ILLUSTRATED AND DESCRIPTIVE

CATALOGUE

—OF—

Engineering, Surveying,

AND

ASTRONOMICAL

INSTRUMENTS.

MADE BY

F. E. BRANDIS,

55 FULTON STREET, NEW YORK,

U. S. A.

1881

The prices quoted in this Catalogue are as low as consistent with first-class workmanship, and will be strictly adhered to.

Parties ordering from distant points, will please remit by P. O. Money Order, Bank Draft, or Registered Letter. When goods are ordered to be sent C. O. D., double the amount of express charges should accompany the order.

All charges for expressage and collection are to be paid by the parties ordering.

Orders for Instruments. accompanied by Draft to the amount of Catalogue prices, will be boxed and packed free of charge.

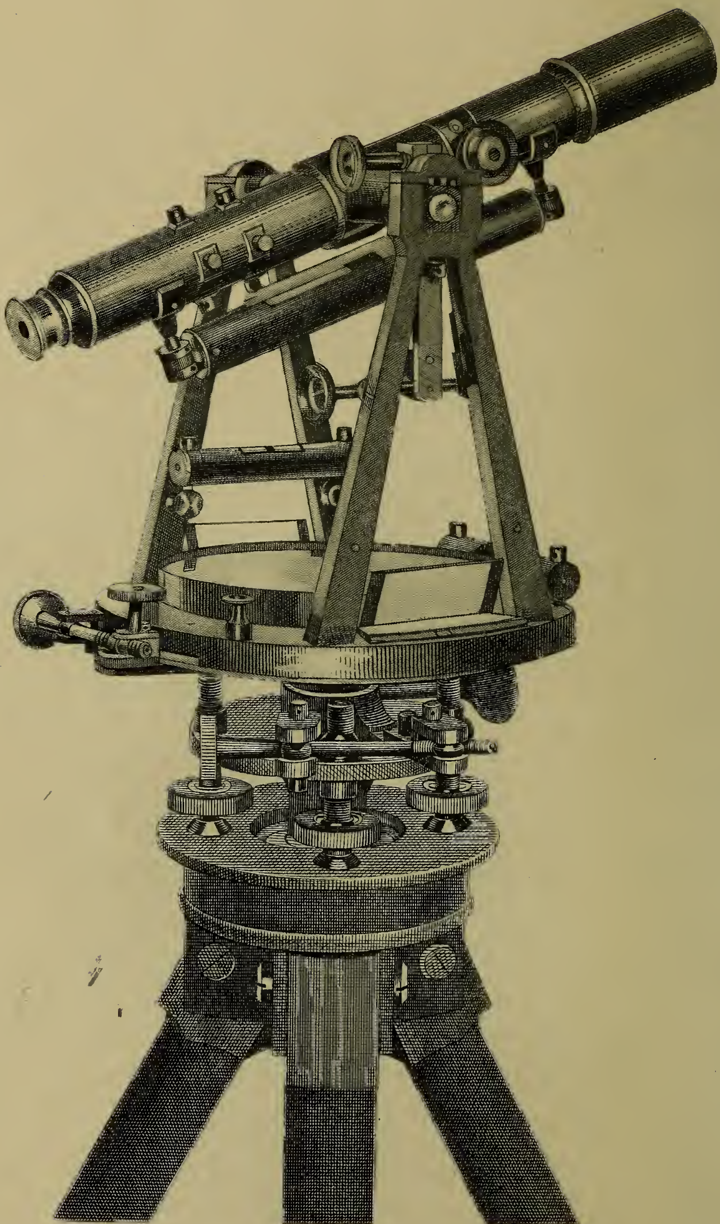
Packing boxes are furnished at cost prices.

New York, May 1881.

F. E. BRANDIS.

TRANSIT WITH LEVEL ATTACHED.

PLATE No. I



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F. E. BRANDIS. NEW YORK.

ILLUSTRATED AND DESCRIPTIVE

CATALOGUE

OF

INSTRUMENTS OF PRECISION

FOR

Field and Astronomical Purposes.

THEIR CONSTRUCTION, CARE OF, AND ADJUSTMENTS.

MADE BY

F. E. BRANDIS,

First part, Field Instruments. Second part, Astronomical Instruments.
Third part, Mathematical Instruments, Drawing Papers, etc.

55 FULTON STREET, NEW YORK, U. S. A.

[1881]

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TO THE ENGINEERING PROFESSION.

In presenting the present edition of my illustrated and descriptive Catalogue to the profession, I am pleased to state that during the past eight years the changes and additions, representing not experiments upon my friends, but improvements for their benefit, have met with the fullest approval of many of our most Eminent Engineers throughout the Country.

For the character of my work I have but one reference to make, *i. e.* the *perfection of graduations*, *power* and *definition* of *telescopes*, and *absolutely fine workmanship*, combined with *lightness*, *strength* and *ease* of *manipulation.*

From my thorough practical knowledge of every branch of the business, aided by the best mechanical skill obtainable, I trust that the reputation I have gained will be sufficient inducement to my friends not only to continue their liberal favors, but also to recommend me to their friends, who may be assured that it will continue to be my aim as heretofore, to merit their valued confidence by a continuance of my prompt and careful attention to any business, they may personally or by letter place in my hands.

The *warrantee* of *my instruments* in regard to *construction*, *accuracy* of *optical parts*, and *excellence* of *workmanship not* being limited as to time, the owners of instruments of my manufacture may rely upon *prompt attention* concerning all reasonable demands made upon me.

In conclusion I would say that Engineers are often misled in ordering instruments of parties *pretending* to manufacture, such as Dealers in Drawing Instruments and Materials, Opticians, Thermometer Makers, etc.

It is needless to say, that instruments furnished by these parties are made for the trade, with the advertisers name engraved upon them, and are a disgrace to the mechanical profession.

In all cases the Engineer should order his instruments from a reputable manufacturer *direct*, in order to obtain a first-class article.

This does not include parties acting as agents for other houses.

F. E. Brandis.

PART I.

FIELD INSTRUMENTS.

ENGINEERING INSTRUMENTS.

To give a minute description of the amount of care, and precise workmanship required to produce a strictly first class instrument would be a difficult task. The fact is, too little attention is paid to the necessary details by some of our American Manufacturers for the reason that most parts are produced by the aid of machinery, making the different parts interchangable and thereby depriving them of such delicate fittings as can be accomplished by hand work only.

This method will do all that is desired for in the manufacture of Fire Arms, but will never meet with success in the manufacture of instruments of precision.

The conscientious Mechanic as well as the intelligent Engineer knows well, that the essential parts must be and are slighted by this method, and by dissecting an instrument can tell immediately whether it is made for use, or for sale.

Two-thirds of the instruments now in use would be condemned, were there a law for them to stand certain tests.

THE ENGINEER'S TRANSIT.

The vital part of an instrument commonly called the centre (or its vertical axis.) Too much attention on the part of the maker cannot be bestowed upon any part of an instrument than this one for the following reasons: First, no matter however correct the graduations may be, a slight defect in the interior cone or socket will never give equal results in reading angles, or in other words, should the socket in which the vernier plate revolves not be perfectly cylindrical, or the centre fit tighter below than above, the result would be a swaying or eccentric motion of the vernier plate which would cause an error of from 30 seconds to 2 and even 3 minutes when clamped. In this case all angular repetitions would prove defective, since the error would not be constant. Second, should both centres not be perfectly concentric with each other, the levels when adjusted upon one centre, would not reverse upon the other, especially should they be sensitive, which of course is out of question in common instruments, as they would not stand the test.

The centres should be compound, and as long as possible to insure steadiness, and the metal "*Phosphor Bronze*" on account of its excellent wearing qualities.

To test the value of his centres, let the Engineer adjust the level attached to the telescope one-half by means of the tangent screw for that purpose, and the other half by means of the parallel plate screws, clamp the instrument and reverse upon the other centre; should the level hold its position the centres are good, if not, his work will prove defective by repetition.

GRADUATIONS.

It also gives me pleasure to state, that the efforts in bringing my new Graduating engine to perfection after six years of incessant labor have been crowned with perfect success. In constructing this engine, I followed the plans on which the celebrated "Gambey" engine was built, description and engraving of it will be found in this Catalogue.

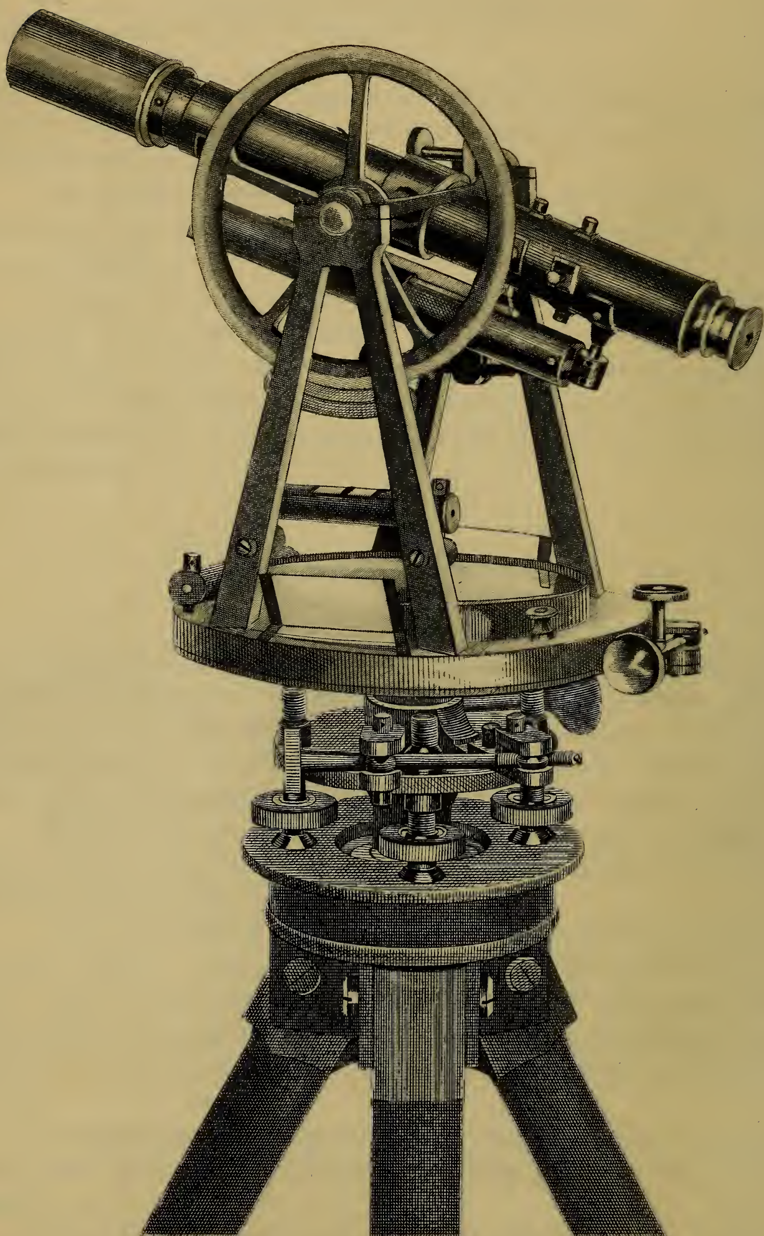
Finding it impossible to obtain a sufficient accurate graduation in this country, I was obliged to send my plates to Europe to be divided, which involved great risks and vexacious delays.

I can now, without exaggeration, claim the most accurate graduation in this country. Engineers should understand the importance of this fact, that, as most of the instruments made in this country are *not* graduated by the makers of other portions of these instruments, they can themselves know nothing with certainty of the accuracy of these graduations.

Accidental errors arising from inexperience or careless management of the *best* dividing engine, frequently exceeds ten times the error of the same.

Therefore these makers cannot conscientiously guarantee their accuracy, while the Engineer after finishing his work with the greatest of care, discovers his work to be incorrect, throwing a doubt over all his angular measurements.

COMPLETE ENGINEERS TRANSIT
AS MADE FOR U.S. ENGINEER CORPS.
PLATE Nº II



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As incorrect graduations are a most serious imperfection in an instrument, it is essential that this delicate operation should be performed with the greatest of care.

Still, with all due diligence on the part of the operator, small errors are sometimes unavoidable, these may be attributed to the following causes, porous metal, changes of temperature, shifting of plates or clamps, defective centering, etc

The errors, of course, cannot be detected until the graduations are made to prove themselves by means of the two opposite verniers reversion and repetition, this will double the actual error, and permit the limb if correctly graduated, to be centred perfectly true.

Instruments with errors of from 30 seconds to 2, and in some cases 3 minutes are of common occurrences. In a first-class instrument the error should never reach 15 seconds.

Reflectors of ground glass protect the graduations by throwing a mild subdued light over the limb and verniers, preventing unnecessary strain upon the eyes of the Engineer.

Graduations vary according to the purpose they are intended for. The regular engineer's transit has the limb divided into 20 minute spaces, 39 of its parts being equal to 40 on the vernier, giving a reading of 30 seconds.

The City Transit (Plate 4) and transit with reversible axis (Plate 3,) have their limbs graduated into 20 minute spaces, 59 of their parts being equal to 60 on the verniers, giving a reading of 20 seconds.

Theodolites from 7 to 9 inches diameter are divided into 10 minute spaces, 59 parts on the limb being equal to 60 on the verniers, giving a reading of 10 seconds.

Theodolites from 9 to 12 inches diameter, used on the U. S. Lake and Coast Surveys are usually divided into 5 minute spaces, 59 parts on the limb being equal to 60 on the verniers, giving a reading of 5 seconds.

Altitude and Azimuth instruments from 12 to 20 inches diameter, have their limbs divided into 5 minute spaces, reading by 3 microscopic micrometers to single seconds.

All limbs to be graduated are turned upon their own bearings or centres, so as to insure a perfectly true horizontal plane. This method is certainly very delicate and tedious, but finding it the only reliable one, the extra labor is not taken into account.

The porous nature of brass or composition casting sometimes seriously interfere with the production of a perfect graduation, unless condensed under the hammer to acquire a uniform density.

The metal thus condensed is always subject to unequal expansion and contraction in changes of temperature, and if not condensed, the small air holes will cause the cutter to deviate from its proper course, producing lines of various thickness and unequal spacings.

For the above reason all graduations should be on solid silver or platinum as the most satisfactory results are obtained thereby, and the Engineer should not take into consideration the comparatively small extra expense, but should get an instrument that will perform the most accurate work he may ever be called upon to do.

NOTE.

Platinum is preferable, especially for underground work, as it does not tarnish, but the expense being considerably higher than silver has prevented its general use.

The figures engraved on the horizontal limb run in quadrants from 0 to 90 degrees each way, and a continuous row from 0 to 360 degrees.

The compass is graduated into ½ degrees, and engraved into quadrants from 0 to 90 degrees each way.

The compass needle is made of the best Swedish shear steel, hardened in a boiling solution of potash and salt, which has the advantage of keeping the same in perfect shape, and according to proportion of mixture used, gives it the proper temper. After searching experiments, this, and the method of magnetising the needle by passing it through a magnetic current proves to be the only safeguard against it losing its magnetic power. The pivot carrying the needle and cap of exceedingly hard agate, is finely pointed and tempered so as to insure a perfect and sensitive performance of the needle.

TELESCOPES.

The telescopes in my instruments are constructed in strict accordance with the purpose they are intended for. The object glasses are perfectly achromatic, well centred and polished, as well as perfectly free from chromatic and spherical abberation, which must insure for them a good definition. The eye pieces are also well centred, and mounted in the most approved manner.

It is unquestionably a great mistake on the part of the Engineer to select a telescope of excessive magnifying power for field work, thus depriving the same of light, flatness and size of field of view.

Optics are governed by mathematical principles, going beyond these. bad results must follow, or in other words, what is gained in one point will prove deficient in another.

Being in constant communication with several of our most distinguished European Opticians of extended experience, I have by their advice, adopted the Frauenhofer and Steinheil system of lenses. By their formula the telescopes give sufficient power, great brilliancy of object and an abundance of light as well as a perfectly flat and large field of view.

The telescope (erect) in the Engineer's transit is 11½ inches long, and has a magnifying power of 25 diameters; in the 17 inch leveling instrument a power of 40 diameters, and the level of precision (inverted) has a power of 50 and 60 diameters.

To preserve the efficiency of his telescopes in atmospheric changes, the Engineer should not select telescopes beyond these powers.

The common defect in telescope slides not moving in and out in perfect straight line, thereby causing errors in unequal distances is wholly obviated by the following procedure. The slides are turned and ground perfectly cylindrical. By a special arrangement the inside of the main tube is undercut, leaving only two bearings ½ inch wide upon which the slide travels, thereby avoiding unnecessary friction and insuring a perfectly straight and free motion.

(The objectionable method of making the sliding tube adjustable clearly shows that there must be some mechanical or optical defect, which has to be concealed by means of this adjustment.)

The slide is moved in and out by means of a rack and pinion, answering to the slightest touch, smoothly, and without lost motion, which is necessary for the exact focusing of an object.

The eye piece, for focusing the cross wires is moved in and out by an improved screw motion.

Spider-web is preferable to any metallic wire, as the latter is never perfectly opaque, and any trouble from breaking or sagging of cross wires must have originated with the maker, fastening them to the diaphragm in a defective manner.

The telescope is thoroughly balanced when focused for mean distance and revolves at both the object and eye ends, even when used at a distance of 5 feet.

SHIFTING CENTERS.

To faciliate the exact centering over any point, the instrument can be shifted 1 inch in any direction without disturbing the tripod legs by simply loosening the parallel screws, bringing the instrument over the desired point, and level the same.

This shifting centre is the most simple and best constructed, and has the advantage that it requires only one separate motion (to centre and level it.) which holds the instrument in firm position, where, in many others the shifting motion is one by itself, and the leveling up another.

The tripod legs are made of thoroughly seasoned, straight grain *bay wood* strong and light, and are held by means of bolts and screws between the cheeks. Split tripod legs have their advantage only in field instruments of greater weight and dimensions, but for instruments of within description the round legs are preferable both for ease in handling and carrying on the shoulder. There is also less danger of injury during transportation.

CLAMP AND TANGENT SCREWS.

It is essential in all proper made instruments that the clamp screws should answer at the slightest touch and the tangent so arranged, that no lost motion (or back lash) may occur. Engineers in possession of instruments with such defects, know well the inconvenience caused by having to give the clamp screw one or two full turns to clamp tight, where, if properly made, this ought to be accomplished by $\frac{1}{6}$ of a turn of the screw.

The lower tangent clamp, as will be observed in the engraving is one of the best devised, and has the following advantages. It is long and rigid, the tangent screw a sufficient distance from the centre so as not to affect the same when clamped. The step straps which hold the *double cup* and *ball* in position are made so that one screw holds the strap firmly in position, and the other (longer one) serves to prevent lost motion. The long tangent screw which does not extend beyond the lower plate is made of Phosphor Bronze, and has a succession of grooves corresponding with those of the screw threads at the revolving point, encased in double cups with similar grooves. These are finely ground one into another, and when turning the screw, both balls will remain stationary, at the same time accommodating themselves to any position the clamp may assume. The joints of the double cups being close, no dust can ever affect this part, and the screw will retain its smooth and delicate motion for years without any attention on the part of the Engineer. This single tangent screw has proved far superior to the two rebutting screws, besides giving the Engineer the freedom of using one hand for the tangent and the other for the telescope.

The upper tangent screw is constructed in a similar manner, with the exception of the straps being held by one screw only.

The clamp and tangent straps are attached to the outside of the circle for the following reasons.

Suppose the clamp were attached to the inside of the circle and the tangent screw on top of the vernier plate as done in a number of instruments, the chances are, there being a slight difference in the graduated surface and the clamp part, the vernier plate would be sprung in drawing up the clamp screw.

This would cause an error in the graduation, the clamp either lifting or depressing the upper plate. To detect this serious evil, it requires a sensitive level, which will at once show the defect.

The greater the distance of the clamp from the plates, the less liability there will be to strain them, providing the balls are so adjusted as to admit of their moving freely, yet with sufficient friction to prevent lost motion.

SPIRIT LEVELS.

This important part of an instrument is generally treated as a secondary affair, though it is absolutely necessary to pay as much attention to a Spirit Level as there is to a good telescope and graduation. It is the Pioneer that guides the Engineer in all his horizontal and vertical measurements, and if a level is not sensitive and quick to respond, and ground to an even curvature so as to travel evenly and a certain distance to a minute of arc to its extreme ends, the best made instrument in the world will not perform well, but, with a proper working level, instrumental errors may be corrected.

The most suitable levels for transit plates should travel at least ¼ of an inch to 1 minute of arc, the level on telescope at least ¾ of inch, and those of a first-class Leveling Instrument 1 to 1¼ inches to 1 minute of arc. If good results are expected, the levels must be of the above sensitiveness.

After repeated experiments the mixture of one-half of sulphuric ether and one-half of 95 % of spirits of wine, have proved the most satisfactory for the above. Levels for higher grades of instruments, or for Astromical purposes provided with air chambers to regulate the length of bulb and reading to single seconds, pure sulphuric ether is used.

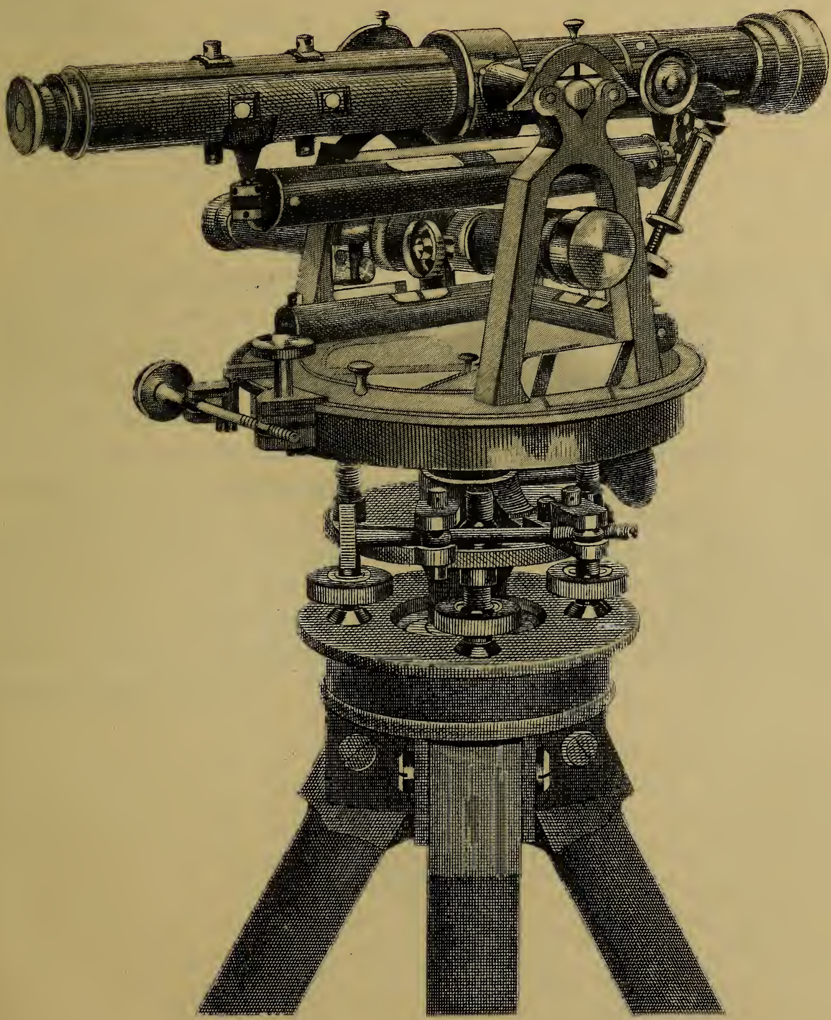
Having every facility for grinding levels of all curvatures and sensitiveness, and paying personal attention to this important part, I can guarantee the best results,

CONSTRUCTION.

Particular attention has been paid to the general construction of my instruments. In comparing them with those of other makers, it will be observed that the distance between the horizontal and parallel plates has been reduced about three inches without shortening the centres, thereby building on a good foundation and securing great steadiness.

IMPROVED CITY TRANSIT.

PLATE No. IV



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Top heavy instruments with a frail and light base will soon wear the centres to such an extent, that they will assume an eccentric motion, and make them useless for accurate work. My first aim was to reduce the objectionable height and gain additional length of centre, which has proved a success.

Altogether these instruments have received a full share of possible improvements, which, with their excellent performing qualities, will be appreciated by the Engineer.

BRONZING OF INSTRUMENTS.

Dark bronzes being preferable to a bright and glaring finish, the use of arsenic and iron, as well as corrosive sublimate, (on account of its cheapness and rapid action,) is generally resorted to by most of our American manufacturers, which is positively injurious to the metal, and in handling of an instrument.

Engineers should insist when ordering an instrument, not to have it covered with this objectionable poison.

All my instruments are finished with Bi-Chlorate of Platinum, giving the same an elegant and fresh appearance, which may be preserved for many years with ordinary care. This bronze has given such satisfactory results during the past ten years, that I have decided to continue its use. Parties prefering to have their instruments finished bright, can do so without extra charge.

ADJUSTMENT OF THE TRANSIT

To enable those, unacquainted with the necessary adjustments of an instrument to correct the same without the aid of the maker, a short comprehensible description is hereby given to accomplish the same.

THE LEVELS.

This adjustment is to determine whether the vertical axis of the instrument, is in a perfectly true vertical position, and for this purpose the levels must be brought at right angles to the vertical axis of the instrument in the following manner.

Bring the bubble of the level in the centre by means of large leveling screws and turn the instrument 180 degrees. Should the bubble run towards either end of the tube, it would indicate that end to be the highest. With the capstan head pin lower it until one-half the error is corrected. Bring the plate back to its original position, and the bubble in the centre by the leveling screws, turn the instrument 180 degrees, and correct one-half as before.

Now bring the bubble in the centre over the other pair of leveling screws, and repeat the same operation as before, until it remains in the centre. To complete the adjustment, repeat the above operation alternately over both pair of leveling screws until the bubbles will remain central in any direction. Should the bubbles not remain in the centre by reversing the instrument on either plate, it would indicate defective centres, which can be corrected by the maker *only.*

THE STANDARDS.

This adjustment is to determine whether the telescope revolves at right angles to the vertical axis of the instrument, so that the telescope may indicate a truly vertical line

To make this correction, level up carefully, select the base and top of a high building or spire, and let the wire bisect some defined object found at the top. Clamp the instrument and bring the telescope down to bisect some object at the base, either marked or found, reverse the instrument 180 degrees, and let the wire bisect the mark at the base, and elevate the telescope to the top mark.

Should the wire cover this mark, the vertical adjustment is correct, if not, remove one-half the error by means of the adjusting screw on the standards. To whichever side the error is inclined, the opposite bearing must be lowered. Repeat this operation until by reversion the wire will cover the same marks.

NOTE.

The adjustable bearing being a double journal, care should be taken to have both adjusting screws to bear sufficiently tight without over-straining them.

THE LINE OF COLLIMATION.

To bring the optical axis of the telescope at right angles to its revolving axis, proceed as follows.

After having adjusted the wires truly vertical, so that the top and bottom of wire will cover the same object by elevating and depressing the telescope, choose two distant objects, say 300 feet in opposite direction which the wires will bisect, reverse the instrument 180 degrees and sight upon the first object, revolve the telescope and sight back upon the second object. If both are bisected the collimation is correct, if not, remove one-fourth the error by means of the capstan head screws. Bring the instrument back to its original position, sight upon first object, clamp it, revolve the telescope in opposite direction and mark or find a second object. Without disturbing the telescope, turn the instrument 180 degrees and bisect the first object, revolve the telescope again upon the second object, and proceed thus, until the wires will cover both objects upon reversion of the instrument.

To faciliate this adjustment, let the Engineer draw from 4 to 6 vertical lines about one-tenth of an inch apart on a piece of white paper, and secure this in nearly opposite direction of a well defined point. It is well to figure these lines to avoid mistakes. This method will save the trouble of finding or marking new points during adjustment. In a first-class telescope whose object slide moves in and out in perfect straight line it is not necessary to take equal back and fore sights, and this adjustment may be perfected between any two convenient points.

HORIZONTAL LINE OF COLLIMATION

To adjust the horizontal line of collimation, level up as before. Select or establish two opposite points in horizontal line, make the telescope as near level as possible to the eye, clamp same, and sight upon some object. Reverse the instrument, and sight upon another either found or marked. Revolve the telescope, sight upon the first object, reverse the instrument and sight upon the other. Should both agree, the adjustment is made, if not, correct one-quarter the error by means of vertical capstan head screws, and repeat this until the wire bisects both objects by reversing the instrument and revolving the telescope, bearing in mind, that the screws must be moved in opposite direction of apparent error in both horizontal and vertical adjustments.

THE TELESCOPE LEVEL.

This adjustment is to bring the level horizontal to the optical axis of the telescope, and is accomplished in the following manner.

Select a piece of ground nearly level, set the tripod firm and level the instrument carefully. Drive a stake at about 300 feet distance, place the leveling rod upon this stake, and after having set the telescope level approximately horizontal, clamp the same and note the height indicated on the target. Drive another stake in nearly opposite direction, reverse the instrument 180 degrees without disturbing the telescope, and correct the height of this stake, until it indicates the same height as that of the first stake.

No matter how much the telescope may be out of level, the top of stakes must indicate a true horizontal line. The instrument must now be moved about 20 or 30 feet from either stake, again carefully leveled, telescope clamped and set horizontal as before. Set the rod first upon the nearest stake, note its height, and next upon the most distant stake and note its height, should both indicate the same height, the adjustment is complete. if not, move the wire by means of the tangent screw over nearly the whole error as indicated on the second stake, and proceed with this operation until the horizontal wire will give the same result at both stakes.

By means of the small nuts on the end of the level, bring the bubble in the centre, being careful not to disturb the telescope, when the same will be truly horizontal.

ZERO OF VERTICAL CIRCLE.

To adjust the vernier of Vertical Circle so as to read zero when the telescope is truly horizontal, level the instrument and reverse 180 degrees. The amount of error indicated on the scale is double, and half must be corrected by means of the leveling screws, and the other half by tangent screw on axis. Repeat this operation until the bubble remains in the centre on any part of the circle, loosen the capstan head screws, taking care not to disturb the position of the instrument, and shift the vernier until its zero line coincides with that on the circle, tighten the screws, and the instrument will be in complete adjustment.

PATENTED IMPROVED ENGINEERS' LEVELING INSTRUMENT.

Of the various leveling instruments, the Wye level, on account of its superior accuracy and facilities of its adjustment, is now almost exclusively preferred in place of the *Dumpy level*, by those engaged in precise work.

The different sizes and power of telescopes of these instruments depend upon the work they are intended for. The engraving represents the 18 inch level of medium size, with which the most accurate results will be obtained.

The smallest size level has a telescope 11½ inches long, and magnifying power of 25 diameters. The 18 inch has a magnifying power of 40, and the level of precision, with 3 screw adjustment and level reading to 5 seconds, inverting telescope 20 inches long, a magnifying power of 40 and 50 diameters.

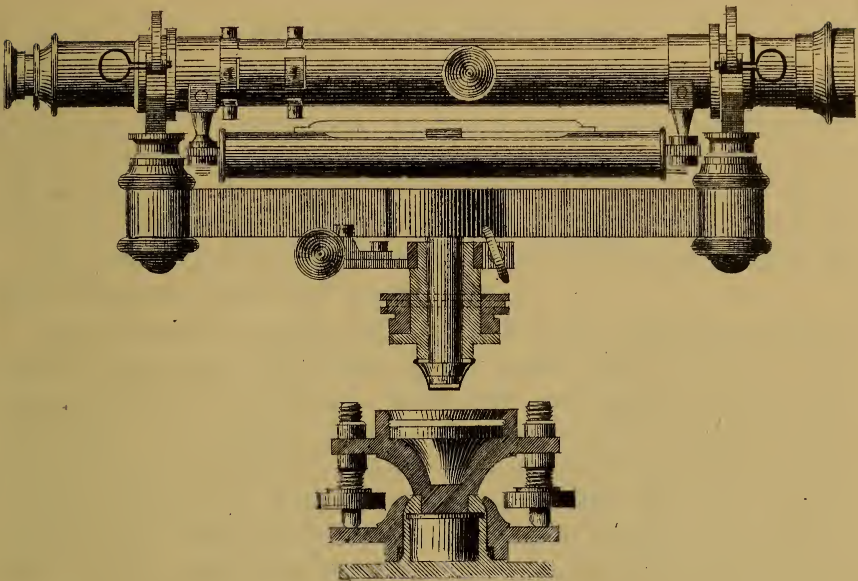
The bell metal rings at each end of the telescope are turned exactly the same diameter, and are held in the Wyes by clips containing cork, which holds the telescope firm in its bearings. The device for keeping the wires in a perfect horizontal position, is extremely simple. Each extreme diameter of the telescope collar carries a projecting pin about ⅛ of an inch long; when either of these pins are brought in contact with the screw passing through one of the wyes, the wires will be found to be in the desired position. This permits the collars to rest in the wyes without the least strain, and the telescope may be revolved without opening the clips, by unscrewing the wye pin sufficient to pass those on the collars.

A rack and pinion, working exceedingly smooth and without lost motion, permits the accurate focusing of an object. The manner in which the telescope slide moves in and out, is explained in the description of the Transit. The object glass is protected by a sun shade 3 inches long, which, when the instrument is used, should always be attached to the object head, (as the level is adjusted with shade attached.)

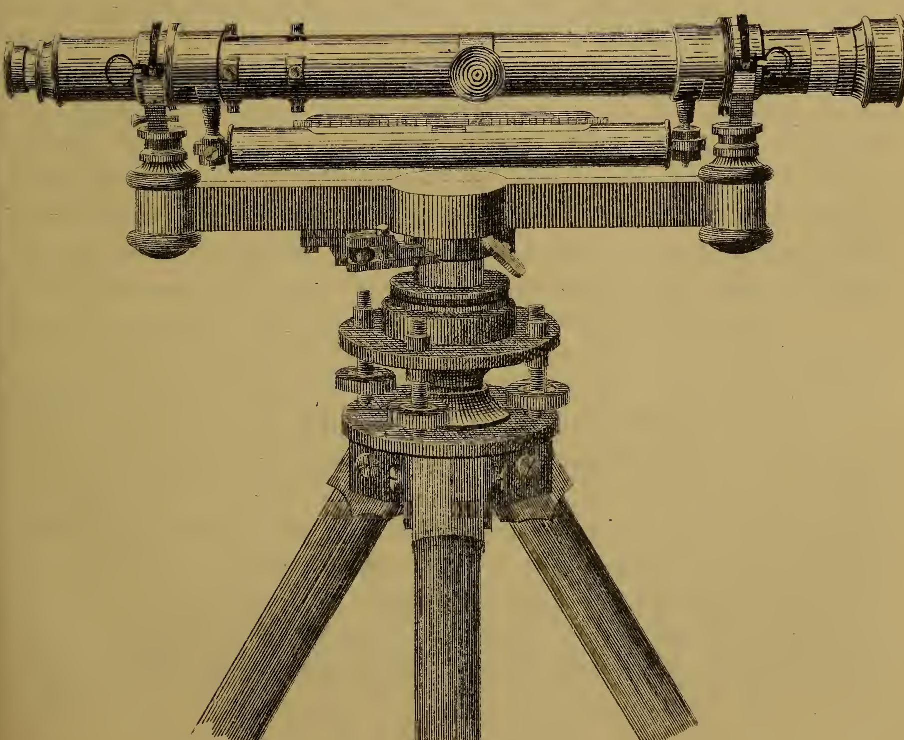
The 12 inch as well as the 18 inch wye level, having undergone a radical re-construction, for which Letters Patent were granted, I would say, that the introduction of this improved invention has met with far

18 INCH PATENTED IMPROVED WYE LEVEL
AS MADE FOR U S ENGINEER CORPS

PLATE Nº V.



SECTIONAL VIEW OF CENTRE



MADE BY
F. E. BRANDIS. NEW YORK

greater success than anticipated. In fact it may be called the *Standard Leveling Instrument.* The results obtained, and the perfectly easy manner with which it can be operated, have caused a number of Engineers to have their instruments altered, and the patented *Centre* and *Seat* attached.

The construction of the old level has long since been known to be decidedly deficient in some vital points.

The unanimous complaints of Engineers in this matter were mainly directed against the construction of the centre, which, from its long distance from the level caused a continuous and annoying unsteadiness of the latter. Of course in such instruments, as most American manufacturers are in the habit of making, carrying levels traveling not more than $\frac{1}{10}$ of an inch to a minute of arc, these difficulties were less perceptible, when compared with levels traveling 1 to 1¼ of an inch to a minute of arc. Apparently these instruments gave entire satisfaction on account of holding their adjustments well, but in reality, being the fault of a slow, sluggish level. To prove this, let the Engineer in possession of one of these instruments, exchange his level vial for one of the latter sensitiveness, and he will discover, that it is impossible to use the instrument, or keep the bubble in the centre during a complete revolution.

Again, the common habit of Engineers leaving the parallel plates attached to the tripod in the rush of business, always involved the risk of injury to the vital part of the instrument; (*the centre*,) and tangent screw, these being connected *with* the parallel plates. The old method of attaching the bar to the parallel plates, has been with a cone on the upper part of the centre, which always required considerable force to detach, when once put on firmly which, in most cases deranged the adjustments.

A trifle of sand or dust in the socket or on the cone would, by the slightest touch on either end of the bar require the re-adjustment of the parallel plate screws, which caused great annoyance and loss of time.

Furthermore, there was no sufficient protection of the centre against the entrance of dust, etc. The main defect however, has been the connection of the *centre* to the parallel plates, which, as all instrument makers are aware of, is entirely wrong. Not only is the bearing of the centre deranged by this method in drawing up the screws tight, but the centre itself is biased, and the strain resulting therefrom, prevents the latter from revolving freely, destroying the conical fitting, and making the instrument useless.

In most cases when the instrument sticks, (as the Engineer generally terms it,) it is the fault of the above, and not grit or sand as is usually supposed.

Some makers have tried to overcome the long distance between level and centre by fitting the same directly to the parallel plates, which is more defective than the other, as the instrument cannot be detached without exposing the centre.

All these disadvantages are avoided by this newly constructed level, and will be readily understood by the within engraving, which represents the instrument lifted from out the parallel plates, giving at the same time a sectional view of the centre arrangement.

The manner of attaching the bar is, as will be observed, entirely different from the old method. The phosphor bronze centre is screwed firmly to the bar; and the socket, which is of composition metal, carries a revolving nut, which, by three turns secures the attachment of the bar to the parallel plates, thereby avoiding biasing by the leveling screws; they being perfectly independent of the latter. By attaching the centre to the bar, the distance between level and centre is reduced 3½ inches, which secures much greater steadiness. The clamp and tangent screw, now always turning *with* the telescope, are easily found.

A cap on the lower end of the centre effectually prevents the entrance of dust, and the parallel plates may now be left on the tripod without incurring the slightest risk of injury, (the centre and clamp not being connected *with* it.)

Without exaggeration I can say that these levels are the most accurate, lightest, and effective instruments made, and recommend them to those engaged in precise work for their superiority over all others.

ADJUSTMENT OF THE LEVEL.

No adjustment for the object slide being necessary, (that being made perfect without this defective appurtance) set up the inst ument firmly, and proceed with the adjustment of

COLLIMATION.

Select some vertical object the full height of the wires, (observed in the field of view) sharp and well defined, and after having adjusted the eye-piece for parallax, bisect it by either wire; revolve the telescope half way, and correct half the error by means of the capstan head screws. Bring the telescope back, and again cover the object by means of tangent screw; again revolve the telescope, and correct as before, until the wire will cover the object at both reversions. Now proceed with the other wire at right angles in the same manner, and repeat the adjustment alternately over both wires, until they will bisect the object at each quadrant. Now centre the eye-piece, by revolving the telescope in its wyes until the object retains its position, or does not deviate from its optical centre.

THE LEVEL TUBE.

By this adjustment the level bubble is brought parallel to the line of collimation. Proceed thus: clamp the instrument, so that the bar will be in line with one pair of leveling screws. Bring the bubble in the centre by means of leveling screws, and reverse the telescope end for end. Should it run to either side, it would prove that the vertical plane passing through the centre of the bubble, is not parallel to that of the axis of the telescope.

Again level the instrument, reverse the telescope end for end in its wyes, and correct one-half the error by means of adjusting nuts on the end of bubble tube, and the other half by the leveling screws. Continue this, until the bubble remains in the centre. Correct the lateral adjustment by moving the bubble about 15 or 20 degrees from its perpendicular position each way. Should it not hold its position, it must be drawn over by the two capstan head screws at right angles to the level tube. This adjustment being likely to disturb the first one, both should be repeated alternately until the bubble remains in the centre in its angular as well as perpendicular position.

NOTE.

(The bubble being so arranged as to always keep its vertical position, this lateral adjustment is not absolutely necessary, but, in case of accident to either pins or screw, which are brought in contact to effect this result, this adjustment has been applied.

THE WYE, OR BAR ADJUSTMENT.

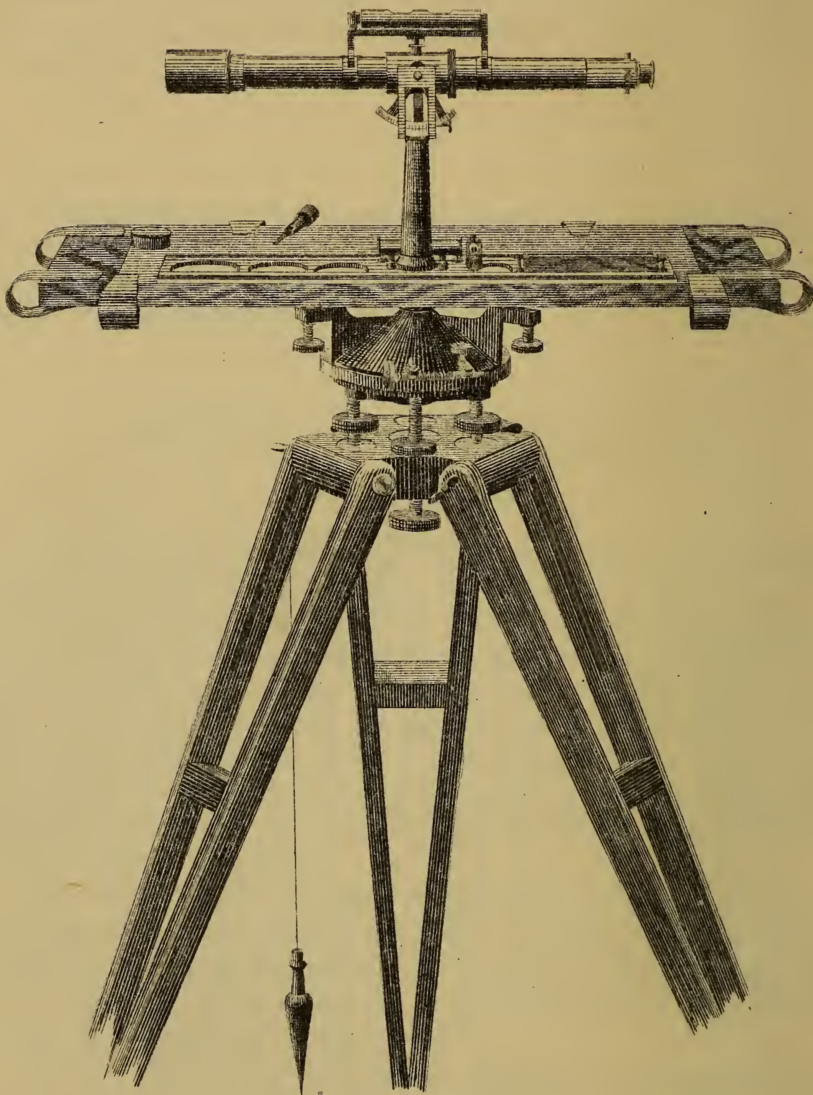
To make the bubble parallel to the line of collimation, and at right angles to its vertical axis, is effected in the following manner.

The previous adjustments being completed, bring the bar directly over one pair of leveling screws, drawing the nut; having only one hole at the end of the wyes up tight. Level carefully, and reverse the instrument, so that the bar will be exactly over the screws as before. The amount the bubble moves to either end is double, and must be corrected by means of the nut on the end of the wye having four adjusting holes. Repeat this adjustment over the other pair of leveling screws until the bubble remains in the centre.

This being only an approximate adjustment, (as, in case the bubble is not brought *exactly* over the screws as before,) a different result would be obtained at each reversion; this adjustment should be repeated alternately over both pair of screws in succession, until the bubble remains central by turning the instrument in any direction.

Now taking care not to disturb the position of the instrument, lift the telescope gently out of the wyes and reverse it end for end. Should the bubble retain its position, the instrument is in perfect adjustment, if not, the collars on the telescope are not the same diameter, which must be corrected by the maker.

PLANE TABLE
U. S. COAST SURVEY PATTERN.
PLATE No. VI



MADE BY
F. E. BRANDIS. NEW YORK.

THE PLANE TABLE.

These instruments have been modified in plan and greatly improved. To show the lower motion to better advantage, only half the board is represented in the engraving. The bearing surfaces being 8 inches diameter, the table is perfectly rigid when clamped; the alidade ruler is 20 inches long, carrying an adjustable column, on which is mounted a powerful telescope of 15 inches focal length by 1½ inches clear aperture.

For the easier adjustment of collimation, the telescope has a conical fitting, which can be turned exactly 180 degrees without taking it from its bearings; a milled head nut screwing against the flange of this fitting holds it firmly in place.

The alidade carries a detachable compass box, and 5 inch magnetic needle., reading 20 degrees each way. It is also well protected against bending by projecting ribs along its edges. Two cylindrical levels are placed at right angles on the ruler, these being more convenient than the circular levels formerly used.

The graduated striding level reads to minutes; the glass diaphragm carries, besides the ordinary cross lines, stadia lines for measuring distances. The vertical arc reads to 30 seconds; the board is perfectly straight, made in 8 panels to prevent warping and is 24 by 30 inches, by 1 inch thick. Same is packed in an extra box.

The revolving plates with conical centre, are securely packed in a strong case. The alidade, 8 paper clamps, plumb bob, adjusting pin and screw driver, are packed in a separate case.

By removing the bolts which connect the tripod legs and lower base, the same can be transported without fear of injury to any of the parts.

ADJUSTMENT.

The rough usage these instruments are often subjected to, makes them liable to have their adjustments disarranged. Occasional examination should be made while at work, and should unaccountable difficulties occur, the adjustments should be scrutinized.

The edge of the ruler should be a perfect straight edge. Place the same upon a true smooth surface, drawing a line along its edge, also marking the ends of the rule. By reversing the same upon these marked points, another line should be drawn; should they coincide, it would prove the ruler to be perfect.

THE LEVELS.

Taking for granted the table to be true, place the alidade in the centre, and level the same by means of the table screws; draw lines along the edges and ends of the ruler, and reverse exactly 180 degrees upon these lines. Should the bubbles remain central, their adjustment is correct, if not, remove one-half the error by means of the table screws, and the other half by capstan head screws on levels. Repeat this, until the bubbles will remain in the centre.

LINE OF COLLIMATION.

For the adjustment of the line of Collimation perpendicular to its axis of rotation, the same method as that in the Engineer's Transit may be applied, with the exception, that the telescope axis must be reversed in its bearings; the base of column is provided with adjusting screws for that purpose.

To adjust the line of collimation, it is only necessary to unscrew the milled nut on axis nearest the eye-end of telescope, bisect some well defined object, and turn the telescope 180 degrees to the right; should the wires bisect the object, the adjustment is complete, if not, correct one-half the error by means of cross wire screws, and repeat this, until the wire will bisect the object at both reversions.

The telescope being provided with a longitudinal striding level, will give the error of vertical arc at once, which can be rectified by the two screws holding the vernier.

Great care having been taken in constructing these instruments, and making the adjustments as firm and few as possible, it is unnecessary to enumerate more than the above: the others being attended to by the maker.

CARE OF INSTRUMENTS.

It is important that the Engineer should understand how to keep his instruments in good order, without aid of the instrument maker.. The following brief guide will save expense and unnecessary vexation in the field.

Be careful to have the vertical axis revolve freely one upon the other. As soon as any fretting is discovered, they should be taken apart and thoroughly cleaned by unscrewing the lower cap from which the plumb bob is suspended; taking care to keep the side of the spring, which takes the dead weight from the instrument, (and is indicated by a circular bright spot) *up* when replaced. Next unscrew the nut; remove the upper clamp screw, and the plates can be lifted from one another. Clean the sockets and centre, and examine them carefully; if any roughness appears in the socket or on the centre, scrape the part with a penknife; wipe with utmost care and replace it *without* oil. Should they revolve freely when dry, replace them with oil sparingly, taking care to distribute it equally by lifting the upper plate occasionally and reversing before replacing the nut. The graduation should be cleaned with a fine camel hair brush, as rubbing with cloth would soon destroy their sharp edges. Keep the object glass glass clean with a soft piece of chamoise leather or rag, and if greasy or very dirty, wash them with spirits of wine. Care should be taken not to wipe the object glass too frequently, as the fine polish will be destroyed It is seldom necessary to clean the inner surfaces of the glasses, and the object glass should not be unscrewed unnecessarily as it is likely to disturb the of line collimation. By unscrewing the cap at the eye-end, the lens may be cleaned in the same manner. The transverse axis when taken from its bearings, should be replaced with a little marrow, (rendered.) and the screws of bearings brought down sufficiently tight to admit its revolving freely.

In case of fretting in telescope slide, the same should be taken out at once; the rough place scraped and burnished, also the inside of tube. Work in and out several times with a little oil, which should be well removed before replacing it. The tangent screws when taken apart, should be replaced according to marks found, and caps bear sufficiently tight to prevent lost motion. The compass needle should be lowered upon its pivot gently, and not allowed to swing until the instrument is leveled. When stored for any length of time, allow the needle to take its own bearing, as lying in meridian, it will retain its magnetic power much longer.

The cross hair adjustment should be made with the greatest of care, so as not to overstrain the screws, as an instrument will never retain its proper adjustment if drawn up tighter than a firm bearing. To keep the instrument steady, see that the screws holding the tripod legs are tight, also the steel shoes, as any shake in either of these will cause the instrument to be unsteady.

Do not take the instrument apart oftener than absolutely necessary, remembering that perfect fittings require care and experience, to put them properly together, and if the greatest precaution is not exercised, may cause defective results in the proper working of an instrument.

REPAIR OF INSTRUMENTS.

Injuries to instruments by accident, are sometimes of a more serious nature than anticipated. Although certain points of injury not apparent to the Engineer may appear trifling, none but those familiar with repairs can realize the amount of time consumed to correct seemingly trivial faults, which however; to put the instrument in good working order, must be corrected. When considered that serious injury to the centres alone, involves the tedious re-centering of graduations, compass needle and pivot, examination of all following adjustments and correction if necessary; the Engineer will have a fair idea of the amount of time consumed.

In all cases when dealing with a reputable firm, it is best to order them to make such warrantable repairs, as will put the same in thorough working order, which, although more expensive, is sure to give better satisfaction and prove more profitable in the end.

The transit being more complicated than the level, is more costly to repair. Bending of the plates can in most cases be remedied, unless the graduated edges are badly injured. The cost of repairs for injuries to plates or centres and tangent screws may vary from $15.00 to $40.00.

Re-graduating and figuring costs $15.00. The cost of re-adjustment of needle and magnetising same is $3.00. A new cap, needle and pivot is $5.00. New compass glass, best French crystal $1.00. Small level vials $1.50 and telescope level vial $3.00.

Repairs of Levels vary from $5.00 to $15.00. Should a new centre be required or the telescope seriously injured, the cost may reach $25.00 or even $35.00. New level vials accurately ground and of any desired sensitiveness $5.00.

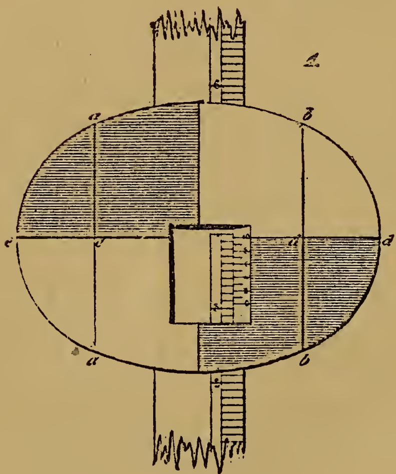
This will give the Engineer an approximate idea of cost of repairs. In all cases when instruments are ordered to be put in first-class condition, it will be done conscientiously; at prices according to time consumed and consistant with first-class workmanship.

In sending instruments for repairs, they should be packed with utmost care, as they are often much injured by careless packing. The name of sender and item of repairs required should be placed in the box.

GIESELER'S
PATENT AMERICAN LEVELING TARGET.

Patented, February 22, 1876.

1.



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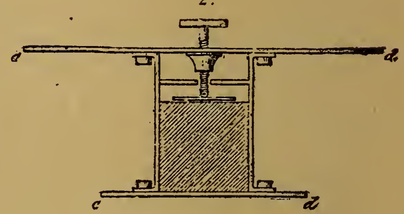

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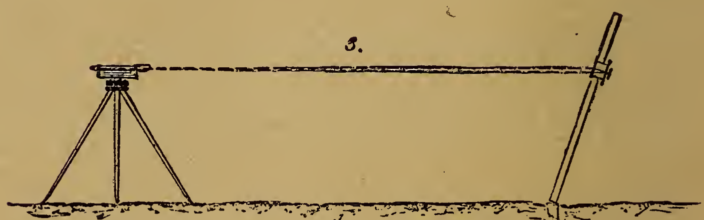


To obtain correct results when leveling, it is essential that the rod should be held perfectly perpendicular.

The observer is able by means of his vertical cross wire to perceive any sideway deviation of the rod from perpendicularity, but he is not able to discern whether the top of the rod is inclined either to the instrument, or in the opposite direction.

This difficulty, which no doubt, is the origin of a great part of the mistakes made in leveling, is entirely removed by the use of the *Patent American Leveling Target.*

The principle of this target is extremely simple, and may be best explained it the following way.

Suppose a target of the old kind, which, in its front view looks exactly like the front view of the new target in Fig. 1, to be cut along the two vertical lines *a a* and *b b*, thus dividing it into three parts,—one centre-piece and two wings.—Suppose furthermore, the centre-piece to remain in its old place at the front of the rod, while the two wings are removed to the rear of the rod, then the consequence evidently will be, that the horizontal line *c c d d* will appear as one unbroken line to the observer only, when the rod is held perfectly perpendicular. Any deviation from perpendicularity in the direction of the instrument or away from it, will cause the two parts *c c* and *d d* of the horizontal line situated at the rear of the rod in the wings of the target, either to show above or below that part *c d* of the horizontal line, which is situated at the front of the rod in the centre-piece of the target.

Fig. 1 giving the front view, and Fig. 2 the top view of the target in ¼ natural size will, in addition to the above description clearly demonstrate the whole.

Fig. 3 shows the working of the apparatus when the rod is held inclined.

In City surveying the leveling rod is frequently used to determine the horizontal distance of the line of houses from the line of sight. It is hardly necessary to say that this new target is quite as useful in this case as it is for leveling.

This target is also fitted with a diopter, the eye-hole of which is situated in the horizontal line of the rear plate, while the sighting point is in the same line on the front plate.

This diopter serves a double purpose. In the first place the rodman by sighting the telescope of the instrument through it, has enabled himself to find the vertical position of the rod, without at the same time losing sight of the observer of the instrument.

In the second place its use will be found convenient whenever the rod is too close to the instrument for the use of the telescope. In these cases it is only necessary to sight the telescope through the diopter, while the rod is held in a vertical position. The position of the target thus obtained will give the correct reading.

The use of the diopter for leveling purposes is of course limited to readings below the height of the rodman, while in determining horizontal distances by means of the leveling rod, it is avaiable for the full length of the rod.

PRICE LIST OF ENGINEERS' AND SURVEYORS' INSTRUMENTS.

No. **1** *Combined Transit and Leveling Instrument*, (Plate 2.) Horizontal plates 7 inches; graduated on silver plate into 20 or 30 minute spaces (as may be desired,) reading by double opposite verniers to 30 seconds or 1 minute. Figured in double rows, one in quadrants from 0 to 90 degrees each way, and the other from 0 to 360 degrees for angular repetition. Reflectors over verniers to facilitate reading of graduations without straining the eye. Compass graduated into ½ degrees, figured in quadrants from 0 to 90 degrees each way, with sensitive needle 5 inches long. Telescope reversing at both object and eye ends, 11½ inches long; glasses perfectly achromatic; of excellent definition, and magnifying 25 diameters. One end of axis adjustable. Compound centres, (extra long,) of phosphor bronze. Clamp and tangent attachment to telescope, with long sensitive level. Vertical circle or sector (as may be desired,) 5 inches diameter reading to one minute. Single tangent motion to lower base, giving the Engineer freedom of using one hand for telescope. Shifting centres, to set the instrument precisely over desired point after approximately setting the tripod legs. Improved double cup and ball tangent screw, to prevent lost motion.

Same packed in fine Mahogany case with strap for carrying, and rubber packings screwed to bottom of case to prevent jarring; containing plumb bob, adjusting pins, sunshade and reading glass.

Price—$250.00

No. **2** Same as above, but without vertical circle, (Plate 1.)

Price—$225.00

No. **3** Plain Transit similar to (Plate 1,) but without clamp and tangent attachment..Price—$200.00

EXTRAS TO COMPLETE, OR PLAIN TRANSIT.

Vertical Arc 7½ inches radius, reading to 1 minute........	Price—	$15.00
Gradienter attachment..................................	"	8.00
Adjustable stadia wires.................................	"	12.00
Fixed stadia wires to cover 1 foot of rod in 100 feet distance	"	5.00

Rain and dust protector for object slide................	Price—	$5.00
Rack and pinion for focusing cross wires................	"	5.00
Extension tripod legs..	"	10.00
Improved sights for offsetting right angles..............	"	5.00
Graduation on solid silver...................................	"	10.00
" " Platinum..	"	30.00

SMALL ENGINEERS' TRANSIT.

No. **4,** It is sometimes desierable to use lighter instruments for Mountain or Mining purposes, which will give as accurate results as instruments of larger dimensions. The construction of this instrument is the same as that of the regular Engineers' Transit. The axis can be made to reverse in its bearings if so desired; in all respects the same care is bestowed upon this instrument as the most costly ones, and is of following dimensions.

Graduated circle 5¼ inches diameter, reading to either 30 seconds or 1 minute. Compass needle 4¼ inches long. Telescope (erect or inverting) 10 inches long, clear aperture 1⅜ inches, magnifying power 22 diameters. Weight 8½ lbs...................................Price $190.00

EXTRAS TO ABOVE.

Accurately ground level, with clamp and tangent attachment to telescope Price—$25.00

Extra detachable side telescope, with vertical circle 5 inches diameter and counterpoise..................................	"	35.00
Adjustable stadia wires......................................	"	12.00
Fixed " "	"	5.00
Rack and pinion for eye-piece..............................	"	5.00
Diagonal eye-piece...	"	12.00
Graduation on solid silver..................................	"	10.00
" " Platinum..	"	28.00

SMALL MINING. RECONNOISSANCE AND MOUNTAIN TRANSIT.

No. **5,** These are exceedingly portable and accurate instruments, they are a fac-simile of (Plate 3,) with the exception of vertical circle, or sector, not shown in the engraving.

The horizontal circle is 4 inches diameter, graduated on solid silver; reading by double opposite verniers to 1 minute, placed either at an angle of 35 degrees or directly under the telescope, permitting them to be read without change of position.

The compass needle is 2¼ inches long. Figures run from 0 to 360 degrees. Centres are compound, 3½ inches long, and of Phosphor Bronze. The telescope is 8½ inches long, with clear aperture of $1\frac{1}{16}$ inches, magnifying power 20 diameters.

The Instrument complete weighs 4¼ lbs., tripod weight 3 lbs. Packed in fine mahogany case, with strap and all accessories.

Price—$175.00

EXTRAS TO ABOVE.

Vertical Circle 4½ inches, reading to 1 minute	Price—	$15.00
Arc or Sector, 6 inches radius	"	12.00
Extra detachable side telescope, with vertical circle 4½ inches, and counterpoise	"	25.00
Diagonal eye-piece	"	10.00
Leather cover for case, with strap	"	5.00
Level, clamp and tangent attachment	"	17.00
Adjustable stadia wires	"	10.00
Graduations on Platinum (both circles.)	"	20.00

MINING TRANSITS.

No. **6,** These instruments have Bell Metal plates, 7 inches diameter, and are graduated into 20 minute spaces, reading by opposite verniers to 20 seconds.

The vernier openings are very wide and placed at an angle of 35 degrees or directly under telescope. The Engineer often being limited as to space in mine work, he will find this method of great convenience, as he is enabled to read the vernier without danger of disturbing the tripod legs in stepping aside of the instrument, besides getting a better light.

In the telescopes of these instruments, it is advisable to have the rack and pinion motion near the eye-end, and the eye-piece inverting; (Plate 3,) the former being more convenient to handle, and the latter giving a more brilliant light. The axis is perforated, and has a small reflector in the centre for illuminating cross wires The smaller instruments have a reflector for that purpose attached to the object head.

An extra side telescope is frequently attached, permitting vertical sighting up or down the shaft, also improved adjustable lamp holder, which can be brought to any height or position, for either reading the verniers or illuminating the cross wires; attached to a convenient place at the base of the instrument.

EXTRAS TO ABOVE.

Extra detachable side telescope with 5½ inch vertical circle and counterpoise	Price—	$60.00
Adjustable lamp holder as described	"	15.00
Reflecting shade for illuminating cross wires	"	8.00
Small bulls-eye lamp, arranged so as to throw light downward on graduations by means of a prism	"	15.00
Detachable prism to eye-piece	"	6.00
Diagonal eye-piece	"	12.00
Offsetting sights, at right angles to telescope	"	5.00
Adjustable stadia wires	"	12.00
Plummet lamp (copper.)	"	10.00
Extra extension leg tripod	"	18.00
Graduations on platinum	"	35.00

TRANSIT WITH REVERSIBLE AXIS.

No. **7**, This engraving, (Plate 3,) represents an instrument specially adapted for extensive triangulations and extremely fine work. It is mounted (as may be desired) on either 3, or 4 leveling screws. The bell metal plates have a solid silver ring $\frac{5}{16}$ of an inch wide, (not jointed,) graduated into 10 or 20 minute spaces, reading by opposite verniers under telescope to either 10 or 20 seconds.

The axis being reversible in its bearings, the best results may be obtained for aligning straight lines. With pivots of exactly the same diameter, these telescopes in vertical plane, give the most accurate results.

The compass, carrying a very sensitive needle 4¾ inches long, is flush with the upper plates. Axis bearings are agate, and so arranged, that by screwing down the covers, sufficient friction will be obtained to hold the telescope in any desired position. The shape of standards admit a right angle telescope to be applied of sufficient elevation and depression. The telescope has a focal lenght of 10 inches by 1¼ inches clear aperture, with Steinheil eye-piece, giving a magnifying power of 30 diameters.

Price—$240.00

EXTRAS TO ABOVE.

Detachable level to telescope (with tangent screw and check nut same as in Plate 4,) .... Price—$25.00

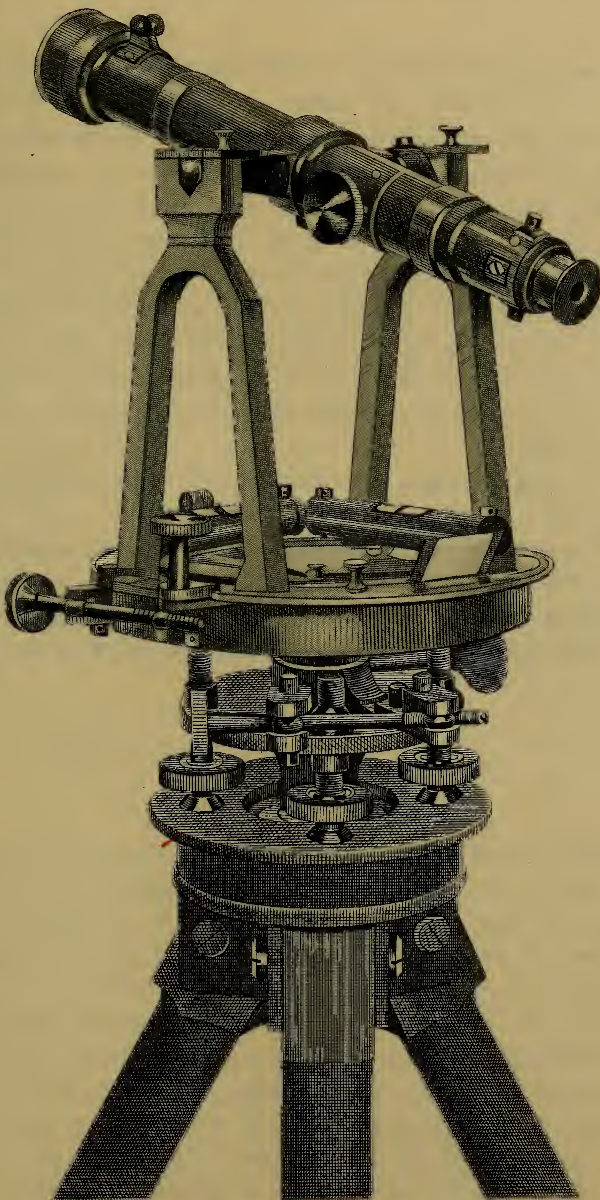
Plain vertical circle 5 inches diameter graduated on solid silver, reading to 1 minute .... " 25.00

Striding level over transverse axis; repeating vertical circle, 6 inches diameter with level alidade, reading by double verniers to 30 seconds........................... " 50.00

Right angle telescope, 11½ inches long, by 1 inch clear aperture .... " 50.00

No. **8**, Same as (Plate 3,) with horizontal circle, 6 inches diameter, reading by opposite verniers to 20 seconds.............. Price—$230.00 Extras ranging in price same as above.

TRANSIT WITH REVERSABLE AXIS
AS MADE FOR U.S. ENGINEER CORPS.
PLATE Nº III



MADE BY
F. E. BRANDIS. NEW YORK.

IMPROVED CITY TRANSIT.

No. **9,** (Plate 4,) Horizontal circle, 7 inches diameter, graduated on solid silver into 20 minute spaces, reading by opposite verniers to 20 seconds. Compass needle 4½ inches long. Extra long compound centres of phosphor bronze. Telescope 15 inches long, clear aperture 1¼ inches, magnifying power, 28 diameters. Long sensitive ground level under telescope, with tangent screw and check nut attached to object end of telescope. The axis is free from clamps, and can be reversed in its bearings by simply withdrawing the pins from tangent piece and clips. Right angle telescope 11½ inches long, clear aperture 1 inch, magnifying power, 25 diameters. The standards being only 4 inches high, gives the instrument great steadiness. Telescope packed in such a manner so as not to rest in its bearings.....................................Price—$350.00,

No. **10,** Same as above, but without right angle telescope.

Price—$300.00

No. **11,** Same as No. 10, but without right angle telescope, level and tangent attachment.................................Price—$275.00

The above instruments, on account of their superior accuracy, are almost indispensable to the city Engineer engaged in precise work.

TRANSIT THEODOLITES.

No. **12,** Horizontal circle 8 inches diameter; graduated on solid silver into 10 minute spaces, reading by opposite verniers to 10 seconds. Telescope has a focal length of 18 inches by 1½ inches clear aperture. Striding level over transverse axis, reading to 5 seconds..........Price—$360.00

No. **13,** Same as above with vertical circle, 7 inches diameter, graduated on silver, and reading to 20 seconds................Price—$425.00

No. **14,** The base and standards are the same as those in (Plate 9,) Horizontal circle 9 inches diameter, graduated on silver into 10 minute spaces, reading by opposite verniers to 10 seconds. Telescope has a focal length of 18 inches by 1½ inches clear aperture. 2 Steinheil-eye pieces of 40 and 50 magnifying powers. Attached reading glasses and all accessories.

Price—$400.00

No. **15,** Same as No. 14, but with repeating vertical circle, 6 inches diameter and level alidade, reading by opposite verniers to 30 seconds.
Price—$475.00

No. **16,** With base and standards same as (Plate 9.) Horizontal circle 10 inches diameter, graduated on silver into 10 minute spaces, reading by 3 verniers to 10 seconds. Telescope has a focal length of 18 inches by 1½ inches clear aperture. 2 Steinheil eye-pieces of 40 and 50 magnifying powers, also fixed stadia wires...... ....Price—$525.00

No. **17,** Same as No. 16, but with repeating vertical circle 7 inches diameter and level alidade, reading by opposite verniers to 20 seconds.
Price—$650.00

No. **18,** With base and standards same as (Plate 9.) Horizontal circle 12 inches diameter, graduated on silver into 5 minute spaces, reading by 4 verniers to 5 seconds. Telescope has a focal length of 20 inches, by 1¾ inches clear aperture; 2 Steinheil and 1 diagonal eye-piece.
Price—$725.00

No. **19,** Same as No. 18, but with repeating vertical circle 8 inches diameter and level alidade, reading by opposite verniers to 10 seconds.
Price—$875.00

NOTE.

All the foregoing instruments are supplied with delicate striding level over transverse axis, attached reading glasses over verniers, and all necessary accessories.

ENGINEERS' LEVELING INSTRUMENTS.

No. **20,** Improved Wye Leveling Instrument, (Plate 5.) with patented "centre and seat" attachment as described, Improved tangent screw, moving *with* bar. Arrangement for keeping the wires perfectly horizontal. Telescope 17 or 18 inches long by 1⅜ inches clear aperture. Object erect; magnifying power 40 diameters. Telescope collars of exactly same diameter. Sensitive level, reading 10 seconds on graduated scale. Extra long phosphor bronze centres. Warranted to retain its adjustment, and perform the most accurate work. Packed in fine mahogany case with strap, containing sun shade and adjusting pins...........Price—$140.00

SMALLER LEVELS.

No. **21,** This refers to an instrument similar to the regular Engineers' Wye level, excepting in size and weight. The telescope is 11½ inches long by 1⅛ inches clear aperture, magnifying power 25 diameters. The centres are long, and can be detached from the parallel plates, same as the larger ones. Accurately ground and sensitive level reading on scale to 15 seconds.

The weight of instrument complete is 4 pounds. weight of tripod 2½ pounds. Packed in fine mahogany case with strap for carrying on shoulder.

Price—$125.00

Extra leather case.............. .. .. " 8.00

LEVEL OF PRECISION.

No. **22,** These instruments are so constructed, so as to insure the most perfect results obtainable. The base has 3, instead of 4 leveling screws, carrying an extra long centre of steel; sockets are phosphor bronze. The horizontal circle is 6 inches diameter graduated on silver, and reading by opposite verniers to 30 seconds.

The phosphor bronze telescope collars, rest on agate bearings. The telescope is inverting, and has a focal length of 18 inches, by 1½ inches clear aperture, 2 Steinheil eye-pieces, magnifying powers 40 and 50 diameters respectively. The level is chambered and reads to 3 seconds. The bearing nearest the eye-end has a Gradienter screw (100 threads to the inch, attached. Micrometer drum is graduated into 100 equal parts. Clamp and double cup tangent movement. Packed complete in case with all accessories..... .. ..Price—$260.00

No. **23,** Same with telescope 12 inches focal length, graduated circle 5 inches diameter, otherwise same as above.............Price—$200.00

GRADIENTER.

No. **24,** This instrument is designed for measuring angles of elevation and depression as well as for taking distances. The compass needle is 5 inches long, reading about 20 degrees each way. Very sensitive striding level over compass box. Horizontal circle 4 inches diameter, vertical arc 5 inch radius, both graduated on silver, and reading to minutes. The telescope is inverting, and has a focal length of 10 inches, by 1¼ inches clear aperture. Extra stadia wires. Packed complete in mahogany case with accessories.......................................Price—$225.00

PLANE TABLES.

No. **25,** Similar to description (Plate 6,) alidade ruler adjustable, 20 inches long, carrying a powerful telescope of 15 inches focal length. Table in panels, 24 by 30 inches. Detachable compass box with 5 inch needle, reading 20 degrees each way. Vertical arc graduated on silver, reading to 30 seconds. All latest improvements. Packed securely in separate cases, containing plumb bob, reading glass, adjusting pins, screw driver and 8 brass clamps. Table packed in extra box.............Price—$275.00

No. **26,** Similar to (Plate 6,) with flat centres...... " 255.00

BURT'S SOLAR COMPASS.

No. **27,** This instrument is designed for determining the true meridian. It is mostly used in running lines on Government Land Surveys. The subdivisions are made by regular angular measurements. As solar work can only be performed in clear weather, this instrument is supplied with a compass needle 5 inches long, and 7 inch graduated circle, reading by opposite verniers to 30 seconds. Latitude and declinations arc's read to minutes. All graduations are on silver.................Price—$280.00

No. **28,** Same with detachable telescope and sights.. " 315.00

No. **29,** Large size solar; plates 8 inches diameter, latitude and declination arc's 7 inches radius.......................Price—$330.00

PATENTED AMERICAN LEVELING TARGET.

No. **30,** Fitted to any New York rod	Price—	$5.50
No. **31,** Lower clamp for rod	"	2.50

SPIRIT LEVELS.

No. **32,** Levels from 2 to 2½ inches long accuately ground; suitable

for transit plates	Price—	$1.25
Same from 2½ to 4 inches long for transit telescope	"	3.00
Same from 4 to 7½ inches long for leveling instruments	"	6.00
Chambered levels reading to 5 seconds	"	12.00
" " " " 3 "	"	15.00
" " " " 2 "	"	25.00
" " " " 1 "	"	40.00

THE STATION POINTER.

No. **33,** This instrument, which is composed of one fixed and two moveable arms, and a graduated circle, is designed for the mechanical solution of the "three point problem," or determination of the distance and true bearing of a point from three other points, whose bearing and distance from each other are known by triangulation, and saves much of the time necessary for the graphical or analytical solution of this problem.

The use of the problem is more frequent in marine, than in land surveying. It is chiefly employed for determining the position of a boat from which soundings are being taken, in a river or along a coast. As the boat moves from point to point to take fresh soundings, it becomes necessary to take new observations at each point, in order to define its position on the chart.

An observation consists in the measurement by a sextant of the two angles subtended by three signals on shore, whose position has been previously determined.

To plot the position on the map, the Station Pointer is employed. The moveable arms are set to the two angles; the edge of the middle or fixed arm is placed on the central object, and the instrument moved until the edges of the moveable arms bisect the points on the chart or plan representing the other two positions. The centre will represent the position of the observer, and may be pricked through on the chart.

No. **34,** Plain as above, with 5 inch circle, graduated on silver, verniers reading to 1 minute, arms 20 inches long.........Price—$65.00

No. **35,** Same, but with 6 inch circle, tangent screw to arms, verniers reading to 30 seconds, extension arms 15 inches long......Price—$105.00

No. **36,** Same, with 7 inch circle, reading to 20 seconds " —$115.00

CROZET'S PROTRACTOR.

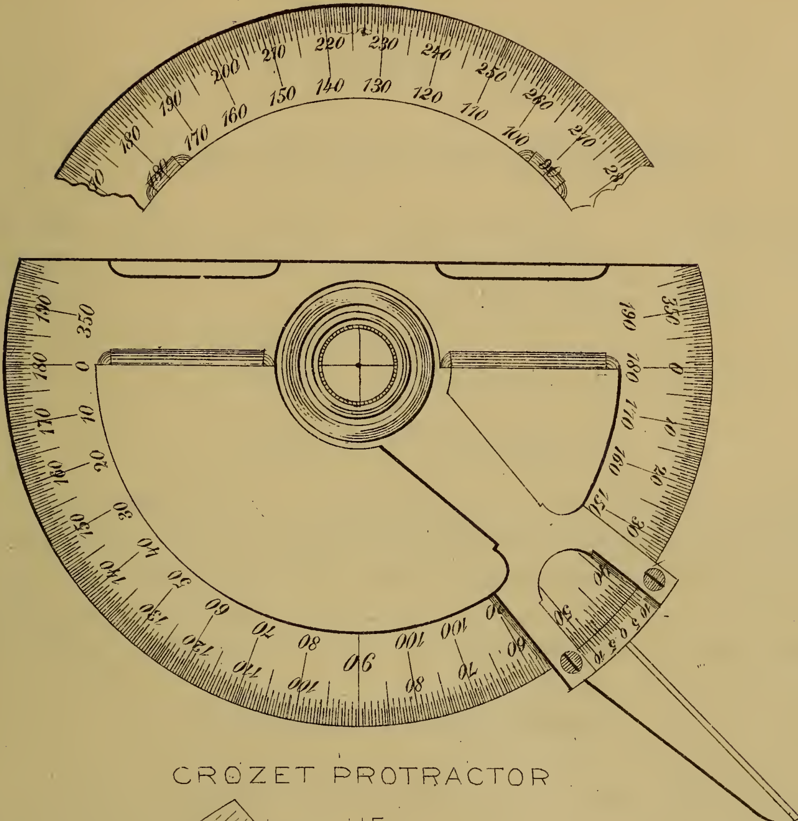
No. **37,** This protractor (Fig. 15,) was designed by Col. Crozet, U. S. Engineer Corps. It is 8 inches diameter, graduated to read to either 30 seconds or 1 minute. To keep the metal from coming in contact with the paper, small ivory pins are placed on the bottom of frame, leaving only the adjustable feather edge bearing upon the paper. The whole is made of German Silver, packed in fine morocco case......Price--$45.00

CIRCULAR PROTRACTORS.

No. **38,** These protractors, as shown in (Fig.14,) are of the best 18% German Silver, and can be recommended for their superiority over Swiss protractors, which have of late years been graduated very irregular and coarse.

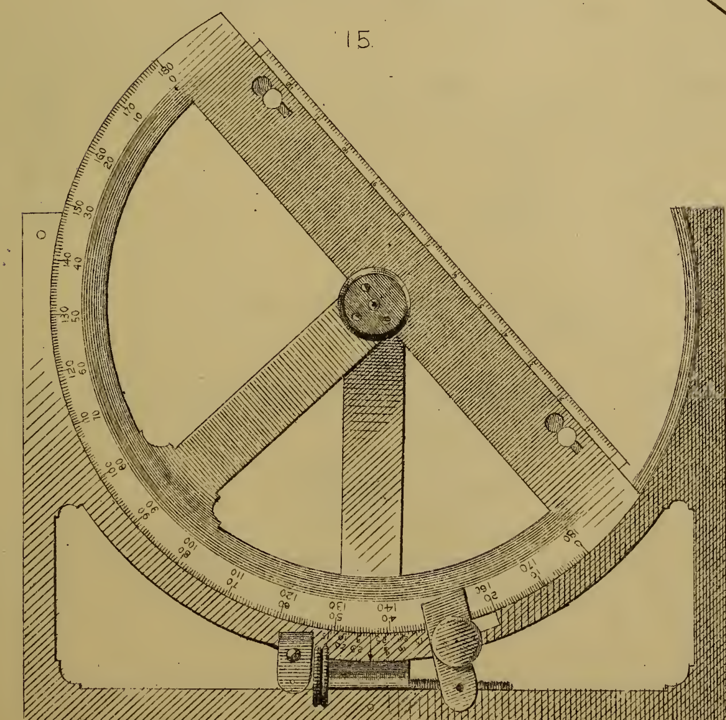
No. **39,** Circular protractor, 6 inches diameter, with horn centre; reading 1 minute..Price—$15.00
No. **40,** Same, 8 inches diameter, reading 1 minute....... " 18.50
No. **41,** " 10 " " " 1 " .... " 22.50
No. **42,** Semi circle protractor, 6 inches diameter, with horn centre; reading 1 minute.......................... " 13.00
No. **43,** Same, 8 inches diameter, reading 1 minute...... " 16.00
No. **44,** " 10 " " " 1 " ...... " 22.00
No. **45,** " 8 " " with 15 inch arm attached, reading glass, clamp and tangent screw to arm, reading to 30 seconds.. " 45.00
No. **46,** Same, with arm 20 inches long............. ... " 50.00
No. **47,** " 10 inches diameter, arm 30 inches long...... " 65.00

No. 14 CIRCULAR PROTRACTOR



CROZET PROTRACTOR

15.



MADE BY

F. E. BRANDIS. NEW YORK

PRISMATIC AZIMUTH COMPASSES.

No. **48,** Compass of brass 3 inches diameter........Price—$25.00
No. **49,** " " German silver 4 inches diameter.......... 30.00
No. **50,** " " " " one side used for vertical,
the other for horizontal angles........................... 75.00
Extra leather case with strap for above.................. 3.00

MINER'S COMPASS.

No. **51,** This consists of a dipping needle 3 inches long, which inclines to any mass of iron, thus discovering its position. In using it for tracing ore, the observer holds the ring in his hand, keeping the needle north and south, and facing west.
By holding it horizontal, it serves as an ordinary compass Price—$12.00

ANEROID BAROMETERS.

All these aneroids are of the best manufactured, and thoroughly tested before sending.

No. **52,**	Aneroid	2½	inches, silver case	............, Price—	$55.00
No. **53,**	"	3	" graduated	6,000 feet...........	35.00
No. **54,**	"	3	" "	20,000 "	45.00
No. **55,**	"	5	" "	6,000 "	35.00
No. **56,**	"	5	" "	20.000 "	50.00

LOCKE'S HAND LEVELS.

No. **57,** Locke's hand level, made of German silver ......Price—$12.00
No. **58,** " " " " " Brass 10.00

PLUMB BOBS.

No. **59,** Brass plumb bob, 10 oz., steel point.............Price—$1.75
No. **60,** " " " 15 " tempered point................ 2.00
No. **61,** " " " 24 " " " 4.00

LEVELING RODS AND RANGING POLES.

No. **62,** Boston Rod (Fig. 16,) Mahogany..............Price—$18.00
No. **63,** Philadelphia Rod (Fig. 17,) Mahogany................ 18.00
No. **64,** New York Rod (Fig. 18,) Satin wood................ 15,00
No. **65,** With Patented American Target..................... 16.00
No. **66,** Ranging poles (Fig. 19,) 6 feet long....... .... 2.50
No. **67,** " " " 8 " " 2.75
No. **68,** " " " 10 " " 3.00
No. **69,** Ranging poles (Fig. 19,) 6 feet long 2.75
No. **70,** " " " 8 " " 3.00
No· **71,** " " " 10 " " 3.25

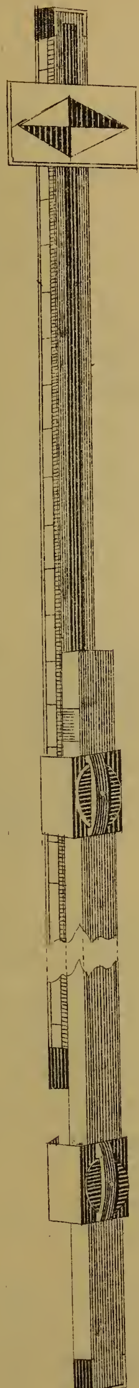
ENGINEERS' AND SURVEYORS' CHAINS.

No. **72,** Engineer's chain 50 feet, 50 links, No. 7 wire....Price—$3.75
No. **73,** " " 100 " 100 " " 7 " .... " 5.00
No. **74,** " " 50 " 50 " " 12 best steel wire, brazed links and rings......................... " 6.00
No. **75,** Engineer's chain 100 feet, 100 links No. 12, best steel wire, brazed links and rings.................. " 11.00
No. **76,** Surveyor's Chain, 2 poles, 50 links, No. 9 wire, oval rings 2.00
No. **77,** " " 2 " 40 " " 8 " " " 2.80
No. **78,** " " 2 " 50 " " 7 " " " 2.80
No. **79,** " " 4 " 100 " " 9 " " " 3.50
No. **80,** " " 4 " 100 " " 8 " " " 4.50
No. **81,** " " 4 " 100 " " 7 " " " 5.50
No. **82,** " " 2 " 50 " " 12 best steel wire, brazed links and rings....... .... 7.00
No. **83,** Surveyor's Chain, 4 poles, 100 links No. 12 best steel wire, brazed links and rings................................ 12.00

Spanish and Mexican Vara Chains made to order.

No. **84,** Marking pins, 11 in set, steel wire, 8 inches............ .75
No. **85,** " " 11 " " " 10 " 1.00
No. **86,** " " 11 " " " 12 " 1.25
No. **87,** " " 11 " " " 15 " 1.50

LEVELING RODS AND RANGING POLES



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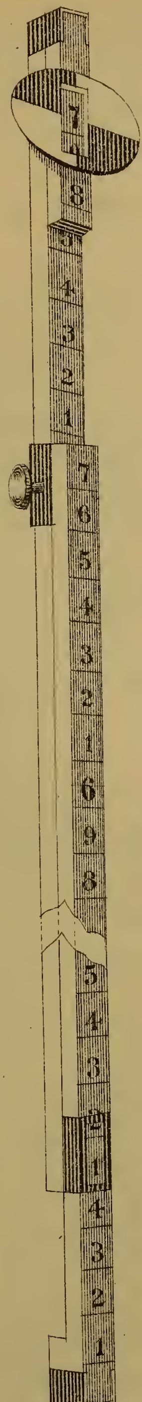

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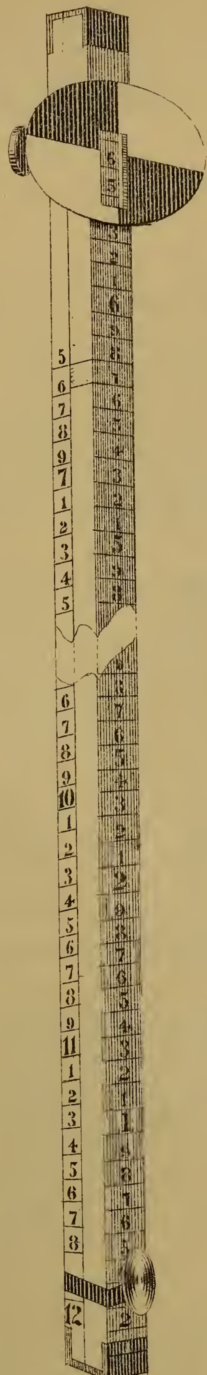

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19

20

F. E. BRANDIS. NEW YORK

STANDARD STEEL TAPE MEASURES.

These tapes are made of the best tempered steel wire, from 100 to 1,000 feet long as may be desired, and are compared with precise U. S. Standard, at office of weights and measures, Washington. The temperature at which they were compared, is stamped upon them.

The steel ribbon of which they are made, is $\frac{1}{32}$ of an inch thick, by $\frac{3}{32}$ of an inch wide. A tape 300 feet long has the first 100 feet graduated at every 50 feet. The second 100 feet at every 25 feet, the next 90 feet at every 10 feet, the next 9 feet at every foot, and the last foot into 10ths.

STEEL TAPES, PRECISE U. S. STANDARD.

No. **88,** First 100 feet, graduated at every 50 feet.......	Price—	$5.00
" " Second 100 " " " " 25 ".......	"	5.80
" " Third 100 " " " " 10 ".......	"	7.00
Reel and handle for above..............................	"	5.00
Brass handles to unship, each..........................	"	1.20
Each additional graduation and figuring,................	"	.20

EXTRAS.

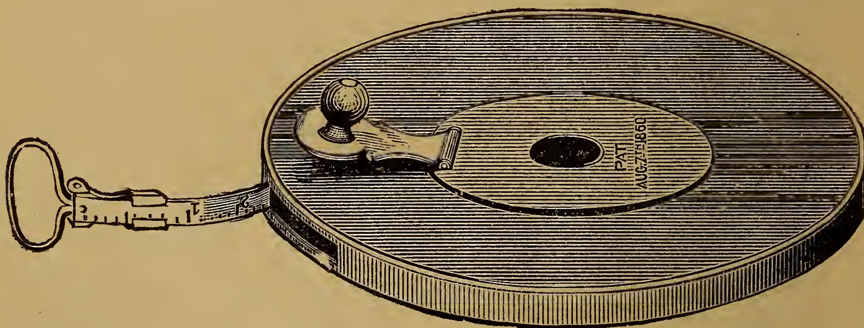
No. **89,** Compensating handle for difference of temperature.	Price—	$5.00
Plain spring balance..............................	"	2.00
No. **90,** Steel ribbon tape as above, 50 feet long, with spring balance, thermometer, 2 handles and folding reel, mostly used for measuring valuable grounds in larger cities..	"	16.00
No. **91,** Grumman Patent Chain, 50 feet, spring balance and thermometer, weight 12 oz......................	"	17.00

PAINE'S PATENT STEEL TAPE MEASURES.

These, and all following steel tape measures are always compared with precise U. S. Standard, and a note of comparison and state of thermometer at the time of testing accompanies every tape. Engineer's may test their tapes at my shop free of charge.

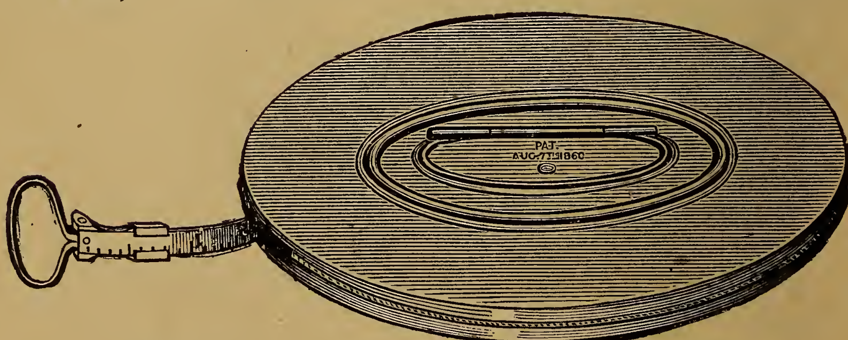
Steel tape in tin cases (Japanned.)........................

No. **92,**	Steel Tapes,	25	feet	long	10ths or	12ths	$ 3.50
No. **93,**	" "	33	"	"	"	"	4.50
No. **94,**	" "	50	"	"	"	"	6.00
No. **95,**	" "	66	"	"	"	"	8.00
No. **96,**	" "	75	"	"	"	"	10.00
No. **97,**	" "	100	"	"	"	"	12.00



Same as above but in leather cases, flush handle.

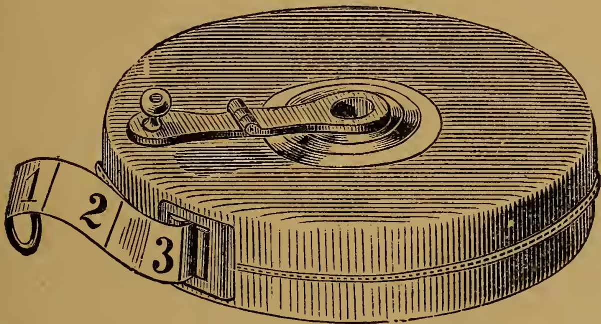
No. **98,**	Steel Tape,	33	feet	long	10ths or	12ths	$ 5.50
No. **99,**	" "	50	"	"	"	"	8.00
No. **100,**	" "	66	"	"	"	"	10.00
No. **101,**	" "	75	"	"	"	"	12.00
No. **102,**	" "	100	"	"	"	"	15.00



EXTRAS TO PAINE'S PATENT STEEL TAPES.

No. **103,** Compensating handles with graduated scale....pr. pair	$3.50
Pocket thermometer	1.50
Spring balance and level	4.00
Extra graduations on reverse side of tape to centimeters...pr. foot	.10

METALLIC TAPE MEASURES.



Extra fine Corded Linen, Bent Leather Case, (red Japanned)

No. **104**,	Metallic tape line, 25 feet long 10ths or 12ths	$2.50
No. **105**,	" " " 33 " " " "	3.25
No. **106**,	" " " 66 " " " "	3.70
No. **107**,	" " " 75 " " " "	4.00
No. **108**,	" " " 100 " " " "	5.00

CHESTERMAN'S STEEL TAPE MEASURES.

In strong bent Leather Cases, flush handle, warranted correct measure,

No. **109**,	Steel Tape, 33 feet long 10ths or 12ths	$6.00
No. **110**,	" " 50 " " " "	7.50
No. **111**,	" " 66 " " " "	9.00
No. **112**,	" " 75 " " " "	10.00
No. **113**,	" " 100 " " " "	12.00

CHESTERMAN'S METALLIC TAPES.

In Leather Case.

No. **114**,	Metallic Tape, 33 feet long 10ths or 12ths	$2.30
No. **115**,	" " 50 " " " "	3.00
No. **116**,	" " 66 " " " "	3.30
No. **117**,	" " 75 " " " "	3.75
No. **118**,	" " 100 " " " "	4.75

A few extracts of letters from correspondents using my instruments are herewith added, and I would refer those unacquainted with the quality of my work to the following, which will speak for themselves:

U. S. Engineer Office,
Chattanooga, *Tenn.*, March 17, 1875.

F. E. Brandis, New York.

Dear Sir:—I enclose herewith detailed report of quality and performance of instruments purchased from you. According to statement of gentlemen using them they seem to give excellent satisfaction.

Yours very respectfully,
Walter McFarland,
Major of Engineers.

U. S. Engineer's Camp, No. 1,
Yuka, *Miss.*, Feb. 7, 1875.

Mr. F. E. Brandis, N. Y.

Dear Sir:—Your letter of January duly received; I wished to see the performance of the instruments sent before answering. Afterward I received orders to press my work, which has since occupied all my time and attention.

The instruments arrived in good order and *almost* perfect adjustment, which is a good indication of a well-made instrument. I think your instruments are *very fine.* I think the graduation of the transits are the finest I ever saw in field instruments. The parts are admirably fitted, and the centering appears to be perfect.

The thermometer was down to about zero, and the contraction resulting therefrom caused the parallel plate-screws of level to jam; this was only for about three days. Afterward the gentlemen using them said they would not desire better. I particularly admire your device for keeping the telescope and bubble always in the same vertical plane. I take great pleasure in recommending your instruments. Very respectfully,

Powhattan Robinson, *U. S. Asst. Engineer.*

College Point Water Works,
College Point,. *L. I.*, Aug. 1, 1877.

Mr. F. E. Brandis, 55 Fulton Street, N. Y.

Dear Sir:—I express with pleasure my entire satisfaction with the City Transit purchased from you three years ago.

The lessening of the distance between axis of large telescope and the centres, thereby causing less vibration, is a great improvement on the old pattern. The graduation is very exact, an eccentricity hardly traceable, and the entire workmanship accurate and careful up to the smallest details. The fine castings and finish, give the instrument an excellent appearance.

The lenses in the telescopes are choice glasses, affording a sharp and distinct sight of an ordinary plumb line at 1,050 feet distance in clear weather and looking north.

The instrument keeps its adjustment remarkably well, as proved by searching tests on the day of its delivery and at various times since.

Yours truly,
W. L. F. Martens,
Engineer and Supt. of Water Works.

New York, Sept. 6, 1877.

Mr. F. E. Brandis.

Dear Sir:—Accept expression of satisfaction, if nothing more, from me in the case of the Theodolite Transit No. 222, sold me some time since. I have never seen a telescope on any transit or level that excels mine in distinctness and flatness of field, which characteristics I consider necessary to the successful working of every instrument.

It may be interesting to mention that I use the midrib of a window sash 1¼ inches wide and 9.800 feet distance as a test of adjustment. I have set my staff at a distance of 4,000 feet without effort. I am pleased to express to you my complete satisfaction with the instrument in its several uses, as an angle measurer, both horizontal and vertical, level, and aligner.

Yours respectfully,
Richard Ferris, C. E.,
Belleville, *Essex Co.*, *N. J.*

Brooklyn, Flatbush, and Coney Island Railway,
Office of Chief Engineer, *Brooklyn*, April 1, 1878.

F. E. Brandis.

Dear Sir:—The patented level which I bought of you Jan. 29 has been in continuous use since that date, and has thus far given complete satisfaction. The glasses are *very fine* indeed, the bubble quick to respond, and the instrument holds its adjustment exceedingly well.

Your idea in protecting the centre, and at the same time leaving it so perfectly independent, is certainly an advance in the right direction.

Yours, etc., A. C. Walbridge.

Buffalo, N. Y., April 24, 1881.

F. E. Brandis, N. Y. City.

Dear Sir:—In answer to your request as to the workings of the transit and level purchased from you some sixteen months ago, I may remark that the period is not sufficient to judge of their *durability*, but have not discovered as yet *any* wear.

With the transit I have set a flag pole (1½ inch gas pipe, painted red and white alternately) thirty-seven hundred feet in a city street with accuracy; with the horizontal circle, which is divided to twenty minutes and reading thirty seconds, I have taken readings by interpellating to fifteen seconds, then repeated the angle four times, and always check within the graduation, *i. e.* thirty seconds.

With the level I am highly pleased; it is compact, well braced, and proportional; has a splendid set of lenses, and a very sensitive bubble. I completed this week the running of levels over a triangle whose sides amounted to forty-four miles (sixteen of which was a gradual slope, and the remainder somewhat broken), and closed on my initial bench 0.32′ low. For the gently sloping country the sights were from 800 to 1,000 feet each way, and the broken ground averaged, say 500 feet each way; the rod only read to hundredths, but all sights were balanced as near as possible; no time was consumed in "splitting hairs," the last 20¼ miles being run in 3½ days.

I would further state that the instruments seldom require adjustment, and when they do it is easily accomplished.

Yours very truly, S. Davis, *Asst. Engineer*,
N. Y. L. & W. Railway.

U. S. Engineer Office, *Fort Montgomery*,
Rouse's Point, *N. Y.*, April 21, 1881.

F. E. Brandis, Esq., N. Y.

Dear Sir:—In regard to the merits of the transit theodolite made and furnished by you to the United States for use at this office in October, 1878, I have to state that the instrument has since that time been in our river and harbor work, and given good satisfaction.

The arrangement of the tripod head for shifting the centre and getting the axis of the instrument over a given point without changing the position of the legs, I have always found convenient.

The level attachment likewise—by leaving the instrument unincumbered when in use as a transit only, and its ready conversion by the application of the attachments thereto when needed as a level, is found convenient in our harbor operations.

And I would more say, that in my use of instruments for the past twenty-five years, I have never used one whose parts moved more freely, and at the same time maintained its adjustments any better.

Yours very respectfully, D. White, *U. S. Asst. Engineer.*

U. S. Engineer Office, May 7, 1881.

The instrument referred to in the above letter was purchased and sent to Mr. White when he was in my employment, and from my knowledge of his experience as an engineer and as one familiar with the use of instruments of this class, I endorse his statement.

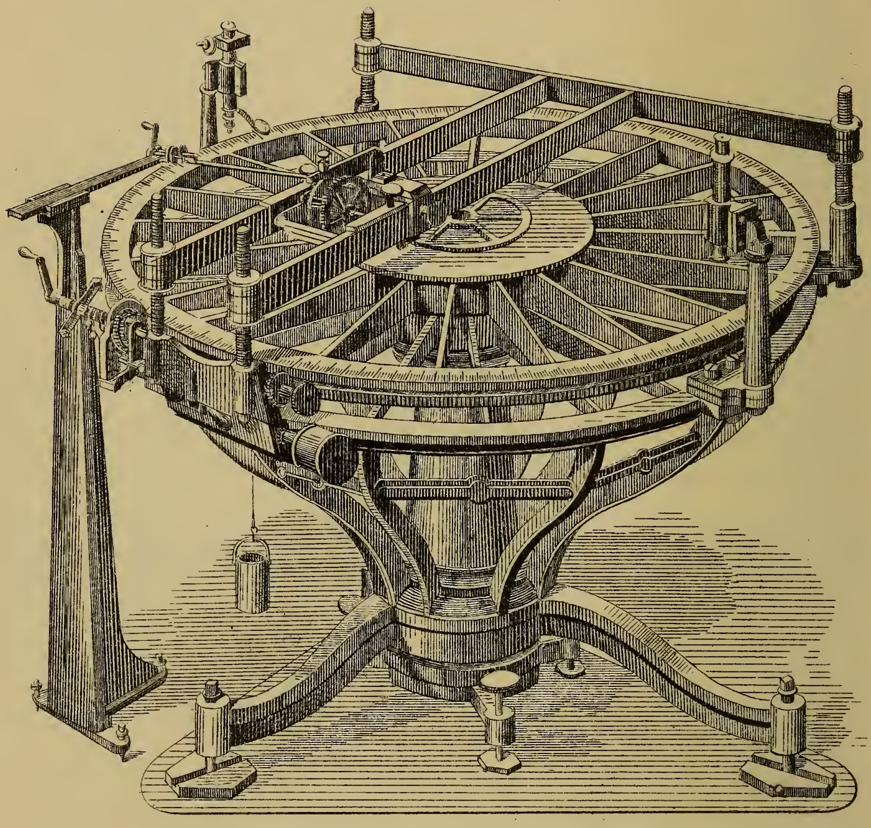
John Newton, *Colonel of Engineers*,
Bvt. Maj. Genl.

PART II.

ASTRONOMICAL INSTRUMENTS.

GRADUATING ENGINE

PLATE Nº VII



MADE BY

F. E. BRANDIS. NEW YORK

DESCRIPTION OF NEW GRADUATING ENGINE.

(Plate 7.)

Astronomical instruments require circles, whose precise accuracy is progressing with their construction.

Resolved to construct a circular dividing engine that would be as perfect as possible, I have attained this after six years of incessant labor.

This engine bears 4,320 points, of which the relative positions are verified exactly to less than 0" 5.'

It will probably be interesting to know the proceedings that were followed in the construction of this machine, chiefly to those who have circles in their possession which are to be verified, and to demonstrate with what precision this part of the work is done. We proceed with three operations.

First Operation.—Two concentric circles, 40 inches diameter were placed at 3 inches distance from one another by a strong iron foot, provided with wedged vises, clamped together on stones. The interior circle which we will call C, was fixed steady, and served to support the accessories.

The other circle c, also moveable around its axis, carries on its upper part a ring of platinum to receive the divisions, and on its interior side a limb of brass to move the denture or set of teeth on the field.

The circles C, and c, could be fastened together by a recalling "pebble lever," which allowed the circle C, to be fixed in an undetermined position. On either point of circle C, a mark on the lengthening of a radius was made, which sought to determine a point which was exactly 180° from the original mark.

For this purpose a microscope pointer was fixed on circle C, in such a manner, that the thread of its reticule did accurately cover the original mark. A moveable ruler was now placed on the centre of rotation at its extremities with a comparator, carrying a needle in alluminum; this needle vertically suspended, and equilateral as a balance beam, ends under the suspension point by two plain parallel surfaces of tempered steel, destined to serve in contact. Its extremity was arranged in quadrants bearing a symetric division by report of an axis that indicated 0.

A microscope reticule held by a moveable ruler, covered the point 0 by a thread in the equilateral position. There was also attached to circle C, at the extremities of the same diameter two horizontal clamps with steel points.

A micrometer vise with a divided drum permitted to advance or retard the points of small quantity. The circle C, having been made unmoveable, the alidade was turned, until the needle of the comparator covered the two points. The point was recalled by means of its clamp, till the needle coincided with 0 of its division before the thread of microscope. Now having made the alidade solid by means of special clamps, the circle c, was made moveable and constrained the system, so as to make the needle cover the second point, and then 0 was covered again as before.

The original point had by this time traveled about 180°. Again the circle C, was made unmoveable, the comparator was brought in contact with the first point, the needle was brought back to 0, and the alidade again fixed to the circle c. The circle was allowed to turn so long, till the comparator covered the second point; the needle had now arrived at 0. By this manipulation the original point passed twice the angle made by the two points, and when these points were at 180°, one or the other line found itself again under the threads of the fixed microscope. The two points were from that time strictly at 180°. A second line was made on the circle c, exactly covered by the moveable microscopic thread. Then the points were displaced, so as to bring them about to 90° of the two lines, and operating as before, two new lines were obtained. Agitating successively in this manner, 720 lines were obtained, representing ½°.

After this, a clamp and tangent was attached to circle C, provided with a micrometric tracer, with which whole and fractions of intervals contained between these 720 divisions could be estimated. Now every interval was divided into 6 parts, and at every new space the tracer would mark a new line on the circle.

The difference between the lines was therefore a 5', and the circle had 4,320 lines. This division was verified by placing on the circle C, four microscopes 90° apart These micrometric microscopes were provided with combs, whose teeth divided in five parts an interval double of that of two consecutive divisions, or 10.' These combs counted the course of the micrometer clamp. The drums of the micrometers were divided in 60 parts, by which the ½" was easily appraised.

SECOND OPERATION.—The question was to establish on the circle a "denture," which, being an exact copy of the divisions, could transform the circle in the machine to divide; therefore, a series of sharp instruments that were mounted on the circle C. along the slope were so placed, that by making the circle c, cut one division each time, you could easily trace a mark on the edge of the ring of copper. There were also made three successive trials by which you could judge whether the denture was deep enough: This delicate operation lasted over six months.

THIRD OPERATION.—Being assured, that the dentures were the exact reproduction of the division which served to obtain it, a tangent vise was fastened on an isolated support. This vise in its dimensions, calculated in advance, presented a diameter large enough, that its contact with the denture took place only on a weak portion of its contour.

By means of this vise, the circle C, was advanced one division, by which a tracer marked one line on the limb in opposite direction of division first obtained. By means of the microscopes, which were placed on circle C, it was observed that each line of the second division was well covered in the same time than its corresponding line of the first was covered by the threads of the reticule.

Such has been the minute operation, by which this dividing engine was established.

At the tangent vise is an adopted accountant whose drum is divided in 300 parts. The tangent vise has a step equal to 5,' each division indicating the second. A crank mounted independent of the machine will catch between four striking points ("a spring") situated perpendicular on the axis of the vise, and turning after this plan entrains the tangent vise in its alternative movements. The agitation given to the contacts by the hands of the operator, is always avoided.

The same carries a system of columns (articulated,) which belong to the apperatus of the tracer. The latter deserves to be specially mentioned. Established in a solid manner on a system of mounted traverses on the nut of a screw on the circle c, by an ingenious disposition (which was Ramsden's,) the tracer was made automatic, and replaced the movement of the ratchet subject to error, by a system of agitation by a straight rule, pivoting around its own summit, whose extremity is fast to the conducting fork of the tool.

It is clear that these prominent parts of the cam will lift the free side of the ruler, and come nearer the circumference of the tool, while in competition an eccentre acting on the fork, moves the tool away from the surface to be divided.

The number of segments of the cam, their more or less prominence determine the length of the lines. But, like the space of one degree divided in twelve, it may become necessary to have lines of various lengths; the diameter of the cam will not allow a number of sufficient segments, but a simple manipulation allows you to change the number of determined lines. An appendix culminating under the "ruler" retires, as soon as the tool has traced.

The whole system is of an incomparable rigidity, and will not permit agitation which would render the lines too long or too short. The tool is no more in the hands of the operator, and you are assured that all the lines are of equal length on the circle in a perfect rectitude.

EQUATORIAL INSTRUMENTS.

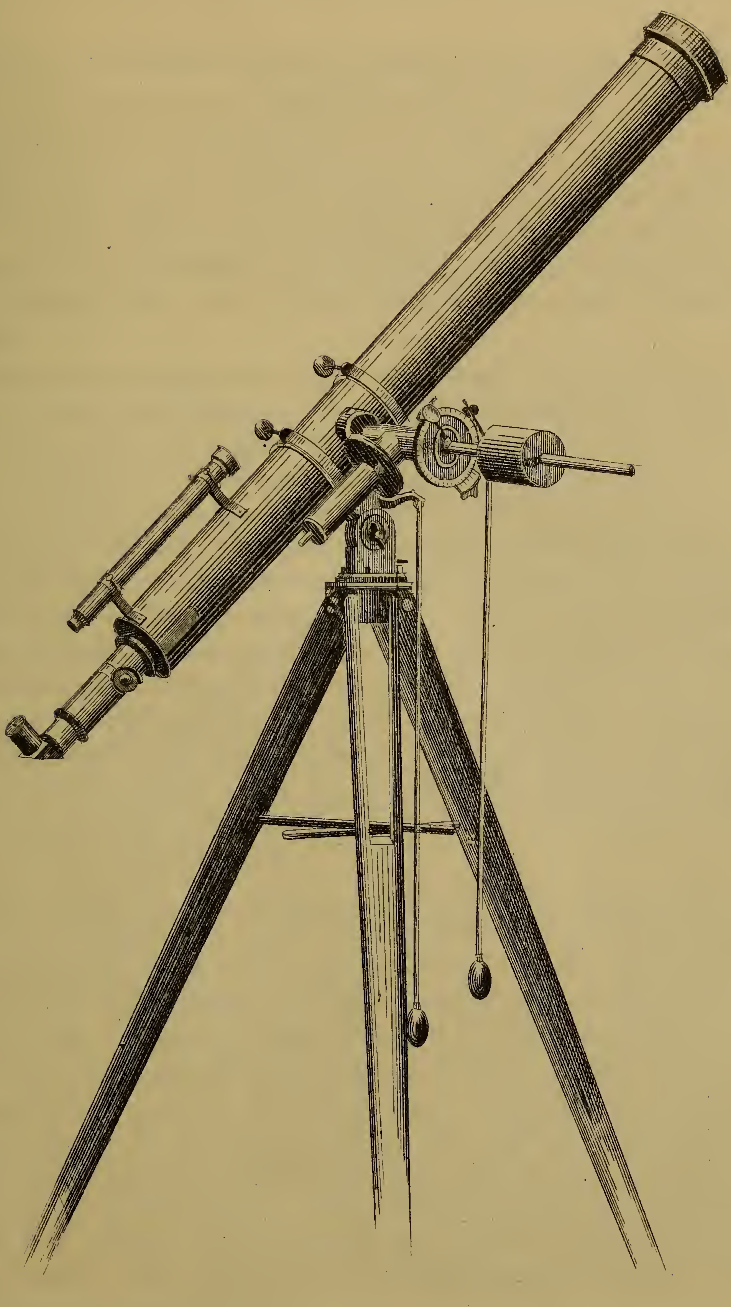
No. **119,** All Equatorials consist by principle of a telescope, supported by two perpendicular, reciprocal axis; of which one is attached in a parallel manner at the axis of the world. Each axis can turn by itself; the axis of declination accompanies the horal axis in its movements.

It is evident, that such an instrument when using the telescope in observing a star, the two axis correspond with the position of the star. If from that time the horal axis is moved, so that it makes a complete revolution around itself in one sideral day, the observer will always have the star in the field of the telescope. The equatorial serves mostly in astronomy to observe comets and small planets, it tells the position of small stars and those in their neighborhood.

This instrument is provided with a position micrometer, which may also be used to obtain the angle that forms with the circle of declination; the line joining the two contacts of a double star, or the axis of a comet's tail.

EQUATORIAL TELESCOPE

PLATE No VIII



MADE BY

F. E. BRANDIS. NEW YORK

It is very convenient to point out rapidly a star invisible to the naked eye, as soon as you know the approximate right declination and ascension and consequently the horal position of a star at any moment.

The equatorial is placed in position on a cast iron or stone foundation; the frame represents an inclined plane pursuant to the latitude of the place. To this inclined plane are attached the bearings which carry the horal axis. It revolves freely on both extreme ends by the aid of tempered steel collars and a screw, which resists the dead weight of telescope and axis.

The horal axis can revolve by itself between agate bearings, placed there in order to avoid friction. It receives its movement from the crank placed on the side of the observer, who, by the position of the wheels which readily connect) commands a gear wheel on the horal axis.,

The rectification in azimuth is made by means of two cheeks, which are placed laterally on the foundation, allowing a slight displacement by the two rebutting screws. The horal axis is of cast steel, has a length of 26 inches, and a diameter of 2½ inches. On the upper extremities is attached an endless screw sector, free on the axis, and destined to procure the slow movement to the horal circle and the supporter of the axis of declination, which follows the horal axis in its movements. By means of a pressure screw moved by the observer, the sector can be fixed to the horal axis. The teeth in the sector connect with a tangent screw, which receives from a clockwork a rotation movement, and is transferred to the whole system in right ascension.

The tangent is placed, so that it moves around the axis parallel to its own axis of rotation, and thereby throws the sector in or out of gear. This manipulation permits that, when the sector is at the end of its course, to send it back to its original position without stopping the movement of the clockwork. A spring suitably arranged, will keep the screw in con-act. On the lower end of the horal axis is attached a circle of direction, to clamp the instrument in right ascension; it is divided to 20' time, and gives the seconds by means of a vernier. This approximation is sufficient to find the star you are seeking. The horal circle is 10 inches diameter, graduated into 5 minute spaces. Two reading microscopes mounted parallel on the axis, will give within a second the position of the instrument in right ascension. The graduations are illuminated by a lamp and two reflectors placed on the horal axis.

The supporter of the axis of declination is a strong piece of cast iron, fastened in a solid manner to the horal axis.

The axis of declination is 24 inches long and 2½ inches diameter. It revolves on tempered steel bearings. These bearings are fastened in a shifting piece to overcome flection. At the extremity of the axis is the circle of declination, 10 inches diameter, graduated into 5 minute spaces; the micrometer allows you to appraise the seconds.

The total length of telescope is 9 feet, and is composed of two brass cones, which are fastened by means of their large base to a cylindrical cast tube. The object glass has a clear aperture of 6 inches, and a principal focal distance of 96 inches. The astronomical eye-pieces give a magnifying power of from 100 to 600 diameters. This instrument is accompanied by a series of micrometers, (Fig. 11 and 12.)

The finder attached, is itself a telescope of considerable power. Its direction parallel to the instrument is indicated by two pairs of metallic threads that cross each other at right angles.

The clock movement produces a movement of rotation by itself on the horal axis in 24 sideral hours. An isochronal regulator, (Faucault's system) keeps the movement uniform. The movement of the clockwork possesses a system of satellic wheels (whose movements produced by the observer are independent of the clockwork) which will allow the observer to retard or advance the movement of the instrument. This manipulation is very utile by observing stars of different swiftness; If the rapidity of the regime is not exactly that of the diurnal movement, you can also without stopping the clockwork, obtain the direction of the star observed, by the threads of the micrometer.

A lamp placed laterally on the telescope near the eye-end, is provided with a prism, and sends its diverging rays into the interior of the tube by means of an opening for that purpose; it is so arranged, as to separate the rays into three streams.

The central stream being parallel, leaves the telescope, and reflects on a mirror of 45°, which sends it back to the clamping circle, where it illumiates the graduations. The two others are received in the tube of the telescope by two small mirrors suitably inclined, which sends them back to the micrometer.

Different reflectors are combined, so that according to the will of the observer, he can obtain the threads of the brilliant or shining micrometer on the black field, or the black threads on the brilliant field; or the threads and the brilliant field.

This instrnment, though of 1,000 pounds weight is so equilateral, that a pressure of the finger on the end of the telescope is sufficient to move it.

Price as above.......................................$2,250.00

No. **120,** Same as above but without clockwork and reading micrometers.. 1,800.00

No. **121,** Same as (No. 119,) with telescope of 84 inches focal length by 5½ inches clear aperture...................... 2,000.00

No. **122,** Same as above, but without clock-work, and reading micrometers, (Declination and horal circle reading by verniers.)... 1,500.00

No. **123,** Same as (No. 119,) with telescope 84 inches focal length by 5 inches clear aperture....................... 1,300.00

No. **124,** Same as (No. 119,) with telescope of 72 inches focal length by 4½ inches clear aperture. Hour and Declination circles 8 inches diameter............................ 1,000.00

CHRONOGRAPHS.

No. **125,** In order to determine the longitude, it requires a cylinder on which register themselves at once the seconds of an Astronomical clock and the observations made on a meridian circle.

During different hours it is necessary to obtain a uniform movement equal to that of an astronomical clock.

For this purpose a wheel-work moved by a weight, and provided with an equitemporary regulator, will turn a large cylinder of a perfect uniform movement. The points mounted on a small carriage of pebbles displacing themselves during the rotation movement with the astronomical clock, mark the seconds on a paper applied around the cylinder; while the other point marks the astronomical observations that are made.

Price—$475.00

PORTABLE EQUATORIAL MOUNTED TELESCOPES.

No. **126,** Mounted on an improved equatorial stand, (Plate 8,) with telescope 72 inches focal length by 5 inches clear aperture, endless screw motion to right ascension axis with 6 inch circle; double verniers reading to 5 minutes of time; endless screw motion to declination axis, with circle and double verniers, reading to 30 seconds. The latitude axis is supplied with screw motion, and arc reading 1 minute...........Price—$750.00

No. **127,** Same as above, with telescope of 72 inches focal length by 4½ inches clear aperture................. " 550.00

No. **128,** Same as above, with telescope of 60 inches focal length, by 4 inches clear aperture............. " 480.00

No. **129,** Same as (No. 128,) with telescope of 50 inches focal length, by 3½ inches clear aperture; circles 5 inches diameter.............................. " 350.00

COMBINED TRANSIT AND ZENITH INSTRUMENT.

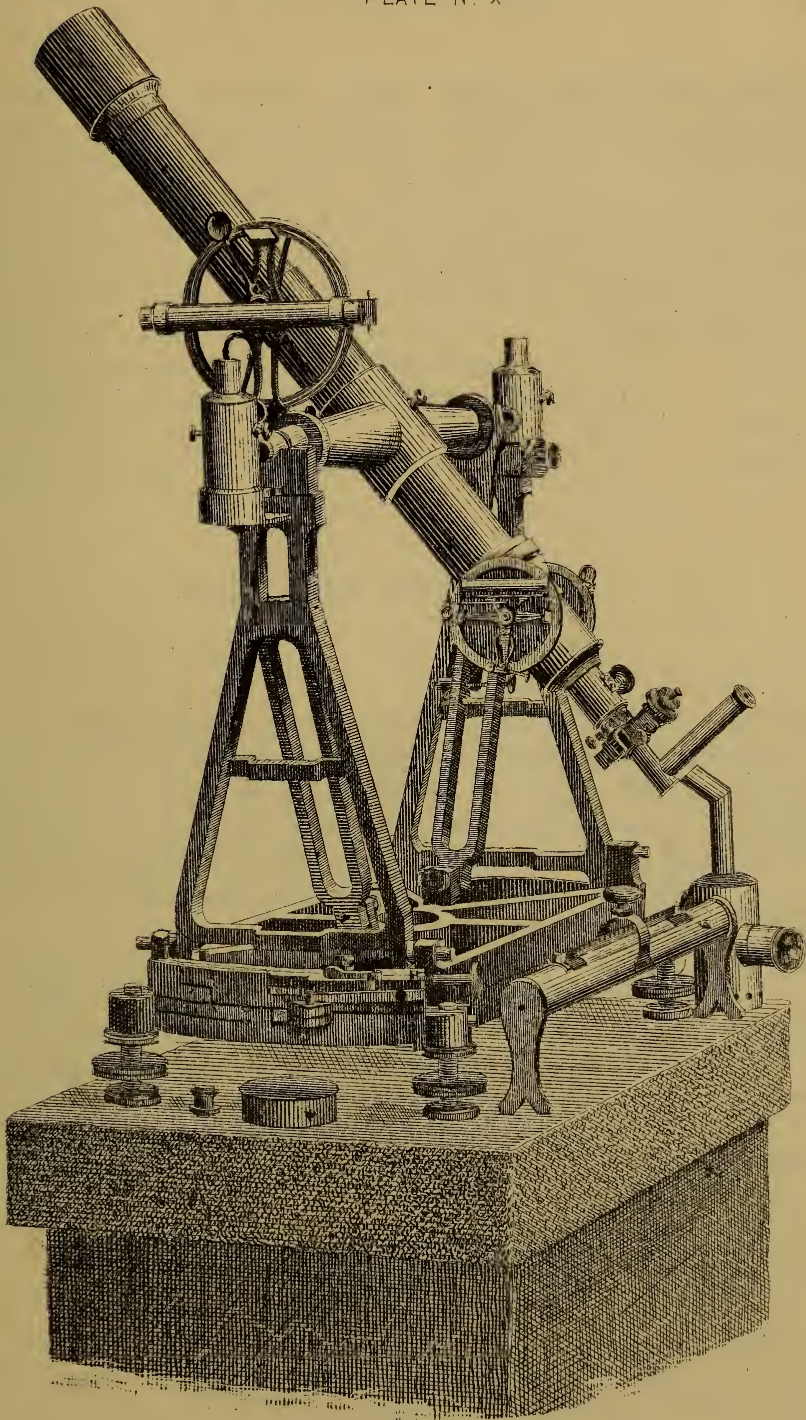
No. **130,** This exceedingly portable instrument with its folding frame as shown in (Plate 10,) serves to supply the local time for astronomical latitudes and azimuths.

The tedious method formerly employed when using it as a Zenith instrument to remove either two or four clamping screws from the frame, and by which much valuable time was lost, has been substituted by a very simple device, by which this can be accomplished in about ten seconds.

The telescope has a focal length of 28 inches by 2⅜ inches clear aperture, and is supplied with a filar micrometer. The same has either five or seven threads fastened vertically across the diaphragm, and two close horizontal threads at right angles. The star can be made to traverse the field between the horizontal threads by means of an extra slide, moved by a rack and pinion, independent of the fine micrometer screw; one Steinheil and one diagonal eye-piece is supplied. The finders are 4 inches diameter reading to minutes. The Zenith circle 7 inches diameter, carries a delicate chambered level reading to single seconds, same reads by double verniers to 20 seconds.

COMBINED TRANSIT AND ZENITH INSTRUMENT.
U.S. COAST SURVEY PATTERN.

PLATE Nº X



MADE BY
F. E. BRANDIS: NEW YORK.

The axis pivots are phosphor bronze, resting on agate bearings, which can be moved in altitude and azimuth. The clamp is of the improved "Davidson" pattern, admitting the telescope to be reversed in its bearings without carrying the clamp *with* it. The striding level is also chambered, and reads to single seconds. The axis is perforated to illuminate the reticule by means of a small reflector in céntre of axis. One reading and two illuminating lamps are supplied. Packed in two seperate cases with all accessories .... Price—$1,020.00

No. **131,** Same as above, but with one finder........	"	970.00
No. **132,** Same as (No. 131,) with single frame (not reversing....................................	"	775.00
Reversing apperatus for any of above (Extra,)	"	100.00

PORTABLE TRANSITS.

No. **133,** Transit mounted on a strong iron stand and tubular pillars, with telescope of about 40 inches focal lenght by 2⅞ inches clear aperture 6 inch setting circle and level alidade, reading to 30"; improved "Davidson" clamp, pivots of phosphor bronze, resting on agate bearings which are adjustable in altitude and azimuth. Illumination through axis; spider line micrometer; one Steinheil and one diagonal eye-piece.

Price— 750.00

No. **134,** Same as above 2¼ inches aperture.........	"	650.00
No. **135,** " " " 2 " " setting circle 4 inches diameter, reading 1 minute............. ...	"	475.00
No. **136,** Smaller transits for watchmakers', telescope 18 inches focal length by 1½ inches aperture..........	"	175.00
No. **137,** Samə as above, telescope 15 inches focal length by 1⅜ inches aperture.........	"	150.00

ASTRONOMICAL THEODOLITES.

No. **138,** This engraving (Plate 9,) represents an instrument with horizontal circle 15 inches diameter, graduated into 5 minute spaces, reading by 3 microscope micrometers to single seconds. The base of this instrument is very firm; the lower plate carries a flange, which is held in position by means of two clamps and screws; the same being 3½ inches distant from the circle, prevents straining it, at the same time allowing any part of the graduation to be brought under the micrometers. The upper plate carries an index pointer for approximate setting. Light is thrown upon the graduations by means of prisms.

The base of standards is screwed firmly to the upper plate and centre flange, to secure steadiness. The centres are phosphor bronze, also axis pivots, which are perforated to illuminate the reticule. Bearings are agate, and clamp of the improved "Davidson" pattern. The striding level is chambered, reading to single seconds. Telescope has a focal length of from 22 to 26 inches, by 2¼ inches clear aperture. The filar micrometer has two Steinheil and one diagonal eye-piece.

Same packed complete in two cases, with two illuminating and one reading lamp, and all necessary accessories............Price—$1,050.00

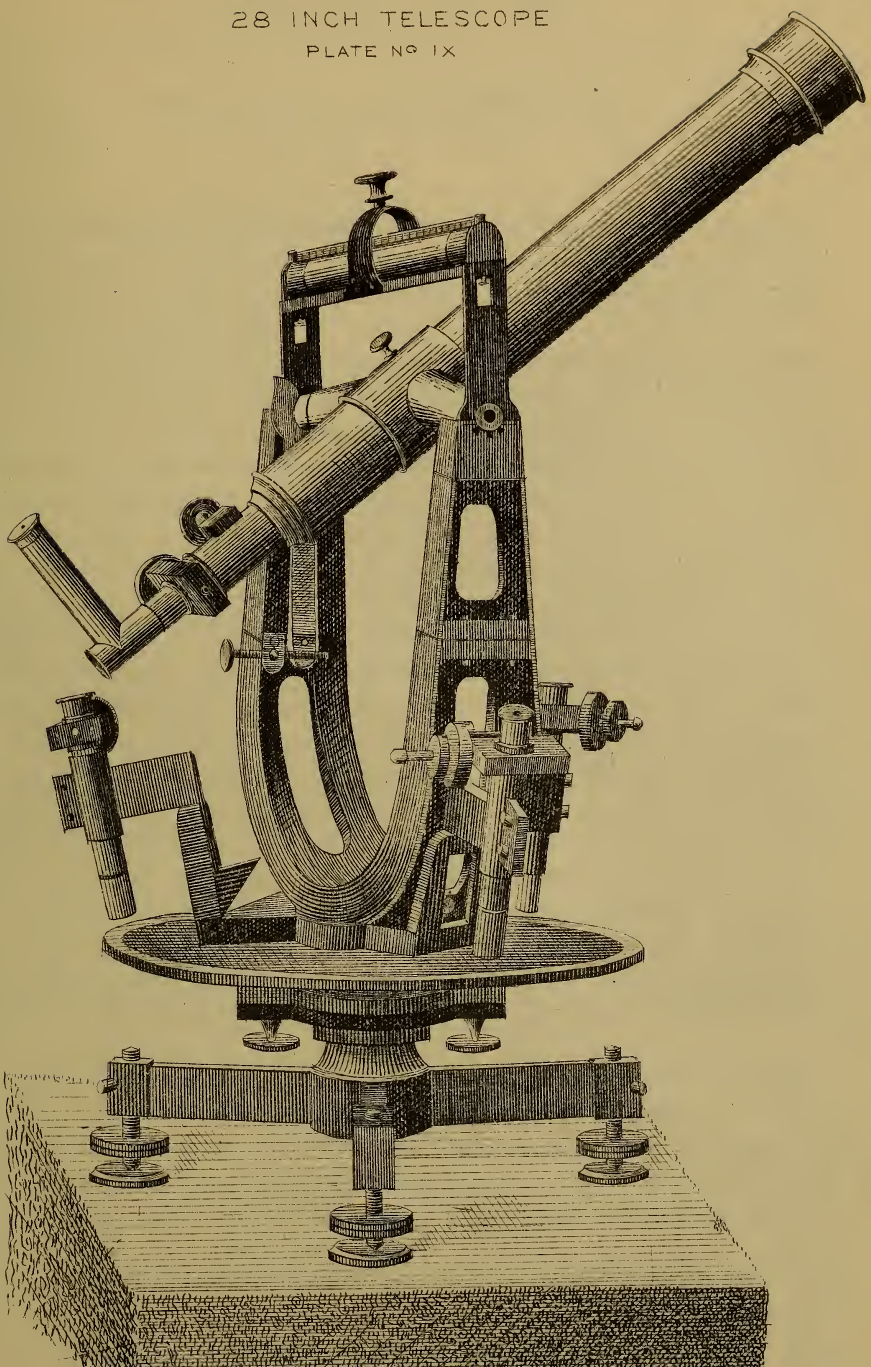
No. **139,** Same as above, but with vertical circle, 10 inches diameter, reading by two micrometers to single seconds, chambered level, controlling the micrometers also reading to single seconds.................... " 1,350.00

No. **140,** Same as (Plate 9,) horizontal circle 12 inches diameter, focal length of telescope 22 inches by 2⅛ inches clear aperture.......................... " 950.00

No. **141,** Same as (No. 140,) but with vertical circle 9 inches diameter reading by two micrometers to single seconds .... " 1,125,00

Special prices for similar instruments of larger dimensions will be furnished on application.

15 INCH ASTRONOMICAL THEODOLITE
28 INCH TELESCOPE
PLATE Nº IX



MADE BY
F. E. BRANDIS. NEW YORK.

MICROSCOPE MICROMETERS.

By instruments of great exactness, the magnifying glass that accompanies the verniers in not sufficient to determine the coincidence of a line on the circle with that of the vernier; hence, an apperatus is substituted, called the microscope micrometer.

Several microscopes are invariably fixed around the circle perpendicular to the graduation. Each of them gives in its interior the image of a certain number of lines of graduations. The image seen in the interior of the microscope has fixed threads in the plane of the image parallel to that of the graduation. In the movement of rotation of the circle, the image of each line will successively coincide with the thread; and as soon as the circle is fixed, the position of the coinciding line can be determined by the thread of the microscope. For this purpose the thread is moveable; the slide on which it travels can be entrained by means of a vise, carrying a divided head, by which the displacement following the perpendicular direction of the lines of graduations can be measured. In other words, this fixed position of the thread as being the zero of the microscope, and ciphered, so that the image which gives the graduation the *point* in which it is crossed, is that point, which the eye of the observer may pass in order to go from the thread to the divided head; then count in every case the number of turns and fractions that corrospond with the position occupied by the thread when in coincidence with the line of the circle. By adding this number, rated in minutes and seconds at the cipher of graduation shown by the line, you have in degrees, minutes and seconds the position of the line of the circle of which the image coincides with zero.

In the plane where the image of graduation is produced, is a rectangular plate, of which two edges are perpendicular to the threads. One of the edges that is visible in the microscope has a "comb," and the space understood between two consecutive teeth is equivalent to one turn of the screw. Every fifth tooth in the comb is deepened, and one of them a little deeper than the others, ends in a circle; the centre of which corresponds with zero of the microscope. In examining the image given by the microscope, you can see immediately the number of turns. The fractions of turns can be read at the graduated drum head.

The measures as we have taken for granted up to this, has been with one thread, but this is not sufficiently accurate. Indeed the thread becomes invisible as soon as it finds itself on the line of graduation. You could therefore be deceived of the apparent thickness of the thread.

To avoid this inconvenience, let the vise of the microscope move two neighboring parallel threads, and bring them in the midst of their intervals, the image of the lines of graduation. Care should be taken that the two luminous threads which are on either side of the lines are at equal distances.

This is the principle on which the basis of the micrometer with movable thread is founded.

No. **142,** Filar micrometer, (Fig. 12.)..................Price—$75.00

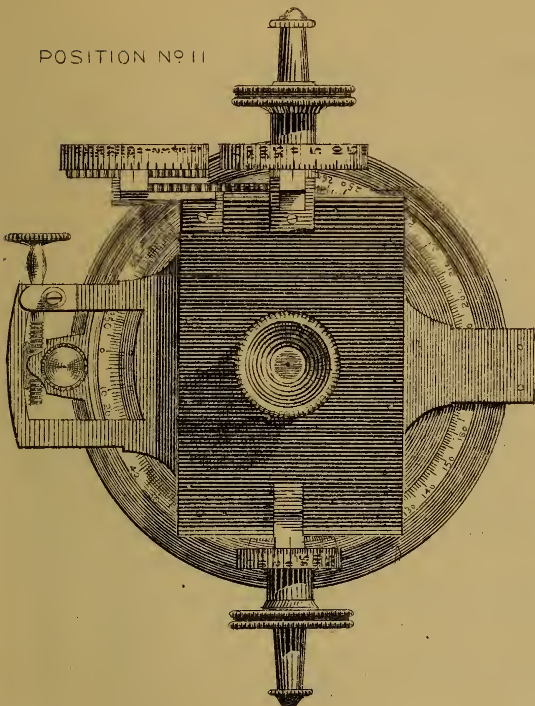
No. **143,** Position micrometer with clamp and tangent movement.. " 125.00

No. **144,** Micrometer with position circle for double stars; three fixed and three movable threads, two micrometric vises, one accountant and one index. This micrometer for measuring double stars has two movable independent threads, conducted by a micrometric vise. The method of observation is the following:

The reticule having been set in such a manner, that the fixed thread perpendicular to the movable ones be parallel to the line that joins the two position threads, bring the image of one of these threads by a general movement in such a position, so that it will nearly find itself at the crossing of the movable thread; set the clockwork in motion, and move the left side of the vise so as to bisect these stars with the movable thread; by means of the vise that commands the other position thread, bring the opposite movable thread in motion. The difference of these two readings will give the distance of the two stars. Repeat this operation several times. The movable thread of the left side, serves in each case the original thread of the index ....Price—$250.00

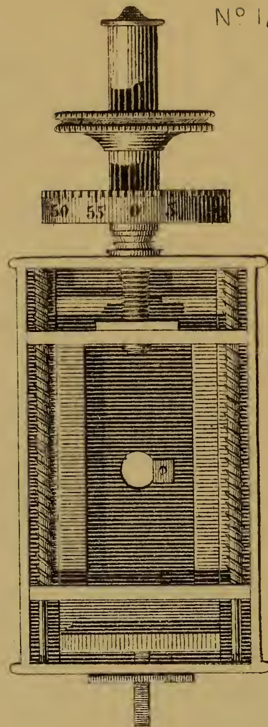
MICROMETERS

POSITION Nº 11



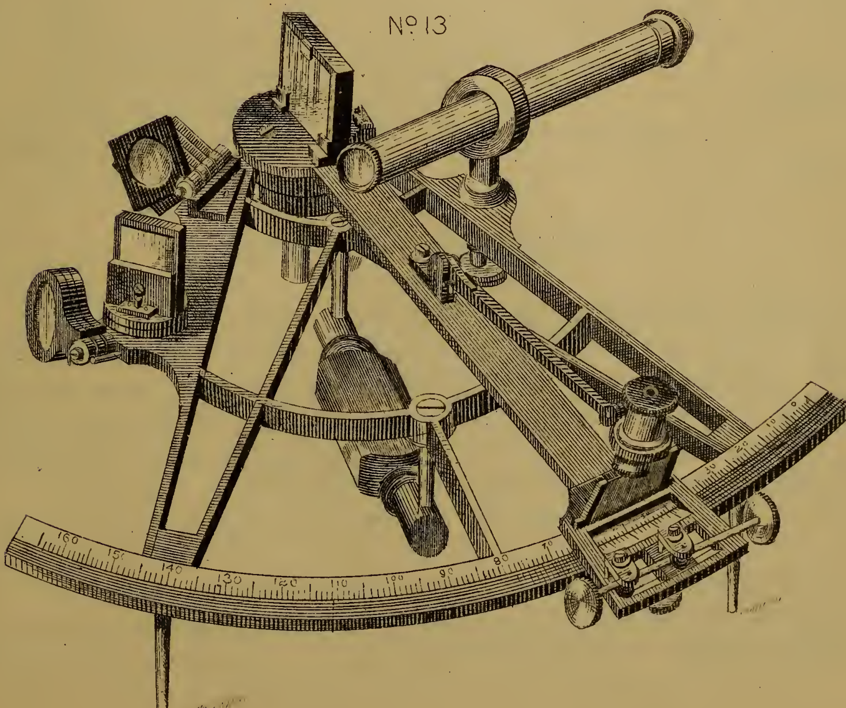
FILAR

Nº 12



HYDROGRAPHIC SEXTANTS

Nº 13



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SEXTANTS.

(Plate 13.)

The frame of these instruments are made of bell metal, and are exceedingly light.

The arc contains 60 degrees, but on account of the double reflection, is graduated into 120 degrees or more; and each degree into six equal parts, of 10 minute spaces, reading by vernier to 10 seconds. To prevent corrosion all the screws are made of German Silver. The telescopes have a very large field of view and high power, which makes them specially adapted for hydrographic work.

No. **145,**	Sextant as above, arc 7½ inches radius.....	Price—	$120.00
No. **146,**	" " " " 7 " "	"	115.00
No. **147,**	" "Gambey" pattern, arc 7 inches radius	"	130.00
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No. **149,**	" " " " 5 " "	"	105.00
No. **150,**	" " " " 4 " "	"	95.00
No. **151,**	Astronomical sextant, arc 6 inches radius, reading to 160 degrees, with double handle, well adapted for taking lunar distances, Monitor dark eye head.......	"	160.00
152,	Pocket sextant, new design, with leather case and strap....................................	"	50.00

ARTIFICIAL HORIZONS.

In order to avoid the cause of errors due to terrestrial refraction by observing stars above the line which terminate the base of one side, it is generally preferred to resort to the earth to determine the height by means of an artificial horizon, which is nothing else than a plane surface, horizontal and reflectant.

This horizon is based upon the principle that the surface of liquid of little extension in repose, can be seen as a plane surface parallel to the apparent horizon.

No. **153,** Artificial horizon with mercury or oil, formed of two glasses with parallel surfaces, and cover to avoid the influence of wind, and a third one to apply to the surface of the mercury ...Price—$45.00

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Swiss, with Patent Pivot Joint.

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No. 525, Ruling Pen, 4½ inch, without hinge	"	1.60
No. 527, " " 5½ " " "	"	1.70
No. 529, " " 6½ " " "	"	1.95
No. 535, Steel Spring Bow divider, 3½ inches, with German Silver handle	"	2.20
No. 537, Steel Spring Bow Pencil, 3½ inches, Round Point	"	2.60
No. 539, " " " " 3½ " Needle "	"	2.85
No 545, " " " Pen, 3½ " Round "	"	2.60
No 547, " " " " 3½ " Needle "	"	2.80

SWISS INSTRUMENTS.

Best German Silver and English Steel.

No. 604, Plain Divider, 5 inch	Price—$2.20
No. 610, Hair Spring Divider, 5 inch	" 3.00
No. 614, Bow Pencil, 3½ inch, with fixed needle point	" 3.50
No. 616, " Pen, 3½ " " " " "	" 3.50
No. 618, " " and Pencil 3½ inch, with fixed needle point	" 5.25
No. 622, " Compass, 3½ inch, with pencil, pen and needle point	" 6.00
No. 634, Compass, 5 inch, with pencil, pen, needle point and lengthening bar	" 8.00
No. 642, Ruling Pen, 4½ inch, with joint and pin, Ivory handle	" 1.60
No. 643, Ruling Pen, 5½ inch, with joint and pin, Ivory handle	" 1.80
No. 644, Ruling Pen, 6½ inch, with joint and pin, Ivory handle	" 2 00
No. 650, Dotting Pen, 6 inch	" 2.25
No. 652, " " 6 " with 6 wheels	" 3.75
No. 654, Railroad Pen	" 3.50
No. 670, Steel Spring Bow Divider, with round points, Ivory handle	" 2.20
No. 672, Steel Spring Bow Divider, with needle points, Ivory handle	" 2.50
No. 674, Steel Spring Bow Pencil, with round point, Ivory handle	" 2.50
No. 731, Proportional Divider 9 inch, graduated for lines and circles.	Each—$13.25
No. 742, Pocket Compass with handles, pencil and pen, points draw out, thus forming a small bow pen and bow pencil	" 9.50
No. 744, Pocket Folding Compass with pen and pencil points	" 8.75

NOTE.

As most draughtsmen prefer to buy just what instruments are required, and seldom purchase ready filled cases of Swiss Instruments, cases of morocco, black walnut or rosewood to contain the instruments selected, are fitted at short notice.

No. 1550, Patent Polar Planimeter of German Silver in morocco case.
Price—$30.00

DRAWING PINS OR FASTENING TACKS.

German Silver Points Screwed and Riveted.

$\frac{5}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$ inch diameter.
.60	.70	.80	.90	$1.00 per doz.

Cheaper grades furnished if desired.

EBONY PARALLEL RULERS.

6	9	12	15	18	24 inches long
25	.50	.75	$1.00	$1.25	$2.00

BOXWOOD SCALES.

Triangular Architect's Scale, divided $\frac{3}{32}$ $\frac{3}{16}$ $\frac{3}{8}$ $\frac{3}{4}$ $\frac{1}{8}$ $\frac{1}{4}$ $1\frac{1}{2}$ $3\frac{1}{16}$ in. to the foot.

6 inches long..Price—$1.50
12 " " .... " 2.00
24 " " .... " 5.00

Triangular Engineer's Scale, divided 10 20 30 40 50 60 parts to the inch

6 inches long..Price—$1.50
12 " " .... " 2.00
24 " " .... " 5.00

Flat Boxwood Chain Scales, 20 in. divided 30 x 50 40 x 60 " 1.50
Flat Offset Scale, 12 in. divided 10 x 20 30 x 50 40 x 60 " 60

Any Scale Made to Order.

T SQUARES

Fixed Heads.

	18	24	30	36	42	48	54 in. long
Mahogany, Ebony Lined,		1.20	1.50	1.75	2.00	2.50	3.25 each.
Maple Blade, Walnut Head,	.55	.75	.90	1.00	1.15	1.25	1.60 "
Hard Rubber Blade, "	1.20	1.75	2.40	3.00			"

Movable Heads.

	18	24	30	36	42	48 in. long.
Mahogany, Ebony Lined,	2.00	2.35	2.65	3.00	3.50	4·25 "
Maple Blade, Walnut Head, 1.20	1.40	1.55	1.75	1.85	1.95	2.20 "
Hard Rubber Blade, " 2.00	2.75	3.25	4.00			"

Extra Lengths of T Squares in Stock and Made to Order.

TRIANGLES.

30 x 60 Degrees.

	6	7	8	9	10	11	12	13	14	15	16 inch.
Mahogany, Ebony Lined,		.60		.70		.80		.90		$1.10	each.
Maple,	.25	.30	.35	.40	.45		.50		.60		.75 "
Hard Rubber,	.35	.40	.50	.60	.65		.90		1.25		1.75 "

45 Degrees.

	6	7	8	9	10	12	14	15 inch.
Mahogany, Ebony Lined,	.60		.70		.90	1.00	1.25	each.
Maple,	.25	.30	.35	.40	.50	.60	.75	"
Hard Rubber,	.45	.55	.70	.80	1.00	1.50	2.00	2.50 "

CURVES.

Maple or Cherry, 6 to 12 inches long. ....Each—$ .15 to $ .50
Hard Rubber, 6 to 12 " " .... " .30 to .75

Curves of any Pattern, Made to Order.

STRAIGHT EDGES.

	24	30	36	42	48	54	60	72 inch.
Mahogany, Ebony Lined,	.55	.70	1.00	1.25	1.60	2.00		each.
Maple,	.25	.30	.40	.50				"
Hard Rubber,	1.00	1.50	2.00	2.50				"
Steel, Nickel Plated,	2.30	3.25	4.20	5.25	6.60		9.00	12.50 "

INDIA INK.

Lion Head...	per cake.—$	.50
Square, Black Figures..............................	"	.75
" " Gilt Figure, Super Super small........	"	1.00
" " " " " " large........	"	2.00
Oblong, " " "	"	3.00
" Gilt, 2⅛ inches long, Very best quality.......	"	4.00
" Black, Gilt Figure, Large cake.............	"	5.00
" " " " " "	"	6.00
" " " " " "	"	8.00
Red India Ink, " "	"	.75
Blue " " " "	"	.75

As the patterns of Chinese or India Ink frequently change, no definite description can be given. The prices of the best inks vary from $1.00 to $8.00 according to size.

JAPANESE INK.

Japanese Ink is somewhat harder than India Ink, it requires more rubbing, but is waterproof. A line drawn with this ink can be washed over without blurring.

Oblong, Black Figures..................................per cake—$1.00
" " " .... " 2:00
" " " .... " 3.00

WINSOR & NEWTON'S WATER COLORS.

			whole cake or pan	½-cake or pan.
Burnt Sienna,	Hooker's Green, No. 2.	Prussian Blue,		
" Umber,	Indigo,	Raw Sienna,		
Chinese White,	Indian Red,	" Umber.		
Chrome Yellow,	Lamp Black	Vandyke Brown	$ .25	$. 15
Emerald Green,	Light Red,	Vermilion,		
Gamboge,	Neutral Tint,	Yellow Ochre,		
Hooker's Green No. 1,	New Blue.			
Brown Madder,	Indian Yellow,	Scarlet Lake,	.45	.25
Crimson Lake,	Purple Lake,	Sepia,		
Cobalt,	Orange Vermilion,	Violet Carmine,	.65	.25
Aureolin,	Carmine,	Lemon Yellow,		
Burnt Carmine,	French Blue,	Pink Madder,	.90	.45
Cadmium Yellow,	Indian Purple,	Rose "		

All other Colors Made by Winsor & Newton at corresponding Prices.

Winsor & Newton's Liquid Colors in bottles, Chinese White, Indian Ink, Oxgall...per bottle—$ .40
Ink, Carmine, Indellible Brown Ink, Prout's Brown.... " .50
Empty Japanned Tin Boxes, for 6 to 24 whole pans......$1.00 to $ 2.00
Winsor & Newton's filled Color Boxes................. 3.00 to 18.00

WATER COLOR BRUSHES.

Red Sable, in Albata, with Handles.....................$ .20 to $2.00
Camel Hair, in Tin " " .... .10 to .40
" " double end Wash Brushes.................. .50 to .75
" " in quills, small sizes.................... .05 to .10
Red Sable.. .10 to .35

All Other Brushes at Reasonable Prices.

CHINA COLOR AND INDIA INK SAUCERS.

Nest of Cabinet Saucers, 6 in a nest,	2⅜	2⅝	3¼	3¾	inch.
	.60	.70	.80	1.00	per nest.

SLOPING TILES.

3	4	5	6	divisions.
.20	.35	.45	.55	each.

COLOR CUPS.

2	2½	3	3½	inch
.10	.15	.20	.25	each.

ARTIST WATER GLASSES.

2⅜	3¼	3¾	4¼	inch.
.15	.25	.35	.45	each.

JOSEPH GILLOTT'S STEEL PENS.

Lithographic Crow Quills.................... per card of 1 doz.—$ .75
Mapping .... " " .75
Lithographic............................. " " .75
Fine Lettering, No. 303..............................per doz.—$ .20
" 170 .. .. " .15
" 404.............................. " .15

RUBBER.

Faber's Ink Erasers,				.06	.10	.20	each.
" Artists Rubber, White,	.10	.20		.30	.40	.50	"
Velvet, " " Oblong,				.10	.15	.20	"

PENCILS.

Dixon's *Artist's* Hexagon, Polished......................per doz.—$1.15
S. Soft, S. M. Soft Medium, M. Medium, H. Hard. V. H. Very Hard V. V. H. Very Very Hard.

Dixon's Graphite, Hexagon S. to V. H. Polished.........per doz.—$ .70
" " Round S. to V. H. " .... " .55
A. W. Faber's Siberian, 6 H. to 2 B................... " 1.25
Red Hexagon, Nos. 1 to 5.............. " .75
Black Round, " 1 to 4.............. " .60
Siberiao Artists Pencils....................each— .35
Best " " .... " .25
Siberian Artists Leads..............................per box— .65
Best " " .... " .35