No. 676,161. Patented June 11, 1901.

W. E. SULLIVAN.

LEVEL ROD.

(Application filed Sept. 28, 1900.)

(No Model.)

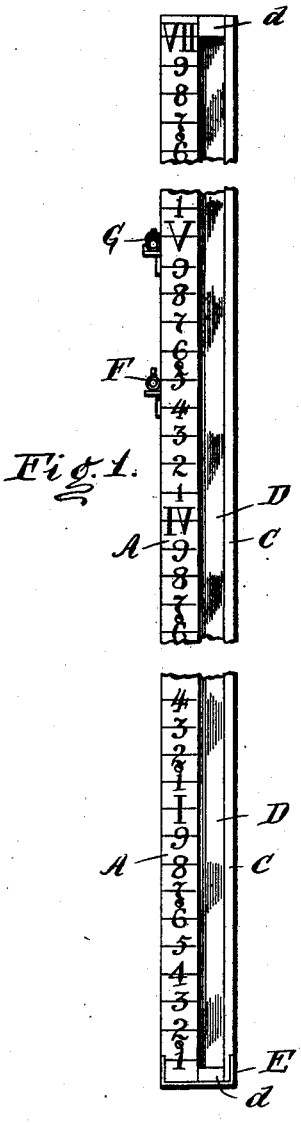


Fig. 1.

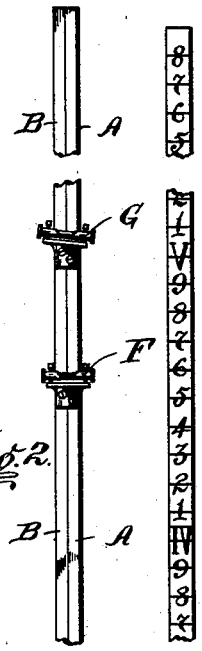


Fig. 2.

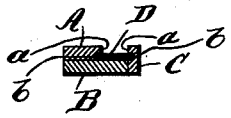


Fig. 3.

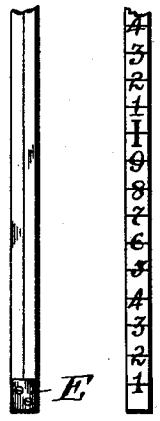
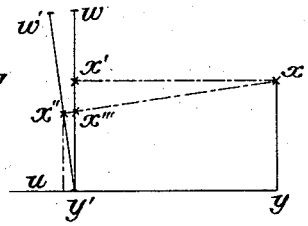


Fig. 4.

Fig. 5.



Witnesses.

Clarence E. Mehlhop.

George Hiderman

Inventor.

Walter E. Sullivan

by Arthur Sturt

his Attorney.

UNITED STATES PATENT OFFICE.

WALTER E. SULLIVAN, OF CINCINNATI, OHIO.

LEVEL-ROD.

SPECIFICATION forming part of Letters Patent No. 676,161, dated June 11, 1901.

Application filed September 28, 1900. Serial No. 31,404. (No model.)

To all whom it may concern:

Be it known that I, WALTER E. SULLIVAN, a citizen of the United States, and a resident of Cincinnati, in the county of Hamilton and State of Ohio, have invented a certain new and useful Improvement in Level-Rods for Engineers, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form part of my specification.

My invention relates to a self-reading level-rod, and is for use in cross-section work, in the setting of slope-stakes, and in all preliminary work in which rapidity is more essential than great accuracy.

It will be apparent that my invention may be applied to other uses than its use as a level-rod, and I do not limit myself to its use as a level-rod.

The object of my invention is to furnish a level-rod which may be used to determine differences of elevation without the use of the Y-level. It may also be used as a stadia-rod for determining horizontal distances.

The various advantages of my improved rod will appear more fully as I proceed with my specification.

In the drawings, Figure 1 is a front elevation of my improved level-rod. Fig. 2 is a side elevation of the same. Fig. 3 is a cross-section of the rod, taken at any point. Fig. 4 is a front elevation of a supplemental rod, and Fig. 5 is a diagrammatic view to be explained in the specification.

In carrying out my invention I make use of the well-known principle of plane reflectors that the angle of incidence is equal to the angle of reflection and more particularly of the corollary of that law that the line from the eye of an observer to its own perceived reflection in a plane mirror or reflector is perpendicular to the plane of said mirror or reflector. Therefore if a plane mirror or reflector be held in a vertical plane the reflection of the eye of an observer which is seen by the observer himself will be on a level with the eye of the observer.

My improved level-rod is made of white pine or other suitable material and is of any convenient length, depending upon the kind of work to which it is to be applied. It is preferably made of three pieces A, B, and C, the two pieces A and C having tongues *a a*, which form grooves *b b* when the pieces A and C are fastened to the piece B. A plane mirror or reflector D fits within the grooves *b b* and is held in place at top and bottom by blocks *d d* or in any other suitable manner.

My rod is provided at the bottom with the usual iron shoe or strap E to prevent wear. The piece A is graduated in the usual manner in feet and tenths of a foot. The three pieces A, B, and C are secured together by screws or in any other convenient manner.

It will be readily apparent that the arrangements of the parts A, B, and C need not necessarily be as shown—that the pieces A, B, and C might be made in one, with the grooves *b b* cut out. Again, the plane reflector might be secured to the rod by other means than by the grooves *b b*.

The whole front of the rod might be a plane reflector with the graduations at one edge thereof or extending entirely across the face.

I do not wish to limit myself to any particular construction, the essential features of my rod being a plane reflector with the graduations.

In order to hold my rod in a vertical position, a level F is secured at one edge thereof at such a point as is easily observed by a man of ordinary stature. The axis of the level F is normally at right angles to the plane of said mirror, so that the bubble of said level-tube will be at the center when the mirror is in a vertical position. The level-tube is provided, preferably, with the usually adjusting-screws. Instead of the level-tube a plumb-line might be used to bring the rod to a vertical position or the usual expedient of an engineer or rodman of simply balancing the pole in a vertical position. I prefer, however, the use of the level, as giving more accurate results and being more convenient.

In order to use my rod to determine horizontal distances, a second level G is fitted to the edge thereof in any convenient manner with its axis normally at such an angle with the plane of the mirror D that when the bubble is at the center the mirror will have a certain definite slope, which for convenience I prefer to make one in ten—that is, when said bubble is in the center a point ten feet from the bottom of the rod will lean one

foot from the perpendicular. The level-tube G is also preferably provided with the usual adjusting-screws.

To use my improved level-rod, it is held in a vertical position at a point the elevation of which is known or which is to be used as a datum. The observer then stands at the point where the elevation is to be determined (the rod being held in such a position that the observer may see his image in the reflector) and notes the graduation nearest the reflected image of his eye. He knows the height of his eye above the point at which he is standing. The difference between this height (which of course is constant for each person) and the reading of the rod shows the difference in elevation of the two points. The observer then moves to the next point, leaving the rod in its first position, and reads it as before, and thus determines the elevation of the second point, and so on. However, I find that it is more convenient and accurate to use a supplemental graduated rod H, (shown in Fig. 4,) because the height of the observer's eye may vary slightly, depending upon the roughness of the ground. Besides this height would generally have a fraction of a foot in it, which would be awkward in subtraction. By using the supplemental rod the observer may place his eye at the level of any even foot and read my improved rod from that position. Of course he proceeds just as before. I prefer to make this supplemental rod of such size that it may be used as a cover for the mirror D and long enough to fill the space between the blocks *d d*.

To use my rod to determine the horizontal distances, the observer stands at one point and directs the rod to be held at the other point. He first has the rod held in a vertical position by means of the level F. Noting the graduation nearest to the reflected image of his eye in this position, he then directs the rod to be held so that the bubble in the level G is brought to the center, in which position the rod, as above described, will have a slope of one in ten. (It must be here noted that the slope of one in ten is only for convenience in multiplication and that any other slope might be used, the only limitation being that it must be a certain, definite, and known slope.) The graduation nearest the reflected image of the observer's eye is noted in this position, and this latter reading is subtracted from the first reading. Ten times this difference will be approximately the distance from the observer to the rod, which is apparent from a consideration of Fig 5.

In Fig. 5 *xy* shows the height and position of the observer, *wy'* the rod in a vertical position, and *w' y'* the rod in a sloping position, as described. *x' y'* is the reading in the vertical position, and *x'' y* the reading in the inclined position. The slope of the rod is so slight that we may consider *x'' y'* equal to *x''' y'*, so that *x' x'''* may be considered equal to the difference between *x' y'* and *x'' y'*. In other words, *x' x'''* is approximately equal to the difference between the readings of the rod, respectively, in the vertical position and in the inclined position. The triangles *x'' uy'* and *xx' x'''* are similar. Therefore we have the proportion $xx' : x' x''' :: x'' u : uy'$. The ratio of *x'' u* to *uy'* is ten. Therefore, the distance *xx'*—that is, the distance from the observer to the rod—is ten times *x' x'''*, or ten times the difference between the two readings, as stated. Of course if a different slope had been used the multiplier would have been different.

Having thus described my invention, what I desire to claim as new and to cover by Letters Patent is—

1. In a level-rod, the combination of a graduated rod, a plane reflector, and means for ascertaining when said plane reflector is in a truly-vertical position, substantially as described.

2. A level-rod, one of whose faces is a plane reflector provided with graduations, substantially as and for the purpose described.

3. In a level-rod, the combination of a graduated rod, a plane reflector and a level-tube whose axis is at right angles to the plane of said reflector, substantially as and for the purpose described.

4. In a level-rod having a graduated face, the combination of a plane reflector parallel to said face and running the length of said rod, and a level-tube whose axis is perpendicular to the plane of said reflector, substantially as and for the purpose described.

5. In a level-rod, the combination of a graduated rod, a plane reflector, and a level-tube adjustably attached to the edge of said rod with its axis normally at right angles to the plane of said reflector, substantially as and for the purpose described.

6. In a level-rod, the combination of a graduated rod, a plane reflector, means for ascertaining when said rod is in a truly-vertical position, and means for ascertaining when said rod is in an inclined position, having a definite, known slope, substantially as and for the purpose described.

7. In a graduated rod, the combination of a plane reflector, a level-tube having its axis normally at right angles to said plane reflector, and a level-tube having its axis at an angle to said plane reflector, substantially as described.

8. In a graduated rod, the combination of a plane reflector parallel to the face of said rod, and a level-tube with its axis normally at right angles to the face of said rod, substantially as described.

9. In a level-rod, the combination of a plane reflector, graduations at one side of said reflector, a level-tube with its axis normally at right angles to said plane reflector, and a second level-tube with its axis at a definite, known, acute angle to the plane of said reflector, said angle being in a plane parallel to the plane passing through one edge of the

rod perpendicular to the plane of the reflector, substantially as and for the purpose described.

10. In a level-rod, the combination of a plane reflector, graduations at one side of said plane reflector, a level-tube with its axis at right angles to the plane of said reflector, and a second level-tube with its axis at a definite known acute angle with the plane of said reflector, said angle being in a plane parallel to the axis of the first level and to the length of the rod, substantially as and for the purpose described.

11. In a level-rod, the combination of a plane reflector, graduations at one side of said reflector, a level-tube adjustably attached, at one end of the rod with its axis at right angles to the plane of said reflector and a second level-tube adjustably attached to the edge of the rod and having its axis at a definite known acute angle to the plane of said reflector, said angle being in a plane parallel to the plane passing through the edge of the rod at right angles to the plane of the reflector, substantially as and for the purpose described.

WALTER E. SULLIVAN.

Witnesses:
CLARENCE E. MEHLHOPE,
GEORGE HEIDMAN.