The *Journal of Marine Research*, one of the oldest journals in American marine science, published important peer-reviewed original research on a broad array of topics in physical, biological, and chemical oceanography vital to the academic oceanographic community in the long and rich tradition of the Sears Foundation for Marine Research at Yale University.

An archive of all issues from 1937 to 2021 (Volume 1–79) are available through EliScholar, a digital platform for scholarly publishing provided by Yale University Library at https://elischolar.library.yale.edu/.

Requests for permission to clear rights for use of this content should be directed to the authors, their estates, or other representatives. The *Journal of Marine Research* has no contact information beyond the affiliations listed in the published articles. We ask that you provide attribution to the *Journal of Marine Research*.

Yale University provides access to these materials for educational and research purposes only. Copyright or other proprietary rights to content contained in this document may be held by individuals or entities other than, or in addition to, Yale University. You are solely responsible for determining the ownership of the copyright, and for obtaining permission for your intended use. Yale University makes no warranty that your distribution, reproduction, or other use of these materials will not infringe the rights of third parties.

This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. https://creativecommons.org/licenses/by-nc-sa/4.0/
A New Internal Curved-Gate Core Retainer

John E. Sanders
Department of Geology
Yale University

ABSTRACT

The new type of core retainer described here uses two internal curved gates cut from cylindrical sections. The radius of curvature of the gates is identical to the inside diameter of the sampling tube. Small levers connect from gates to an external sliding sleeve that moves up and down on the outside of the cutting head attachment. The external sleeve remains in its up-position during penetration and the internal curve gates are held open. Because these gates are countersunk, they do not in any way obstruct the entry of sediment into the tube. During extraction, the external sleeve is forced into its down-position; it thereby closes the two internal curved gates, which assume the form of a vaulted arch and seal the end of the tube.

Introduction. The problem of collecting core samples of firmly packed sands under water involves two special difficulties: (1) Penetration. Any tube that is driven into the sand by a steady force or by a series of repeated blows in the same direction without intervening relief increases the packing pressure between grains owing to the incompressibility of the individual grains. Increased packing pressure ultimately causes refusal. (2) Retention. Sand grains and their interstitial water behave as a fluid and tend to drain out of the sampling tube. Without a suitable core retainer, loss generally occurs as the hydrostatic pressure at the lower end of the tube increases from the weight of the ever-lengthening column of sample and from water in air when the tube is raised above the water level to the deck of the ship.

Up-and-down directional vibration of the sampling tube eliminates the build-up of packing pressure. This technique has already been successfully applied by Soviet investigators (Sanders, 1960).

The internal curved gate core retainer here described eliminates sample loss, in all grades of sand.

1 Supported by Contract Nonr 609(40) between Geography Branch, Office of Naval Research, and Department of Geology, Yale University.
The purpose of this paper is to describe this new core retainer and to comment on the design problems that were encountered during its early use and subsequent modification.

*Description.* The internal curved-gate core retainer consists of five essential elements: (1) mounting and attachment housing, (2) external sliding sleeve, (3) internal curved closing gates, (4) connecting levers, and (5) cutting head.
When fully assembled, the unit consists of only two components: (1) the core-retainer housing, which is attached to the lower end of the steel sampling tube by threads and a set screw, and (2) the cutting head, which screws onto the lower end of the core-retainer housing. Figures 1 and 2 show drawings of the unit. Specially designed wrenches facilitate threading and unthreading.

1. Mounting and Attachment Housing. The mounting and attachment housing, which joins the core retainer to the lower end of the sampling tube, provides a platform for the plastic core liner that fits inside the steel sampling tube and houses the moving parts of the gate-closing apparatus.

The inside wall is recessed to permit the gates to be countersunk. Packing of sediment around the gates is prevented by beveling sharp corners. A projecting pin on each side externally accommodates a groove in the external slid-
ing sleeve to prevent rotation of this sleeve, since such rotation would bind the levers and inhibit their easy action.

2. EXTERNAL SLIDING SLEEVE. The external sliding sleeve opens and closes the internal curved gates by its up-and-down motion. Its movements are controlled in two ways: (1) Rotation is prevented by fitting the groove-and-pin arrangement just described, and (2) up-and-down motion is limited by raised circular stop ledges on the outer wall of the housing unit and cutting head, respectively.

The raised circular stops permit the external sleeve and walls of the core-retainer housing to absorb the frictional and impact stresses which arise during penetration and extraction; they also prevent such stresses from being transferred by the sleeve to the connecting levers or to the internal curved closing gates.

The lower edge of the external sliding sleeve is beveled so that the beveled edge acts like a plow and dislodges any thin layer of sediment that may have adhered to the small recessed space ahead of it. Also, the lower stop is made as narrow as possible (0.017 in.). The upper edge of the sliding sleeve should not be beveled, because greater width of the upper stop is needed to provide extra bearing area for the strength needed during penetration. The upper edge of the external sleeve is pressed firmly against the upper stop during penetration so that no recessed space is available for the packing of sediment.

3. INTERNAL CURVED CLOSING GATES. The two internal curved closing gates, which represent the new principle of this core catcher, are cut from a cylinder whose inside diameter is the same as that of the liner tube inside the steel sampling tube; they are machined so that they form a tight junction when their edges are in contact, and they must be shaped so that they completely fill the orifice of the sampling tube when closed. Each gate resembles a vaulted arch. When properly mounted in their recessed housings, the gates do not interfere with entry of the sample, nor do they mark or scratch it in any way.

Each gate requires a small pivoting arm which is soldered to the outside in line with the radius of curvature of the gate. This arm not only permits the gates to move toward each other as they close but allows particles to pass through rather than jam the gates open. An alternative method of mounting the gates would be by pins at their pointed ends, a method commonly used in open-close type ash trays. The pinned-end type of mounting is too susceptible to jamming to be of much use in a successful core retainer.

The distinct advantage of the internal curved-gate core retainer over most other types of internal core retainers is that the curved-gate type here described does not rely on frictional drag against the sample to activate closing. The upward motion of the external sliding sleeve forces the curved gates together.
4. **Connecting Levers.** A connecting lever extends from the external sliding sleeve to the arm on each internal curved gate. These two levers transmit the movement from external sliding sleeve to the gates.

5. **Cutting Head.** The cutting head is beveled both exteriorly and interiorly in order to facilitate penetration. It is also cut with a small circular stop which limits the downward movement of the external sliding sleeve during extraction.

**Remarks.** Although it has been especially designed for use on a vibro-activated sampling tube, this new core retainer appears to be suitable for any type of sediment-collecting tube, including Kullenberg piston core samplers (Kullenberg, 1947). The cutting head, external sliding sleeve, and mounting and attachment housing can easily be made strong enough to withstand the impact that occurs on the lower end of a heavily weighted free-fall tube. The curved closing gates are fully recessed so that they do not disturb or mark the entering sample. The closing action of the internal closed gates does not in the least depend on friction between sample and gates; it is entirely activated by the downward movement of the external sliding sleeve. The device does not work in soft mud because the mud between the curved gates requires more force to cut than is exerted on the external sliding sleeve.

Two other types of curved-gate retainers have been developed: (1) The single curved gate type invented by Kullenberg (1947), and (2) the spring-activated, flexible-gate type invented in the Soviet Union (see Acknowledgements).

The Kullenberg model relies on frictional drag. The entering sample holds it open and downward movement of a sample trying to escape is supposed to close it.

The Soviet spring-activated model inspired the present type. The gates of this core-retainer are made of thin, flexible bronze sheets. The gates are plane when closed but bend to fit the interior curvature of the sampling tube when they are open. The powerful closing spring is compressed when the gate is open. Levers to the outside activate the spring catch; upward movement of the sampling tube releases the spring catch and the spring snaps the gates closed. The spring-activated, flexible-gate core retainer is an excellent general-purpose model which works in mud as well as in sand. The strength of the gates is limited, however. If this type is to be used with a vibrating coring tube, then the movement required to release the spring must be greater than the amplitude of vibration of the tube, or else the gates may close prematurely.

**Conclusion.** The curved-gate core retainer here described operates on a new principle: an external sliding sleeve opens and closes the gates. In its up-position, the sleeve holds the internal curved gates open; during movement
to its down-position, this sleeve closes the curved gates. When open, the curved closing gates are completely free of the entering sample; when closed, they seal the open end of the sampling tube and prevent escape of the sample. The device has been tested successfully in two field operations, and in its present form it seems to provide an effective and reliable means of circumventing the loss of sandy sediment from the lower ends of sampling tubes.

Acknowledgments. I am grateful to Drs. John M. Zeigler and William D. Atherearn, of the Woods Hole Oceanographic Institution, for showing me the Woods Hole model of the Russian spring-loaded core retainer, and for supplying shop drawings of it. I am enormously indebted to Mr. Adrian A. Disco, Superintendent, and to Anthony Massini and Donald A. Johnson, Machinists, of the Yale University Physics Department machine shop, for their skill and ingenuity in designing and building the first model and in making subsequent modifications of it as directed by the writer on the basis of its performance in field tests.

Mr. Fred E. Walters, Office of Naval Research, New York, arranged for use of the U.S.S. COATES, Destroyer Escort 685, for an underwater field test of the vibro-activated core sampler and internal curved-gate core retainer in May 1961. Lt. Frederic Jonasz, Commanding Officer of the COATES, and the officers and men of the ship’s complement, were very cooperative and helpful during the planning and execution of the underwater field test.

I also wish to thank Dr. Vaughan T. Bowen of the Woods Hole Oceanographic Institution and Dr. Robert G. Paquette of The Department of Oceanography, University of Washington, Seattle, for their constructive criticisms of the manuscript.

REFERENCES

KULLENBERG, B.

SANDERS, J. E.