(No Model.)

C. L. BERGER.

ENGINEER'S OR SURVEYOR'S INSTRUMENT.

No. 591,153. Patented Oct. 5, 1897.

Fig. 1.

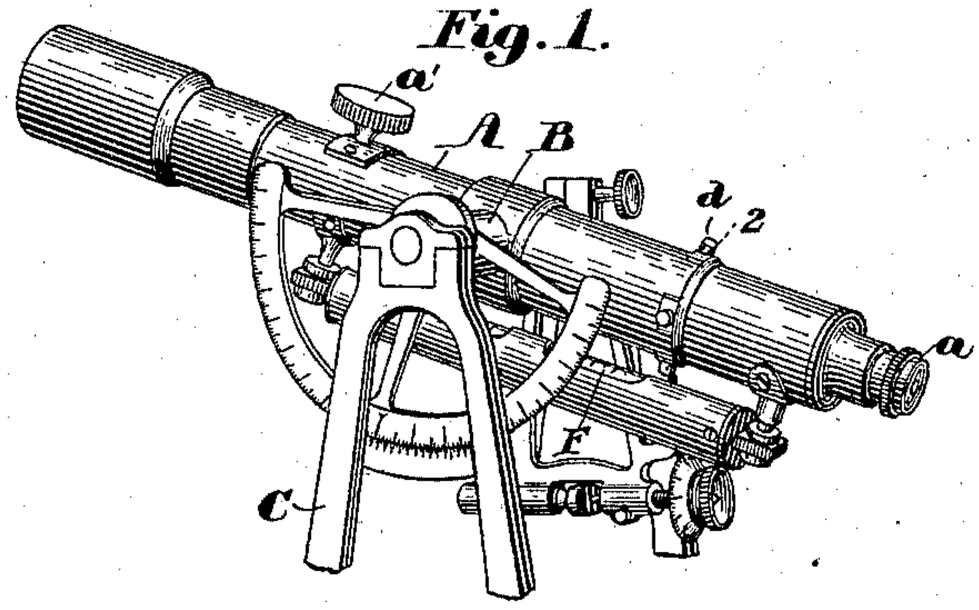


Fig. 2

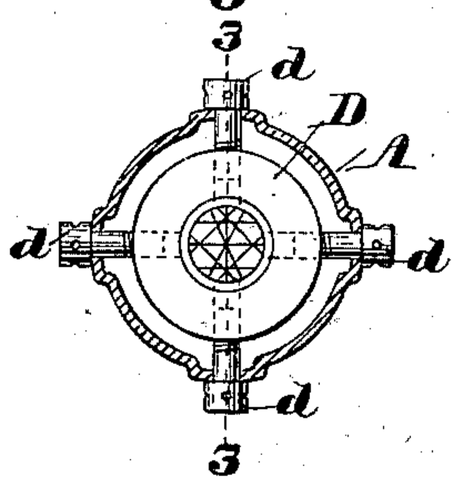


Fig. 3.

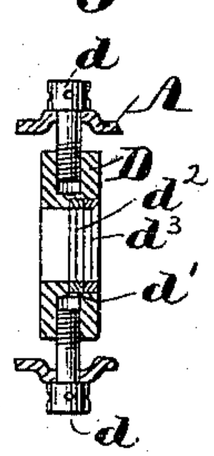


Fig. 4.

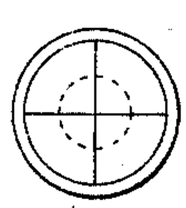


Fig. 5.

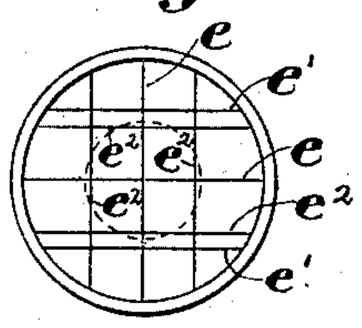


Fig. 6.

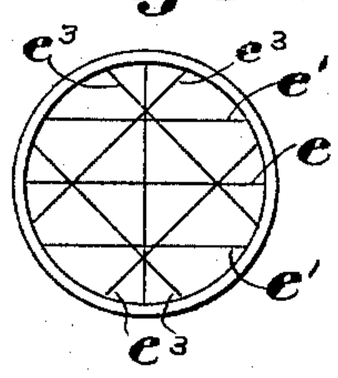


Fig. 7

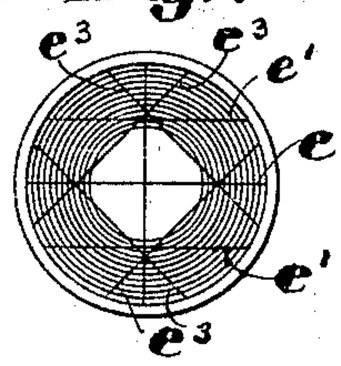


Fig. 8.

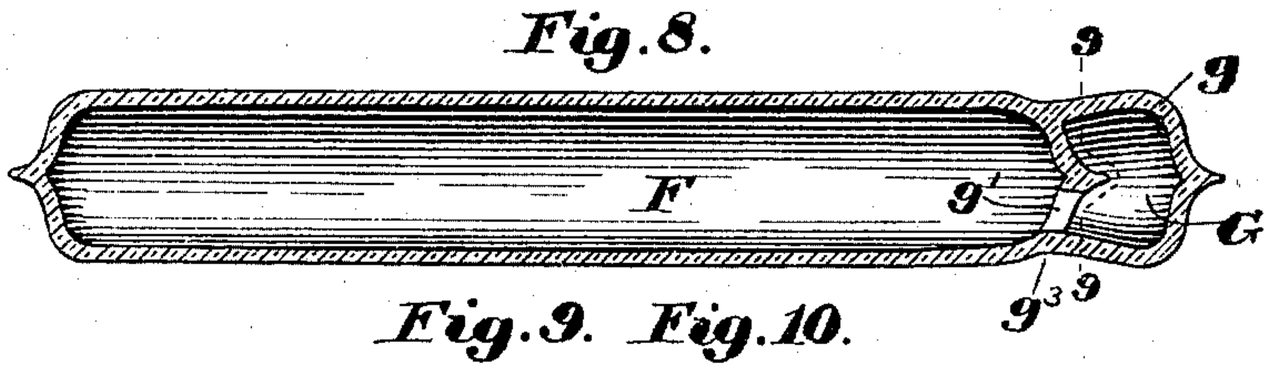
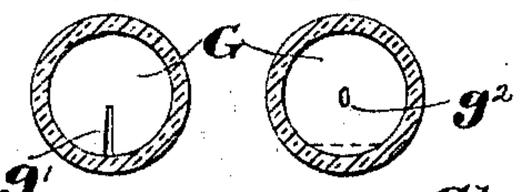


Fig. 9. *Fig. 10.*



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UNITED STATES PATENT OFFICE.

CHRISTIAN L. BERGER, OF BOSTON, MASSACHUSETTS.

ENGINEER'S OR SURVEYOR'S INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 591,153, dated October 5, 1897.

Application filed December 17, 1896. Serial No. 616,003. (No model.)

To all whom it may concern:

Be it known that I, CHRISTIAN L. BERGER, of Boston, county of Suffolk, State of Massachusetts, have invented an Improvement in Engineers' or Surveyors' Instruments, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings designating like parts.

In engineers' and surveyors' instruments, particularly in those of very high grade, capable of or intended for use in astronomical work, it is often desirable to employ different arrangements or figures of cross-wires, and in order to do this it has been necessary heretofore either to provide a complicated arrangement of reticule-frames or to remove one reticule-frame and insert another one when a change in cross-wires was desired.

One object of my invention is to provide a telescope or instrument having the required plurality of cross-wire figures mounted therein and instantly adjustable for separate use as desired without any chance for confusion or mistake or necessity for any removal or substitution.

A further object of my invention relates to the provision of novel reticules or cross-wire figures particularly adapted to this class of work and obviating recognized objections to the usual arrangement of cross and stadia wires, as will be hereinafter explained. I combine with the usual bisecting or quartering cross wires or lines additional sun wires or lines for solar work, arranging the latter lines so as to avoid all confusion between these and the stadia-lines, and yet have all the benefit of definite sun-lines ready at hand in connection with the lines required for general engineering-work. Engineers' instruments used for this solar work, &c., require levels of high efficiency, the best for the purpose being those having an air-chamber, by means of which the length of bubble can be regulated according to the temperature, and as these telescopes are subjected to much turning on their horizontal axes, and with a consequent extreme agitation of the fluid in the levels, the cement with which the air-chambers are cemented to the main tube is washed off and gathers as sediment on the glass and the bubble is changed when not desired. I have therefore invented a level of superior sensitiveness, made homogeneous and integral throughout, and which cannot accumulate any sediment, and have also provided an improved connection or passage between the chamber and the main tube.

The details of my invention will be fully pointed out in the following description, reference being had to the accompanying drawings, the invention being more particularly defined in the appended claims.

In the drawings, Figure 1 shows in perspective a sufficient portion of a transit provided with my improvements to furnish a clear understanding thereof. Fig. 2 is a vertical cross-section of the telescope-tube, taken on line 2, Fig. 1, showing my improved reticule, its frame, and adjustments. Fig. 3 is a vertical section taken on line 3 3, Fig. 2. Fig. 4 is an enlarged view in elevation, showing the usual arrangement of cross-wires, the position of the sun's disk being indicated therein by dotted lines. Fig. 5 is a greatly-enlarged view similar to Fig. 4, showing one form of my improvement in the arrangement of the cross wires or lines. Figs. 6 and 7 are similar views of another form thereof, the latter view showing the position of the sun's disk. Fig. 8 is a vertical longitudinal section of the spirit-level, the inclosing casing thereof being removed. Figs. 9 and 10 are vertical cross-sectional views of the air-chamber, the main tube of the level being represented in end elevation, showing different means of communication between the chamber and the tube.

The telescope A, containing a focusing-eyepiece *a*, object-glass, and focusing-screw *a'* therefor, mounted on a horizontal axis B in a frame C, is of any usual or preferred kind.

D designates the reticule-frame, customarily provided to hold the cross-wires, which may be platinum wires, spider-webs, lined glass, or other reticule, and delicately mounted for accurate adjustment in the telescope-tube by means of capstan-screws *d*. In this frame D, I have mounted a plurality of reticules or sets of cross-wires, one behind another, two sets being shown, the frame being milled out slightly on its inner circumference, as at *d'*, to receive one set d^2 behind the front set d^3.

For convenience of illustration I have shown the front set of wires as being the same in figure or arrangement, as shown enlarged in Fig. 6, the rear set of wires being the simple X figure as used in tunnel-work. However, I wish it to be understood that any figures desired may be employed. The successive reticules are in parallel planes so closely adjacent to each other that either one may be quickly brought into accurate focus by means of the focusing-eyepiece *a*, turning the latter forward slightly serving to make the wires d^2 visible and the wires d^3 invisible or out of focus and moving the eyepiece outward slightly having the reverse effect. Not only are the required reticules thus quickly and readily brought into focus for use, but they are accurately adjusted simultaneously by means of the capstan-screws *d*. The importance of the latter feature will be evident by considering Fig. 5, for instance, where the sun's disk is indicated in dotted lines. Supposing it were found that the sun's disk was not exactly quartered by the cross-wires *e e*, so that it became necessary to shift the reticule slightly, and supposing that another reticule, such as shown in Fig. 4 or in Fig. 6, were behind it, the two reticules being carried by separate frames and independent adjusting-screws, it will be evident that as one reticule would be shifted the wires of the other reticule would very nearly but not quite overlie its wires, making it exceedingly difficult, excepting to the most skilled operator, to determine which reticule should be shifted and which adjusting-screws to operate, the result being that probably the operator would find it impossible or at least very tedious to correctly adjust the reticules.

I will now describe the new reticules shown in Figs. 5 to 7.

By reference to Fig. 4, where the position of the sun is indicated by a dotted circle, it will be easy to understand the uncertainty labored under by the engineer in "bisecting" or "quartering" the sun, as it is called. As the operator looks through the telescope all is absolutely dark excepting a very small bright disk, (Fig. 2 showing the actual dimensions of the reticule,) this bright spot being the sun, as seen through the telescope. Now it is evident that it is very difficult to determine whether this spot or disk is accurately bisected or not by the lines of spider-web fineness arranged as usual, Fig. 4, a slight error to right or left being imperceptible to the eye. Accordingly I have invented the arrangements of lines or wires, as shown in Figs. 5, 6, and 7, the former having the sun's disk indicated by a dotted circle and the latter by a white space. The horizontal and vertical sighting cross-wires are indicated at *e e* and the stadia-wires at *e'*. Arranged at such distances from the center as to cut off segments of the sun's disk are horizontal and vertical sun-wires e^2 in Fig. 5 and oblique sun-wires e^3 in Figs. 6 and 7.

It will be evident that by my invention it will be no longer possible to make the error above alluded to in bisecting the sun, for the reason that the four small segments must all be seen by the operator before he can read his meridian, and these cannot be seen until the sun is exactly centered or bisected, as will be more apparent from Fig. 7, remembering that all the lines out of the field of the sun's disk are invisible to the operator, as indicated by the shading.

The advantage of arranging the sun-wires obliquely or at an angle of forty-five degrees, as shown at e^3 e^3, is that even the most careless operator cannot, in his regular engineering-work, mistake them for the stadia-wires *e'* or for the sighting-wires *e*, but on the contrary they act as pointers, as it were, to direct the operator to the proper center of the reticule.

Another marked advantage of the inclined square arrangement, as shown in Figs. 6 and 7, is that it gives additional accuracy and quickness of adjustment in placing the wires by affording a geometrical test or a proof or demonstration by geometrical figure that the wires are properly placed, for it will be readily understood by those skilled in the art without going into unnecessary details here that the lines e^3 e^3 must intersect the sighting cross-wires *e* at common points, and that the upper and lower of these points will fall just outside of the stadia-lines *e'*, so that if in sighting the sun the operator should find that no segments of the sun's disk were cut off by the sun-wires or that the segments were large he would know at once that the lines under observation were wrong or by inspection of the geometrical figure that the sun's lines were not correctly placed. In other words, the inclined square of Fig. 6 serves as a check or means of correction by which accuracy is insured, besides affording the convenience similarly with the reticule of Fig. 5 of combining in one reticule and one telescope all the wires required both for solar and for general work.

As before briefly explained, when an instrument of the character employed for purposes of illustration in Fig. 1 is used for the high grade of work which we have been discussing the usual spirit-level is ineffective.

The usual spirit-level of the best kind comprises a tube, as F, and a chamber, as G, the latter being cemented onto the former by isinglass or other cement, a segmental opening being provided between the two, as indicated by dotted lines in Fig. 10. The manufacture of these levels is very expensive and very delicate, and a most serious objection has arisen in their use by reason of the fact that the agitation and perhaps the chemical action of the contained liquid has resulted in disintegrating the cement, the latter appearing as a mass of dark specks in the tube F; also, the said agitation has caused the transfer of the liquid between the tube and chamber too freely and at times when it was not desired,

thereby impairing the efficiency of the instrument until the proper proportions were restored, so as to accommodate the bubble to the temperature. I have obviated these objections as follows: Having ground and finished the tube F (the latter being ground and on a curvature preferably of a radius of three hundred to five hundred feet) and filled it with the fluid, a quick-acting fluid, such as sulfuric ether, being used, the end piece *g* is placed snugly over the end of the tube under such temperature and conditions as to produce a vacuum therein in use, and the edges of the end piece *g* are then fused directly onto the tube F, so as to constitute therewith one integral solid piece without any foreign matter to be ground away by the impact of the fluid. This impact is marked in field instruments. It is to be understood that the chamber is provided to permit the use of a quick-acting fluid, as mentioned, as with a slow fluid, such as alcohol, the bubble is so slow to settle that it makes the process of leveling too tedious; but a quick-acting fluid, like ether, has a coefficient of expansion so marked that a small bubble in the summer-time would become in winter temperature as long as the tube and render the level useless. Therefore the chamber G is provided in order to permit the length of bubble to be adjusted as the temperature changes. I have found that the improper interchange of fluid already alluded to between the tube F and chamber G is obviated by providing a vertical slit, as *g'*, extending radially, as shown in Fig. 9, or for some uses a more restricted slit or aperture may be used at or near the center, as at g^2, Fig. 10. Preferably, also, there is a depression g^3 in the glass adjacent the slit or opening *g'*, coöperating therewith in retarding the passage of the bubble or "air" from one side to the other in case the level is turned bottom side up.

By the provisions of my invention, as herein described, it is rendered possible to use a transit or level telescope without change for all the delicate purposes mentioned, whereas heretofore a telescope or attachments had to be specially provided to reach the same ends.

While I have described the details of my invention in connection with an ordinary engineer's and surveyor's transit, it is to be understood that this is illustrative merely, inasmuch as my improvements herein described are in no wise restricted to any instrument and instruments, but may be used in various relations and instruments; nor do I restrict myself to the various details herein set forth, inasmuch as many changes in form, arrangements, and proportions of parts may be resorted to within the spirit and scope of my invention.

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

1. In a telescope, the combination with the object-glass, and a focusing-eyepiece, of a reticule-frame, a plurality of reticules therein, in parallel planes, and means to simultaneously adjust all of said reticules in and with relation to the telescope, substantially as described.

2. In a reticule, the combination with the sighting-wires, and stadia-wires, of sun-wires arranged to intercept segments of the sun's disk, substantially as described.

3. In a reticule, the combination with the sighting-wires, of sun-wires arranged obliquely to said sighting-wires to intercept segments of the sun's disk, substantially as described.

4. In a reticule, the combination with the sighting-wires, of sun-wires arranged in an inclined square intersecting said sighting-wires at its corners, substantially as described.

5. A spirit-level, having a main tube and an air-chamber separated therefrom by the apertured end of the main tube, made in one integral, homogeneous piece, substantially as described.

6. A spirit-level, comprising a main tube, and an air-chamber, said chamber being separated from the tube by a wall, and the latter being provided with a narrow opening at or near the center thereof, substantially as described.

7. A spirit-level, comprising a main tube, and an air-chamber, said chamber being separated from the tube by a wall and the latter being provided with a narrow opening at or near the center thereof, and extending radially outward therefrom, substantially as described.

8. A spirit-level, comprising a main tube, and an air-chamber, said chamber being separated from the tube by a wall, and the latter being provided with a narrow opening at or near the center thereof, and extending radially outward therefrom, the inner connecting-surface of the said tube and chamber adjacent the outer end of the said opening being depressed, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHRISTIAN L. BERGER.

Witnesses:
GEO. H. MAXWELL,
JOHN C. EDWARDS.