(Model.)

2 Sheets—Sheet 1.

E. C. STOUT.

STADIA ROD.

No. 525,520. Patented Sept. 4, 1894.

Fig. 1.

Fig. 2.

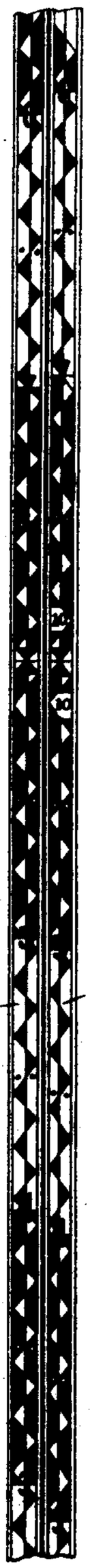

Fig. 3.

Witnesses
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Theo. L. Gatchell

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(Model.) 2 Sheets—Sheet 2.

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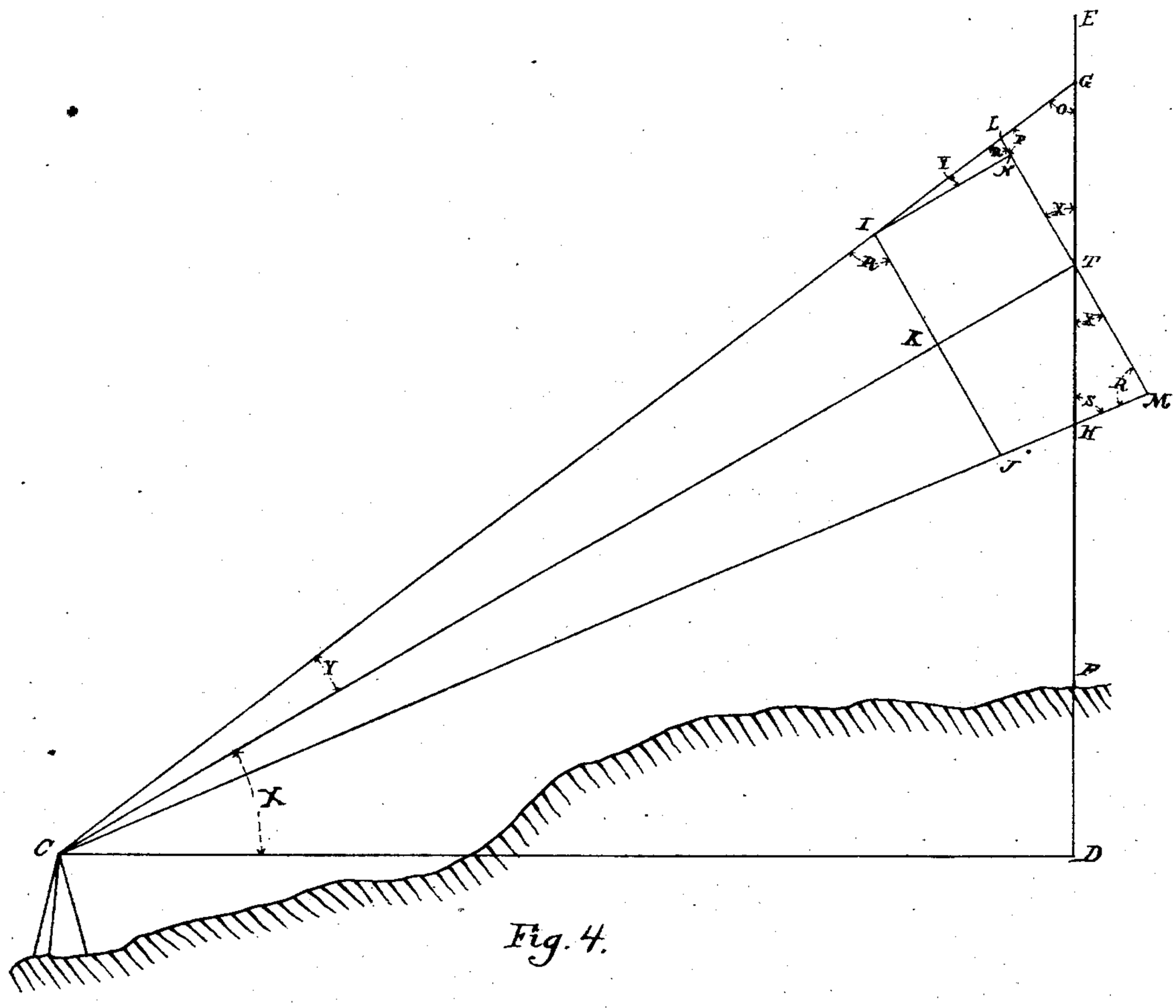

Fig. 4.

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UNITED STATES PATENT OFFICE.

EDMUND C. STOUT, OF SCARBOROUGH, NEW YORK.

STADIA-ROD.

SPECIFICATION forming part of Letters Patent No. 525,520, dated September 4, 1894.

Application filed April 20, 1893. Serial No. 471,125. (Model.)

To all whom it may concern:

Be it known that I, EDMUND C. STOUT, a citizen of the United States, residing at Scarborough-on-the Hudson, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Stadia-Rods; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to certain new and useful improvements in graduated rods for surveyors' use, and it has for its object among others to provide an improved rod by the use of which not only is the labor made lighter and easier, but the tendency to commit errors is materially lessened. When the engineer's transit is used in connection with a stadia rod for horizontal sights, no errors are liable to occur, but when the ground is very uneven an error in distance is unavoidable, and to reduce such readings to their horizontal equivalents two operations are necessary in the office. It can therefore be readily understood that a device which will do away with these two computations will necessarily save a large amount of work. The two errors which are liable to occur are due first to the difference in length between the hypotenuse, or line of sight, and the base, or required distance, and the second is due to the angle at which the line of sight intersects the vertical plane or rod.

It is therefore the object of my invention primarily to so construct and graduate a rod as to overcome these objections and at the same time to give to the graduations such a character that the same will not be so liable to be misread in topographical work, as are the usual graduations. Either of these features may be present without the other, but it is preferred to combine the two for more accurate work.

Other objects and advantages of the invention will hereinafter appear and the novel features thereof will be specifically defined by the appended claims.

The invention is clearly illustrated in the accompanying drawings, which, with the letters of reference marked thereon, form a part of this specification, and in which—

Figure 1 is a view of one face of my improved rod. Fig. 2 is a perspective view looking at one edge, showing two of the faces and the relative length of the graduations of each. Fig. 3 is a face view of one side of the rod, on an enlarged scale. Fig. 4 is a diagram view illustrative of the method of determining the length of the graduations for the sides of the rod having distorted scales thereon.

Like letters of reference indicate like parts throughout the several views in which they appear.

The rod, aside from its graduations, may be of any well known form. It is provided upon one side or face with the usual United States standard feet and tenths, as seen at *a*, to be used for any sights having a vertical angle of two degrees or less, and with which the greatest possible error that can occur by using the extreme vertical angle of two degrees is 0.12 feet per one hundred feet of sight. Upon another side or face the rod A is provided with graduations proportioned to an angle of four degrees, to be used for all sights having vertical angles from two degrees to five degrees thirty minutes. The greatest error possible by using this side is 0.44 feet per one hundred feet of sight. Upon still another face or side the rod has graduations proportioned to an angle of seven degrees for sights with vertical angles from five degrees thirty minutes to eight degrees thirty minutes. The maximum error that can occur from using this side is 0.73 feet per hundred feet of sight. Upon the remaining side or face of the rod are graduations *b* proportioned to an angle of ten degrees for sights with vertical angles from eight degrees thirty minutes to eleven degrees. The greatest possible error by using this side and having the extreme vertical angle of eleven degrees is 0.67 feet per one hundred feet of sight.

The foregoing are the apparent maximum errors which can occur providing the vertical angle is always determined by sighting at the exact height which the telescope of the instrument is above the ground when set up. These errors, however, are entirely theoretical and will never be approximated in practice, for there are ten feet of length of rod, up or down which the line of sight may be moved and thus bring the line of sight to, or nearly

to, the angle for which the face of the rod is graduated, before the distance is read. Thus, the above-mentioned errors need never occur and the actual possible error is reduced to a minimum. Of course I do not intend to limit myself to these exact distortions or angles as forming the basis thereof, as others may be employed. These are merely given as an example of the theory upon which the graduations are arranged. Further use may demonstrate the fact that the distortions had better be based upon other angles. However, ground must be very rough and uneven which will require vertical angles greater than eleven degrees, and after careful trials I have adopted the angles and distortions above described. The greater the angle the greater the distortion.

The graduations upon the sides containing the distorted scales are so made that when a side is used containing such distorted scale at the angle of vision at which the side is adapted to be used, the lines of division between one distorted foot and those adjacent to it will be exactly intercepted by the upper and lower stadia hairs, at one hundred feet distance. Just what the length of a distorted foot is on the different scales may be determined by reference to Fig. 4. In this figure, C is the instrument, E—F is the rod, and X is the vertical angle of the line of sight, which is determined in each instance by the instrument. For clearness of illustration, this angle is shown in the diagram as thirty degrees. The face on the rod corresponding to this angle is now used. This face is so graduated that G—H, a distorted foot, will be intercepted exactly by the upper and lower stadia hairs at a distance of one hundred feet. C—D, the horizontal or required distance is therefore one hundred feet. Now we want to determine the distance G—H. T is the point at which the line of sight intersects the rod, and G—H = G—T + T—H.

I—J represents an imaginary rod, with United States standard face, placed at right angles to the line of sight, with the stadia hairs intercepting one foot thereon. Then C—K = C—D = 100, I—J = 1, and C—T = C—D × sec. X. L—M is parallel to I—J and is the distance that would be intercepted on a rod at the distance C—T from the instrument if the line of vision were horizontal, or if the rod L—M were at right angles to the line of sight. I—N is parallel to the line of sight C—T and at right angles to I—J and L—M. $\frac{I—J}{2}$ = I—K. I—K ÷ C—K = tang. Y (a known angle) and C—T − C—K = K—T = I—N. From the angle Y and the side I—N, L—N can be found. L—N + N—T = L—T = T—M. Angle P = 180° − R. In the triangle G—L—T, we have found the side L—T and the angles X and P, and in the triangle M—T—H, we have found the side T—M and the angles X and R, and from these the angles O and S can be found. Then sin. O : sin. P :: L—T : G—T, and sin. S : sin. R :: T—M : T—H, from which G—T and T—H can readily be obtained. And G—T + T—H = G—H, which is the distorted equivalent of I—J for the angle X.

From the above formulæ, the distorted equivalent for a standard foot can be obtained for any angle of sight, and by dividing the above distorted equivalent into twelfths, the distorted equivalent for an inch can be obtained, and so on for the fractional parts of an inch.

In order to make the graduations more distinctive and less liable to be misread at a distance, I have given to them the form seen best in Fig. 3 wherein it will be seen that the points designating tenths are the intersections of the extremities of triangles placed alternately on opposite sides of a vertical line; and assuming a vertical base, the apex of each triangle is the half-tenth. They may be represented by any suitable or desired color upon a white ground, or white upon a colored back-ground. It has been proven by actual experience that this form of graduations can be much more readily seen and distinguished than the ordinary straight marks, thereby avoiding numerous little errors which are almost unavoidable in the use of the usual rod for this class of work.

Modifications in the character of the graduations as well as the basis upon which the angles of distortion are made may be resorted to without departing from the spirit of the invention or sacrificing any of its advantages.

What I claim as the invention is—

1. A graduated rod of the class described having its sides provided with graduations proportioned to the angle of sight, as set forth.

2. A graduated rod for the purpose described, having each of its sides provided with graduations proportioned to different angles of sight, as set forth.

3. A rod having its faces provided with graduations which are equivalents of the United States standard units of measure for the angles of sight for which the respective faces are used.

4. A stadia-rod having one of its faces provided with graduations made according to the United States standard and its other faces with graduations which are equivalents of the same for the different angles of sight for which they are respectively adapted to be used.

In testimony whereof I affix my signature in presence of two witnesses.

EDMUND C. STOUT.

Witnesses:
I. W. REYNOLDS,
A. D. SHEPARD, Jr.