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RESEARCH REPORT NO. 326

A METHOD OF INSTALLING ACCESS TUBES FOR SOIL MOISTURE MEASUREMENT BY THE NEUTRON PROCEDURE

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ABSTRACT

A portable power driven flight auger is used to remove the soil inside a metal tube casing sunk into the ground as a caisson. Using multiples of 3 feet, successively longer lengths of tubing are used, and removed, until the desired depth is reached. Thereafter an access tube, the same outside diameter as that used for casing but with the bottom end welded shut, is inserted into the hole for use in soil moisture observations.

INTRODUCTION

The neutron method of measuring soil moisture provides the research worker with a unique, accurate, and sensitive tool. The advantages of a non-destructive measurement are combined with those of a repetitive measurement in situ. Problems do exist, however, in the use of the neutron method. One of these problems, the proper, simple, and economical installation of the access tube, is of great importance. Without proper installation of the access tube, the data will be inconsistent with the actual soil moisture conditions. Unless the procedure is simple, the advantages in the use of the neutron procedure will be diminished. Furthermore, the cost of the access tube installation must be reasonable in order that the considerable expense of the electronic equipment necessary for the neutron method not detract unduly from the advantages of the method. Installation, therefore, of the access tube becomes an important procedure.

It is the purpose of this report to describe in detail the method developed in north Mississippi of installing access tubes for use in the neutron method of measuring soil moisture. The method of access tube installation described is the result of extensive development and use in the field. The installation described is for the Troxler-type neutron probe which has an outside diameter of 1.865 inches. However, the same procedure, with slight modifications, can be used for installing access tubes for use with neutron probes of other manufacture and/or diameter.

1/ Contribution from the Sedimentation Laboratory, Agricultural Research Service, USDA, Oxford, Mississippi, in cooperation with the University of Mississippi and the Mississippi State University.

2/ Soil Scientists.

BACKGROUND

Several methods using hand augers of various types were investigated. All of these methods were unsatisfactory. Most frequently enlargement of the hole occurred each time the auger was removed from the hole. Even with very slow and careful work, the use of hand augers did not prove successful. Not only was the alignment of the hole difficult to maintain but soil adhering to the auger would erode the sides of the hole each time the auger was removed, thereby enlarging the hole and making it useless. A close contact of the soil and the access tube is necessary. Incorrect readings would be obtained if significant air spaces were to exist between the undisturbed soil and the access tube.

Driving steel tubes into the ground and excavating the center core did not prove satisfactory with the soil types found in north Mississippi. This method was extremely slow even when using drive tubes with sharpened case-hardened cutting edges. Constant driving using a sledge caused these steel tubes to buckle due to the excessive resistance offered by the soils in north Mississippi. Striking the driver off center, or vibration, usually caused enlargement of the hole, especially near the surface.

PROCEDURE

The equipment used in the installation of the access tubes is described below. This equipment can be varied, of course, to suit the individual needs of any particular operation. A list of the specific items and possible supplier is given in the Appendix.

Access Tubes: Aluminum irrigation pipe is used in north Mississippi because of its low cost and the high resistance to corrosion over a long time use in the soil. Where alkali conditions occur, the use of steel pipes would be recommended. Other metal pipes and sizes also may be installed by the following method. The aluminum pipe used is standard two-inch O.D. aluminum irrigation pipe with a wall thickness of 0.041 inches. It is highly important that no moisture collect in the access tube as this would result in inaccurate readings and thus false soil moisture values. A number of methods were tested in the field in order to insure a water-tight seal at the bottom of the access tube. Various types of stoppers and sealing adhesives were tried but all were unsatisfactory. This was especially true in soils with a high moisture content or where access tubes extended below the water table. Access tubes which had an aluminum disk welded to the lower end and were pressure tested for leaks proved entirely satisfactory. Accordingly this procedure is recommended. All access tubes should be checked before installation to insure the unobstructed entry of the soil moisture probe. This may be done either with the actual probe or with a die of the same diameter.

Drilling Tools: A portable Power Soil Sampler (see Appendix) is used to drill the holes for the access tubes (Figure 1). A full-flight two-inch auger is used to drill the hole. This auger is ground to fit inside steel tubing utilized as drill casing (Figure 2). The steel casing is welded mechanical tubing, two-inch O.D., with 0.065-inch wall thickness. One end of each steel casing is sharpened with the bevel on the inside. Various lengths of this steel tubing are used depending on the depth of drilling. Sections in multiples of three feet were found to be useful. The top of the two-inch full-flight auger is modified so that standard one and one-half-inch diameter flight extensions can be attached (Figure 3). These full-flight auger extensions, one and one-half-inch diameter, are used with an adapter as a part of the Power Soil Sampler.

In order to force the drill casing into the ground, and to remove it when desired, an oak puller of the type shown in Figure 4 is needed. An assortment of wrenches, steel tape, wire brush, a supply of water, and oil are needed (Figure 1). Other equipment may be found useful depending on the needs of the operator and conditions under which drilling is done.

Installation: The following procedure of drilling the holes and installing the access tubes has been developed to provide quick, economical, and satisfactory results.

The equipment necessary for the installation of an access tube is shown in Figure 1. A short section (two-foot) of the mechanical steel tubing has the oak-wood puller clamped to it (Figure 4). The two-inch diameter auger, directly attached to the power unit, is used to excavate the soil from within the steel tubing. In order to insure a straight and vertical hole, an assistant holds the oak puller steady as in Figure 5. The helper holding the oak puller also applies downward pressure causing the steel tubing to slip into the soil as the auger excavates the soil from within and slightly below the end of the tube casing. Care should be taken to keep a straight, steady entry of the casing into the ground (Figure 6). Much of the success or failure of the drilling operation depends on the drilling of this first increment. The hole is augered a slight distance below the bottom of the casing to allow an easy entry of the next longer section of casing (Figure 6). In order to insure a straight hole, the depth of drilling beyond the steel casing should not be as great as the length of the full-flight auger.

As the auger excavates the hole below the end of the casing, a thin ring of soil is left between the augered hole and the outside diameter of the cutting edge of the casing. This thin ring of soil offers little resistance to the penetration of the steel casing. The auger extensions are added as necessary to permit drilling to the desired depth. Sections of casing, successively three feet longer, are used as drilling proceeds.

Drilling in soils that have a high silt and clay content will produce a problem when the casing is pulled from the ground. Soil will cling to the steel making it difficult to remove the casing without disturbing the sides of the hole. This disturbance can be eliminated by applying a small amount of water to the sides of the hole before putting in the casing. The water acts as a lubricant with no permanent change in the soil.

The approximate depth of the boring can be noted by the number of lengths of the auger and extensions employed. A simple marking system on the auger, extensions, or transmission housing is sufficient for depth control. Extreme care should be made in inserting each successively longer section of casing. If the casing is not pushed straight into the hole, the sharpened edge may cut the sides of the hole and thereby enlarge the hole and make it useless.

The hole should be carefully inspected upon completion. A flashlight, or a mirror on a sunny day, can be used. Any flaws in the side walls of the hole which would cause errors in soil moisture determination can be easily detected. If such flaws are detected, the hole should be carefully refilled and another drilled from three to five feet away.

Upon completion of drilling, an aluminum access tube of the proper length is installed. Care should also be made in installing the access tube. Here again resistance may be encountered in pushing the access tube into the prepared hole. This problem can be eliminated by again applying a small amount of water on the side walls as a lubricant. If the access tube is still difficult to push into the hole, a steady pressure with a slight twisting motion should allow the tube to slip the full length of the hole. The addition and careful packing of a small amount of soil immediately around the top of the access tube will prevent any surface water from flowing down the outside of the tube from the ground surface.

Maintenance: There is very little maintenance required after the access tube is once installed. A stopper should be provided for the top of the access tube. A simple device, Figure 7, can be made to provide an ideal water-tight stopper. This device is made from a Number 10-1/2 rubber stopper, a universal hose clamp, and a regular two-inch radiator hose clamp. No alterations or holes are needed in the access tube. This device is ideal when the site is located in pastures or cultivated fields where disturbances to the tube may be expected.

There will be some condensation of moisture on the inside of the access tube that projects above the ground. This moisture should be removed with an absorbent tissue or cloth before the neutron probe is inserted in the access tube. A can painted with a bright paint may be used to cover the top of the tube and stopper.

Access tubes have been installed by the above procedure to a depth of twenty feet. These installations have yielded excellent results over a two-year period of time (Figure 8). Experience at Oxford indicates a three-man crew is desirable when the access holes are to be drilled to ten feet or more. The variability in soils, drilling complications, and experience of the crew will determine the speed of installation. Under ideal conditions, two ten-foot holes may be completed in an hour.

APPENDIX

1. Portable Power Soil Sampler, Testlab Corp., Chicago, New York, Cat. No. TD 1.612, $237.80.

2. Extension, full flight, 1-1/2" diameter in 3 ft. lengths. Testlab Corp., Chicago, Cat. No. TD 1.61122, $17.50 ea.

3. Adapter, Power Soil Sampler, Testlab Corp., Chicago, Cat. No. TD 1.61129, $4.50.

4. Auger, 2" diameter, full flight, 42" long overall. (Grinding to size needed can be done locally.) Testlab Corp., Chicago. Special order.

5. Electric welded steel mechanical tubing, 2" O.D. x .065" wall thickness. One piece 2-3' long, others to desired depth.

6. Oak puller. (Local construction -- see Figure 4).

7. Two 14" wrenches.

8. One 7" crescent wrench.

9. Two 3/8" diameter steel rods.

10. Gasoline can.

11. Measuring tape or folding ruler.

12. Flashlight and mirror.

13. Two-inch O.D. aluminum irrigation tubing sealed on one end and cut to desired lengths or other access tubing as desired.

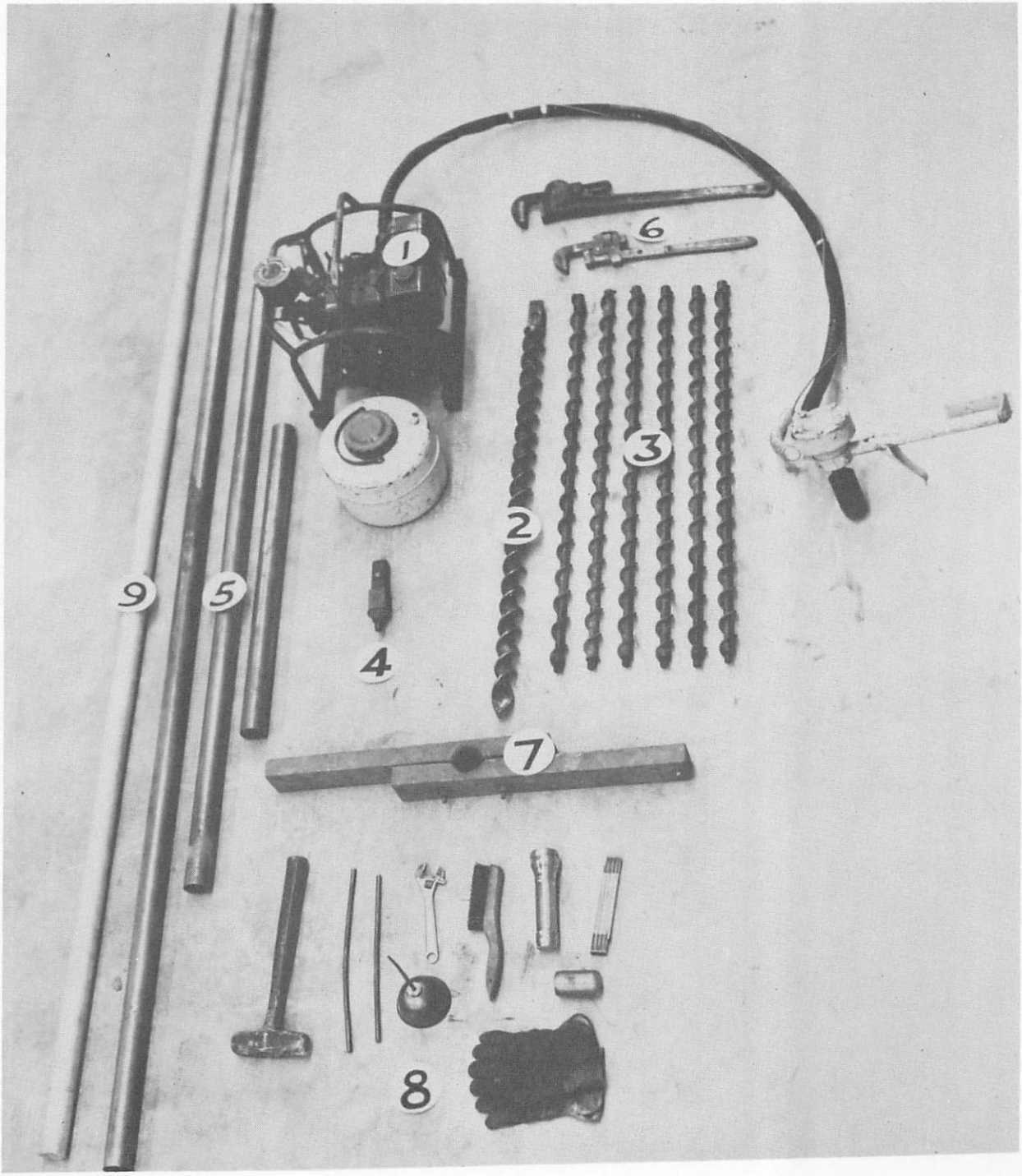

Fig. 1. Equipment used in the installation of access tubes for soil moisture measurement by the neutron method. (1) Portable power soil sampler; (2) two-inch auger; (3) full-flight extensions; (4) Adapter for power soil sampler; (5) steel tubing, two-inch O.D.; (6) pipe wrenches; (7) oak puller; (8) miscellaneous; (9) aluminum access tube, two-inch O.D.

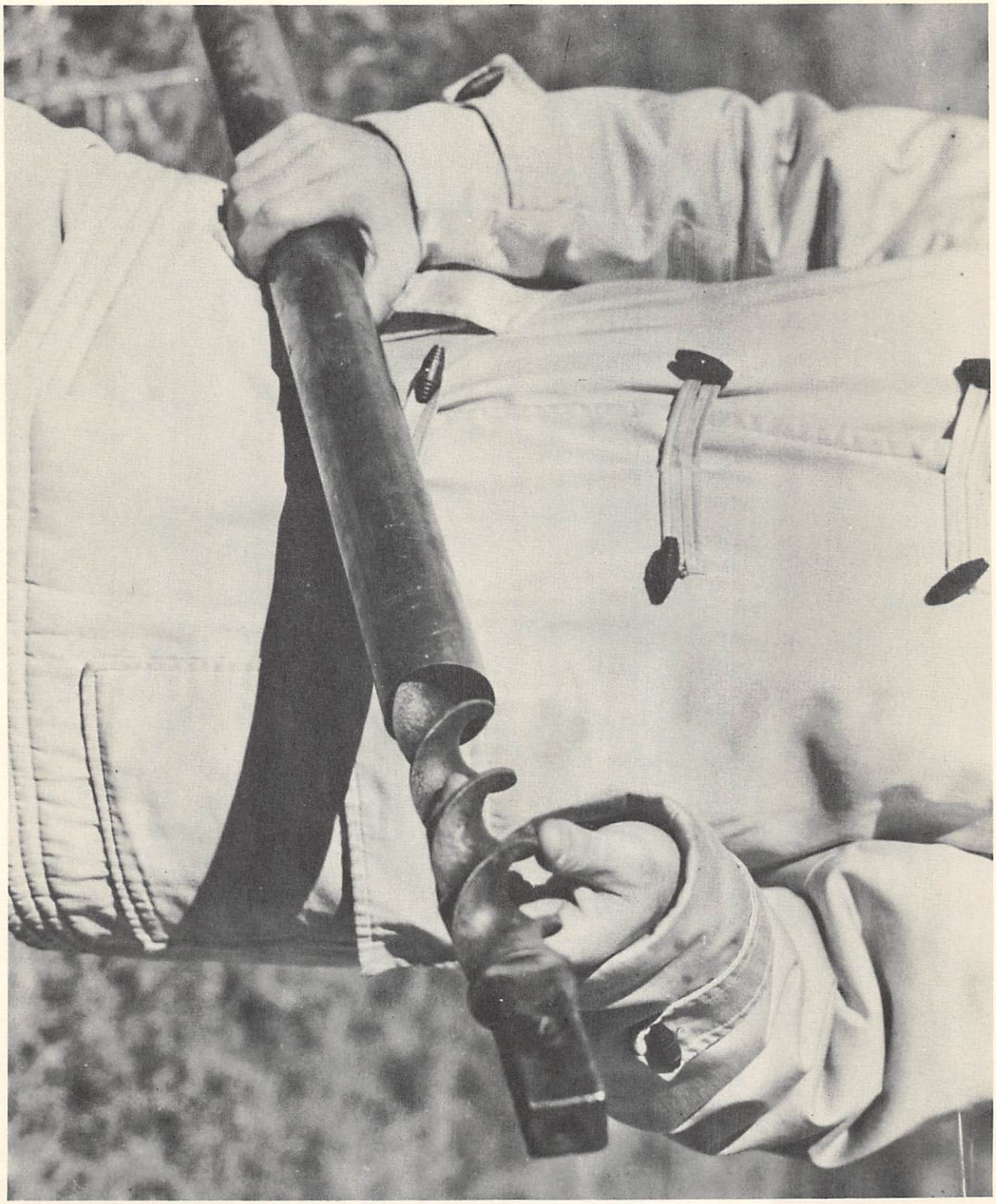

Fig. 2. Full-flight two-inch auger ground to fit inside steel tubing utilized as drill casing.

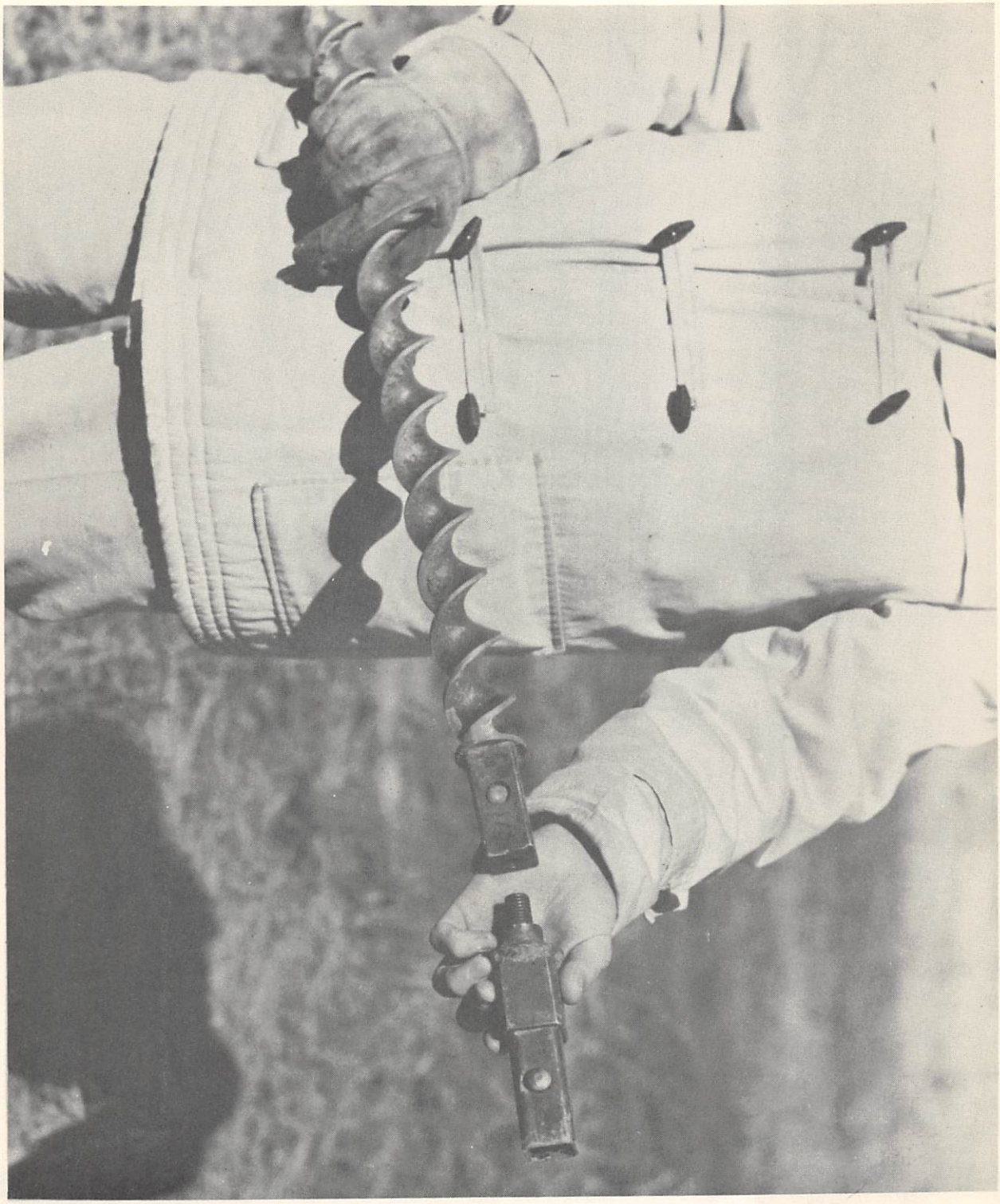

Fig. 3. Two-inch full-flight auger showing special adapter for attachment to power sampler.

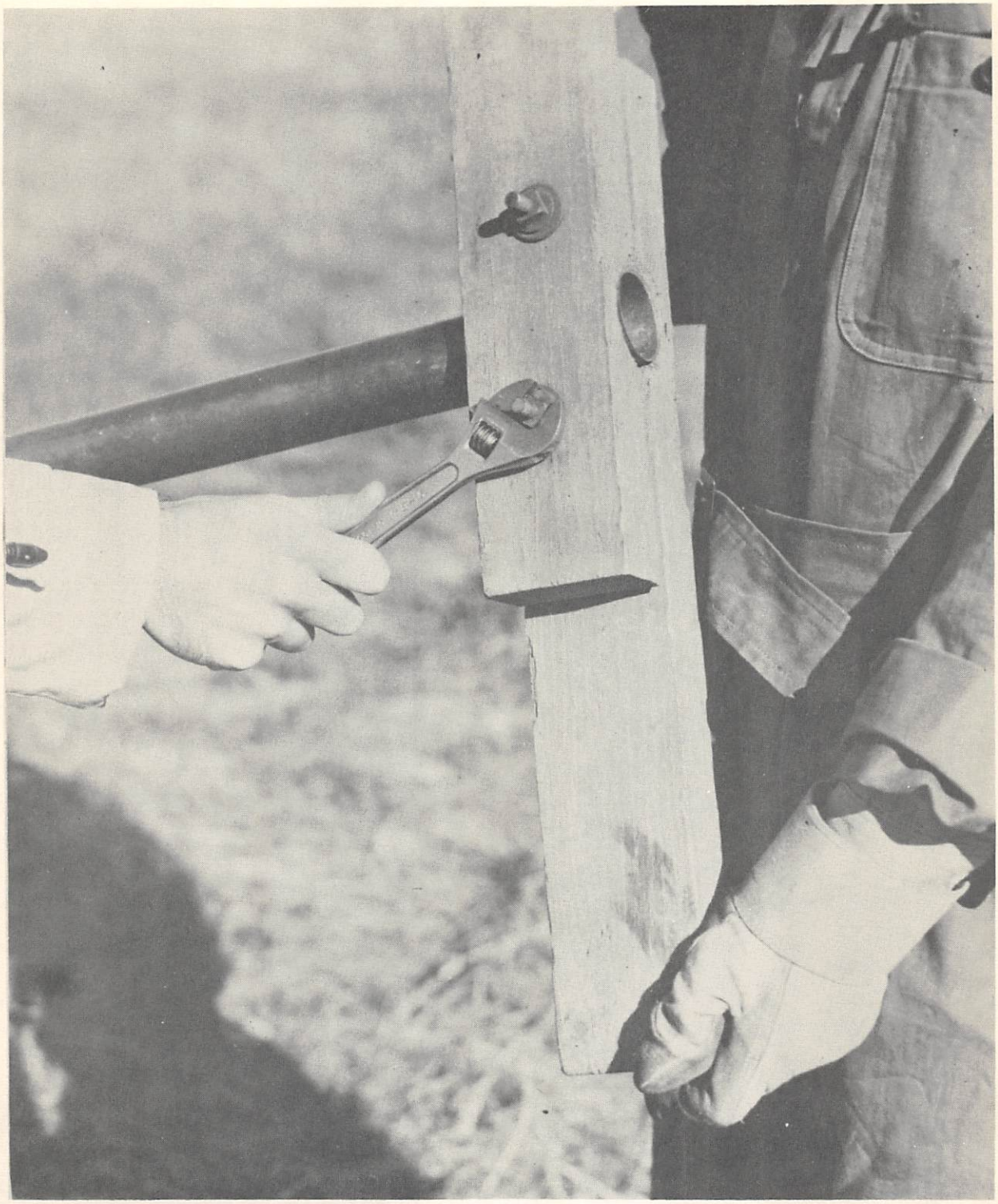

Fig. 4. An oak puller used to push steel casing into the ground and to remove same after drilling.

Fig. 5. Drilling operation showing assistant holding oak puller steady while driller operates power sampler.

Fig. 6. Drilling operation showing oak puller flush with ground surface and driller deepening hole preparatory to installing longer casing.

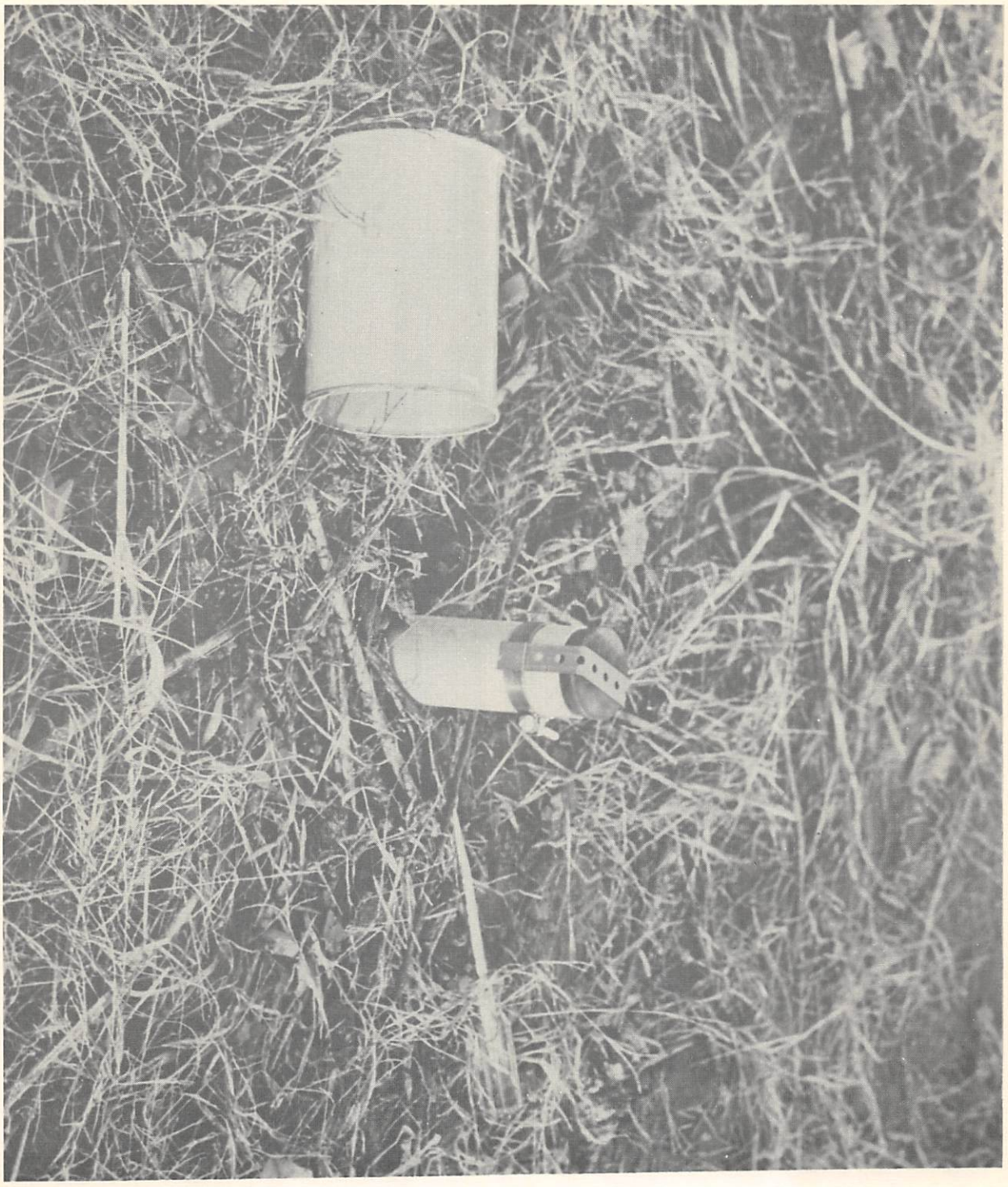

Fig. 7. Access tube installation showing aluminum access tube, stopper, securing device, and painted can used to cover the projecting tube.

Fig. 8. Access tube in use. Note presence of growing plants and general appearance of area surrounding installation.