

[54] **EXPENDABLE CORE NOSE AND CORE CATCHER RETAINER**

[75] Inventors: **Richard T. Bachman**, La Mesa;
Lawrence R. O'Mara, San Diego,
both of Calif.

[73] Assignee: **The United States of America as
represented by the Secretary of the
Navy**, Washington, D.C.

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[58] Field of Search **175/5, 6, 20, 22, 58, 243,
175/251, 253, 254, 255, 232, 236**

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Primary Examiner—David H. Brown

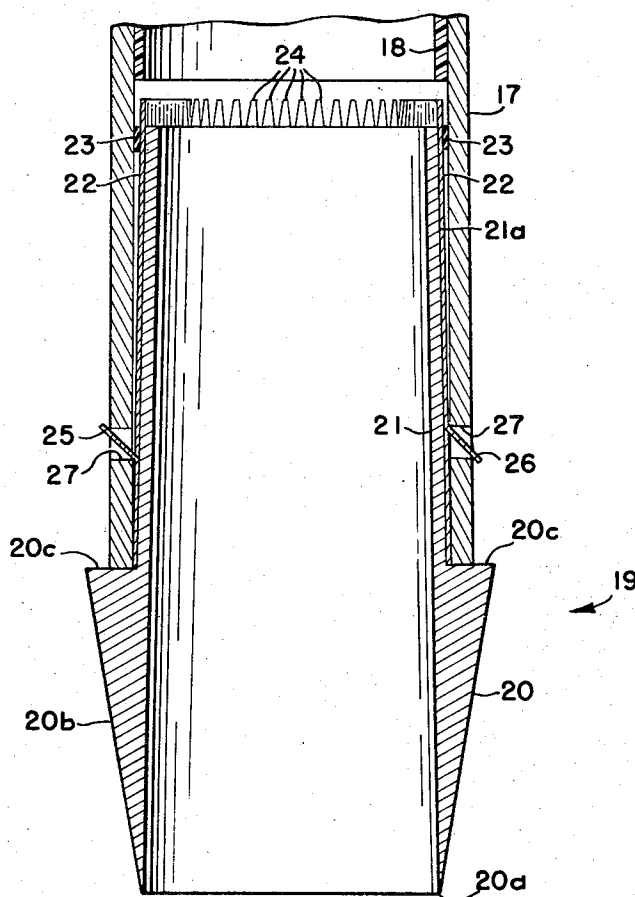
Attorney, Agent, or Firm—Richard S. Sciascia; Ervin
F. Johnston; Thomas Glenn Keough

[57]

ABSTRACT

An improved corer for taking a core sample of marine sediment is dropped onto and embedded in the ocean floor. During penetration, a core sample fills an elongate barrel member. As the corer is withdrawn, a tapered corer nose remains in the sediment while the elongate barrel member is pulled free. Simultaneously, a cylindrically shaped array of flexible fingers are drawn together by an elastic band to retain the core sample inside the barrel member. Since the flexible fingers are held outside of the path of the core sample as it enters the barrel member, there is no disturbance or commingling of the different layers of the core sample when it is being taken. A one-way valve and the flexible fingers cooperate to retain the intact core sample while it is being lifted to the surface to provide an undisturbed specimen for later study by marine geologists and oceanographers.

10 Claims, 5 Drawing Figures



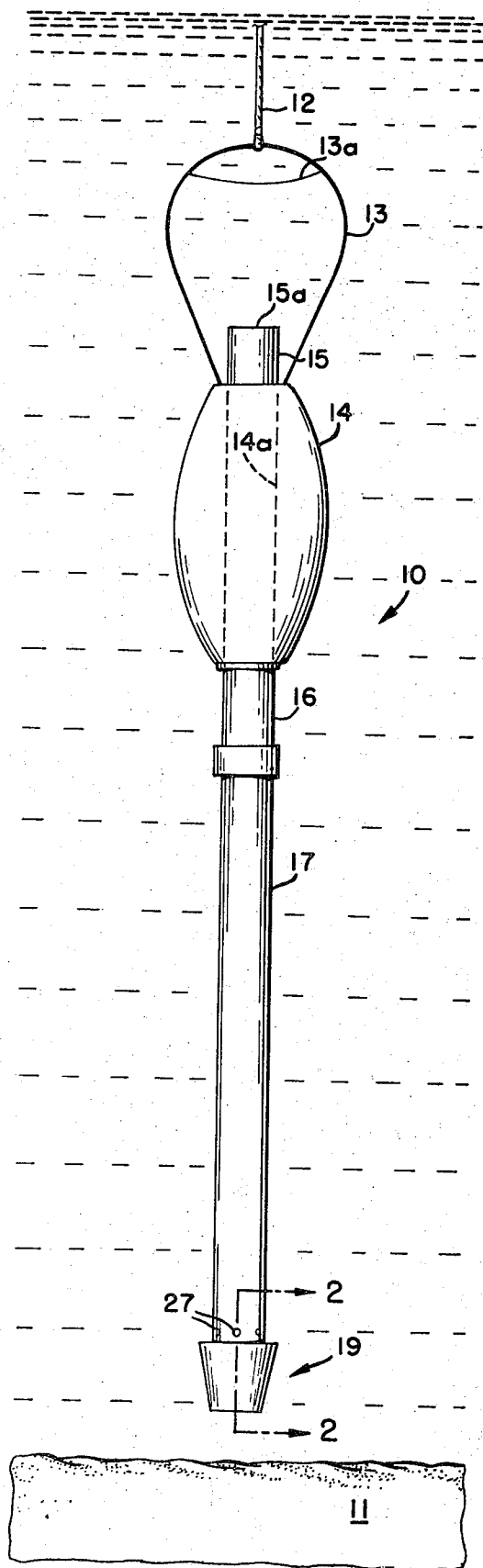


FIG. 1

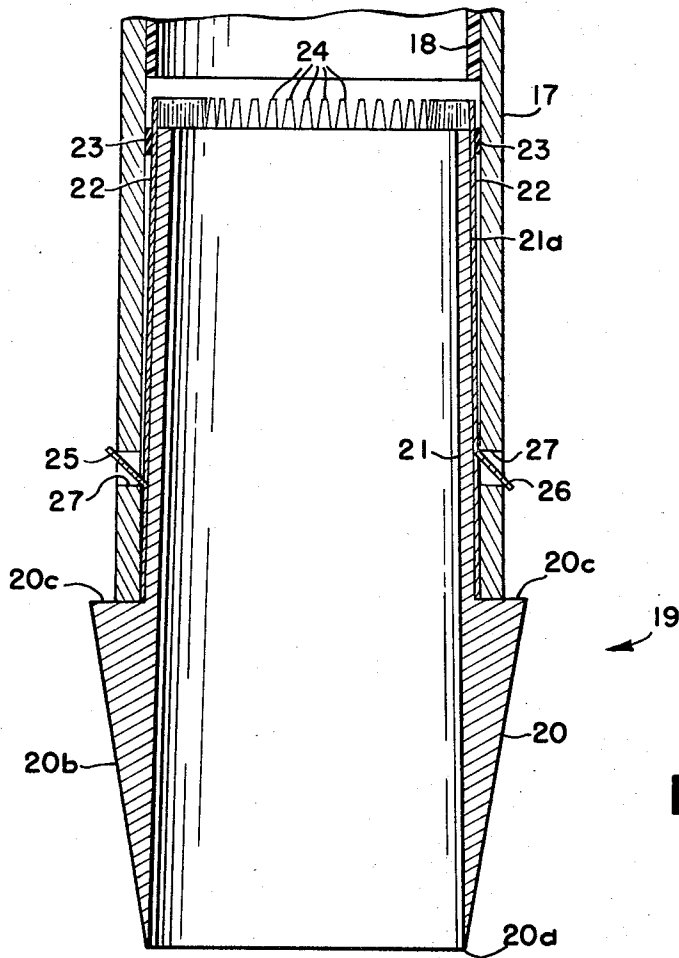


FIG. 2

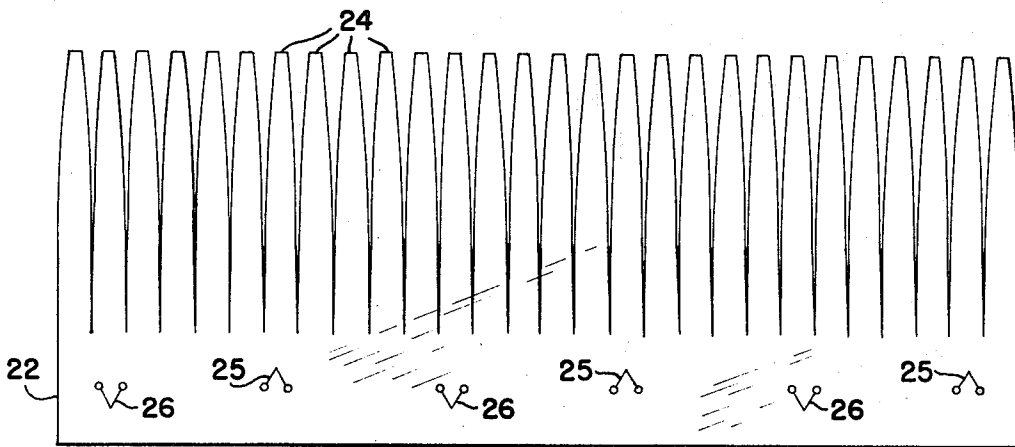
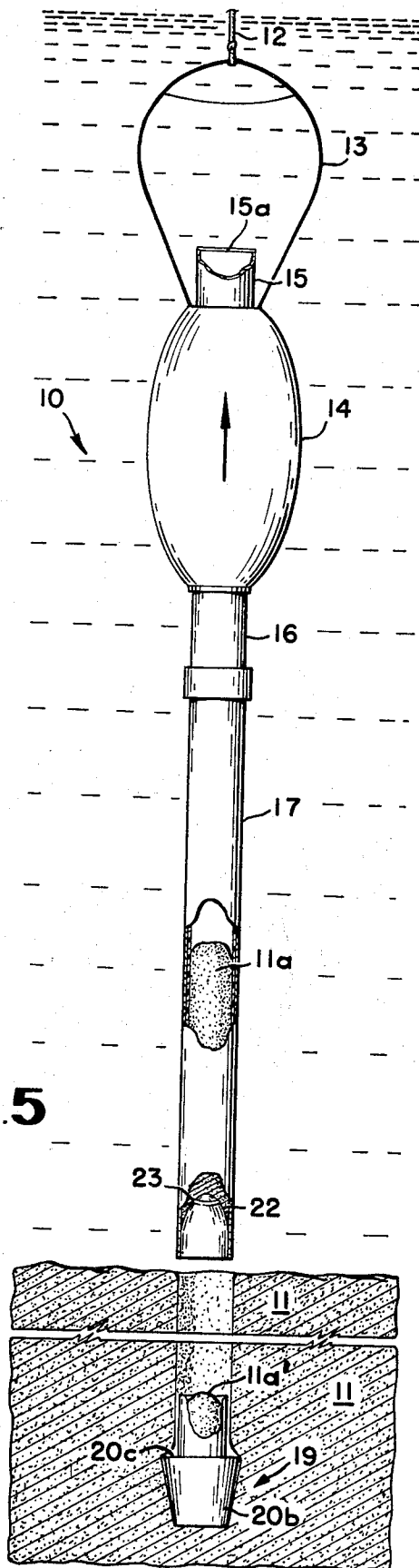
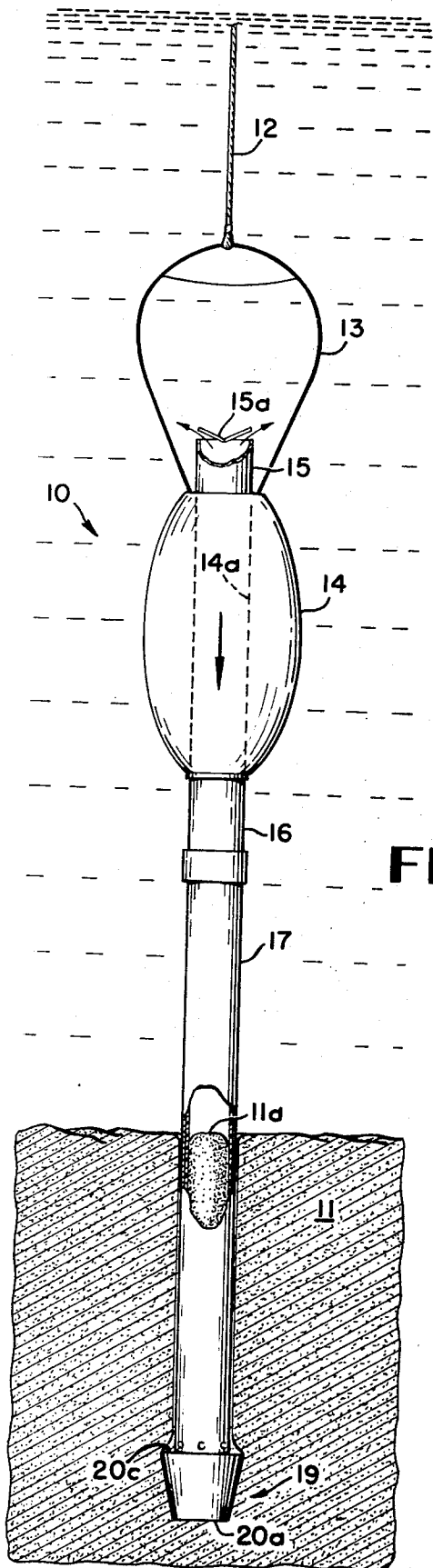


FIG. 3



EXPENDABLE CORE NOSE AND CORE CATCHER
RETAINER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

With the ever increasing interest being shown in understanding the ocean and in developing its resources, more and more efforts are directed toward the study of the ocean's floor. Certain areas of the ocean's floor are covered with thick layers of accumulated sediment. Scientists frequently need to know the exact composition and characteristics of the accumulated deposits. Different sediments have different acoustic properties, different bearing capacities, and varying degrees of contamination, for example. Any number of undersea endeavors are likely to fail if certain conditions are or are not present. One well known and generally exploited technique for studying the ocean's bottom relies upon the analysis of core samples taken by gravity-propelled sediment core samplers. These samplers usually assume the form of a long, weighted pipe properly oriented by a supporting cable to be dropped on and embedded in a deposit or sediment. Various mechanisms draw in and retain a core sample after the core has penetrated the bottom. The sample retaining member is usually referred to as a core catcher. Unfortunately, the operation of, or the complexity of these core catchers often compromised reliability and, consequently, the samples tended to be lost or disturbed. Particularly with respect to a disturbed or commingled sample, it is of little value for later study. One type of core sampler which is notorious for its disturbing the core sample employs a core catcher having several converging self-biased fingers. This core catcher looks like a peeled orange viewed from the top, and it is readily apparent to see how a captured core sample is raked and intermixed as it passes through such a core catcher. A variety of corers equipped with this type of core catcher have varying degrees of self biasing of the converging fingers so that the disturbance of the core sample is varied. For some scientific observations, no disturbance of the core sample is tolerable and hence, this type core sampler often is considered unacceptable. An alternate core catcher which does not overly disturb the core sample is the relatively complicated and expensive sphincter type. Usually a sphincter type core catcher uses a fixed and a moveable ring separated by a length of a sheath-shaped fabric. After a core sample fills the corer a preprogrammed actuator imparts rotational motion to the moveable ring. The sheath-shaped fabric is twisted closed in the process. A complete understanding of one relatively uncomplicated sphincter core catcher is disclosed and set out on pages 142 to 162 in the publication *Marine Geology*, Volume 4, 1966, published by the Elsevier Publishing Company, Amsterdam, Netherlands. The disclosed sphincter catcher has demonstrated the capability for reliable operation under a variety of conditions. However, the mechanism by which the core catcher is actuated is vulnerable to abuse and the design is of questionable reliability. A need continues for an inexpensive, preferably gravity-deployed, marine corer which has the capability

ity for retrieving undisturbed samples of marine sediment.

SUMMARY OF THE INVENTION

5 An apparatus for retaining a core sample of marine sediment includes a weighted, elongate barrel member. A corer nose section is releasably held on the downward end of the elongate barrel member and is configured for ensuring the admission of the core sample during penetration and is designed to be pulled from the elongate barrel member after the core sample has been taken. An array of flexible fingers are interposed between the barrel member and the corer nose section to allow the unimpeded admission of the core sample during penetration, yet an elastic band closes the flexible fingers to retain the core sample in the barrel member after the corer nose section is pulled from the barrel member.

10 A prime object of the invention is to provide an improved sediment corer.

15 Another object is to provide a corer having resiliently biased, flexible fingers held out of the path of a core sample being taken during penetration into a deposit of sediment.

20 Another object is to provide an improved corer having elastically biased flexible fingers which close upon the withdrawal of the corer from the sediment.

25 Another object is to provide a corer which allows a core sample to be retrieved undisturbed.

30 Yet another object is to provide a corer of reduced complexity and hence, greater reliability, particularly at extreme ocean depths.

35 These and other objects of the invention will become more readily apparent from the ensuing specification when taken with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the invention about to strike the ocean floor.

40 FIG. 2 shows a cross-sectional representation of the nose portion and core catcher taken generally along lines 2-2 in FIG. 1.

FIG. 3 shows the corer catcher unrolled to more graphically depict the juxtaposed, flexible fingers.

45 FIG. 4 shows a side view of the corer during penetration in the sediment.

FIG. 5 shows the corer during withdrawal and retrieval of the core sample.

50 DESCRIPTION OF THE PREFERRED
EMBODIMENT

Referring now to the drawings, there is depicted a representative embodiment of a corer 10 just prior to its hitting and becoming embedded in a sediment deposit 11 found on the ocean's floor. The corer is raised and lowered by a line 12 joined to a bail 13 on the corer's upper end. For the purposes of ensuring an aligned, vertical impact on the ocean's floor it has been found expedient to include a vane surface 13a on the upper portion of the bail. Obviously, any fin-like arrangement is includable so long as the end result is that the corer is vertically aligned with respect to the ocean floor.

65 A heavy weight 14 is disposed below the bail and is hydrodynamically shaped to facilitate upward or downward motion through the water. Experience has shown that there must be a sufficient mass to achieve satisfactory penetration in the ocean floor and the weight,

therefore, may range upward in the neighborhood of several hundred pounds. Preferably, the weight is provided with an axial bore 14a in communication with and axially aligned with a valve unit 15.

The valve unit includes a concentrically mounted butterfly valve 15a which is mounted to allow only a one-way flow of water outwardly from the corer. Further insight regarding the unique hydraulic co-action afforded by the axial bore and the valve unit will be more thoroughly set forth later in text. Joined to the opposite side of the heavy weight, a section of pipe 16 is fitted. This section of pipe is not overly essential to realize the advantages of this invention. But when the pipe is joined to the heavy weight and it is provided with a threaded outer surface on its lower end a releasable innerconnection is capable of being made to a corer barrel 17.

The corer barrel optionally is fabricated from a heavy metal to add additional weight and facilitate penetration in the sediment. Of course, if the corer is heavy enough any one of a number of commercially available sections of heavy-duty plastic piping may be used. If the latter course is chosen, marine scientists need only disconnect the corer barrel from the section of piping after a core sample of sediment 11a has been taken. Screwing another corer barrel into the section of pipe readies the corer for reuse and the core sample taken is set aside for later examination. Provision is made within the teachings of this invention to fit a cylindrically shaped liner 18 inside the corer barrel. The inner surface of the liner is smooth to accept the core sample and is removable to facilitate examination of the sample.

The essence of the instant invention partially resides in the configuration and co-action of a corer nose 19 and associated elements. The corer nose includes a hollow, conical frustum section 20 and an interconnected rigid sleeve section 21. The two sections are either integrally formed or welded together in a unitary structure and are fabricated from a relatively inexpensive material since the corer nose is to be expendable. A variety of polycarbonates are well suited as being the structural material for the corer nose since they have the strength to penetrate submarine sediment and are not overly expensive. The conical frustum section is shaped with a sharpened rim 20a designed to penetrate the marine sediment and a relatively smooth outer surface 20b which does not create excessive drag as penetration and travel through the sediment is happening.

An annular rim 20c is fashioned to extend beyond an axial projection of corer barrel 17, the purpose of which will be explained below.

Inside the corer barrel an outer surface 21a of rigid sleeve section 21 is frictionally retained during deployment and penetration by an array of juxtaposed, flexible fingers 22 that are under a constrictive force exerted by an elastic band 23.

The array of flexible fingers is fabricated from a thin sheet of stainless steel having a thickness of approximately five thousandths of an inch. Individual fingers 24 are machined in the stainless steel sheet and when the sheet is wrapped over about itself the array of flexible fingers assumes a cylindrical shape. After being so formed, this cylindrically shaped array of flexible fingers is inserted inside the lower end of the corer barrel and allowed to expand to fit along the barrel's inner wall.

Sets of keeper tabs 25 and 26 have already been punched in the stainless steel sheet and after being bent outwardly, fit through appropriately disposed holes 27 in the lower end of the corer barrel. Noting FIG. 2 and FIG. 3 of the drawings it is seen that keeper tabs 25 are bent in a first direction while keeper tabs 26 are bent oppositely. This is so to prevent the array of flexible fingers from being bidirectionally displaced within the corer barrel. Keeper tabs 25 prevent the array from being pushed upwardly and deeper in the barrel and keeper tabs 26 prevent the fingers from being pulled out of the corer barrel when the corer nose 19 is pulled from it.

When corer nose 19 is pulled from the corer barrel the tensile force exerted by elastic band 23 draws all individual fingers 24 together to converge in a hemispherically shaped obstruction. This hemispherically shaped obstruction prevents a corer sample 11a from being lost from the corer barrel.

In addition to drawing the array of flexible fingers together, the elastic band serves to retain corer nose 19 in the end of corer barrel 17. Were it not for the constricting force of the elastic band about the array of flexible fingers which, in turn, grip outer surface 21a of rigid sleeve section 21 the corer nose would fall from the corer barrel en route to the ocean floor.

In operation the uncomplicated design of the corer thusly described produces a nearly one hundred percent acceptable recovery factor to be achieved. Dropping corer 10 overboard allows the corer to sink rapidly due to the mass of its heavy weight 14. An acoustic transducer device, not shown in the drawings, optionally is carried on the corer to provide an indication of when the corer is nearing the ocean floor. When the corer reaches predetermined distance from the ocean's floor, it is allowed to free-fall toward the floor, see FIG. 1.

Upon hitting the deposited sediment 11, sharpened rim 20a of the corer nose begins penetration. The inner walls of corer barrel 17 (or a liner 18, if so desired), slide along sediment corer sample 11a as the inertia of the heavy weight 14 continues to embed the length of the corer barrel in the deposited sediment. Water which heretofore has filled the corer barrel is purged through butterfly valve 15a as the drag on the inner and outer surfaces of the corer barrel and the corer nose continues to increase beyond the magnitude of the remaining inertial force, further penetration is arrested, note FIG. 4.

Core sample 11a is in no way disturbed, scraped or intermingled along its length by its passage through the corer nose and the corer barrel. The inner surface of the corer barrel and rigid sleeve 21 are smooth and the array of flexible fingers is kept from the core sample by the rigid sleeve section.

FIG. 5, shows the withdrawal of the corer from the sediment layer and the retrieval of a sediment core sample 11a. An upward force exerted by the line withdraws the corer except for corer nose 19. The corer nose is retained in the sediment layer by the friction exerted on outer surface 20b as well as the weight and pressure the surrounding sediment bears on annular rim 20c. Pulling the corer nose from the corer barrel draws rigid sleeve section 21 out of the corer barrel. Because a portion 11a' of the corer sample stays in rigid sleeve section 21 after the corer barrel has been pulled away from the corer nose there is created in the

corer barrel a volume, void of sediment. Into this void elastic band 23 constricts and converges the array of flexible fingers into an essentially hemispherical configuration. At the beginning of the withdrawal sequence butterfly valve 15a closes due to a suction created inside the corer barrel. The butterfly valve cooperates with the constricted array of flexible fingers and retains the corer sample 11a in the barrel member.

Once the corer is brought to the surface, the threaded interconnection between the section of threaded pipe and the corer barrel is disconnected. Another corer barrel is connected and the array of flexible fingers is removed from the first barrel and reused. A new expendable corer nose is placed in the new corer barrel and the corer is ready for deployment. The first corer barrel is used to store the core sample for later study. It naturally follows that the taking of a sample and the replacement of a liner 18 is an equivalent alternate scheme to that just disclosed.

What has been described herein embodies the preferred embodiment of the Applicants' inventive concept. The dimensions of a corer successfully deployed have been carefully controlled to approach as nearly as possible the ratios generally accepted as ideal for sampling of soil. In the publication *Subsurface Exploration and Sampling of Soil for Civil Engineering Purposes* by M. J. Hvorslev in his 1949 U.S. Army Corps Engineer Publication, certain ratios were identified as being ideal. These ratios given the designations C_i as being indicative of the inside friction, C_o as being indicative of the outside friction and Ca as being indicative of the volume of displaced sediment were found to be functions of the inner and outer diameters of the corer barrel and corer nose.

The ratio controlling the inside friction, C_i is given by the formula:

$$C_i = D_s - D_e/D_e$$

where D_s is the minimum inside diameter of the corer barrel or corer liner and D_e is the minimum inside diameter of the corer nose, see FIG. 2.

Similarly the ratio controlling the outside friction C_o , is given by the formula:

$$C_o = D_w - D_i/D_i$$

Where D_w is the maximum outside diameter of the corer nose and D_i is the maximum outside diameter of the corer barrel.

The ratio controlling the volume of the displaced sediments, Ca and, hence the degree of penetration in the sediment layer is given by the formula:

$$Ca = D_w^2 - D_e^2/D_e^2$$

Multiplying these ratios obtained by one hundred gives percentages which are considered ideal in terms of the quality of the sample obtained and its amount. The ratio should fall within the following limits: For optimum performance by gravity fall corers:

$$0.75 \text{ percent} < C_i < 1 \text{ percent}$$

$$C_o < 3 \text{ percent}$$

$$Ca < 10 \text{ percent}$$

With these ratios in mind, and within the constraints of readily available standard materials, an optimum design for the Applicants' corer was constructed. The inside diameter of the corer barrel was 2.750 inches, the minimum inside diameter of the corer nose was 2.705 inches, the maximum outside diameter of the corer

nose was 3.060 inches, and the maximum outside diameter of the corer barrel was 3.000 inches. The relatively thin five thousandths of an inch thick array of flexible fingers did not greatly degrade the ratios since it was covered by the rigid sleeve section 21 while a core sample 11a was being taken.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than specifically described.

What is claimed is:

1. An apparatus for retaining a core sample comprising:

means for containing the core sample therein;

means coupled to the containing means for driving it a sufficient length of penetration to allow the admission of the core sample;

means releaseably held on the inside of a first end of the containing means for ensuring the admission of the core sample during penetration, the ensuring means is adapted to be pulled from the containing means during withdrawal of the containing means;

means interposed between the containing means and the ensuring means for remaining in an open position to allow the unimpeded admission of the core sample during penetration and a closed position to retain the core sample in the containing means during withdrawal after the ensuring means has been pulled from the containing means; and

means disposed adjacent the remaining means for urging the remaining means to the closed position to ensure the retention of the core sample in the containing means.

2. An apparatus according to claim 1 further including:

means coupled to the opposite second end of the containing means for allowing the evacuation of the containing means during penetration and the retention of the core sample during withdrawal of the containing means.

3. An apparatus according to claim 2 further including:

means connected to the containing means for permitting the penetration and withdrawal of the containing means.

4. An apparatus according to claim 3 in which the ensuring means is a hollow conical frustum joined to a rigid sleeve, an annular rim of and exposed surface of the conical frustum are shaped to provide sufficient drag to be pulled from the containing means during withdrawal.

5. An apparatus according to claim 4 in which the remaining means is a cylindrically shaped array of flexible fingers arranged in a juxtaposed relationship, said rigid sleeve is disposed and formed to position the flexible fingers out of the path of the core sample during the admission of the core sample to avoid disturbing the core sample.

6. An apparatus according to claim 5 in which the urging means is an elastic band disposed and sized to bend the flexible fingers together to the closed position after the rigid sleeve has been pulled out of the containing means.

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7. An apparatus according to claim 6 in which the containing means is an elongate barrel member having at least one lateral hole at the first end and the array flexible fingers are formed with at least one keeper tab inserted in the lateral hole to couple the array of flexible fingers to the elongate metal barrel.

8. An apparatus according to claim 7 in which the allowing means is a butterfly valve mounted across an opening in the elongate barrel member at the opposite second end.

9. An apparatus according to claim 7 in which there is disposed a tubular liner inside of the elongate barrel

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member to expedite the removal of the core sample from the elongate barrel member.

10. An apparatus according to claim 7 in which the inner diameter of the hollow conical frustum and rigid sleeve and the inner diameter of the elongate barrel member are selected to control internal friction during penetration and the outer diameter of the annular rim of the hollow conical frustum and the outer diameter of the elongate barrel member are selected to control external friction during penetration.

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