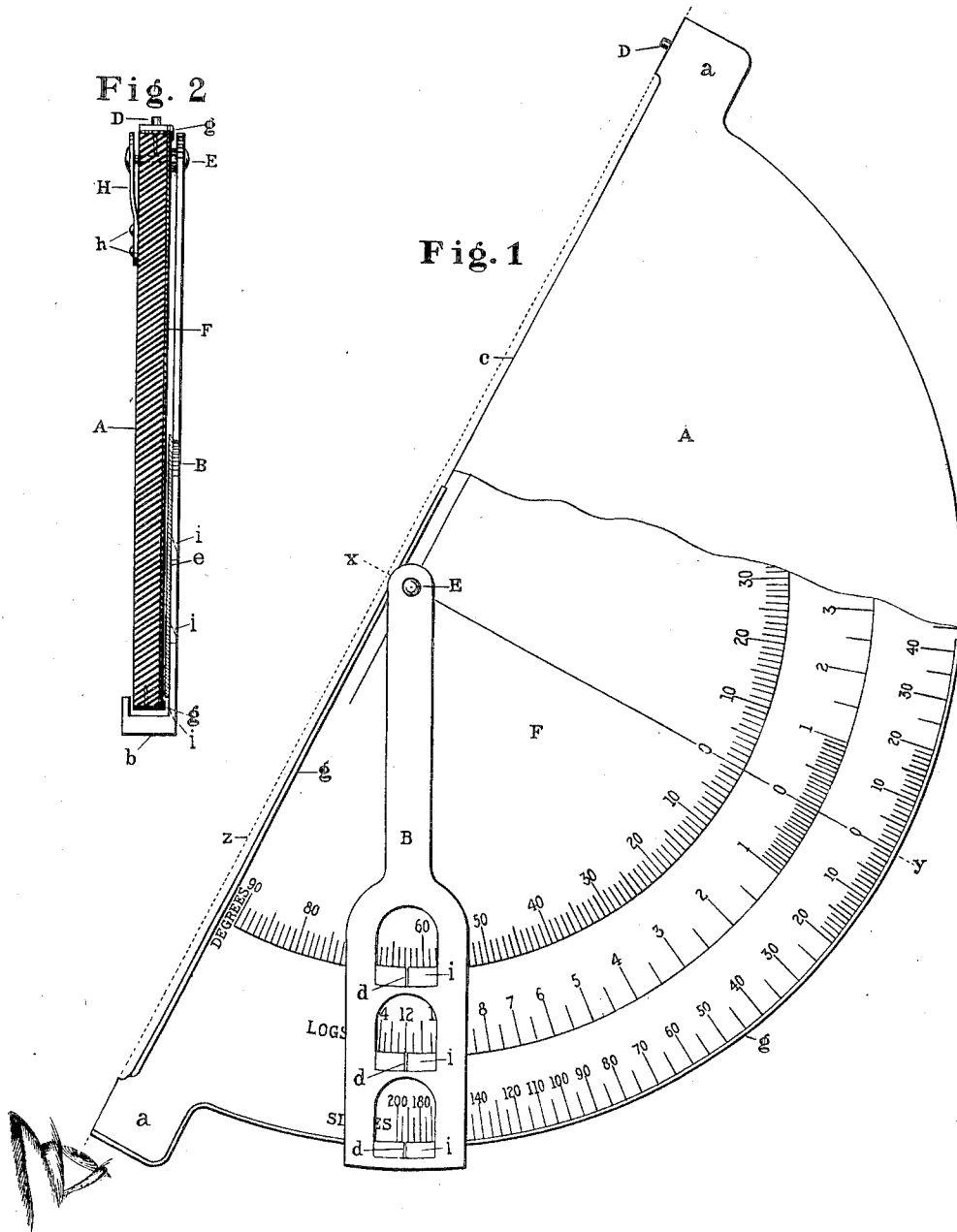


1,116,452.



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SURVEYING INSTRUMENT.

1,116,452.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, MADISON J. LORRAINE, a citizen of the United States, residing in the city and county of San Francisco and State of California, have invented a new and useful Improvement in Surveying Instruments, of which the following is a specification.

The object of my invention is to provide a hand operated, simple, ready, efficient, and inexpensive instrument to be used by civil engineers, surveyors, timber cruisers, and others in their surveying operations.

My device is illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of the instrument held upright and inclined in a vertical plane with the pendulum plumb. Fig. 2 is a cross section on the line $x-y$, or the zero line, with the pendulum at the zero line. The drawings are made to actual size.

The instrument consists of an arc shaped plate A, almost semicircular in shape to which is directly suspended a freely swinging pendulum B. The plate has a straight edge c , preferably at right-angles to the center line $x-y$ of the plate. At the extremities of the side c are hand lugs a with their upper edges slightly higher than and parallel to c to facilitate sighting along the top of one lug to the other, on which is a sight pin D. The lugs are intended to support the instrument upright upon the hands of operator while using it to perform certain of its functions.

In the design shown in the drawings A is used as a base-plate and has applied to one face a thin sheet F, of paper, white celluloid, metal, or other material on which are placed either printed, etched, or cut graduated arcs having a common center E at the center of the arc of the base-plate. In the form of instrument shown the inner arc is graduated in degrees; the middle one in altitudes of 16 feet, and fractions thereof, with a given base of 100 feet; and the outer one to represent a rise or fall of 5 feet vertical for each 100 feet of linear horizontal distance, the first 20 feet of rise being graduated to smaller divisions of 1 foot. The pendulum B is loosely attached directly to the plate, by a pivot E at the center common to the graduated arcs and the arc of the plate. In the lower end of the pendulum are formed openings of sufficient size to show, separately, the figures of the graduated arcs and the

graduations to be read, all the graduations being on lines radiating from the center of the arcs. The bottom side, i , of each opening is beveled, and cut into each of these beveled sides is a channel d made coincident with the middle normal line of the pendulum. The lower extremity of the pendulum, b , is turned backward and upward to form a guard to retain it closely to the face of the instrument. Around the edge of plate is a flange g to aid in securing the graduated sheet to the face of the base plate, and to which it is fastened by means of nails or screws applied at the edge of the plate. In Fig. 2 is shown a pendulum clamp H secured to the back of the plate by fastenings h . In the same figure is shown, attached to the back of the pendulum, a layer, e , of cloth, rubber, or other material, the purpose of which will be hereafter explained.

The instrument, as designed and shown, performs four functions:

First. Taking topography to ascertain the rise or fall of ground slopes. When so used it is held supported, vertically, by its own weight, on the fore-finger of the left hand and the thumb of the right hand of the operator under the lugs a . In that position the pendulum being freely pivoted at E it will always hang plumb, or vertical. With the eye at the sighting end, and looking along the line z , to the foresight D, as shown, the sighting edge of the instrument is brought parallel, either approximately or by sighting at the height of the eye of an assistant, or upon a graduated rod held by him, the instrument being moved in a vertical plane for the purpose, and as the pendulum hangs plumb, by its own weight, the graduations rotate by it until the instrument is brought to rest when it is then turned over on its side, with the graduations uppermost, the layer of cloth, rubber, or other material e , on the back of the pendulum increasing the friction and aiding the pendulum in clinging to the face of the instrument without slipping, and the rise or fall of the slope is read on the outer arc by means of the channeled line d at the lower side of the lower opening in the pendulum. In Fig. 1 the pendulum records a rise of 192 feet, as near as it can be read. It is not necessary to have a measured base to ascertain slopes, as they may be of any length, but the rise of any slope having an ascertained length other than the 100 feet on which the graduations

are based, is found by multiplying the rise indicated by the instrument by the ascertained length expressed in decimal parts of 100 feet. Given the rise shown of 192 feet for a linear horizontal distance of 85 feet, $192 \times .85 = 163.2$ feet rise for the 85 feet.

Second. To ascertain linear horizontal distance when measurements are made on slopes instead of horizontal. Handle the instrument the same as in the first instance but read the angle of the slope on the inner graduated arc marked degrees and multiply the cosine of the angle found by the slope distance. In the drawing the angle is $62\frac{1}{2}$ degrees, its cosine being .46175. If the slope distance is 184.1 feet, then, $.46175 \times 184.1 = 85$ feet linear, horizontal distance.

Third. To measure the heights of trees to ascertain the number of 16 ft. logs they contain. Handle the instrument the same as in the other instances, but from the end of a 100 ft. base measured from tree under consideration, and sight up the tree to where it is estimated the top log cut will come and read, direct, the number of logs on the middle graduated arc. In the drawing the pendulum indicates exactly 12 logs. Should the base line be increased to 200 feet the figures of the middle graduated arc will be doubled.

Fourth. To measure horizontal angles. For this purpose the instrument is held or laid flatwise, or horizontal, with the pendulum uppermost and resting on the face of the plate above the graduations. Held or laid in this position the sighting edge is brought, as near as possible, coincident with a known or established line at the intersection of the line the angle of which, with the other line, is to be found, and with the operator standing at *x*, and using the pendulum as a pointer he places it in the direction required, with his hand, the pendulum indicating on the inner arc the complement of the angle inclosed between the two lines. As designed and shown in the drawing the instrument will only approximately determine horizontal angles. They can be determined more accurately by attaching folding sights to the upper side of the pendulum.

In addition to what has been fully explained the instrument can be provided with the pendulum clamp H, shown in Fig. 2 to hold the pendulum fixed in any position in which it may hang or be placed with reference to the plate. This clamp is made of flat, spring material about $\frac{1}{4}$ inch wide, and bent in the shape shown in the drawing. The lower end is secured to the back of the plate by the fastenings *h*. Fig. 2, the upper end being perforated, or forked, to surround the pivot E which is made of sufficient length to have longitudinal play, the pressure of the spring-clamp keeping the pivot, normally, pulled in the direction that causes

its head, at E, to hold the pendulum tight against a washer interposed between it and the face of the plate, thus clamping it. To free the pendulum so it can swing freely the clamp spring and pivot end against which the spring bears, directly, or through a washer, are pressed inward toward the plate with the finger of the right hand, thus relieving the pressure of the spring on the pendulum and unclamping it. Should it be desired to protect the graduations from wear without obscuring their visibility a sheet of transparent celluloid may be placed over them and be held in place either by the flanged rim *g*, shown in the drawings, or by other mechanical means.

What I claim and desire to secure by Letters Patent, is:

1. A surveying instrument consisting of an arc shaped plate having one edge formed as a sighting line, a free swinging, normally vertically hanging pendulum pivoted to the center of its arc, and directly thereto, and having at its lower end openings with a channeled line in their lower sides for reading graduated spacings placed upon the plate on radial lines of the arc of the plate and with the zero line of such graduations at right angles to the sighting line of the instrument, substantially as set forth.

2. A surveying instrument consisting of an arc shaped, integral plate having one edge formed as a sighting line, a front sight at one extremity of the sighting line, hand lugs one on either side of the plate at the extremities of the sighting line for supporting the instrument vertical in the plane of the line of sight by its own weight, a free swinging, normally vertically hanging pendulum pivoted directly to the plate at the center of its arc and having at its lower end openings with a channeled line in their lower sides for reading graduated spacings placed upon the plate on radial lines of the arc of the plate and with the zero line of such graduations at right angles to the sighting line of the instrument, substantially as set forth.

3. A surveying instrument consisting of an arc shaped plate having one edge formed as a sighting line, a free swinging, normally vertically hanging pendulum pivoted directly to the plate at the center of its arc and having at its lower end means for reading graduated spacings placed upon the plate on radial lines of the arc of the plate and with the zero line of such graduations at right angles to the sighting line of the instrument; hand lugs integral with the plate for supporting it vertically suspended in the plane of the line of sight; and a hand releasing spring clamp attached to the back-top of the plate and acting to confine the pendulum in fixed position on the face of the instrument, substantially as set forth.

4. A surveying instrument consisting of an arc shaped base plate, a graduated sheet superimposed on the face of the base plate, a retaining flange secured to the edge of the plate for holding the graduated sheet in position thereon, and a free swinging pendulum secured to the plate at the center common to the arc of the plate and the arc of the graduations and having at its lower end means for reading the graduations of the sheet, substantially as set forth.

5. In a hand operated surveying instrument the combination of an arc shaped plate having upon its face graduations formed on radial lines of the arc of the plate, and having a sighting line formed on one edge at right-angles to the zero line of its graduations and with a sight pin at one extremity thereof, of a free swinging, normally vertically hanging pendulum pivoted to the plate at the center common to its arc and the arc of the graduations provided with a frictional surface acting upon the face of the graduated plate, said pendulum having separate openings at the lower end thereof spanning the graduations and figures applying thereto and having indicating lines in the lower side of the openings coincident

with the middle, normal line of the pendulum for reading the graduations of the plate which become coincident therewith in the operation of the instrument, substantially as set forth.

6. A hand operated, multiplied functioned surveying instrument consisting of an arc shaped plate having upon its face a series of arcs graduated upon radial lines of the arc of the plate, and with one edge formed as a sighting line with a sight pin at one extremity thereof; a free swinging normally vertically hanging pendulum pivoted directly to the plate at the center of its arc, and having at its lower end separate openings spanning the graduated lines and figures of the different arcs and with an indicating line in the lower side of each opening coincident with the middle, normal line of the pendulum for marking off and determining the extent of the different graduations reached as the plate is turned in a vertical plane, substantially for the purposes set forth.

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Witnesses:

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