

OCEAN BOTTOM SAMPLER FOR SHIPS UNDER WAY.

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ABSTRACT.

A simple bottom sampler has been developed which may be used from ships under way at speeds up to 12 knots. The sampler is allowed to fall freely under its own weight, and is recovered by reeling in a wire attached to the front. An open tube at the front will obtain about $\frac{1}{2}$ pint of surface material from mud, sand, gravel, or coral bottoms. Existing models have been used in depths to 300 fathoms. At a speed of 8 knots, using a winch a $\frac{3}{4}$ h-p. motor, one man can take a sample in 3 minutes in 10 fathoms of water, and in 8 minutes in 100 fathoms.

Models have been built with trap doors to close the tube after taking the sample, and to allow the water in the tube to escape when the sample is taken. These have been discarded as the improvement in the samples was negligible. The sampler can be easily combined with free-falling hydrographic instruments, such as the bathythermograph.

Operation under way improves the ease and accuracy with which the position of a sample may be fixed as the ship can maintain its speed and course. It greatly increases the area covered and the number of samples taken in a given time.

INTRODUCTION.

Bottom samples have been used for many years as aids to navigation, and in marine biological investigations. During the past 30 years, the increasing use of sonic and supersonic instruments for sounding and echo ranging has created a demand for bottom-sediment charts to correlate observed variations with bottom materials. More recently, geochemical and sedimentation studies have created a further demand for samples of the ocean floor.

The oldest and simplest equipment for bottom sampling is the sounding lead armed with tallow or grease. This can be used under way at slow speeds, but has many obvious disadvantages. To obtain better bottom samples, dredges and *coring tubes* have been used (1). (Reference 1 has a good survey of all types). These devices require that the ship be stopped, which slows down the work and greatly reduces the precision with which locations may be fixed. The sampler described here can be used while the ship is under way, and will obtain samples of mud, sand, gravel, or coral bottoms, satisfactory for most investigations.

CONSTRUCTION OF SAMPLER.

The bottom sampler (Fig. 1) consists of a sample tube, a body weight, a body extension member, and tail fins. The sample tube is made of brass or steel tubing, round or square, about 10 inches long, and 2 inches in diameter. The free length inside the tubing of these dimensions must be greater than 6 inches in order to retain the sample; but lengths greater than 8 inches show no improvement in the size of the sample or the ability to retain it. The sample tube forms the nose of the instrument. About 2 inches of the tube overlap on the body weight and are fastened to it with a simple screw or bayonet connection for convenience in cleaning.

The body weight is a bar of brass or steel, 12 to 15 inches long, with a suitable eye for a cable attachment just behind the sampler tube. The body extension member is made of tubing similar to the sample tube, about 10 inches long, and is attached

(1) Jack HOUH, "Bottom Sampling Apparatus", Recent Marine Sediments, A Symposium (Tulsa, Oklahoma: A. A. P. G., 1939), pp. 631-664.

to the rear end of the body weight. Four tail fins, each with an area of 16 to 20 square inches, are attached in a cross shape at the rear of the body-extension member.

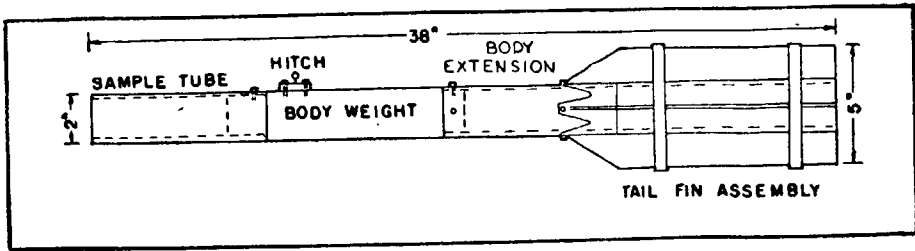


FIG. 1.

Underway bottom sampler.

With this arrangement of parts, the sample tube strikes bottom first when the instrument falls freely; but is uppermost while the sampler is being recovered.

The first samplers were built with a shear pin at the forward cable attachment, and a permanent attachment at the tail to facilitate recovery of the sampler if fouled on the bottom. This precaution proved unnecessary and has been abandoned.

OPERATION.

Free-fall method.

The operation of the sampler (Fig. 2) is an adaptation of a method first successfully used by Ewing and Vine in 1940 for bathythermograph observations from ships under way. The sampler is allowed to fall freely in the water, and the wire is paid out as required by the fall of the sample and the movement of the ship. When the sampler strikes bottom, the wire becomes slack. The winch brake is then applied and the sampler quickly rises to its equilibrium level close to the surface, which is determined by the speed of the ship, the amount of wire paid out, and the weight and drag coefficients of the wire and sampler. The strain of the wire from the sudden application of the brake is not excessive, due to the shock-absorbing action of the large curve of the wire. Shortly after the main strain has passed, the winch clutch is engaged and the instrument recovered. The principal force to be overcome in recovering the instrument is the drag of the wire, so it is desirable to use the smallest wire possible. For instruments weighing 25 pounds or less, and wire lengths up to 2,000 feet, 1/16-inch 7×7 —strand stainless steel airplane control cord, with a breaking strength of 900 pounds, is used.

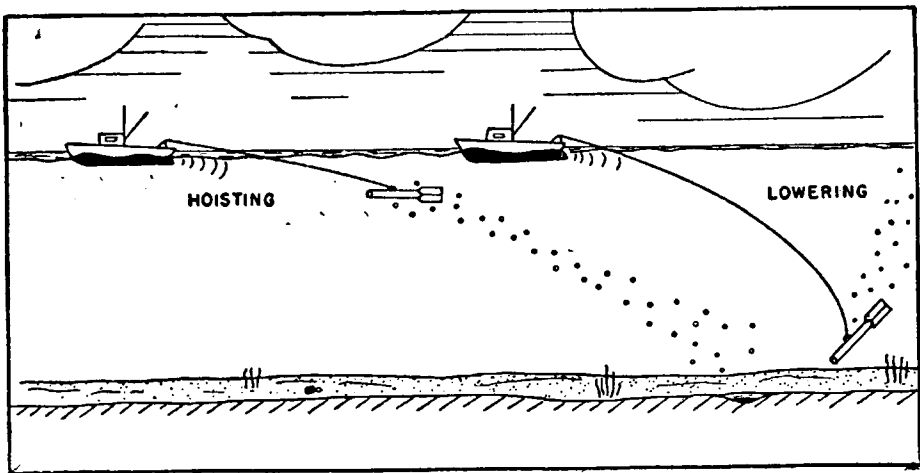


FIG. 2.

Method of taking bottom sample.

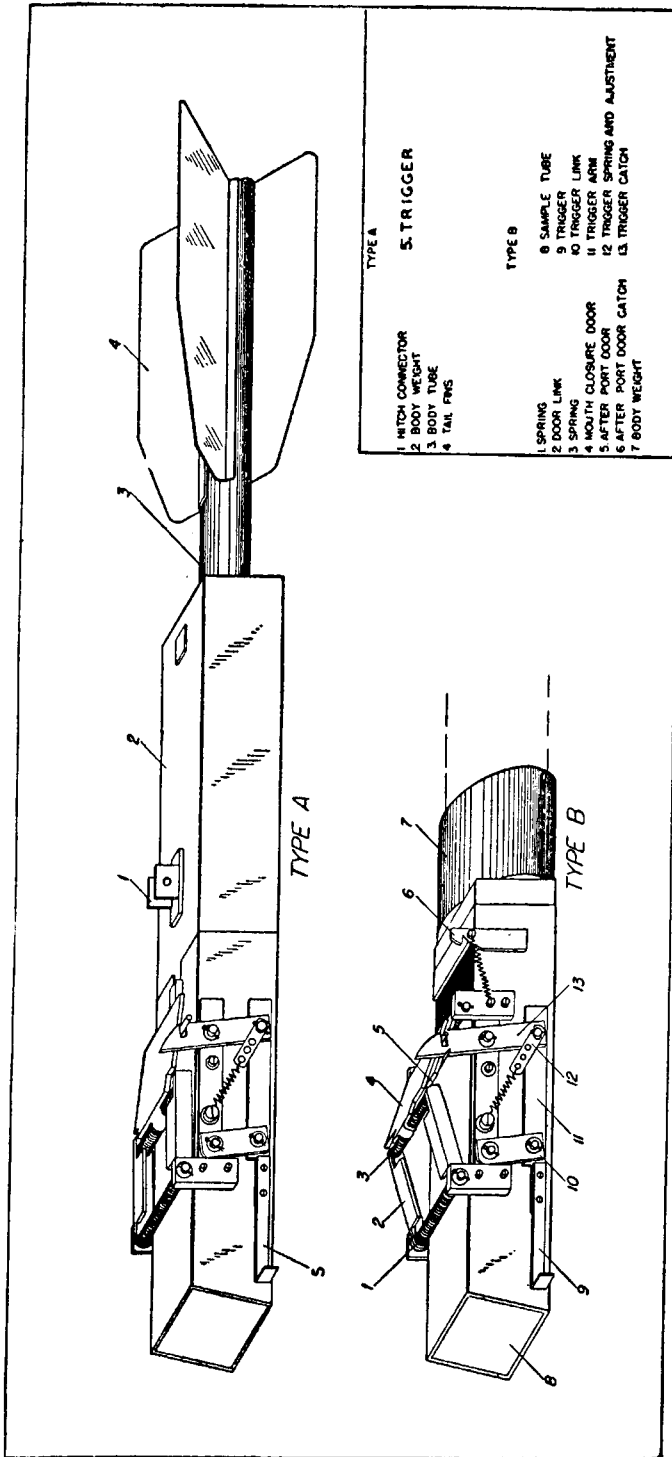


FIG. 3.

Design details of two types of bottom samplers.

Electric winch.

A small electric winch is used, with a $3/4$ h-p. motor for intermittent, and a $1\ 1/2$ h-p. motor for continuous operation. These are stock 1,600 r.p.m. motors, geared down, using one countershaft, by a 12-to-1 ratio, so that the winch drum turns at 133 r.p.m. The drum is brass, base diameter 10 inches, width 4 inches, and flange width 2 inches. Brake and clutch on the same lever, the brake at one extreme, the clutch at the other; on center the clutch is disengaged and only the drum shaft turns as the cable pays out. A counter is attached to the drum shaft to determine the amount of cable paid out at any time.

MODIFICATIONS.

Trap-door models.

A sampler has been made with a trap door over the end of the tube to prevent washing of the sample. The door is closed on contact of a trigger with bottom (Fig. 3, Type A). Qualitative comparisons of samples taken in the same area with open-ended and trap-door models show no discernible difference. No quantitative comparisons have been made.

Another model has two trap doors (Fig. 3, Type B), one in the nose and one at an opening in the back end of the sample tube, to allow the water in the tube to escape freely when the sample is taken. No appreciable gain in sample size is observed.

Trap-door models have an advantage in rough weather. If the boat rolls as the instrument is brought out of the water, the tail fins may contact the water again, and the sampler may slip over. An open-mouthed model will then usually lose the sample, while a trap-door model will retain it. This loss can, however, largely be avoided by skilful operation of the winch. The advantages of trap-door models are not sufficient to justify their complicated construction, and the open-ended sampler has been adopted as the standard model.

Combination with hydrographic instruments.

Hydrographic instruments operating on the free-fall principle can easily be adapted to take bottom samples, provided their operation is not impaired by the jar of contact with bottom. For example, the bathythermograph, developed by Ewing and Vine, which gives a continuous record of temperature versus depth, was made to take bottom samples by the addition of an open tube on the nose. No damage to the temperature or depth-recording mechanism has been observed. Samplers have also been built with a depth-recording gauge in the body tube which automatically gives the depth at which a sample is taken.

CONCLUSIONS.

The samplers described above have been used in water depths to 300 fathoms. Heavier instruments can be designed, and operation in depths of the order of 1,500 fathoms is reasonable. Samples of mud, sand, gravel, and coral have been taken, varying in size from about two pints for soft mud to a tablespoon for coarse gravel; the average size is about $1/2$ pint. Fresh chips of rock have also been recovered.

The only losses of instruments to date were caused by the ship's propeller cutting the wire as a result of poor communication between observer and ship's officers, not of the ordinary yawing of the ship. No samplers have yet been lost by fouling on bottom.

Samples can be taken at speeds from 0 to 12 knots. At a speed of 8 knots, one man can take samples at 3-minute intervals in 10 fathoms of water, and at 8-minute intervals in 100 fathoms. The position of a sample can be located as accurately as the navigation of the vessel permits. Rapid reconnaissance or closely spaced surveys may be made. A recent survey was made with the sampler in one-fifth the time necessary for similar work with dredges, snappers, and coring devices.

