

ESTABLISHED 1871.

INCORPORATED 1898.

# BUFF & BUFF

## INSTRUMENT MFG. COMPANY

GEO. L. BUFF—PRES. & MANAGER.  
SENIOR MEMBER BUFF & BERGER, 1871-98.

L. F. BUFF—TREASURER.  
FORMERLY WITH BUFF & BERGER.

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HIGH GRADE  
ENGINEERING, SURVEYING,  
ASTRONOMICAL & MINING INSTRUMENTS

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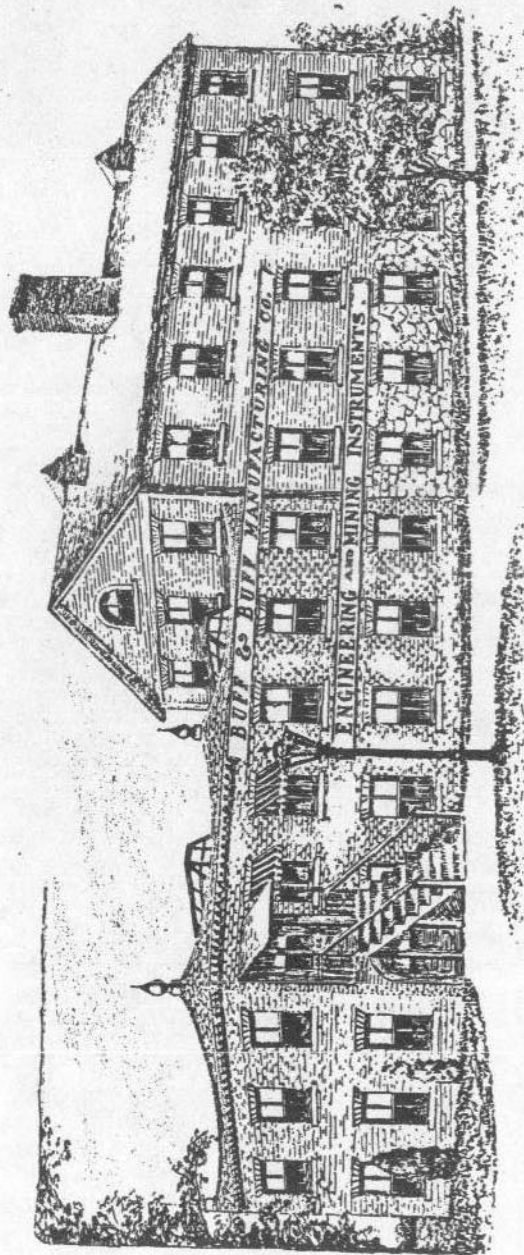
SHOPS AT  
506-510 ATLANTIC AVE., BOSTON.  
AND JAMAICA PLAIN STA., MASS.

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MAIN OFFICE:  
JAMAICA PLAIN STA.  
BOSTON, MASS.

CITY OFFICE:  
302 WASHINGTON ST.



THE MOST PRECISE INSTRUMENT SHOPS IN THE WORLD.

View Looking West; Jamaica Plain Shop.



## TESTIMONIALS.



ORDINARY printed testimonials are of little value. They are easily obtained, are often antiquated, and usually mean little. We have scores of letters which might serve as references, if we were to ask permission of the writers to print them. To any one desiring in good faith to ascertain the merits of our instruments, we will be pleased to send the name and address of some one in his vicinity if practicable, to whom we have furnished such, and who will doubtless give an opinion which will be valuable, because based on experience, and unbiased by any solicitation on our part.



## HISTORY.

**T**HE BUSINESS now conducted and carried on by the B. & B. Mfg. Co., was organized Oct. 26, 1898, by GEO. L. BUFF, the present manager, who aided in the founding of the now extinct firm of Buff & Berger in 1871. Mr. Buff was senior member of that concern to 1898 when it formally dissolved.

The world-wide and long-established reputation of the Buff & Berger instruments for uniformity of graduations and durability, is attested by thousands of owners and engineers who have used them.

The quality of the "B. & B. Transit" (Reg. Trade Mark,) is alone considered in its manufacture, and we claim for our product even greater accuracy owing to the improved machinery, improved methods of manufacture and of the work performed by our new and unrivalled dividing engines upon our instruments, all under the exacting supervision as exercised by our senior member.

**"QUALITY IN ENGINEERING INSTRUMENTS"**

OUR MOTTO.

## TO THE ENGINEERING PROFESSION.

**A**FTER an experience extending over 35 years in the manufacture of thousands of engineering and astronomical instruments, it seems hardly necessary for us in presenting this catalogue to the engineering profession, to enlarge upon the success attained. The number produced and the increasing demand, speaks for their international popularity and worth. We have, therefore, given an outline only of the types of construction, the particular features of our instruments, and brief descriptions of the different styles regularly made.

The illustrations shown are by half-tones direct from photographs of our instruments.

At the rear of this catalogue we have appended some few remarks on Adjustments of our instruments which we trust may be of service to the engineer.

For convenience in communicating with us we have arranged a cable code, which will be found on the last pages.



THE  
"B. & B. TRANSIT."

(U. S. REG. TRADE MARK.)

THE B. & B. Transits meet with the minimum atmospheric resistance as the construction is such as to cut the air,—not to obstruct it and collect dust as the standards and forms of most instruments do.

As to dust and preventing its entry into the transit, it is our claim that the better the instrument, the more effectively is the dust excluded, and therefore we consider that our instruments are as nearly dust-proof as it is possible to make.

B. & B. instruments will withstand a greater degree of heat and moisture without impairment of the accuracies due to the superior material and the precise method of putting together and the final finish.

B. & B. instruments will also withstand more severe shocks without disturbing the adjustments owing to the density of the metals employed, combined of course with the superior grade of workmanship in the construction.

Suffice it to say therefore:—

"The best instrument procurable is the cheapest in the end." By its use, aggravating and expensive repetition is avoided.



Characteristics of our Instruments.

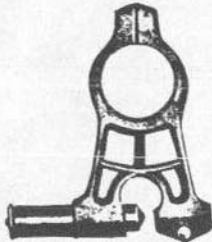
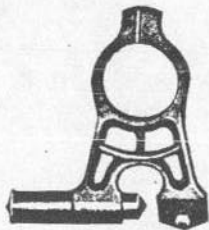
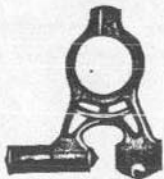
Under this heading we will take up first the four vital parts of the engineers' transit.

1. The CENTRES.
2. The GRADUATIONS.
3. The TELESCOPE.
4. The SPIRIT LEVELS.

And then the secondary ones of

5. The COMPASS, NEEDLE and FORM.
6. The IMPROVED GRADIENTER.
7. The Stadia.
8. The VARIATION PLATE.
9. The TRIPOD.
10. The Plumb-bob.
11. The Final Finish of our Instruments.





Showing some external forms embodying great strength as well as grace of design.

## The Centres.

Next to the graduations it is as equally important that the centres be accurately spherical and truly fitted to retain that accuracy and also constructed of the most suitable metals.

That our centres are truly spherical, we are convinced by many and exhaustive tests and moreover are convinced that they must be so in every one of our instruments, because of the methods we employ in turning them (upon what we are pleased to call "dead centre lathes" — being precision lathes without spindles, and merely having a dead head-stock with immovable centre and tail stock with centre).

That they are fitted to retain that accuracy, — we take especial pride in stating, — because

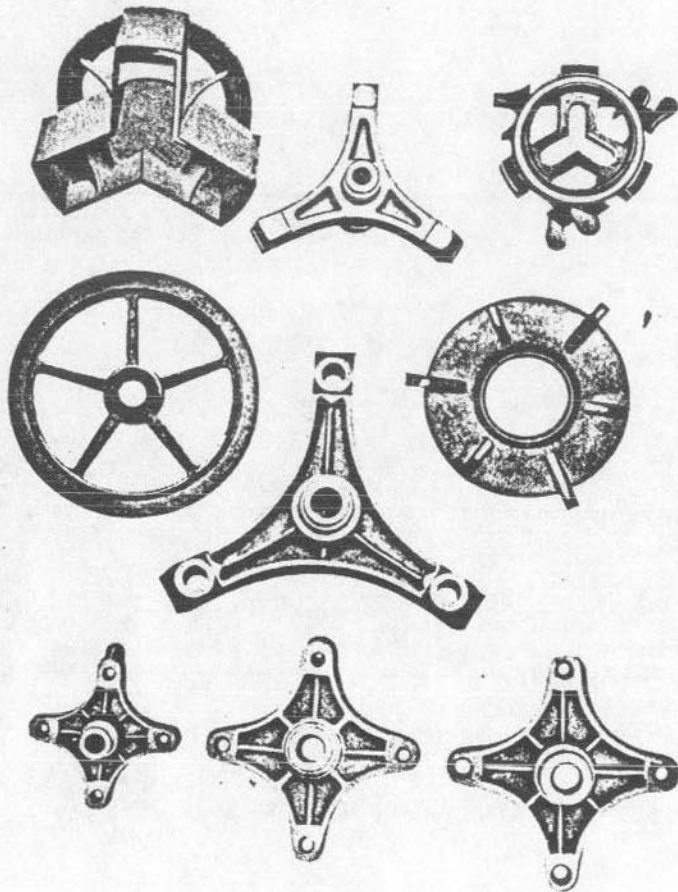
1. The long tapers, possible in our instruments, terminating in the large heavy flanges are theoretically and practically the best.

2. These long tapers, — theoretically correct are in practice, most carefully and perfectly fitted by the expenditure of much expert labor (for upon the nicety of this fit, depends the accuracy and longevity of the entire instrument).

That the different metals employed in their construction are the best for the purpose, — the experience of 35 years dictates. The three widely different compositions of phosphor-bronze, — gun metal, — and hard red composition, — are the metals chosen for the engineer's transit, as each having for the next respectively, the least co-eff. of friction, and altogether for the others having the minimum difference of the co-efficients of expansion and contraction.

For the Wye level centres, — where the presence of iron is not prohibitory — an option has been recently offered (at the slight additional expense of \$5.00) of a hardened steel centre in a socket of best annealed charcoal iron.

It would be hardly necessary to elaborate upon these metals as the very best possible for any centres, since this combination



A few Centres.

is so universally adopted for all large astronomical instruments as giving,—

1. The minimum co-eff. of expansion of any two metals.
2. The minimum difference of the co-eff. of expansion of each.
3. The minimum co-eff. of friction.

Thus in every way it certainly gives the ideal centre, theoretically.

To insure the fit of this steel centre special tools have been erected of the latest types for grinding, which in accuracy cannot be excelled.

## Graduations.

For view of Graduating Engine—See Page 62.

Points in which our graduations excell :

1. The absolute and equi-distant spacing of the division.
2. The uniform thickness of line all around the circle.
3. The fitting together of the verniers and graduations.

The CORRECTNESS of the SPACING,—as performed upon our dividing-engines, which were recently completed by our senior member, we are able to guarantee within  $1\frac{1}{2}''$  of arc. This represents an error of less than  $\frac{1}{54000}$  part of an inch. Errors smaller than this it would be manifestly impossible for human ingenuity to eliminate, since other factors must be taken into consideration and these are respectively,—

Due to the precaution exercised,— these errors are *virtually* negative.

1. Errors due to temperature changes, though this change be inside of  $1^{\circ}$  F.
2. Errors due to the personal equation in setting up, leveling and centring the circle of the transit upon the dividing engine.

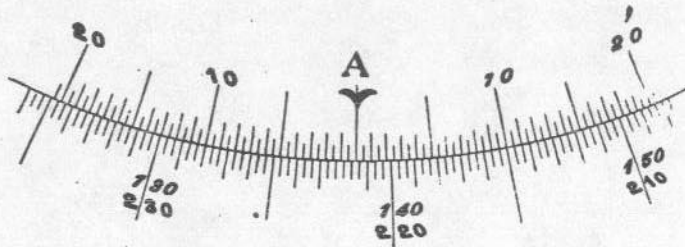
(Compared in sum total to the personal error of manipulation in the field, as usually accounted for in the closest triangulating, these combined errors are infinitesimal *in our graduations.*)

The UNIFORMITY of the GRADUATION LINE,—as put upon our circles and verniers, we deem the special features of our graduations next to accuracy. We claim this because:—

1. The delicately poised mechanism, supporting the finely ground cutter, is of such rigid construction.
2. The long experience dictating the proper combination of cutting angles ensures that the cutter is ground to the angles, which will cut the last line equally as wide as the first.

The FINAL FITTING TOGETHER of the GRADUATION and VERNIERS, as performed by ourselves, is guaranteed to be the same that won the reputation for the old B. & B. graduations, and performed by the same able expert.

We can also graduate in the French Centesimal system of  $\frac{1}{100}$



Usual form of figuring for 30 sec. graduation.

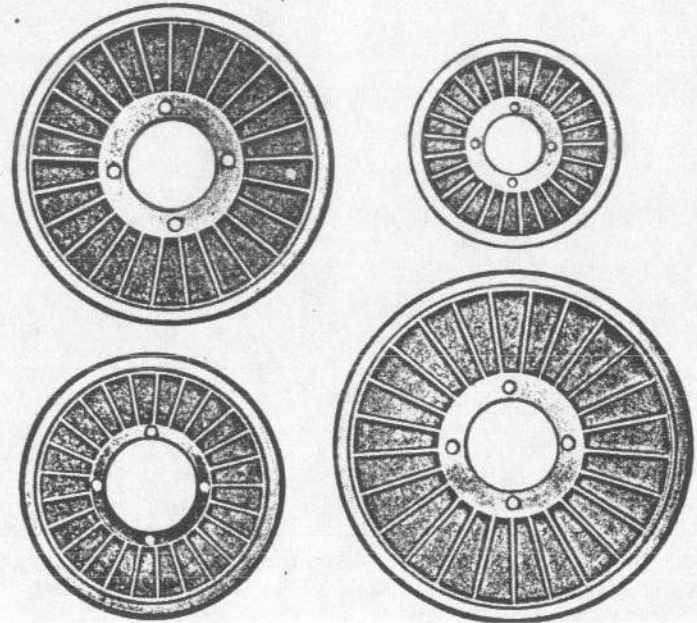
Sizes and diameters of the different transits are measured at the edge of graduation.

No.	Dia.	Needle.	Wt. of Plain Transit.
No. 1 . . . . .	6 $\frac{1}{4}$ "	4 $\frac{1}{2}$ "	14 lbs.
" 2 . . . . .	5 $\frac{1}{8}$ "	3 $\frac{3}{4}$ "	10 "
" 3 . . . . .	4 $\frac{1}{2}$ "	3 $\frac{1}{4}$ "	7 "
" 4 . . . . .	4"	2 $\frac{3}{4}$ "	5 "



THE CIRCLES.

Which take upon the inlaid silver the complete circular graduation.



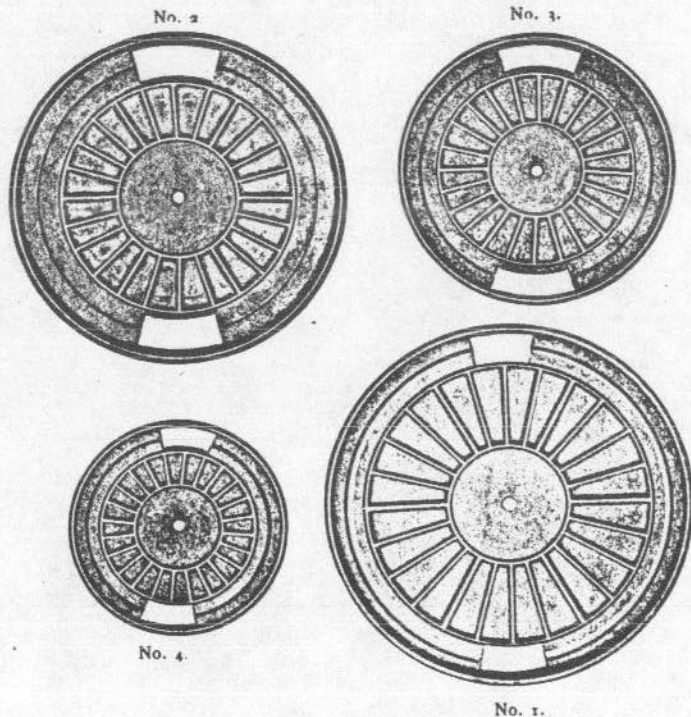
SHOWING UNIFORMITY OF RIBBING.





### THE PLATES.

To which are attached the verniers which read off the circular graduation.



UNIFORM RIBBING

## Telescope.

In adapting our forms of telescopes with their re-calculated systems of lenses and diaphragms to the different styles of instrument, we have been governed by the other factors that go to make that particular instrument, such as the fineness of graduations and sensitiveness of spirit-levels, in order to obtain an harmonious whole in which every element is consistent with the other.

In accomplishing this, we have been able to greatly improve the entire lens system by instituting somewhat longer focus objectives, giving, —

1. Much more satisfactory working combination.
2. Vastly improved illumination.
3. Slightly greater power.
4. Flatter and sharply defined field.

Additional points that we secure in our telescopes. —

5. Reversible at both ends.
6. Perfect balance in all positions.

The power we choose for each of the several transit telescopes is the one where the slightest motion of vernier or bubbles causes a deflection, of the cross-wires in the field of view, to be easily noticeable. A higher power is useless and can only result in proportionately decreasing illumination. A lower power, on the other hand, could not develop the maximum capacities of the other dependent features of a first-class instrument.

In our terrestrial (erecting) telescope, for the regular No. 1 size transit, we obtain a power of  $26\frac{1}{2}$  dia. with a  $1\frac{1}{4}$ " aperture objective.

In the 18" Engineer's Wye level, with the larger objective of  $1\frac{3}{8}$ " and the greatly increased available focal depth, a power of 36 diameters is obtained.

The eye-piece for all terrestrial mountings is constructed of the combination of 4 lenses giving an unsurpassed large field



which has all the illumination possible since full size diaphragms are used, (no attempt being made to cut the diaphragm down at the expense of light) to gain definition. This, of course, necessitates the very finest workmanship on the eye-piece lenses.

For the astronomical telescope we have adopted an admirable eye-piece which is a modification of the Kellner. (It is modified insomuch as a somewhat longer working focus is obtained which, in the field practice of the engineer, prevents any chance of destroying the cross-wires, when placing them in focus).

To obtain this it has been necessary to make the field lens a double one, making three lenses altogether in the eye-piece.

For large flat field with the full aperture admitting the full quota of light, this modified Kellner is unsurpassed.

In conclusion, the factors aiding us greatly in the matter of good glasses in our telescopes are, —

1. Because every eye-piece and objective before being accepted by us, is tested on a special apparatus and compared to a known and standard telescope of excellent and tried qualities, and up to which standard each must come.

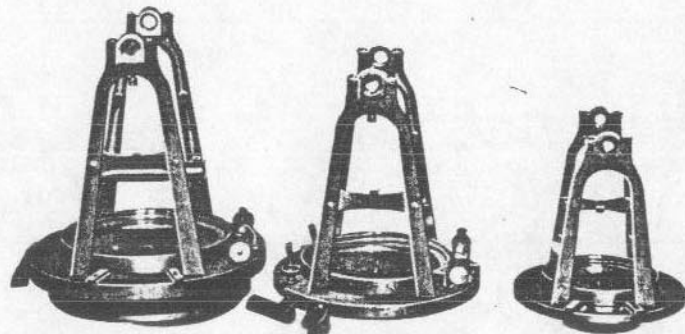
2. That both eye-pieces and objectives are made by one and the same celebrated continental makers, who know no peer for quality or price.

It is hardly necessary to state that nothing but the purest Jena glass of a suitable refractive index is used in our lenses.

### SPECIAL.

A true and valuable improvement on our telescope (one that is typical of our endeavor to simplify and not merely adopt subterfuges), is the precise fit of our focussing slide into the main telescope tube. By development from the foundation and by the use of improved precision machines in boring out and

fitting, we obtain the great regularity in permanent collimation so desirable. As for the use of aluminum in top and solar telescopes, we cannot favor such at all, since the very few ounces saved in weight can not offset the inaccuracies and lack of permanency of such construction.



No. 1-6 1/4"                      No. 2-5 1/4"                      No. 3-4 1/4" .  
 Showing the relative size of the standards which swing the respective telescopes and allow reversal at either end.

## Spirit Levels.

### BUBBLES.

In developing thoroughly the methods of manufacture in producing the spirit levels for our instrument, it has been our aim to obtain much more uniform and reliable results than formerly customary.

In consequence we have constructed new machines, which are automatic in their grinding, and produce, we are certain, truer curves than could be ground by hand on a lathe arbor.

Carefully testing and marking each bubble, we separate them into groups of definite sensitiveness, from which, according to the type of instrument, we select the most preferred sensitiveness for that type.

Incidentally, the method of grinding is precisely the reverse of hand grinding, and also eliminates that objectionable heat of the hand from grinding on an arbor in the lathe. This heating plays a very important part in the accuracy of the vials and is truly accountable for the inaccuracies heretofore experienced.

In addition to the regular grades of sensitiveness, the finest being the 8" vial, for the finest leveling instruments, we are prepared to furnish guaranteed spirit levels ranging from 1" up for astronomical uses.

## The Compass.

The compass circle in all our instruments is graduated to  $\frac{1}{2}^\circ$  on its upper surface, and is figured from 0 to 90 on each side of N. and S.

The graduation and inside face of compass are completely silvered.

On the south end of the needle, a fine coil of wire is wound to equalize the attraction due to dip. As the dip of the negative needle varies, we make the correction on the needle dependent upon the locality to which instrument is to be shipped. The variation of the dip is taken from the government charts issued each year.

The needle and its form, as made by us, plays quite an important part in the accuracy which we claim for our compass. Long experience has developed the form (as in pen sketch) with jewel bearing on delicate hardened steel pivot.

Special magnet steel only is used.

## The Improved Gradienter.

As applied by the B. & B. Mfg. Co. the attachment is guaranteed within  $\frac{1}{10}$  of one per cent. accuracy. This approximates the average of what can be expected of the stadia.

Thus with an equivalent accuracy, it has the several advantages of ability to run definite grade lines with the minimum work, etc., and to measure horizontal distance, difference of level and vertical angles.

The attachment is certainly quite worthy a place on the full Engineer's transit.

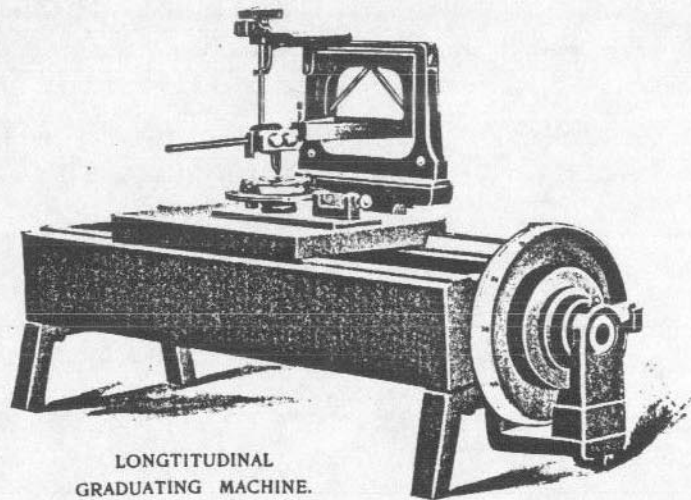
As made by us, the gradienter dial is graduated so that two complete revolutions will subtend the space of one foot at one hundred feet. Or, in other words, if moved through two rev. and sighting on a leveling rod at any distance, the diff. of the two rod readings, multiplied by one hundred will give the actual distance in feet from the centre of instrument to sight.

The setting of a grade would be even simpler, for in that case the reading of the gradienter screw is taken with level-bubble standing in centre of tube. The necessary rev. of the grad. screw from this position would then be twice the grade in feet per hundred.

On the No. 3 and No. 4 sizes of transit, we have also perfected the gradienter attachment, but on these instruments the value of the graduation on the screw dial is for one rev. 1' in 100', and for distance work the diff. of rod readings, subtended by one rev. of screw, would be multiplied by 100 to obtain the distance in feet.

## The Stadia.

In advocating the stadia wires in lieu of the grader attachment, we stand alone, we believe, (though we claim either fully the equal of the other in accuracy of construction). The superiority of the stadia lies however in the permanency of the stadia wires under all conditions, and this is due to their simplicity. With the grader, the resultant errors, owing to neglect to guard against back-lash of the screw, will be of such frequent occurrence, that the entire attachment will not be valued at its proper worth, simply because not given proper manipulation.



LONGTITUDINAL  
GRADUATING MACHINE.

Reading to  $\frac{1}{20000}$  part of an inch. Used to mark diaphragm for insertion of stadia wires.

In ruling the diaphragm, for the insertion of the fixed stadia, the objective, with which this stadia is to be used, is very carefully measured for its mean focal length on our special Focal-length Apparatus. Having this value, in hundredths of an inch, the dependent value in ten-thousandths of an inch is ruled off by the delicate drafting cutter in our diaphragm ruling apparatus.

This ruled diaphragm is then inserted under our special microscopic stand with the variable micrometer feed-screw adjustments, and then the proper thickness of spider's web selected, cleansed, stretched and accurately placed in the tiny groove previously ruled.

We say, proper thickness of spider web, because here again we are governed by the magnifying power of our respective telescopes and select the diameter of web that fulfills the proper requirements.

The diameter of an ordinary spider web is .001 inch.

Diameter of web, as we use it, .00025.

Diameter of minimum web for finest astronomical telescopes, .0001 and less.

The price to insert the stadia in any of our new telescopes is \$3.00. Disappearing stadia wires complete—\$5.00.

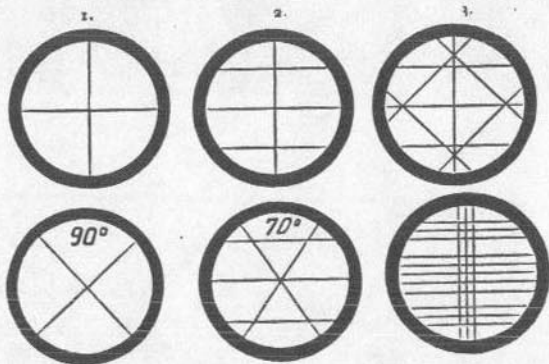
The constant, which is to be added to all stadia measurements can be accurately assumed at  $1.5 \times$  the focal length of the object-glass with our system of lenses. Its value is supplied with every instrument.

For the adjustable stadia wire the charge is \$10.00. This form we do not however care to recommend very strongly since so liable to derangement.

Diaphragms below show the best arrangements for all cases of engineering and surveying practice.

Special arrangements can be supplied if desired.





- 1. Ordinary cross-wires.
- 2. Cross and stadia wires.
- 3. Stadia and solar wires.
- 4. Plain Triangulation wires.
- 5. Complete Triangulation with stadia wires.
- 6. Stellar observation wires.

Prices:

- No. 1. and 4 are furnished as part of equipment.
- 2. Wire arrangement, - - - - \$3.00
- 3. " " - - - - 4.00
- 5. " " - - - - 4.00
- 6. " " - - - - 6.00
- No. 2. fitted as disappearing stadia wires, Complete, \$5.00.

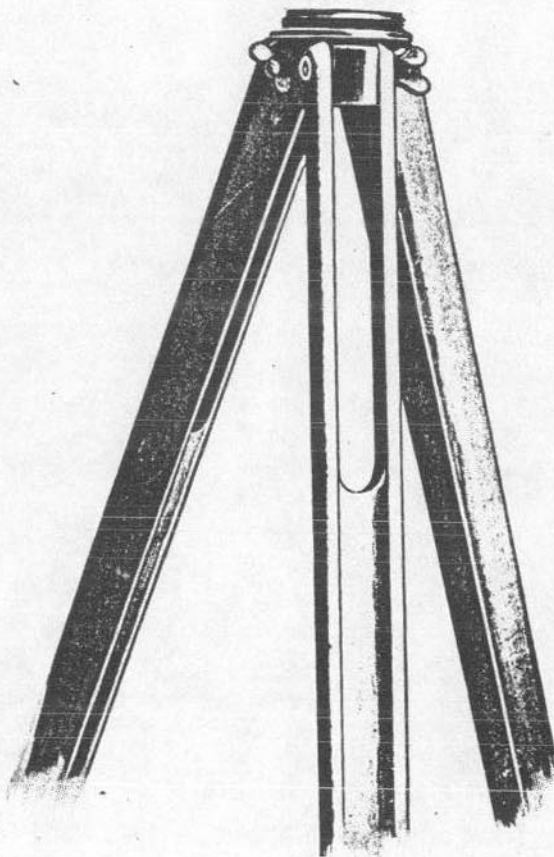
## The Variation Plate.

It is well-known that the magnetic North varies in almost all parts of the world, and also that the deviation is constantly on the increase or decline in a series of years.

To avoid the confusion arising from adding or subtracting the error to each reading we make an additional movable graduated ring, called the variation plate. It will readily be seen that the engineer, having such an arrangement, can pick up old lines on farm surveys, etc., with much ease, provided the variation giving the time meridian is set off by means of the milled head adjusting screw, East or West as the case may warrant.

The cost of this attachment as applied to our instrument is \$10.00.

Special chart for the current year of the magnetic variation and days.— mailed post free for - - 50c.



THE TRIPOD



## Tripod.

Our latest split-leg tripod for our regular instruments, as recently designed, we construct entirely of pure white rock maple. (The advantages of maple over ash as previously used, are the straighter grain and closer grain, the better finish and the more durable finish).

The iron shoe as provided on our regular tripods is of improved and superior design, as has been found necessary by field work. It embraces a projecting spur for the boot, and of suitable size to admit of easily pushing the leg to a firm bearing in the earth.

The bell-metal head, holding the three legs together at the top, is of a single casting which is strengthened by curved and graceful ribs, adding to the grace of this part and increasing the rigidity.

The finish on our tripod is of the most acceptable type, being of three coats of hard shellac, which are each rubbed down and dressed in oil, thus procuring an almost indestructible, permanent finish.

## Plumb-Bob.

Similar to several other insignificant yet important details when assembled into a whole, is the accuracy of our plumb-bob. This depends upon the carefulness in the making and the design permitting an unobstructed view of the plumb-point.

The care in the making produces a bob that will, when suspended, and rotated, swing truly in the theoretical centre.

This is obtained by having centre of gravity low, fitting hole in top closely to size of plumb-string, and finishing carefully. They excel in the following points:—

1. Accuracy due to careful work.
2. Design and proportions permitting a low centre of gravity and unobstructed view of the point.
3. Thoroughness of construction from hardest bell-metal and the point of hardened and tempered tool steel.

## Finish.

The finish of our instruments can be divided into three types of one class (since all finishes are of the best grade).

1. Bright Finish—This is the usual finish and embraces polished surfaces throughout.
2. Bronze Finish—Is the handsome, dark-polished finish most suitable for mining work.
3. Cloth Finish—Which resembles a covering as of cloth; can be applied to any or all parts of instrument, as desired.

Our bright finish is of the pleasing lacquer color, so unique among only our instruments. It is not a glaring finish, but is bright enough to throw off the objectionable heat rays. Altogether it makes the most permanent finish.

The bronze finish is upon the same finely polished surface, which is burnt a delicate brown with acid, and finely lacquered with white lacquer to preserve the rich tone of the brown. This one is suitable for mining work since it throws off no reflections, adding thus materially to the manipulation and speed.

Cloth finish, so-called, because to the touch it resembles cloth, is not cloth, but merely a finely prepared material of the requisite color, greenish-brown, of which three separate coats are applied with japan and each one baked on. Contrary to belief, it is also a durable finish, for the reason that it is so firmly baked on. This style is much desired for astronomical instruments, on account of the equable temperature possible. Since the necessity of finely polishing these surfaces to be cloth-finished is thereby unnecessary, the cost of thus finishing is lower than with the two preceding styles.



THE  
STANDARD  
"B. & B. TRANSIT."

(REGISTERED TRADE MARK.)

The B. & B. Standard instrument has behind it now a history of twenty-nine years of uninterrupted success which has been unparalleled, demonstrating beyond cavil the correctness of the design and the accuracies of its constructions.

It is the foundation of our present large and growing business, and it is because of the completeness with which it has always fulfilled our most sanguine expectations that we have been encouraged to extend our facilities for the manufacture of our new types, which are, in a sense, successors to the old Buff & Berger instruments.

The old B. & B. instrument has kept pace with the growth of business in this country, showing that it covers a field peculiarly its own, and has inherent advantages that cannot be outweighed.

Consequently, we not only continue to build B. & B. instruments with the same scrupulous care as before, but we are to-day building them better in every point where the experience with over three thousand transits of this particular type has indicated that improvement was possible. Incidentally, this instrument comes

more nearly than any other to being purely elementary in design and grace of finish. That it has thrived for over a quarter of a century suggests the possession of tangible merit, easily discernible by those whose good sense enables them to discriminate between a superior and an average instrument.

With an unusually skilled force, comprising men especially belonging to the instrument makers of the world, we stand in the position to offer our customers the best possible.

ITS ECONOMY.

In point of economy the B. & B. standard transit is unequalled by any other engineering transit made.

On widely varying work we believe it to be superior to the best of any particular instrument built for only one use, because of the excellence of the workmanship, allowing it and the power of the telescope to accommodate themselves to circumstances and to offer up the clearest work at all times, and for a much longer period to retain its adjustments and, in the total, to wear very much longer, because of the rare skill in constructing of the toughest metals, the centres.

(It is hoped that the above will not be set aside as a piece of common advertising bombast. It is really the careful and deliberate statement of a manufacturing concern of established reputation, which realizes that it cannot afford to hazard that reputation by false or misleading statements).

SPECIFICATIONS,—No. 1 Bubble Transit.

Graduation,  $6\frac{1}{4}$  inch diameter, with two double opposite verniers to minutes, placed at either  $90^\circ$  or  $30^\circ$  to line of sight. Two rows of opposite inclined figures  $0^\circ$ - $360^\circ$ . Graduations silvered and covered by pure crystal plate glass.

Telescope, erecting or inverting, is balanced and reverses at either end; 12 inches long,  $1\frac{1}{4}$  inch aperture, with power of 26.5 dia. improved eye-piece, unsurpassed large, clear field. Ad-

justment for vertical plane, and line of collimation correct for all distances. Sensitive level bubble, 6" long with clamp. Improved lower and upper spring tangent clamps. Shifting centre with  $\frac{3}{4}$  inch adjustment. Spirit levels truly ground by special machine, rated and sensitive.

Standards are cloth-finished.

Long taper centres with broad flanges.

Compass needle is  $4\frac{1}{2}$  inches long and of the accepted forms. Compass graduation is silvered and figured with single row

0-90 on each side of N. and S.

Tripod improved; split-leg, with wing-nuts.

The mahogany instrument box is provided with strap, lock and hooks, and contains plumb-bob, pocket-magnifier, sun-shade, wrench, screw-driver, pins, etc.

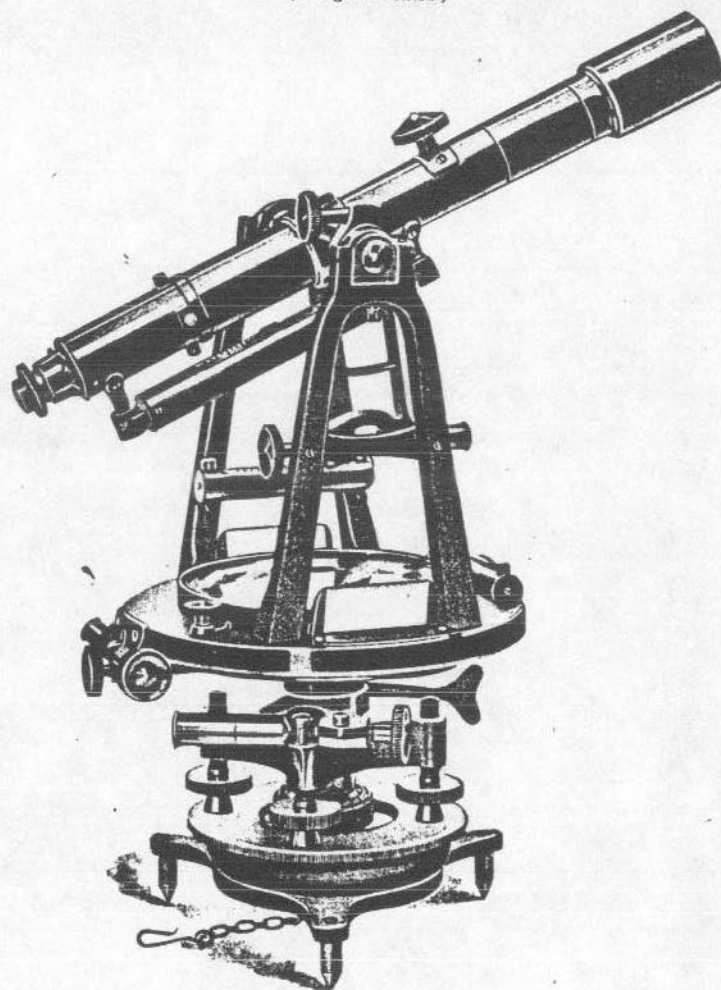
N. I. Plain Transit weighs—14 lbs. Stiff leg-tripod— $7\frac{1}{2}$  lbs.

### EXTRAS TO NO. 1 SIZE TRANSIT.

Graduation, horizontal circle, solid silver, ..	\$10.00
“ “ “ reading to 30” . . .	10.00
“ “ “ “ “ 20” . . .	20.00
“ “ “ “ “ 10” . . .	25.00
“ vertical circle, solid silver, . . .	5.00
“ “ “ reading to 30” . . .	10.00
Ground Glass shades to verniers, . . . . .	3.00
Standards finished and polished bright (like telescope)	5.00
Improved gradienter attachment, . . . . .	5.00
Reversion level, for leveling with telescope reversed. (page 36)	15.00
Fixed stadia wires, guaranteed, . . . . .	3.00
Variation plate and ring, . . . . .	10.00
Silk waterproof bag, to cover instrument, . . .	1.00
Superfine watch oil, per bottle, . . . . .	.25
Extension tripod, . . . . .	10 $\frac{1}{2}$ lbs.
Reg. “ . . . . .	7 $\frac{1}{2}$ “

### STANDARD B. & B. NO. I BUBBLE TRANSIT.

(Design Patented.)



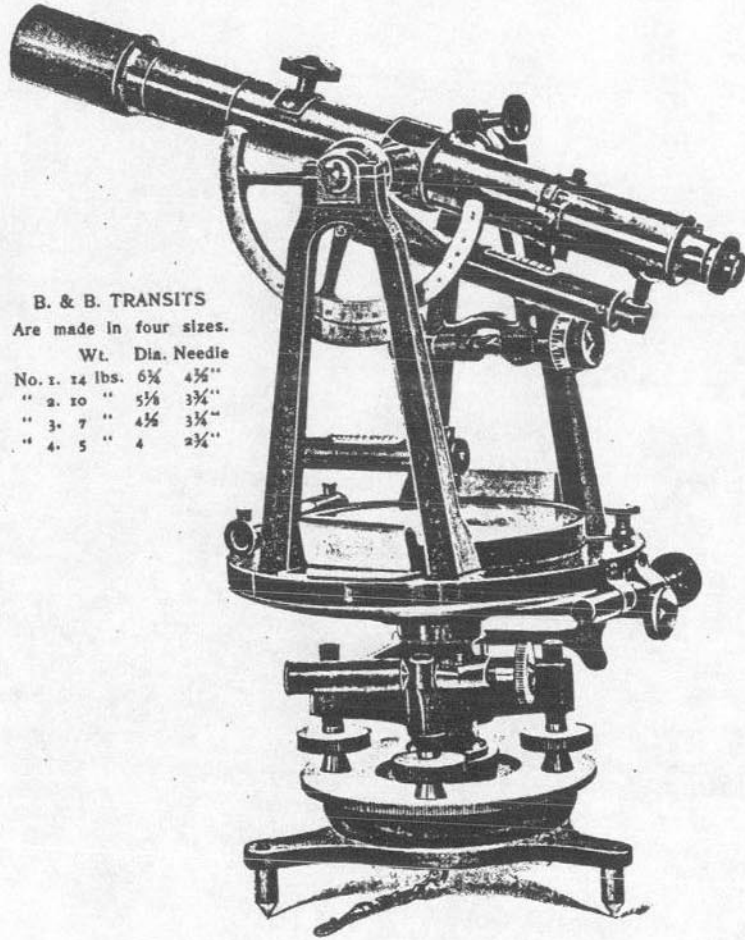
CODE-WORD--THEODITE.

The sensitiveness of the spirit level attachment is equivalent to that of many Wye levels, and allows of high accuracy in leveling up to 200 feet sights. Price as in cut \$20.00. Price of Plain Transit—Code—THEOCAT, without bubble and clamp. \$180.00.



STANDARD B. & B. NO. I BUBBLE AND ARC TRANSIT.

(Design Patented.)



B. & B. TRANSITS

Are made in four sizes.

No.	Wt.	Dia.	Needle
No. 1.	14 lbs.	6 1/2"	4 1/2"
" 2.	10 "	5 1/2"	3 1/2"
" 3.	7 "	4 1/2"	3 1/4"
" 4.	5 "	4 "	2 3/4"

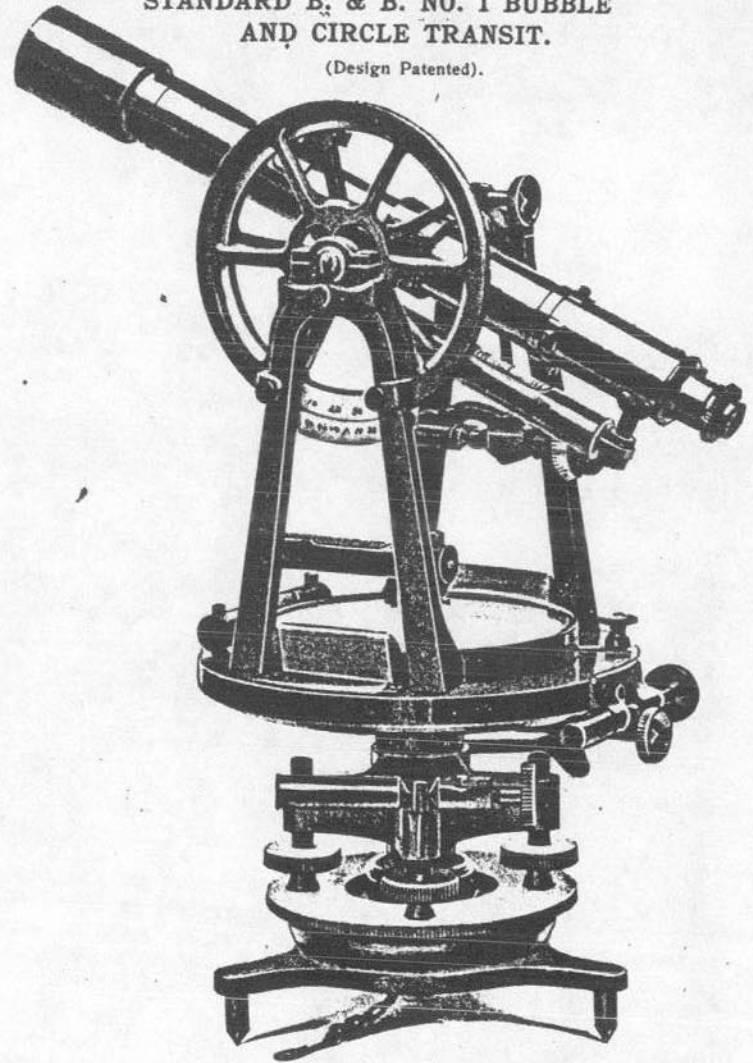
Price, as in cut, \$225.00.

For specifications see pages preceding.

CODE-WORD—THEODAS

STANDARD B. & B. NO. I BUBBLE AND CIRCLE TRANSIT.

(Design Patented.)



Price, as in cut, \$234.00.

5" full circle reading to minutes is protected by aluminum guard.

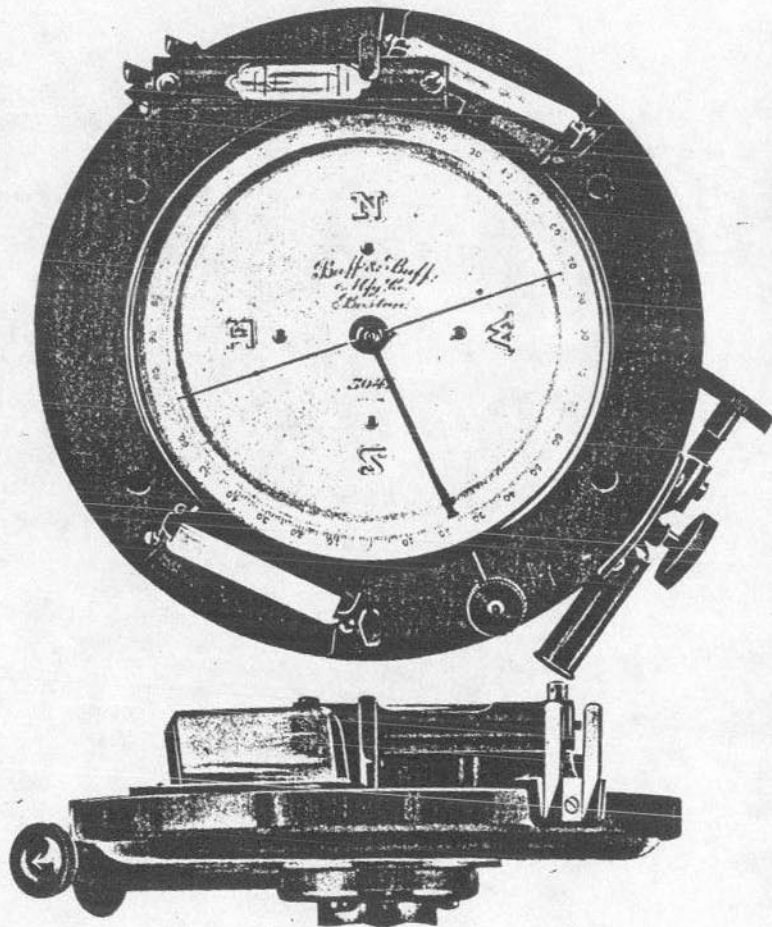
CODE-WORD—THEODUSE.



**OPTIONAL ARRANGEMENT OF VERNIERS AT 30°  
TO LINE OF SIGHT.**

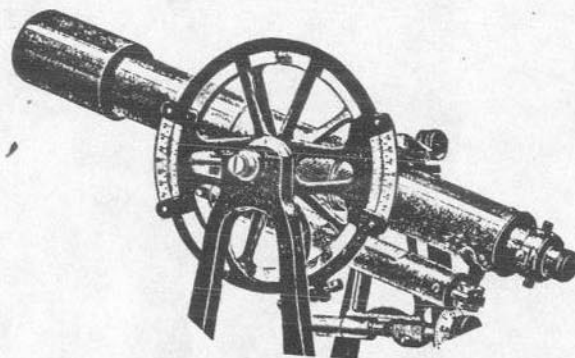
(SHOWING NEW ARRANGEMENT WHEREBY WE USE FULL LENGTH  
OF PLATE BUBBLE AND ALSO PROVIDE AMPLE PROTECTION.)

(Design Patent Applied for.)



The advantages and disadvantages of the verniers at 30° to line of sight are several—and should be carefully weighed in view of the future requirements of the work to be performed.

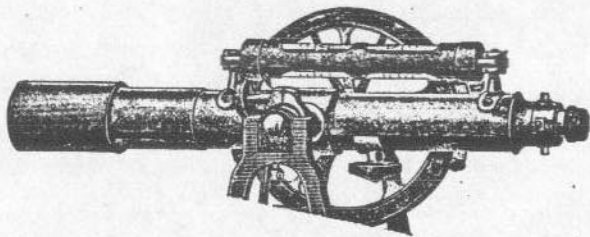
**DOUBLE OPPOSITE VERNIER ATTACHMENT.**



This arrangement is provided with adjusting screws to set zero of  
vernier. Price, complete with guard, . . . \$20.00  
Reading-glasses for both verniers, . . . 10.00  
Graduation reading to 30°, - - - 10.00

### REVERSION LEVEL.

For Leveling with Telescope Reversed.



A guard is provided with this level to protect the under side of the vial when not in use.

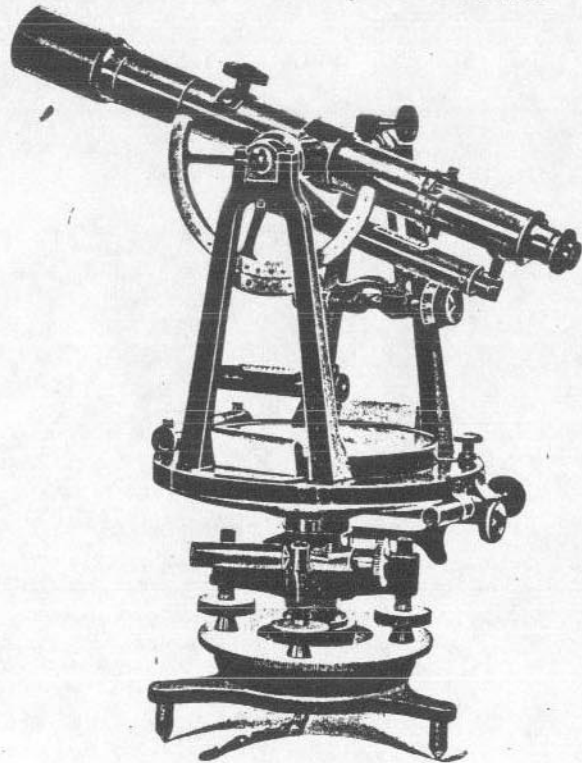
Price, complete when ordered on any of our new instruments, \$15.00.

## Engineers' Transit.

No. 2 Size.

### SPECIFICATIONS.

Graduation,  $5\frac{1}{2}$  inch diameter with two double opposite verniers to minutes, placed at either  $30^\circ$  or  $90^\circ$  to line of sight. Two rows of figures 0-360 inclined. Graduations are silvered and covered by pure crystal plate glass. Vertical arc 5 inch diameter and reads to minutes by double vernier.



CODE-WORD—TRANDATE:  
B. & B. NO. II TRANSIT.  
(design patented)

Telescope, erecting or inverting, is perfectly balanced, and reverses at both ends. Length is  $10\frac{3}{4}$  inches and has aperture of  $1\frac{1}{4}$  inch, power = 22.5 dia. Eye-piece gives sharply defined field of improved illumination.

Sensitive level bubble to telescope,  $5\frac{1}{2}$  inches long with clamp. Adjustment for vertical plane of telescope and line of collimation is correct for all distances.

Improved lower and upper spring tangent clamps, shifting centre with  $\frac{5}{8}$  inch adjustment.

Standards are cloth-finished.

Long taper centres with wide flanges.

Compass needle is  $3\frac{3}{4}$  inches long and of preferred form.

Tripod improved, split leg form with thumb-nuts.

Mahogany case is fitted with strap, lock and hooks, and contains plumb-bob, pocket magnifier, sun-shade, wrench, screw-driver, etc.

#### EXTRAS TO NO. 2 SIZE OF ENGINEERS' TRANSIT.

Graduation, horizontal circle, solid silver,	\$10.00
“ “ “ reading to 30”	10.00
“ “ “ “ “ 20”	20.00
“ vertical circle, solid silver,	5.00
“ “ “ reading to 30”	5.00
Standards finished bright or bronzed,	5.00
Extension tripod—wt., $9\frac{1}{2}$ lbs.	16.00
(Or can order instead of stiff leg.)	
Ground Glass shades to vernier,	3.00
Gradienter attachment,	5.00
Stadia wires, fixed,	3.00
Variation plate and ring,	10.00
Silk waterproof bag to cover instrument,	1.00
Superfine watch oil, to lubricate centres,	.25

This No. 2 size of Engineers' Transit in design is identical with the regular larger size, but on account of decreased size and weight is admirably adapted for work of a reliable nature where a lighter weight instrument is desirable.

Price, precisely as in cut, \$225 and per specifications preceding.

## THE B. & B. TRANSIT.

No. 3 and No. 4 Size.

### SPECIFICATIONS.

Graduations,  $4\frac{1}{2}$  and 4 inch diameter with two double opposite verniers to minutes, placed at  $90^\circ$  or  $30^\circ$  to line of sight. Two rows opposite inclined figures 0-360. Graduations are silvered and covered by pure plate glass.

Telescope, erecting or inverting, is balanced and reverses at both ends, 8 inches long with  $1\frac{1}{2}$  inch aperture and power of 18-20. Improved eye-piece giving large clear field. Level attachment with bubble 4 inches long to telescope with clamp and tangent adjustment. Vertical arc with double vernier reads to minutes.

Line of collimation correct for all distances.

Shifting centres.

Standards are cloth finished.

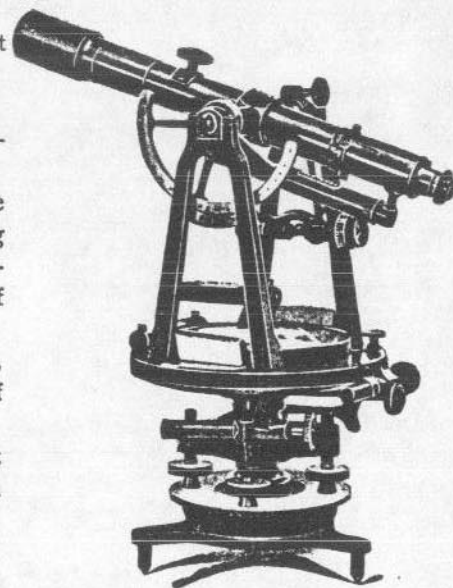
Compass magnetic needle is  $3\frac{1}{4}$  and  $2\frac{3}{4}$  inch long and graduations are silvered with one row of figures 0-90.

Tripod has extension legs, or our improved stiff legs if ordered.

The mahogany instrument case is equipped with lock, strap and hooks, and contains plumb-bob, pocket magnifier, sun-shade, wrench, screw-driver, pins, etc.

(If ordered, instrument can be packed in case to lay flat.)

Weight of plain No. 3 transit,—7 lbs.—plain No. 4 transit,—5 lbs.





## EXTRAS TO NO. 3 & 4 SIZE TRANSITS.

Graduation, horizontal circle, solid silver, . . .	\$10.00
“ “ “ reading to 30” . . .	10.00
“ vertical circle, solid silver, . . .	5.00
Ground glass shade to vernier . . .	3.00
Standards polished and finished bright, or bronze, . . .	5.00
Gradienter attachment, improved, guaranteed accurate, . . .	5.00
Stadia wires, fixed, . . .	3.00
Two reading glasses to Hor. circle, . . .	15.00
Aluminum guard for circle, as in mountain transit, . . .	4.00
Prism, attachable to eye-piece, . . .	8.00
Prism, “ “ “ pivoted, combination, . . .	12.00
Leather cover over case, sole leather, with handle, . . .	9.00
Leather cover for extension tripod, . . .	8.50
Detachable side-telescope with counterpoise, . . .	35.00
Silk bag to cover transit, and bottle of superfine watch oil, . . .	1.00
Striding level to complete transit, . . .	15.00
For this instrument made with the U shaped standard, cast in one piece, without compass, thus gaining great transverse stiffness, add 10.00 to cost.	
Steel centre in this latter form . . .	5.00

We should in all cases prefer to make this instrument with an inverting eye-piece, believing that the utmost satisfaction will thereby be obtained. If a detachable side-telescope is ordered, it should be on the instrument having the U shaped standards.

For the use of explorers, reconnaissance surveys, with the additional power we are enabled to obtain, we are confident that we are offering in our new No. 3 transit an instrument that can be used with the greatest satisfaction and accuracy in the results, and an instrument that has long been asked for by a great number of engineers. Price as in cut, \$215.00.

The compactness of the No. 4 peculiarly adapts it for explorers and reconnaissance surveys.

It makes the neatest set on the market.

## THE B. & B. MINING TRANSIT.

Designed and Manufactured by the

**BUFF & BUFF MFG. Co.,**  
BOSTON, MASS., U. S. A.

### MINING INSTRUMENTS.

The noticeable advancement that has taken place in the design and efficiency of the small and medium sized engineers' transit, during the past two years in particular, is clearly traceable to the greatly increased demand for a superior mining transit of higher power and greater accuracy.

The elements entering into the design and construction to obtain these qualities with absolute rigidity, are more numerous and conflicting than is commonly understood, but have been gained in the new B. & B. by successfully meeting and satisfying all the requirements. Engineers contemplating the purchase of such instruments, however, must not overlook the facts and base their calculations, arbitrarily upon the power and the relative weights, without considering that, particularly for mining uses, power is not so much desired, (since sights are comparatively much less than for surface work,) as light and defining power. In every way the design is strictly up-to-date, and in modified form is of the same type as our regular larger triangulation instruments, that permit utmost rigidity consistent with a total weight ensuring the most efficient operation.

In every way they are built with the same exactitude of fit, to justify hard usage under mining conditions, and with only reasonable care give splendid service for many years.

The accompanying engraving will in itself show to the critical engineer points of excellence sought for and secured.



Accessories and attachments are perfect and very complete. The hard bronze finish highly pleasing, without being elaborate, is of the practical kind, consistent with every-day service in mines.

### MINING INSTRUMENT.

No effort has been made to cheapen these instruments at any point, the result being instruments constructed by superior labor under superior supervision, which must give *superior service for many years.*

The accompanying engravings of our instruments from photographs of those actually built, clearly indicate to the critical engineer where their superiority of design exists, and why the B. & B. so invariably met and successfully underwent the most severe conditions of usage without injury.

Our aim is not to manufacture instruments so that we may get the business of repairing them when they fail (through poor design and workmanship) but it is to keep them out of our own and other repair shops for an indefinite time, provided reasonable attention is given to the glasses and centres, semi-occasionally.

## THE B. & B. MINING TRANSIT.

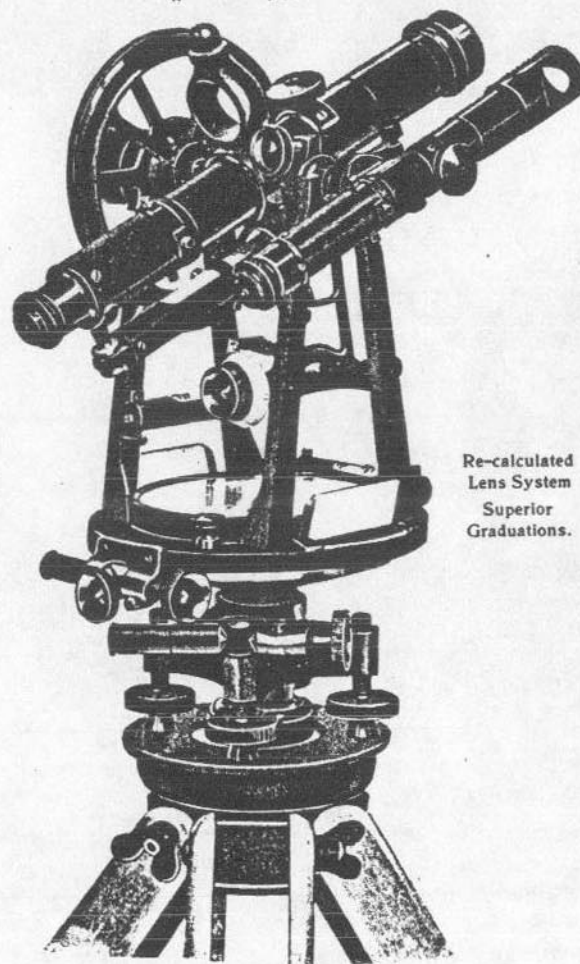
No. 2 SIZE.

### SPECIFICATIONS.

Horizontal circle  $5\frac{1}{2}$  inch diameter with double opposite verniers reading to minutes on graduation, which is silvered.

Needle is  $3\frac{3}{4}$  inches long and of improved form.

Standards are cloth finished.



Weight as in cut,  
 $12\frac{1}{4}$  lbs.

Weight  
Exten. Tripod,  
 $9\frac{1}{2}$  lbs.

Re-calculated  
Lens System  
Superior  
Graduations.

CODE-WORD—TRANDOLITE.

### B. & B. MINING TRANSIT.

(NO. 2 SIZE—ERECTING EYE PIECE.)

5-inch dia. at edge of graduation, inverting or erecting eye piece.	Price, complete,	
with full vert. circle, bubble and guard, extension tripod, etc.	- - -	\$234
Universal top and side telescope, (D. D. Scott's design).	- - -	45
Solid silver graduations throughout,	- - -	15

Telescope,  $10\frac{3}{4}$  inches long and aperture of  $1\frac{1}{4}$  inch.  
 Power of 22 dia. with erecting eye-piece.  
 Sensitive level bubble  $5\frac{1}{2}$  inches long to telescope, with clamp and tangent adjustment.  
 Verniers may be either at  $90^\circ$  or  $30^\circ$  to line of sight (see page 34).  
 Weight of instrument complete is  $12\frac{1}{2}$  lbs., extension tripod  $9\frac{1}{2}$  lbs., regular tripod 7 lbs.  
 Aluminum protection guard for circle.  
 The weight and size are the only points of difference to the No. 1, every detail being of equal thoroughness of construction.  
 Mahogany case, with all fittings as per No. 1 transit and with extension tripod.

#### EXTRAS TO MOUNTAIN TRANSIT No. 2.

Ground glass shades, to facilitate reading of vernier, . . . . .	\$3.00
Standards finished bright or bronze, . . . . .	5.00
Gradienter attachment, improved, . . . . .	5.00
Graduations, horizontal and vertical circle on solid silver, . . . . .	15.00
Variation plate, with ring, . . . . .	10.00
Silk waterproof bag to cover transit, . . . . .	1.00
Superfine watch oil, to lubricate centres and axle, . . . . .	.25
Saegmuller Solar Attachment (attached), . . . . .	50.00
Prism, attachable to eye-piece, . . . . .	8.00
Prism, combination pivoted, with colored glasses, . . . . .	12.00
Reflector shade for illuminating cross-wires, . . . . .	4.00
Universal Top and Side Telescope, embracing D. D. Scott's invention, . . . . .	45.00
Trivot, for setting instrument on beams, etc., in longitudinal passages, . . . . .	3.50
Complete Mining Target, with lamp and tripod (send for special circular) . . . . .	90.00
Detachable side telescope with counterpoise, . . . . .	35.00
Extra regular tripod, . . . . .	16.00
Plummet-lamp, improved form, . . . . .	8.00

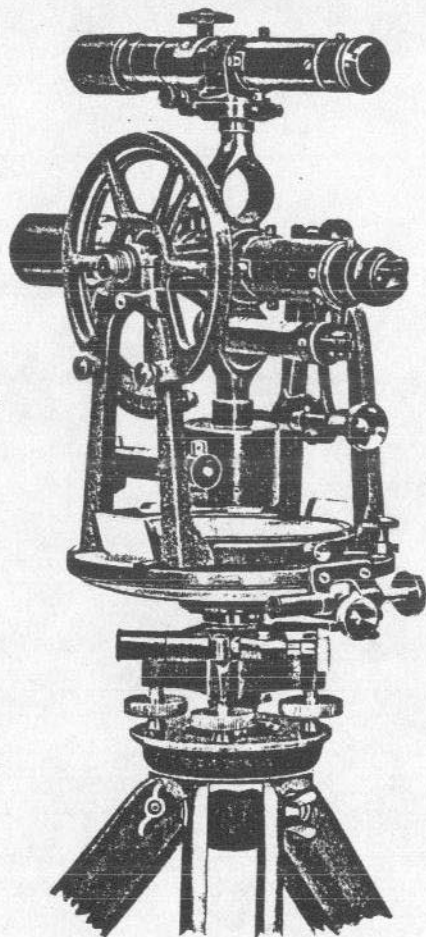
#### SPECIFICATIONS No. 3 SIZE MINING TRANSIT.

Horizontal circle  $4\frac{1}{2}$ " dia. at edge of graduation with double opposite verniers reading to minutes on silvered surface.  
 Needle is  $3\frac{1}{4}$ " long.  
 Standards are cloth finished.  
 Telescope is 8" long with  $1\frac{1}{8}$ " aperture power of 18.  
 Sensitive level bubble to telescope is 4" long, and provided with clamp and tangent adjustment.  
 Verniers may be either at  $30^\circ$  or  $90^\circ$  to line of sight.  
 Vertical circle reads to minutes and is protected by an aluminum guard.  
 Weight of instrument complete is 7 lbs., extension tripod 7 lbs., regular stiff leg tripod 5 lbs.  
 Instrument complete in mahogany case with plumb-bob and adjuster, pocket reading glass, screw-driver, wrenches and adjusting pins, etc. Price \$224.00.

#### EXTRAS TO No. 3 MINING TRANSIT.

Solid silver graduations throughout, . . . . .	\$15.00
Standards finished bright or bronze, . . . . .	5.00
Gradienter attachment, complete, . . . . .	5.00
Fixed stadia wires, . . . . .	3.00
Ground glass shade, complete to vernier, . . . . .	3.00
Variation plate, with ring, . . . . .	10.00
Universal top and side telescope, . . . . .	45.00
Silk cover for instrument, . . . . .	1.00
Superfine watch oil, for lubrication, . . . . .	.25
Reflector shade for illuminating cross-wires, . . . . .	4.00
Trivot for setting instrument on beams, . . . . .	3.50

THE "ROCKY MOUNTAIN FAVORITE."



Weight as in cut,  
without top  
telescope  
7 lbs.

Exten. Tripod  
7 lbs.

Re-modelled design  
of axle ensures  
utmost rigidity  
to top telescope.

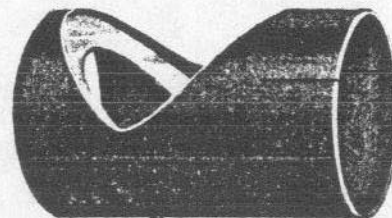
Superior  
Graduations.

Unexcelled  
Telescopes.

**B. & B. Mining Transit.**

(No. 3. SIZE—ERECTING EYE PIECE.)  
CODE-WORD—TRIGON.

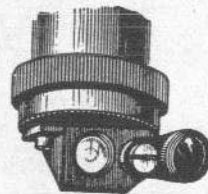
4 1/4 inch dia. at edge of graduation. Price, complete, with full vertical circle, bubble and guard, extension tripod, etc.,	\$224
Universal top and side telescope (embracing D. D. Scott's invention,)	45
Solid silver graduations throughout,	15



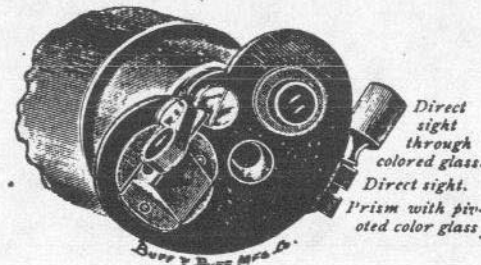
REFLECTOR SHADE.

To illuminate the Cross Wires in Mining Work.

Made in all sizes to attach to object end of telescope. It is the best method of illuminating the cross wires. Price, ready to attach, \$4.00.



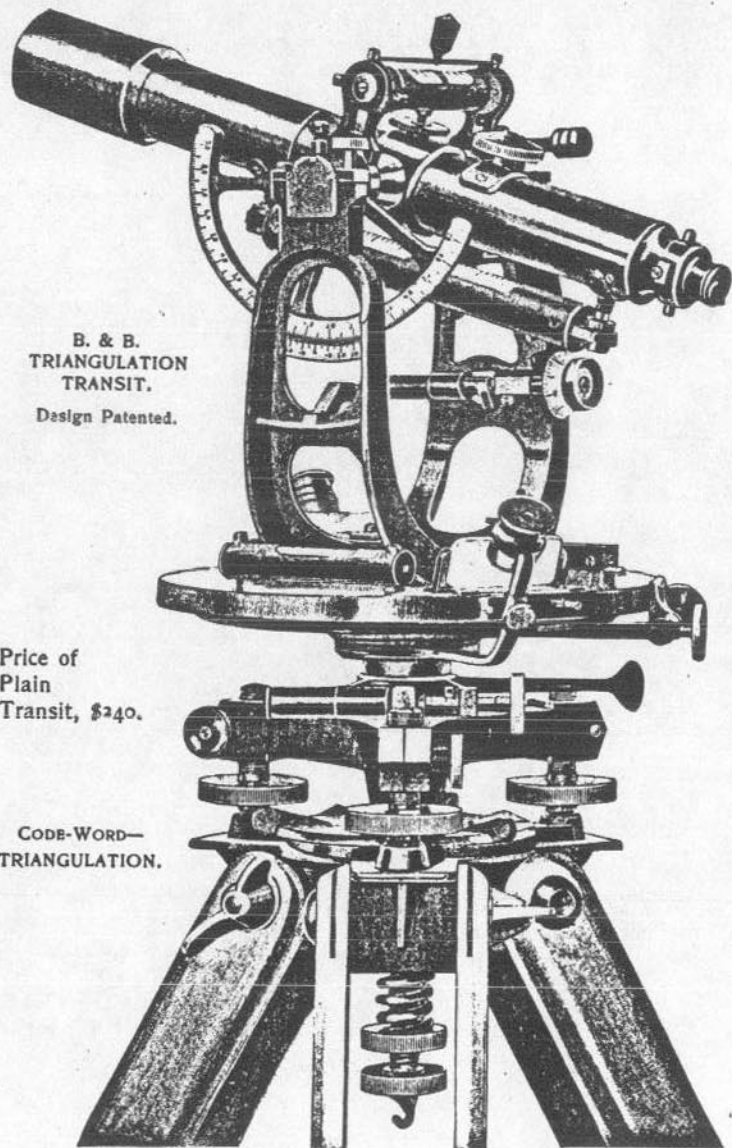
1  
PRISM AND COLOR GLASS.  
For Solar Observations.



2  
PIVOTED PRISM AND COLORED GLASSES.

1. Plain diagonal prism with hinged color glass and to be screwed on to eye-piece, \$8.00. See cut 1.
2. Prism and glasses, pivoted, and a very convenient arrangement, \$12.00. See cut 2.





B. & B.  
TRIANGULATION  
TRANSIT.

Design Patented.

Price of  
Plain  
Transit, \$240.

CODE-WORD—  
TRIANGULATION.



## Triangulation Transit.

Designed for use in cities and triangulating.

### SPECIFICATIONS.

- Graduation,  $6\frac{1}{4}$  inch diameter with two double opposite verniers to  $30^\circ$  and placed at  $30^\circ$  to line of sight. Graduations on solid silver and protected by crystal plate glass. Two rows of figures in opposite directions.
- Telescope,  $12\frac{1}{2}$  inch, power 29, aperture  $1\frac{1}{4}$ " to  $1\frac{1}{2}$ ", improved eye-piece. Reversible in standards and in bearings.
- Improved tangent clamps.
- Shifting centre.
- Finish, bright or bronze throughout.
- Improved form of tripod and case.
- Price for plain transit, \$240.

### EXTRAS.

Graduations, reading to $20''$	\$10.00
"    on $7''$ circle to $10''$ ,	30.00
Vertical arc, reading to minutes,	20.00
Reading glasses as in cut, with shades,	15.00
Shifting centre for 3 leveling screens,	5.00
Striding level,	20.00
Spirit level with clamp to reverse to telescope,	35.00

A striding level should always be ordered with above instrument.

# Engineers' Levels.

18" HYDROGRAPHERS' WYE LEVEL.

18" WYE LEVEL.      14½" WYE LEVEL.

15½" DUMPY LEVEL.

## SPECIAL TO ALL WYE LEVELS.

### A STEEL CENTRE IN A SOCKET OF ANNEALED IRON.

This new adoption of the steel centre in a socket of annealed iron, (though an ancient practice as regards the construction of larger astronomical instruments as giving the ideal non-friction and non-expansion bearing,) is one that has been withheld from application to engineers' levels heretofore, for the reason of the great expense incidental to setting up precision grinding machines necessary to fit the hardened steel centre and also the rapid dulling of the reamers by the iron socket. This, the only obstacle, no longer stands in the way of securing such an admirable centre in an instrument (permissible since no compass is used.)

The shop cost of making such a centre for a level is still greater than in making one of bell-metal or phosphor-bronze, for the reason that the hardened steel centre requires to be ground in with special apparatus and consumes more time in the final fitting. It is without question (if the term can be used since even the B. & B. regular centre of bell-metal has always been so superior to other makes in this respect), a more permanent centre.

The prime advantage, however, lays in the small and equal co-eff. of expansion, ensuring freedom from the errors due to atmospheric changes, and also in the small co-eff. of friction.

# ENGINEERS' 18" WYE LEVEL.

(Power, 36 diameters.)

Improved telescope 18" long, having 1½ inch objective and giving increased illumination and clearness. Protection to object slide. Erecting or inverting eye-piece giving large, flat field of view. Phosphor-bronze contact points in wyes for the bell-metal collars. Regular bell-metal centre in socket of phosphor-bronze. Line of collimation correct for all distances. Instrument finally adjusted to obtain the finest possible, with sun-shade in position and focused on, mean distance. Complete in mahogany case with strap and hooks, sun-shade, wrench, screw-driver, adjusting pins, etc. Entire telescope and level tube will be cloth finished.

Unless otherwise ordered, on this level the sensitiveness of spirit level will be what is rated as a 10" bubble.

(One division of scale equalling 10" of arc.)

Wt. of complete instrument, about 10¾ lbs. Tripod, 7 lbs.

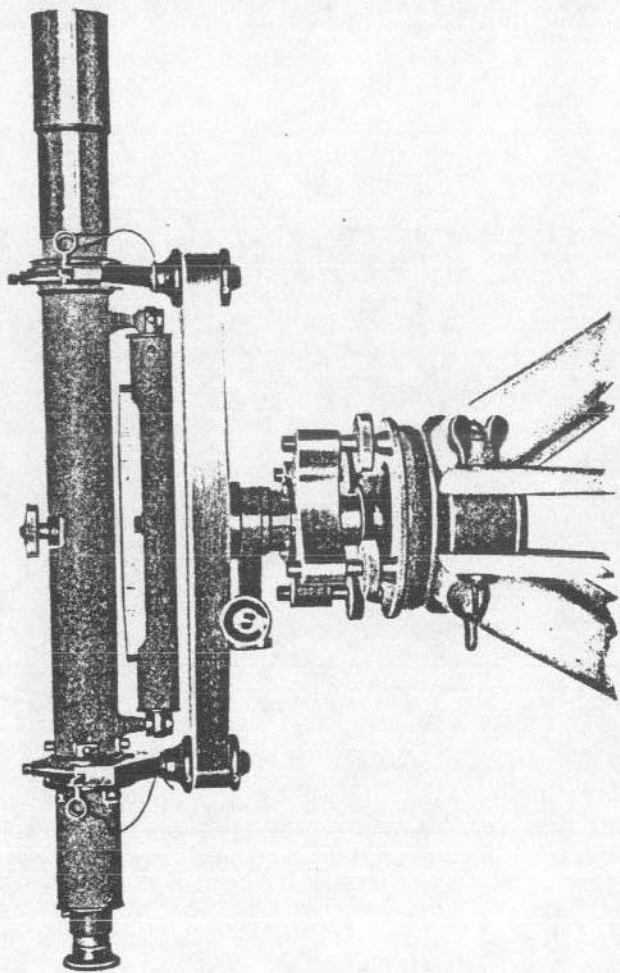
Net price, \$140.00.

### NOTE:—

*For the most precise uses,—where a specially sensitive spirit level is specified, the steel and iron centre as catalogued below is strongly recommended as securing the most nearly perfect centre theoretically as well as practically,—giving the ideal bearing.*

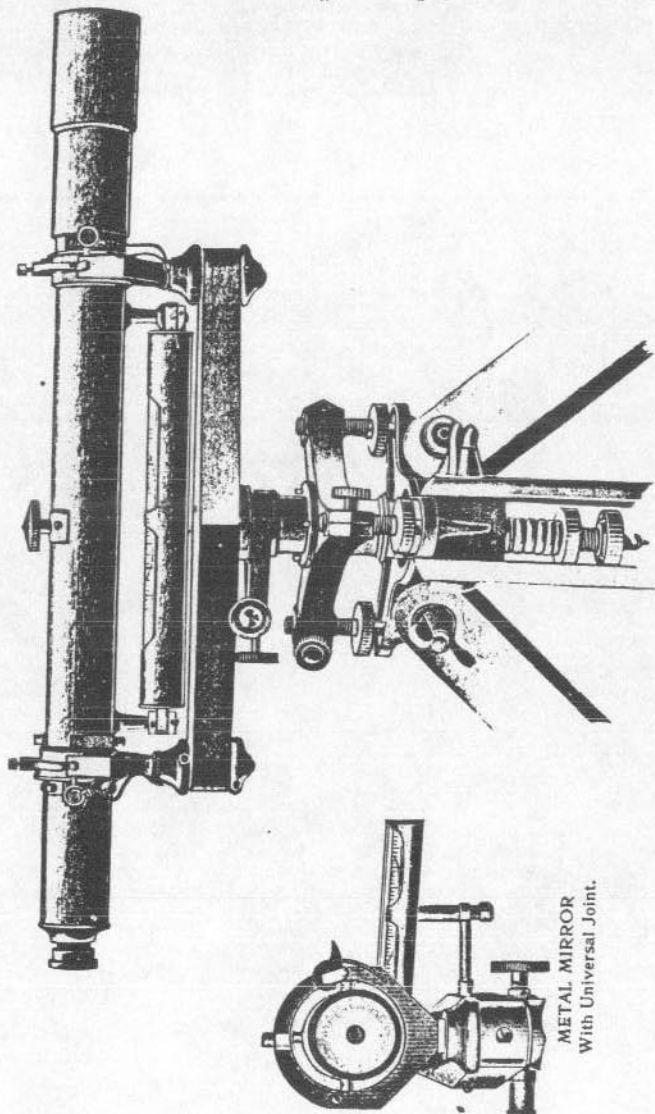
### EXTRAS.

Hardened steel centre in phosphor-bronze socket . . . . .	\$5 00
“ “ “ “ annealed iron . . . . .	5.00
Fixed stadia wires, . . . . .	3.00
Extra sun-shade having aperture for use when the light is too bright for accurate work, . . . . .	1.50
Metal mirror, jointed, to read bubble without removing from eye-piece, silver-plated arms, . . . . .	10.00
Waterproof bag of rubber to protect the level from rain, . . . . .	1.00
Bottle of superfine watch oil to lubricate the centres, . . . . .	.25



**ENGINEERS' 18" WYE LEVEL.**

Power, with erecting eye-piece, 36 diameter.  
 AS MADE BY BUFF & BUFF MFG. CO., BOSTON.  
 Price, complete, \$140.00.  
 CODE-WORD—WYES.



**HYDROGRAPHERS' 18" WYE LEVEL.**

WITH THREE-LEVELING SCREW LOWER CENTRE  
 Wt. complete, 12 lbs. Regular stiff leg Tripod, 8½ lbs.

METAL MIRROR  
 With Universal Joint.



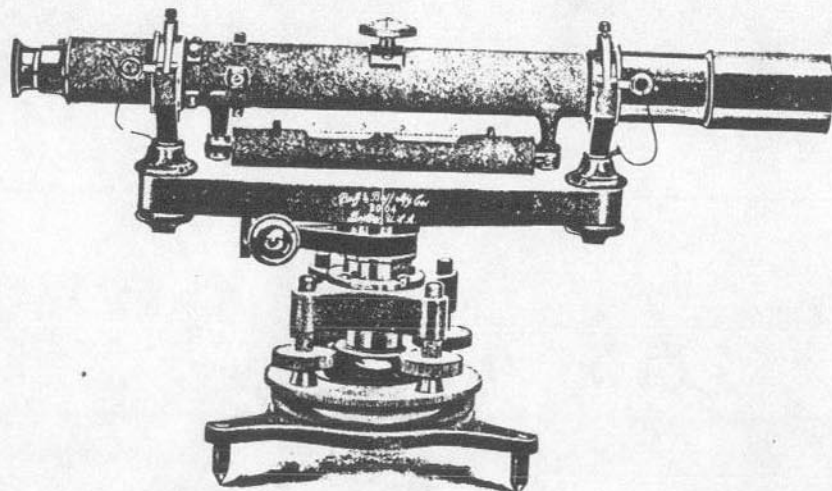
## Hydrographers' Wye Level.

This precision wye level is similar in construction to the engineers' wye level, except that three leveling screws are provided instead of four. The sensitiveness of the spirit level is also somewhat increased, being from 8 to 10" for 1 div. of scale. The weight is about 1 lb. more owing to the stiffer form of tripod. Telescope and bubble are cloth finished. Price, complete, \$158.00.

The general preference is given to this type of 3 leveling screw instrument because for bench leveling, the bubble (and hence the line of sight) can be more easily controlled. Frequently the levels have a sensitiveness of a single second of arc for a division of  $\frac{1}{50}$  part of an inch. We are prepared to attach our auxiliary micrometer screw to even further facilitate the ease and accuracy of manipulations. Price and description on application.

### EXTRAS TO HYDROGRAPHERS' WYE LEVEL.

Hardened steel centre in annealed iron, . . . . .	\$5.00
“ “ “ “ phos.-bronze, . . . . .	5.00
Fixed Stadia wires, . . . . .	3.00
Metal mirror with universal joint, . . . . .	3.00
(See cut.)	10.00
Extra sun-shade with smaller aperture, . . . . .	1.50
Gossamer waterproof bag, . . . . .	1.00
Bottle of fine watch oil, . . . . .	.25



### ENGINEERS' 14 $\frac{1}{2}$ " WYE LEVEL.

Power, 28 diameters. Similar to the preceding style level and complete with box and tripod.

Net price, \$136.00. Wt. 9 $\frac{1}{2}$  lbs.

Aluminum bar on this instrument reduces the wt. to 8 lbs.

### SPECIAL.

In all but one respect this level is fully the equal of its larger prototype,—it being only in the shorter telescope,—that less power is obtained and consequently the sensitiveness is cut down slightly. The level bubble furnished, unless order specified, has the rating of 12 to 14" sensitiveness.

Altogether this level is specially adapted for the closest work in mountainous work where weight is an object, and still where it is desirable to have a level capable of complete and instant adjustment.

### EXTRAS.

Stadia wires fixed, . . . . .	\$3.00
Hardened steel centre in socket of annealed iron, . . . . .	5.00
Extra sun-shade for use when sun's rays are too strong, . . . . .	1.50
having small aperture, . . . . .	1.00
Gossamer rubber bag for protection against the weather, . . . . .	1.00
Bottle of superfine watch oil to lubricate the centre, . . . . .	.25

## ENGINEERS' DUMPY LEVEL.

With a dumpy level of our improved make, in correct adjustment, since the same sensitiveness of level-bubble is put into this instrument as into our regular Wye levels with an objective of the same focus and diameter, giving the same power of 32 diameters, equally accurate work can be done as with the Wye level.

Particularly for work of a roughing-out nature where liability to slight knocks is present (that would seriously injure a Wye level) the possibilities of a compact dumpy level are at its best.

An engineer certainly can perform as close work with this level,—and yet feel reasonably sure that his adjustments once made, will keep so indefinitely.

Entire instrument is cloth-finished above the leveling screws, including telescope and bubble.

The centres of this instrument are of the regular type that we put into transits, being the hardest bell-metal in phosphor-bronze, which are most carefully fitted to a true bearing shoulder.

The instrument is packed in mahogany case, with sun-shade, screw-driver, wrench and adjusting pin.

Weight of level, complete, 9½ lbs.

Weight of tripod, regular type, 7 lbs.

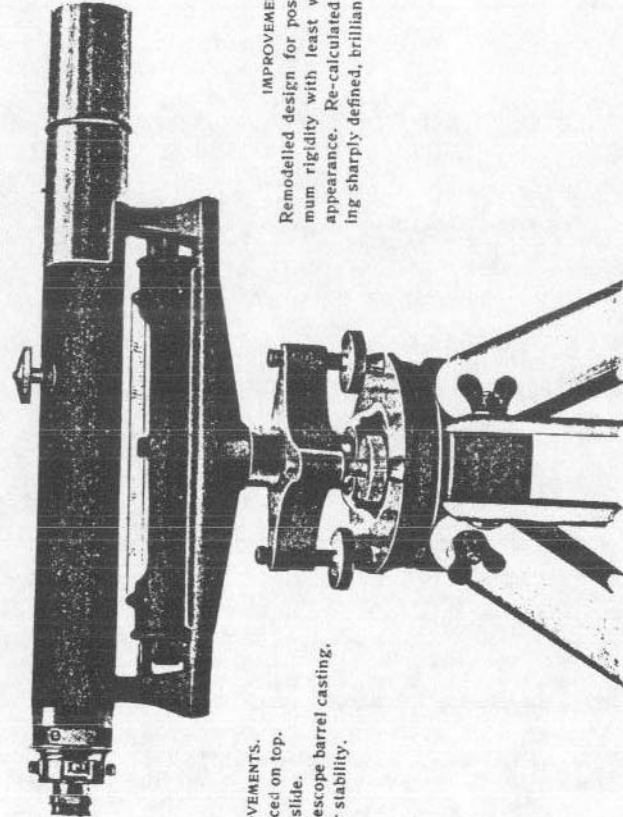
Price, complete as above, \$100.00.

### EXTRAS.

Inside centre of hardened steel in annealed iron . . .	\$10.00
Stadia wires, fixed, . . . . .	3.00
Rubber bag of heavy sheeting, for protection against rain and the weather, . . . . .	1.00
Bottle of superfine watch oil to lubricate the centre, . . . . .	.25
Instrument provided with clamp and tangent screw, . . . . .	13.50

The inverting eye-piece in this instrument provides our most ideal telescope for brilliancy and clearness,—power,—36 dia.

## ENGINEERS' 15½" DUMPY LEVEL.



IMPROVEMENTS.  
Focussing screw placed on top.  
Protection to object-slide.  
Improved form of telescope barrel casting, ensuring greater stability.

IMPROVEMENTS.  
Remodelled design for posts, procuring maximum rigidity with least weight and graceful appearance. Re-calculated lens-system obtaining sharply defined, brilliant field.

Power, as above, 36 diameters. (Inverting eye-piece, as per cut, completes an ideal lens system.)  
BUFF & BUFF MFG. Co., BOSTON.  
PRICE, with tripod and mahogany case, \$100.00.  
CODE-WORD—DUMPIUS.

## Adjustments.

The adjustments of a standard B. & B. transit important to the engineer in the field are:—

1. That the plate and standard bubbles are perpendicular to the axis of the plate.
2. That the line of collimation moves in the plane that is exactly above centre of horizontal circle.
3. That the line of collimation is perpendicular to the horizontal axis.
4. That the line of collimation is parallel to the telescope level bubble.

The adjustments of the engineers' Wye level, important in the field and which can be corrected by him are:—

1. That the telescope spirit-level is parallel to the axis of collimation.
2. That the optical axis is identical with the axis of collimation.
3. That the vertical axis of revolution is perpendicular to line of collimation.

For the simplest field methods of making these adjustments we issue a special pamphlet entitled, THE B. & B. STANDARD TRANSIT AND ITS ADJUSTMENTS, which will be mailed on request.

### A FEW CAUTIONARY REMARKS AS TO THE CARE OF INSTRUMENTS.

In general, when not in use, it is well to bear in mind, that,— (though there is one country, India, where protection or no protection the average life of an engineers' transit is short of two years on account of the fine and penetrating dust continually in the atmosphere) *a silk hood, as furnished by us, is of much protection to an instrument both from dust and weather.*

When about to remove a film of dust from the glasses, notice that the texture of silk is too abrasive and that only pure and soft linen should be used.

Carefully note the position of instrument in box before removing and grasp the lower parts to remove, (not the standards for they are *not* the handles.)

Observe before shouldering your instrument that centres be lightly clamped, thus preventing unnecessary wear, and that the leveling screws have a firm bearing, and above all, that the instrument is screwed well on to tripod head. Nuts on legs of tripod are to be well tightened against the wood. Shoes on tripod should also be examined occasionally, that they be not loose nor too dull, for upon their rigidity depends the entire stability of the instrument.

The most common causes of error are due to

1. Loose legs of tripod.
2. Loose tripod shoes.
3. Carelessness in not occasionally verifying adjustments.
4. Thoughtlessness in unnecessarily exposing to the dust and weather.
5. Lifting instrument by the standards or telescope or vertical circle, since undue strain of entire weight is put upon these parts which are not designed to be used in such a manner.

### A FEW DONT'S.

Do not unscrew object glass without reason, since both the final and nice adjustment of the line of collimation depends upon a fixed position of all the lenses, but also the cleanliness of cross-wires is thereby assured.

Do not allow playing with the needle, and do not pick up instrument with needle swinging idly, nor with centres unclamped.

Do not oil or grease object slide, nor expose screws to collect dust and grit.

Do not think that the small adjusting pin furnished to adjust the small capstan-headed screws of cross-wire diaphragm,—is not



strong enough to impose very injurious strains upon the telescope by excessive tightening, and above all, if any slight grinding or whirring noise is heard, do not fail to clamp entire instrument and subject to careful examination in the office. There the centres and principal movements may be examined and subjected to taking apart. The irritation or cause of fretting may be removed by careful treatment and careful and thorough cleaning before applying fresh oil. Be very careful, however, not to rub or come against the graduation edge in any way, since the slightest burr or sharpness of edge removed would work costly damage to an instrument. Fresh watch oil only, as put up by us, should be applied, after cleaning, to all the centres.

With each instrument sold we enclose a carefully prepared treatise on the adjustments of the standard "B. & B." transit.

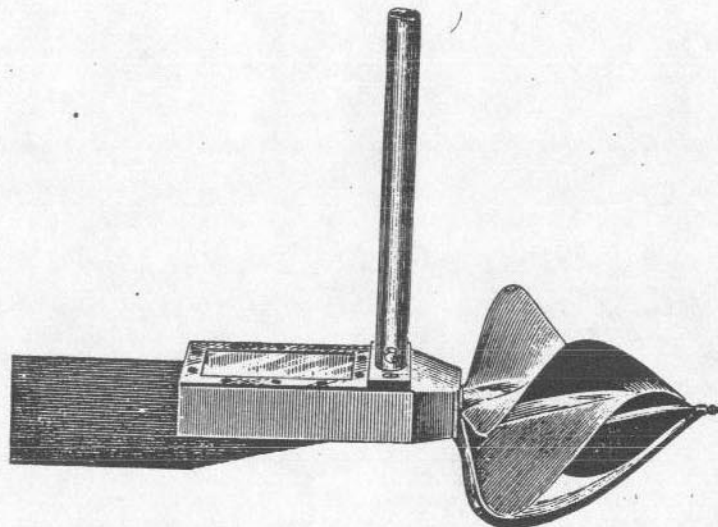
## Current - Meters.

The various types of current-meters,—both electrical and mechanical registering,—as made by us in the past, have generally been but special orders. Since they have seldom or never been made again, we have removed the cuts of such from this catalogue, and will merely outline the different forms.

- No. 4. Current-meter with electric register, after Gen. Ellis, embraces a meter applicable to deep river measurements. In design it is similar to the vanes of the customary wind velocity measuring apparatus.
- No. 5. Current-meter, after A. Fteley, embodies an enclosed type of wheel similar to the turbine water wheel.
- No. 7. The latest type of meter and a successful type for delicate measurements, consists of a propeller form of wheel, and the employment of ball-bearings.
- Prices and specifications furnished on request.

## CURRENT - METER.

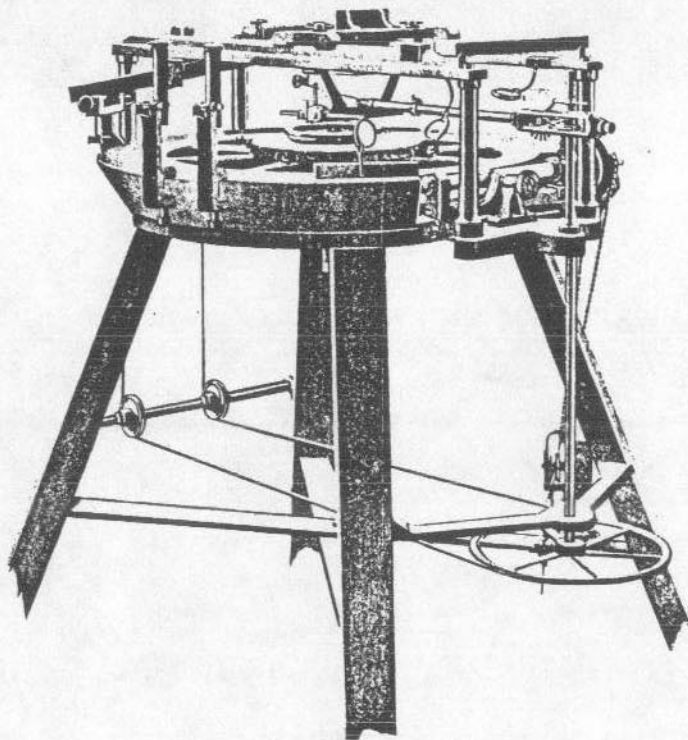
(Mechanical Recording.)



BUFF & BUFF MFG. CO.

Pen-sketch of Special Current-Meter constructed for U. S. Irrigation Investigations.

The improvements constitute—the propeller form of wheel and employment of ball-bearings—with extremely simple recording mechanism. Prices on application.



NO. II, GRADUATING MACHINE.

Built by  
GEORGE L. BUFF, BOSTON, MASS., 1899

*Simplicity and Massive Design have produced that infinite rigidity which is a vital characteristic.*

New construction entirely of Steel and Iron.

Diameter of hor. circle, 28.5"

No. of teeth, 1800.

*Capacity of work* upon this machine is up to 30" diameter, and *kind of work*,—circular graduations (horizontal or bevel) from and including  $\frac{1}{2}^{\circ}$  to  $\frac{1}{12}^{\circ}$  with verniers to 5". Also hour circle graduations and the French centesimal system of 400 in the circle with the corresponding verniers.

*Accuracy of work* upon this machine is guaranteed to be within  $\frac{1}{34103}$  part of an inch for a diameter of 28.5 inches. Prices on application.

## Precision Planimeter.

This measuring instrument, as made by us, is of the Polar type, as originated by Jacob Amsler in 1855.

It has only been until within a short time that this instrument has met with the recognition that its design merits. This is, however, clearly due to the accurate graduations and thorough workmanship now employed, and also to the careful instructions furnished with each instrument.

For cross-section and earth-work of all kinds, the saving of time in obtaining areas or cubic contents in inches, millimeters or acres, make it indispensable to every engineering office.

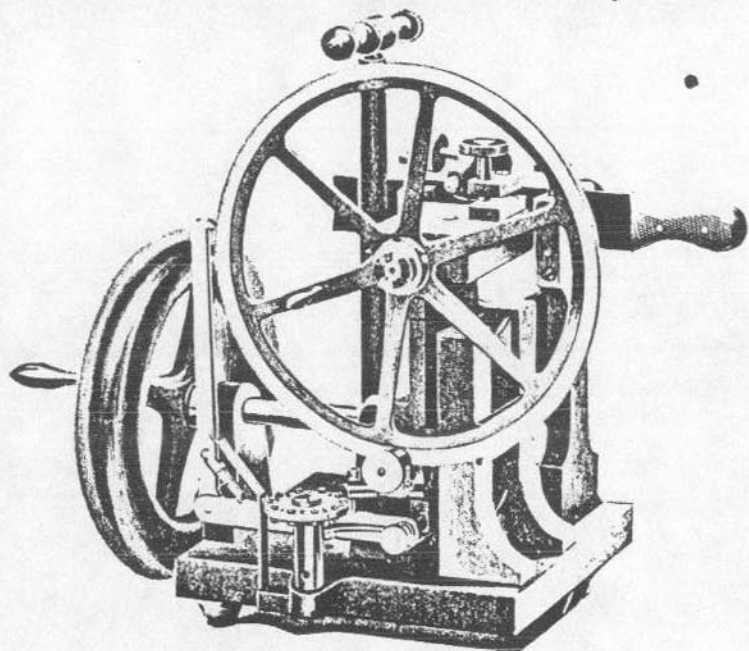
For the accurate measuring of indicator cards this instrument is especially adapted and recommended to the mechanical engineer.

The personal error in the manipulation of this instrument need never exceed .02 of a square inch, and by consecutive measurements of the same area may be reduced much below this.

The cost of accurately rating such an instrument by an expert engineer we furnish, at cost, to the purchaser, \$4.00.

Price of Planimeter complete, in case, \$29.00.

## Minot-Blake Precision Microtome.



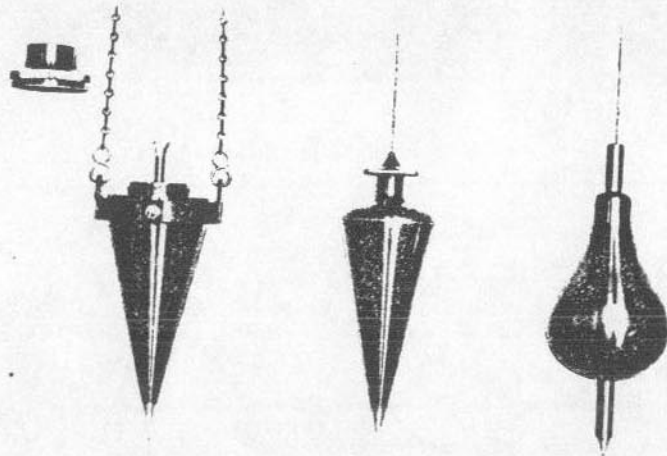
THE MINOT-BLAKE PRECISION MICROTOME.

As made by  
BUFF & BUFF MFG. CO.

This new microtome was constructed to meet the want for an instrument capable of cutting single-micron sections in series accurately. That it has done so was the result of careful design and accurate workmanship.

Prices and special description on application.

*Dr. Bumpus of Brown Univ. says, "The only fault that I find with the new microtome is the fact that it has put all our old microtomes out of commission. It does such superior work that the students will use no other machine except under compulsion."*



PLUMB - BOBS AND PLUMMET - LAMPS.  
Hardened and tempered tool-steel points.

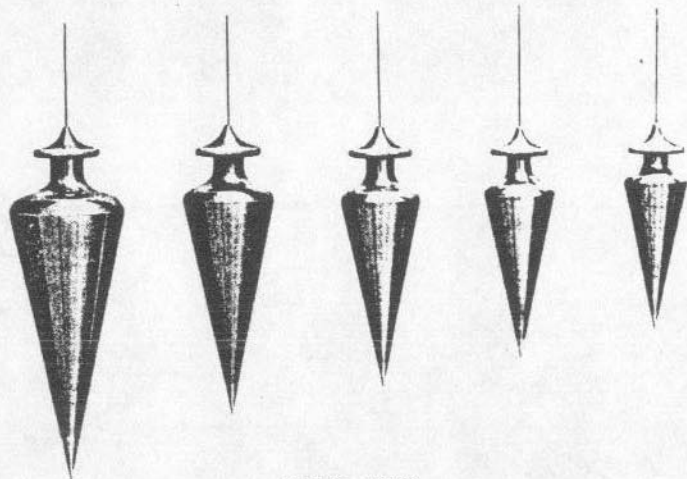
### PRICE LIST.

PLUMMET-LAMP NO. 12. Weight, 20 oz. Price, complete, \$9.00.	TUNNEL-BOB NO. 13. Weight, 26 oz. Price, complete, \$4.00.	SHAFT-BOB NO. 14. Weight, 44 oz. Price, complete, \$5.00.
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In style and construction our plumb-bobs are all of a standard form, one that has been found to be taper enough to allow the line of sight to pass easily by, and not be obstructed by the roundness of the bob from easily seeing the point.

Tool-steel points which are hardened and tempered in oil, are fixed to all our plumb-bobs and plummet-lamps. (This feature is one that will be appreciated by the engineer accustomed to the soft points which are so easily bent, even by plunging into wood.)



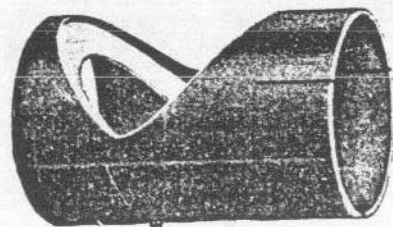


PLUMB - BOBS.

All of our plumb-bobs have the hardened and tempered tool-steel points, common to only our make.

PRICE LIST.

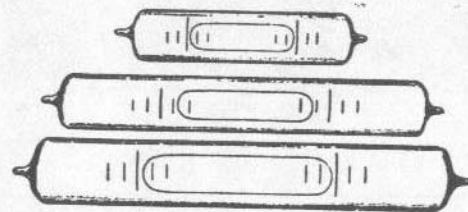
SIZE	WEIGHT	PRICE	GENERALLY FURNISHED WITH THE BELOW INSTRUMENTS.
No. 0	26 oz.	\$4.00	Plane-table, Mining.
No. 1	13 oz.	2.50	No. 1 Transit.
No. 2	9 oz.	2.25	No. 2 Transit.
No. 3	6 oz.	2.00	No. 3 Transit.
No. 4	4½ oz.	2.00	No. 4 Transit.



REFLECTOR - SHADE.

To illuminate the cross-wires in mining work. Made in 3 sizes for our different instruments.

Price each, \$4.00.

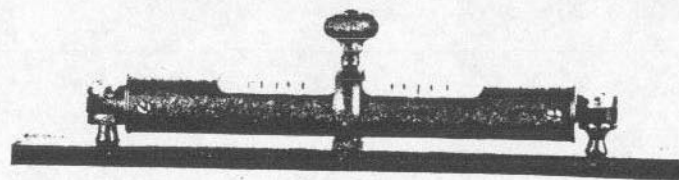
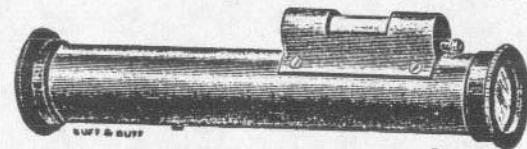


SPIRIT-LEVELS.

Spirit-levels of any sensitiveness and size ground to specification, and guaranteed of the same superior quality as for our instruments and made by our own improved process, producing that regularity unattainable by any form of hand grinding. Prices on application.

LOCKE'S HAND LEVEL.

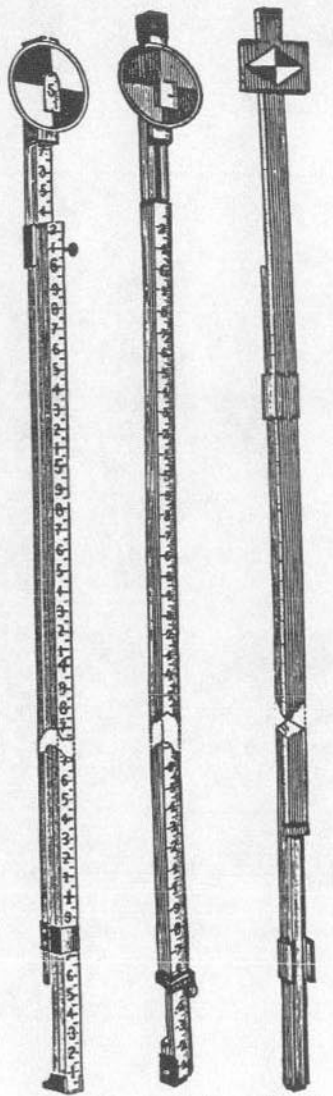
For preliminary and particularly cross-section work and slope-stake work on railroads this instrument is extremely useful, fully accurate enough and a rapid worker. Price, complete as in cut, in morocco case, \$9.00.



LEVELS ON METALLIC BASE.

Spirit-level on 8 inch base, with handle, accurately ground so that one division of level is equivalent to a deflection of 30" of arc. Bubble is adjustable and is complete in morocco case, \$12.00.

Spirit-level on 3½" base, with handle, 1 division of level is equivalent to 1 min. of arc. Bubble is adjustable and is complete in morocco case. Net, \$6.50.



Philadelphia. New York.

Boston.

## Leveling Rods.

Warranted Accurate.

### Philadelphia LEVELING ROD.

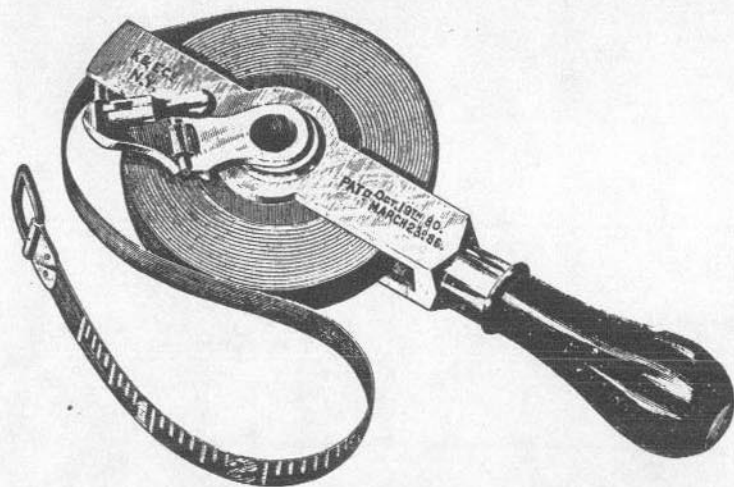
A perfect self-reading rod, with target, vernier and clamps, 7' long, sliding to 12'. Scale on tangent reads to half-hundredths, \$14.00.

### New York LEVELING ROD.

Hardwood, 6½' sliding to 12', verniers to thousandths of a foot, \$14.00.

### Boston LEVELING ROD.

Of mahogany, machine divided on satinwood with target, verniers at both ends read to thousandths of a foot. 6½ feet long, sliding to 11 feet. Convenient on account of its lightness, \$14.00.



Excelsior Steel Tapes, ½" wide, on patent frame, with folding handle, graduated in 10ths, 100 ft. \$11.00; 50 ft. \$6.00.

Excelsior Steel Tapes, ½" wide, in leather case, improved centre, 100 ft., \$11.25.

Excelsior Steel Tapes, ⅝" wide, leather case, improved centre, with large handles, \$11.25.

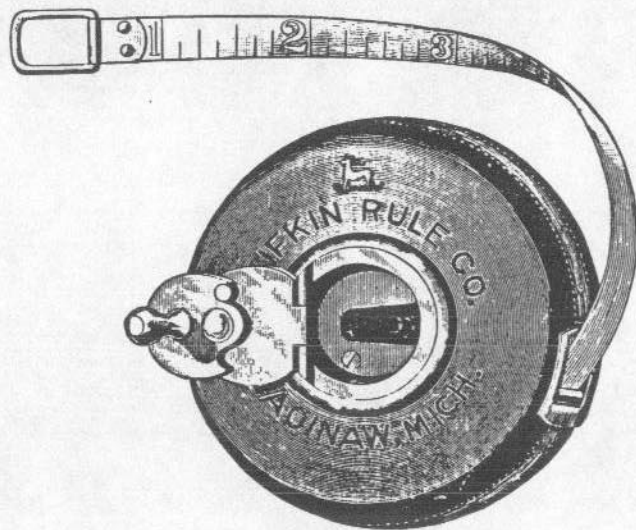
## Saegmuller Solar Attachment.

Price, attached to new B. & B. instruments, \$50.00.

Price of solar attachment, with hour glass, \$60.00.

The advantage of this solar, as recommended by us, lay in

1. Accuracy.
2. Simplicity.
3. Can be used as vertical sighting telescope.



## Tapes.

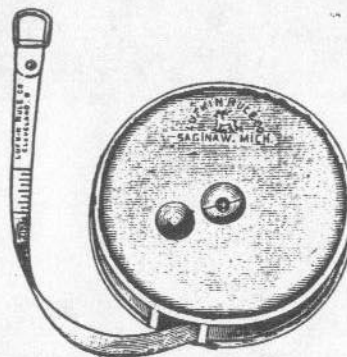
### LUFKIN STEEL TAPES.

100 ft. Lufkin steel tape, $\frac{3}{8}$ inch wide, divided in 10ths	\$11.00
25 " " " " $\frac{3}{8}$ " " " " "	4.25
50 " " " " " " " " " " "	4.00

### PAINE'S PATTERN STEEL TAPE.

$\frac{1}{4}$ " wide, in thin leather case, flush handles.

100 feet steel tape, divided in 10ths, . . . . .	\$11.00
50 " " " " . . . . .	6.00



### Lufkin POCKET STEEL TAPE

Measure.

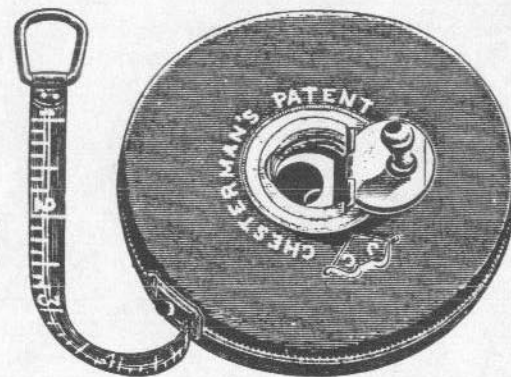
EXTRA QUALITY.

In German Silver case, with spring and stop.

36" long, divided in 10ths or inches, \$1.25  
60" long, . . . . . 2.00

### Chesterman's.

100 feet,	\$11.00
50 feet,	6.00



### LUCAS IMPROVED STEEL TAPES.

$\frac{1}{4}$ " WIDE.

100 feet, (brass centre, \$1.50) . . . . . Style D . . . . .	\$4.00
200 feet, . . . . . " P . . . . .	7.00
300 feet, . . . . . " O . . . . .	8.50
400 feet, . . . . . " O . . . . .	11.00



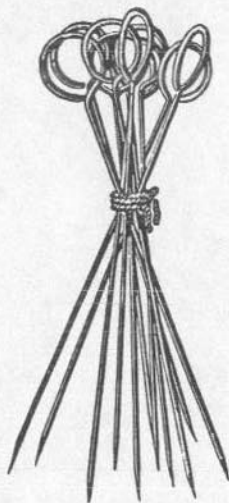
## Range Poles.

WOOD.

Manufactured from well-seasoned ash, of octagon shape, hand-dressed and painted alternate white and red in feet, with tempered steel point shoe, a thoroughly first-class rod, 6 feet long, \$1.50. 7 or 8 feet long, \$1.65.

### IRON TUBULAR RANGING POLES.

Iron tubular ranging pole, 6 feet long, painted alternate feet red and white,  $\frac{1}{8}$ " dia. steel shoe, \$2.75.



MARKING PINS.

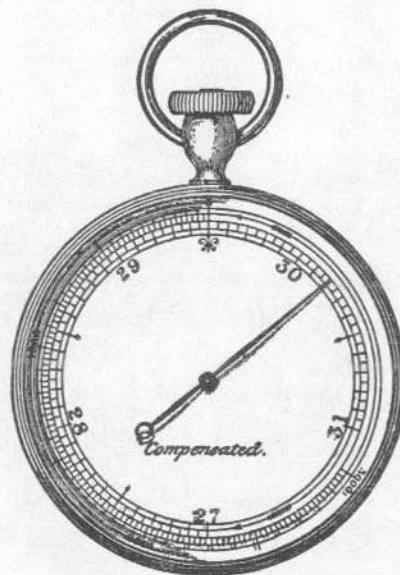
Set of 11 best spring steel marking pins, 14" long, No 8 wire, (rings closed to hold tags,) 80 cents.

Spring balance, extra quality,  $\frac{1}{2}$  lb. intervals to 20 lbs, guaranteed correct, \$1.50.

## Aneroid Barometers.

TO MEASURE HEIGHTS AND ATMOSPHERIC PRESSURE.

Style as in cut.



Made by the most reliable makers and guaranteed by us to be the best.

### SPECIFICATION,

2 $\frac{1}{2}$  inch diam., in morocco case, polished brass case, silvered dial, revolving altitude scale, compensation for temperature.

#### ALTITUDE SCALE.

3,000 by 10 ft.	—	\$21.00
6,000 " 20 "	—	20.00
12,000 " 50 "	—	21 00
18,000 " 100 "	—	22.00

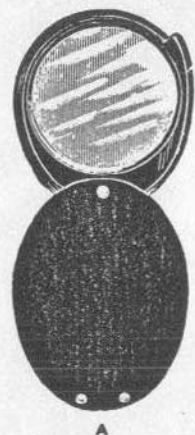
### MINING BAROMETER.

2,000 ft. below } by 20 ft.  
6,000 ft. above }

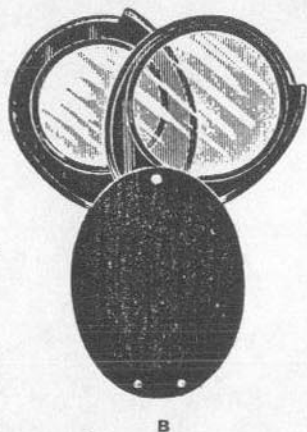
2 $\frac{3}{4}$ " diameter, in bronze finished case, silvered dial, rack and pinion to operate scale, compensation for temperature, each, \$34.50.

### A GOOD ANEROID BAROMETER.

1 $\frac{3}{4}$ " diameter, Watch pattern, silvered dial, revolving altitude scale, 8,000 ft. by 50 ft., (estimates to 25 ft.,) each \$13.50.



## Pocket Magnifiers.



A

Style A.—Ivory.

B

1" diam. lens, enclosed in ivory cell, zylonite case, each \$ .60

1 1/4" " " " " " " " " .90

1 1/2" " " " " " " " " 1.15

Style B.—Ivory.

1 1/4" " " " " " " " " 1.30

Style A.—Vulcanized Rubber.

1" " " " " " " " " " .30

hard rubber case,

1 1/4" " " " " " " " " " .45

1 1/2" " " " " " " " " " .60

Style B.—Rubber.

1 1/4" " " " " " " " " " .90

## GOSSAMER BAGS.

Bag of rubber sheeting to protect Wye level from dust and rain, 3 sizes, each \$1.00.

## SILK TRANSIT HOOD.

Made of first quality heavy umbrella silk, for transits of our make, in 4 sizes, each \$1.00.

## OIL.

1/4 oz. bottle, Superfine watch oil, put up expressly for lubricating centres, 25 cents.

## Field Glasses.



In the rating given these excellent glasses for the military and navy, 11 lines are equivalent to one inch. The power and definition depends upon the size of the object lenses.

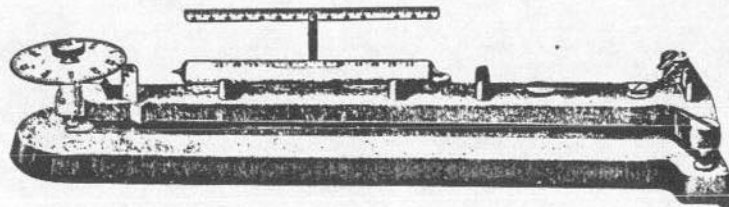
*No. 1 Binocular*, 24 lines diam., 8 lenses, power  $3\frac{3}{4}$  times, vertical angle  $9^\circ$ . In soft case with handle, price \$16.00.

*No. 2 Binocular*, 19 lines, power 8 times, vertical angle  $4\frac{1}{2}^\circ$ , with sun-shade, finish morocco. In case, with shoulder strap, price \$22.50.

No. 1 glass embodies the maximum size of object glass, and is an admirable glass for general search use.

No. 2 is strictly a high powered glass for the army and navy and mountain use.

## "B. & B" LEVEL TRIER.



Price of this instrument, complete, \$35.00.

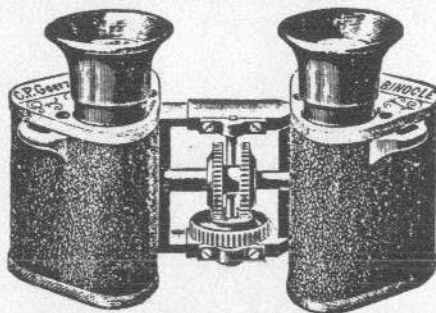
For use in Observatories, Laboratories, and Schools in testing the sensitiveness of level vials. Reads to single second of arc.

## Trieder Binocular.

Send for special catalogue.

The method of construction of the Trieder glass demands a high degree of technical perfection, as is shown by the fact that until within a few years ago it was impossible to obtain the proper material for the reflecting prism.

Thus, by the use of all the modern improvements in technical optics, and the glass of sufficient purity, C. P. Goerz has overcome all the difficulties experienced in the manufacture of the re-inverting prisms and we believe we here place before the engineering profession a glass which will fulfill every requirement in the most satisfactory manner. Send for special catalogue.



GOERZ TRIEDER BINOCULARS.  
One-half its natural size.

---

### TRIEDER BINOCULAR, NO. 10.

Field of view 7 times that of best opera glass of the same power, net \$44.50.

---

### TRIEDER BINOCULAR, NO. 20.

Power 6 times, surface manification 36 times, a perfect glass for the theatre as well as for touring and the army and navy; for races and regattas unsurpassed, net \$54.00.

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### TRIEDER MONOCLE TELESCOPE.

Power 6 times, net \$22.00.

## Testimonials.

*Rapid Transit R. R. Comm., New York.*

It gives me pleasure to state, that we have in use on the present work here in New York twenty-nine instruments of your new "B. & B." make.

Yours very sincerely,  
WM. BARCLAY PARSONS, Ch. Engr.

*Spokane, Washington.*

We judge, therefore, that errors below 2" of arc have been entirely eliminated in your graduations. . . . We would state further that it is the first and only transit we have used in which the graduations could be proved accurate to 2" second of arc and less.

*Austin, Texas.*

After six months' constant field use of my transit I have found no occasion to adjust the same at all. The gradienter attachment works accurately. The line of collimation is still perfect and the telescope focussing slide works very perfect with little or no back lash.

*Atlanta, Georgia.*

I am pleased, in fact, very pleased with your "B. & B." transit lately sent me. After a month's steady use I do not hesitate in stating my convictions that in your own words, "Quality in Engineering Instruments" holds first place in every part. The glasses in the telescope please me greatly and are the best I own in any of my six instruments.

*Sault Ste. Marie, Ontario, Canada.*

In concluding would say, we are especially pleased with the two transits furnished us recently, and will assure you, we certainly consider your make the best, and what we shall choose when again in the market.

*Denver, Colorado.*

The No. 4 Transit is a beauty in looks and more than that in action, for there is not one feature that I should even suggest as having been overlooked to make it the eminent success it is.

*Eldora, Colorado.*

The telescope in definition far excels my old Buff & Berger transit, and certainly makes your transit a superior but above all a "consistent transit of the highest quality."



*Honolulu, H. I.*

I must say it exceeded my most sanguine expectations, it is the most cute looking instrument I have ever seen. The first preliminary test of the transit fully confirmed your assertions that "it leaves our shops in excellent adjustment." . . . . Since my last letter I have put the transit to some thorough tests in the field, and it worked splendid. The line of collimation is absolutely perfect for all distances, stadia works beautiful, and the excellence of the graduations was even more demonstrated in triangulation work.

*Granite, Colorado.*

A transit that is altogether satisfactory in every respect, with particularly clear lenses. Once again complimenting you on the beauty of form and general appearance of the instrument.

*Tucson, Arizona.*

The finish is really the best I have ever seen, and together with the proportion of the longer telescope, etc., makes a handsomely finished and graceful transit.

*Mexico City, Mexico.*

It pleases me in the graduations and the clear light in the verniers, with your admirable arrangement of the verniers at 30° to telescope. The especial feature that catches my attention is the position of the plate bubble inasmuch as it does not stick out on the edge of the plate, thereby being free from knocks.

*Mobile, Alabama.*

The summary then of this extended triangulation survey with your transit No. 3026 gives the corrected angle with an error of 0.26 second of arc, a result that we have no hesitation in saying is better than the best result ever attained in our office with any of the older Buff & Berger transits.

*Sydney, N. S., Canada.*

Respecting the accuracy of my new "B. & B." transit when put to the test, and of its extreme rigidity and satisfactory working capacity, I am more than pleased. Without question the transit is the most gracefully proportioned I have ever seen, etc., etc.

*Seattle, Washington.*

The particular feature that delights my men, is the very excellent telescope that you have furnished in the transit. To use their own words, "the glasses in the new Buff & Buff transit are clear and sharp and much better than our old Buff & Berger transit."

## B. & B. TELEGRAPHIC CODE.

### ENGINEERS' TRANSITS.

Transits will include the following (unless ordered to the contrary):

- Ground Glass Shades.
- Solid Silver Graduations (Complete in case with accessories).
- Verniers at 90° to line of sight (Stiff leg tri. for No. 1 and No. 2 transit).
- Erecting Telescope (Extension tripod for Nos. 3 and 4 transit).

	NO. 1 TRANSIT. Dia. 6-1/4", Wt. 14 lbs.	NO. 2 TRANSIT. Dia. 5-1/4", Wt. 10 lbs.	NO. 3 TRANSIT Dia. 4-1/2", Wt. 6 1/2 lbs.
Plain . . . . .	Theocat.	Trandus.	Trius.
Bubble . . . . .	Theodite.	Trandist.	Tribat.
Bubble and Arc. . . . .	Theodas.	Trandate.	Trio.
Bubble Circle and Guard . . . . .	Theoduse.	Trandolite.	Trigon.

### ENGINEERS' LEVELS.

	DUMPY LEVEL.	14-1/2" WYE LEVEL.	18" WYE LEVEL.
Erect . . . . .	Dumpat.	Wyeing.	Wyes.
Invert . . . . .	Dumpus.	Wyeate.	Wyat.
Erect, Fixed Stadia . . . . .	Dumpfixt.	Wyefix.	Wyfixt.
Invert, Fixed Stadia . . . . .	Dumpinix.	Wyecatfix.	Wyatfix.

### MISCELLANEOUS.

	CODE.
What is the price of, and how soon can you ship? . . . . .	Scandia.
Answer by wire, night message . . . . .	Oakley.
Send particulars by mail . . . . .	Ongo.
Enter our order for . . . . .	Raker.
We are awaiting your remittance . . . . .	Schalls.
By what line have you shipped? . . . . .	Tabor.
Ship by express . . . . .	Talmo.

## INDEX.

Adjustments for Transit . . . . .	58-60	Magnetic Needle . . . . .	20
Adjustments for Levels . . . . .	58	Magnetic Variation Plate . . . . .	24
Aneroid Barometer . . . . .	73	Magnifying Glasses . . . . .	74
Astronomical Transit Theodolite . . . . .	48-49	Marine Glasses . . . . .	75
Bags . . . . .	74	Marking Pins . . . . .	72
Binoculars, Regular . . . . .	75	Mining Transit . . . . .	41-46
Binoculars, Trieder . . . . .	76	Minot-Blake Microtome . . . . .	64
Care of Instrument . . . . .	58-59-60	Mountain Transit . . . . .	46
Centres, Regular . . . . .	11-12-13	Paine's Steel Tape . . . . .	70
Centres, Special . . . . .	50	Planimeter, Precision . . . . .	63
Chesterman's Steel Tape . . . . .	71	Plumb-bob . . . . .	26-65-66
City Transit . . . . .	29-30-31	Plummet Lamps . . . . .	65
Cloth Finish . . . . .	27	Prismatic Eye-Piece . . . . .	47
Compass . . . . .	20	Range Poles . . . . .	72
Cross Wires . . . . .	47	Reflector Shade . . . . .	47-66
Current-Meter . . . . .	60-61	Side Telescopes . . . . .	46
Dumpy Level . . . . .	50-57	Solar Attachment . . . . .	69
Engineers' Transit . . . . .	37-38	Spirit Levels . . . . .	19-20-67
Engineers' Wye Level . . . . .	51-52	Stadia Wires . . . . .	22-23-24
Excelsior Tapes . . . . .	69	Striding Level . . . . .	48-49
Field Glasses . . . . .	75	Tapes, Steel . . . . .	70-71
Finish . . . . .	27	Theodolite . . . . .	48-49
Fixed Stadia Wires . . . . .	22 23-24	Telescope, Description of . . . . .	17-18
Graduating Engine . . . . .	62	Telescope, Top for Mining . . . . .	43
Graduations . . . . .	13-14	Transit, Standard B. & B. . . . .	28-30
Gradienter Attachment . . . . .	21	Transit, Engineers' . . . . .	37-38
Hand Level, Locke's . . . . .	67	Transit, Mining . . . . .	41-46
Hydrographic Wye Levels . . . . .	53-54	Transit, Triangulation . . . . .	48-49
Lamps for Mining Work . . . . .	65	Transit Adjustments . . . . .	58-60
Levels . . . . .	50-57	Tripod, Regular Stiff Leg . . . . .	25-26
Level Attachment . . . . .	31	Variation Plate . . . . .	24
Leveling Rods . . . . .	68	Wye Level . . . . .	51
		Wye Level Adjustments . . . . .	58

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ART. VI.—*Observations on Surveying Instruments, and the means of remedying their imperfections; by* LUCIUS LYON, Surveyor and Civil Engineer—(with a print.)

Detroit, Michigan Territory, Jan. 26th, 1828.

MAGNETISM is the well known name of a mysterious power, manifested only by its effects, and of whose ultimate cause we are ignorant.

Among its effects, none is more important, than that which results from the application of one of its familiar properties, to the art of surveying.

By no other means at present known, can lines be run, new lands be laid off, estates subdivided, their boundaries defined, and the local position of places ascertained, with so much facility as by the magnetic needle. To perform the same services, in any other way, with any tolerable degree of accuracy, would be an interminable labor.

But, although the magnetic needle affords great facilities for the practice of surveying, and in most cases is the only means which it is practicable to employ; it ought not to be relied on as entirely correct.

It is subject to many irregularities, to which our present limited knowledge of the laws which govern magnetism does not enable us to apply corrections. Although more than three hundred years have elapsed, since Columbus, with astonishment, discovered the variation of the magnet from the poles of the earth; little or nothing has yet been done toward finding out its cause, or satisfactorily explaining the reasons for the different variation at different places, or the change of variation, at the same place.

Great improvement has, however, been made, in the application of the magnet to practical purposes, in the manufacture of magnetic needles, and in fitting them to the instruments with which they are used; as well as in perfecting the form, and increasing the accuracy and convenience, of those instruments. In this respect we seem to have improved more than other nations, in proportion to the unsettled state of the boundaries of extensive tracts of our lands, the newness of much of our country, and the consequent necessity for using surveying instruments. Of the truth of this remark, any person who is a competent judge, and who will take the trouble to compare American with English compasses, will be

convinced. For although the latter generally show a high finish, and nice graduations; I have never seen one that had a convenient disposition of its parts. And they often present the inconsistency, of a nonus, by which the divisions may be read off to every minute, while the needle is so clumsy that the course cannot be determined, nearer than to half a degree.

The inaccuracy of surveys has, (as Mr. Gummore very justly observes,) been a more fruitful source of litigation in the United States, than all other causes put together. Hence arises the necessity that every person who practices surveying should be provided with good instruments, that error may be avoided as much as possible, and without such instruments it is in vain to expect any tolerable degree of accuracy. Hence also, our government, which has already surveyed about one hundred and forty millions of acres, and has more than one hundred and thirty millions yet to survey, with a view of the importance of the subject, and with a design to promote accuracy, directs, that no compasses be used in its surveys, but such as have Rittenhouse's improvements.

In the course of surveying more than three thousand miles, for the United States, and in using compasses manufactured by several of our best artists, although excellent of their kind, I have frequently experienced considerable inconvenience in passing over hilly ground, from not being able to elevate or depress, as the case might require, the forward end of the instrument. The theodolite is represented by writers on the subject, to be the perfection of instruments for this kind of business, but however well it may be adapted to surveying in an open country; it is altogether too unwieldy for use in the woods. Considering that an instrument combining the advantages of the theodolite in a portable form, would be a desideratum, I had what I conceived to be such a one made, to order, by Mr. Benj. Platt, a very ingenious artist of Columbus, Ohio—far a representation of which, see Fig. 1.\*

*Explanation of the Figure, and description of the instrument.*

Fig. 1 represents a view of the "improved elevating compass," from a point somewhat lower than the compass box,

\* Mr. Platt has for some time made compasses on a similar construction, and their superiority is bringing them into general use in the western country. He calls it the patent elevating compass.

as standing upright on its staff, with its forward end, or end farthest from the observer, elevated at an angle of about forty-five degrees.

A, a hollow plate, covering the whole bottom of the compass box, and about four tenths of an inch in thickness on the outer edge; a part of which plate projects and forms axles at D and d.

B and C, two bars about four tenths of an inch thick, encircling the compass box and attached by screws to the joints D, d, and turning on the aforesaid axles.

E, a plate, the upper part of which forms the card, or face of the compass, to which is attached the graduated ring. This plate, provided with a nonius represented at O, and with two spirit levels in the face of the compass, is turned at pleasure by the trundle P, and made fast by the screw T. The nonius should always be made to turn off, at least fifteen degrees. Compasses are usually faulty in this respect.

G, a semicircle, graduated to degrees, and attached to a projection of the circular bars.

H, an index with a nonius, by which the divisions on the semicircle may be read off for every five minutes, attached by a screw, to the end of the axle at D, and made fast to the semicircular arch, when necessary, by the thumb screw at e.

K, a *trigonometer* attached by screws to the circular bar, but which may be conveniently carried in the pocket. It has an index or hand with a fiducial edge, so divided as to correspond with the size of the divisions on the plate. One end of this index turns around a centre at g, and the other comes over the edge of the plate, (which forms an arc of a circle, and is graduated up to 45°, thence backward to 90°), the index being the hypotenuse, and the divisions on the plate, the legs, of a right angled triangle.

L, ball and stem. Around the stem of the ball is a small circular plate in contact with the screws a, b, c, which pass through the top of the socket, and by which the compass may be nicely adjusted to a level, when great accuracy is required.

M, a screw to regulate the ball, and N, another to fasten the socket to the staff.

P, screw, which by means of a spiral spring, raises the needle off the centre-pin.

S, a screw acting against the spring, i, by which the compass may be made fast to the stem of the ball. This part of the compass which fits on to the stem, runs up through the plates, and has attached to it in the face of the compass, an index with a nonius, (see fig. 2.) If the screw at R, which fastens the compass to the part just described, be loosed, and the screw S made tight; the compass may be turned around at pleasure, while the index remains stationary—and thus any contained angle may be measured, without reference to the needle, with great facility.

T and V, are sight-vanes, with eye-holes and cross-hairs for levelling. They need be but short, as they can be elevated or depressed to the direction of the object at pleasure.

Fig. 2 shows an oblique view of the face of the compass, with the needle, index, and levels, and also shows the manner in which the parts of the joints are put together.

This instrument, after a fair trial in surveying upwards of five hundred miles, has fully answered my expectations. By the addition of a telescope, which may easily be made to the sight-vanes, it will unite all the excellencies of the theodolite, and have the advantage, that it may be divested of its appendages for measuring vertical angles, and rendered as portable as a common circumferentor. The *trigonometer* which is attached to it, may be carried in the pocket, and if well made, will entirely supersede the necessity of carrying a traverse-table; as on it, the latitude and departure for any course, and any ordinary distance may be seen at a glance. The surveyor will find it a very convenient and expeditious method of measuring the distance across streams, &c.—particularly if the weather be wet and he cannot use tables.

The experience that I have had with needles of different forms, seems to confirm the truth of Professor Eaton's remark, (Am. Jour. of Science, vol. XII, page 16,) namely, that "the flat kinds are the best, which are wide in the middle, and of a true taper to the points." I have been so well convinced of this, that for several years I have used no other. They should be nicely pointed, the south part blued by a gentle heat, and the north part well polished. No letters, as is usually seen in the face of compasses, to denote the cardinal points, ought ever to be placed on the card. They answer a good purpose on the mariner's compass, where the position of the card is always the same with respect to the cardinal points; but on the surveyors compass, they will be



very likely to mislead those who pay any attention to them. A simple *fleur de lis* on the north part of the needle, is all that is necessary.

With a view to the improvement of instruments, and to obviate, if possible, some of the difficulties and embarrassments which the practising surveyor has to encounter, I will venture to add to the observations already made, a few

*Remarks on the errors of the Compass.*

Those in the use of ordinary instruments, will be many, such as may arise from imperfect graduations, &c. ; but I shall mention only a few of those which are common to all, or at least the greater part.

Most of the compasses that I have seen, have steel centre-pins passing through the card, and extending from an inch, to an inch and a half below, and frequently of the size of a common crow's quill.

Should this pin by any means get magnetized, and acquire polarity, as it will be very likely to do, by standing in a vertical position ; it is obvious, that in many cases, it might exert a sensible influence upon the needle. The larger part of the centre-pin which passes through the plate, should be of brass or copper, and into this the small steel pivot, on which the needle librates, should be firmly screwed.

Much uncertainty and difficulty in the practice of surveying, particularly in tracing old lines, arises from the constant changing of the declination of the needle.

This difficulty might be obviated in relation to future surveys, by carefully observing, once or twice every year, the exact variation of the magnetic, from the true meridian ; and by establishing a true meridian line for the adjustment of different instruments.\*

Such observations being made and registers of them kept, at as many places as might be necessary, we should thence, knowing the dates of the different surveys thereafter made, have the means of determining the precise bearing of a given line at any time when it might be convenient, whether the survey had been made by the magnetic, or by the true meridian. Such observations besides a practical, would have a

\* Mr. Gummere, author of an excellent treatise on the theory of surveying, I think proposes something similar. See his discourse on land surveying.

scientific value, and may be made at any place in a variety of ways, with far less trouble than their importance might demand.\*

In October, 1822, in company with I. Mullett, Esq., surveyor general of Michigan, I made several observations, to determine the precise variation of the needle at Detroit, and the mean of the different observations was  $3^{\circ} 13' 22''$  declination eastwardly. I have, during the present month, repeated the observations in company with the same gentleman, and find  $2^{\circ} 50'$  variation eastwardly ; thus showing a traverse of the magnetic meridian to the westward of  $23' 22''$  in little more than five years, or about  $4\frac{1}{5}$  per year. On the Island of Michilimackinac in July last, I found the variation eastwardly to be  $2^{\circ} 59'$ . In the winter of 1825-6, on the Grand River of Lake Michigan, in the western part of the peninsula, I observed the variation every clear night, for several months, and every night in a different place, extending over a tract of country about seventy miles long by twenty-four broad. The results were various, from  $3^{\circ} 45'$  E., to  $6^{\circ}$  E., varying sometimes  $50'$  in a distance of six miles ; and that without any apparent cause, as the country is entirely alluvial, and scarcely a trace of iron can be found. The declination, however, generally appeared to increase in going westwardly.

Practising surveyors, in all parts of the United States, whether amongst the primitive mountains, or on the alluvial plains, often complain of the errors and perplexities arising from the aberrations of the needle, and suppose the cause, which they call local attraction, to exist in the earth.

In hilly countries, where ores abound, it is reasonable to suppose that they may exert an influence upon the needle, and sometimes cause it to vary from its general direction, but on extensive alluvial plains, where there is no trace of ores of any kind, its aberrations are, on this supposition, inexplicable ; and I am well convinced that in most cases they depend entirely on another cause, which I do not recollect to have seen mentioned by any writer on the subject, namely, the development of electricity or magnetism, or both, in some part of the glass of the compass, by its friction against the clothes of the person carrying the instrument.

\* Mr. Mullett keeps a register of the daily variation at Detroit.



The common method of carrying the compass for convenience and for the protection of the glass, particularly in the woods, is to throw it over the left arm, with its face towards the body, holding one sight-vane in the hand, while the other lies across the arm above the elbow.

In this position, one part of the glass will frequently come in contact with the covering of the body; and I have found by abundant experience, that it is the part thus excited, which, in a dry atmosphere, very often produces the aberrations of the needle so much complained of, the cause of which has generally been considered so inexplicable.

I believe, that in nine cases out of ten, where local attraction is suspected, the surveyor need not look beyond his instrument for the cause.

Sometimes from this cause, when the compass is set, and the needle let down on to the centre-pin, it will swing hastily around to a certain position, where it will suddenly stop, and remain for several minutes, until the excitement appears to have in some measure abated, when it will leisurely move off and apparently assume its proper position. At other times, when the surrounding atmosphere is drier, and circumstances seem more favorable to the development of the disturbing cause, the needle when lowered on to the pivot, will fly immediately to some point in the glass, and attach itself so closely by one of its ends, that it is with difficulty, that it can be immediately removed.

*Note.*—With a view to ascertain whether the attracting cause is developed by friction in all compass glasses alike, I lately made several experiments in company with Mr. Mullett; the result of which was, that out of the four different compasses which we examined, three, by rubbing a few seconds on any part of the glass with silk or woollen cloth, would attract the needle from twenty to eighty degrees, and hold it in contact with the glass from five to fifteen minutes. The other glass, by rubbing, showed no signs of attraction, either for the needle or electrometer—neither would an excited stick of sealing wax, nor a disk of polished glass, when excited, affect the needle through it; although they would, through the other glasses at a greater distance. The glass was then placed over the other needles with the same result. Hence we inferred that this glass had no affinity for the electric or electro-magnetic fluid, and that it was impervious to it.

Neither of us having ever before used a compass glass that could not be excited, this singular exception of the fourth glass induced us to try another experiment, to see if a steel magnet of the same attractive power as the sealing wax, in relation to the other needles, when held at a certain distance, would attract the needle through this glass. The result proved that it would vary sensibly. Hence then, if the cause of the attraction of the needle, developed in the glass and sealing wax, be magnetism, there must be two kinds; one that can communicate its influence through this glass, and another that cannot.

On one occasion, the needle of my compass was so strongly attracted to the glass, that it was with the greatest difficulty that I could shake it off, and when I had succeeded in detaching it, it would immediately return and adhere as firmly as before.

In this dilemma, I washed the glass on both sides, in a neighboring brook, which seemed to lessen the attraction considerably, but so strong was the excitement about the instrument, that near half an hour elapsed before I felt any confidence in its accuracy.

To obviate the errors arising from this source, by preventing the friction of the glass, Mr. Mullett proposes to cover the face of the compass with two semicircular brass plates, to turn on hinges, and so contrived that by means of a spring, they can be made to fly open when required.\*

I will only add, that the surveyor's compass, or any other instrument, depending on the needle, requires to be used with great circumspection.

In order to ascertain, whether the attraction of the needle in the aforementioned cases, was caused by the electricity excited, or by magnetism, which from the strong attraction of the needle, I suspected might be a concomitant, I subsequently made a variety of experiments with different substances, by a very delicate electrometer, and a small needle nicely balanced. A stick of sealing wax or a disk of polished glass, when excited, attracted and covered themselves with iron filings, and also attracted the needle and electrometer; but on being dipped in water, they suddenly lost all their attractive power, and did not affect the needle. The disk of glass, however, when excited, did not seem to have its attractive power materially lessened by holding it between two brass plates for several minutes, and would attract either the electrometer or the needle; but the needle seemed the most sensitive, and would be attracted by a small excitement of the glass, when the electrometer, which was a small down feather, would not be moved. The stick of sealing wax, or the glass when excited and placed on a tea cup in a pan of water, could be drawn by a magnet from one side of the pan to the other, to and fro, at pleasure. The same could also be done by a piece of iron, a brass scale, or boxwood rule, or any thing else with equal facility. Hence it appears the attraction of the needle by the glass was not owing to any particular affinity of the electricity of the glass for the magnetism of the needle, but that the electricity attracted it by the same virtue, and with the same force that it does all other bodies.

\* This would answer, provided the glass is the only part of the instrument in which the magnetic or electric influence can, in this way be developed, but I have observed at times, that the whole of one part of the compass appeared to be temporarily magnetized, and this is the only way that I could account for the hasty swing and sudden stop of the needle before mentioned, when it was apparently, not at all influenced by the glass. I have also observed in some instances, when the needle appeared to have been disturbed in settling, that putting the hand toward it, would attract it several degrees. I have never observed this curious phenomenon, except when I had been walking, and suppose it may be attributed to the electricity thus excited. Mr. Mullett and others, have observed the same thing in similar circumstances.

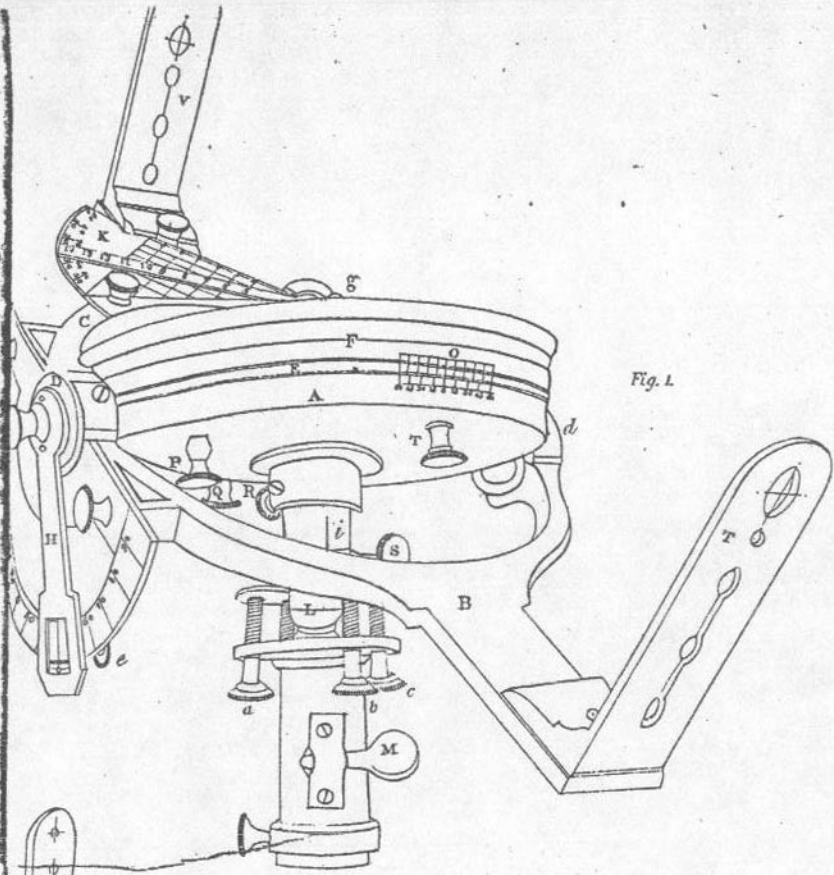


Fig. 1.

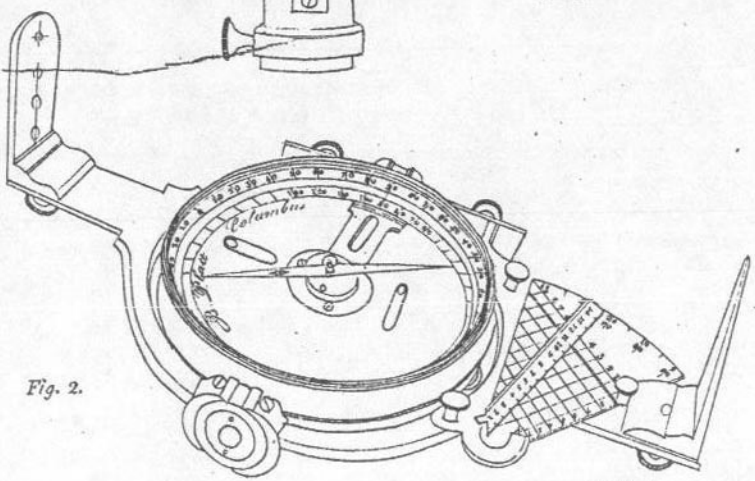


Fig. 2.

A. D. Smith sc.