15.—ON THE APPLIANCES FOR COLLECTING PELAGIC ORGANISMS, WITH SPECIAL REFERENCE TO THOSE EMPLOYED BY THE UNITED STATES FISH COMMISSION.

BY COMMANDER Z. L. TANNER, U. S. NAVY.

THE SURFACE TOW NET.

The tow net for collecting minute animal and plant forms from the surface of the sea was among the first devices of the naturalist, and the same apparatus has been used at intermediate depths. The range was formerly confined within narrow limits, generally not exceeding a few fathoms, and even then it was not altogether satisfactory, as specimens would naturally find their way into the net while it was being hauled to the surface, the exact depth of their habitat remaining a mystery.

The rings of surface nets in common use by the Fish Commission are of one-fourth inch brass or iron wire, from 12 to 18 inches in diameter; the nets are generally of silk gauze, although they may be made of cheese cloth or other suitable material. The usual practice is to tow them with a small line either astern or over the side while the vessel moves slowly through the water. Another method has been practiced successfully on board the *Albatross* for ten years, which, in combination with a submarine electric light, has added many new species to our collections.

A ring, slightly heavier than ordinarily used with a surface net, has a shank which is inserted into a staff, usually a bamboo pole of sufficient length. The net is of silk bolting cloth. This device may be used at any time when the vessel is lying without headway, or moving very slowly through the water. Its greatest achievements have been in connection with the electric light. At night, preferably from one to three hours after dark, the vessel lying broadside to the wind and without headway, an ordinary Edison 50-candle incandescent lamp, attached to a properly insulated cable, is lowered from the lee gangway, 6 feet or more from the ship's side, just sufficiently to keep it submerged with the ordinary motions of the vessel. Slow-moving forms which are floating on the surface, collect in large numbers at the water line as the vessel sags slowly to leeward, and more active species gather to feed upon them; as soon as the light is lowered, the latter gather around it, as moths about a candle, sometimes in great swarms, and it is then that the net reaps its richest harvests.

Surface collecting has always been a marked feature in the work of the *Albatross*, and improved methods were sought from the first. The opportunities for this line of investigation, without interfering with other work, were unprecedented, as the net above described could be used whenever the vessel was hove-to for sounding, etc., and the tow net was available from the time the trawl was put over the rail until it was on board again, from half an hour to six or eight hours later. Observing this, it soon occurred to us that something might be done to develop this field of inquiry, and various devices were tried from time to time with greater or less success until, on the 8th of May 1885, the present form of surface tow net, devised by the writer, was first used and became a part of the regular scientific outfit.

IMPROVED SURFACE TOW NET.

The ring is of ⅝-inch galvanized iron, 4 feet 1½ inches in diameter; the net has a ½-inch mesh, thread 24–6 stow, barked, 10 feet in length, same size throughout, and has a pocket of the same material 5 feet in length, which is formed by turning in a portion of the upper end of the net, thus doubling the material for 5 feet from the ring. A small cord is passed around the net between the parts, and is included in the turns of the lashing which secures the net to the ring. There is a drawstring in the lower end of the pocket.

A mosquito-net lining is secured on the lower inside portion of the net, and hangs a foot below it, in order that it may have sufficient slack to insure the outer net taking the strain of towing. An ordinary surface net with 12-inch hoop and a silk-gauze bag, 20 inches in length, is suspended in the mouth of the larger net by four bridles of small stuff secured to the ring; it is intended to collect minute forms that might pass through the coarser material of the large net. A 2½-inch bridle with four legs is secured at equal distance around the ring, and a 3-inch rope hitched through the bight is used for towing.

To prepare the apparatus for collecting: First, lash the lower end of the lining, place it inside of the net and lash the latter; rig out the swinging-boom, reeve the tow rope through a block near its outer end, and bring the hauling part inboard; hitch one end of a small guy rope to the bridle, making the other end fast to the rail. Man the tow rope, attend the guy, lift the net carefully over the rail, keeping the ring in hand, reduce the speed of the vessel to about 2 knots, lower the net carefully into the water by the guy, and haul in the tow line until the ring floats at the desired depth.

The net is taken in by hauling on the guy and slacking the tow line as the ring leaves the water. It is common practice on board the *Albatross* to use two of these nets at the same time, one at each boom, whenever the vessel is engaged solely in surface collecting.

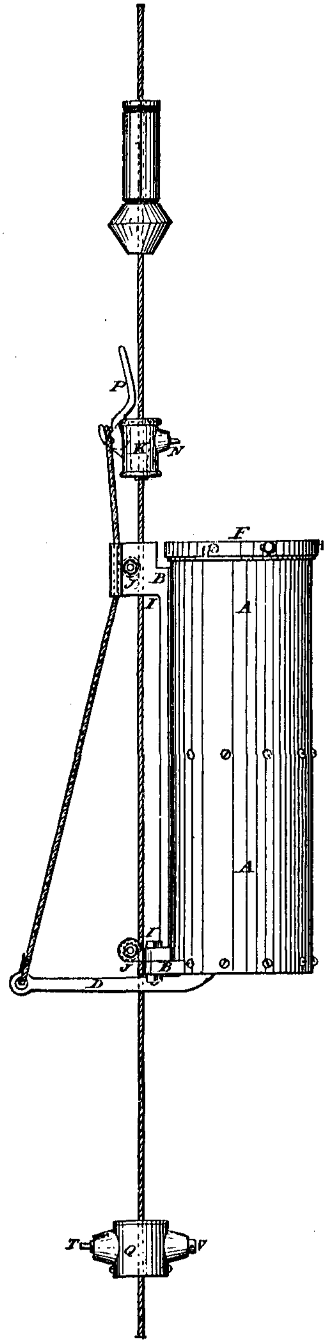
TOW NETS FOR INTERMEDIATE DEPTHS.

The possibilities of a tow net of large size, drawn rapidly through the water for the purpose of taking fish at various depths, were discussed with Prof. Baird in 1882, and, to test the matter, a net was made under the direction of the writer, and used for the first time on May 8, 1883.

The ring was made of 1-inch round iron, and was 10 feet in diameter; the net, 2-inch mesh and 20 feet in length; the bridle had four legs, which were seized at equal distances around the ring, and the steel-wire dredge rope was used as a tow line.

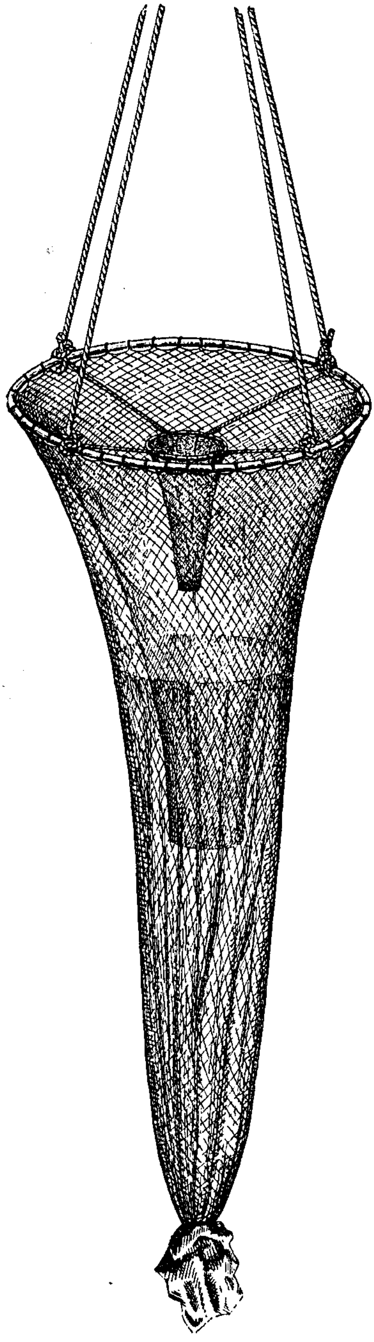
This apparatus was towed at various depths, from surface to bottom, at speeds ranging from 2 to 7 knots per hour, but it failed utterly in so far as the capture of pelagic forms was concerned; any fish which had sufficient celerity of movement to escape a beam trawl would avoid this net. The trouble seemed to arise from its

Fig. 1.



Sigsbee's gravitating trap for obtaining animal forms from intermediate depths.

Fig. 2.



Improved surface tow net.

"firing," for when used at night its track could be distinctly seen several fathoms below the surface. On one occasion, when a school of mackerel was attacked with it on a dark night, we could see the mass separate only a few feet in advance and then promptly close again in its rear, and not one was caught. The school was so dense that it seemed impossible to drag so large a net among them without catching one or two at least; but after an hour or more of towing in every direction at varying speeds from 1 to 8 knots, without the capture of a single specimen, we were impressed with the fact that our latest invention was not a success for mackerel fishing. Slight consolation was afforded us at the reflection that as a crab net it would be immense.

Surface tow nets attached to the dredge rope were used on board the *Challenger* for intermediate collecting, but a knowledge of the depths at which the specimens were secured was still lacking. The same practice was followed on board the *Fish Hawk* until we improved upon it by adopting wing nets, which were attached to each end of the trawl beam, and performed the functions of collectors from surface to bottom, and thence to the surface again. They were like an ordinary tow net with a pocket added. The material was cheese cloth, and being much finer than any portion of the trawl which they accompanied, they usually contained a miscellaneous collection of small forms, many of which would not have been secured by any other method in practice at that time. Of course, we had little knowledge of the depths at which the various forms were secured. Such as were common to both wing net and surface net were, in a general way, assigned to areas within the influence of sunlight, while those found in the wing nets alone were allotted to depths more profound.

SIGSBEE'S GRAVITATING TRAP.

Prof. Alexander Agassiz long felt the need of some reliable method of ascertaining the depth at which specimens were taken, and in 1880 he requested Lieutenant Commander C. D. Sigsbee, U. S. Navy, to coöperate with him in devising the necessary apparatus. Referring to this matter, Sigsbee says (Bulletin of the Museum of Comparative Zoölogy, Cambridge, vol. VI, pp. 155–6):

> It occurred to me that by using an apparatus in connection with a line and lead, paid out vertically as in sounding, and by dragging vertically, instead of horizontally, as formerly, there would be as much certainty with regard to depths as in the old method, and that simple mechanical devices could be invented to satisfy the conditions of the work. * * * Our plan is to trap the specimens by giving to a cylinder, covered with gauze at the upper end and having a flat valve at the lower end, a rapid vertical descent between any two depths as may be desired, the valve during such descent to keep open, but to remain closed during the process of lowering and hauling back with the rope. An idea of what it is intended to effect may be stated briefly thus: Specimens are to be obtained between the intermediate depths A and B, the former being the uppermost. With the apparatus in position, there is at A the cylinder suspended from a friction clamp in such a way that the weight of the cylinder and its frame keeps the valve closed; at B, there is a friction buffer.
>
> Everything being ready, a small weight or messenger is sent down, which on striking the clamp disengages the latter and also the cylinder, when messenger, clamp, and cylinder descend by their own weight to B, with the valve open during the passage. When the cylinder frame strikes the buffer at B, the valve is therefore closed, and is kept closed thereafter by the weight of the messenger, clamp, and cylinder. The friction buffer, which is 4 inches long, may be regulated on board to give as many feet of cushioning as desired. * * It is necessary first, to regulate the buffer, to cushion the stoppage of the falling weights, which are, cylinder and frame, 38 pounds; clamp, 4 pounds; messenger, 8 pounds; total, 50 pounds. The *Blake* adopted a resistance of about 80 pounds (this resistance being, of course, constant during the whole movement of the buffer), it having been found that a blow of that

force resulted in no injury to the apparatus. On the ascent the buffer must withstand not only the weight of the 50 pounds of metal, but also the resistance which the water offers to the passage through it of the several parts of the apparatus. Moreover, when the cylinder emerges from the water it is full of that liquid, and with this increased weight would overcome the stated resistance of the buffer and force the latter downwards until the lead was reached. To meet these conditions it was not thought advisable to increase the resistance of the buffer, which would involve a heavier blow against the apparatus, but a rope-yarn seizing or stop was placed on the rope about 15 or 20 feet below the buffer, beyond which the latter could not pass.

Having secured the buffer to the rope about 5 or 6 fathoms above the lead (a very heavy lead to keep the rope straight) and paid out the length of rope required to span the stratum to be explored by the cylinder, the clamp and cylinder are attached, the latter being suspended from the former as follows: The rope having been placed between the two sliding chocks of the clamp, the arm of the eccentric tumbler is thrown up, which moves the chock M inwards; then, by means of the adjusting screw, the chock L is pressed against the rope, securing the clamp in position. The cylinder hangs 4 or 5 inches below the clamp, and is supported by a loop of soft wire which rests on the lip of the tumbler; the ends of the wire, being run through holes in the upper part of the frame of the cylinder, are fastened permanently to the outer arms of the lever D, to which the valve is screwed. It is seen that by this method of suspension the weight of the cylinder and its frame is used to keep the valve closed while paying out. The cylinder should be filled with water, poured down through the upper sieve, to maintain the valve on its seat while the cylinder is being immersed. Rope is then paid out slowly until the cylinder is at the desired depth, when the rope is stoppered and the messenger sent down. The messenger strikes the arm of the eccentric tumbler, throwing it down and tripping the cylinder. The tumbler in falling relieves the pressure on the sliding chock M, which is then free to recede from the rope.

Messenger, clamp, and cylinder fall together, the valve being held open by the resistance of the water. A current is established through the cylinder, and specimens which enter are retained by the upper sieve. When the buffer is reached, the valve is closed by the pressure against the outer arms of the lever.

A very slight pressure on the adjusting screw of the clamp, after the chocks are bearing on the rope, is enough to prevent the clamp from slipping, but by an increased pressure on the screw a greater force is required to trip the tumbler, and by this feature the arm of the tumbler is utilized to break the force of the blow which the body of the clamp receives from the falling messenger.

A few rings of sheet lead may be laid on the top of the clamp and buffer, respectively.

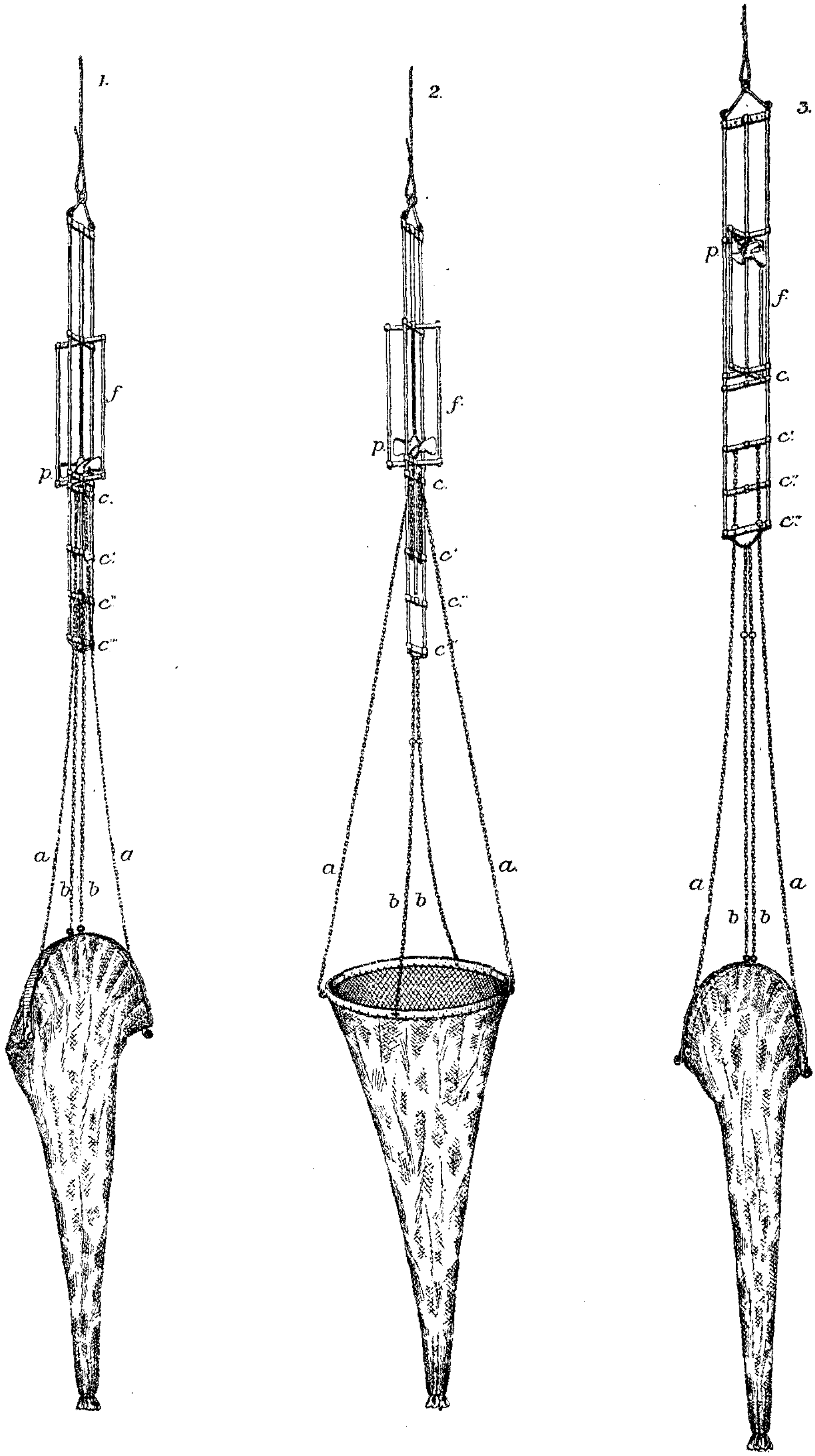
Nomenclature of Sigsbee's Gravitating Trap.

A. Cylinder; copper.	I. I. Loops, or fairleaders.	N. Adjusting screw.
B. Frame; wrought iron.	J. J. Rollers.	P. Eccentric tumbler.
D. Lever.	K. Frame of friction clamp.	X. Messenger.

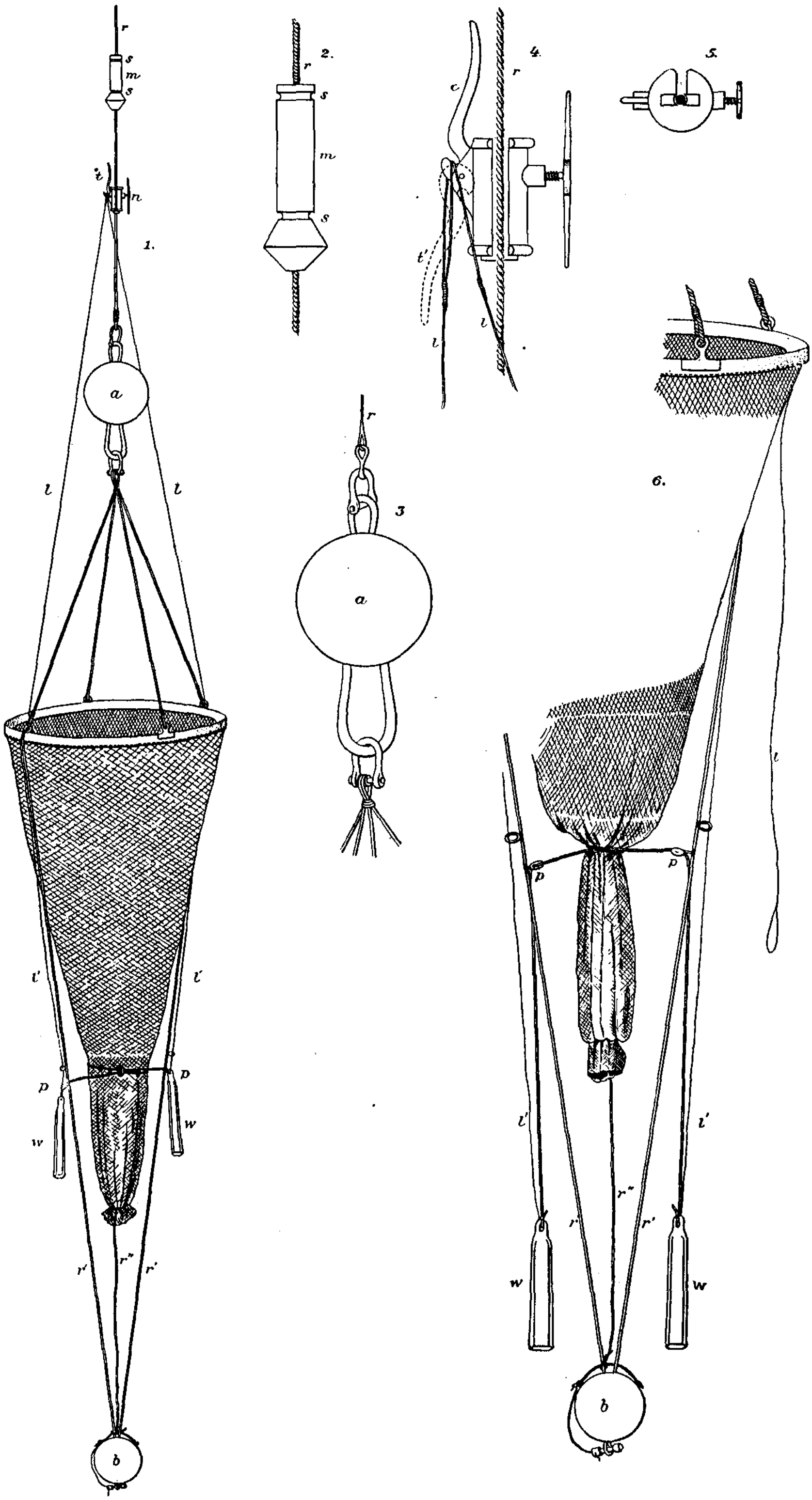
This apparatus was successfully used by Prof. Agassiz on board the *Blake*, but it did not fulfill all the requirements; the strainers were fine-wire sieves, which were somewhat destructive to the more delicate forms, it collected through a vertical area when it was desired to explore horizontally, and its limit of action was strictly confined to the allotted interval on the tow line between the friction-clamp and the buffer. It was the best device of the time, however, and was duly appreciated by Prof. Agassiz.

THE CHUN-PETERSEN INTERMEDIATE TOW NET.

The next apparatus to attract attention was the Chun-Petersen tow net, designed to collect by towing horizontally at known intermediate depths. A slightly modified form of this device was constructed for Prof. Agassiz by D. Ballauf, of Washington, D. C., in 1890, and sent to the *Albatross* early in 1891.



THE CHUN-PETERSEN INTERMEDIATE TOW NET.



THE TANNER INTERMEDIATE TOW NET. FIRST PATTERN.

Describing the apparatus, Agassiz says (Bulletin of the Museum of Comparative Zoölogy, vol. XXIII, No. 1):

Fig. 1 shows the closed net ready to lower; fig. 2, the net opened, ready to tow at the required depth; and fig. 3, the closed net on its way up. *f* is the metal frame protecting the propeller *p*. The propeller shaft extends to the cross bar *c''*, fitting into a socket from which it is relieved after a few turns of the propeller, when the net is first moved horizontally, and liberates the rings of the chain *b* from the bar *c''*, and thus opens the jaws of the net, bringing the strain on the two parts of the chain *a*. As soon as the propeller shaft passes beyond the crossbar *c*, the upper parts of the chain *a* are relieved, and it then becomes the longest, and the strain comes upon the chain *b*, which pulls together and closes the jaws of the net at the termination of the time of towing, and it remains closed until it reaches the surface.

The net was ½-inch mesh, thread 24–6 stow, barked, lined with mosquito-net the entire length, with an inner lining of silk gauze in its lower half.

The apparatus was tested on the 25th of February, 1891, when it was towed near the surface, where every detail of its action could be noted, this precaution having been taken merely as a matter of form, as our confidence in the device was explicit. It was soon apparent, however, that the propeller would not act at all under the low speed required with the fine-mesh net of delicate material needed for our purpose, and, increasing the speed sufficiently to work the propeller properly, the strain on the parts was so great that no dependence could be put upon its uniform action.

THE TANNER INTERMEDIATE TOW NET, FIRST PATTERN.

This element of uncertainty being inherent in the system, we decided to abandon it and seek for some method more direct and positive in its action. I had thought very little of the matter, having perfect faith in the Chun-Petersen device; but, seeing the disappointment of Prof. Agassiz and knowing how important he considered our contemplated exploration of intermedial depths, I set about devising an apparatus for its accomplishment. Taking the ring and net of the Chun-Petersen apparatus, we removed the mosquito-net lining from the upper portion of the latter, and added a bridle having four legs of equal length which were secured around the ring in such a manner that it would remain open at all times.

The steel-wire dredge rope, which served as a tow line, was attached to the bridle by a shackle; the lower bridle has two legs 10 feet in length attached to opposite sides of the ring, and a 60-pound sounding-shot is toggled on the bight at the lower extremity to act as a sinker. The lower end of the net being properly secured, the ends of the lashing are carried down to the sinker and made fast, in order to keep the net in place while going down.

Four small brass rings are secured to the bag, at equal distances, a few inches below the upper edge of the silk-gauze lining, and through them is rove a soft white tie line, which makes a complete round turn, the ends being passed through the same ring, then rove through small metal blocks on the lower bridle, and finally secured to leads weighing 14 pounds each. Two tripping-lines with eyes in their upper extremities are hooked over a friction clamp on the tow rope, then rove through small eyes on the rim of the net, and through brass rings on the lower bridle above the metal blocks before mentioned. The ends being hitched to the leads support their weight, allowing the tie or draw string to hang loosely and the net to retain its natural form while sinking and being towed.

To use the apparatus, prepare it as in fig. 1, plate 11, lower it vertically to the proper point, and tow it slowly through the water, veering and heaving in on the tow line in order to maintain the desired depth, which can be determined within a few fathoms by the dredging quadrant, an instrument in constant use on board the *Albatross.*

To recover it, stop and back until the tow rope is vertical, heaving in sufficient line during the operation to keep the net at the proper depth; then send the messenger down to act on the friction clamp, release the tripping lines, and close the lower part of the net as shown in fig. 6.

The net may be run up to the surface at any desired speed, the upper portion taking in anything it encounters en route, while the lower part remains closed against even the most minute forms.

The messenger is in two parts, which, having been placed around the tow rope, are seized together with marline. It sinks at the rate of about 650 feet per minute, and the impact can usually be distinctly felt by taking hold of the tow line.

This apparatus was used successfully to a depth of 1,700 fathoms, yet I looked upon it as a makeshift; the heavy sinker on the lower bridle caused the net to tow at a considerable angle, thus diminishing the useful area of the ring. An improved form of intermediate tow net was subsequently devised by the writer, in which fully three-fourths of the area of the ring does useful work. The apparatus is simplified, and its action more direct and certain.

THE TANNER INTERMEDIATE TOW NET, IMPROVED PATTERN.

This apparatus is composed of a brass frame carrying a net so arranged with drawstring, movable weights, messenger, friction clamp, and tripping lines, that the lower part can be closed at will. Its construction may be readily understood by reference to plate 12 and the following explanations:

A. A. Ring: brass pipe.
B. B. Arms: brass pipe.
C. C. C. C. Legs: brass pipe.
D. Apron: sheet brass.
E. E. E. E. Apron bolts: brass.
Tees, for arms and legs: brass.
F. F. F. F. Blocks, for drawstring: brass.
G. G. Weights for drawstring: lead.
H. Sinker: cast iron; wrought links.
I. Friction clamp: frame, brass; tumbler, steel.
K. Messenger: cast iron.
L. Wrench: steel.
Net: $\frac{1}{2}$-inch mesh.
First lining: mosquito net (for whole net).
Second lining: silk gauze (for lower half).
Guide-rings: brass.
N. Drawstring: braided cord.
O. Lashing: cod line, cotton.
M. Tripping-lines: codline, cotton or flax

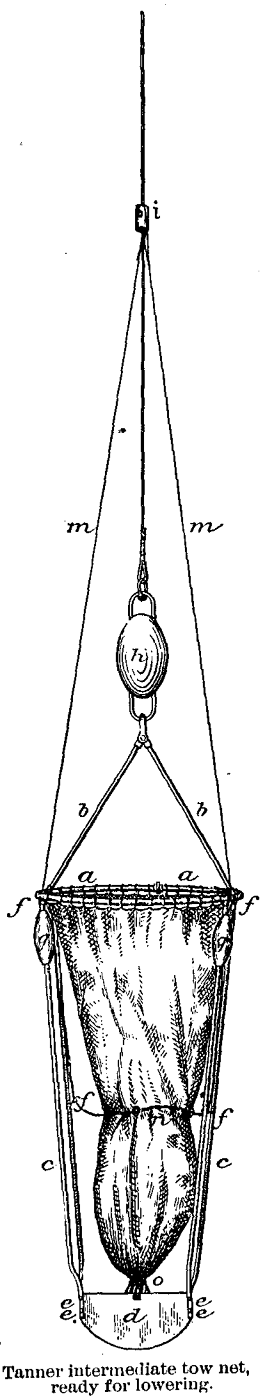
General description.—The ring is 2 feet 5 inches inside diameter, composed of brass pipe $1\frac{1}{16}$ inch outside diameter, bent in a circular form, the ends joined by a union. On the ring are four tees, two on each side, spaced 6 inches apart, and secured in place. The half of the ring opposite the union is filled with lead, which gives it a preponderance of about 10 pounds.

The arms are of brass pipe of the same diameter as the ring; the lower ends are screwed into tees which move freely on the ring between those above mentioned, the upper ends having a hinge joint held in place by the shackle pin.

The legs, four in number, are also of brass pipe, $\frac{13}{16}$ of an inch outside diameter and 5 feet $5\frac{1}{2}$ inches total length, with net length (from lower side of ring to apron) 5

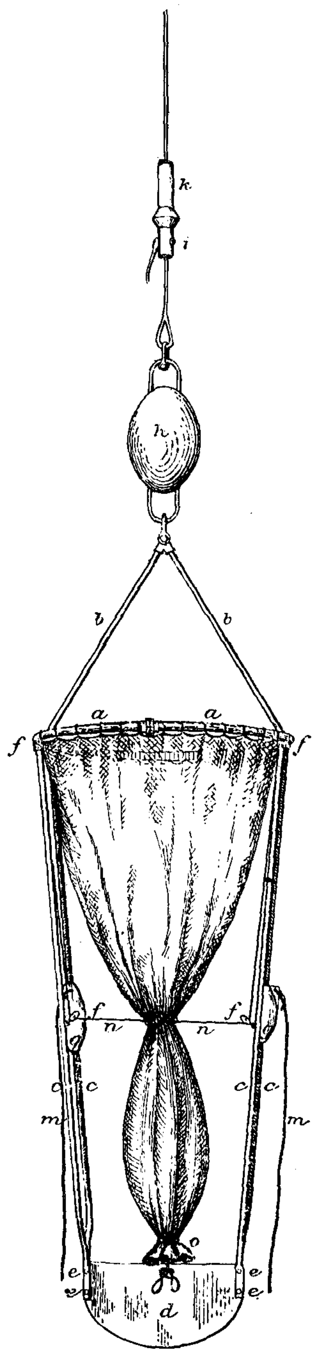
PLATE 12.

Fig. 1.



Tanner intermediate tow net, ready for lowering.

Fig. 2.



Tanner intermediate tow net, ready for hoisting.

THE TANNER INTERMEDIATE TOW NET. IMPROVED PATTERN.

feet. The lap of legs over the apron is 4½ inches, and the upper ends screw 1 inch into their respective tees.

The apron is of sheet brass ⅛ inch thick, 18 inches in length; straight on the upper edge, the lower part semicircular with a radius of 10 inches. It is secured to the flattened extremities of the legs by two screw bolts in each end, $\frac{5}{16}$ inch in diameter and 2¼ inches in length. An oblong hole in the central upper part of the apron is for the purpose of securing the tail of the net, in order to prevent its floating up or becoming entangled while being lowered.

The functions of the apron are threefold: first, to afford rigid and secure fastenings for the lower ends of the legs; second, by its form to aid in guiding the net down vertically when lowering it to the prescribed depth; and finally, to give the apparatus a tendency to take a horizontal position when towing, thus increasing the area of collecting surface within the ring. The weights are all at or near the ring while the net is being lowered and towed, and there is a preponderance of 40 pounds on one side of it, so placed as to cause the apron to expose its flat surface to the water and greatly increase the tendency of the light rear end to seek the level of the more ponderous weighted ring whenever it is moving forward.

Blocks, four in number, for operating the drawstring, are of brass, 1¼ inches in length. Two of them are secured to a pair of legs by through bolts, riveted 2 feet 4 inches above the apron; the others are seized with wire to the tees holding the upper ends of the other pair of legs upon which the movable weights traverse.

The movable weights of lead, two in number and weighing 30 pounds each, are provided to put the required tension on the drawstring when it is desired to close the net. They are egg-shaped, 3 inches in diameter by 7½ inches long, and have an inch hole through the center; ⅜-inch holes in lugs at their upper extremities furnish a convenient method of attaching the drawstring and tripping lines.

The sinker is of cast iron, 130 pounds weight, oblong in form, with projecting links of wrought iron at each end, through which shackles for attaching tow net and dredge rope pass. The sinker is used to facilitate lowering the net, and to prevent kinking the steel dredge rope or tow line.

The friction clamp is composed of brass and steel, the barrel of the former metal, the eccentric tumbler, sliding chocks, striking face, and adjusting screw of the latter. A small steel wrench is provided to work the adjusting screw.

The messenger is of cast iron, 9 pounds in weight, made in halves, with two scores on the external surface for convenience in passing lashings. To use it, pass the halves over the rope and take a few turns of a lashing. The hole in the messenger is sufficiently large to allow it to pass freely over splices in the dredge rope.

The net is half-inch mesh; thread 24–6 stow, barked; it is seized to the ring with seine twine, and hangs 5 feet 6 inches in length, the same size throughout. It is lined with mosquito netting the whole length, and there is an inner lining of silk gauze extending up 3 feet 6 inches from the lower end. The outer net is intended to take the strain in towing, the linings pressing against it on all sides, and acting simply as collectors. The lower end of the net is closed by a cod-line lashing, which includes the outer net and mosquito-net lining, the silk gauze or inner lining being secured separately and placed inside of the others as an additional protection against wear and tear. After the outer net is securely lashed, the ends of the same lashing are taken through the hole in the apron and knotted, leaving about 6 inches slack to allow for closing the net, shrinkage, etc.

Guide rings for drawstring, six in number, of brass $\frac{3}{16}$-inch wire and 1 inch diameter, are secured to the outer net at equal distances around its surface, 2 inches below the drawstring blocks. They are so placed, in order to give sufficient slack in the upper portion of the net to allow it to close without bringing undue tension on the web.

The drawstring, 13 feet long, is a braided cord $\frac{1}{4}$ inch diameter, used to close the net after towing, and before hoisting it to the surface. Cod line or any other material of the proper size would answer the purpose, but the braided cord was selected as less liable to kink while hanging loosely during the process of lowering and towing; it presents a smooth surface to the net, and reduces to a minimum the wear on the web caused by repeated opening, closing, towing, and hoisting.

Tripping lines, two in number, are of cod line, barked, 9 feet 6 inches long, with a 7-inch loop or eye on the upper end. Any material of proper size may be used.

To assemble the apparatus.—The ring being intact, with the arms lying side by side across it, their lower ends attached to their respective tees, raise the arms and shackle the sinker in place. Shackle the tow line, or dredge rope, to the other end of the sinker, and suspend the ring at a convenient height; screw the legs into their respective sockets, which will be recognized by marks of a center punch, thus— ÷ ÷÷ ÷÷÷ ÷÷÷÷; then place the apron in position and secure it by the screw bolts. The movable weights should not be removed from their legs, ÷ and ÷÷÷÷.

Seize the net to the ring, take one turn of the drawstring around the body of the net through the rings, middle it, and take an overhand knot in it; then pass each end outward through a ring, reeve them through the lower blocks, then through the upper blocks, and hitch to the movable weight through the holes in the lugs provided for the purpose.

Hitch the ends of the tripping lines through the other holes in the lugs, place the friction clamp on the rope, slip the loops over the lip of the tumbler, and slide the clamp up the rope until the weights are suspended about 4 inches below the ring; then with the wrench provided for the purpose, tighten the adjusting screw, keeping the tumbler elevated and pressed against the rope until the clamp grips it with sufficient force to hold it in place. Having once ascertained the proper place for the clamp by measurement it can thereafter be secured at the same joint without further attention to the tripping lines, which may be hooked in place and the weights suspended as desired by simply taking in a trifle more or less at the hitch.

The length of tripping lines, 9 feet 6 inches, was intended to give sufficient drift for the weights to close the net even if the tumbler failed to capsize or the loops to unhook from it. A single weight will securely close the net if from any cause the other fails to act.

To use the net.—Having assembled the parts as directed, and attached the tow line, overhaul the drawstring until the net hangs entirely free from stricture; then swing the apparatus out, taking care that it does not come in contact with the ship's side. Bring the vessel to a dead stop, and lower away about 25 fathoms a minute, until the required depth is reached; then move slowly ahead, veering gently on the tow rope until enough has been paid out to maintain the net at the proper depth. This can be done with sufficient accuracy by observing the angle of the tow line from the vertical, and, after making allowance for the catenary, using the angle and length of rope out as the hypothenuse of a right-angle triangle, the depth representing the perpendicular. If the triangle is complete and the net towing from 1 to $1\frac{1}{2}$ knots an hour, nothing more is required, but, should it be towing too high, more rope or less speed will be requisite; if below the depth, less tow line or an increase of speed will soon bring it up.

The practice on board the *Albatross* is to observe the angle of rope constantly, using a dredging quadrant designed for that purpose, thus regulating the speed and resultant angle, the data for the construction of the triangle being obtained from the traverse tables in Bowditch's *Navigation.*

Having towed the net a sufficient length of time, the engines are stopped and the rope reeled in, backing slowly, if desired, to keep the net at its proper depth. When the line is vertical and the vessel at a standstill, send the messenger down to reverse the eccentric tumbler, release the movable weights and close the lower half of the net. The impact of the messenger on the friction clamp can be felt by grasping the tow rope, but this method is not always reliable below 300 fathoms; a safe practice is to time the descent of the messenger for greater depths, allowing about 50 seconds for each 100 fathoms.

Having closed the lower bag, steam slowly ahead and reel in at the rate of 25 fathoms a minute until the net is on board. The upper portion from the mouth to the drawstring remaining open, will usually be found to contain an assortment of specimens collected on the way up.

A few turns of a lashing should be taken around the net immediately below the drawstring, as soon as possible after the apparatus reaches the deck and while it is hanging vertically by the tow rope, to avoid the possibility of opening communication with upper and lower compartments by the accidental slackening of the drawstring. This done, the frame should be lowered gently on deck, the lashing removed from the tail of the net and the parts turned back, leaving the inner or silk gauze lining exposed; remove its lashing, carefully open the bag over a pan of prepared sea water which has been carefully strained to remove any surface forms it might have contained, and finally rinse the net in it to remove minute specimens adhering to its sides or lodged in the numerous folds.

The contents of the lower bag secured, the drawstring is removed, the upper bag turned inside out into a tub of water, and the specimens secured by thorough rinsing, after which the lashing is taken off and the net carefully washed, usually by towing a few minutes if the vessel should be moving slowly through the water; otherwise by washing and repeated rinsings until all trace of life is destroyed. The last rinsing should be in fresh water, and the frame should be wiped off to prevent oxidation.

If the apparatus is to be stowed away, remove the apron, unscrew the legs, hang the ring with net attached in a convenient place to dry. The tripping lines and the drawstring should be hitched to arms or ring and dried. When ready to store, reeve the drawstring in place, roll the net up snugly, and stop it with the ends of the drawstring; remove the shackle pin and fold the arms across the ring, using the tripping lines to hold them in place and to confine the net as far as possible within the ring, thus making a snug and convenient package to handle or store.