The hose u-tube level

J P. Fallon

Department of Agriculture
Fig. 1.—This photograph shows the instrument in use in the field. A true contour line is being surveyed and pegs placed at fifty foot intervals to mark the line.

THE HOSE U-TUBE LEVEL

A Simple and Accurate Home Made Levelling Instrument

By J. P. FALLON, B.Sc.(Agric.), Adviser, Soil Conservation Service

WITH the growing use of soil conservation practices throughout the farming areas, there has been an increasing demand for a simple levelling device that will enable farmers to take their own levels. When they have become familiar with the use of pasture furrows, contour banks and the various other mechanical erosion control measures, farmers with the aid of such an instrument would be able to make an immediate start on an erosion control programme. The instrument would also prove useful for numerous small jobs around the farm when accurate levels are required. Tests have shown the "Hose U-Tube Level" here described, to be an accurate and reliable farm levelling instrument.

In a separate article to appear in the Water Erosion Control series in the Journal, the construction and use of several other simple levelling devices will be discussed. These levels include the carpenter's spirit level fitted with peep sights and mounted on a tripod; U-Tube water levels on tripods, and various types of A-frame levels. Although most of these instruments could be made by the farmer, some of them are complicated enough to need fairly skilled carpentry work if they are to be at all accurate. Most of them require some form of adjustment every time they are used and some are difficult to use. Moreover, the accuracy of even the best of them is at the most somewhat doubtful. The hose level outclasses these other types of instrument in that it has the three essential features needed for a good home-made levelling device. It is easy to make, easy to use and is both accurate and reliable.

PRINCIPLE AND CONSTRUCTION

This level consists of a U-tube open at both ends and partly filled with water. The water rises to the same level in both arms of the tube. In the type of U-tube level designed for soil conservation work the U-tube was made up, as shown in the diagram, of two 3ft. lengths of colourless plastic waterpipe joined by
THE HOSE U-TUBE LEVEL

Since the formation of the Soil Conservation Service in this State, officers of the S.C.S. have examined published descriptions of many devices for taking levels, and a number of these have been constructed and tested by Mr. J. P. Fallon, the author of this article.

The "Hose U-Tube Level", devised and built by Mr. Fallon, is immensely superior to any of these devices and is an instrument which can be made easily by any handyman, and which will always give accurate and reliable levels.

L. C. LIGHTFOOT,
Assistant Commissioner of Soil Conservation.

A 60ft. length of quarter-inch three-ply or two-braid air hose. Any length of hose may be used, the limit being determined only by the need for ease of handling of the system in the field. The lengths of plastic waterpipe were bolted to 6ft. lengths of light wood batten. An adjustable foot was fitted to one of the battens. Movable pointers were also attached to each batten or staff. Small taps fitted to the ends of the plastic waterpipe serve to prevent loss of water from the system during transport (for construction details see diagrams).

Care must be taken in filling the system to ensure that air bubbles do not form in the hose. A steady pressure of water should be allowed to flow through the system by connecting the hose to a tap and allowing the tap to run for a few minutes. When all air bubbles are expelled and while the system is still full of water, the top gas tap is closed and the hose removed from the water tap and screwed to the end of the plastic pipe. When the top gas taps are open, the water finds its own level at about the centre of the pipes. (It is convenient to have the level of the water surfaces as near as possible to eye level.) The instrument is now ready for use.

USING THE HOSE U-TUBE LEVEL

Two persons are required to operate the instrument and in this description, they will be referred to as A and B. To mark out true contour lines the two battens or staves are set up vertically side by side on level ground. When the water in the system has come to rest, the pointer on each staff is set at the water level which is of course at the same
height in each pipe. Staff man A then moves around the slope to the extent of the length of the hose and moves the staff up or down the slope as required until the level of the water in each pipe is again at the pointers. **These two sites are at the same level and are now pegged or marked in some way.**

![Image of adjustable foot](image-url)

**Fig. 3.—**This photograph shows the adjustable foot which is fitted to one of the staves. The foot is extended to show details of its construction.

Staff man B now moves to where A was and A moves on another hose length around the slope and again brings the staff to the site where the water level is at the pointers. This procedure is repeated until the entire line has been surveyed. It is suggested that the two staves be kept facing each other when levelling. This is convenient and has the advantage that the staves are used in the same position relative to the ground slope. When the leading staff man finds the correct location for his staff, he must be careful to peg the site in same position relative to the foot of the staff each time (e.g., in the centre position at the back of the staff, or at the same corner of the staff). When the other staff man moves up to the peg placed by the leading man, knowing the system being used, he must be careful to place the staff in the correct position (e.g., if the leading man placed the peg at the centre position behind the staff, then the other man must also locate the foot of his staff in this position). If this is done, the resulting line will be more accurate than if the staff positions are not systematically marked.

When moving from one site to another it will be found necessary to close the taps at the tops of the plastic pipes to prevent water squirting from the system.

**SURVEYING GRADED LINES**

To run a line on a gradient, it is necessary to make use of the adjustable foot on one of the staves. When using this instrument to run graded lines for the first time, be careful not to set the required grade on the adjustable foot before adjusting the water level pointers. If this is done, the line surveyed with the instrument will be on a true contour and not on a grade. If the following procedure is carried out carefully, no mistake will be made.

1. The staves are first set side by side and the pointers adjusted to mark the level of the water as in preparation for running a contour line.

2. The foot is then adjusted to give the required grade. To run a gradient of six inches per 100ft. with a 50ft. length of hose between staves would require the
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leading staff to be extended three inches by means of the adjustable foot. The foot is therefore extended three inches and bolted in this position.

N.B.—Don't make the mistake of extending the foot to run a gradient before adjusting the water level markers. Always adjust the markers, then extend the foot.

(3) Staff man A takes the staff with the adjustable foot and walks around the slope to the extent of the hose. He then moves up or down until the water level is again at the pointers. This site is then three inches below that at which B is standing.

(4) Staff man B then walks to A, and A moves on around the slope and the process is repeated until the line is completed or a point reached where it is necessary to change the gradient.

If a variable grade is required, when the point is reached where the grade needs to be increased or decreased the length of the foot is re-adjusted to give the new grade. A tabulation of the amount to extend the foot to give various grades is set out below.

**TABULATION OF GRADIENTS FOR CONTOUR BANKS**

<table>
<thead>
<tr>
<th>Grade in %</th>
<th>Grade in inches/50 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
<td>0.6 ins. per 50 feet</td>
</tr>
<tr>
<td>0.2%</td>
<td>1.2 ins. per 50 feet</td>
</tr>
<tr>
<td>0.3%</td>
<td>1.8 ins. per 50 feet</td>
</tr>
<tr>
<td>0.4%</td>
<td>2.4 ins. per 50 feet</td>
</tr>
<tr>
<td>0.5%</td>
<td>3.0 ins. per 50 feet</td>
</tr>
<tr>
<td>0.6%</td>
<td>3.6 ins. per 50 feet</td>
</tr>
<tr>
<td>0.7%</td>
<td>4.2 ins. per 50 feet</td>
</tr>
<tr>
<td>0.8%</td>
<td>4.8 ins. per 50 feet</td>
</tr>
<tr>
<td>0.9%</td>
<td>5.4 ins. per 50 feet</td>
</tr>
<tr>
<td>1.0%</td>
<td>6 ins. per 50 feet</td>
</tr>
</tbody>
</table>

The accompanying diagrams show an adjustable foot with quarter-inch holes spaced six-tenths of an inch (0.6 inches) apart. This is the most convenient spacing of the holes if a 60ft. length of hose is used. A 60ft. hose gives an effective
length of 50ft. between staves. However, levels may be taken at any point up to 50ft. apart. When surveying a line around sharp curves on ridges or in depressions, pegs should be placed at rather closer intervals than 50ft. In these situations a 25ft. spacing of pegs will give a more accurate line, but the adjustable foot will need to be reset for the new spacing if the same grade is to be maintained. When running graded lines it is important to remember that if the distance between the staves is altered, the gradient of the resulting line will also be altered unless the foot is adjusted to the distance used.

DETERMINATION OF VERTICAL INTERVALS

To determine vertical intervals with the level, the staves are again set up side by side and the pointers adjusted so that the zero marks are at the level of the water. One staff man then walks down hill at right angles to the contour almost to the extent of the hose. As he moves downhill, he raises the staff in the air until advised to stop by the other staff man when the level of the water is again at the zero mark.

Loss of water from the system can be avoided if the man at the higher level turns the tap on and off as needed until equilibrium is reached when the tap is left open. The vertical interval from the staff man above to the man below is the height of the foot of the staff, held by the lower man, from the ground. For most practical purposes unless really accurate vertical intervals are required, the height of the foot of the staff may be estimated using the height of the person holding the staff as a standard. Alternatively, a tape measure may be glued to the staff.

The operation of this levelling instrument depends on certain principles and as long as these principles are adhered to, variations in the details of its construction may be made in many places. For instance, instead of having an adjustable foot on one of the staves in order to run a graded line, the same effect may be obtained by using the sliding scales, or zero markers, if they are graduated. In this method, the staves are set side by side and the zero markers moved to the level of the water in the pipes. The required grade is obtained by setting half the grade on each scale by moving one pointer up on one staff and the other down on the other staff.

In actual tests, this instrument has proved itself an accurate makeshift level. Carefully used, it gives results well within the limits of accuracy considered adequate when using a surveyor's dumpy level for soil conservation work.
The instrument has an additional advantage over other levels in that there is a double check on all readings. Each of the two people using the level can see at a glance whether or not the correct reading has been obtained. If the water level on one staff is at the correct position, then the level of the water on the other staff must also be correct.

However, an important point to remember when using this type of instrument is that nearly all the errors that are likely to be made are cumulative errors. For instance, if the zero markers are adjusted when the staves are not on level ground, an error of perhaps one half inch may be made. This means that the difference in level of the first two pegs of a contour line would be one half inch, which doesn’t sound much. However, the difference between pegs one and three would be one inch and between one and four one and one half inches, and so on. In effect, a graded line would be run instead of a contour line. Similarly, to get accurate grades, the spacings of the holes in the adjustable foot must be accurate. As long as the persons using the level are aware of the possible pitfalls in the use of the instrument they can readily avoid them and, with very little effort, do really accurate work.

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