vessel left Hakodadi on the 30th of June, and the soundings on the inshore route were completed to Glory of Russia Bay, Tanaga Island, where she arrived on the 19th of July; having made ninety-seven casts since leaving Yokohama.

A line of soundings was then run in the Behring's Sea to the northward of the Aleutian Islands, between Tanaga and Ounalashka Islands; the vessel arriving at the latter island on the 29th of July.

To complete the soundings on the northern route, there now remained only the gap between the position of the last sounding made on the great-circle route in September, 1873, and Ounalashka Island.

A line of soundings was run between those points, and also two other lines, one to the northward and the other to the southward of the first line, to ascertain how a deep hole of 3,359 fathoms might be avoided. Sixty-five casts were made after leaving Tanaga Island; making the total number of casts since leaving Yokohama one hundred and sixty-two, and since the commencement of the cruise four hundred and eighty-three.

The last cast was made on August 21, and the vessel arrived at San Francisco September 2, 1874.

SOUNDING OUTFIT.

The following is a list of the machines and stores furnished to the Tuscarora for sounding-purposes:

1 Sir William Thomson's sounding-machine for piano-wire, (original pattern,) with spare drum.

1 sounding-machine for rope, with steam-reel, and a dynamometer designed by Passed Assistant Engineer T. W. Rae, (originally fitted for the Juniata.)

10 Brooke's sounding-rods.
6 Brooke's sounding-rods, (long.)
15 Brooke's modified attachment and sinkers.
210 slings for Brooke's sounding-apparatus.
11 Sands' cups for sounding-purposes.
1 spare spring for sounding-purposes.
6 Fitzgerald's sounding-apparatus.
8 sounding-cylinders.
100 copper sleeves for sounding-rods.
1 Massey's registering-apparatus.
1 Trowbridge's registering-apparatus.
600 bored shot, VIII-inch, for sinkers.
50 bored shot, 32-pounder, for sinkers.
25 bored shot, XV-inch, for sinkers.
Square sinkers, 18 to 30 pounds, for the Fitzgerald apparatus.
Split sinkers, from 20 to 300 pounds.
1 200-pound sounding-lead.
2 150-pound sounding-lead.
2 100-pound sounding-lead.
6 90-pound sounding-lead.
1 80-pound sounding-lead.
1 50-pound sounding-lead.
180 pounds piano-wire, Birmingham gauge No. 22.
950 pounds Albacore line, ($\frac{3}{4}$-inch untarred hemp, 9 thread.)
2,270 pounds $1\frac{1}{4}$-inch Manilla whale-line.
1,700 pounds $2\frac{1}{2}$-inch Manilla carbolized line.
3,750 pounds $1\frac{1}{4}$-inch carbolized line.
2,800 pounds $1\frac{1}{2}$-inch carbolized line.
1,575 pounds $1\frac{3}{4}$-inch carbolized line.
665 pounds $1\frac{1}{4}$-inch lead-line.
590 pounds $1\frac{1}{2}$-inch lead-line.
9 dozen cod-line.
1 Burt's buoy and nipper.
3 accumulators.
3 iron dredge-frames.
22 swivels.
1 galvanized-iron tub.
12 Miller-Cassella thermometers.

6 self-registering thermometers, (Saxton's.)
1 standard thermometer.
1 photographic apparatus.
1 microscope.
100 glass bottles for specimens of the bottom.
4 cans of caustic soda for preserving the wire.
Drawing-instruments and materials.
Surveying-instruments.

After the superiority of Sir William Thomson's machine had been proved by experience, and the invention of the sounding-cylinders by Commander Belknap, some of the instruments and appliances given in the list of outfit were not required, and were placed in store at the navy-yard. The supply of articles was kept up from time to time as required.

DESCRIPTION OF SOUNDING-MACHINES, ETC.

SIR WILLIAM THOMSON'S SOUNDING-MACHINE, (ORIGINAL PATTERN.)

A general side-elevation of this machine is shown in Plate XVII. It consists of a hollow, circular drum, *a*, for the piano-wire; a counter, *b*, to indicate the revolutions of the drum; a dynamometer-wheel, *c*, and dynamometer, by means of which the tension on the wire plus the friction is measured; a platform on which the drum, the dynamometer-wheel, and dynamometer are secured; and an endless rope, with its pulley-wheel and pendant attachments.

The drum is made of galvanized sheet-iron, and is securely soldered to a small iron shaft, which passes through its center. Its circumference is six feet, so that each of the first turns of the wire is a fathom in length. The sides of the drum are extended, forming the rims of a score three inches wide and two inches deep, in which the wire is reeled.

A projection of galvanized iron, attached to the right side of the drum, (looking from the dynamometer toward the drum,) forms the V-groove around which the endless rope is passed. To the shaft on the left side of the drum is secured a ratchet, in which a pawl works to keep the drum from turning when it may be desirable. The left end of the shaft is fitted with a square shoulder for a crank to reel up the wire when not sounding; and the shaft revolves in trunnion-holes at the upper end of two iron braces, which are bolted to the platform. The drum weighs about 60 pounds. To the left brace of the drum is screwed a plate of iron to attach the counter, which consists of a rectangular box of brass, containing cog-wheels of different diameters, so arranged that they work the hands of the three dials on one face of the box, showing the number of revolutions of the drum in tens, hundreds, and thousands. The motion is given to these wheels by a wormed wheel of brass, which is secured to the shaft of the drum.

The dynamometer-wheel is made of iron ten inches in diameter, and has two grooves on its rim: one wide enough to hold two parts of the endless rope; and the other narrower, to receive a cord. It revolves in an iron crotch secured to an upright block of wood fastened to the platform in rear of the drum, so that the wheel and V-groove of the drum are directly in line. The dynamometer is constructed on the principle of the spring-balance. The case is made of iron, is bell-shaped, and on one face has a graduated scale in pounds, with a pointer, which is connected with the springs in the interior of the case, so that when a tension is brought upon the springs the pointer shows on the graduated scale its amount. The dynamometer is secured to a block of wood which is fastened to the platform alongside the block for the dynamometer-wheel. The dynamometer and dynamometer-wheel, when required for use in sounding, are connected by a cord or check-line, which rests in the narrow groove in the rim of the wheel, and passes down through a hole in the rim of the wheel, and is secured to an eye in the end of a rod, which is attached to the springs of the dynamometer. Then, as the dynamometer-wheel turns by the action of the endless rope, the cord acts upon the rod, which extends the springs, moving the pointer, and showing on the graduated scale the number of pounds of tension.

[An ordinary spring-balance was substituted for the dynamometer described above.]

The platform is made of hard wood, 3¼ feet in length, 1¼ feet wide, and 2½ inches thick. To the forward end of the platform is secured a lignum-vitæ clamp, through which the wire passes, and which may be used to clamp the wire when desirable.

The endless rope is made of 9-thread Albacore-line, untarred hemp, and is attached to the machine in the following manner: One bight of the rope is placed in the outer edge of the V-groove in the drum, and the part leading from the bottom of the drum is taken up over the dynamometer-wheel, and once around it, and the other bight of the rope is kept taut by being placed over a pulley-wheel to which a pendant is attached, which is rove through a stationary block, and to the other end of the pendant hooks are seized, to which weights are attached.

The object of the endless rope is to produce friction on the drum, by which the running-out of the wire may be regulated, and to connect the drum and the dynamometer so that the tension on the wire, making allowance for friction, may be measured. It was also used at first to reel up the wire in sounding.

The above description is that of the machine originally furnished to Commander Belknap for sounding with piano-wire, with the exception of the weight-attachments to the pendant, which he adopted in place of the tackle, for keeping the pendant taut. Experience suggested other improvements, such as the strengthening of the drum, which was found too weak, and the adoption of a separate reel for reeling up the wire in sounding. Commander Belknap recommends the construction of a steel drum, which he thinks may be made to withstand any strain that may be brought upon it in sounding, and which will otherwise work successfully.

The reeling-in apparatus, which, with the flying-bridge, was designed and constructed by Carpenter Jos. L. Thatcher, of the Tusarcora, is represented in Plate XVIII.

Fig. 1 shows a section through reel: *a* and *a'* are spokes of white pine placed at intervals around the inside of the drum, as shown in Fig. 2, fitting snugly to the shape of the inside of the drum; *b* and *b'*, disk of white pine made to fit inside circle of face, cutting through the spokes; *c* and *c'*, clamps of iron used to hold the reel in proper position; *d*, bed for reel to slide in, made any length to suit; *e* and *e'*, rivets or screws. Fig. 3 is a section through friction-roller stand, and Fig. 4 is an end-elevation of the reeling-in apparatus. In Plate XVII, the dotted line represents the belt or rope for reeling in, which is placed over the V-groove of the drum, and the groove of the reeling-in apparatus. This rope is made of 15-thread tarred hemp, well stretched, fitted with eyes and laniard. In fitting the eyes, a few of the yarns are taken out, and strands of annealed wire laid in to make the parts of the eyes and lashing uniform in size with the rest of the line, so as to run smoothly, and prevent the tendency to jump. The eyes should be served and examined frequently, as the strain upon them is very great, and they soon wear out. When not in use, the rope should be kept dry, working much better in that condition than when wet.

SOUNDING-MACHINE FOR ROPE.

This machine is represented in Plate XIX, which was made from a rough sketch taken on board the Tuscarora. A machine working on the same principle was designed by Passed Assistant Engineer T. W. Rae for use with piano-wire, but this was afterward altered, in obedience to orders, for use with sounding-line. It was originally constructed for the Juniata, which vessel was detailed to run lines of soundings in the North Atlantic, and on the change of her orders the machine was sent to the Tuscarora. In Plate XIX, *a* and *a'* are two fixed elevated sheaves, over which the line passes. Midway between these sheaves there is another one, *b*, riding on the line, which is attached to a rod, *c*, moving vertically in a standard, *d*, and having at its lower end a piston, *e*, moving readily in a cylinder, *f*, which is filled with water or oil to prevent violent and vibratory motion of the dynamometer. The rod *c* is so fitted that weights, *w*, may be attached, which serve to measure the strain on the line. The weights are small, so that they can be added one by one as the weight of the line overboard increases, and a uniform strain may be kept continually upon it. By carefully regulating the weights, surplus line may be prevented from running out when the sounding-apparatus strikes the bottom. If the weighted pulley did not ride on the line it would stretch straight between the sheaves *a* and *a'*. It, however, depresses the line a certain distance, which corresponds to a given strain on the calculated scale *g*. The sounding-line is wound upon the reel *h*, and leads from the reel to the drum *j*, around which several turns are taken, and then leads over the sheaves *a'* and *a* to the sheave *k*, in the end of out-rigger *l*, and the end is attached to the sounding-apparatus. The drum is controlled by a break, and the number of revolutions, from which the quantity of line out is calculated, is shown by a counter at *m* For reeling-in, a small engine, *n*, couples to the drum. To keep the turns from riding on the drum, there is a plough-edge at *o*, but by experience it was found necessary to lead the line through fair leaders at *p* and *p'*. The drum, as originally designed, had two plough-edges, which would have obviated the use of the fair leaders, and it was intended that the line should lead from the upper instead of the under side of the drum. This machine was used at first in taking some of the soundings at moderate depths, and in taking serial temperatures; but it was afterward landed at the navy-yard, and a duplicate Thomson's machine was placed on the forecastle for obtaining temperatures.

SANDS' SPECIMEN-BOX FOR DEEP-SEA SOUNDINGS.

Plate I, Figs. 1 and 2.

A key, *a*, secures the tenon *b* into the bottom of the deep-sea lead, into which tenon is screwed the tube *c*, (which is conical at the lower end for penetrating the bottom,) over which moves a cylindrical sliding-valve, *d*, with flange, *e*, which, resting on the bottom when the lead reaches it, is pushed up above the elliptical hole *f* in the side of the tube for the admission of the specimen, and closed by the spiral spring *g*, (when the lead is free from the bottom,) which keeps it firmly down on the rest-pin *h*, preventing the washing-out of the specimen in the jerking motion of hauling in the line by hand. The tube is unscrewed from the tenon, and the specimen emptied out at the upper end.

SANDS' DEEP-SEA SOUNDING-APPARATUS.

Plate II.

The rod *a a* is of half-inch round wire, about 18 inches long, with a swivel on the upper end for the lead-line, and a socket at the lower end to receive the tenon of the specimen-tube *b*, fastened by the key *c*. Two wire-rods, *f*, about a foot in length, on each side of the rod connect the flange *g* of the specimen-tube with a small band, *h*, around the rod, having two spurs pointing downward. Surrounding the sounding-rod are two semicylindrical weights of cast iron, *e*, *e*, grooved on the flat-sides to receive the rod, and to allow the valve-connecting rods to play freely between the weights. Holes of three-fourths of an inch diameter are drilled in their lower ends to receive the plugs *d d* that are hinged upon the ends of the key *c*, and which keep the weights in their seat; and in their upper ends, of one-fourth inch in diameter, to receive the small spurs of the band *h*, which confine the upper ends of the weights to the sounding-rod. In the act of the specimen-tube piercing the bottom, the sliding-valve of the tube is raised to admit the specimen, lifting also the band *h* connected with it by the wire-rods *f*, releasing the upper ends of the weights, and causing them to fall free from the rod, leaving nothing but the rod and specimen-tube to be brought on board. The upper portion of the sounding-rod is flattened, and pierced with two holes, to allow the self-registering indicator (Plate III) to be clamped to it.

BROOKE'S DEEP-SEA SOUNDING-APPARATUS.

Paltes IV and V.

In Plate IV, Fig. 1, is shown the detaching-apparatus; Fig. 2, the lead ready for sounding. Plate V, Fig. 1, shows the shot in the act of detaching; Fig. 2, the slings. *a* is a shot cast with a hole through it and slight grooves on its sides to receive and steady the slings *e*.

b is a rod, to which is attached an arm, *c*.

c is an arm moving vertically about the pin *d*, and from which the shot *a* is suspended by the slings *e*.

e, slings and washer, which are thrown off with the shot.

The lower end of the rod is tubular, receiving the barrels of several goose-quills, open at both ends, retaining their places by their elasticity.

f is a valve of thin leather, opening outward, permitting the water to flow through the quills *q* as the rod descends, and closing as it is drawn up.

The original sounding-apparatus, invented by Brooke, had a double-armed detachment at *d*, which required nicety of construction and manipulation to insure its working, and Brooke then constructed the single-armed detachment, which has proved so successful. He afterward designed a registering-apparatus, to indicate the number of fathoms of descent of the weight, which was attached to the link *h*, and to the upper end of which was attached the sounding-line. This, like all similar self-registering instruments, is of no practical use for great depths.

THE FITZGERALD SOUNDING-MACHINE.

Plate VI.

The following description and accompanying plate of the Fitzgerald sounding-machine are taken from "The Depths of the Sea," by Prof. C. Wyville Thomson:

The sounding-line is attached to the center of the bar of iron *f*. The bar terminates at one end in a claw, and at the other in an eye, to which the chain *g* is attached. A scoop, *a*, with a sharp, spade-like lip, is fixed to a long and rather heavy iron rod, *d*, with an expanded rudder-shaped end, *h*, to steady it in passing quickly through the water, and beneath this an eye, which fits the claw of the bar *f*, as at *i*. A door, *b*, fits the scoop, to which it is hinged, and it is also hinged to the arm *c*, which, when held in a vertical position, keeps it open. The arm *c* is attached to the bar *f* by the chain *g*, and the arm and chain correspond in length to the rod *d*. Two teeth, *e*, *e*, project from the rod *d*, and on these is hung the weight *k*. The apparatus is so adjusted that when the weight is attached, and the instrument hanging, ready for use, as represented in the figure, the rod *f* maintains a horizontal position. When the instrument strikes the bottom, the tension on the bar *f* is relieved, the weight draws the rod *d* off the claw, and slips off, at the same time filling the scoop. When hauling up, all of the instrument falls into a nearly vertical line, and the scoop comes up full in the middle, the weight of *d* keeping its mouth closed up against its lid.

Professor Thomson says in regard to this machine that he never knew it to fail; but Commander Belknap reports that "it does not impress me favorably; the form is irregular, and the open scoop opposes so much resistance to the water that it does not go down straight; it also gets the line full of turns, is hard to haul in, owing to its form and weight, and the sinker is apt to slip off." This machine, as furnished to the Tuscarora, weighed $11\frac{1}{2}$ pounds.

THE BROOKE-SANDS SOUNDING-APPARATUS, AS FIRST MODIFIED BY COMMANDER BELKNAP.

This instrument is represented in Plates VII and VIII: *a* is the Sands cup; *b*, Brooke's washer and laniard; *cc'*, modification of Brooke's movable arm; *f*, movable socket for shoulder of sinker; and *g*, screw for clamping movable socket.

The Sands cup was made larger and with lighter spring, and reduced one pound in weight. In place of the movable arm of the Brooke attachment, one ring traversing within another was substituted, by means of which the laniard and washer are saved. The socket inclosing the upper ends of the split sinker, when the apparatus is ready for use, is movable, and kept in any position by the screw *g*, so that sinkers of greater or lesser weights can be attached, and the Sands sinkers are cast with the shoulders *e* fitting into the socket *f*. The weight to haul up is $4\frac{1}{2}$ pounds.

BELKNAP DEEP-SEA SOUNDING-CYLINDER NO. 1, WITH BROOKE'S DETACHING-ROD AND SINKER.

Plates IX and X.

The sliding-cylinder *b* traverses freely over the cylinder *a a*, and in sounding is held up by the lug *h* resting on the shot. The rod *c* terminates in a cone, *l*, which screws into the cylinder *a'*. In descending, the water passes freely in through apertures *p p'*, up through holes *n n'*, into chambers *m m'*, thence up through outlets *i i* and *r r*; upon touching the bottom, the shot falls and disengages in the usual manner. Cylinder *b* also drops, assisted by friction of shot, and closes apertures *p p'*. The shoulders *j j'* bear on outer surface of cylinder *a*; the rest of the inner surface of outer cylinder being turned out, as shown at *k*, and upward, to decrease friction and prevent particles of sand from jamming it. *g g* are leather valves. Upon hauling up the line, the pump-valves *o o'* and the valves *g g* close, and the cylinder comes up as shown in Plate

X, Fig. 1, and brings up both mud and water from the bottom. The ring *w* is clamped to the rod *c* by the screw *x*, and prevents the outer cylinder from going so high as to clear the inner cylinder. Being adjustable, it can be set for either the XI-inch or VIII-inch shot. The cylinder; *a* unscrews from *a'* to enable the specimens to be taken out easily; and it also forms a shoulder to keep the valve *n* in place. The valve *n'* screws into the cylinder from above. These cylinders can be made any size desired; the sinkers to be cast with holes accordingly. To save the sinker in shoal water, the cup of the inner cylinder might be made in duplicate, as shown in Fig 3, Plate IX; the latter having a pin like that in the Sands cup running through and projecting from the outer surface, so as to catch the sinker and prevent its dropping off. The mud would act as a cushion to ease the shock and save the pin from bending or breaking.

BELKNAP DEEP-SEA SOUNDING CYLINDER NO. 2.

Plates XI and XII.

a is a cylinder, which screws into the casting *b* at *b'*, the lower part of which is bored out to form the tube. *c* keeps the valve-plate *e* from ing up any higher. *f* and *g* are lifting-valves, with leather washers. The plunger *h* is kept in position by its own weight and the force of the light spring *k*. The rod *l* screws into the casting *b* at *l'*. When the cylinder strikes the bottom, detaching the shot, the plunger *h* is forced upward, admitting mud and water. The water in its flow upward escapes through the holes *m* and *n*, lifting the valves *f* and *g*, and, upon hauling up the cylinder, the valves close and the plunger drops down. The specimens brought up are readily gotten out by unscrewing the casting *b* at *b'*, when the entire interior mechanism comes out. The screw *p* seems to make little or no difference in the working of the plunger in muddy bottom, but would be of more service if hard bottom was met with.

BELKNAP DEEP-SEA SOUNDING-CYLINDER NO. 3.

Plates XIII and XIV.

The auger-twist *a*, terminating in the cup *b*, revolves at the swivel-joint *j* in the casting *c*, and is kept from unscrewing by the pin *p*.

The cylinder *e* is kept up by the lug *l*, resting on the shot or sinker *s*. In descending, the water flows upward through the holes *m m'* and *n n'*. When the bottom is reached, the sinker and cylinder fall, the former detaching in the usual manner, and the latter fetches up at the shoulder *t*, and the shoulder *h* of the cylinder brings up snugly around the edge of the cup *b*. The cup and twist offering no obstacle, and in very deep water when the tension on the wire or line prevents the sinker from striking with full force, this machine generally brings up a better specimen than cylinders Nos. 1 and 2. Though the screw is made to turn at the joint *j*, it does not seem to be necessary, as in practice, using the wire, there seems to be no tendency to twist.

In hauling back, the valves *v* and *v'* close. The cup and screw, being made of iron, should be galvanized. The laniards are attached to the shot or sinker, as shown in Plate XIV, to prevent the use of the Brooke washer, which is liable in detaching to catch in the twist near the cup. The dotted lines in Plate XIV show the laniards fitted with small iron rings in place of the wire eyes, which do not so easily detach from the arm.

BELKNAP'S COASTING-LEAD.

Plates XV and XVI.

The lead *a* is fastened to the brass cylinder *b* by the screws *s s'*. When set for use, the laniard *e* raises the lead *a*, and hooks on the Brooke attachment *f*. In descending, the water flows freely in through the apertures *g g'* of the cup *c*, and upward through the holes *h h'* and *i i'*, and out through the holes *j j'*. The ring *k* and the screw *l* keep the lead from going too high up the rod *r*. When bottom is reached, the lead *a* drops down over the cup *c*, closing the apertures *g g'*, and the curved end of the cylinder *b*, shutting closely down over the holes *h h'*, acts as a valve to shut the water off, preventing the specimen from washing out. By making the cylinder proportionally larger, it could be made of cast iron, and galvanized to prevent rust; and the expense of the cylinder *b* would be saved, as the sinker, being of hard metal, could be cast so as to fit and slide over the cup. The dotted lines suggest a modification of form if desirable. As the cylinder *b* shuts closely over the holes *h h'*, the leather valves *v v* can be dispensed with.

Cylinder No. 3 was designed for use in localities where ooze, mud, or clay is found, and with such a bottom could hardly be bettered. On hard, sandy, or gravelly bottom, cylinder No. 2 was found generally to bring up the best specimen. Cylinder No. 1, also, did excellent service, especially in mud and ooze.

DESCRIPTION OF THE PIANO-WIRE, SOUNDING-LINES, ETC.

The piano-wire furnished is known as No. 22, Birmingham gauge. It comes in lengths of from 200 to 400 fathoms, and is spliced together by overlapping the ends about two feet, soldering one end, and laying the other end up so that each turn will take up one inch of the wire, and as soon as all the wire is expended the end is soldered. The two parts are also soldered together at three or four intermediate points between the ends, and the whole splice is tightly served with well-waxed flax twine.

The wire weighs 14 pounds in air and 12 pounds in water to the statute-mile, and the breaking-strain of English wire is about 230 pounds and of American 195 pounds. When it breaks at great depths, it draws down to two-thirds of its normal size before parting, and Commander Belknap suggests the use of a larger wire for depths beyond 4,000 fathoms. It is preserved from rust when new by being kept in sperm-oil, and, after it has been used, by keeping it covered with a solution of caustic soda.

The sounding-lines furnished were of various kinds and sizes, as shown in the list of sounding-outfit. In testing these lines, the 1¼-inch Manilla whale-line bore a steady strain of 1,830 pounds with a length of 2 fathoms between seizings, and the Albacore line bore a strain of 520 pounds with the same length between seizings. A greater portion of the sounding-line was carbolized to prevent rotting, but it was found that this did not answer the purpose intended, and besides weakened the line. The following table shows the test of the carbolized line:

Size in inches.	Kind.	Length in fathoms.	Breaking-strain in pounds.	Length between seizings in fathoms.	Time of hanging.	Weight of ten fathoms in air in pounds.
1¼	Hemp	12,000	1,180	2	10 seconds	3½
1¼	....do	8,000	1,280	2	2 minutes 15 seconds	3¼
1¼	Hemp, (cable-laid)	3,000	1,480	2	3 minutes	5¼
2¼	Manilla	9,000	2,600	2½	9 minutes 40 seconds	8¼

The lines were marked as follows: At every 50 fathoms, with a knot; and at the first hundred fathoms, with a red rag; second hundred, white; third hundred, red and blue; fourth hundred, blue and red; fifth hundred, red and white. Commencing again, the sixth hundred is marked with a red rag; and so on, adding one knot for each 500 fathoms, beginning from second five-hundred mark.

The sinkers furnished were bored 32-pounder, VIII, XI, and XV-inch shot, the holes being 2¼ and 2½ inches in diameter; also square sinkers, from 18 to 30 pounds, for the Fitzgerald apparatus, and split sinkers, from 20 to 300 pounds a pair.

In the Brooke apparatus, the shot is supported by a washer with laniards attached, which go over the detaching-arm of the sounding-rod; but, with the Belknap cylinders, it was found best to do away with the washer, which, in detaching, sometimes catches between the cup and the screw, and this is obviated by attaching the laniards to the shot, either by having the shot fitted with lugs, or by slinging it by making two grommets, of small-sized, annealed wire, of a little less diameter than that of the shot, and securing them on it perpendicular to the hole by passing a lacing between the grommets after the manner of drum-head hoops and lacing. The laniards can then be secured to the lower grommet, (see Plate XIV.) With the piano-wire, and at moderate depths, say 2,500 fathoms, the VIII-inch sinker, (hole, 2¼ inches,) weighing 55 pounds, was principally used. At greater depths, the weight of sinker was increased from 15 to 20 pounds by attaching castings of lead to fit over the upper half of the sinker.

With rope, 1¼-inch Manilla whale-line and Albacore line, sinkers weighing from 300 to 400 pounds were used in depths over 1,200 fathoms.

METHOD OF SOUNDING WITH SIR WILLIAM THOMSON'S MACHINE AND PIANO-WIRE.

In preparing to sound, if the ship be under sail, steam is gotten up and the machine is placed on the flying-bridge athwartships, and properly secured there, so that the wire, which has been previously reeled upon the drum, will lead fair from the drum and clear of the ship's side. To reel up the wire, the counter is placed in its position on the axle of the drum, and the inner end of the first hank is securely attached to the drum, a hole being drilled in the rim for the purpose. The wire is then carefully reeled up, being measured as it is wound upon the drum, until the end of the hank is reached, and this end is spliced to the end of the second hank in the manner previously described, and this process is continued until the required amount of wire is upon the drum.

In handling the wire, whether measuring or splicing it, or paying it out, great care is observed to prevent its kinking; and in measuring and reeling in, it is kept hand taut. In reeling in the wire on the drum, the number of revolutions corresponding to each splice and the number of fathoms between the splices are noted in a book for future reference.

The machine having been secured in its place on the bridge, the endless rope is passed, as previously described, and the weights are attached to the pendant, and the dynamometer-wheel and dynamometer are connected by a cord, as described on page 6. The machine is now ready for sounding, with the exception of attaching the wire to the specimen cylinder, which is done in the following manner:

To prevent the wire from touching the bottom and kinking, a stray-line, 25 fathoms in length, made of ⅜ inch Albacore line, intervenes between the wire and the cylinder. The end of the wire is secured to a rope grommet, made of 1½ or 2 inch rope, by sticking the wire through the strands of the grommet, and taking half a dozen round turns against the lay, and serving the whole neatly. A small, oval-shaped lead, weighing 4 pounds, and fitted with laniards, is attached to the grommet opposite to the wire by one of its laniards, and the other one is made fast to the upper end of the stray-line. (The object of this lead is to prevent the end of the wire from turning up and kinking when the strain on the wire has been relieved by the apparatus resting on the bottom.) The lower end of the stray-line is secured to an eye in the upper end of a rod of stout wire, one-eighth inch in size, and a fathom in length, and an eye in the lower end of the rod is seized to the swivel-link in the upper end of the sounding-cylinder, on which the weight or sinker has been placed, with its laniards over the detaching-arm. Thus, between the end of the wire and the specimen-cylinder there is a grommet, an oval-shaped lead, the stray-line, and the iron rod; the rod falls down when the apparatus strikes the bottom, and takes the stray-line clear of the apparatus, and prevents fouling. These preparations having been made, the ship is brought stern to the wind, and kept in that position by the backing of the engines. In the Tuscarora, it was found that this was the best method of heaving to the vessel for sounding, and in some instances it was done when the force of the wind was as great as 8, and with a heavy sea running. When the ship has become steady, the sounding-apparatus is carefully lowered into the water by hand, the self-registering thermometer, for ascertaining the bottom-temperature, is attached to the stray-line; and the line is permitted to run out until the wire is reached, when the latter is clamped in the lignum-vitæ clamp. The weights on the pendant are now adjusted so that the friction of the endless rope on the drum will keep it from turning but slowly when the wire is unclamped. A careful petty-officer is stationed to attend to the putting on and removing of the weights.

Everything being ready, the officer in charge of the machine directs that the wire be unclamped, and it is permitted to run out slowly at first, and, when well started, some of the weights on the pendant are removed to allow the wire to run more freely; but it is never allowed to run out faster than from 90 to 100 revolutions per minute. The weights on the pendant, at first, generally aggregate 90 pounds, the indications shown by the dynamometer being 37 pounds; and when the wire is running out at the greatest speed admissible, the pendant weight is 25 pounds, and the dynamometer shows 15 pounds. Sometimes, when the vessel is rolling badly, the drum will almost stop, and in a moment start again more rapidly than ever; but in this case, the too rapid running-out may be checked by pressing the hand down on the endless rope.

When it is judged that the cylinder is nearing the bottom, the revolutions of the drum are decreased by increasing the weights on the pendant to 90 or 100 pounds, the dynamometer showing from 35 to 40 pounds; and the moment of the cylinder's striking the bottom is shown by the action of the dynamometer and the cessation of the revolutions of the drum. When the cylinder reaches the bottom, a few turns are allowed to run out, but not enough to allow the wire to reach bottom and kink.

The cord is then cast off from the dynamometer-wheel, to allow it to turn freely, and the officer in charge takes hold of the endless rope and hauls in until he thinks the cylinder is off the bottom with the sinker detached; the men then man the rope and reel in 50 fathoms, when the officer again tries the line himself, and, if still satisfied that the sinker has been detached, the wire is clamped, the endless rope taken off, the dynamometer-wheel unshipped, and the belt or rope passed from the drum to the reeling-in-apparatus, as shown in the dotted line, Plate XVII. All being ready, the men go to the cranks of the reeling-in-apparatus, the wire is unclamped, and the reeling in is begun, slowly at first, but after a little while as fast as the men can do it. In reeling in or paying out, petty-officers stand on the platform outside of the ship on each side of the drum, with round sticks in their hands, to guide the wire fair; the inner ends of the sticks are lashed to the rail of the platform, so that in case it is necessary the men may let them go for a time.

When the self-registering thermometer arrives at the platform, it is cast off from the stray-line and its reading noted; and when the specimen-cylinder comes to hand the line is unbent from it, and the specimen of the bottom is removed and put in bottles, which are properly labeled, with the date, number of cast, and the latitude and longitude.

The stray-line is now unbent from the wire; the counter removed from the drum; the drum is unshipped and placed in a tub containing a solution of caustic soda, which is renewed from time to time; and the machine is taken down and stowed in a secure place.

In reeling in, a pan of the solution of caustic soda and a hand-swab are kept near the drum to wet the inner turns of the wire. The caustic soda preserves the wire, but eats up the solder on the splices, requiring a renewal of it occasionally.

Both in running down and reeling in, an officer is stationed to note the time of every 100 revolutions, and also the number of the splices.

The revolutions must not be confounded with fathoms; for, though the first turns on the drum will be a fathom for each one, the diameter is constantly increasing, and therefore, after the first layer or two of wire is on, there is a slight gain in the length of the wire for each turn.

The following table will perhaps make the matter clear:

Number of splices.	Number of revolutions.	Number of fathoms.	Gain of fathoms.	Rates of gain.
1	240	242	2	1 fathom to 120 revolutions.
2	500	510	10	1 fathom to 32½ revolutions.
3	800	820	20	1 fathom to 30 revolutions.
4	1, 200	1, 230	30	1 fathom to 40 revolutions.

When bottom is reached, the counter is read and the number of revolutions is noted. In reeling in, and when the last splice out has come back to the reel, the counter is again read. This number of revolutions gives the splice, and by looking at the table the corresponding number of fathoms is found. Then the difference between the whole number of revolutions and the number of revolutions at the splice is taken, and, by interpolating, the number of fathoms corresponding are found.

EXAMPLE.

Bottom: Number of revolutions, 850.

Splice: Number of revolutions, 800 by table.

Third splice.

Difference between whole number of revolutions and revolutions of splice, 50.

Gain by table, 20 nearly.

Length of wire out, 872.

Stray-line, minus height of reel from water, 25.

Depth, 897 fathoms.

Now, when the machine is put into use, the weight of the wire out tends to wind it very tightly on the drum as it comes in; therefore there is a constant change in the number of revolutions, sometimes gaining, sometimes losing, so that equal revolutions do not give equal numbers of fathoms; hence the necessity for the table.

The journal of soundings is kept as in the form shown on page 18, which is a copy of one of the soundings of the Tuscarora.

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Depth, 897 fathoms.

Now, when the machine is put into use, the weight of the wire out tends to wind it very tightly on the drum as it comes in; therefore there is a constant change in the number of revolutions, sometimes gaining, sometimes losing, so that equal revolutions do not give equal numbers of fathoms; hence the necessity for the table.

The journal of soundings is kept as in the form shown on page 18, which is a copy of one of the soundings of the Tuscarora.

Journal of deep sea soundings, North Pacific Ocean, by United States steamship Tuscarora, Commander George E. Belknap, commanding; Yokohama, Japan, to Cape Flattery, via Aleutian Islands.

CAST NO. 28.—JUNE 17, 1874.

Number	28.
Hour	9 h. 50 m. 54 s., a. m.
Wind	Variable.
Force	0.5 to 1.
Weather	b c f clouds, cirrus. Prop. clear, 8.
Sea	Smooth.
Line	Piano-wire, No. 22.
Sinker	8-inch shot and 19 lbs. lead weight on casting.
Weight	74 lbs.
Machine	Sir William Thomson's.
App. for spec	Belknap cylinder, No. 1.

Latitude, 42° 57′ N., obs.
Longitude, 148° 23′ E., chro.
Barometer, 30.18; ther. att'd, 55°.8.
Temperatures:
Air, 54°.6, D. B.; 55° W. B.
Sea-surface, 49°.5.
Under-surface 700 fms., 34°—0°.49=33°.51. (18143.)
Depth, 4,356 fms.
Bottom, yellowish mud with sand and specks of lava.
Surface-current, 3 fms. N. E.
Under-current:
10 fms., 3 fms. NE. by N.
20 fms., ½ fms. N. W.
30 fms., 1 fm. W.
50 fms., 1½ fms. W.
100 fms., 2 fms. W. by S.
200 fms., 6 fms. SW. by S.
Value of sounding, undoubtedly good.

Current shown by observation during past 24 hours, N. 45° E., 3 fms. per hour.

Fathoms or revolutions.	Time. Hour.	Time. Min.	Time. Sec.	A. m. or p. m.	Interval. Min.	Interval. Sec.	2d Diff. Min.	2d Diff. Sec.	Time hauling in. Hour.	Time hauling in. Min.	Time hauling in. Sec.
	9	50	54	a. m.	...	...	...	...	...	...	...
100	9	52	02	a. m.	1	08	...	...	...	1	12
200	9	52	53	a. m.	...	51	...	17	...	1	08
300	9	53	43	a. m.	...	50	...	1	...	2	02
400	9	54	33	a. m.	...	50	...	...	...	1	23
500	9	55	25	a. m.	...	52	...	2	...	1	29
600	9	56	19	a. m.	...	54	...	2	...	1	26
700	9	57	14	a. m.	...	55	...	1	...	1	29
800	9	58	10	a. m.	...	56	...	1	...	1	28
900	9	59	07	a. m.	...	57	...	1	...	1	52
1000	10	00	08	a. m.	1	01	...	4	...	1	50
1100	10	1	11	a. m.	1	03	...	2	...	1	59
1200	10	2	16	a. m.	1	05	...	2	...	1	48
1300	10	3	22	a. m.	1	06	...	1	...	1	54
1400	10	4	29	a. m.	1	07	...	1	...	2	02
1500	10	5	36	a. m.	1	07	...	...	...	2	07
1600	10	6	47	a. m.	1	11	...	4	...	2	19
1700	10	7	57	a. m.	1	10	...	1	...	2	20
1800	10	9	10	a. m.	1	13	...	3	...	2	00
1900	10	10	23	a. m.	1	13	...	...	...	2	04
2000	10	11	37	a. m.	1	14	...	1	...	2	08
2100	10	12	53	a. m.	1	16	...	2	...	2	10
2200	10	14	10	a. m.	1	17	...	1	...	2	18
2300	10	15	28	a. m.	1	18	...	1	...	2	19
2400	10	16	47	a. m.	1	19	...	1	...	2	11
2500	10	18	07	a. m.	1	20	...	1	...	2	37
2600	10	19	24	a. m.	1	17	...	3	...	2	43
2700	10	20	43	a. m.	1	19	...	2	...	2	27
2800	10	22	00	a. m.	1	17	...	2	...	2	15
2900	10	23	23	a. m.	1	23	...	6	...	2	14
3000	10	24	45	a. m.	1	22	...	1	...	2	51
3100	10	26	09	a. m.	1	24	...	2	...	2	49
3200	10	27	33	a. m.	1	24	...	...	...	2	47
3300	10	29	01	a. m.	1	28	...	4	...	2	41
3400	10	30	43	a. m.	1	42	...	14	...	2	40
3500	10	32	25	a. m.	1	42	...	...	...	2	56
3600	10	34	05	a. m.	1	40	...	2	...	2	54
3700	10	35	55	a. m.	1	50	...	10	...	2	31
3800	10	37	48	a. m.	1	53	...	3	...	2	50
3900	10	39	46	a. m.	1	58	...	5	...	2	59
4000	10	41	51	a. m.	2	05	...	7	...	2	51
4071	10	43	30	a. m.	1	39	...	...	...	2	02
Time going out					52	36	Com'g in		1	30	10
Finished									12	17	51 p. m.
Total time of cast									2	26	57

Remarks.

Fine calm weather; engines moved occasionally; Lieutenant F. M. Symonds went out in whale-boat to try under-surface currents.

Before beginning this cast, wound 706 fathoms more of wire on the reel. Reel so much strained by these deep casts that the wire will have to be wound upon a new one.

At end of cast kept on course under fore and aft sail, foresail, and steam; wind very light.

SERIAL TEMPERATURES.

Surface, 49°.5.
10 fms., 42°.7—0°.00=42°.7. No. 18145.
15 fms., 36°.5—0°.01=36°.49. No. 18145.
25 fms., 33°.6—0°.02=33°.58. No. 18145.
50 fms., 32°.7—0°.03=32°.67. No. 18143.
100 fms., 33°.4—0°.07=33°.33 No. 18143.
300 fms., 33°.8—0°.21=33°.59. No. 18145.
500 fms., 34°.5—0°.35=34°.15. No. 18145.
700 fms., 34° —0°.49=33°.51. No. 18143.

Weights on pulley.	Dyn. ind.	
125 lbs	48 lbs.	
90 lbs	44 lbs	50 fms.
65 lbs	36 lbs	70 fms.
50 lbs	30 lbs	90 fms.
25 lbs	18 lbs	170 fms.
40 lbs	18 lbs	970 fms.
90 lbs	35 lbs	3,390 fms.
112 lbs	40 lbs	3,600 fms.
150 lbs	47 lbs	3,985 fms.

Number of revolutions, 4,071.

Number of measured fathoms	4,331
Stray line	25
Depth	4,356

TABLES OF DEEP SEA-SOUNDINGS,

NORTH PACIFIC OCEAN,

OBTAINED IN

UNITED STATES STEAMSHIP TUSCARORA (THIRD RATE),

Commander G. E. BELKNAP, Commanding.

SOUNDINGS ON EXPERIMENTAL LINE OFF SAN FRANCISCO.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1873.		N. ° ′	W. ° ′			
Aug. 13	1	37 30	123 01	141	Blue mud.	
	2	37 28	123 13	830	Blue mud.	
	3	37 27	123 21	1015	Blue mud.	
	4	37 25	123 26	1195	Blue mud.	
	5	37 27	123 33	. .	. . . .	Rope broke.
	6	37 27	123 33	1361	Blue mud.	
Aug. 14	7	37 21	123 55	. .	. . . .	Not obtained.
	8	37 21	123 55	1949	Blue mud.	
	9	37 24	123 38	. .	. . . .	Wire broke.
	10	37 24	123 38	. .	. . . .	Wire broke.
Aug. 15	11	37 28	123 05	503	Blue mud.	

SOUNDINGS OFF AND ON SHORE BETWEEN CAPE FLATTERY AND SAN FRANCISCO.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
Oct. 17	1	48 00	125 10	76	Fine black sand and mud.	Line 1.
Oct. 18	2	47 47	125 20	118	Black sand and gravel.	
	3	47 45	125 27	360	Clay with fine dark sand.	
	4	47 43	125 37	570	No specimen.	Line parted in reeling in.
	5	47 41	125 45	623	Clay with fine sand.	
	6	47 39	125 53	780	Greenish mud and fine sand.	
	7	47 37	125 59	700	Ooze and clay.	
	8	47 32	126 14	1063	Brown mud and ooze.	
	9	47 25	126 28	1304	Clay, mud, and ooze.	
Oct. 18–19	10	47 14	126 42	1387	Light brown mud and ooze.	
Oct. 19	11	47 01	127 04	1385	Blue clay and brown mud mixed, giving it variegated appearance.	
	12	46 44	127 42	1492	Ooze and brown mud.	
Oct. 20	13	46 14	128 48	1535	Clay, brown mud, and ooze.	
	14	45 18	128 57	1539	Ooze.	
Oct. 21	15	45 19	127 38	1576	Brown ooze.	Line 2.
	16	45 10	126 35	1498	Ooze.	
	17	45 10	125 48	1578	Clay.	
Oct. 22	18	44 57	125 29	1532	Clay with specks of coarse black sand.	
	19	44 54	125 13	834	Fine gray sand with black specks.	
	20	44 54	125 05	733	Blue mud with fine black sand.	
	21	44 53	125 01	525	Hard clay with fine bl'k specks.	
	22	44 52	124 55	294	Clay.	
	23	44 52	124 47	237	Gray sand with black specks.	
	24	44 51	124 40	206	Gray sand with black specks.	
	25	44 50	124 33	134	Gray sand.	
	26	44 49	124 28	97	Mud and gray sand.	
Oct. 23	27	43 55	124 37	160	Blue mud and sand.	
	28	43 25	124 32	61	Dark sand.	Running down the coast.
	29	43 26	124 41	140	Dark sand.	Line 3.
	30	43 27	124 48	180	No specimen.	
	31	43 27	124 57	492	Dark sand with black specks.	Line parted in reeling in.
	32	43 27	125 06	716	Dark sand with black specks.	
Oct. 24	33	43 08	125 23	1692	Clay, mud, and specks of black sand.	
	34	43 07	125 14	1270	Clay and mud.	
	35	43 10	125 46	1684	No specimen.	
Oct. 25	36	43 12	127 00	1689	Brown ooze with particles of sand.	

SOUNDINGS OFF AND ON SHORE BETWEEN CAPE FLATTERY AND SAN FRANCISCO.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1873.		N. ° ′	W. ° ′			
Oct. 25	37	43 24	128 10	1667	Yellow-brown ooze.	
Oct. 26	38	41 54	128 59	1805	Yellow-brown ooze.	Line 4.
Oct. 27	39	41 38	128 03	1707	Brown ooze.	
	40	41 30	127 11	996	Rock, few particles of black sand came up.	
	41	41 32	126 54	1689	Clay ooze.	
Oct. 28	42	41 30	127 11	1721	Greenish clay.	
	43	41 29	127 27	1667	Clay and brown ooze.	
	44	41 16	127 12	1356	Calcareous sand with black specks, and *Globergareya* and *Obulink* shells.	
	45	41 07	127 10	1499	Clay ooze.	
	46	40 54	127 09	1521	Greenish clay and ooze with particles of sand.	
	47	40 56	126 27	1703	Greenish-clay ooze.	
Oct. 29	48	41 03	125 38	1666	Whitish-clay ooze; calcareous, with minute shells.	
	49	41 03	125 16	1698	Clay ooze.	
	50	41 02	125 04	1666	Clay ooze.	
	51	41 01	124 48	966	Clay ooze.	
	52	41 00	124 35	358	Clay ooze.	
	53	41 00	124 27	261	Whitish clay ooze with fine sand.	
	54	41 01	124 19	66	Clay, mud, fine sand.	
Oct. 30	55	40 16	124 30	601	Hard gray sand.	Line 5.
	56	40 20	124 26	72	Hard gray sand.	Bottom so hard that only few particles were brought up.
	57	40 19	124 28	176	Hard gray sand.	
	58	40 18	124 30	544	Hard gray sand.	
	59	40 19	124 32	731	No specimen, but undoubtedly hard sand.	
	60	40 21	124 41	766	Gray sand.	
	61	40 22	124 56	1166	Hard gray sand.	
	62	40 25	125 15	821	Greenish mud and black sand.	
	63	40 24	125 24	939	Grayish-black sand.	
Oct. 31	64	40 11	125 44	1567	Clay ooze.	
	65	40 09	126 12	2263	Clay and mud.	Line 6.
Nov. 1	66	39 06	125 27	2006	Clay ooze.	
Nov. 2	67	39 05	125 14	1984	Clay ooze.	
	68	39 04	124 40	1832	Clay ooze.	
	69	39 02	124 09	423	Black sand.	
	70	39 00	124 00	127	Black sand.	Line 7.
Nov. 3	71	38 33	123 31	173	Black sand.	
	72	38 32	123 24	81	Black sand.	
	73	38 31	123 41	520	Black sand and mud.	
	74	38 31	123 46	911	Clay mud.	
	75	38 32	123 53	1586	Clay ooze.	
	76	38 34	124 09	1821	Clay ooze.	
Nov. 4	77	38 38	124 32	2115	Clay ooze.	
	78	38 37	125 28	2068	Clay ooze.	
	79	38 25	125 57	2308	Gray and bluish ooze.	Line 8.
Nov. 5	80	37 33	126 17	2443	Brown and greenish ooze mixed.	
	81	37 34	125 25	2257	Whitish-clay ooze.	
Nov. 6	82	37 40	123 36	1726	Brown ooze.	
	83	37 39	123 08	155	Gray sand.	

SOUNDINGS OFF AND ON SHORE BETWEEN SAN FRANCISCO AND SAN DIEGO.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1873.		N. ° ′	W. ° ′			
Dec. 20	1	37 20	122 51	113	Grayish-black sand.	Line 1.
	2	37 18	122 54	181	Grayish-black sand.	
	3	37 15	122 59	358	Grayish-black sand.	
	4	37 12	123 05	673	Hard black sand.	
	5	37 04	123 22	1200	Grayish-black sand and fine gravel.	
Dec. 21	6	36 48	124 03	2165	Greenish mud.	
	7	36 37	123 56	2104	Greenish mud.	Line 2.
	8	36 34	123 37	1940	Greenish mud or ooze.	
	9	36 32	123 11	1685	Greenish mud.	
Dec. 22	10	36 27	122 54	1650	Greenish mud.	
	11	36 28	122 31	1170	Greenish mud with black sand	
	12	36 26	122 09	486	Dark mud.	
	13	36 25	122 04	190	Grayish-black gravel.	
Dec. 24	14	36 13	121 50	207	Greenish-black sand with shells.	Line 3.
	15	36 10	121 56	686	Very hard grayish-black sand.	
	16	36 06	122 04	988	Rock.	
	17	36 02	122 12	882	Hard grayish-black sand.	
Dec. 25	18	35 52	122 29	1814	Greenish mud and sand.	
	19	35 40	122 52	1995	Greenish mud.	
	20	35 28	122 44	1940	Greenish ooze with particles of fine sand.	Line 4.
	21	35 26	122 17	2044	Greenish ooze.	
	22	35 24	121 52	862	Greenish mud with fine gray sand.	
Dec. 26	23	35 21	121 38	499	Hard black sand.	
	24	35 19	121 31	437	Hard black sand.	
	25	35 17	121 21	371	Dark-greenish mud.	
	26	35 15	121 12	289	Dark-greenish mud.	
	27	35 15	121 02	147	Greenish mud.	
	28	35 15	120 58	65	Greenish mud.	
	29	35 01	120 44	46	Greenish mud with fine particles of sand.	Line 5.
	30	34 50	120 47	80	Clay mud.	
	31	34 55	120 53	176	Dark mud and sand.	
	32	34 45	121 06	309	Dark-greenish mud.	
	33	34 36	121 16	490	Grayish-black sand.	
Dec. 27	34	34 23	121 32	1995	Dark-green mud.	
	35	34 29	121 23	1198	Green mud and sand.	
	36	34 09	121 33	1988	Greenish ooze.	
	37	34 03	121 14	1783	Greenish mud.	Line 6.
	38	33 59	121 13	1467	Hard black sand.	
Dec. 28	39	33 46	121 05	1674	Greenish mud.	
	40	33 41	120 50	1092	Greenish sand, mud, and gravel.	
	41	33 38	120 38	530	Coarse gray sand.	
	42	33 35	120 28	694	Greenish mud.	
	43	33 33	120 14	634	No specimen.	
	44	33 32	119 59	260	Black sand.	
	45	33 16	119 50	123	Hard black sand.	
Dec. 29	46	33 07	119 58	542	Hard black sand.	Line 7.
	47	32 54	120 09	551	Hard black sand.	
	48	32 41	120 16	1833	Yellow-brown mud.	
	49	32 29	120 08	1052	Grayish-black sand and gravel	
	50	32 29	119 52	844	Yellowish-brown mud.	Line 8.
	51	32 28	119 32	769	Gray sand.	
	52	32 23	119 21	759	Yellowish mud and sand.	

SOUNDINGS OFF AND ON SHORE BETWEEN SAN FRANCISCO AND SAN DIEGO.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1873.		N. ° ′	W. ° ′			
	53	32 14	119 07	727	Light-greenish mud with particles of sand.	
Dec. 30	54	32 15	118 51	695	Gray and black sand.	
	55	32 18	118 27	955	Yellowish-brown mud.	
	56	32 22	118 52	445	Coarse gray sand with minute shells.	
	57	32 22	117 44	784	Yellowish-green mud.	
	58	32 33	117 28	687	Dark mud.	

TABLES OF SOUNDINGS

FOR

SUBMARINE CABLE

BETWEEN

CALIFORNIA AND JAPAN,

SOUTHERN ROUTE.

SOUNDINGS BETWEEN SAN DIEGO, CALIFORNIA, AND HONOLULU, HAWAIIAN ISLANDS.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	W. ° ′			
Jan. 6	1	32 31	117 20	71	Gray and black sand and broken shells.	
	2	32 31	117 22	355	Dark mud with fine sand.	
	3	32 30	117 24	622	Dark mud with fine sand.	
	4	32 27	117 27	579	Dark mud.	
	5	32 17	117 47	1053	Greenish mud.	
Jan. 7	6	32 04	118 12	203	Rock.	Took a duplicate cast; obtained 328 fathoms sandy bottom; concluded it to be the cap of a submarine peak.
	7	32 00	118 26	595	Gray sand with fine black specks.	
	8	31 56	118 41	566	Gray sand with black specks.	
	9	31 51	119 03	980	Whitish-green mud.	
	10	31 43	119 28	1915	Yellowish-brown mud.	
Jan. 8	11	31 25	120 04	2177	Brown mud.	
	12	31 04	120 46	2178	Brown mud.	
	13	30 52	121 37	2246	Yellowish brown mud or ooze.	
Jan. 9	14	30 39	122 28	2251	Yellowish brown mud or ooze.	
	15	30 31	123 15	2103	Yellowish brown mud or ooze.	
Jan. 10	16	30 16	124 08	2363	Yellowish-brown clay, very sticky.	
	17	29 55	125 12	2049	Hard black sand.	
Jan. 11	18	29 53	126 06	2199	Yellowish-brown ooze.	
	19	29 39	126 59	2400	Yellowish-brown ooze.	
Jan. 12	20	29 15	128 05	2409	Yellowish-brown ooze.	
	21	28 58	128 48	2517	Yellowish-brown ooze.	
	22	28 42	129 34	2583	Light-yellowish-brown mud.	
Jan. 13	23	28 22	130 28	2587	Yellowish-brown mud.	
Jan. 14	24	28 19	131 19	2604	Yellowish brown mud or ooze.	
	25	28 08	132 05	2356	Yellowish brown ooze or mud.	
Jan. 17	26	28 03	132 35	2323	Yellowish-brown ooze.	
Jan. 18	27	27 45	132 22	2540	Yellowish brown mud or ooze.	
	28	27 30	134 11	2477	Yellowish brown mud or ooze.	
Jan. 19	29	27 10	134 58	2541	Yellowish brown mud or ooze.	
	30	26 51	135 51	2440	Yellowish brown mud or ooze.	
	31	26 36	136 38	2356	Yellowish-brown mud.	
Jan. 20	32	26 22	137 22	2159	Whitish mud or ooze.	
	33	26 15	138 10	2650	Yellowish-brown mud.	
Jan. 21	34	26 09	139 00	2689	Yellowish-brown mud.	
	35	25 59	139 45	2628	Yellowish brown mud or ooze.	
Jan. 22	36	25 52	140 40	2695	Yellowish brown mud or ooze.	
	37	25 43	141 31	2553	Yellowish brown mud or ooze.	
	38	25 36	142 14	2618	Yellowish brown mud or ooze.	
Jan. 25	39	25 21	142 29	2690	Yellowish brown mud or ooze.	
	40	25 08	143 18	2634	Yellowish brown mud or ooze.	
Jan. 26	41	24 59	144 04	2841	Yellowish brown mud or ooze.	
	42	24 49	144 52	2841	Yellowish brown mud or ooze.	
Jan. 27	43	24 40	145 35	2856	Yellowish brown mud or ooze.	
	44	24 23	146 19	2982	Yellowish brown mud or ooze.	
Jan. 28	45	24 08	147 03	2922	Yellow-brown mud or ooze.	
	46	23 54	147 47	2993	Yellow-brown mud or ooze.	
Jan. 29	47	23 38	148 42	2982	Yellowish brown mud or ooze.	
	48	23 20	149 37	2936	Yellow-brown mud or ooze.	
	49	23 10	150 31	3054	Yellow-brown mud or ooze.	
Jan. 30	50	23 01	151 26	3053	Yellow-brown mud or ooze.	
	51	22 50	152 17	2953	Yellow-brown mud or ooze.	
Jan 31	52	22 40	153 17	2726	Yellow-brown mud.	
	53	22 26	154 04	2562	Yellow-brown mud or ooze.	
Feb. 1	54	22 10	154 52	2488	Yellow-brown mud with fine particles of sand.	
					Yellow-brown mud.	

SOUNDINGS BETWEEN SAN DIEGO, CALIFORNIA, AND HONOLULU, HAWAIIAN ISLANDS.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	W. ° ′			
Feb. 1	55	21 55	155 39	2752	Brown mud.	
	56	21 43	156 21	3023	Brown-mud ooze with fine particles of sand.	
Feb. 2	57	21 32	157 01	2086	Brown mud with fine sand.	
	58	21 26	157 19	498	Yellowish-gray sand.	
	59	21 24	157 26	403	Whitish-gray sand.	
	60	21 14	157 36	63	White coral.	
	61	21 12	157 42	272	Whitish-gray sand.	
	62	21 13	157 47	255	Whitish-gray sand.	

SOUNDINGS BETWEEN HONOLULU, HAWAIIAN ISLANDS, AND PORT LLOYD, BONIN ISLANDS.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
Mar. 17	1	21 10	158 04	206	Gray sand with black specks and coral.	
	2	21 07	158 14	1468	Coarse whitish sand with pieces of lava the size of small pebbles.	
	3	21 06	158 31	1580	Coarse whitish sand.	
Mar. 18	4	21 00	159 25	2418	Yellow-brown ooze.	
	5	20 54	160 22	2565	Yellow-brown ooze.	
Mar. 19	6	20 48	161 19	2555	Yellow-brown ooze on rock.	
	7	20 38	162 16	2495	Rock.	
Mar. 20	8	20 25	163 25	2733	Rock; black sand.	
	9	20 18	164 27	2720	Yellow-brown ooze.	
Mar. 21	10	20 13	165 31	2794	Yellow-brown ooze.	
	11	20 12	166 35	2803	Yellow-brown ooze.	
Mar. 22	12	20 12	167 46	2460	Rock.	
	13	20 16	168 57	2737	Yellow-brown ooze.	
Mar. 23	14	20 31	170 31	2421	Yellow-brown ooze.	
	15	20 41	171 33	1874	White coral with lumps of lava.	
Mar. 24	16	20 52	172 39	3045	No specimen.	Wire broke in reeling in.
	17	21 04	173 54	2952	Yellow-brown ooze.	
Mar. 25	18	21 21	174 57	2993	Yellow-brown ooze.	
	19	21 27	176 03	3106	Yellow-brown mud or ooze.	
Mar. 26	20	21 21	177 10	3100	Yellow-brown ooze.	
	21	21 29	178 15	2828	Yellow-brown ooze.	
Mar. 27	22	21 38	179 27	2725	Light yellow-brown ooze.	
		N.	E.			
Mar. 29	23	21 40	179 20	1964	Whitish cream-colored ooze.	
	24	21 41	178 04	1625	Coral mud.	
Mar. 30	25	21 41	176 50	1108	White coral.	
	26	21 47	175 44	1817	White coral.	
Mar. 31	27	21 56	174 44	1613	White coral and sand.	
	28	22 01	173 43	2813	Light yellow-brown ooze.	
April 1	29	22 05	172 41	2836	Yellow-brown mud with piece of lava.	
	30	22 09	171 32	2771	Yellow-brown mud.	
April 2	31	22 20	170 31	3090	Yellow-brown ooze; grains of sand.	
	32	22 29	169 28	3211	Yellow-brown ooze.	
April 3	33	22 44	168 23	3262	Dark yellow-brown mud.	
	34	22 51	167 21	3232	Yellow-brown mud.	
April 4	35	22 59	166 13	3155	Yellow-brown mud.	
	36	23 05	165 13	3185	Yellow-brown mud.	
April 5	37	23 09	164 03	3148	Yellow-brown mud.	
	38	23 17	162 58	2870	Yellow-brown mud.	

SOUNDINGS BETWEEN HONOLULU, HAWAIIAN ISLANDS, AND PORT LLOYD, BONIN ISLANDS.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	E. ° ′			
April 6	39	23 31	161 51	3009	Yellow-brown mud.	
	40	23 45	160 56	1400	Coral limestone and sand.	
April 7	41	24 07	160 09	3023	Yellow-brown mud.	
	42	24 19	159 21	2938	Yellow-brown mud; lump of lava.	
April 8	43	23 55	158 07	2042	Coral limestone with sand.	
April 9	44	23 46	157 12	2173	Coral limestone with sand.	
	45	23 56	156 10	3075	Yellow-brown ooze.	
April 10	46	24 02	155 08	3273	Yellow-brown mud.	
	47	24 20	154 06	1499	Coral limestone with specks of lava.	
April 11	48	24 25	152 01	2956	No specimen.	Wire broke.
	49	24 41	151 46	3023	Yellow-brown ooze.	
April 12	50	24 46	150 51	3061	Yellow-brown ooze.	
	51	25 11	149 46	3287	No specimen.	Cylinder came up battered. Must have struck rock.
April 13	52	25 42	148 30	1712	Coral limestone with particles of sand.	
	53	25 55	147 47	2534	Yellow-brown ooze with hard lumps of clay.	
April 14	54	26 09	146 10	3018	Yellow-brown ooze with particles of black sand.	
	55	26 18	144 54	1700	Coral limestone with particles of lava.	
April 15	56	26 28	143 33	2080	Gray sand with black specks.	
	57	26 41	142 42	1331	Coral limestone with specks of lava.	Coffin and Peel Islands in sight.
	58	26 52	142 21	814	Gray sand with specks of coral and lava.	
	59	26 55	142 14	487	Coral limestone.	

SOUNDINGS BETWEEN PORT LLOYD, BONIN ISLANDS, AND YOKOHAMA, JAPAN.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
April 18	1	27 07	142 07	73	Coral and broken shells.	
	2	27 16	141 56	108	Lava, coral, small and broken shells.	
	3	27 47	141 50	345	Coral limestone with specks of lava.	
	4	28 09	141 42	869	Coral limestone with lumps of lava.	
April 19	5	28 56	141 50	1344	Coral limestone with lumps of lava and broken shells.	
	6	29 56	141 52	2435	Slaty-brown mud, with particles of lava, sand, and broken shells.	
April 20	7	30 29	141 04	1669	Lumps and particles of lava with brown mud.	
	8	31 18	140 53	1382	Hard with fine particles of lava.	
April 21	9	32 13	140 37	1135	Blue mud with coarse sand.	
	10	32 58	140 22	566	Lava; small specimen.	
	11	33 46	140 21	437	Coral and broken shells.	Cylinder came up, battered on point.
April 22	12	34 31	140 14	1618	Blue mud with lava.	
	13	34 45	140 01	595	Grayish-black sand.	
	14	34 53	139 46	35	Broken shells.	No Sima light bearing (p.c.) NW. by N., distant 10 ms.

SOUNDINGS BETWEEN SAN FRANCISCO, CALIFORNIA, AND HONOLULU, HAWAIIAN ISLANDS.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	W. ° ′			
Nov. 1	1	37 36	123 09	435	Mud.	
	2	37 33	123 14	850	Greenish ooze.	
	3	37 29	123 26	1060	Specimen not obtained.	
	4	37 17	123 51	2045	Greenish ooze.	
Nov. 2	5	37 03	124 24	2041	Blue mud.	
	6	36 48	125 01	2399	Blue and yellow mud.	
	7	36 20	125 48	2529	Yellow-brown ooze.	
	8	35 58	126 23	2543	Yellow ooze.	
Nov. 3	9	35 41	126 58	2571	Yellow-brown ooze.	
	10	35 25	127 31	2538	Yellow-brown ooze.	
	11	35 13	128 10	2630	Brown ooze.	
	12	34 57	128 43	2576	Yellow-brown ooze.	
Nov. 4	13	34 40	129 17	2688	Brown ooze.	
	14	34 26	129 52	2742	Brown mud.	
	15	34 08	130 28	2746	Brown mud.	
Nov. 5	16	33 55	130 46	3252	Specimen not obtained.	Wire broke in reeling in. Depth not to be depended upon within 400 fathoms.
Nov. 6	17	33 23	131 19	2716	Brown ooze.	
	18	33 10	131 53	2561	Brown mud.	
	19	32 59	132 26	1407	Coral and lime.	
	20	32 57	132 31	435	Coral.	
Nov. 7	21	32 56	132 34	413	Rock.	Erben Bank
	22	32 50	132 32	975	Rock.	
	23	32 52	132 31	404	Hard rock.	
	24	32 54	132 42	1481	White mud mixed with sand.	
	25	33 03	132 37	2282	Brown ooze.	
	26	32 50	133 15	2288	Brown mud.	
Nov. 8	27	32 35	133 54	2177	Brown mud.	
	28	32 21	134 32	2471	Brown mud.	
	29	32 07	135 11	2700	Brown mud.	
Nov. 9	30	31 53	135 50	2537	Brown ooze.	
	31	31 37	136 30	2534	Brown ooze.	
	32	31 21	137 14	2908	Brown ooze.	
Nov. 10	33	31 04	137 52	2436	Brown ooze.	
	34	30 48	138 27	2547	Brown ooze.	
	35	30 30	139 04	2597	Brown ooze.	
Nov. 11	36	30 12	139 40	2481	Brown ooze.	
	37	29 51	140 22	2652	Brown ooze.	
	38	29 33	141 00	2682	Brown ooze.	
Nov. 12	39	29 16	141 35	2684	Brown ooze.	
	40	28 58	142 12	2759	Brown ooze.	
	41	28 41	142 57	2724	Brown ooze.	
Nov. 13	42	28 26	143 33	2652	Brown ooze.	
	43	28 12	144 09	2625	Thin light-brown ooze.	
	44	27 57	144 45	2685	Brown ooze.	
Nov. 14	45	27 47	145 20	2657	Brown ooze.	
	46	27 30	146 00	2694	Light-brown ooze.	
	47	27 09	146 30	2821	Yellowish-brown ooze.	
Nov. 15	48	26 48	147 03	2794	Brown ooze.	
	49	26 27	147 37	2884	Brown ooze mixed with lava.	
	50	26 12	148 08	2904	Thin yellowish-brown ooze.	
	51	25 55	148 39	2950	Brown ooze.	
Nov. 16	52	25 38	149 11	2882	Brown ooze.	
	53	25 25	149 45	2893	Light-brown ooze.	
	54	25 04	150 19	2941	Brown ooze.	
Nov. 17	55	24 42	150 52	2934	Brown ooze.	
	56	24 20	151 26	2910	Brown ooze.	
	57	23 39	152 37	2994	Yellowish ooze.	
Nov. 18	58	24 00	152 00	3115	Brown ooze.	
Nov. 23	59	23 07	153 51	2617	Brown ooze.	
	60	22 37	154 27	2443	Brown ooze.	
	61	22 03	155 10	2464	Sand.	
Nov. 24	62	. .	. .	2685	Sand mixed with mud.	

TABLES OF SOUNDINGS

FOR

SUBMARINE CABLE

BETWEEN

CALIFORNIA AND JAPAN,

NORTHERN ROUTE.

SOUNDINGS BETWEEN YOKOHAMA, JAPAN, AND TANAGA ISLAND, ALEUTIAN GROUP.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
		N. ° ′	E. ° ′			
June 9	1	34 58	140 03	50	Grayish-black sand; shells.	
	2	35 04	140 15	235	Grayish-black sand.	
	3	35 10	140 27	33	Grayish-black sand and broken shells.	
	4	35 18	140 36	19	Grayish-black sand and broken shells.	
	5	35 26	140 44	25	Grayish-black sand with broken shells.	
	6	35 33	140 53	15	Grayish-black sand with broken shells.	
	7	35 44	141 06	72	Grayish-black sand.	
	8	35 52	141 22	580	Grayish-black sand with gray mud.	
June 10	9	36 13	141 34	871	Dark mud with grains of sand.	
	10	36 33	141 58	1358	Clay-colored mud with fine particles of sand.	
	11	36 58	142 15	1425	Clay-colored mud with particles of sand.	
	12	37 19	142 42	1274	Clay-colored mud with fine particles of sand.	
June 11	13	37 37	143 09	1833	Clay-colored ooze.	
	14	37 54	143 40	3427	Clay mud.	
	15	38 11	144 33	4643	No specimen.	Wire broke. Bottom not reached. Not on profile.
June 13	16	38 13	142 09	411	Grayish-black sand.	
	17	38 34	142 39	1358	Gray-black sand.	
	18	39 09	142 33	1153	Gray sand and mud.	
June 14	19	39 36	142 41	1017	Clay-colored mud.	
	20	40 10	142 57	653	Grayish-black sand with fine gravel.	
	21	40 39	143 25	1137	Clay-colored mud, sand, and gravel.	
	22	41 09	144 01	2266	Grayish-black sand.	
June 15	23	41 25	144 47	2856	Clay-colored mud.	
	24	41 46	145 40	3439	Hard yellow sand with black specks.	
June 16	25	41 53	146 08	3587	Yellowish and clay-colored mud with coarse sand.	
	26	42 08	146 50	3507	Yellow and clay-colored mud with specks of lava.	
June 17	27	42 34	147 38	4340	Yellow and clay-brown mud.	
	28	42 57	148 23	4356	Yellowish mud and sand with specks of lava.	
June 18	29	43 21	149 12	4041	Yellow and clay-colored mud and gravel.	
	30	43 47	150 02	4234	Rocky.	
	31	44 10	150 50	4120	Yellow and clay-colored mud mixed.	Point of cylinder came up battered.
	32	44 28	151 37	4411	No specimen.	
June 19	33	44 55	152 26	4655	No specimen.	Wire broke.
June 20	34	46 21	151 25	1445	Grayish-black sand and fine gravel.	Wire broke.
	35	46 00	150 45	881	Grayish-black sand and fine gravel.	
June 21	36	45 35	150 12	317	Grayish-black sand and gravel	
	37	45 07	149 46	232	Gray sand and gravel.	
	38	44 44	149 23	944	Hard; no specimen came up.	
	39	44 23	148 53	1246	Grayish-black sand.	

SOUNDINGS BETWEEN YOKOHAMA, JAPAN, AND TANAGA ISLAND, ALEUTIAN GROUP.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	E. ° ′			
June 22	40	44 02	148 16	1050	Grayish-black sand.	
	41	43 42	147 44	1103	Clay-colored mud with fine particles of sand.	
	42	43 20	147 04	1048	Clay-colored mud with gray sand.	
	43	42 59	146 25	1329	Hard clay and mud.	
June 23	44	42 36	145 49	1379	Grayish-black sand.	
	45	42 15	145 09	1619	Clay-colored mud and sand.	
	46	41 54	144 35	1108	Grayish-black sand; gravel.	
	47	41 32	144 18	1582	Clay-colored mud.	
July 4	48	46 38	151 47	702	Coarse grayish-black sand.	
	49	46 56	152 19	490	Coarse grayish-black sand.	
	50	47 11	152 54	1134	Gray sand with specks of lava.	
	51	47 30	153 33	1594	Gray sand.	
	52	47 44	154 15	1040	Grayish-black sand.	
July 5	53	48 01	154 51	1371	Grayish-black sand with gravel and clay-colored ooze.	
	54	48 21	155 28	1919	Grayish-black sand with gravel and pebbles and clay-colored ooze.	
	55	48 40	156 07	2631	Whitish ooze with sand.	
July 6	56	48 59	156 42	3039	Whitish ooze with sand.	
	57	49 23	157 21	3119	Clay mud.	
July 7	58	49 41	157 58	2797	Clay-colored mud with fine sand.	
	59	50 02	158 49	3274	Clay-colored ooze.	
	60	50 22	159 40	3754	Clay-colored ooze.	
July 10	61	51 06	161 08	2970	Clay-colored mud with fine sand.	
	62	51 22	162 20	2934	Clay-colored mud.	
July 11	63	51 31	163 23	2981	Yellowish mud with lumps of hard clay, and particles of fine black sand.	
	64	51 39	164 30	2720	Yellowish ooze with fine black mud.	
	65	51 43	165 25	2793	Yellowish ooze with fine particles of black sand.	
	66	51 47	166 26	1896	Clay with particles of sand.	
July 12	67	51 50	167 22	1777	Yellowish mud with fine sand.	
	68	51 52	168 10	2005	Yellowish clay or mud with fine sand.	
	69	51 55	169 00	2320	Yellowish mud with fine particles of sand.	
	70	51 58	169 42	2711	Yellowish mud with sand and lumps of lava.	
July 13	71	52 01	170 28	2463	Yellowish mud.	
	72	52 04	171 15	4037	Yellowish ooze.	
	73	52 09	172 02	2463	Clay with gravel and fine sand.	
July 14	74	52 11	172 41	1857	Clay-colored mud with black sand and fine gravel.	
	75	52 14	173 14	947	Clay-colored mud with fragments of lava and fine sand.	
	76	52 05	174 01	1668	Clay-colored mud with sand.	
	77	51 58	174 31	332	Grayish-black sand.	
	78	51 50	175 09	303	Grayish-black sand.	
July 15	79	51 40	175 55	799	Grayish-black sand.	
	80	51 33	176 34	998	Grayish-black sand.	
	81	51 30	177 14	1014	Grayish-black sand.	

SOUNDINGS BETWEEN YOKOHAMA, JAPAN, AND TANAGA ISLAND, ALEUTIAN GROUP.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	E. ° ′			
July 15	82	51 25	177 55	565	Grayish-black sand.	
	83	51 23	178 19	282	Black sand with gravel.	Not on profile.
July 16	84	51 22	178 29	208	Grayish-black sand.	Not on profile.
	85	51 12	178 20	1313	Grayish-black sand and lumps of clay.	Not on profile.
	86	51 15	178 35	548	Gray-black sand.	
	87	51 10	178 58	237	Gray-black sand and gravel.	
	88	51 05	179 23	975	Gray-black sand.	
	89	51 05	179 41	1358	Gray-black sand.	
		N.	W.			
	90	51 14	179 39	1131	Grayish-black sand.	Not on profile.
	91	51 01	179 14	1838	Clay-colored mud with grayish-black sand.	
	92	51 08	178 35	1779	Clay-colored mud with grayish black sand and sponges.	
	93	51 15	178 01	1034	Clay-colored mud with grayish-black sand.	Not on profile.
July 17	94	51 28	177 59	233	Rocky, with grayish-black sand and pebbles.	Not on profile; cylinder came up very much battered.
July 19	95	51 35	178 13	45	Broken shells and pebbles.	
	96	51 44	178 10	53	Black sand.	
July 25	97	51 47	178 12	44	Rocky.	Not on profile.

SOUNDINGS BETWEEN TANAGA, ALEUTIAN ISLANDS, AND CAPE FLATTERY.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
July 25	98	51 51	178 36	995	Clay-colored mud and black sand.	Not on profile.
	99	51 57	178 27	993	Black sand and gravel.	
	100	52 02	178 07	1055	Black sand.	
	101	52 06	177 28	1339	Black sand.	
July 26	102	52 11	176 48	1681	Clay-colored mud with fine black sand.	
	103	52 18	176 01	1681	Clay-colored mud with dark sand and fine gravel.	
	104	52 25	175 18	1755	Clay-colored mud with fine gray sand.	
	105	52 32	174 27	1548	Clay-colored mud with fine gray sand.	
July 27	106	52 39	173 51	1257	Clay-colored mud with hard lumps of clay and black sand.	
	107	52 47	173 04	1029	Clay-colored mud with black sand and gravel.	
	108	52 58	172 11	928	Clay-colored mud, black sand and gray gravel.	
	109	53 08	171 19	1006	Grayish-bl'k sand and broken shells.	
July 28	110	53 17	170 23	1032	Clay-colored mud with gray-black sand.	
	111	53 57	169 28	1158	Clay mud with fine gray sand.	
	112	53 40	169 01	770	Clay-colored mud with fine gray-black sand.	Not on profile.
	113	53 57	168 08	1169	Clay-colored mud with gray-black sand.	
July 29	114	54 06	168 31	1212	Clay mud with black specks.	Not on profile.
	115	54 13	167 57	812	Clay-colored mud with fine sand.	Not on profile.

SOUNDINGS BETWEEN TANAGA, ALEUTIAN ISLANDS, AND CAPE FLATTERY.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1874.		N. ° ′	W. ° ′			
July 29	116	54 11	167 18	959	Clay-colored mud with fine sand.	
	117	54 06	166 54	658	Clay-colored mud and black sand.	
Aug. 7	118	54 14	166 17	602	Clay-colored mud, black sand, and gravel.	
	119	54 23	165 40	231	Black sand and gravel.	
	120	54 20	165 05	89	Black sand.	
	121	54 17	164 41	33	Fine black gravel.	
Aug. 8	122	54 09	163 54	46	Black sand and gravel.	
	123	54 09	163 17	42	Coarse gray-black sand.	
	124	54 10	162 39	44	Coarse gravel and broken shells.	
	125	54 11	162 10	360	Clay-colored mud with gray-black sand.	
Aug. 9	126	54 08	161 31	500	Hard clay.	
	127	54 05	160 44	1365	Clay-colored mud with lumps and sand.	
	128	54 03	159 58	1500	Clay-colored mud with particles of sand.	
Aug. 10	129	54 01	159 10	1925	Clay with fine particles of sand	
	130	54 00	158 22	3359	Hard.	No specimen; cylinder bruised.
	131	54 00	157 27	3130	Hard clay.	
	132	53 59	156 33	2814	Clay.	
Aug. 11	133	53 54	155 38	2525	Clay mud.	
	134	53 58	154 44	2459	Clay mud.	
	135	54 02	153 50	2520	Clay mud.	
Aug. 12	136	54 21	155 07	2843	Clay mud.	
Aug. 13	137	54 21	156 21	2910	Clay	
	138	54 27	158 08	1148	Clay-colored mud,black sand, and gravel.	
Aug. 14	139	54 11	159 04	1263	Clay mud.	
	140	53 46	161 25	2149	Clay mud.	
Aug. 15	141	53 38	162 31	1955	Clay mud.	
	142	53 33	163 20	1540	Clay mud.	
	143	53 30	164 08	1555	Clay mud.	
	144	53 33	164 51	827	Clay mud with fine gravel and lava.	
	145	53 40	165 15	145	Gray-black sand.	
Aug. 16	146	53 57	165 25	54	Black sand.	
	147	54 00	165 46	53	. . . .	No specimen.
	148	(*)	(*)	64	. . . .	No specimen.
	149	(†)	(†)	38	. . . .	No specimen.
	150	(†)	(†)	35	. . . .	No specimen.
	151	(†)	(†)	18	. . . .	No specimen.
	152	54 03	166 03	27	. . . .	
Aug. 17	153	54 05	163 34	55	Grayish-black sand.	
	154	53 53	163 14	592	Clay-colored mud, black sand, and pebbles.	
Aug. 18	155	53 44	162 20	1327	Grayish sand.	
	156	53 37	161 32	2506	Clay mud.	
Aug. 19	157	53 35	160 00	3664	Clay mud.	
	158	53 31	158 57	2854	Clay mud.	
	159	53 22	157 45	2587	Clay mud.	
Aug. 20	160	53 16	156 37	2482	Clay mud and fine dark sand.	
	161	53 06	155 13	2419	Clay mud with fine sand.	
Aug. 21	162	52 36	153 39	2513	Clay mud with particles of fine sand.	

* One mile west of Akoutan Pass. † Akoutan Pass.

SOUNDINGS BETWEEN TANAGA, ALEUTIAN ISLANDS, AND CAPE FLATTERY.

Date.	No. of cast.	Latitude.	Longitude.	Depth in fms.	Nature of bottom.	Remarks.
1873.		N. ° ′	W. ° ′			
Sept. 30	34	53 58	153 00	2534	Ooze with fine black sand.	
Sept. 29	33	53 51	151 19	2492	Ooze with coarse black gravel and sand.	
	32	53 55	150 01	2267	Ooze mixed with fine sand.	
Sept. 28	31	53 45	149 03	2337	Ooze and shingle.	
Sept. 27	30	53 33	147 27	2299	Ooze with fine gravel.	
	29	53 27	146 13	2292	Ooze with black gravel and shingle.	
Sept. 26	28	53 17	145 06	2243	Ooze with black sand and gravel.	
	27	53 02	143 55	2158	Oooze with black sand and fine gravel.	
	26	52 59	142 37	2117	Ooze.	
Sept. 25	25	52 37	141 18	2074	Ooze.	
	24	52 13	139 55	2032	Brown ooze.	
Sept. 24	23	52 02	138 44	1995	Ooze and brown mud.	
	22	51 40	137 32	2031	Ooze and brown mud.	
Sept. 23	21	51 28	135 54	2030	Clay, ooze.	
Sept. 22	20	51 03	134 41	1933	Clay.	
	19	50 59	133 41	1828	Clay.	
Sept. 21	18	50 45	132 39	1626	Clay ooze.	
	17	50 36	131 47	1611	Ooze.	
	16	50 25	131 03	1579	Ooze.	
Sept. 20	15	50 06	129 57	1452	Sand and gravel.	
	14	49 46	129 27	1007	Sand and mud.	
	13	49 26	128 37	1316	Blue mud.	
Sept. 19	12	49 26	128 37	. . .	. . . .	Duplicate cast of 12 not obtained.
	11	49 16	128 14	1318	Clay and mud.	
Sept. 18	10	49 12	127 24	900	Blue clay and mud.	
	9	49 12	127 10	648	Clay.	
	8	49 10	127 00	554	Sandy.	
Sept. 17	7	49 06	126 56	399	Sandy.	
	6	49 02	126 46	292	Clay.	
	5	48 53	126 20	88	Sand.	
	4	48 47	126 02	55	Sand.	
	3	48 41	125 42	42	Coarse gravel.	
	2	48 35	125 25	47	No specimens except a few particles of fine black sand.	
	1	48 33	125 11	55	Gray black sand.	

SERIAL TEMPERATURES

OF THE

NORTH PACIFIC OCEAN

AND

BEHRING SEA,

OBTAINED IN THE

UNITED STATES STEAMSHIP TUSCARORA (THIRD RATE),

Commander G. E. BELKNAP, Commanding.

SERIAL TEMPERATURES OBTAINED ON EXPERIMENTAL TRIP OFF SAN FRANCISCO.

Date.	No. of cast.	Position. Lat. N. ° ′	Position. Long. W. ° ′	Surface-temperature. °	Fms. 10 °	Fms. 20 °	Fms. 30 °	Fms. 40 °	Fms. 50 °	Fms. 60 °	Fms. 70 °	Fms. 80 °	Fms. 90 °	Fms. 100 °	Fms. 130 °	Fms. 150 °
1873. Aug. 13	2	37 28	123 13	50.4												
	3	37 27	123 21	59.3												
	4	27 25	123 26	59.1												
	6	37 27	123 33	59.0												

TEMPERATURES AT DEPTHS OF— (continued)

No. of cast.	Fms. 200 °	Fms. 250 °	Fms. 300 °	Fms. 350 °	Fms. 400 °	Fms. 450 °	Fms. 500 °	Fms. 600 °	Fms. 700 °	Fms. 800 °	Fms. 900 °	Fms. 1000 °	Fms. 1100 °	Fms. 1200 °	Fms. 1300 °	Fms. 1400 °	Fms. 1500 °	Bottom. Depth, Fms.	Bottom. Tem. °
2																		830	36.4
3																		1015	35.8
4																		1195	35.2
6																		1361	34.0

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS OFF AND ON SHORE BETWEEN CAPE FLATTERY AND SAN FRANCISCO.

Date.	No. of cast.	Lat. N. ° ′	Long. W. ° ′	Surface-temperature. °	Fms. 10 °	Fms. 20 °	Fms. 30 °	Fms. 40 °	Fms. 50 °	Fms. 60 °	Fms. 70 °	Fms. 80 °	Fms. 90 °	Fms. 100 °	Fms. 130 °	Fms. 150 °
1873. Oct. 18	10	47 14	126 42	57.0			50.0									
Oct. 19	11	47 01	127 04	57.1										44.2		
	12	46 44	127 42	57.2												
Oct. 20	13	46 14	128 48	58.5												
	14	45 18	128 57	59.5		55.2	54.2	47.7	45.6					44.2		42.9
Oct. 21	15	45 19	127 38	59.0												
	16	45 10	126 35	57.0												
Oct. 22	18	44 57	125 29	53.3												
	19	44 54	125 13	52.3										45.1		
	22	44 52	124 55	51.2												
	23	44 52	124 47	50.4												
Oct. 24	34	43 07	125 14	53.2	52.4	48.7	46.1	45.5	45.4					43.8		
	35	43 10	125 46	52.1	50.4	50.6	45.5	44.4		44.5		44.3		44.4		42.4
Oct. 25	36	43 12	127 00	54.9	53.2	53.6	50.8	45.4	45.2	45.2		45.1		44.6		
	37	43 24	128 10	57.6	55.4	54.3	53.6		45.8					44.7		43.7
Oct. 26	38	41 54	128 59	54.8	54.0	52.9	48.3	47.3	46.3					45.2		43.6
Oct. 27	39	41 38	128 03	58.1		56.2		49.7		47.6		46.2		45.0		43.6
	40	41 30	127 11	54.8	52.1				46.7					44.4		
	41	41 32	126 54	53.3												
Oct. 28	44	41 16	127 12	53.0		52.3			46.0			44.8		44.0		
	45	41 07	127 10	54.6												
	47	40 56	126 27	51.0			49.5		47.7					44.5		42.9
Oct. 29	48	41 03	125 38	52.0	51.0	49.0	47.2	47.0	45.7					44.4		
	49	41 03	125 16	50.2	49.6	49.3	48.3		47.3			46.2		45.1		43.6
	50	41 02	125 04	50.0			47.7		46.6					44.9		
	51	41 01	124 48	49.4												
	52	41 00	124 35	49.0					46.7					44.4		
	53	41 00	124 27	48.5			47.3			46.3						
Oct. 30	58	40 18	124 30	49.6												
	59	40 19	124 32	50.6												
	61	40 22	124 56	55.6			46.4		45.0					43.6		
	62	40 25	125 15	51.2				48.0				44.9				
Oct. 31	64	40 11	125 44	53.2					45.2					43.8		41.9
	65	40 09	126 12	55.0					48.4					44.4		
Nov. 1	66	39 06	125 27	55.8	54.3	54.3	49.7	48.0	46.8					44.8		
Nov. 2	67	39 05	125 14	53.1												
	68	39 04	124 40	52.8												
Nov. 3	74	38 31	123 46	51.7												
	75	38 32	123 53	52.8												
Nov. 4	78	38 37	125 28	57.9			53.6		45.6		45.5			45.1		
	79	38 25	125 57	58.0												
Nov. 5	81	37 34	125 25	58.2	57.5		54.6		52.1			46.5		45.2		
Nov. 6	82	37 40	123 36	55.0												

TEMPERATURES AT DEPTHS OF— (continued)

No. of cast.	Fms. 200 °	Fms. 250 °	Fms. 300 °	Fms. 350 °	Fms. 400 °	Fms. 450 °	Fms. 500 °	Fms. 600 °	Fms. 700 °	Fms. 800 °	Fms. 900 °	Fms. 1000 °	Fms. 1100 °	Fms. 1200 °	Fms. 1300 °	Fms. 1400 °	Fms. 1500 °	Bottom. Depth, Fms.	Bottom. Tem. °
10																		1387	
11	41.2																	1385	
12			39.4															1492	
13	40.4		38.7		38.3													1535	34.0
14																		1539	
15							37.6		36.1									1576	
16								37.1										1498	
18																		1532	33.8
19	41.6		39.3		38.2		37.5	36.7										834	35.4
22																		294	39.9
23																		237	41.0
34	41.4		39.9		38.4		37.9	37.0	36.3		35.0							1270	34.6
35																		1684	
36	41.6				38.7					35.8								1689	33.6
37	40.9				38.9													1667	
38	42.2		39.8				37.8		36.8			35.2						1805	32.9
39	42.3		41.4				38.6		36.5									1707	
40	42.0									35.3								996	35.8
41																		1689	34.0
44	41.8		40.0															1356	
45																		1499	34.3
47	41.3																	1703	
48			39.9				37.8											1666	
49	42.1		41.0															1698	
50			40.8				38.1		36.2									1666	33.5
51																		966	35.1
52																		358	
53																		261	
58																		544	37.2
59																		731	35.9
61																		1166	
62																		821	
64	40.5																	1567	
65							38.3											2263	
66																		2006	33.1
67																		1984	33.2
68							37.6					34.7						1832	
74					39.0													911	35.2
75																		1586	33.6
78	41.4		39.4															2068	33.3
79							37.7											2308	33.2
81																		2257	33.2
82			40.3															1726	

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS OFF AND ON SHORE BETWEEN SAN FRANCISCO AND SAN DIEGO, CALIFORNIA.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Temperatures at depths of— Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1873.		N. ° '	W. ° '	°	°	°	°	°	°	°	°	°	°	°	°	°
Dec. 20	3	37 15	122 59	55.1							47.7			44.0		43.2
Dec. 21	7	36 37	123 56	53.8					47.0							
	8	36 34	123 37	53.2		52.9		49.5		47.3		45.9		45.3		43.8
	9	36 32	123 11	54.0												
Dec. 22	10	36 27	122 54	54.0												
	11	36 28	122 31	55.5			53.4		50.6					46.3		45.0
	12	36 26	122 09	55.0												
	13	36 25	122 04	54.0												
Dec. 24	15	36 10	121 56	55.0		53.0			50.5		48.9			47.0		45.5
	16	36 06	122 04	55.0												
	17	36 02	122 12	54.9	53.3				48.3					45.9		44.1
Dec. 25	18	35 52	122 29	55.0												
	19	35 40	122 52	55.0	53.2				48.7					45.2		44.1
	20	35 28	122 44	54.1					49.2					46.9		
	21	35 26	122 17	55.0		52.5		50.3		48.5		47.2		45.8		44.4
	22	35 24	121 52	55.0												
Dec. 26	24	35 19	121 31	55.0												
	25	35 17	121 21	55.0		53.6		53.0	51.6		50.0					
	26	35 15	121 12	55.0												
	28	35 15	120 58	54.3												
	30	34 59	120 47	54.1												
	32	34 45	121 06	55.0		52.1		50.0		47.7		46.4		46.0		44.2
	33	34 36	121 16	55.2												
Dec. 27	34	34 23	121 32	57.0												
	35	34 29	121 23	56.0												
	36	34 09	121 33	57.0												
	37	34 03	121 14	55.6		54.9		49.5		47.2		46.8		46.4		44.5
	38	33 59	121 13	56.0												
Dec. 28	39	33 46	121 05	56.0												
	40	33 41	120 50	57.0		55.0		48.9		48.0				46.9		43.9
	41	33 38	120 38	56.8										46.8		
	42	33 35	120 28	56.4												
	43	33 33	120 14	56.0												
	44	33 32	119 59	56.4												
Dec. 29	46	33 07	119 58	57.0												
	47	32 54	120 09	57.0												
	48	32 41	120 16	57.0		55.2		51.8	50.5			47.5		46.2		
	49	32 29	120 08	59.6												
	50	32 29	119 52	58.0												
	51	32 28	119 32	59.0												
	52	32 23	119 21	59.5												
	53	32 14	119 07	59.9												
Dec. 30	55	32 18	118 27	59.0												
	56	32 22	118 52	58.4												
	57	32 22	117 44	59.6												
	58	32 33	117 28	59.8												

No. of cast.	Temperatures at depths of— Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth. Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
3	40.9		39.8															358	39.8
7																		2104	33.1
8																		1940	
9																		1685	33.3
10																		1650	33.9
11	43.3																	1170	34.8
12																		486	38.8
13																		190	44.9
15																		686	37.3
16																		988	35.4
17	43.6		41.4															882	35.6
18																		1814	33.3
19	42.7		40.8															1995	33.7
20	44.7		41.1		40.0		38.8											1940	33.2
21	43.6																	2044	
22																		862	35.7
24																		437	39.0
25																		371	40.3
26																		289	42.5
28																		65	48.0
30																		80	48.0
32																		309	41.8
33																		490	39.2
34																		1995	33.2
35									37.7	37.1	36.1							1198	34.7
36	45.1				40.2			37.9		36.3		35.8						1988	
37																		1783	33.7
38																		1467	34.1
39																		1674	33.8
40	42.9																	1092	35.2
41	43.2		41.7		39.9													530	38.8
42																		694	37.3
43																		634	38.1
44																		260	43.0
46																		542	39.1
47																		551	39.1
48																		1833	33.7
49																		1052	35.4
50																		844	36.9
51																		769	36.8
52																		759	36.9
53																		727	37.1
55																		955	36.8
56																		445	39.7
57																		784	36.8
58																		687	37.5

SERIAL TEMPERATURES OBTAINED ON LINE OF SOUNDINGS BETWEEN SAN DIEGO, CALIFORNIA, AND HONOLULU, HAWAIIAN ISLANDS.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Temperatures at depths of— Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1874.		N. ° '	W. ° '	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan. 6	3	32 30	117 24	57.8												
	4	32 27	117 27	58.0												
	5	32 17	117 47	58.8												
Jan. 7	7	32 00	118 26	59.6												
	8	31 56	118 41	59.1												
	9	31 51	119 03	59.8												
	10	31 43	119 28	59.0		57.4		51.5		48.8		47.5		46.3		44.7
Jan. 8	11	31 25	120 04	58.7												
	12	31 04	120 46	61.0										46.8		
	13	30 52	121 37	60.0		57.0	57.0	54.0	51.5	49.8	48.8	48.6	48.0			45.2
Jan. 9	14	30 39	122 28	60.4	59.7	59.6	59.6	59.0	54.9	54.3	52.2	48.3	48.1	47.3		46.0
	15	30 31	123 15	61.0					57.9					48.3		45.5
Jan. 10	16	30 16	124 08	63.0					61.5					50.2		
	17	29 55	125 12	63.1			59.7		59.7		59.2			51.9		47.0
Jan. 11	18	29 53	126 06	63.0			61.3		59.6		57.7	54.5	50.9	49.5		
	19	29 39	126 59	63.2					59.4					52.4		
Jan. 12	20	29 15	128 05	61.8	56.6		57.3		56.7			56.5		53.0		46.5
	21	28 58	128 48	63.4												
	22	28 42	129 34	64.5			58.9		58.5			58.8	56.9	52.9		47.1
Jan. 13	23	28 22	130 28	64.1												
Jan. 14	24	28 19	131 19	65.0	64.6	64.1		63.1		62.5		62.4		58.6		49.4
	25	28 08	132 05	66.4	65.5		65.3		65.3		65.1		64.7	63.6	62.2	57.9
Jan. 17	26	28 03	132 35	65.2	64.2		63.0		62.6		61.8		61.7	59.3		50.4
Jan. 18	27	27 45	133 22	65.6					64.4					59.9	51.8	49.1
	28	27 30	134 11	66.2			64.8					61.2		57.5	50.1	48.8
Jan. 19	29	27 10	134 58	66.2				64.1		63.1		62.3		56.6	52.3	49.5
	30	26 51	135 51	66.0	65.2		65.2		65.1		62.2			56.2	51.1	48.6
	31	26 36	136 38	66.4		66.2	66.2		65.3	64.3		63.4		58.6		49.8
Jan. 20	32	26 22	137 22	67.8			67.8		67.8	67.6		63.9		61.4	55.2	50.4
	33	26 15	138 10	69.2					69.0	68.7	68.6	65.8	64.8	64.8	55.1	50.5
Jan. 21	34	26 09	139 00	68.8					67.2		65.9	64.3		63.4	54.2	50.2
	35	25 59	139 45	68.8					68.0		64.6			61.1		49.4
Jan. 22	36	25 52	140 40	68.0					65.0	65.0	63.7	63.3	61.1	59.8	51.6	49.6
	37	25 43	141 31	68.0		67.2	67.2	67.0	66.8		64.0	63.3	63.3	60.7	53.1	50.3
	38	25 36	142 14	69.2					68.5			64.9		60.6	54.7	51.5
Jan. 25	39	25 21	142 29	69.5			68.8		68.8		68.7			63.2	58.5	55.4
	40	25 08	143 18	69.2					69.0		65.6			64.4		53.4
Jan. 26	41	24 59	144 04	70.0										63.0		
	42	24 49	144 52	70.6					68.7	68.4	66.2	65.5	64.3	61.4	54.0	52.4
Jan. 27	43	24 40	145 35	70.8												
	44	24 23	146 19	70.0					68.9		67.3		64.0	60.5		52.2
Jan. 28	45	24 08	147 03	70.6					68.8	68.8	68.6	68.2	68.0	63.3	56.2	55.4
	46	23 54	147 47	72.8										64.3		
Jan. 29	47	23 38	148 42	72.0					68.6		68.3		66.5	65.0	58.2	54.1
	48	23 20	149 37	72.6	71.4	71.4	71.3	71.1	70.3	70.3		67.3	66.6	64.9	62.1	52.9
	49	23 10	150 31	72.8					70.5		67.9			64.0		54.2
Jan. 30	50	23 01	151 26	71.2					70.2		68.2			64.5	55.6	52.8
	51	22 50	152 17	73.4					71.0		68.6	67.5	66.5	64.6	57.9	52.5
Jan. 31	52	22 40	153 17	71.9												
	53	22 26	154 04	73.2			71.9		71.3		68.4	66.0	65.1	62.9	58.1	53.6
Feb. 1	54	22 10	154 52	72.5					70.9					63.2		54.2
	55	21 55	155 39	74.0												
	56	21 43	156 21	73.7					72.0		70.5	68.9	67.8	66.2	60.0	55.0
Feb. 2	57	21 32	157 01	73.0		72.5		72.4		70.8		68.6		65.1	60.2	54.2
	58	21 26	157 19	73.2												
	59	21 24	157 26	73.3												
	60	21 14	157 36	74.0												
	61	21 12	157 42	73.6												
	62	21 13	157 47	73.3												

No. of cast.	Temperatures at depths of— Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
3																		622	38.4
4																		579	38.8
5																		1053	36.3
7																		595	38.6
8																		566	38.6
9																		980	36.2
10																		1915	34.0
11																		2177	33.9
12	43.2		40.8		40.2		39.6											2178	33.9
13	43.9																	2246	33.8
14	44.1																	2251	33.9
15	43.0																	2103	33.9
16	44.5				40.1			37.5		36.4		35.7						2363	33.9
17	44.4		40.5															2049	33.8
18																		2199	33.9
19			41.3				39.0		36.7		35.6		35.4					2400	33.8
20	44.8																	2409	33.7
21	43.8				39.5			37.6		36.1		35.4		35.1	34.7			2517	33.8
22	43.9																	2583	33.7
23			40.8				38.8		36.9		35.8		35.0		34.7	34.6		2587	33.7
24	46.0	43.5																2604	33.2
25	48.5																	2356	33.7
26	46.5	43.8	41.5	40.3	40.0		38.8											2323	33.7
27	44.9	43.1	41.2		39.8		38.4	37.7										2540	33.7
28	45.9	43.8	41.4				38.6		37.5									2477	33.6
29	45.6	42.7																2541	33.7
30	45.1	42.4																2440	33.7
31																		2356	33.7
32	46.9	43.2	40.9															2159	32.6
33	46.6	43.0	41.3	40.3	39.4		38.5											2650	33.6
34	45.8	43.4																2689	33.6
35	45.5	43.1	41.3	40.3	39.3	38.6	38.5	37.8										2628	33.6
36																		2695	33.6
37	46.1	43.4	41.1															2553	33.8
38	47.9																	2618	33.3
39	48.4	45.3																2690	33.6
40	47.5	43.4	41.7															2634	33.6
41	48.9		42.5		39.7		39.2	38.4	37.0	36.9	35.9	35.3	35.1	34.6				2841	33.2
42	47.2	43.8	41.3															2841	33.6
43											36.0	35.7	35.1	34.6	34.2	34.3		2856	33.8
44	46.7	44.4	41.4															2982	33.6
45	48.2	44.2																2922	33.6
46	48.3		41.6		39.9		38.7	38.0		35.8		35.5		34.5		34.3		2993	33.7
47	49.4	45.0																2982	33.6
48	46.6	45.3	42.1															2936	33.3
49	48.2	44.4	42.1															3054	33.2
50	48.2	44.7																3053	33.4
51	48.6		42.2		40.1		39.1	38.2	37.8									2953	33.2
52									37.4	36.9	36.1	34.9		34.7	34.6			2726	33.6
53	47.7																	2562	33.5
54	48.4	44.2	42.2															2488	33.5
55									37.2	36.6	35.4	35.2		35.1		34.3		2752	33.2
56	48.7																	3023	33.5
57																		2086	33.5
58																		498	40.4
59																		403	42.6
60																		63	70.4
61																		272	44.8
62																		255	45.1

SERIAL TEMPERATURES OBTAINED ON LINE OF SOUNDINGS BETWEEN HONOLULU, HAWAIIAN ISLANDS, AND PORT LLOYD, BONIN ISLANDS.

TEMPERATURES AT DEPTHS OF—

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150	Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth. Fms.	Bottom. Tem.
1874.		N. ° '	W. ° '	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
Mar. 17	*3	21 06	158 31	75.0					72.8					65.5		55.8	49.1	45.3	42.8															1580	33.6
Mar. 18	4	21 00	159 25	74.0					71.4					66.1																				2418	32.9
	5	20 54	160 22	73.0					70.7					63.3			48.6		42.5		40.0		39.1	38.5										2565	33.5
Mar. 19	6	20 48	161 19	74.0			71.2		70.6			68.0		64.1			46.4		41.8		40.1													2555	33.1
	7	20 38	162 16	73.0					71.8		71.0		68.6	64.4		55.7	49.4		43.4		40.5		39.2	38.4										2495	33.9
Mar. 20	8	20 25	163 25	74.4					70.0		69.8		69.8	67.7		57.6	50.0																	2733	33.9
	9	20 18	164 27	73.7					70.3					65.9			49.4		42.7		40.2		39.6	38.6										2720	33.3
Mar. 21	10	20 13	165 31	73.0	70.5			70.4			69.2			63.5	58.8	55.8																		2794	33.0
	11	20 12	166 35	74.0																					37.7	37.2	36.3	34.3		34.3				2803	33.6
Mar. 22	12	20 12	167 46	74.0					72.2		70.7			67.9			50.4	46.3	43.6															2460	33.5
	13	20 16	168 57	74.6					73.3					69.5		63.5	51.4		42.7		40.6		39.3	38.8										2737	
Mar. 23	15	20 41	171 33	74.5					71.0			69.9		69.6	64.3	59.9	52.6																	1874	
Mar. 24	16	20 52	172 39	74.0										71.2		61.9	58.8	49.3	48.7	43.4	42.7		40.7											3045	
	17	21 04	173 54	74.2					71.3			71.0		68.9																				2952	
Mar. 25	18	21 21	174 57	74.1					71.4			68.9		66.6		58.2	52.9		43.8		40.7		39.9											2993	
	19	21 27	176 03	74.2					70.2			65.9		62.7	59.8	55.2																		3106	33.4
Mar. 26	20	21 21	177 10	73.2		71.1	70.9	70.3			70.9		70.6	70.5		62.9	55.8		46.4															3100	
	21	21 29	178 15	73.2										70.2		58.5	52.7	47.7																2828	
Mar. 27	22	21 38	179 27	74.6					73.0					65.5			51.7		44.4		40.1		39.4											2725	33.2
		N.	E.																																
Mar. 29	23	21 40	179 20	73.0					71.7					65.6			53.2	48.4																1964	
	24	21 41	178 04	74.6					70.8					65.3	60.9	58.2	52.7	48.7	44.7															1625	
Mar. 30	25	21 41	176 50	74.7					72.1			69.3		64.9		58.7																		1108	34.6
	26	21 47	175 44	74.0		72.3		71.7		71.7		71.6		67.0			53.5		41.5		40.1		39.0											1817	33.8
Mar. 31	27	21 56	174 44	75.0										63.5			53.6		44.3		40.3		39.6	38.4	38.3	36.7	36.3	35.5						1613	34.2
	28	22 01	173 43	73.0			72.1		71.7		70.9			65.9	60.5	58.6																		2813	33.2
April 1	29	22 05	172 41	73.2					70.8					63.6		58.2	53.4	48.7	45.2	42.1	40.2		39.3											2836	33.9
	30	22 09	171 32	74.7		71.6		71.5		71.3		71.0		68.1	63.1																			2771	33.6
April 2	31	22 20	170 31	73.8					71.4					64.2		58.6	54.4		46.3		41.2		39.3	38.5										3090	33.2
	32	22 29	169 28	75.5					72.5					69.4	63.1	60.5	56.5																	3211	33.2
April 3	33	22 44	168 23	75.1	74.7				72.6		70.2		65.2	63.8	61.2																			3262	33.7
	34	22 51	167 21	75.8					71.5					65.9		59.1	56.4	52.3	47.8		41.4		39.3											3232	33.9
April 4	35	22 59	166 13	75.0			71.6		70.7		67.9		63.4	62.4	60.3	59.5																		3155	33.6
	36	23 05	165 13	76.0					70.1					62.2		59.5	55.8	51.8	48.1		41.8		40.1											3185	33.7
April 5	37	23 09	164 03	74.5		71.6		71.0		70.3		69.1		63.2																				3148	33.2
	38	23 17	162 58	76.0					71.8					64.8		59.0	56.0	52.3	48.2		41.7		39.4											2870	33.9
April 6	39	23 31	161 51	76.0	73.5		73.5		73.7		72.5		70.2	67.8	63.8	61.2	58.6																	3009	33.2
	40	23 45	160 56	75.8										69.8			57.1		49.1		42.3		39.8	38.5		35.9		35.6						1400	34.9
April 7	41	24 07	160 09	73.2		71.6		69.8		67.3		62.9		60.9																				3023	33.2
	42	24 19	159 21	74.7			72.8		67.4		66.5			62.4	61.2	59.4	55.2																	2938	33.8
April 8	43	23 55	158 07	73.4										62.6			55.1		47.0		41.4													2042	
April 9	44	23 46	157 12	75.6			72.5		72.4		72.3			68.4	63.4	61.7	57.2	53.1	48.9															2173	33.2
	45	23 56	156 10	73.2				70.0		67.5		65.5		62.8			56.3		46.4		41.6		39.7											3075	
April 10	46	24 02	155 08	72.8					68.5		66.8			62.1	60.8	60.6																		3273	33.2
	47	24 20	154 06	74.0			72.7		71.2		68.0			63.5	61.2	60.6																		1499	34.1
April 11	49	24 41	151 46	74.0					71.3					64.2		60.4	58.2	53.8	48.7		42.1		39.6											3023	
April 12	50	24 46	150 51	75.1					72.7		72.5			70.8	66.7	64.3	59.3	54.0	50.1															3061	
	51	25 11	149 46	72.4				68.3		66.3		63.8		62.6																				3287	
April 13	52	25 42	148 39	72.8										61.9			56.4		48.4		41.7		39.3	38.0		35.9		35.5						1712	
	53	25 55	147 47	73.2			71.9		68.8		66.1			62.6	61.0	60.0																		2534	33.4
April 14	54	26 09	146 10	70.0					68.4		65.7			63.5	62.8	62.6	60.3	57.1																3018	
	55	26 18	144 54	74.9				73.8		73.4		70.6		69.6			59.8		51.3				40.2		37.0		35.8		34.8					1700	33.8
April 15	56	26 28	143 33	71.2					67.5					63.3		61.2	58.4	53.5	50.3															2080	33.5
	57	26 41	142 42	72.0					66.5		64.6			61.4	60.4	59.9																		1331	34.4
	58	26 52	142 21	71.0																														814	35.7
	59	26 55	142 14	71.0																														487	41.8

SERIAL TEMPERATURES OBTAINED ON LINE OF SOUNDINGS BETWEEN PORT LLOYD, BONIN ISLANDS, AND YOKOHAMA, JAPAN.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Temperatures at depths of— Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1874.		N. ° '	E. ° '	°	°	°	°	°	°	°	°	°	°	°	°	°
April 18	4	28 09	141 42	69.0					67.1		65.8			63.7	62.1	60.6
April 19	5	28 56	141 50	68.2				66.5		64.2		63.9		62.6		58.8
	6	29 56	141 52	66.0					63.5					63.1		61.2
April 20	7	30 29	141 04	67.0					64.3					62.9		
	8	31 18	140 53	63.0			62.6				61.5			61.4	61.4	
April 21	9	32 13	140 37	66.2										62.9		59.9
	10	32 58	140 22	68.0					66.0					64.2		61.4
April 22	12	34 31	140 14	62.5												
	13	34 45	140 01	60.0												

No. of cast.	Temperatures at depths of— Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth. Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
4																		869	35.7
5	57.8																	1344	34.4
6	58.9	54.9	51.5															2435	33.5
7	58.2		50.6		43.3		40.6											1669	33.8
8																		1382	34.3
9	60.9		53.2		44.3		40.9											1135	34.8
10	60.0	56.1	51.7	45.8	42.2													565	
12																		1618	33.8
13																		595	37.9

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS BETWEEN YOKOHAMA, JAPAN, AND TANAGA ISLAND, ALEUTIAN GROUP.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1874.		N. ° '	E. ° '	°	°	°	°	°	°	°	°	°	°	°	°	°
June 10	9	36 13	141 34	68.0					57.7					52.3		47.4
	10	36 33	141 58	69.4					59.6					53.2		
	11	36 58	142 15	70.4			65.4		63.6		61.6			58.4		
	12	37 19	142 42	71.0												
June 11	13	37 37	143 09	69.0										61.9		
	14	37 54	143 40	68.2		65.6		63.5		63.3		62.6		62.3		60.8
June 13	16	38 13	142 09	69.0										58.4		
	17	38 34	142 39	69.1					62.3					50.3		46.8
June 14	19	39 36	142 41	55.6					43.6					39.7		
	20	40 10	142 57	60.2		49.5		45.6		42.2		37.9		37.6		37.6
	21	40 39	143 25	58.8					42.6					37.5		
June 15	23	41 25	144 47	60.3	58.5	56.5	55.6		50.6		45.6			42.7		
	24	41 46	145 40	47.4					34.3					34.0		34.5
June 16	25	41 53	146 08	52.0	48.8	38.9	36.6	34.6	34.7					35.5		
	26	42 08	146 50	51.4					35.3					35.4		
June 17	27	42 34	147 38	51.1	49.0	44.0	41.2	39.3	36.2	36.4		35.5		34.3		
	28	42 57	148 23	49.5	42.7				32.7					33.3		
	29	43 21	149 12	43.0	40.2	34.3	33.6	32.5	32.3			33.2		33.3		
June 18	30	43 47	150 02	49.3					33.3					33.5		
	31	44 10	150 50	45.0	44.0	33.3	32.0			32.0				32.9		
	32	44 28	151 37	41.0					32.5					32.3		
June 19	33	44 55	152 26	41.4					32.3					34.5		
June 20	34	46 21	151 25	36.4										34.6		
	35	46 00	150 45	37.1					33.9					32.9		
June 21	37	45 07	149 46	39.5					34.4					33.4		
	38	44 44	149 23	39.9										34.5		
	39	44 23	148 53	39.8												
June 22	40	44 02	148 16	39.2												
	41	43 42	147 44	47.0												
	42	43 20	147 04	50.9					34.2					35.2		
	43	42 59	146 25	50.3					34.8					34.7		
June 23	44	42 36	145 49	50.2												
	45	42 15	145 09	45.1												
	46	41 54	144 35	49.8	42.5											
	47	41 32	144 18	59.5			47.2			44.9				37.6		
July 4	48	46 38	151 47	36.8												
	49	46 56	152 19	40.0		36.0			33.7		33.6					
	50	47 11	152 54	38.0	35.3	34.8	35.3	35.2	35.3							
	51	47 30	153 33	40.4										34.4		
	52	47 44	154 15	41.1												

No. of cast.	Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth. Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
9				40.2	37.7													871	35.1
10																		1358	34.4
11	48.8		41.3															1425	
12																		1274	34.4
13	58.6		50.1		42.6		39.5	38.0										1833	
14	57.9		50.0		42.5													3427	33.4
16	47.4		38.2		37.7													411	
17	45.4																	1358	34.8
19	39.2		38.3		37.5													1017	35.3
20																		653	
21	36.6		35.9															1137	34.8
23	36.3		36.5				36.5											2856	
24	34.5				34.7			34.9										3493	
25	35.6						34.3											3587	
26			36.1				35.7			35.3		34.8						3507	32.0
27																		4340	
28			33.6				34.2		33.5									4356	
29			33.2				33.6											4041	
30	33.1						34.3			33.0			33.2					4234	
31	35.4							34.4						32.9				4120	
32	33.5		33.4		32.0													4411	
33	34.4		35.3				33.7											4655	
34	33.5		32.2															1445	
35	32.9																	881	
37																		332	33.8
38	33.3																	944	32.9
39																		1246	34.5
40																		1050	31.6
41																		1103	33.2
42	34.4		33.8															1048	34.5
43																		1329	34.1
44																		1379	33.9
45																		1619	31.9
46																		1108	33.2
47																		1582	33.6
48																		702	33.5
49																		490	32.3
50																		1134	33.1
51	34.7		35.1															1594	32.5
52																		1040	33.3

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1874.		N. ° ′	E. ° ′	°	°	°	°	°	°	°	°	°	°	°	°	°
July 5	53	48 01	154 51	43.2	41.9	36.6	33.5									
	54	48 21	155 28	43.9	39.3	35.9			32.7					32.5		
	55	48 40	156 07	41.9	40.3	33.3	32.1		32.5					32.2		
July 6	56	48 59	156 42	43.1	43.0	35.7			34.0					35.4		
	57	49 23	157 21	43.2	42.3	36.2	34.0		33.8					36.0		
July 7	58	49 41	157 58	42.9	42.1	36.9	34.0		32.4					32.2		
	59	50 02	158 49	43.7	41.7	36.3	34.6		33.7					36.6		
	60	50 22	159 40	42.6	41.0	33.7	31.5		31.1					31.9		
July 10	61	51 06	161 08	43.8	42.5	35.2			33.6					36.3		
	62	51 22	162 20	43.1	42.7	35.7			33.5					35.5		
July 11	63	51 31	163 23	42.6	42.1	35.3	34.8		34.2			34.9		34.8		
	64	51 39	164 30	45.0		37.0	34.8		34.1					35.3		
	65	51 43	165 25	46.3	43.8	40.6	37.3	35.5	35.0	34.7		36.2		37.6		
	66	51 47	166 26	46.1		40.0	38.0		37.0			36.4		37.6		37.5
July 12	67	51 50	167 22	45.0		40.4	38.0		37.0			36.2		37.7		
	68	51 52	168 10	46.4		39.6	38.4		37.2			36.9		37.4		
	69	51 55	169 00	47.2	46.5	42.2	40.9	39.1	37.8			39.2		39.2		
	70	51 58	169 42	47.2		42.7	40.0	39.6	38.6		38.3	38.4		38.3		
July 13	71	52 01	170 28	46.7			41.4		38.9			38.2		38.8		
	72	52 04	171 15	46.4		42.7		40.3						39.1		
	73	52 09	172 02	46.0	44.3	42.0	40.6	40.3	40.0					38.9		
July 14	74	52 11	172 41	46.2	44.7	42.0	41.3	40.0	40.5					39.4		
	75	52 14	173 14	45.9	44.3	42.5	41.5		39.2							
	76	52 05	174 01	45.8				39.6						38.2		
	77	51 58	174 31	45.1	44.4	42.1										
	78	51 50	175 09	44.9												
July 15	79	51 40	175 55	43.3			40.7		40.2					39.7		
	80	51 33	176 34	42.6					40.3					39.4		
	81	51 30	177 14	44.7	44.0	41.6	40.9							39.5		
	82	51 25	177 55	44.9												
	83	51 23	178 19	43.2												
July 16	85	51 12	178 20	43.0		40.4			39.9					39.2		
	86	51 15	178 35	43.8												
	87	51 10	178 58	42.6												
	88	51 05	179 23	43.4												
	91	51 01	179 14	46.1												
	92	51 08	178 35	47.0		44.2	41.9		41.0					39.4		
	93	51 15	178 01	45.9					40.7					39.2		
July 17	94	51 28	177 58	43.9												

BETWEEN YOKOHAMA, JAPAN, AND TANAGA ISLAND, ALEUTIAN GROUP.

Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth, Fms.	Bottom. Tem.
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
33.3																	1371	33.3
32.6																	1919	31.3
		34.9															2631	32.0
						35.7											3639	32.9
																	3119	33.3
36.6		36.3															2797	
31.2																	3274	33.1
																	3754	
34.6		34.6				34.7											2970	
35.2		34.3															2934	
						35.2											2981	
																	2720	
																	2793	33.5
																	1896	33.7
37.4																	1777	34.0
38.6									36.0		34.8						2005	33.8
38.6		37.8															2320	34.0
38.4		37.8				37.4											2711	
																	2463	
		38.0				36.9		36.8		36.0		34.5					4037	
38.3						37.1					35.4						2463	
																	1857	34.2
																	947	35.9
37.2																	1668	34.7
																	332	37.5
																	303	37.4
																	799	34.4
39.2																	998	35.2
																	1014	35.0
																	565	37.1
																	282	36.7
																	1313	34.3
																	548	37.3
																	237	39.1
																	975	35.6
																	1838	34.4
37.8																	1779	34.3
		38.4				37.9											1034	
																	233	39.6

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS BETWEEN TANAGA ISLAND, ALEUTIAN GROUP, AND CAPE FLATTERY.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Temperatures at depths of— Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms. 100	Fms. 130	Fms. 150
1874.		N. ° ′	W. ° ′	°	°	°	°	°	°	°	°	°	°	°	°	°
July 25	100	52 02	178 07	48.0												
	101	52 06	177 28	47.2	46.1	44.0	41.8	40.1	39.4							
July 26	102	52 11	176 48	43.2		41.2	41.0		40.3					38.7		
	103	52 18	176 01	47.6	44.0		41.0		40.1					39.0		
	104	52 25	175 18	48.0	46.4	43.8	41.8	40.9	40.1					37.7		
	105	52 32	174 27	47.0	47.2	42.7			39.9							
July 27	106	52 39	173 51	48.0										38.6		
	107	52 47	173 04	48.2	46.3	43.1	41.2	40.5	39.3					38.7		
	108	52 58	172 11	47.4					39.5					38.3		
	109	53 08	171 19	46.2		42.7		40.2		38.2		37.6				
July 28	110	53 17	170 23	44.7			41.5		38.5					38.3		
	111	53 57	169 28	47.6					37.9					37.6		
	112	53 40	169 01	48.6	44.4	42.7		40.4	39.9					39.2		
	113	53 57	168 08	47.9	43.9	40.7			38.8							
July 29	114	54 06	168 31	47.9			40.1		40.3					39.0		
	115	54 13	167 57	47.4	44.5	42.5	41.3									
	116	54 11	167 18	46.6	43.8	42.5										
	117	54 06	166 54	47.4												
Aug. 7	118	54 14	166 17	48.8												
	119	54 23	165 40	48.9	44.6	44.0										
	120	54 20	165 05	49.1												
Aug. 8	123	54 09	163 17	54.4												
	124	54 10	162 39	54.2												
Aug. 9	126	54 08	161 31	54.2	46.0		40.6		40.3							
	127	54 05	160 44	55.2	53.4	42.9	40.3							40.2		
	128	54 03	159 58	55.0	54.8	49.5	40.6	39.8								
Aug. 10	129	54 01	159 10	55.0	54.5	48.3	41.4		39.8					39.4		
	130	54 00	158 22	55.1	48.0	44.0			38.2					38.1		
	131	54 00	157 27	55.0	54.2	46.4	42.0	39.2	38.9					38.9		
	132	53 59	156 33	54.8	53.0	44.0	40.6		38.6					38.4		
Aug. 11	133	53 54	155 38	55.0	54.1	48.7	40.1		38.8					38.7		
	134	53 58	154 44	55.0	55.0	51.7	42.1	40.2	40.2					39.2		
	135	54 02	153 50	56.0	55.6	45.3	40.9		38.7					38.8		
Aug. 12	136	54 21	155 07	56.0	55.9	46.2	41.3		38.6					38.6		
Aug. 13	137	54 21	156 21	54.0	48.9	42.4	40.5		40.0					39.9		
	138	54 27	158 08	54.0	53.9	47.9	42.4		39.6							
Aug. 14	139	54 11	159 04	55.8	54.2	42.5	41.0									
	140	53 46	161 25	56.4	54.5	43.7	40.6		39.1					38.6		
Aug. 15	141	53 38	162 31	56.2		49.4	43.6	40.2	39.2					39.1		
	142	53 33	163 20	56.6	55.8	42.6	40.9									
	143	53 30	164 08	57.1		47.4	46.2		40.9					39.2		
	144	53 33	164 51	57.0	45.3		43.2									
	145	53 40	165 15	56.2												
Aug. 16	146	53 57	165 25	53.9												
Aug. 17	153	54 05	163 34	58.8												
	154	53 53	163 14	57.9												
Aug. 18	155	53 44	162 20	57.8	53.7	42.0	40.6		40.0							
	156	53 37	161 32	57.8	55.5	48.3	43.9		39.1					38.2		
Aug. 19	157	53 35	160 00	57.0	55.6	50.0	41.4		39.2					39.0		
	158	53 31	158 57	58.0	55.9	48.3	41.6		39.0					39.1		
	159	53 22	157 45	57.2	52.7	39.0	41.1	40.3	39.7					38.5		
Aug. 20	160	53 16	156 37	56.1	55.0	46.0	41.4	39.9	39.0					38.2		
	161	53 06	155 13	57.1	55.2	43.4	40.3	39.4	39.3					38.6		
Aug. 21	162	52 36	153 39	58.5	55.6	46.9	41.8		39.1					38.7		

No. of cast.	Temperatures at depths of— Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms. 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth, Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
100																		1055	35.1
101																		1339	34.7
102	38.5																	1681	33.9
103			36.8															1681	34.6
104																		1755	34.4
105																		1548	34.0
106	38.3				37.1		36.9											1257	
107																		1029	35.3
108			38.2															928	35.5
109																		1006	35.5
110																		1032	35.1
111			37.6				36.6											1158	
112																		770	36.1
113																		1169	35.3
114																		1212	34.1
115																		812	36.1
116																		959	35.4
117																		658	37.0
118																		602	37.2
119																		231	38.5
120																		89	41.4
123																		42	44.7
124																		44	42.5
126							38.0											500	38.0
127																		1365	34.9
128																		1500	33.8
129	39.3																	1925	33.5
130			38.0				36.6											3359	34.2
131			38.0				36.9		36.4									3130	
132																		2814	34.1
133																		2525	34.1
134			38.4															2459	33.7
135			38.4															2520	34.1
136																		2843	34.1
137			38.8				37.2											2910	
138																		1148	35.2
139																		1263	35.0
140			38.6															2149	34.1
141																		1955	34.1
142																		1540	34.5
143			38.7															1555	34.4
144																		827	35.9
145																		145	40.6
146																		54	44.6
153																		55	41.8
154																		592	37.9
155																		1327	34.6
156			38.1				35.7											2506	
157			38.4				37.3		36.5									3661	33.8
158	38.6		37.9		37.7		37.3											2854	
159																		2587	
160																		2482	34.2
161																		2419	33.6
162							37.3		36.4									2513	

SERIAL TEMPERATURES OBTAINED ON LINES OF SOUNDINGS BETWEEN TANAGA ISLAND, ALEUTIAN GROUP, AND CAPE FLATTERY.

Date.	No. of cast.	Position. Lat.	Position. Long.	Surface-temperature.	Temperatures at depths of— Fms. 10	Fms. 20	Fms. 30	Fms. 40	Fms. 50	Fms. 60	Fms. 70	Fms. 80	Fms. 90	Fms 100	Fms. 130	Fms 150
1873.		N. ° ′	W. ° ′	°	°	°	°	°	°	°	°	°	°	°	°	°
Sept. 30	34	53 58	153 00	50.5	49.1	48.8	38.4	37.0	36.9					37.0		
Sept. 29	32	53 55	150 01	50.7												
Sept. 27	30	53 33	147 27	51.4												
	29	53 27	146 13	51.0												
Sept. 26	27	53 02	143 55	52.2												
	26	52 59	142 37	51.9												
Sept. 25	25	52 37	141 18	54.2												
	24	52 13	139 55	53.0												
Sept. 24	22	51 40	137 32	53.3												
Sept. 22	20	51 03	134 41	55.6												
Sept. 21	18	50 45	132 39	56.9												
Sept. 20	16	50 25	131 03	57.2												
	14	49 46	129 27	58.0												
Sept. 19	11	49 16	128 14	59.0												
Sept. 18	8	49 10	127 00	54.6												
Sept. 17	5	48 53	126 20	56.5												
	4	48 47	126 02	53.2												
	3	48 41	125 42	51.8												
	2	48 35	125 25	50.4												

No. of cast.	Temperatures at depths of— Fms. 200	Fms. 250	Fms. 300	Fms. 350	Fms. 400	Fms. 450	Fms. 500	Fms. 600	Fms 700	Fms. 800	Fms. 900	Fms. 1000	Fms. 1100	Fms. 1200	Fms. 1300	Fms. 1400	Fms. 1500	Bottom. Depth, Fms.	Bottom. Tem.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°
34	36.9																	2534	32.6
32																		2267	33.1
30																		2299	32.8
29																		2292	33.1
27																		2158	33.7
26																		2117	33.9
25																		2074	34.1
24																		2032	34.0
22																		2031	34.1
20																		1933	34.2
18																		1626	34.4
16																		1579	34.4
14																		1007	35.7
11																		1318	34.8
8																		554	41.6
5																		88	43.6
4																		55	44.9
3																		42	44.4
2																		47	44.9

BURT'S SOUNDING NIPPER.

Fig. 3.

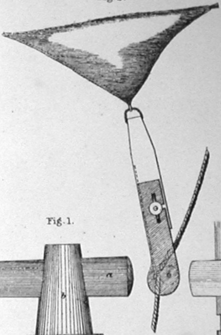


Fig. 1.

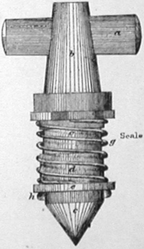
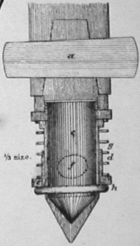


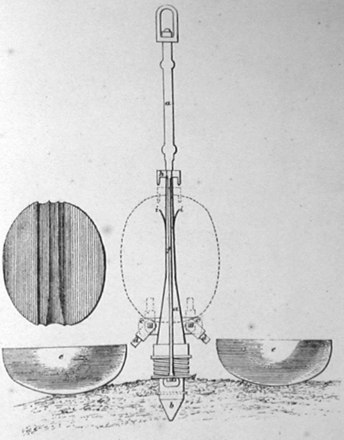
Fig. 2.



Scale for Fig. 1 & 2 1/3 size.

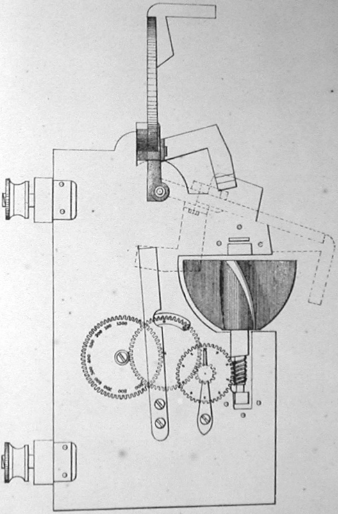
SAND'S SPECIMEN BOX FOR DEEP SEA SOUNDINGS.

SAND'S DEEP SEA SOUNDING APPARATUS.



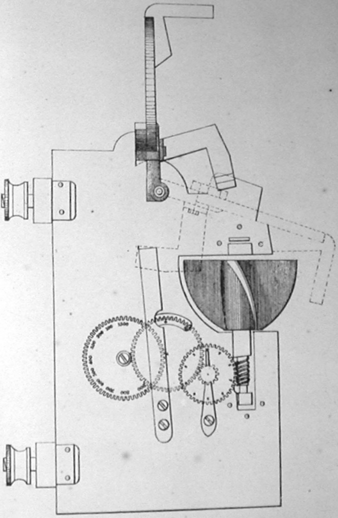
Scale ⅜ size.

MASSEY'S SOUNDING INDICATOR
ATTACHED TO SAND'S SOUNDING APPARATUS.



Scale ½ size.

MASSEY'S SOUNDING INDICATOR ATTACHED TO SAND'S SOUNDING APPARATUS.



Scale ½ size.

BROOKE'S DEEP SEA SOUNDING APPARATUS

Fig.1.

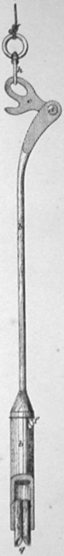
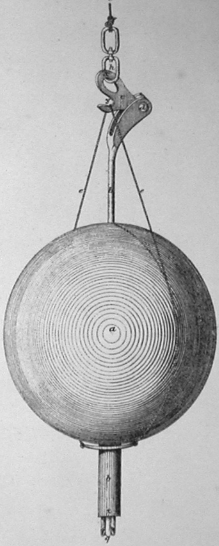


Fig 2.



BROOKE'S DEEP SEA SOUNDING APPARATUS.

Fig. 1.

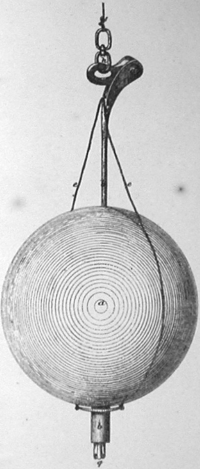
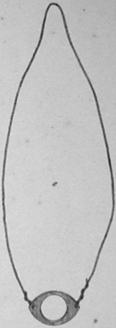
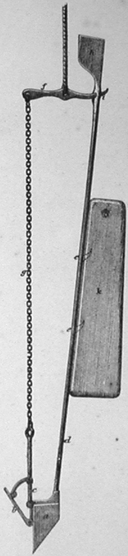


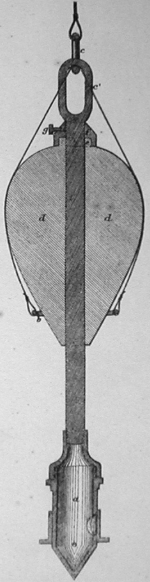
Fig. 2.



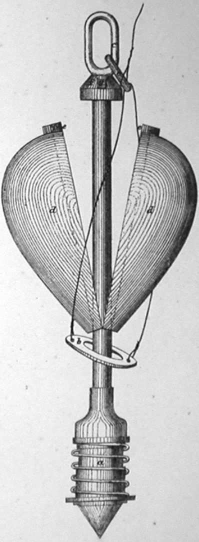
FITZGERALD SOUNDING MACHINE.



THE BROOKE-SAND'S SOUNDING APPARATUS
AS FIRST MODIFIED BY COMDR. BELKNAP.



THE BROOKE-SAND'S SOUNDING APPARATUS
AS FIRST MODIFIED BY COMDR. BELKNAP.

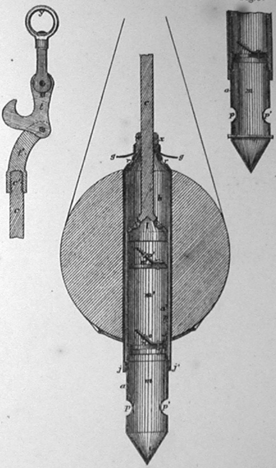


BELKNAP DEEP SEA SOUNDING CYLINDER No. 1
WITH
BROOKE'S DETACHING ROD AND SINKER.

Fig 2.

Fig. 1

Fig. 3.



BELKNAP DEEP SEA SOUNDING CYLINDER No. 1 WITH BROOKE'S DETACHING ROD AND SINKER.

Fig. 2.

Fig. 1.

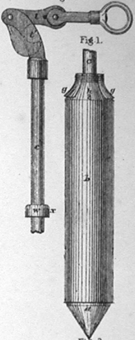
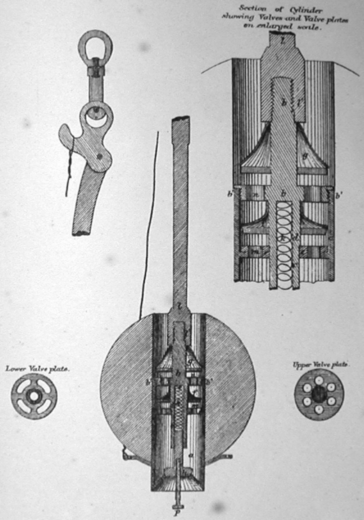
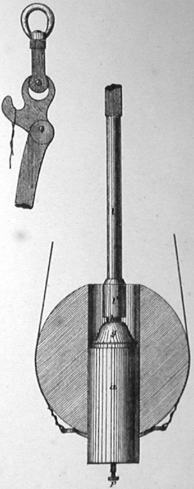


Fig. 3.

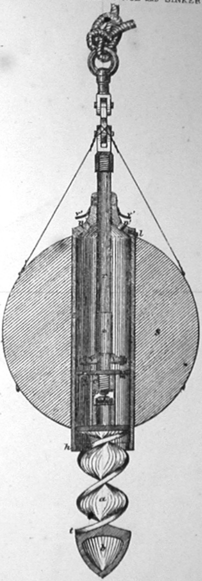
BELKNAP DEEP SEA SOUNDING CYLINDER No. 2
WITH
BROOKE'S DETACHING ROD AND SINKER.



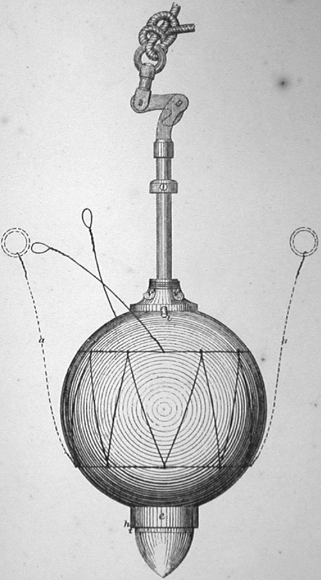
BELKNAP DEEP SEA SOUNDING CYLINDER No. 2
WITH
BROOKE'S DETACHING ROD AND SINKER.



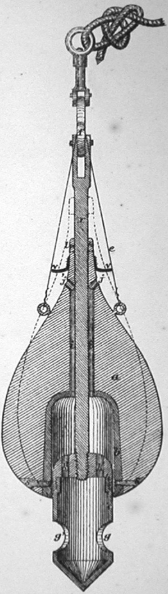
BELKNAP DEEP SEA SOUNDING CYLINDER No. 3
WITH
BROOKE'S DETACHING ROD AND SINKER.



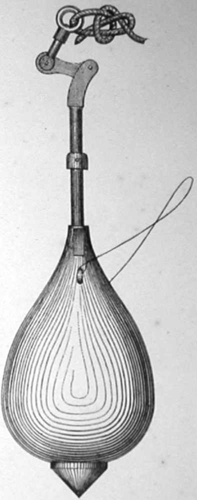
BELKNAP DEEP SEA SOUNDING CYLINDER No. 3
WITH
BROOKE'S DETACHING ROD AND SINKER.



BELKNAP'S COASTING LEAD.



BELKNAP'S COASTING LEAD.



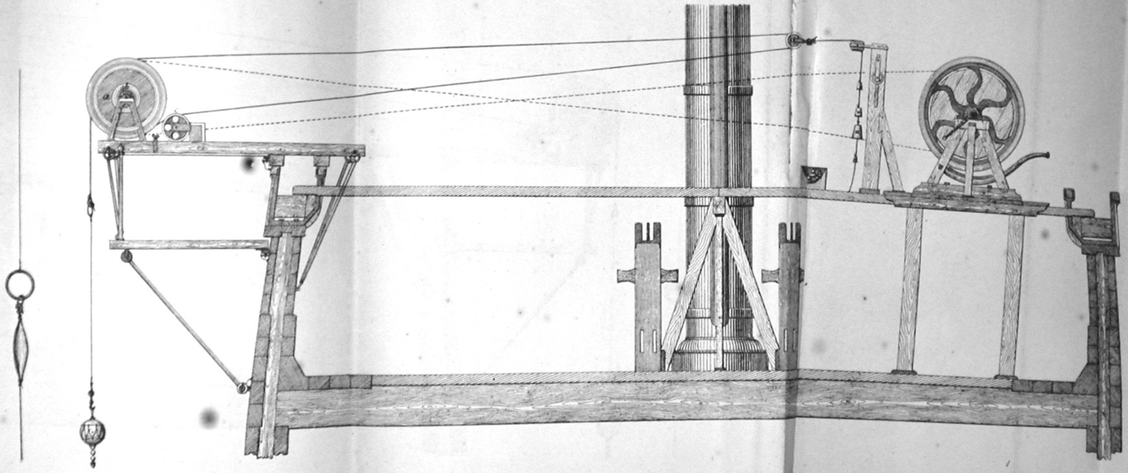
SIDE ELEVATION

OF THE

FLYING BRIDGE OF THE U.S.S. TUSCARORA.

Showing its position and the arrangement for reeling in, using Sir Wm. Thomson's machine and piano wire.

Note. The reeling-in apparatus constructed on board the vessel.



SIDE ELEVATION

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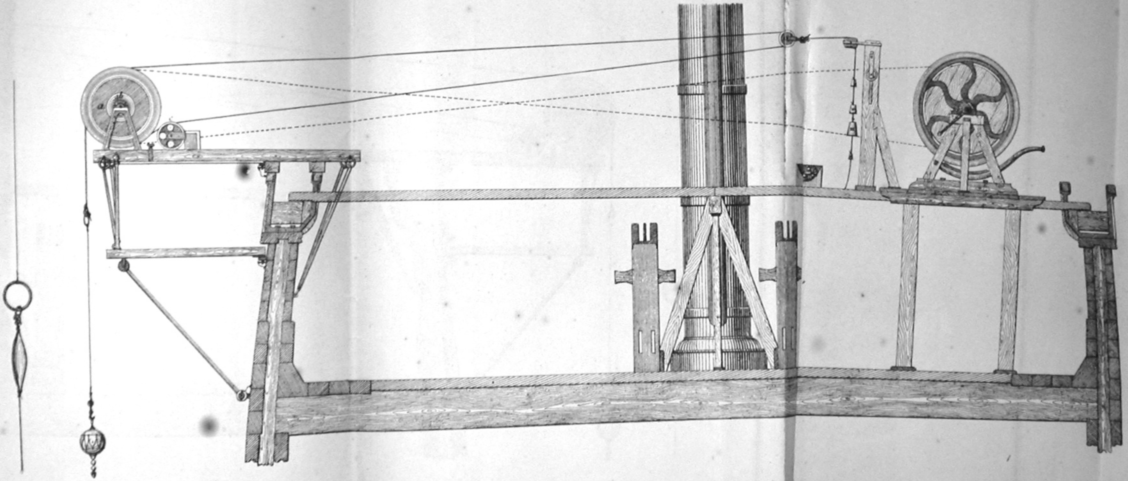


REELING IN APPARATUS DESIGNED AND CONSTRUCTED ON BOARD THE TUSCARORA.

Fig. 1.

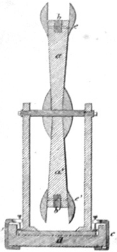


Fig. 2.

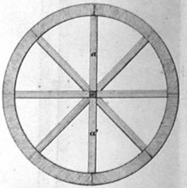


Fig. 3.

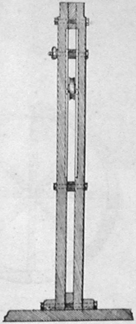
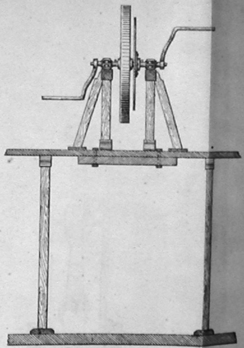
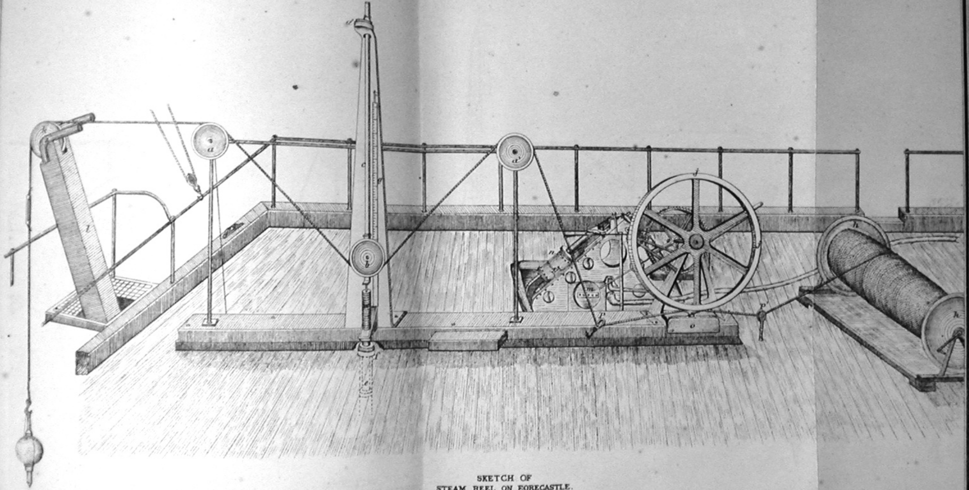


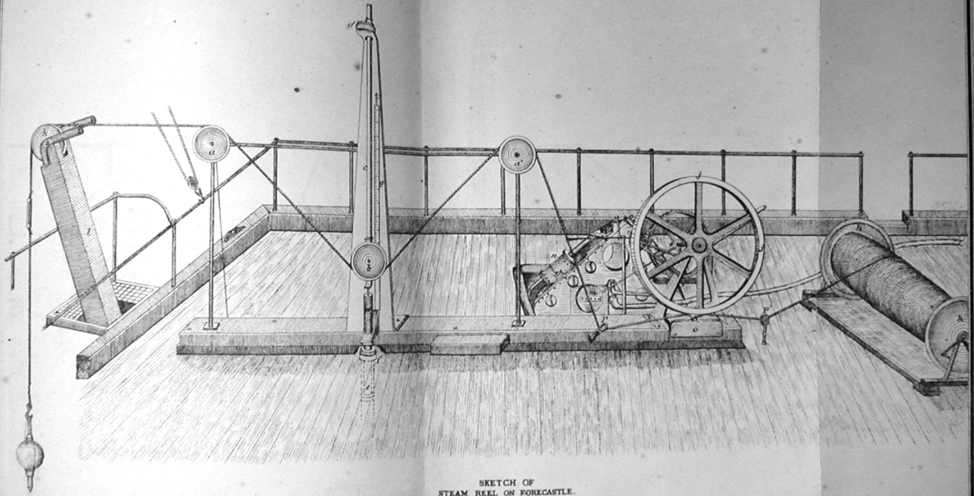
Fig. 4.



Scale ¾ in. = 1 foot.



SKETCH OF
STEAM REEL ON FORECASTLE.
Showing position of large dynamometer with rope.



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