# Chapter F-7
# Equipment for Disturbed Soil Sampling In Borings

## 7-1. Sampler Type

Various types of augers and drive and displacement samplers are available for obtaining disturbed samples of most soils. In general, the equipment (and procedures) for obtaining disturbed samples of soil are similar (or perhaps require minor modifications) to the equipment and methods which were discussed in Chapters 5 and 6 for undisturbed sampling operations. The most satisfactory type of sampler depends upon the nature of the material to be sampled, the purpose for which the sample is intended, and the type of drill rig which is used. Procedures for obtaining disturbed samples are discussed in Chapter 8.

## 7-2. Augers

Augers may be used for obtaining disturbed samples in all types of soils except clean cohesionless sands and gravels with little apparent cohesion or those soils in which the borehole will not remain open. Augers are best suited for sampling above the water table. Samples are taken directly from the auger upon its withdrawal from the hole. Augers are generally available in sizes from 25- to 75-mm- (1- to 3-in.-) diam for hand-held devices to 2.4-m- (96-in.-) diam or larger for machine-operated helical and disk augers. A photograph of a bucket auger drill in operation is presented in Figure 3-10.

*a. Hand augers*. Iwan-type posthole augers and light helical augers are used for shallow borings. Figure 7-1 is a photograph of Iwan augers.

*b. Barrel augers*. Barrel-type augers may be used with drill rigs to obtain disturbed samples of most cohesive soils above and below the water table. The Vicksburg solid and hinged augers and the McCart split auger, as shown in Figures 7-2 and 7-3, respectively, are typical barrel-type augers. The Vicksburg and McCart augers are fashioned after the Iwan auger and are equipped with rigid overlapping curved blades at the bottom of the barrel. The blades of the Vicksburg hinged auger are held together during augering operations by a hinge and slip ring. The blades of the McCart auger are held together by a bolt. Split augers are especially adapted for removal of sticky soil from the auger barrel. However, split augers are not strong enough to be used in hard or stony soils.

*c. Helical augers*. Helical augers, which are sometimes called worm-type augers, may be used with drill rigs to obtain disturbed samples of cohesive soils from above or below the water table. The auger consists of a stem onto which the helical fluting or auger flights are wrapped. A drive head is attached to one end of the stem; fluting, pilot bit, and cutting teeth are attached to the other end. As the names imply, the auger stem may be either solid or hollow; the fluting may consist of as few as one revolution of the fluting or one flight to continuous fluting over the total length of the stem. Figure 7-4 is a photograph of a short-flight solid-stem auger. Figure 7-5 is a photograph of segments of a continuous-flight hollow-stem auger and a continuous-flight solid-stem auger.

The operations of the short-flight and the continuous-flight augers are similar. The principal difference is the method in which the soil is brought to the ground surface. For the short-flight auger, the auger must be returned to the surface each time the flights are filled with soil. The principal advantage of the short-flight auger is a better knowledge of changes of strata. The disadvantage of this method is that the auger must be removed from the borehole each time the flights are filled with soil. The advantage of the continuous-flight auger is that the soil is automatically brought to the ground surface by the rotation of

the auger as it penetrates. However, the quality of soil samples may be of questionable value because of the potential for mixing soils from different strata.

The hollow-stem auger may be used as casing to prevent caving of unstable soils. After the boring has been advanced to the desired depth, the center rod and pilot bit are removed. A sampling device can be operated through the stem of the auger.

*d. Bucket augers*. A bucket auger consists of a relatively short barrel which is open at the top and equipped with cutting teeth attached along slots on a hinged drop bottom. Two designs for the slots in the bottom of the bucket are available. For cohesive materials, open slots are located ahead of the cutting teeth. For cohesionless materials or for drilling below the water table, hinged steel or rubber flaps are used to cover the slots in the bottom of the bucket to prevent the loss of material. To fill, the bucket is rotated and the flaps pivot upward to allow the material to enter. When the bucket is filled, it is pulled out of the borehole and moved away from the rig by a dump arm before it is emptied. Figure 7-6 is a schematic drawing of several types of bucket augers. Figure 7-7 is a schematic drawing of a hinged drop-bottom bucket which was designed for rapid removal of cohesive or cohesionless soil from the bucket.

A variety of types of bucket augers are available for specific tasks. For example, belling buckets are used for underreaming, such as when a larger diameter of borehole is needed at depth. To activate the belling bucket, downward pressure is applied by the kelly to open the reamers. Other types of buckets include those for picking up large boulders and buckets to chop hard materials. Examples of the use of bucket augers include drilling large-diameter accessible borings, boreholes for cast-in-place piles, water wells, and pressure relief wells near Corps structures.

## 7-3. Push or Drive Samplers

Push or drive samplers, which are pushed or driven into the soil without rotation, may be used for obtaining disturbed samples of most soils. Push-tube samplers can be subdivided into two broad groups: open samplers and piston samplers. Open samplers consist of a vented sampler head attached to an open tube which admits soil as soon as the tube is brought in contact with the soil. The sampler head itself may be equipped with a ball check valve which creates a partial vacuum that aids in sample recovery and prevents the entrance of drilling fluid during sample withdrawal. Some open samplers are equipped with a cutting shoe and a sample retainer. Piston samplers have a movable piston located within the sampler tube. The piston helps to keep drilling fluid and soil cuttings out of the tube as the sampler is lowered into the borehole. The piston also helps to retain the sample in the sampler tube.

As compared to piston samplers, open samplers have advantages due to cheapness, ruggedness, and simplicity of operation. The principal disadvantage of open-drive samplers include the potential for obtaining nonrepresentative samples because of improper cleaning of the borehole or collapse of the sides of the borehole.

*a. Open samplers*. Various types of pushed or driven open samplers are available. The sampling tube may be either thick-walled or thin-walled. In most instances, split-tube samplers are preferred because the two halves can be separated to observe soil stratification. Sample retainers may be required for sampling sand, gravel, and very soft or friable soils. The type of open-drive sampler which is selected depends upon availability and experience, location and accessibility of borehole, and the soil to be sampled.

(1) *Thin-walled samplers*. The thin-walled open sampler consists of a tube affixed to a sampler head assembly which may or may not be equipped with a check valve. Most sampling tubes are drawn to provide a suitable inside clearance, although this "requirement" is only necessary for undisturbed sampling operations. These tubes normally have an OD of 75 to 125 mm (3 to 5 in.) and a length of 76 to 91 cm (30 to 36 in.). Thin-walled tubes are sharpened on one end and therefore, may be easily damaged by buckling or by blunting or tearing of the cutting edge as they are driven into stiff or stony soils. To reduce the potential for damage, the tube should be pushed rather than driven. Hence, the basic principle of operation of the thin-walled sampler is to force the cylindrical tube into the soil in one continuous push without rotation.

Thin-walled open-drive samplers may be used to obtain samples of medium-to-stiff cohesive soils. Soils which cannot be sampled with this device include soils which are hard, cemented, or too gravelly for sampler penetration, or soils which are so soft or wet that the sample will not stay in the tube.

(2) *Thick-walled samplers*. A large number of thick-walled samplers are available. The most-well known split-tube or split-barrel type sampler is the split-spoon sampling tube which is used with the SPT, as described in Appendix G of the Geotechnical Manual. Another thick-walled sampler includes the California sampler.

Thick-walled split-spoon samplers of various sizes have been used extensively for obtaining disturbed samples of all types of soil, both above and below the water table. The sample-tube barrel is threaded on both ends and split lengthwise. When assembled, the two halves are held together by the driving shoe at one end and the head at the other end. A space is provided in the driving shoe for a spring basket-type sample retainer.

Split-spoon samplers are commercially available in 50- to 115-mm (2- to 4-1/2-in.) OD sizes. The 51-mm (2-in.) OD by 35-mm (1-3/8-in.) ID split-barrel sampling tube which is used for the SPT gives good representative disturbed samples of all soil types except gravel and gravelly soils. Larger sizes of samplers are used to obtain samples of material containing gravel or large-volume samples. Except for the requirements imposed for the SPT, the sampling spoons can be driven with any convenient weight hammer. Figure 7-8 shows two sizes of split-spoon samplers and various types of sample retainers.

*b. Piston samplers*. Piston-type samplers perform satisfactorily in obtaining disturbed samples of most types of soil. By locking the piston at the bottom of the sample tube, piston samplers can also be used as displacement samplers. Piston samplers are discussed in paragraph 5-1*a*(2).

## 7-4. Displacement Samplers

The Memphis and the Porter samplers are retractable-plug displacement samplers. With the plug locked at the bottom of the sampler, the sampler is driven to the desired sampling depth. To sample, the plug is retracted and the sampler is driven to obtain the sample. These samplers are intended for manual operations in soft soils and are limited for use to a depth of about 10 m (33 ft). Both samplers have a 32-mm (1-1/4-in.) OD by 25-mm (1-in.) ID barrel and cutting shoe and are equipped with an extension pipe of the same diameter as the barrel. The Porter sampler is fitted with a segmented brass liner consisting of seven, 150-mm- (6-in.-) long segments. Each liner segment is 25-mm (1-in.) OD by 24-mm (15/16-in.) ID. Caps are provided for sealing the individual segments of samples after recovery.

## 7-5. Vibratory Samplers

A variety of large-scale and small-scale vibratory samplers offers rapid, inexpensive methods of obtaining disturbed, and usually representative, samples of saturated, cohesionless materials, i.e., silts and fine sands found in barrier islands and deltaic deposits which are often inaccessible by conventional drilling and sampling equipment. The principle of operation consists of the application of a vibrating or oscillating energy to the sampling tube rather than the application of a brute force, such as by a percussion hammer or hydraulic drive. The oscillation of the sampling tube tends to induce positive pore pressures which result in a reduction of the effective stresses within the material to be sampled. For the hand-operated sampler, a small gasoline engine designed for use as a concrete vibrator is the power source of the system. A flexible shaft attaches the motor to the vibrator head mounted on the sampling tube. A tripod, which consists of a tripod headplate and legs, is required to support the sampling tube during sampling operations and to provide a reaction frame for extracting the sampling tube and sample from the borehole. The system uses thin-walled aluminum sampling tubes of various lengths and diameters that are commercially available. The use of vibratory samplers has made it possible to obtain inexpensive representative disturbed soil samples to depths in excess of 10 m (33 ft) at sites, such as unconsolidated backswamp deposits, previously considered to be inaccessible to most drilling and sampling equipment. Figure 7-9 is a photograph of a portable vibratory sampler. Additional information is presented in paragraphs 8-2 and 10-5.

## 7-6. Percussion Samplers

Percussion drilling, which includes the use of churn or cable-tool drills, wireline drills, and hammer drills, such as the Becker hammer and the eccentric reamer system, may be used to advance borings for disturbed sampling in hard cohesive soils, cemented sands and gravels, and gravelly soils. Samples obtained with a bailer or from the return wash water in percussion borings are not satisfactory as disturbed samples because the finer materials will be suspended in the water. Therefore, drive samplers or core barrels are required for obtaining disturbed samples from a borehole advanced by a churn drill. When the Becker hammer drill is used, disturbed samples may be taken from the return cuttings. However, these samples are a mixture of all soil materials in the depth interval from which the particular sample was obtained.

*a. Wireline samplers*. Wireline samplers are similar to other percussion-type hammer samplers except that the entire sampling assembly, including the hammer, drive head, and sampling tube, is lowered into the borehole to obtain the sample. The hammer is activated by a cable attached to the surface. This type of system is particularly adapted for deep borings and nearshore drilling because the drill rods do not have to be assembled and disassembled each time a sample is obtained. A variety of sampling tubes and various hammers have been successfully used to obtain representative disturbed samples of all soils except those containing large gravel. Figure 7-10 illustrates a split-spoon sampler with a New Orleans wireline drive hammer.

*b. Hammer drills*. Several hammer drills are available for obtaining disturbed samples of soil and fragmented rock. The most widely recognized hammer drills are the Becker hammer drill and the eccentric reamer (ODEX) system. Both drilling systems are patented and are discussed in detail in paragraph 3-3*d*. The use of the Becker hammer drill as a penetration test is discussed in Appendix H of the Geotechnical Manual.

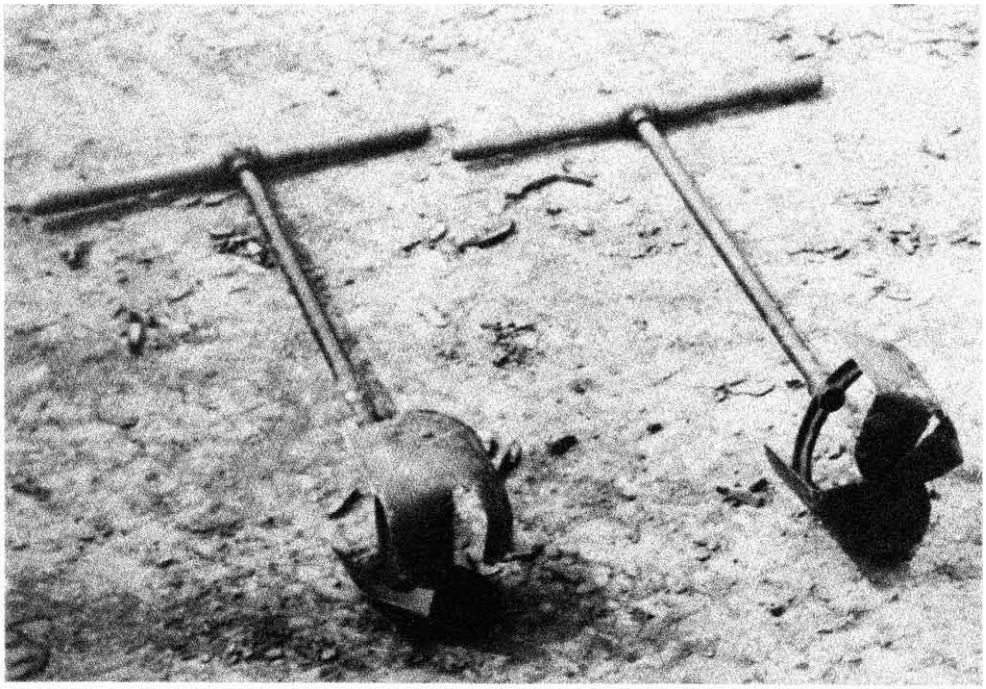

**Figure 7-1. Photograph of an Iwan auger**

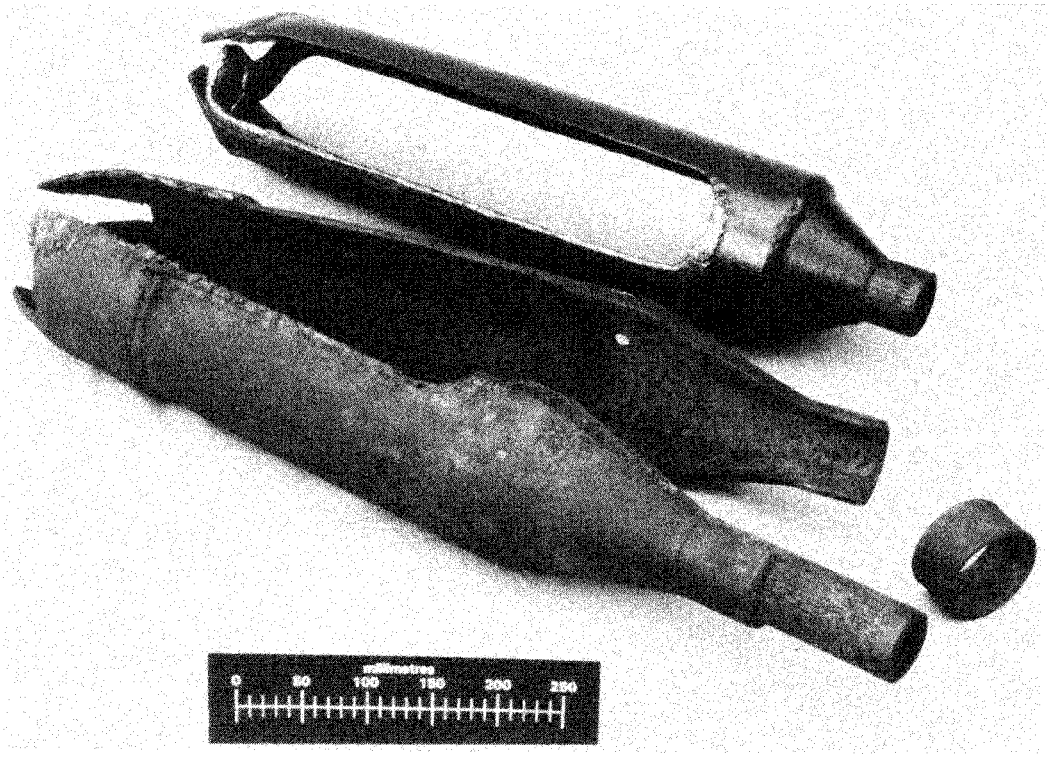


**Figure 7-2. Photograph of the Vicksburg solid and hinged barrel-type augers**

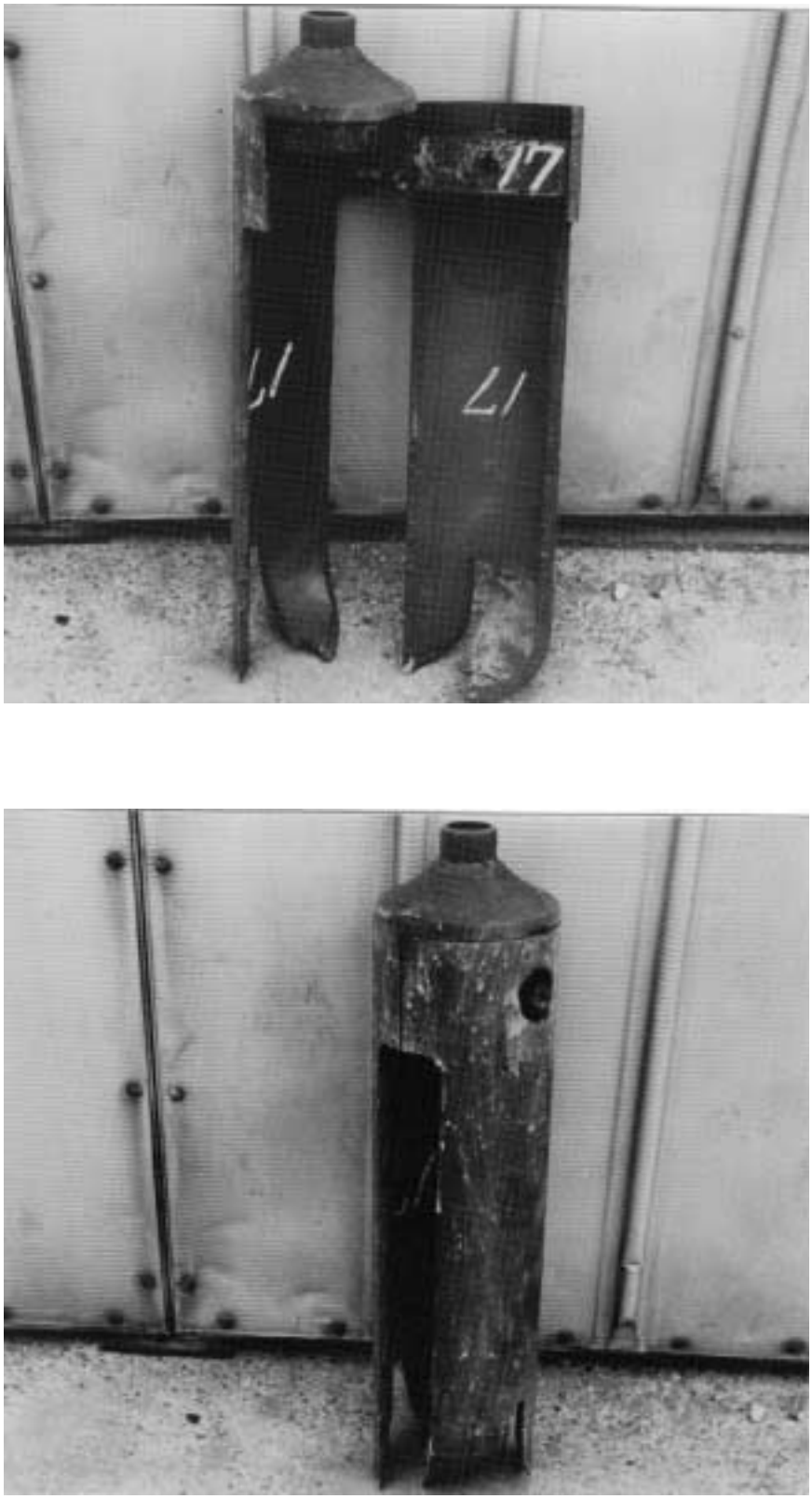

Figure 7-3. Photograph of the McCart split barrel-type auger

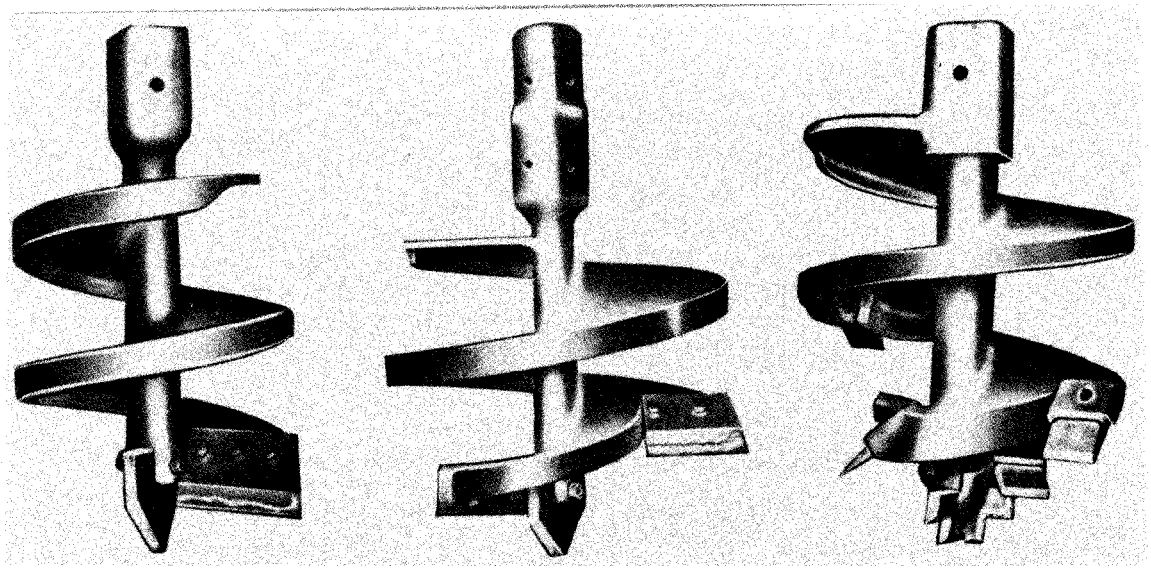

**Figure 7-4. Photograph of short-flight solid-stem augers**

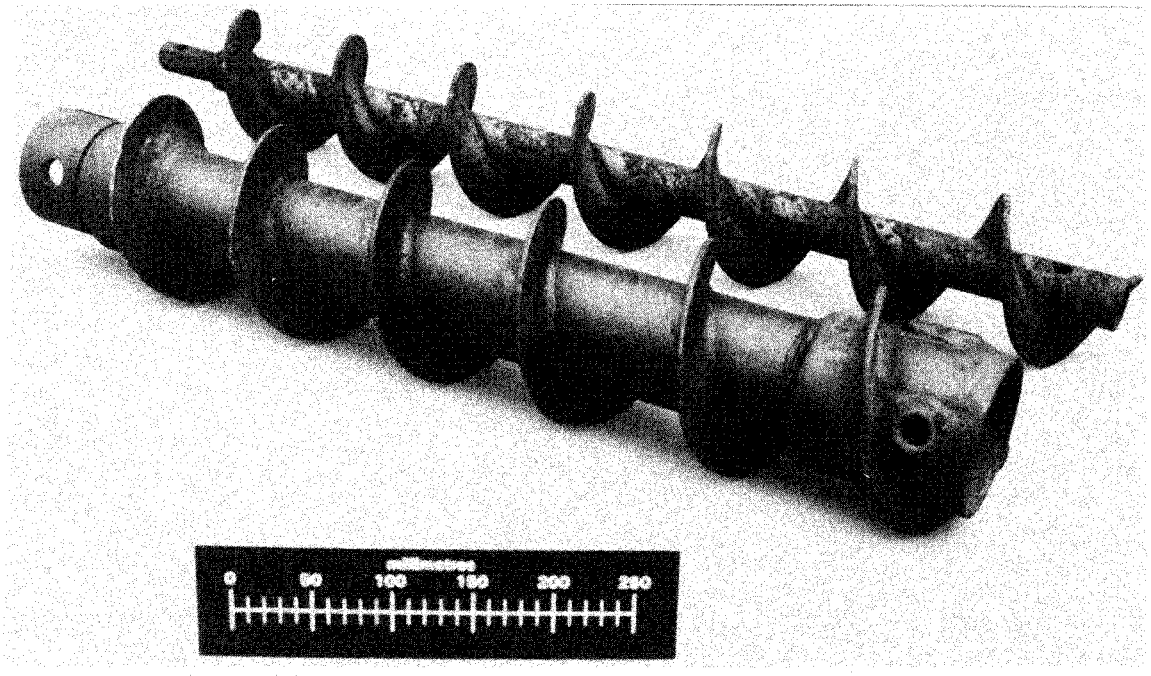


**Figure 7-5. Photograph of segments of a continuous-flight solid-stem auger and a continuous-flight hollow-stem auger**

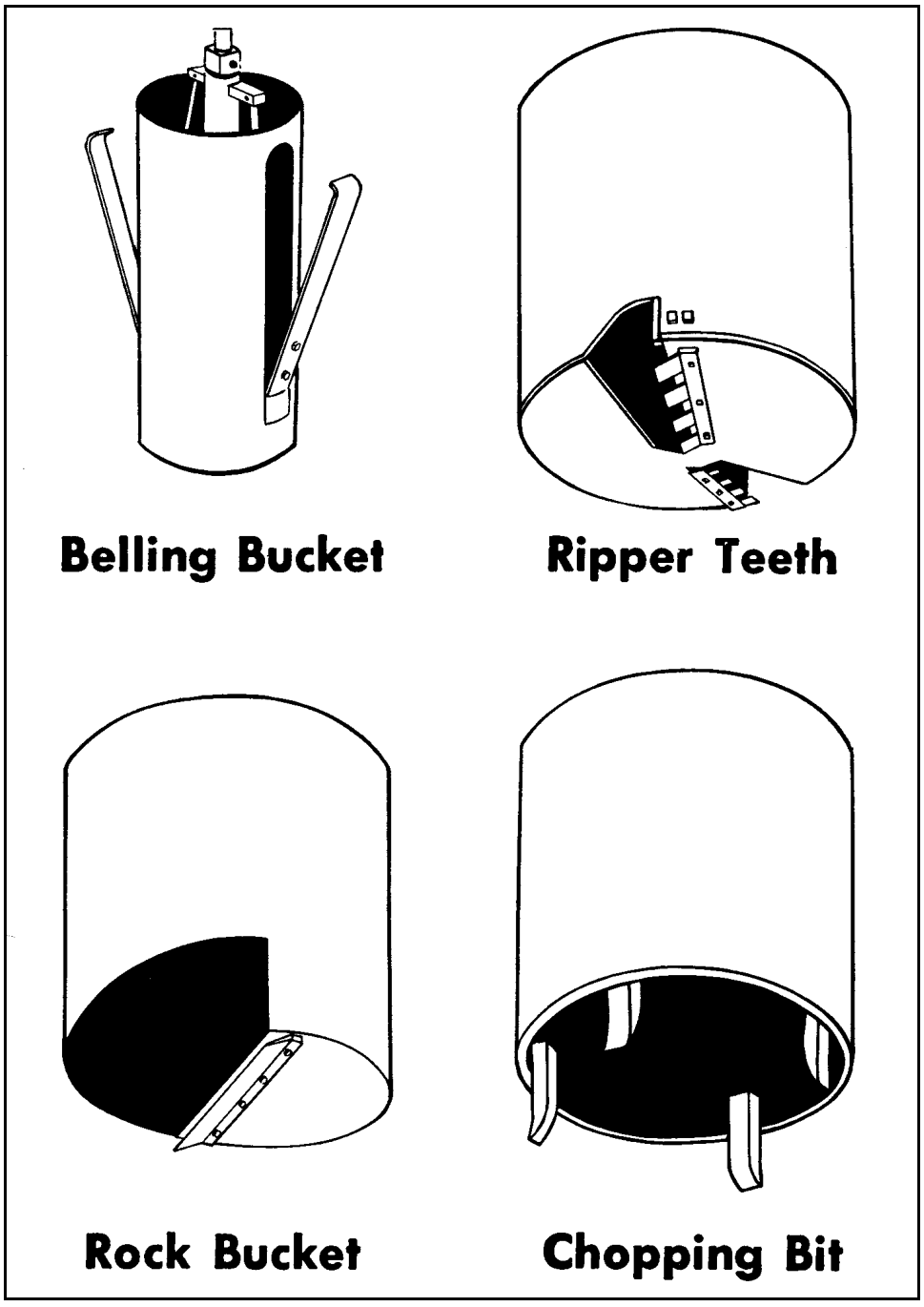


Figure 7-6. Isometric drawing of several types of bucket augers

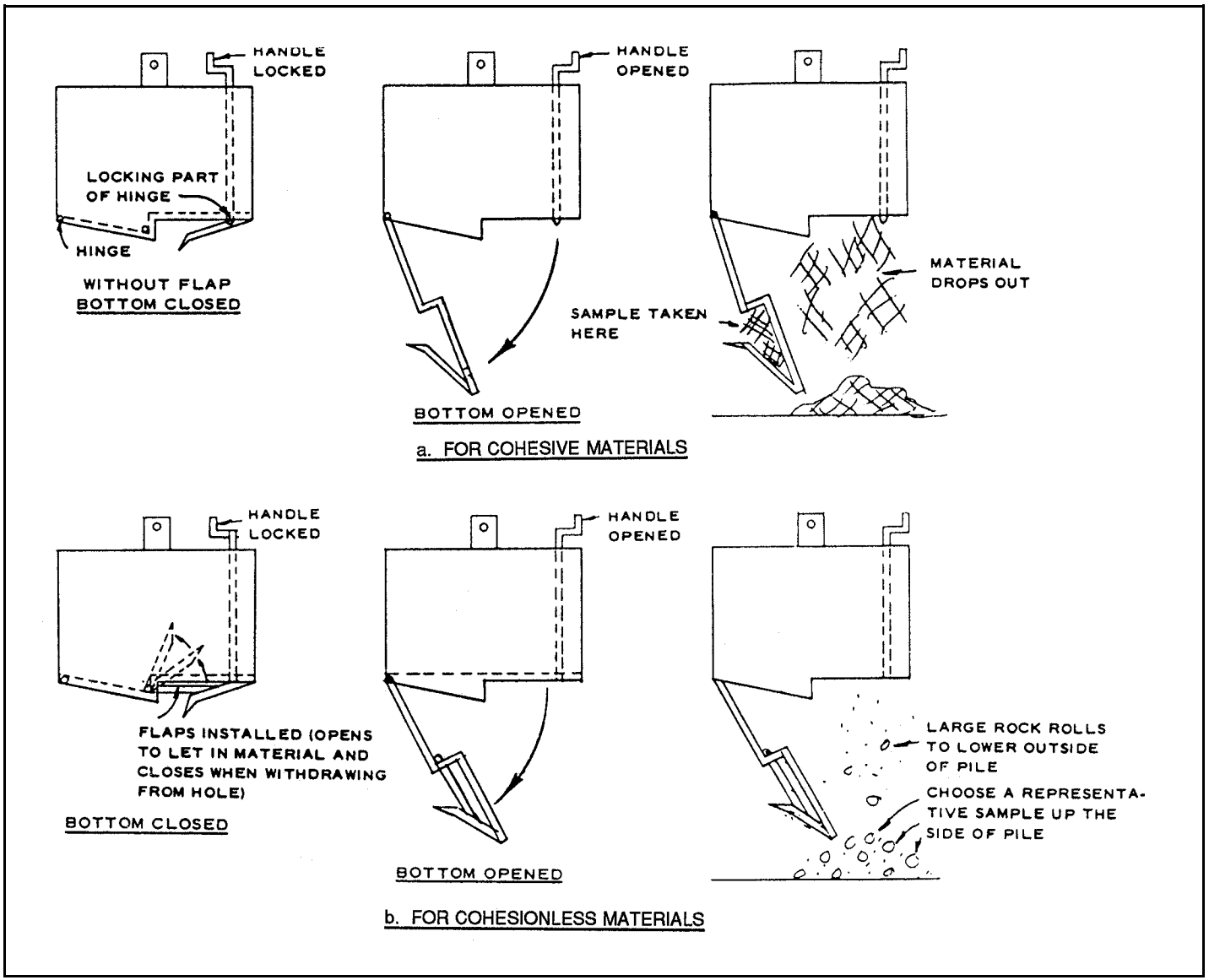


**Figure 7-7. Schematic drawing of hinged drop-bottom buckets which were designed for rapid removal of cohesive or cohesionless soils**

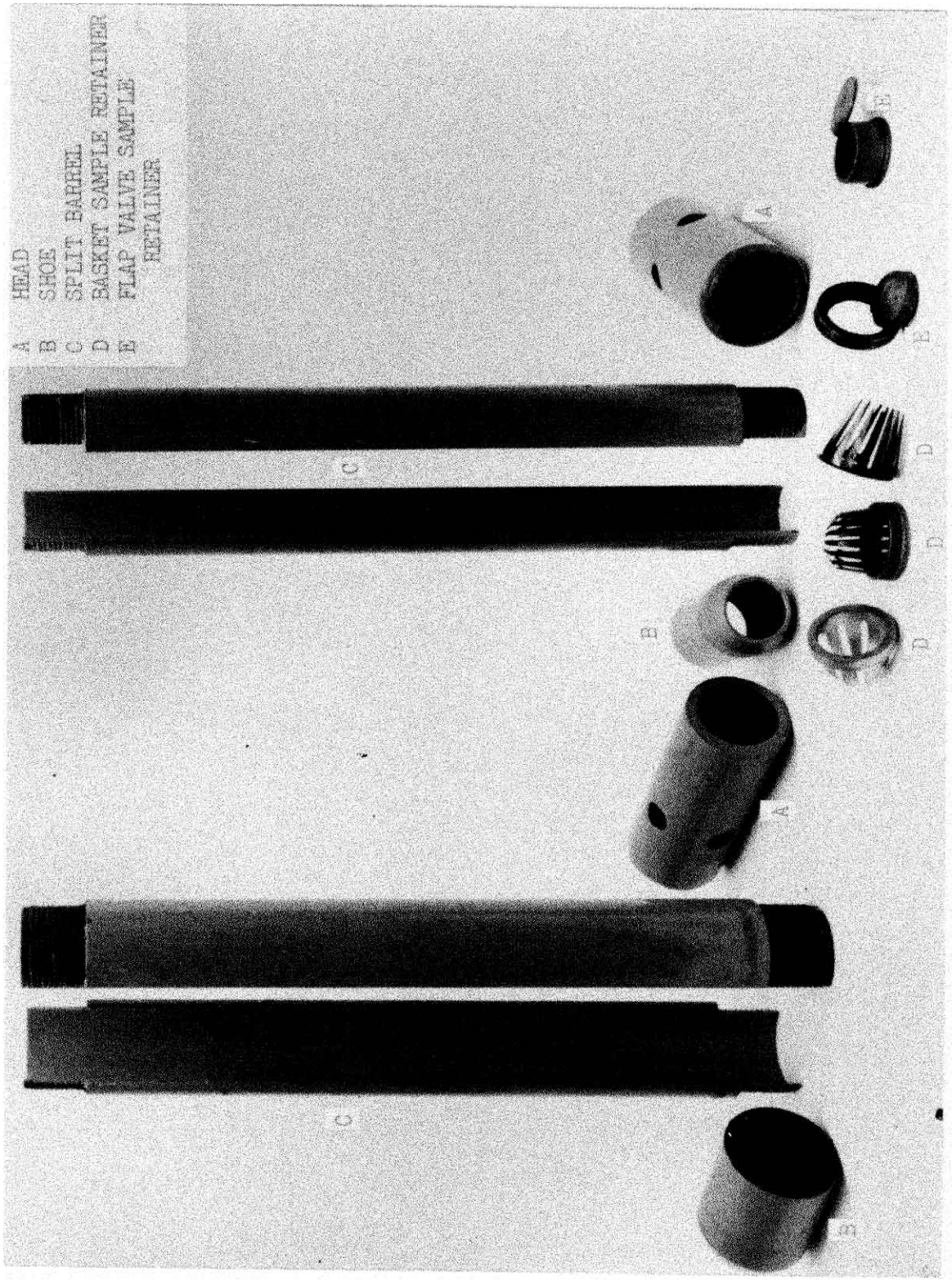


Figure 7-8. Photograph of two split-spoon samplers and several sample retainers

**Figure 7-9. Photograph of a portable vibratory sampler (after Smith, Dunbar, and Britsch 1986). Note: Safety is a very important consideration for Corps of Engineers projects. Safety items, including hardhats, gloves, safety shoes, protective clothing, and dust or vapor masks, should be worn, as appropriate, for the particular drilling and sampling operation**

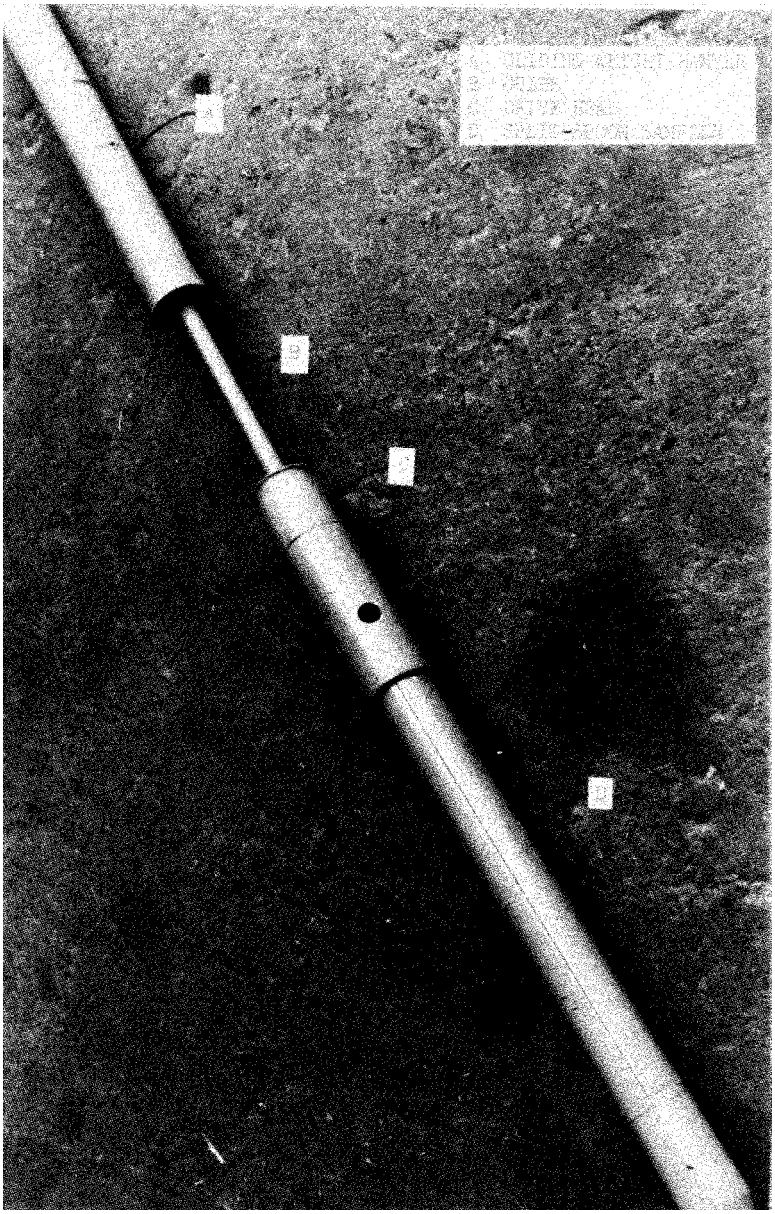

**Figure 7-10. Photograph of a split-spoon sampler with a New Orleans wireline drive hammer**