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Stone

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(54) **THEODOLITE**

(76) Inventor: **Samuel Stone**

Samuel Stone, Long Green, Maryland,

Letters Patent.

The Schedule referred to in these Letters Patent and making part of the same, containing a description in the words of the said Samuel Stone himself of his improvement in the art of measuring distances from one station with a theodolite or any other instrument by which an angle can be made either perpendicularly or horizontally having a telescope attached to it.

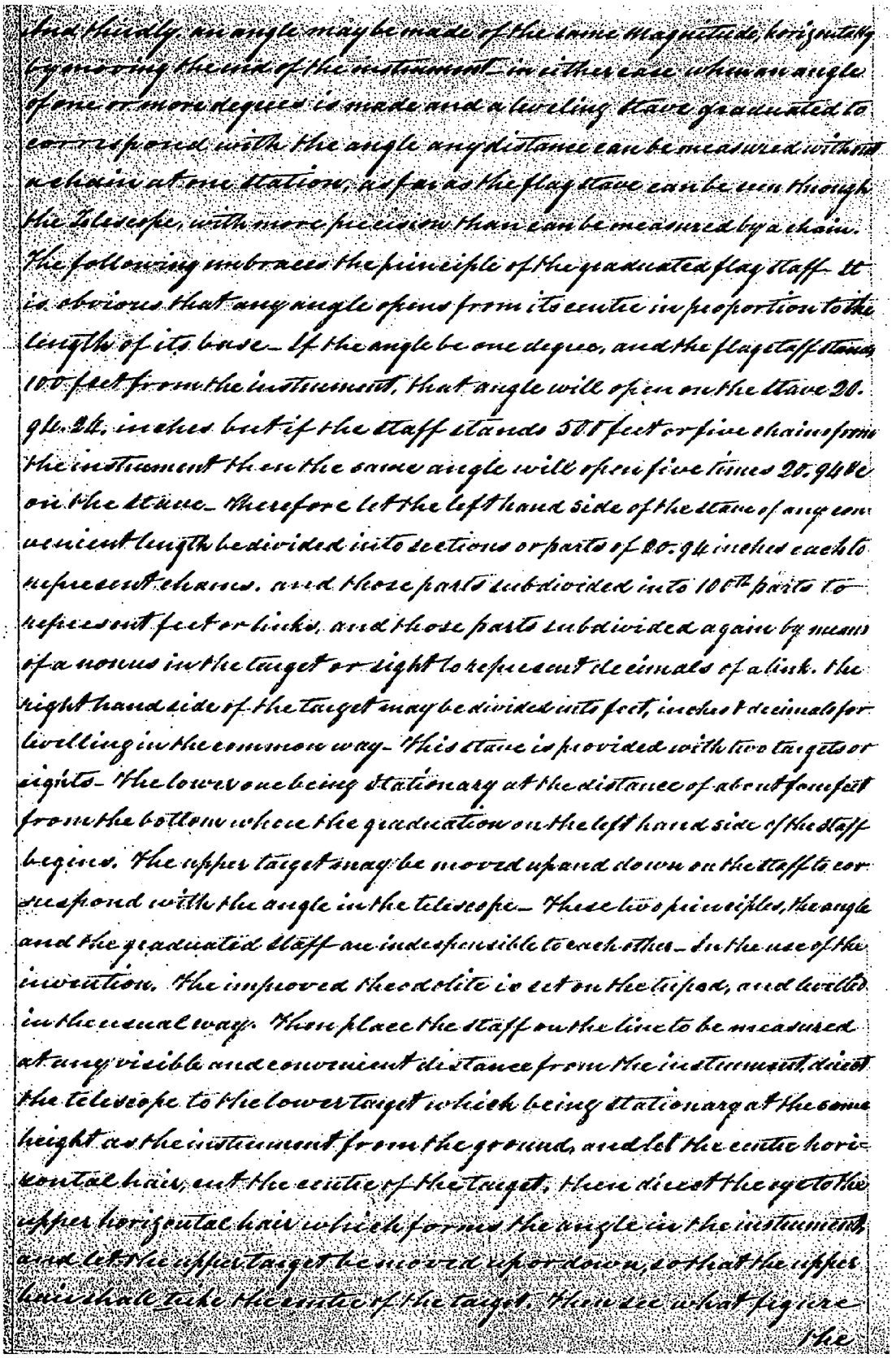
To all to whom these presents shall come:

Be it known that I Samuel Stone of Long Green Baltimore County & State of Maryland, have invented a new and useful improvement in the art of measuring distances at one station, with a theodolite or any other instrument by which an angle can be made either perpendicularly or horizontally, having a telescope attached to it, by making use of a flag staff, similar to a common leveling staff, graduated to suit the angle made by the instrument as will be more fully described hereafter and that the following is a full and exact description of the construction and operation of the said improvement as invented by me. The improved instrument is fixed on a tripod and stand of the usual kind. The horizontal limb is extended in diameter beyond the usual dimensions. The extension being for the purpose of forming a surface as well as centre on which a circular rim or plate revolves. The upper surface of this rim or plate, coincides with that of the limb & the limb & plate form a plane on which are delineated the logarithmic lines of numbers, lines & tangents. The said rim or plate is connected with the limb by means of a narrow rim which is screwed to the under part of the rim overlapping the outer edge & allowing it to revolve freely. The plane is provided with a moveable index which shows the coincidence of the different lines with each other. All above the limb is the same as the modern theodolite with the exception of two additional

hairs

hairs one above and the other below the horizontal hair & parallel with it. The whole horizontal limb of this instrument is about eleven inches diameter, having adjusting screws made in the common form. In this improvement the horizontal limb is extended about one inch and a half all round, beyond the usual dimension of the common theodolite, forming a plain with the limb of about two inches all round, on which is delineated the calculations which are as follows. On the upper surface of the limb & which forms a part of the above described plane are exhibited the logarithmic line of numbers on a circle, & corresponds in all respects with the nature and use of a table of logarithms, on the upper surface of the rim or revolving plate before mentioned are also exhibited the same logarithmic line of numbers divided and subdivided in proportional parts in all respects as on the limb, and as the nature of the line of numbers requires. Next to this line of numbers on this rim are exhibited a logarithmic line of sines, extending to 90 degrees subdivided into minutes, where the spaces will admit of such division. and so continued as to correspond with the line of numbers. Next to this on the same plate are exhibited the logarithmic line of tangents to forty five degrees, subdivided into minutes and corresponding with the line of sines and numbers by which any calculation can be made that can be performed by the tables of logarithms and logarithmic tables of sines and tangents. Every Telescope used for surveying has two spiders webs or hairs crossing the centre of the focus glass at right angles, one perpendicularly and the other horizontally which are distinctly seen at the show glass. now in order to make an angle in the cylinder or tube of the telescope from the eye glass. let another hair be placed above the horizontal hair parallel with it, at a distance if possible to make an angle of one degree, or as large an angle as can be made in the field of observation it may be more or less than a degree as the construction of glass will admit. But in my present calculations I have supposed the angle to be one degree. Secondly. A vertical angle may be made by elevating or depressing the telescope, and that angle being measured by the graduated arch, or semicircle attached to the telescope

and



And thirdly, an angle may be made of the same magnitude, horizontally by removing the end of the instrument in either case when an angle of one or more degrees is made and a leveling staff graduated to correspond with the angle any distance can be measured without a chain at one station, as far as the flag staff can be seen through the telescope, with more precision than can be measured by a chain. The following embraces the principle of the graduated flag staff. It is obvious that any angle opens from its centre in proportion to the length of its base. If the angle be one degree, and the flag staff stand 100 feet from the instrument, that angle will open on the staff 20.96. 24. inches but if the staff stands 500 feet or five chains from the instrument then the same angle will open five times 20.96 24 on the staff. Therefore let the left hand side of the staff of any convenient length be divided into sections or parts of 20.96 inches each to represent chains, and those parts subdivided into 100th parts to represent feet or links, and those parts subdivided again by means of a nonius in the target or sight to represent decimals of a link. The right hand side of the target may be divided into feet, inches & decimals for levelling in the common way. This staff is provided with two targets or sights. The lower one being stationary at the distance of about four feet from the bottom where the graduation on the left hand side of the staff begins. The upper target may be moved up and down on the staff to correspond with the angle in the telescope. These two principles, the angle and the graduated staff are indespensible to each other in the use of the invention. The improved theodolite is set on the tripod, and levelled in the usual way. Then place the staff on the line to be measured at any visible and convenient distance from the instrument, direct the telescope to the lower target which being stationary at the same height as the instrument from the ground, and let the centre horizontal hair cut the centre of the target. Then direct the eye to the upper horizontal hair which forms the angle in the instrument, and let the upper target be moved up or down, so that the upper hair shall take the centre of the target. Then see what figure the

the upper target stands at which will show the distance the staff stands from the eye. suppose the target stands at the first large division on the staff marked 100. or 1 chain then the staff is one chain from the instrument and so of any other division, for the farther the target is from the eye the higher the upper target must be raised. If the angle in the telescope be disregarded and you make use of the cross hairs only which are common to all leveling instruments and form a vertical angle by elevating the telescope one degree; it will have the same effect, for instance let the cross hair strike the centre of the lower target as before; then elevate the telescope one degree and let the upper target be moved up or down, so that the hair shall strike it, which will point out the distance at which the staff stands from the instrument By the same rule the angle may be made horizontally. and the staff turned down horizontally at right angles with the line, then sight through the telescope and let the hair cut the target in the centre as before. Then move the end of the instrument one degree, and let the target be moved till the hair strikes it in the centre, and the figure on which it stands will be the distance the staff stands from the instrument as before, for it is immaterial what way an angle is made; whether in the tube of the telescope, or a vertical or horizontal angle be made by the instrument, of one degree and applied to the staff in either case it will have the same effect, but if this angle be made more or less than a degree the staff must be graduated to suit the angle, and applied as above directed, and it will have the same effect. The above described art of measuring distances without a chain is founded upon the principle of making an angle with any correct instrument by making the flag staff one side of the triangle. Although the length of the staff is not brought into consideration, yet it is known when an angle is made by a mathematical calculation, how far that angle will open in the distance of the chain

or—

or 100 feet, then the perpendicular of that angle will be 20.946 inches. Now instead of making on the staff the length of the perpendicular of that angle, I mark the length of the base in that same place viz 100 feet for when this angle opens 20.946 inches on the staff, the base must be 100 feet. but if the angle open on the staff 41.88.48 inches, instead of marking 41.8 I mark 200 feet or 2 chains, which must be the base or distance the staff stands from the instrument, and in like proportion for any other angle. By this method we discover that the perpendicular of the triangle or length of the staff is not brought into particular consideration, although it is Mathematically measured, and the staff is in reality one side of the triangle by which the base is determined. This invention also calculates the latitude & departure of every course measured, and if the line be not horizontal it calculates the base, and perpendicular of the line, and the surface becomes the hypothenuse of the triangle which is also calculated. It solves any question in Multiplication, Division Rule of three, Interest, Mensuration, Gauging, Plane Trigonometry, or any question that can be solved or performed by a table of logarithms, by tables of logarithmic sines, and tangents. Any question in plane Trigonometry as well as the questions of common arithmetic if one statement can be solved in one minute with precision. In short this invention comprehends all the principal tables in Gibbons Surveying which fill nearly half his volume. The first improvement which I claim is the mechanical additions to the common theodolite, by extending the diameter of the horizontal limb, for the purpose of forming a surface as well as a centre, on which a circular rim or plate revolves as already described; and also the application of the logarithmic calculations as applied to the circle as already described. But I particularly claim the improvement of measuring distances by an angle at one point or station, using the pole or staff with its graduations for one side of the triangle.

Henry Burr
D. C. Burr

Samuel Stones