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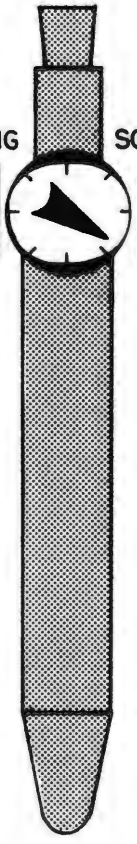
MAKING AND USING SOIL MOISTURE

TENSIOMETERS



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MAKING AND USING SOIL MOISTURE TENSIOMETERS

by

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WHAT ARE TENSIOMETERS?

Soil moisture tensiometers are instruments which measure the availability of water held by the soil, irrespective of soil type. Tensiometers can be purchased or parts purchased and assembled.

HOW DO THEY WORK?

Figure 1 shows a cross section of a tensiometer. The porous ceramic cup is located at the desired depth. As the soil dries, water moves from the tube to the cup into the drying soil, creating a vacuum in the tube. The gauge indicates the negative pressure or tension by showing a higher reading.

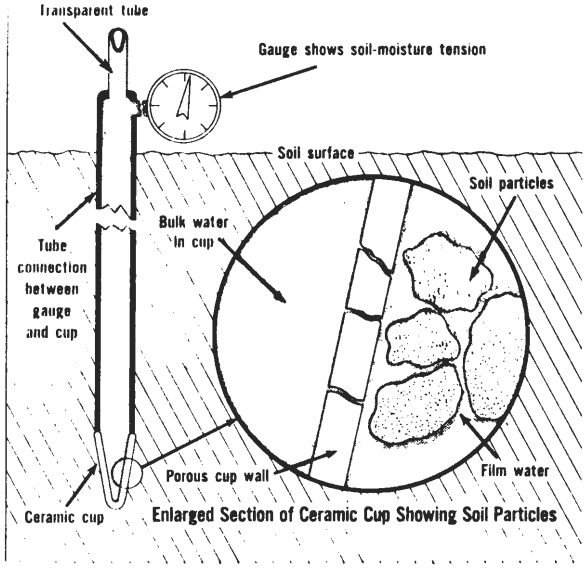

Figure 1. Cross section of a tensiometer

When the soil becomes wet from irrigation or rain, water moves back into the tensiometer, reducing the tension and causing the gauge to return to a lower reading.

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HOW ARE THEY USED?

Generally it is best to locate tensiometers at two depths at each location to better indicate wetting and drying trends throughout the rooting area. One tensiometer at one-third and another at two-thirds of the active rooting depth indicates average soil moisture conditions. On shallow-rooted crops requiring high soil moisture, such as potatoes, one tensiometer at a 9 to 12-inch depth may be sufficient. The number of stations needed in a field or orchard depends on size and differences in soil conditions. Two stations should be sufficient up to 10 acres, four stations for 40 acres, and eight stations for 160 acres.

On surface irrigated crops, stations should be located at the upper and lower ends of the field. On fields requiring several days to irrigate, stations should be located where irrigation is started and completed.

TABLE 1. Suggested location depths and tensions when irrigations should be made.

Crop	Centibars	Depth (In.)	Crop	Centibars	Depth (In.)
Beans (snap)	75	9	Potatoes	20	9
Cabbage	75	9	Alfalfa†	70	18
Peas (canning)	30	12	Small Grain†	50	18
Sweet Corn	75	9	Sugar Beets†	50	18
Strawberries	20	8	Fruit†	60	18

† Estimates only--specific research on these depths not available.

INSTALLING

Use a soil probe of the same size or slightly smaller than the tensiometer to make a hole in the soil to the desired depth. Fill the tube with clean water, place the stopper slowly, place some loose soil into the hole, place the tensiometer into the hole. A small amount of slurry of water and soil can be poured back into the hole to assure a good contact between the cup and the surrounding soil.

If air bubbles have appeared remove the stopper, refill with water and restopper. Backfill around the tube as needed.

PRECAUTIONS

When tensions exceed 75 to 80 centibars, air may enter the tensiometer requiring refilling the tube with water when an irrigation is made. If the stopper is to be removed while some vacuum is present, be extremely cautious. The gauge needle may return with such force it will require readjustment. Remove tensiometers during winter as freezing moisture will break ceramic cups. Protect tensiometer from machinery and livestock. Do not place in low areas where water may gather and erroneously show higher than normal moisture levels.

Under sprinklers cover the exposed portion of the tensiometer with a cover such as a quart can to prevent water from entering the gauge. If large air bubbles occur frequently and readings do not exceed 40 to 50 centibars, the instrument is probably leaking. If readings are not 0 when the stopper is removed or reads over 90, the gauge should be checked and recalibrated.

CONSTRUCTION PLAN 1

Cement with an epoxy metal compound a tensiometer-type ceramic cup into one end of the No. 80 ½-inch PVC pipe after cutting the pipe section to the desired length. Immediately place the pipe and attached tensiometer cup in a vertical position until the epoxy starts to harden. Then cement a Schedule 80 ½- x ½-inch slip and ½-inch threaded PVC tee onto the other end with epoxy metal compound. Cement a 1- to 2-inch piece of ½-inch PVC tubing in the other end.

In 15 to 20 minutes after cementing on the tee, place the tensiometer in an upright position with ceramic tip down--and cement a short piece of the plexiglass tubing into the top of the piece of ½-inch pipe in the tee with epoxy.

As soon as the epoxy stiffens or hardens (2 to 3 hours, depending on air temperature), lay the tensiometer flat with the right angle of the tee upright and attach the ½- to ¼-inch plastic reducer bushing by use of metal compound. This time allow the metal compound to completely harden. Place the tensiometer vacuum gauge into the reducer bushing using pipe thread sealer, pipe thread tape, or plumber's pipe thread compound.

Fill the tensiometer with water and seal with a Size "000" neoprene plastic stopper.

CONSTRUCTION PLAN 2

1. Cut PVC plastic pipe to desired length. The PVC pipe should be one to six inches longer than the desired depth of tensiometer placement in the soil. For row crops, use one inch extra length to place bottom of vacuum gauge near the ground surface so cultivating equipment can pass over. The clear tubing length should be from 2 to 6 inches long.

2. Coat about 1 ½-inch of one end of the PVC pipe and the inside of the PVC slip coupler with epoxy. Insert the pipe all the way through the coupler while the cement is fresh.

3. At the end of the PVC pipe without the coupler it is necessary to have a good smooth, square cut for a good fit between the ceramic cup and the pipe. A simple jig is very helpful for this cut.

4. Using the same procedure as for cementing PVC pipe to coupler, cement the clear tubing into the end of the pipe with the coupler.

5. Drill a 7/16-inch hole through coupler and PVC pipe, centering the hole about one inch down from the top of the coupler. With a standard ¼-inch pipe (IPS) tap, thread the hole to receive the vacuum gauge. Be careful to insert the tapered tap only far enough to allow the gauge to be screwed in because too large a hole will cause a leak.

6. Coat the neck and top of shoulder of the ceramic tensiometer cup with epoxy metal compound (PVC cement hardens and makes a brittle joint, so it should not be used). Apply epoxy metal compound to the bottom and into the inside of PVC pipe for about ½-inch. Allow to dry. Apply another coat to the neck and shoulder of the cup. Insert the neck of the cup into the PVC pipe with a twisting motion. Wipe off excess cement. Let the joint cure 24 hours before wetting it. Take care to keep the cup clean and free of grease. (If the cup gets dirty or greasy, it should be cleaned by sanding.)

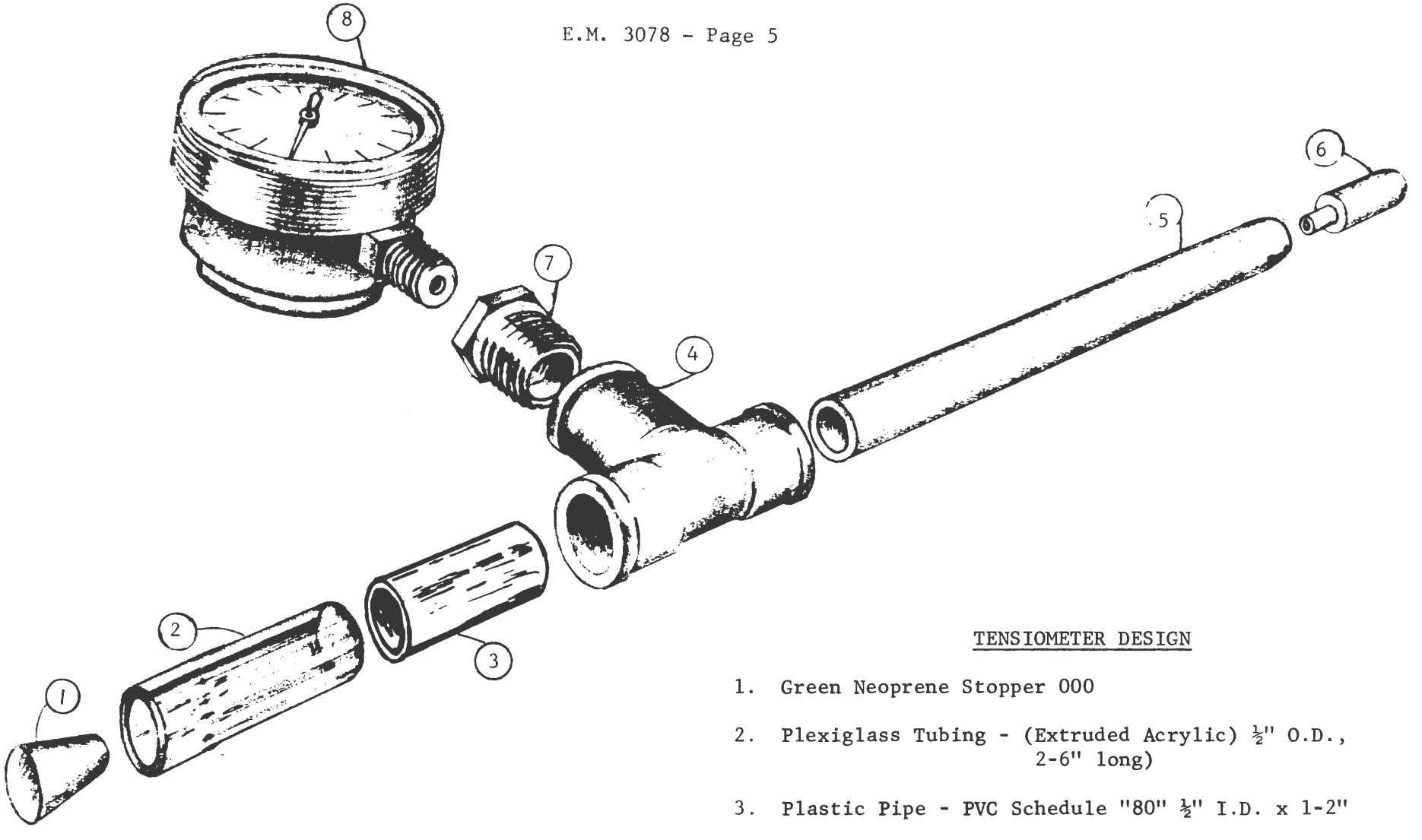
7. Install the vacuum gauge, using a thread cement, thread tape, or epoxy metal compound as a thread dope.

TESTING

The tensiometer must be free of leaks to function properly, and each instrument must be tested before use. Testing is easier if the ceramic cups are soaked in water for a day or two before starting. Fill the instrument completely with freshly boiled and cooled water. (If convenient, avoid use of hard water.) Tap the instrument and gauge lightly to help remove air, and if air accumulates at the top, refill with water. Close the top, wipe excess moisture off the outside of the cup, and expose the cup to open air. Water will evaporate from the cup and the vacuum gauge should register 50 or more without collecting much air at the top of the sight tube after five to eight hours in still air or one to two hours if a fan is used to blow air past the cup. If the instrument does not pass this test, open the top, remove the air, refill and retest as before. If the tensiometer does not perform properly, look for a leak.

The most common points where leaks have developed are (1) where the vacuum gauge is threaded in, (2) at the neoprene stopper, (3) where tees and bushings are cemented, and (4) rarely where the ceramic cup is cemented to the PVC pipe.

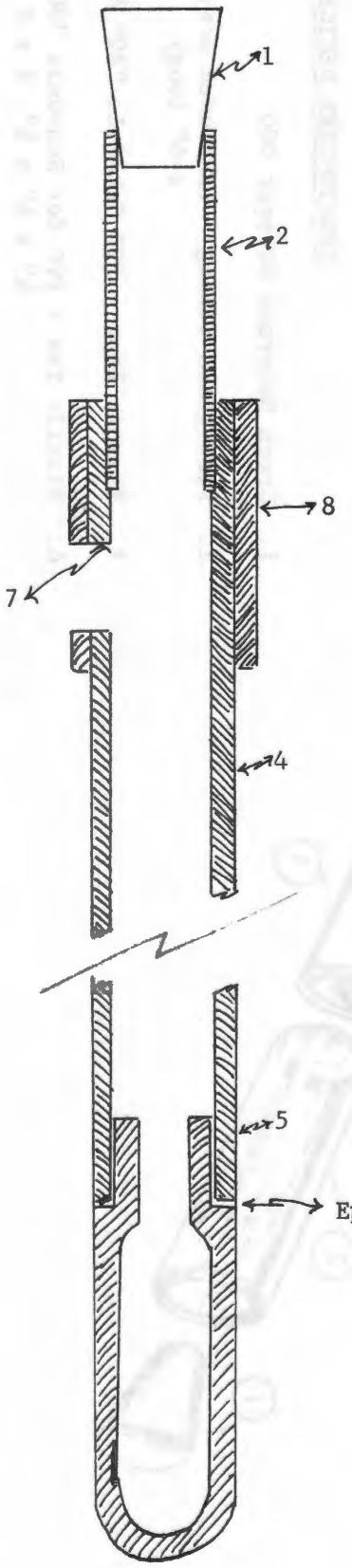
If the tensiometer passes this test, it is probably satisfactory for field use. However, an additional testing step is desirable and may be a continuation of the first step. When the dial is reading in the range from 40 to 70, place the cup in a small plastic bag and close around the tubing above the cup with a rubber band to prevent further evaporation, and record the dial reading. If the dial reading the next day is within five units of the reading when the plastic bag was put on, the instrument has passed a stiff test, and should function well in the field. If it passes the first step but not the second, a slow leak is indicated.



TENSIOMETER DESIGN

1. Green Neoprene Stopper 000
2. Plexiglass Tubing - (Extruded Acrylic) ½" O.D., 2-6" long)
3. Plastic Pipe - PVC Schedule "80" ½" I.D. x 1-2"
4. Plastic Tee - PVC for Schedule "80" Pipe ½" x ½" x ½", S x S x S
5. Plastic Pipe - PVC Schedule "80", ½" I.D.
6. Ceramic Cup - Tensiometer Type
7. PVC Reducer Bushing ½" x ¼"
8. Vacuum Gauge

PLAN NO. 2



1. Green Neoprene Stopper 000
2. Plexiglass Tubing - (Extruded Acrylic) ½" O.C., 2-6" long
4. Plastic Pipe - PVC Schedule "80", ½" I.D.
5. Ceramic Cup - Tensiometer Type
7. Drill and Tap ¼" Pipe Thread for Vacuum Gauge
8. PVC Coupler for ½" Schedule "80" Pipe