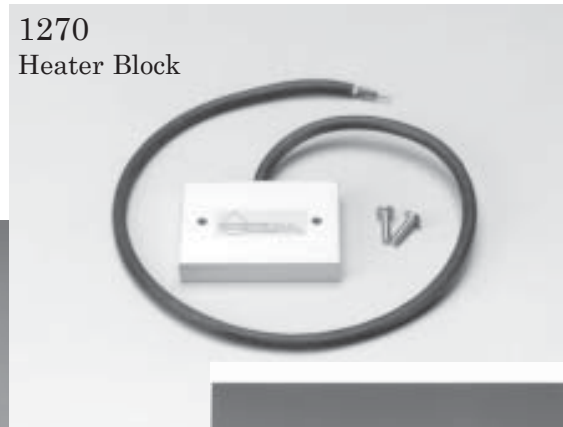


1250

OPERATING INSTRUCTIONS

Volumetric Pressure Plate Extractor and Hysteresis Attachments

04/2005



1250 OPERATING INSTRUCTIONS

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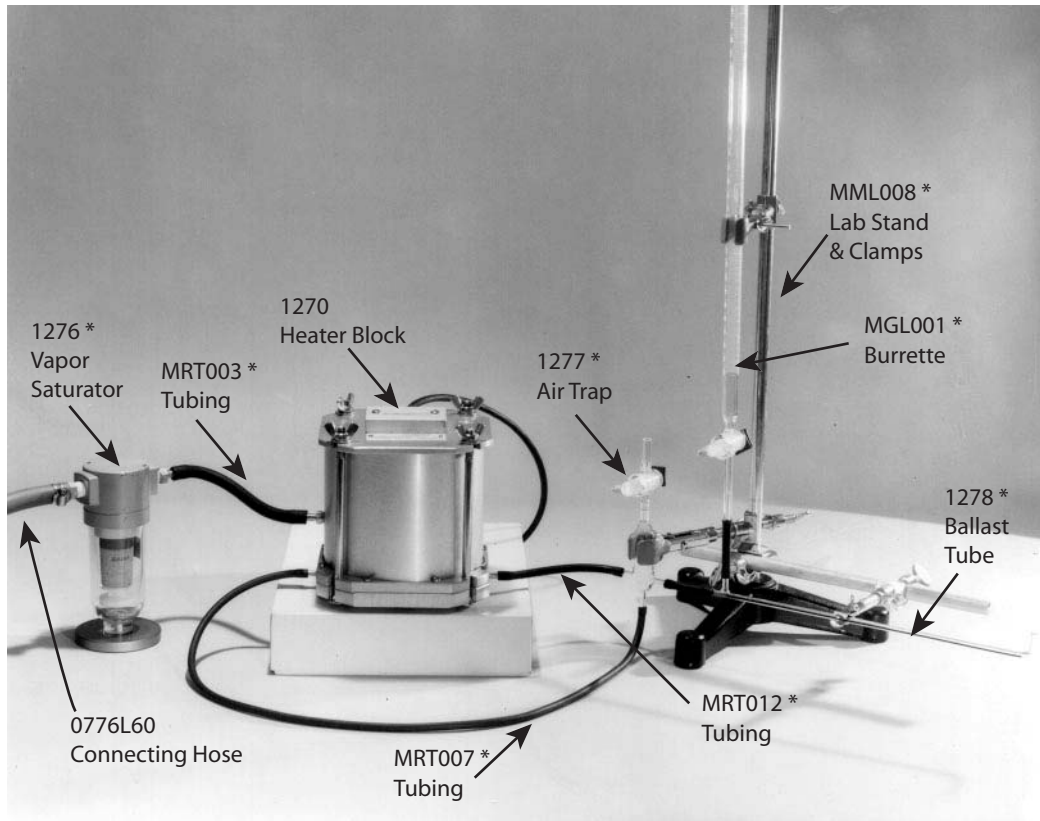
SOILMOISTURE EQUIPMENT CORP.

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THE MODEL 1250 VOLUMETRIC PRESSURE PLATE EXTRACTOR is a precision extractor designed so that the outflow section of the instrument is stable dimensionally. When the extractor is used in conjunction with the Hysteresis Attachments, the volume of water removed from the sample at each increasing pressure step can be accurately measured and retained. When pressure values are subsequently reduced, the volume of water that returns to the soil can then also be accurately measured.

By this means, one can investigate the hysteresis properties of the soil. The Volumetric Pressure Plate Extractor in conjunction with the Hysteresis Attachments also makes it possible to measure the capillary conductivity of soils. The extractor can, of course, be used for any routine moisture extraction work on disturbed samples or undisturbed soil cores.

For full range operation, the extractor requires a source of carefully regulated air pressure with a range of 0 to 30 psi (2 Bars or 200 kPa).

UNPACKING

When unpacking your Volumetric Pressure Plate Extractor, carefully remove all packing material and tape, and check for any damage that may have occurred during shipment, especially to the Porous Ceramic Plate.

NOTE: ANY DAMAGE FOUND UPON RECEIPT SHOULD BE REPORTED IMMEDIATELY TO THE TRANSPORT CARRIER FOR CLAIM. IT IS IMPORTANT THAT YOU SAVE THE SHIPPING CONTAINER AND ALL EVIDENCE TO SUPPORT YOUR CLAIM.

Be sure to read all operating instructions thoroughly before operating the extractor.

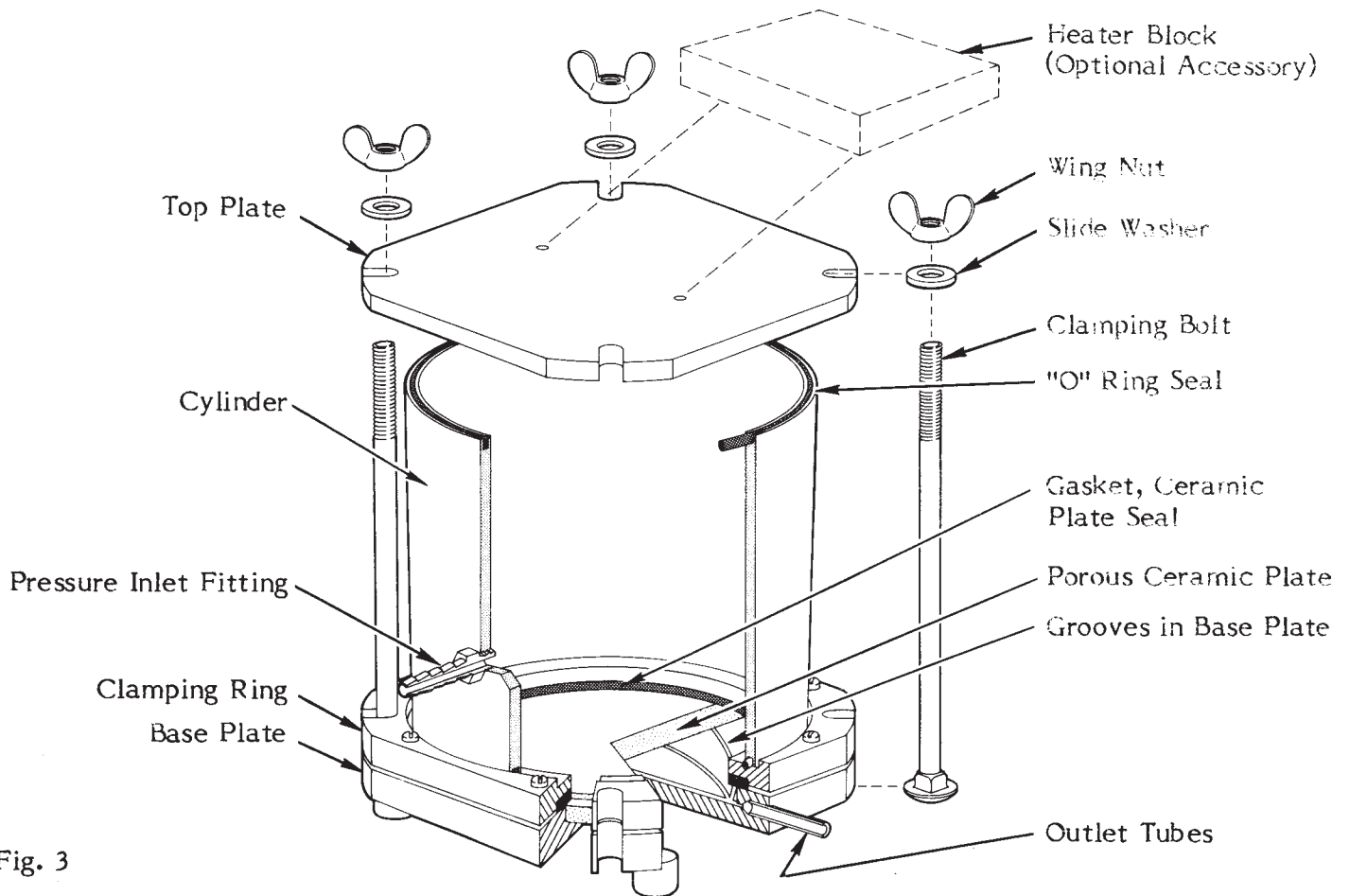


Fig. 3

ACQUAINT YOURSELF WITH THE PARTS CONSTRUCTION DETAILS

The extractor incorporates a 2 bar porous ceramic plate which permits the operation of the extractor at any pressure between 0 and 2 bars (30 psi).

Fig. 3 shows a cutaway view of the extractor. The three operating sections of the unit are held together by four clamping bolts and wing nuts. In breaking the unit down for loading, it is only necessary to loosen the four wing nuts and slip the clamping bolts out of their slots. You will note that the clamping bolts have square sections at the head of the bolt which fits into the constraining groove in the base plate. This prevents the bolts from turning when the wing nuts are tightened or loosened. The porous ceramic plate has been carefully ground and fitted to the base plate so that there is a minimum space for entrapment of air. Five symmetrically machined grooves in the base plate, beneath the porous ceramic plate, provide channels for the outflow of moisture from the extractor to the two outlet tubes on opposite sides of the base plate.

The cylinder of the extractor contains the pressure inlet fitting to supply regulated pressure to the extractor. The cylinder is sealed to the base plate and the top plate when assembled by "O" ring seals which are snugly fitted into the grooves in the ends of the cylinder. The "O" ring seals assure a reliable pressure seal requiring only moderate clamping force on the wing nuts.

Two tapped holes in the cover of the extractor are provided to accept the Heater Block. If one is conducting long-run, precise experiments, such as in the investigation of the hysteresis properties of soils, errors can be introduced by moisture condensing on the inside walls of the extractor due to temperature differences between the soil sample in the extractor and the walls of the extractor. This can be avoided by conducting the work in a temperature-controlled laboratory room. If this is not available, one can mount the Heater Block. The Heater Block operates on 12 volts AC or DC and puts out 3 watts of heat. This small source of heat maintains the walls of the extractor at a slightly higher temperature than that of the soil sample, and eliminates condensation on the inside walls of the extractor.

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The Heater Block is ordered separately as an accessory item.

UNIT SPECIFICATIONS

Pressure Rating: 2 Bars (30 psi)
Ceramic Plate Working Diameter: 4.69 in. (11.7 cm)
Ceramic Plate Thickness: .32 in. (.81 cm)
Ceramic Plate Conductivity: $K = 6.30 \times 10^{-7}$ cm/sec.
Overall Dimensions:
Height: 6 inches (15.3 cm)
Width: 5-7/8 inches (14.9 cm)

MODEL 1275 HYSTERESIS ATTACHMENTS

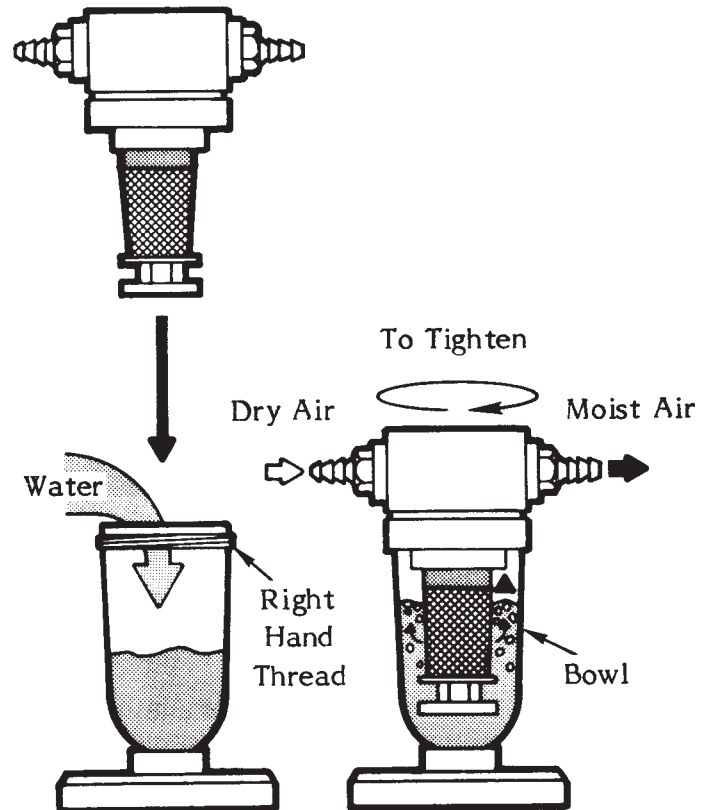
The Hysteresis Attachments have been designed specifically to operate with the Volumetric Pressure Plate Extractor. The purpose of the Hysteresis Attachments is to accurately retain all of the moisture removed from a sample during the extraction process and to permit the backflow of moisture from the storage area into the sample as extraction pressures are reduced. The attachments therefore, provide a means of accurately determining the moisture removed from a sample at progressively increasing pressure steps for comparison to the moisture absorbed by the sample as the pressure is successively reduced. This process corresponds to the drying and wetting cycle that occurs in soils in the field. From the information obtained, one can delineate the hysteresis effects of various soils.

Because of the extreme accuracy with which moisture removal and uptake can be measured with the Volumetric Pressure Plate Extractor in conjunction with the Hysteresis Attachments, the apparatus also makes it possible to measure the unsaturated capillary conductivity of soils.

The various parts of the Hysteresis Attachments are pictured and identified in Fig. 2 by an asterisk (*).

VAPOR SATURATOR

Air enters through the Vapor Saturator. Prior to use, the bowl of the saturator is unscrewed from the cap and partially filled with water, see Fig. 4. The bowl is then replaced. The purpose of the saturator is to completely saturate incoming air to the Volumetric Pressure Plate Extractor so that there will be no drying effect on the soil sample being tested, so that no errors will be introduced into the water volume measurement from this source. The Vapor Saturator is designed for operation at pressures up to 30 psi.



AIR TRAP

The Air Trap, see Fig. 5, fabricated from glass, provides a place for collection of air that may defuse through the porous ceramic plate in the extractor or which may come out of solution in the water during a run. The "level mark" on the stem of the Air Trap provides a convenient reference point to set the water level before reading the amount of water removed from a sample during a run.

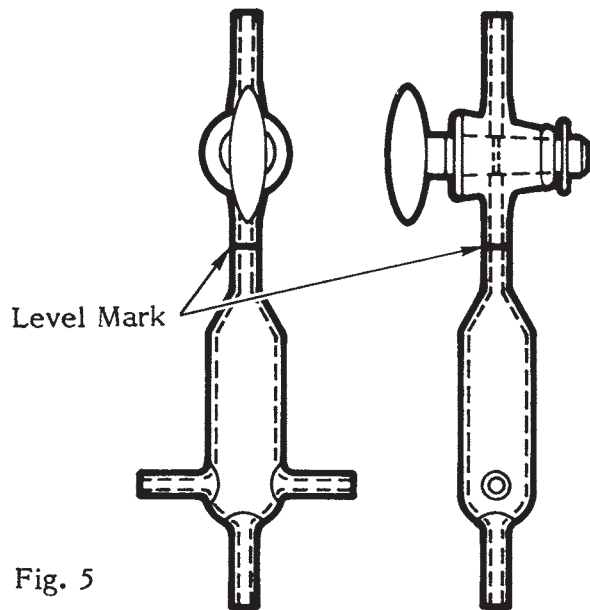


Fig. 5

BALLAST TUBE

The Ballast Tube, see Fig. 6, fabricated from glass, provides a horizontal storage area for water flowing in or out of the soil sample within the extractor. Because the Ballast Tube is in a horizontal position the outflow of moisture or uptake of moisture does not change the hydraulic pressure relations existing within the soil sample during the extraction process.



Fig. 6

The Ballast Tube is positioned either at the center line of the soil sample or at the base line of the soil sample, depending upon the requirements of the test being run. A "level mark" on the upturned end of the Ballast Tube provides a reference point for setting the water level when outflow or uptake volume measurements are being made.

BURETTE

The Burette shown in Fig. 2 provides a storage place for water. When measurements are made after equilibrium is reached, the height of the liquid within the Burette indicates precisely the amount of moisture removed or added to the soil sample within the extractor.

ADDITIONAL HYSTERESIS EQUIPMENT

In addition to the glass parts, the Hysteresis Attachments include a suitable laboratory stand and assortment of laboratory clamps to support the various operating parts of the attachments, see Fig. 2.

The interconnecting rubber tubes to link up the various parts, as indicated in Fig. 2, are also supplied.

AIR PRESSURE SOURCES

EXISTING LABORATORY AIR SUPPLY AS SOURCE

The input pressure can be from a laboratory supply line which delivers pressure of 50 psi or higher. For accurate extraction work, it is essential to have a well regulated pressure. Our Model 0700G3 Manifold is normally used to provide regulated pressure to the Volumetric Pressure Plate Extractor, see Fig. 7. The Model 0700G3 Manifold provides regulated pressure in the range from 0 to 60 psi with accuracy of regulation within 1/100 psi of the set value. The maximum input pressure to the Model 0700G3 Manifold is 400 psi.

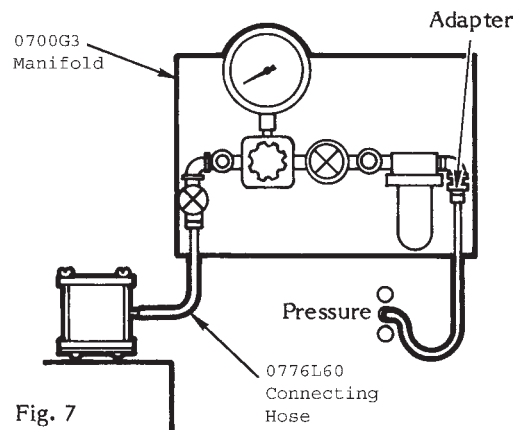


Fig. 7

Thread size on the Model 0700G3 Manifold fittings are 1/4 NPT pipe thread, which is a U. S. standard pipe size. Where you are providing hose connection from a laboratory supply line you may need to replace the inlet fitting of the Model 0700G3 Manifold. Our current price list carries a number of adapters that may suit your requirements. Our Model 772G02 Adapter converts the 1/4 NPT inlet thread to a 1/4" I.D. hose size.

LABORATORY COMPRESSOR AS SOURCE

The input pressure can be from our Model 0500 Series PM Compressors which are designed to provide a source of pressure for all of our extractors, see Fig. 8.

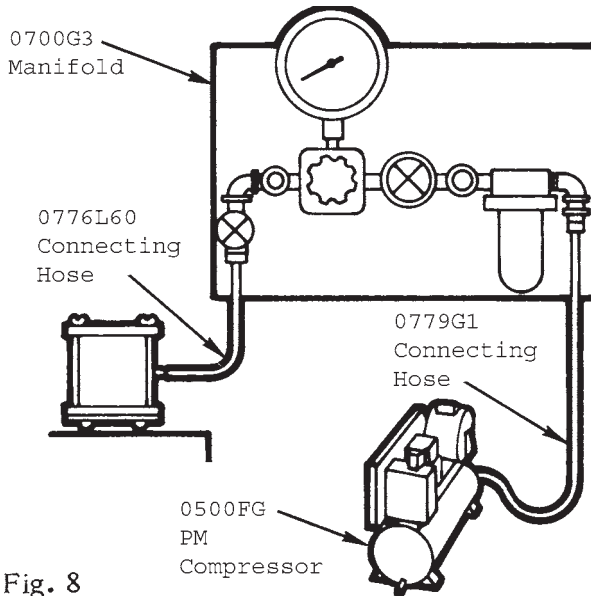


Fig. 8

PRESSURIZED AIR CYLINDER AS SOURCE

If air from a compressor is not available and one is obliged to operate from high pressure compressed air or nitrogen in tanks, our Model 0750G3 Manifold can be used. Accuracy of pressure regulation from this source is not as accurate as from our Model 0700G3 Manifold. From the Model 0750G3 one can expect variations of pressure in the low pressure range of approximately 1/10 to 2/10 psi from the set value. Fig. 9 shows a schematic view of the laboratory setup.

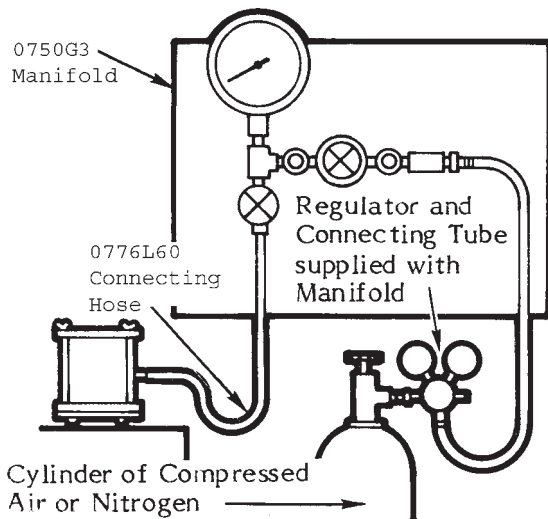


Fig. 9

The Model 0700G3 or the Model 0750G3 Pressure Control Manifold may also be purchased as part of a combination pressure control manifold, such as the Model 0700CG123 or 0750CG123, used where several different types of extractors are operating together.

CAUTIONS OR WARNINGS

Be sure seating area of "O" rings are clear of soil particles before assembling the extractor. Check to see that the top plate is set firmly in place, with the bolts and wing nuts seated properly. Inspect for wear on the threads and bolts, then tighten until a good seal is made.

The regulated pressure supply must always include an accurate pressure gauge to register pressure within the extractor.

Increase pressure gradually and carefully, preventing the possibility of over-pressurizing the unit.

MAKING A RUN FOR PERCENT MOISTURE DETERMINATION

In making a run with the Volumetric Pressure Plate Extractor, soil samples are handled in the same manner as for other pressure plate extractors.

Undisturbed soil cores should be trimmed flat so that they make good contact with the ceramic plate.

Disturbed or loose soil samples should be prepared in conformance to recommendations by the United States Department of Agriculture as outlined below:

The soil is passed through a 2 mm round hole sieve with the aid of a rubber stopper. One purpose of such sieving is to remove rocks larger than 2 mm; another is to reduce all aggregates to less than 2 mm. In the removal of rocks between 2 mm and 6 mm, they may be returned to the screened sample if desired. The entire sub-sample is then placed on a mixing cloth and pulled in such a way as to produce mixing. Some pulling operations will produce segregation instead of mixing, and special care must be exercised to obtain a well mixed sample. The soil sample is then flattened until the pile is 2 to 4 cm deep.

For moisture retentivity, hydraulic conductivity, and modulus of rupture tests, 2 to 6 sub-samples, each having a fairly definite volume, are required. Use paper cups to hold the individual sub-samples. Mark with a pencil line around the inside of the cup the height to which the cup is to be filled to give the correct amount of sub-sample. Then, using a thin teaspoon or a small scoop,

lift small amounts of soil from the pile, placing each in successive cups and progressing around the pile until the cups are filled to the desired level. It is difficult with some soils, especially if they have been passed through a 2 mm round-hole sieve, to take samples from the pile, without allowing the larger particles to roll off the spoon or scoop. This roll back should be avoided because it makes the extracted sub-sample non-representative. The rollback problem is practically absent from some soils, especially if all the sample has been passed through an 0.5 mm sieve.

Undisturbed soil cores or prepared soil samples must be appropriately retained by a Soil Sample Retaining Ring or other cylinder, see Accessories on Page 12, so that they can be supported on the porous ceramic plate of

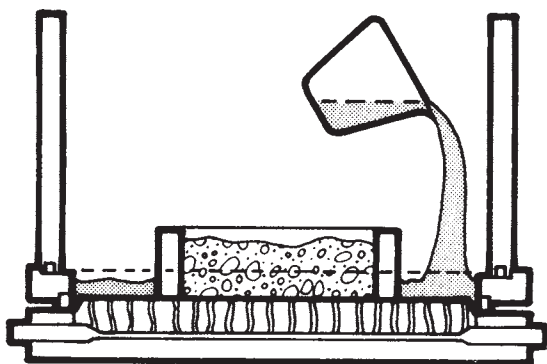


Fig. 10

the extractor. After the sample is mounted on the porous ceramic plate, see Fig. 10, an excess of water is allowed to stand on the plate so that the samples can be soaked with water for at least 16 hours until they are fully saturated. The reservoir formed by the clamping ring of the extractor is convenient for retaining water during this soaking period.

After the soaking period, excess water on the plate can be removed by a syringe or plastic spout top bottle.

The cylinder and top plate of the extractor are then mounted so that air pressure can be applied to the extractor. Care should be taken to clear any soil particles from the seating area of the "O" rings prior to assembling the cylinder and top plate.

If the purpose of the run is simply to bring the soil sample to some known moisture content such as 1/3 bar, 1 bar or any specific value between saturation and 2 bars, then the air pressure within the extractor is set at the desired value. Setting the pressure at 4.8 psi (1/3 bar) will

cause moisture to be removed from the sample until, at equilibrium, the soil suction value within the sample will be 1/3 bar. Likewise, setting the air pressure at 14.5 psi (1 bar) will cause moisture to be removed from the sample until at equilibrium the soil suction value within the sample will be 1 bar.

As soon as air pressure is applied, water will start dripping from the outlet tubes on either side of the base plate, see Fig. 11. For this type of application, one of the outlet tubes can be closed by a rubber stopper so that the outflow comes from one tube. The water can be collected if desired in a burette so that the change in rate

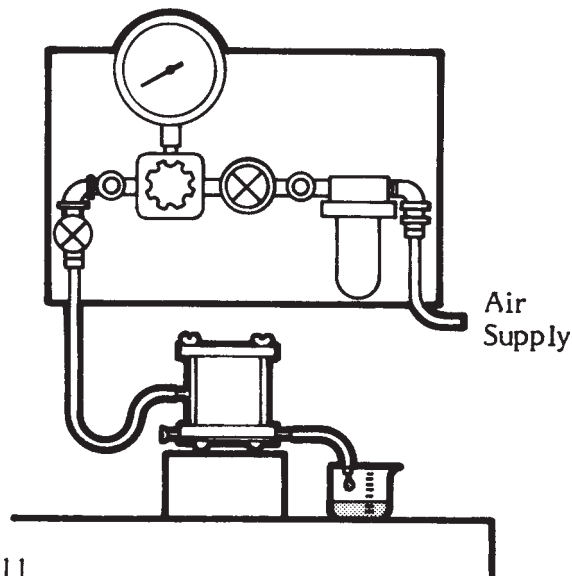


Fig. 11

of outflow can be observed. Initially, the flow from the plate will be at a maximum and then will taper off as equilibrium is approached. At equilibrium, there will be no flow of water from the extractor.

If the soil samples in the extractor are 1 cm high, as retained in our Soil Sample Retaining Rings, equilibrium on all types of soils will be reached within 48 hours. Some soils will approach equilibrium in 18 to 20 hours. In general, the time to reach equilibrium is a function of the height of the soil sample as well as the conductivity characteristics of the soil. The time to reach equilibrium is proportional to the square of the height of the sample. In other words, a sample 2 cm high would require 4 times as long to reach equilibrium as a sample 1 cm high. In any event, true equilibrium can be determined by the outflow of moisture, and when this ceases equilibrium has been reached.

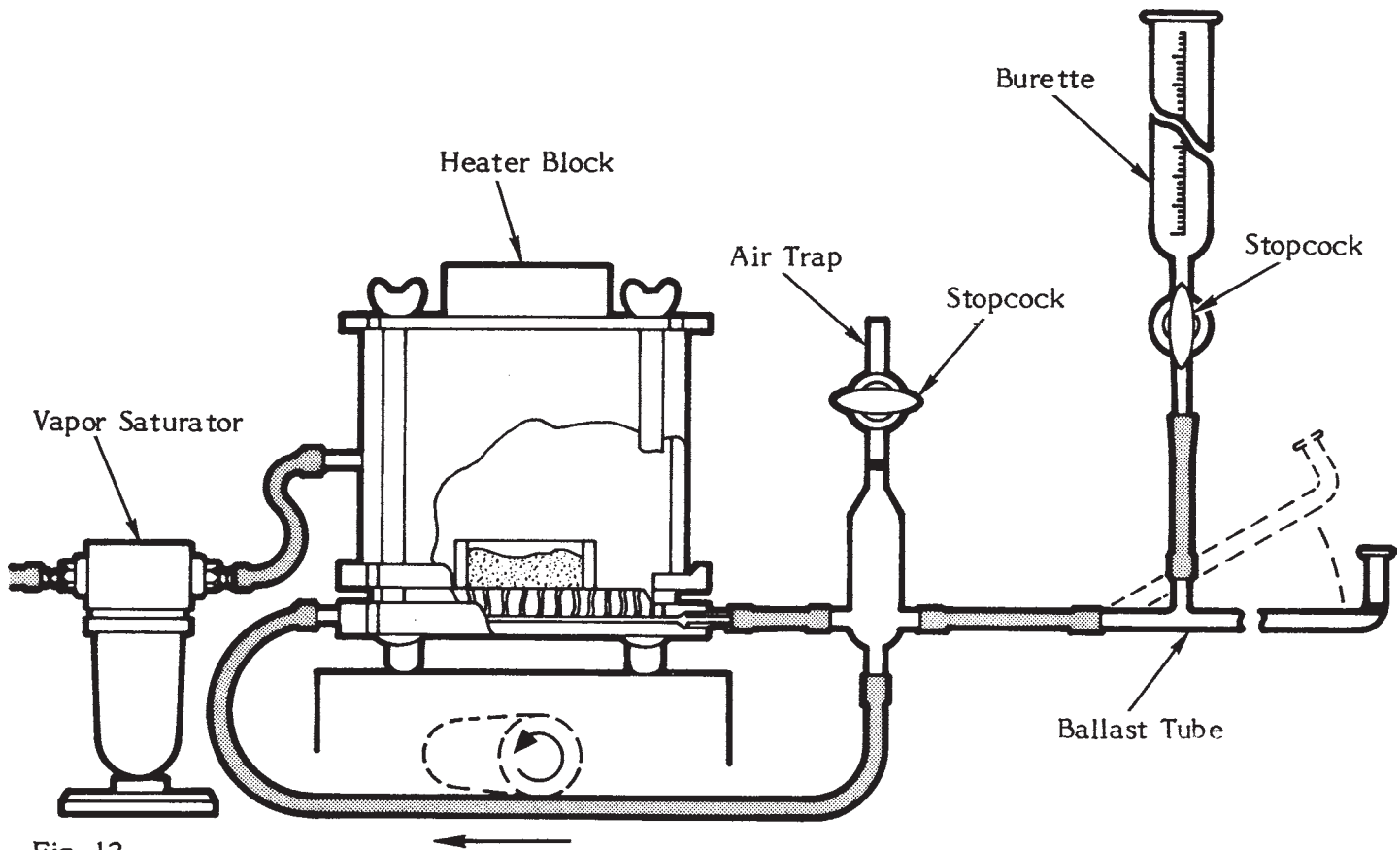


Fig. 12

After equilibrium has been reached, the pressure is released and the extractor immediately opened and the samples removed and placed in moisture boxes to prevent any further changes in moisture content. If the purpose of the run is to measure the moisture content at the specific soil suction value, then the sample and moisture box would be weighed. The sample would then be dried to constant weight at 105°C. The loss in weight of the sample would then be divided by the dry weight of the sample and the moisture content would be expressed as a percentage of dry weight.

MAKING A RUN FOR HYSTERESIS STUDIES

After the soil sample has been prepared and fully saturated in the extractor, as indicated on Page 6, connections are made to the various parts of the Hysteresis Attachment. This is shown in Fig. 2, and then further clarified in Fig. 12 above, which shows a diagrammatic view of the arrangement.

For accurate hysteresis measurements, the extractor should be run in a temperature controlled room or you should attach and operate the Heater Block. This is essential to keep moisture from accumulating on the inside of the extractor walls and thus introducing an error in the measurement, as explained on Page 3.

Water is now added to the Hysteresis Attachments to fill the various connecting tubing and the Air Trap up to the "level mark". This is most easily accomplished by pouring a small quantity of water in the Burette. The stopcock at the base of the Burette is then opened and the stopcock at the top of the Air Trap is opened so that water can flow into the Air Trap and connecting tubing. Care should be taken to adjust the Ballast Tube so that water does not flow out the end of the Ballast Tube during this initial filling operation. When water has reached the "level mark" in the Air Trap, the stopcock at the base of the Burette and the stopcock at the top of the Air Trap are closed.

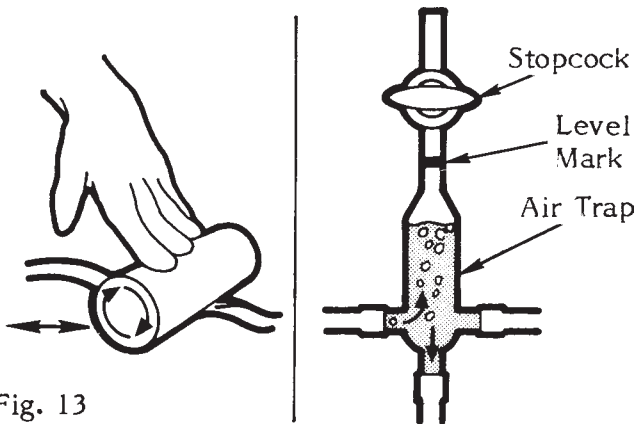


Fig. 13

Water is now circulated underneath the porous plate within the extractor by running a roller over the connecting tube as shown in Figs. 12 and 13. Running the roller over the connecting tube pumps water from the Air Trap through the grooves in the base of the extractor, underneath the porous ceramic plate. This pumping action forces out air bubbles which then accumulate in the Air Trap. When all the air has been removed, this rolling (pumping) operation is stopped. The water is then, again adjusted to the "level mark" of the Air Trap by opening the stopcock at the top of the Air Trap and then opening the stopcock at the bottom of the Burette so that additional water can flow in until it reaches the "level mark". At this point the stopcock at the top of the Air Trap is immediately closed and the stopcock at the bottom of the Burette is closed.

The height of the Ballast Tube is now adjusted so that it is level with the top surface of the porous ceramic plate of the extractor, or with the center line of the sample, if this reference point is desired. To do this it may be necessary to elevate the extractor by placing it on a block of wood or other support. The extractor is now closed.

Water remaining in the Ballast Tube should be removed before applying pressure to the extractor. This is accomplished by applying a low vacuum at the top of the Burette, see Fig. 14. Very little vacuum is required, and this can be supplied by a conventional laboratory vacuum line or by an air aspirator or by mouth. While the vacuum is applied at the top of the Burette, the stopcock is carefully opened at the bottom of the Burette. Existing water then begins to move from the Ballast Tube up into the Burette. When sufficient water has been brought up into the Burette, the stopcock at the bottom of the Burette is closed and the vacuum is removed.

In order to establish a starting point for the soil moisture hysteresis attachments, a low pressure such as 1/

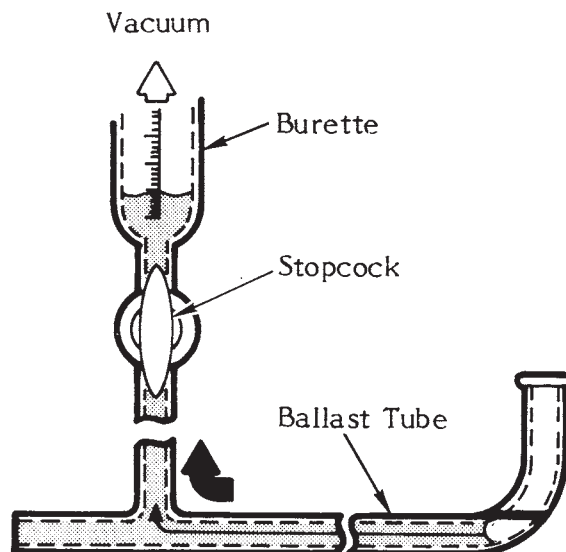


Fig. 14

10 bar, 1.45 psi, is applied to the extractor from the pressure supply manifold.

Once the pressure has been applied to the extractor, moisture will begin to move out of the sample until the first equilibrium value is established. As moisture is removed, it will accumulate in the Ballast Tube. When the Ballast Tube fills with water and outflow is still taking place from the extractor the existing water in the Ballast Tube is pulled up into the Burette, as shown in Fig. 14.

CAUTION

The initial outflow of water may be of considerable volume if the soil sample being run is large. Attention must be paid for the first few hours after the pressure is first applied to make sure the Ballast Tube does not overflow.

The lifting of the water up into the Burette provides the additional volume needed to take care of additional outflow of moisture from the soil sample.

When outflow of moisture from the sample has completely ceased, as determined by a stoppage of water flowing into the Ballast Tube, then equilibrium has been reached.

Before making a reading, several adjustments need to be made.

First, purge any accumulated air from the grooves underneath the porous ceramic plate. This is done by run-

ning a roller over the connecting tube as shown in Figs. 12 and 13, and as explained earlier. During a run, air tends to accumulate in the grooves underneath the porous ceramic plate. This air accumulation would introduce errors in the liquid volume measurement if not removed. Air accumulation under the porous ceramic

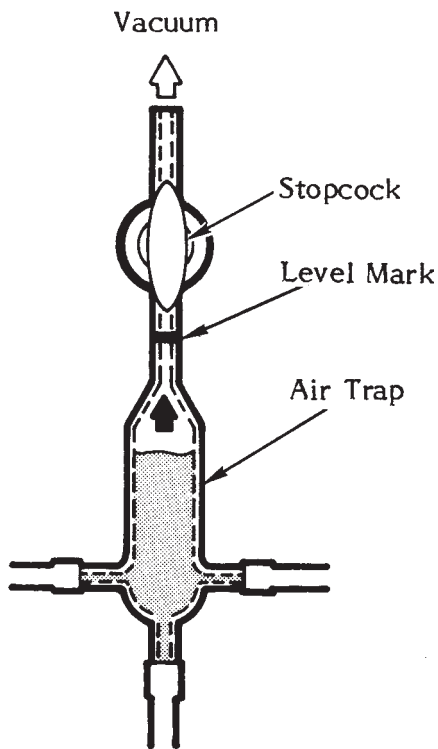


Fig. 15

plate would also tend to prevent liquid uptake by the sample in experiments where air pressure is reduced after equilibrium is reached. Running the roller over the connecting tube purges accumulated air which collects in the Air Trap.

Next, adjust the water in the Air Trap to the "level mark", see Fig. 15. If water in the Air Trap is below the "level mark", apply a vacuum to the outlet stem of the Air Trap and carefully open the stopcock on the Air Trap until the water rises to the "level mark". Then close the stopcock and remove the vacuum.

The water level in the Ballast Tube is now adjusted to the "level mark", see Fig. 16. If the water level is below the "level mark", the stopcock on the Burette is carefully opened to allow water from the Burette to flow into the Ballast Tube up to the "level mark". The stopcock is then closed. If the water level in the Ballast Tube is above the "level mark", then a low vacuum is applied to the top of the Burette before the stopcock is opened. When the burette stopcock is carefully opened, the

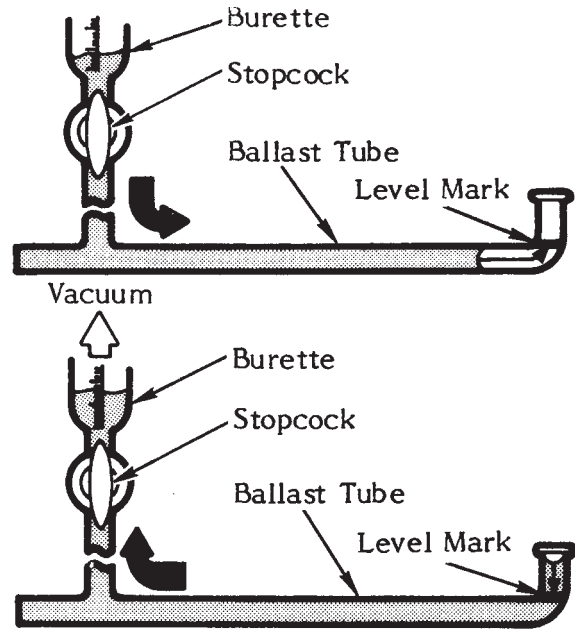


Fig. 16

vacuum will pull water out of the Ballast Tube up into the Burette. When the water reaches the "level mark" in the Ballast Tube, the Burette stopcock is closed and the vacuum is removed.

The volume reading in the Burette at the first equilibrium value is now noted down. This will then be the starting point for all future measurements of moisture removed from the sample during the run.

After the establishment of the starting volume value on the burette, pressure within the extractor is raised to the next desired value. As soon as the pressure is raised within the extractor, moisture will then flow from the soil sample and collect in the Ballast Tube. Where you are removing moisture from the soil sample at successively increasing pressure values, you must make provision for the outflow of additional water by pulling water from the Ballast Tube up into the Burette. In other words, after you have made the equilibrium volume reading on the Burette, you again apply vacuum to the top of the Burette, open the stopcock at the bottom of the Burette and pull water from the Ballast Tube up into the Burette, and then close the stopcock at the bottom of the Burette. This procedure provides a volume within the outflow system for the accumulation of additional water from the soil sample, see Fig. 17.

Again, after equilibrium at the new pressure value is reached, as indicated by the stoppage of additional water flowing into the Ballast Tube, the water within the outflow system is adjusted up to the "level mark" on the

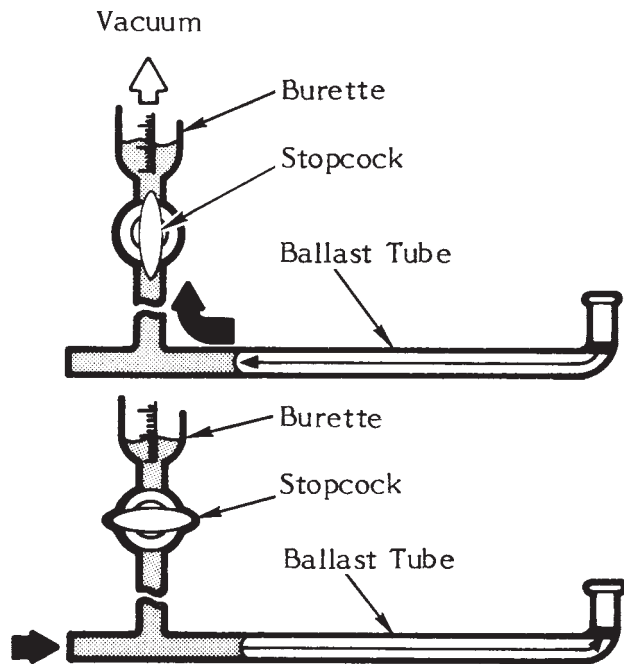


Fig. 17

Air Trap on the Ballast Tube, as indicated earlier. A new volume measurement is then made on the Burette, and recorded. The change in volume, as indicated by the two measurements on the Burette, indicate precisely the amount of moisture that was removed from the soil sample between the two equilibrium air pressure values applied to the soil sample in the extractor.

This process is repeated at increasing pressure values until the desired range in pressure is covered.

The reverse process can now be carried out. In this case, the pressure within the extractor is now reduced. When the pressure in the extractor is reduced, water will begin to flow back into the sample from the Ballast Tube. This backflow of moisture into the sample can be noted by the movement of the water meniscus in the Ballast Tube. When movement of water from the Ballast Tube has ceased, a new equilibrium at the lower pressure has been reached.

During the backflow of moisture into the sample, more water may be required than is stored in the Ballast Tube. To add more water to the Ballast Tube, simply open the Burette stopcock and allow water flow into the Ballast Tube up to the "level mark". See Fig. 18.

When equilibrium is reached, the water is again adjusted to the "level mark" on the Air Trap and the "level mark" on the Ballast Tube as described earlier. After the wa-

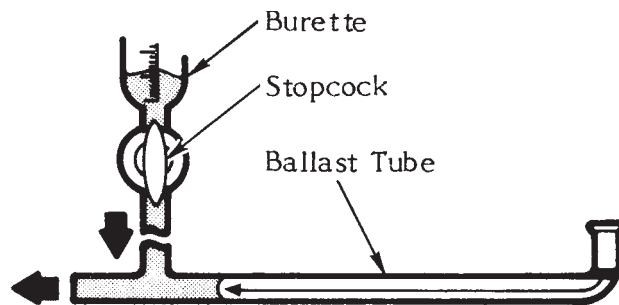


Fig. 18

ter level has been established at these two "level marks", the volume at the Burette is read and recorded. The decrease in volume in the Burette is an exact measurement of the amount of water that has moved back into the sample as a result of the decrease in pressure within the extractor.

At the close of the run after the last equilibrium value has been established and Burette reading recorded, the pressure in the extractor is released, and immediately opened, and the complete soil sample immediately removed and transferred to a conventional moisture box and weighed. The complete soil sample is then oven dried at 105°C, until no further loss of weight occurs.

The sample is again weighed. The moist weight of the sample at the last equilibrium value is then compared to the dry weight of the sample so as to develop the moisture percentage in the sample at the last equilibrium value. The changes in the volume of water removed from the sample as developed by the volume readings on the

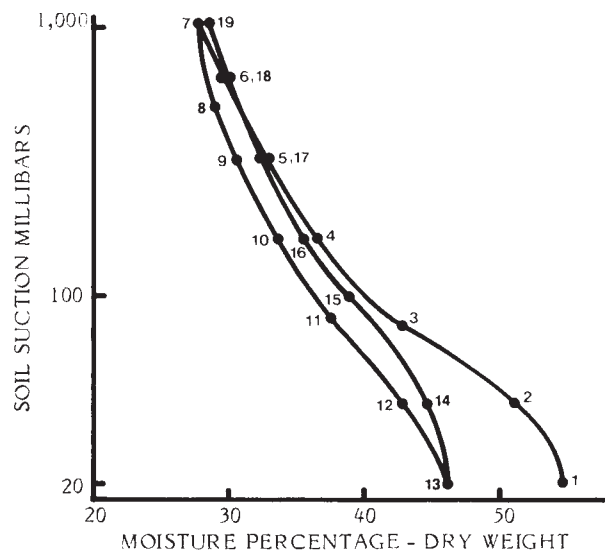


Fig. 19

Burette during the course of the run permit you to determine accurately the moisture percentage within the soil sample at each of the equilibrium values established during the run. The percent of moisture is then plotted against the equilibrium pressure values. Fig. 19 shows the hysteresis effects in Aiken Clay Loam as developed from measurements with the Volumetric Pressure Plate Extractor.

MAKING A RUN TO ESTABLISH MOISTURE RETENTION CURVES

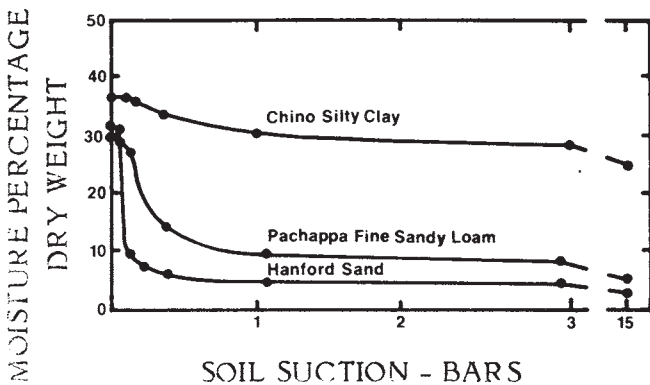


Fig. 20

The Volumetric Pressure Plate Extractor can be used to develop accurate moisture retention curves on all types of soils in the 0 to 2 bar range.

A moisture retention curve, or moisture characteristic as it is sometimes called, is the relationship of the moisture content of the soil to the soil suction value at which the moisture is held. Typical moisture retention curves for 3 types of soils are indicated in Fig. 20.

The procedure for developing moisture retention curves is identical to that used for measuring the hysteresis effects with the exception that the equilibrium values are established only at increasing pressure equilibrium values within the extractor.

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF UNSATURATED SOILS

The Volumetric Pressure Plate Extractor is suitable for measurement of hydraulic conductivity in unsaturated soils by the Unsteady State Method. This procedure is best described in the following publication:

Methods of Soil Analysis
Agronomy No. 9, Part I
Available from:
American Society of Agronomy
677 South Segoe Road

Madison, Wisconsin 53711, U.S.A.

Sections 16 and 17 of this publication describe the measurement of hydraulic conductivity of unsaturated soil, and the measurement of water diffusivity, which is closely related.

GENERAL CARE AND MAINTENANCE

Care of the Volumetric Pressure Plate Extractor

The extractor is ruggedly built and requires little in the way of maintenance. "O" ring seals and clamping bolts may need replacement over a long period of time. These are available and listed below and along with the Extractor on our current price list.

To prevent evaporation deposits on the porous ceramic plate of the extractor, which will slow down the flow rate, it is recommended that after a run the extractor is wiped dry of moisture and then a small quantity of a fine sandy loam soil may be placed on the porous ceramic plate of the extractor. The base of the extractor is then allowed to air dry. Moisture from the porous ceramic plate will move into the fine sandy loam during the drying process and any salt deposits will be made in the fine sandy loam rather than on the surface of the porous ceramic plate. After thorough drying, the soil on the plate can then be removed and the extractor closed for storage.

REPLACEMENT PARTS

Model No.	Description
M802X251	"O" Ring, Cylinder Seal
1252	Clamping Bolt Assembly
1253B02M1	Porous Ceramic Plate, 2 Bar
1254	Gasket, Ceramic Plate Seal
1276	Vapor Saturator
1277	Air Trap
1278	Ballast Tube
MRT003	Neoprene Tubing, 3/16" I.D. X 1/8" wall
MRT012	Neoprene Tubing, 1/8" I.D. X 1/16" wall

ACCESSORY ITEMS

PART NO.	DESCRIPTION
0206L06	Cylinder, 2-1/4" O.D. X 6 cm long
0206L03	Cylinder, 2-1/4" O.D. X 3 cm long
0206L01	Cylinder, 2-1/4" O.D. X 1 cm long
0700G3	Manifold
0750G3	Manifold
0772G02	Adapter, 1/4 NPT male pipe to 1/4" I.D. hose
1093	Soil Sample Retaining Rings, 1 dozen
1270	Heater Block & Mounting Screws
1275	Hysteresis Attachments
0776L60	Connecting Hose, 40" long
1426L6	Cylinder, 3-1/2" O.D. X 6 cm long
1426L3	Cylinder, 3-1/2" O.D. X 3 cm long

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