PRICE LIST

OF

Engineering, Mining and Surveying

INSTRUMENTS,

MANUFACTURED BY

YOUNG & SONS,

INVENTORS AND INTRODUCERS OF

ENGINEERS TRANSIT,

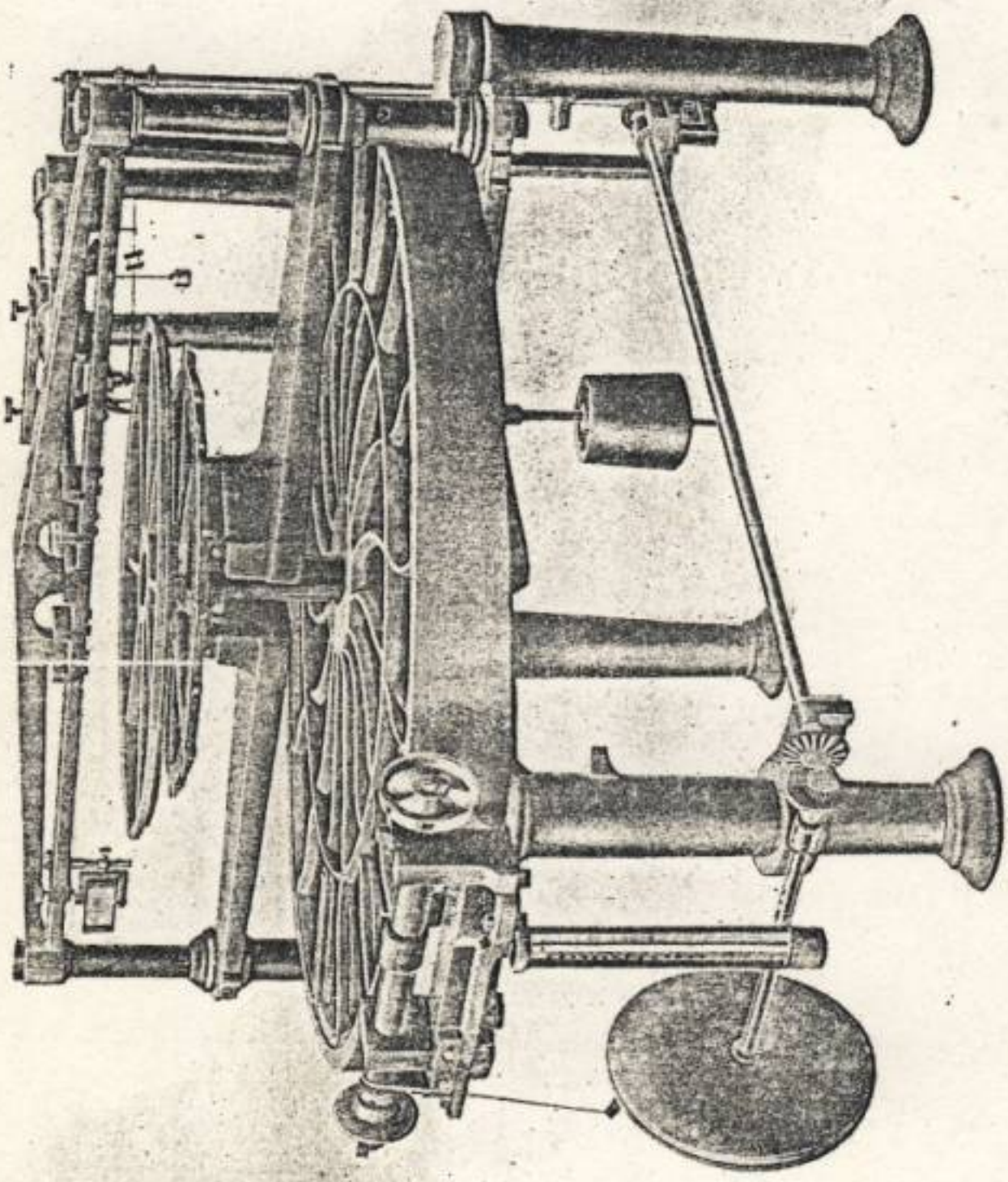
No. 43 NORTH SEVENTH STREET,

PHILADELPHIA.

INCLUDING

AN ACCOUNT OF INVENTION AND INTRODUCTION OF ENGINEERS' TRANSIT.

SMITHSONIAN LIBRARY



YOUNG & SONS' LARGE AUTOMATIC GRADUATING ENGINE

CG20.1055
Y54
no.24,1911

New Aluminum Alloy.

Now Used by Us, Reduces Weight 20 Per Cent.
No Loss in Strength or Accuracy.

We are now making the non-working parts of Transits and Levels of a patented Aluminum Alloy, which reduces the weight of these instruments twenty per cent.—an advantage to Engineers that needs only to be mentioned to be appreciated.

Until recently, we had excellent reasons for discouraging the extensive use of Aluminum in instruments of precision.

In fact, it was not until a short time ago that we felt justified in regularly using the superior Alloy which now enters into the making of our instruments.

The United States Government and several standard railways have made exhaustive tests with instruments made by us, containing the patented Aluminum Alloy, and have demonstrated its worth beyond any peradventure or doubt. Every requirement has been admirably met, and the result is that we can confidently pronounce our instruments not only the lightest in weight, but the most rigid and durable, and—in connection with our patented ball-bearing centres —the ideal engineers' instruments.

In the past, the principal objection to the use of Aluminum, both pure and alloyed, has been the impossibility of obtaining a metal in which screws would obtain a firm hold. In this patented Alloy, however, the screw itself will break before the threads in the metal will give or stretch. Its stiffness, rigidity and elasticity are remarkable, especially as compared with the bronzes and brasses. It has two to four times the strength in any direction, three times the volume, or one-third the weight, of these metals.

Its characteristics are similar to those of cast steel of the highest and costliest quality. It has been positively proven the strongest light metal known.

For nearly a century our establishment, founded by William J. Young in 1820, has been engaged in the manufacture of Engineering, Mining, Surveying and Astronomical Instruments.

For the character of our work we make but one reference—the number of our instruments throughout the country, the number of years they have been in use, and the reputation they have maintained during that time. Some of these instruments, made over fifty years since, are yet in active service, doing accurate work, while cheaper instruments are being discarded after a few years' work.

We refer with pride to the invention and introduction, by us, of the American Engineer's Transit, both in its original form, and in our subsequent styles. In the earlier days of railroad construction, when transportation was slow and difficult, requiring months for an instrument to reach its destination or to be received back from instrument maker in case of repairs, our Transit was strong, simple, substantial, almost impossible to be placed out of repair. Our later instruments are replete with every modern improvement, capable of the most delicate and accurate work. From the earliest to the present time, the superiority of these instruments has been unquestioned.

The graduations, the main point of all instruments for angle measuring are performed under personal inspection, upon a superior line of graduating engines, fully illustrated and described elsewhere. The materials in our instruments, our style, models and process of manufacturing, have been adopted after trial and test, during the past fifty years. Making no pretentions for sale of low priced instruments, we require only such prices as will enable us to produce good instruments.

All orders, foreign and domestic, entrusted to us will receive our prompt and best attention.

Yours respectfully,

YOUNG & SONS,
Philadelphia.

Cable Address
"YOUNGSONS"

LEVELS.

Our Levels are divided into two classes: No. 1 is designed for the highest grade of engineering work, and is made in three sizes: 18, 20 and 22 in. telescope.

The 18 in. telescope is the size most generally used on railroad work and for general practice in cities and towns, where portability must be taken into consideration.

The 20 and 22 in. telescope sizes have heavier and larger bars, centers and tripods to support the increased weight. They are mostly selected for bridge and hydraulic work and special work in cities.

The No. 3 Level is intended for work of ordinary accuracy—it is only made in one size of 18 in. telescope.

No. 2½ is a light Level, 15 to 16 in. telescope. In all our Levels the centers are attached permanently to the leveling screws, and instrument detaches from the tripod only. The object is to afford a better protection to the centers which pass through the plate carrying the screws.

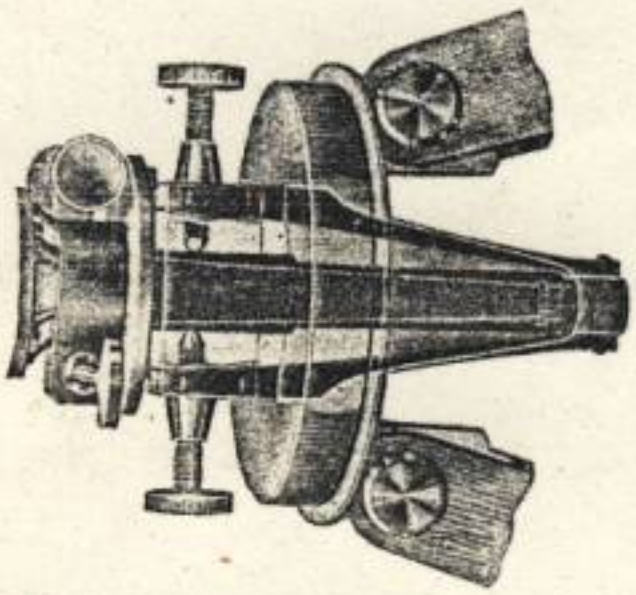
SPIRIT-LEVELS.—The interior surface of a glass bubble is ground barrel-shape, and the value of the level in seconds of arc, depends upon the degree of curvature given. To insure a perfect level, it is essential that the surface should be ground uniform the whole length of the tube, in order to secure a regular motion of the bubble. As a general rule, the more sensitive the bubble, the more perfect the work, but in an exceedingly sensitive level will not remain stationary, and is difficult and annoying to work; on the other hand, a dull level, while it gives the appearance of steadiness to instrument, and an impression that it "keeps" its adjustment, is incapable of accurate work.

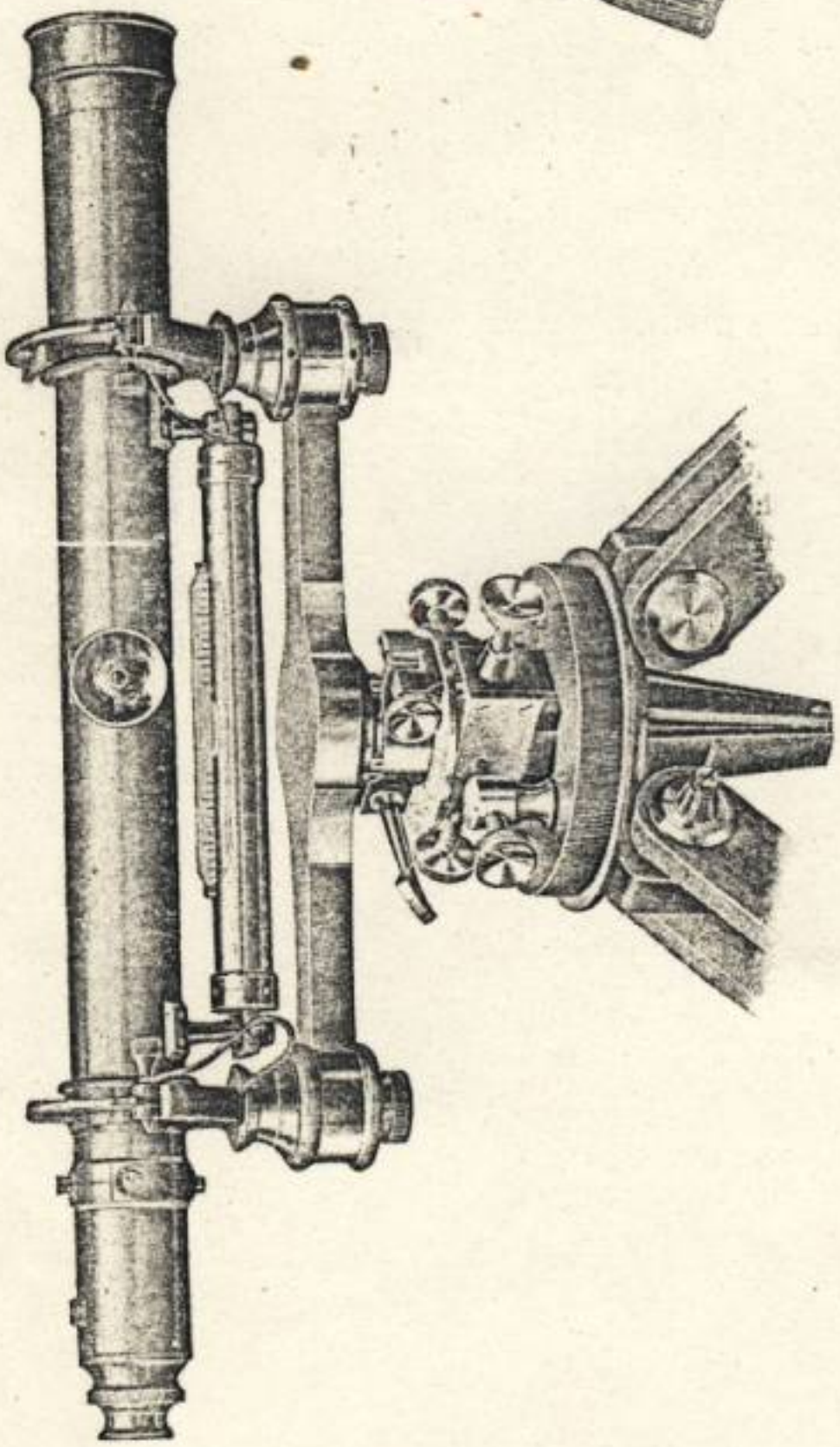
The value of a level-bubble we place upon our instruments varies according to the work to be done, but unless specially ordered, the levels with an 18 in. telescope will be furnished with the level having a value of 20 to 30 seconds of arc, on division of scale $\frac{1}{100}$ of a foot. For the larger sizes they can be furnished to 10 seconds if desired. The degree of sensitiveness of a ground level is measured by the distance the air space moves when one end of the level is raised or depressed. This value is generally expressed in measurement of arc: as a 1 minute or a 20 seconds level, but is apt to be misleading, unless it is known what distance the air-space has moved in that amount of elevation or depression.

There is no positive standard what should be the value of the divisions on the scale, but we, and several other makers of American instruments have used the scale expressed in hundredths of a foot for many years. It would be well for engineers to bear this in mind.

The fluid used in spirit levels is chiefly alcohol. Pure alcohol is slow acting and takes some time in settling, or more properly speaking, obtaining its equilibrium.

Ether, while quick acting, in this respect is objectionable on account of the contraction and expansion for slight changes in temperature being too great. To meet the requirements between these extremes, we use a special fluid.





YOUNG & SONS' IMPROVED DENISON LEVEL

Code Words—18-inch, Apple; 20-inch, Orange; 22-inch, Grape

Improved Level.

Patented by L. B. DENISON, Feb'y 3, 1880.
" " YOUNG & SONS, Aug. 27, 1907.

The aim of this Level is to furnish an instrument which is capable of

INCREASED STEADINESS,
USE OF MORE SENSITIVE SPIRIT LEVEL,
SMOOTHER MOVEMENT OF LEVELING APPARATUS.

The object is accomplished:

1st. By use of longer radius upon which the leveling motion is made.

2d. By use of independent centres for the motions, at right angles to each other.

3d. By having these centres unconnected with the attachment of the leveling screws, so that the action of the screws neither tightens nor loosens the centres upon which the leveling takes place.

This action of the screws in one direction being effected upon their own centre, without any movement or direct action upon the centre on which other screws move, leave the whole instrument free from strain.

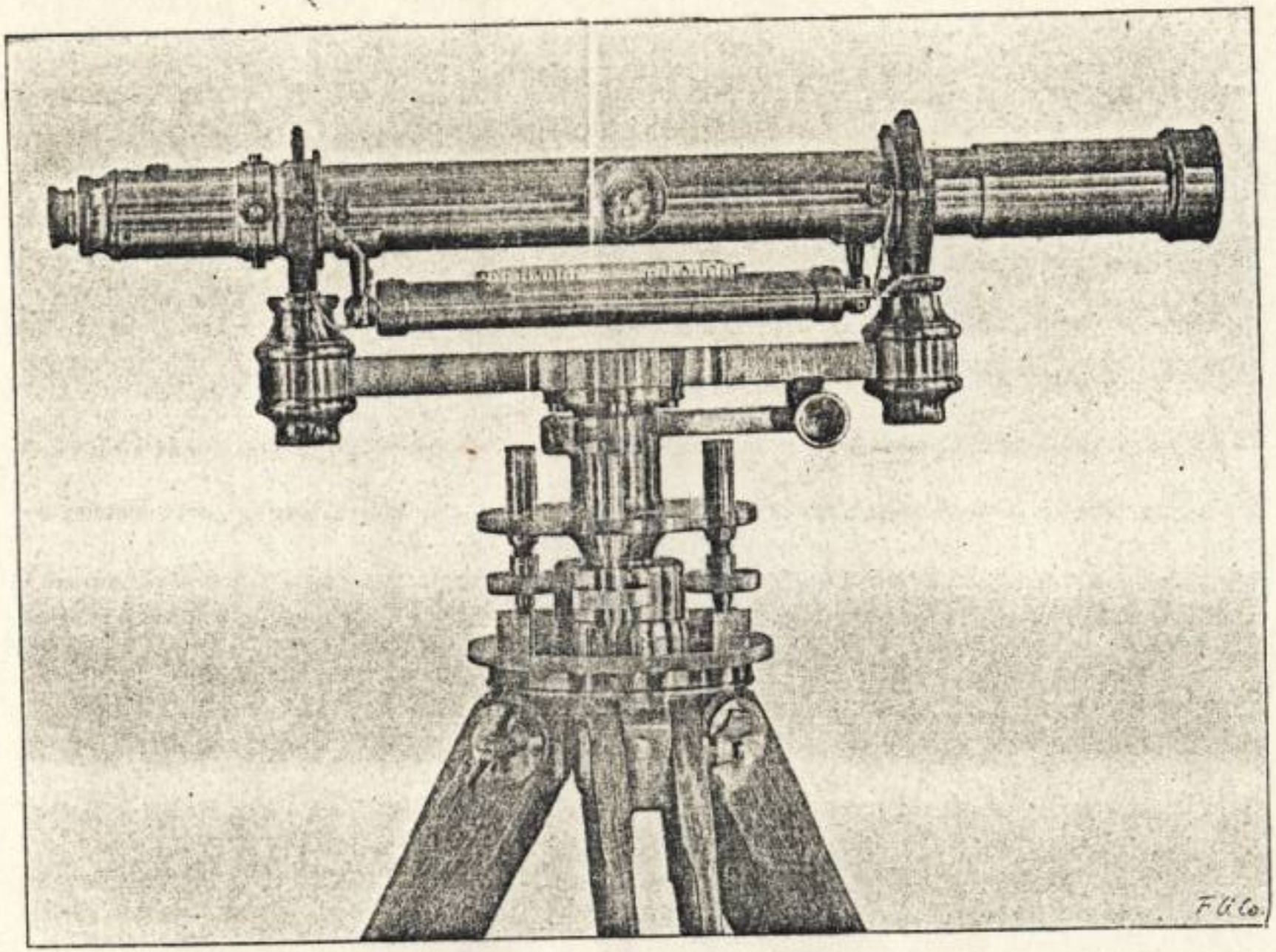
By the construction, the centre upon which the instrument revolves can be made longer, while the whole instrument is kept lower in the tripod. This length of centres is another cause for increased steadiness, to which the low position on tripod contributes, and is an end sought in all instruments.

For City and Hydraulic Engineering, for the finer kinds of Railway work, this instrument will be found more satisfactory in its workings and results.

PRICES:

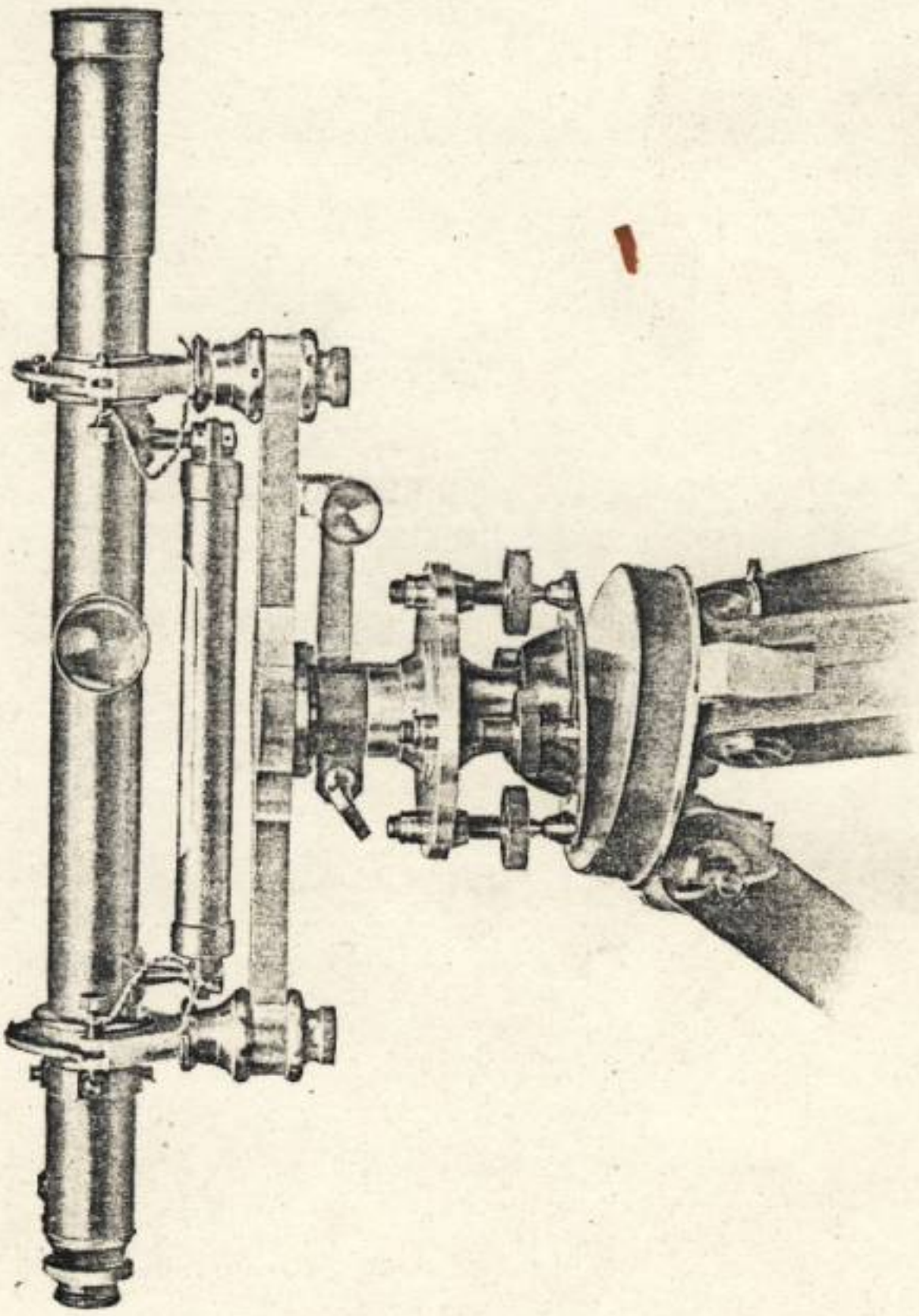
All our improvements on telescopes.

Telescope,	18	inch,	power	40	dia.,	objective	1⅜	inch,	. .	$160 00
"	20	"	"	45	"	"	1⅜	"	. .	175 00
"	22	"	"	50	"	"	1⅜	"	. .	185 00



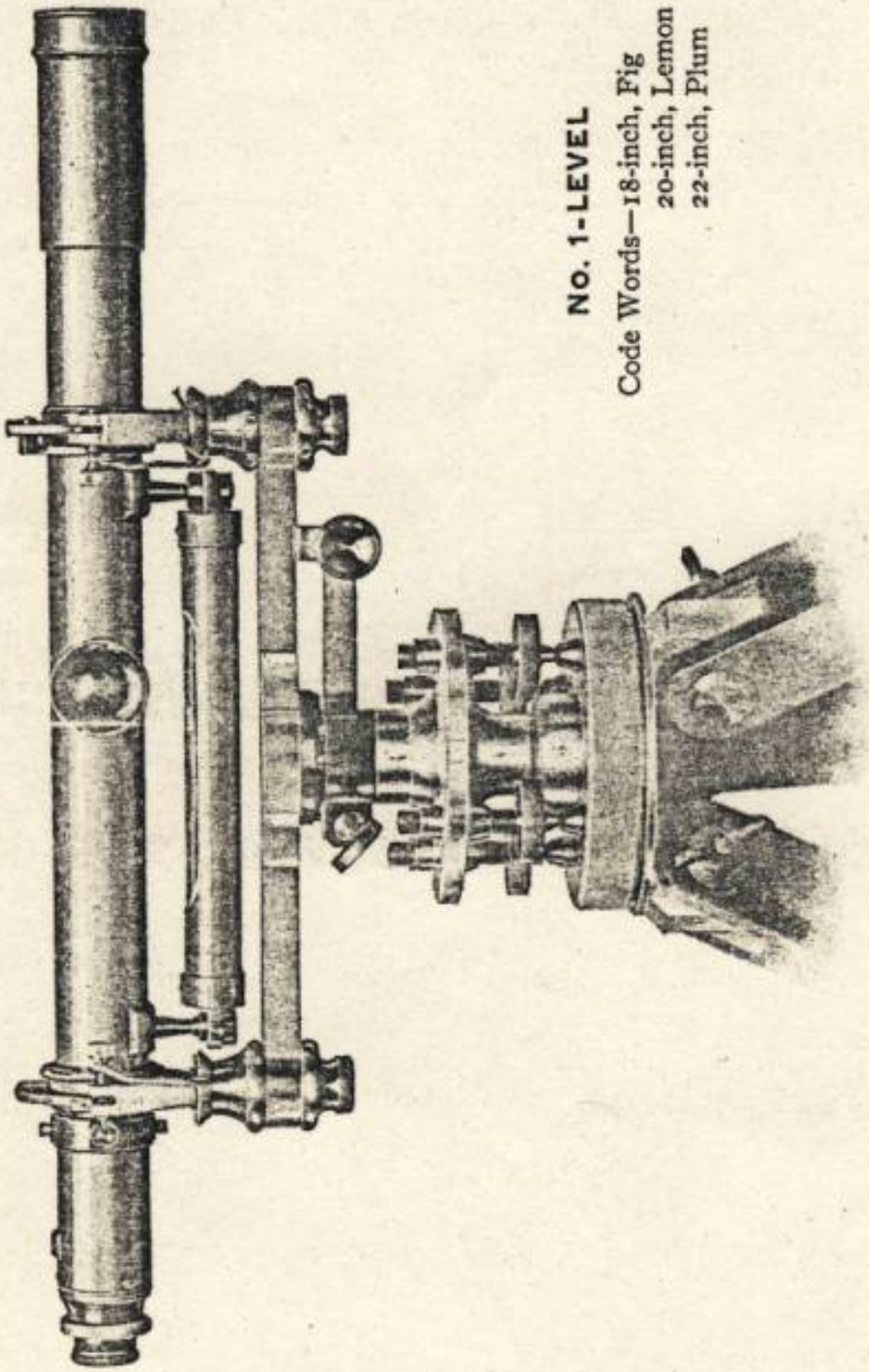
NO. 1-LEVEL, WITH 3 LEVELING SCREWS

		Code Words
Price, with Telescope, 18 ins. long	$145 00	Starfig
Price, with Telescope, 20 ins. long	160 00	Starlemon
Price, with Telescope, 22 ins. long	175 00	Starplum



NO. 1-LEVEL, WITH QUICK LEVELING ATTACHMENT

		Code Words
Price, with Telescope, 18 ins. long	$145 00	Sunfig
Price, with Telescope, 20 ins. long	160 00	Sunlemon
Price, with Telescope, 22 ins. long	175 00	Sunplum



NO. 1-LEVEL

Code Words—18-inch, Fig
20-inch, Lemon
22-inch, Plum

Level No. 1.

This is our Standard Level. It is designed to insure the highest obtainable accuracy and efficiency, combined with portability.

The centres are permanently connected with the leveling screws, and the instrument detaches only from the tripod.

This is the Level we recommend for general work, except when a special instrument is desirable. The centres, bar and wyes of the 20 and 22 inch telescope are larger and heavier than the 18 inch. Level vial, long and of large diameter, ground accurately full length of tube. Value, 20 to 30 seconds. Scale, $\frac{1}{100}$ of a foot.

Telescope,	18	inch,	power	40	dia.,	objective	1⅜	inch,	. . .	$135	00
"	20	"	"	45	"	"	1⅝	"	. . .	150	00
"	22	"	"	50	"	"	1⅝	"	. . .	160	00

Clamp with spring tangent screw.
Long bell-metal centres. Heavy flanges.
Non-detachable, anti-friction cups under leveling screws.

These Levels are furnished with

YOUNG'S IMPROVED EYE-PIECE,
" " DUST GUARD TO OBJECT SLIDE,
" " FASTENER, to keep vertical and horizontal cross-wires in position.

EXTRAS: Fixed Stadia Hairs, ... $3 00
Adjustable Stadia Hairs, ... 8 00

Weights (without tripods): 18 inch, 11½ lbs; 20 inch, 15 lbs.; 22 inch, 15¾ lbs.

Hydrographer's Level.

For work of especial accuracy.

Similar to our No. 1 Level; 18 inch telescope.
Three leveling screws.
Telescope showing objects erect or inverted.
Adjustable mirror, for reading level vial without change of position on spongy ground; made of metal, detachable. Level vial; value, 10 seconds of arc; scale, $\frac{1}{100}$ of a foot, . . . **$175.00**

Level No. 3.

A portable and convenient Level for general work. Suitable for preliminary surveys and work of ordinary accuracy. A modest priced Level designed to hold its adjustments and to withstand rough usuage.

The centres are connected permanently with the leveling screws, and instrument detaches only from the tripod.

Telescope 18 inches long; medium high power, with a large and clear field.

Carefully ground Level vial.

Dust guard to object slide.

Cups under leveling screws. Anti-friction. Non-detachable.

Long bell-metal centres. Heavy flanges.

Improved eye-piece. Draw pattern.

Improved web fastener, to keep cross-webs in position.

Weight without tripod, 11½ lbs. **$110.00**

EXTRAS FOR NO. 3 LEVELS:

Stadia Hairs, Fixed, ...	$3 00
" " Adjustable, ...	8 00

No. 2½, Light Level.

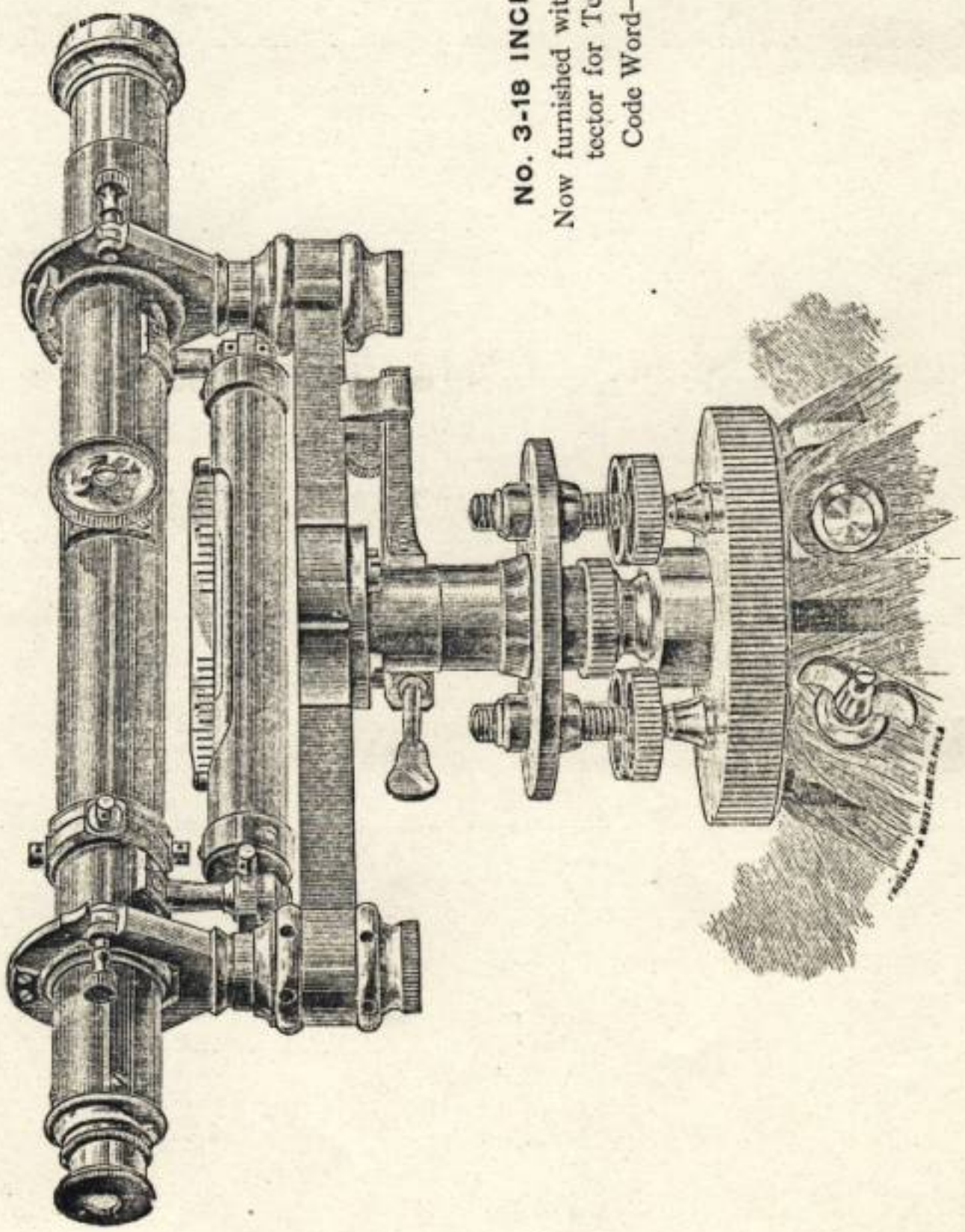
Telescope, 15 inch, power 16, weight 8 lbs. without tripod, . . $90 00

This level is capable of all adjustments of larger instruments.

NO. 3-18 INCH LEVEL

Now furnished with Slide Protector for Telescope

Code Word—Pear



TELESCOPES

All the glasses used in the telescopes on Young & Sons' Instruments are made of the best quality Jena glass, and under a special guarantee by the best opticians. We order in such quantities that will enable the optician to have the best tools and mechanics obtainable, and give an extra price to have each objective thoroughly corrected for centering, flatness of the field, and definition. Every glass is again carefully tested by Young & Sons on standard marks and comparison with a standard telescope.

The general demand is for a high power; and those unacquainted with subject consider the higher power the better telescope. The *power* of a telescope depends upon proportion of focal lengths of object glass and eye piece, and while in theory *any* power may be given to any telescope, in practice the extent is limited by other *points,* such as effects of aberration loss of light and size of field of view. With the same object glass *every* increase of power is followed by a decreased illumination, or a decrease of light and a smaller field. These results follow in obedience to mathematical laws, and cannot be obviated. Science has given certain proportions between power and length of telescopes, and the best opticians of Europe, with their extended experience, invariably follow these proportions.

To force the power beyond these bounds; the result, is, that while under very favorable circumstances the centre of field of view will give a somewhat better definition, it will only do so under favorable circumstances, such as clear atmosphere and strong illumination of the object, and that either the field must be much reduced or objects out of immediate centre will not be in focus. In cloudy weather, in lesser light of morning and evening, in the tremulous condition of atmosphere, arising from evaporation from surface of ground, especially cultivated, these high powers all suffer.

There are purposes, such as stadia measurements, where great definition is so much an object as to supersede all other telescopic requirements, in which these high powers are advisable; but the Engineer should understand and especially remember the exact focusing required of them, otherwise parallax produces a sensible error.

Fortunately the particular use of engineering instruments requiring definition on but one point at a time, allow us to make other conditions of optically good glass subordinate to this one of power to a great extent.

INVERTING glasses are not more powerful, except that from small space occupied by the eye piece, they allow for same length of telescope a greater focal length of object glass and thus increase the power. They however, have a greater amount of light, or greater illumination and a larger field. The prejudices of American Engineers are against them, but in Europe, their merits are almost universally acknowledged, and they are almost the only ones used.

We have remarked on this subject because of the gradually increasing interest of Engineers, and that they may form an idea of the principles governing instrument makers, desirous of giving the best general, but not sensational, properties to the telescope.

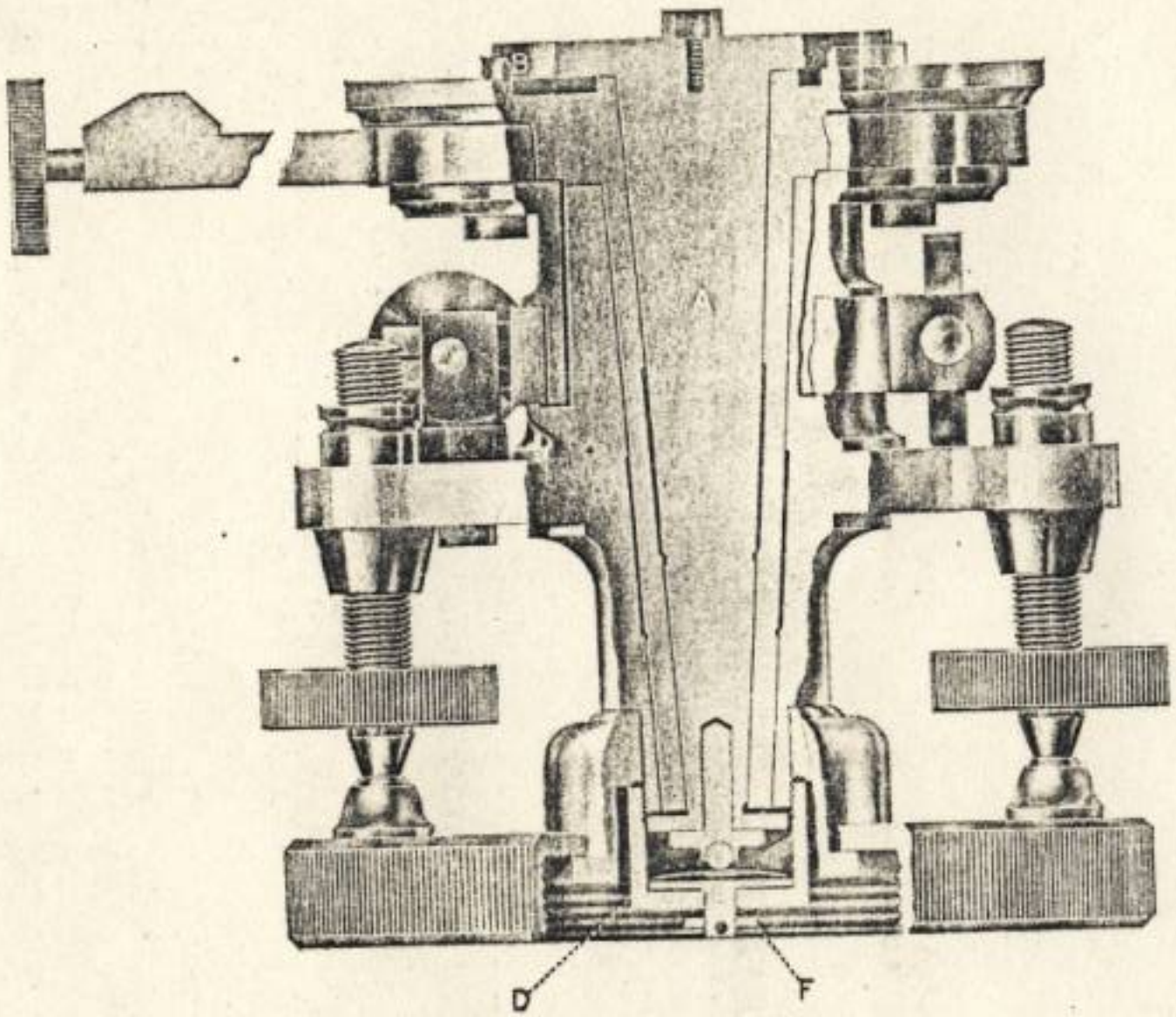
The thoroughness that we give to matters of detail during construction, produces an instrument that will maintain its adjustments in all latitudes, and under unusual hard conditions, which makes our instruments a favorite with Engineers not easily accessible to an instrument maker.

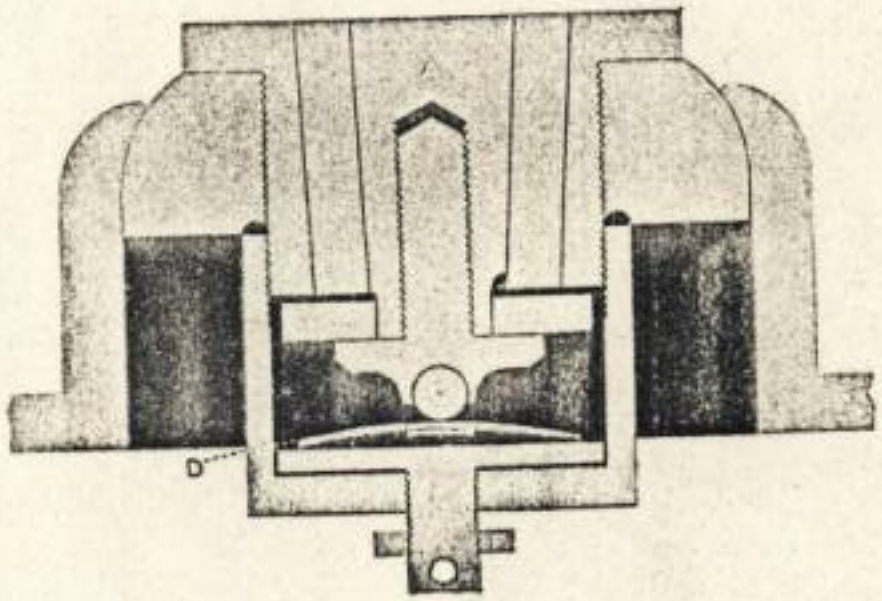
WORLD'S COLUMBIAN EXPOSITION

Department of Liberal Arts **CHICAGO, 1893** **Engineering Instruments**

Medal and Diploma Award, to Young & Sons, Philadelphia, for Uniform Excellence in Design and Workmanship, and Accuracy of Graduation

ILLUSTRATING
YOUNG & SONS' BALL-BEARING
ATTACHMENT FOR TRANSITS
AND LEVELS





Ball-Bearing Attachment.

For Engineers' Transits and Levels—Our Patented Device Reduces Friction to the Minimum.

We have recently been granted a patent on a Ball-Bearing attachment for Engineers' Transits and Levels, by which wear and friction of centres are reduced to a minimum.

It will be readily seen that ease of operation is essential at this point (see fig.1) and our new device achieves this desideratum more successfully than any other yet introduced.

Fig. 1 shows a sectional view of centre in which our new Ball-Bearing device is employed.

In ordinary instruments, the inside centre "A" works in the hollow middle centre, the weight being supported by the shoulder "B."

In practice, if the shoulder "B" wears faster than the cone "A," the centre works hard, causing friction, and any sudden change in the temperature, or a jolt received in transportation or otherwise, is liable to make it stick. If the cone "A" wears faster than "B", the inner centres will become loose and "shake", and the levels cannot be adjusted.

Ball "C" bearing and a spring "D", partially support the inside centre "A" from the bottom and prevent undue wear of the shoulders and cones of all the centres.

The spring is adjustable by means of the screw "E" which is held in position by the jam nut "F".

We feel certain that this improvement will immediately commend itself to the profession.

GRADUATING ENGINES

THE GRADUATIONS being the really important part of an angle-measuring instrument, we have devoted especial attention to enable us to stand preeminent on this point.

With this edition, we present to the Civil Engineers of this and foreign countries, a complete view of our line of Circular Graduating Engines. From this they may be able to judge of our capacity, to insure accuracy in the most important part of their instruments; also to judge of the labor and expense we have incurred that the work may be faithfully performed, and be such as they can implicitly rely upon.

Our Engines have all been made in our establishment.

They are:

A Foot Engine, of 22 inches diameter, used for Protractors, Needle Rings, and such work requiring heavy graduations, but not especial accuracy.

An Automaton Engine, of 24 inches diameter, upon which is placed finer work, and which is capable, by late test, of finer graduations than any similar engine of this country.

The large Automaton Engine, 48 inches diameter, which is intended for the finest astronomical and other work, and which is unequalled and unapproached by any such engine here. *Upon this engine we now graduate our Engineers' Transits, etc.*

The vital point of any instrument is the graduation. Defects in other parts may prove an annoyance or inconvenience, and yet instrument work correctly. With defects of graduation, accuracy, if not impossible, is a mere matter of accident. Defects in ordinary parts of instrument become evident to the Engineer. In the graduations they are unknown; and frequently the only evidence of their existence is the unsatisfactory condition of the finished work, leaving the Engineer in doubt whether the unsatisfactory results, condemning his work, arises from his own carelessness or the imperfections of his instrument. The delicacy required in graduations of Transits is such that reliance cannot be placed upon personal operation. the heat of the body in contact with the engine, the uneven strain placed upon the parts by the hand, the uneven velocity, and especially the many evils resulting from the long continued strain upon the attention of the individual, make the AUTOMATON movement necessary for any approach to perfection.

GRADUATIONS

SILVER OR ROLLED BRASS

Experience has shown us the materials upon which graduations of our Engineer's Transits are made, being brass plates ROLLED especially for us, and condensed under our trip hammer, especially adapted for the purpose, obtains a uniform density rivalling that of silver, and a hardness much to be desired. The porous nature of all castings, excepting, perhaps, yellow brass, which can be hammered and condensed, has compelled the adoption, in larger instruments, of silver or other homogeneous metals. The small air holes, and deficiencies of castings, causing the point of cutter to deviate from proper place, producing unequal spaces and unequal thickness to lines. This is one reason we avoid castings for our graduated plates of best instruments. The silver has objection, it is so soft that the least particle of dust or dirt between verniers and plates turns up edges of graduations, destroying their accuracy, in many cases obliterating graduations at the edge.

We consider that, for fine graduations, such as under thirty seconds, silver is best material, principally on account of surface requiring no working after graduations, to endanger obliteration of fine lines; but that for graduations of one minute, or even to thirty seconds, *our rolled condensed brass is preferable.*

These specially prepared plates, when ready to be graduated are centred upon the Engine by means of an angle reflecting mirror, viewed at a distance through a Transit telescope provided with fine cross hairs.

Improvements made on Young & Sons' Instruments.

Improved Telescope or Web Fastener.

In the usual construction of the Level instrument, even when in perfect adjustment, an observation taken other than at immediate intersection of cross web, tends to produce error, from the rotation of telescope in Y bearings throwing all other parts of horizontal web above or below the true level line. The bringing to exact intersection on rod is tedious,—the examination and correction of horizontal web each time still more so; while, unless one of these are resorted to, error is almost certain, and this error is the great source of inaccuracies in operation of leveling.

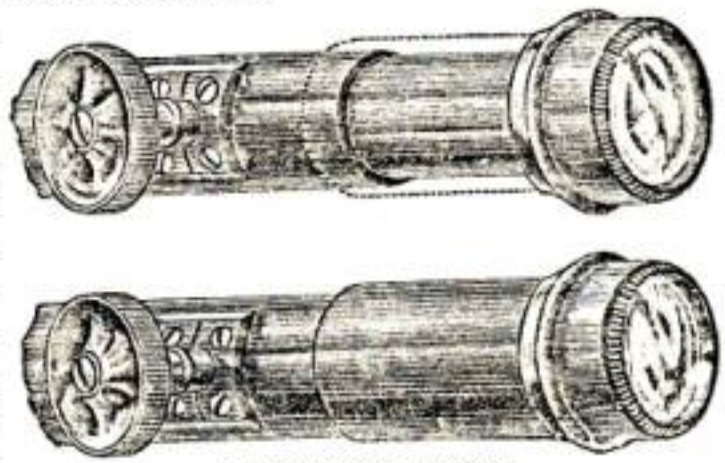
WEB FASTENER.

To obviate these errors, we fasten the telescope on the Y's so as to prevent any rotation. Observations can be made at any portion of the field of view, equally as well as the centre. Another advantage consists in the certainty with which the Engineer can regulate the perpendicularity of his rod.

The attachment interferes in no manner with adjustment of instrument. It has met with universal approbation wherever used.

Slide Protector.

The motion of tube or slide of object glass upon main telescope tube is apt in time to wear, one or both sufficient to produce a shake, the result of which is to throw line of sight to one side or other in focusing the telescope. Inability to wear a long time without shake is a sign of a poorly constructed instrument; but even in best constructed the dirt, grit, &c., which adheres to slide and is carried into tube by it, is a cause of more rapid wearing, or a greater inconvenience at the time, by a fretting of the slides. Rain and moisture is also carried in making air inside of tube damp and affecting the performance of telescope.

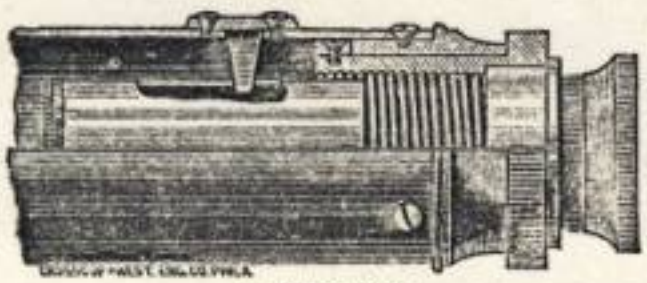


SLIDE PROTECTOR.

As a preventative we have added our SLIDE PROTECTOR,—a thin tube or sleeve covering the slide and moving with it, so that neither dust nor dirt can reach it.

The attachment preserves the slide, upon which perfection of collimation depends, in good condition for a much longer time.

Eye Piece.*



EYE PIECE.

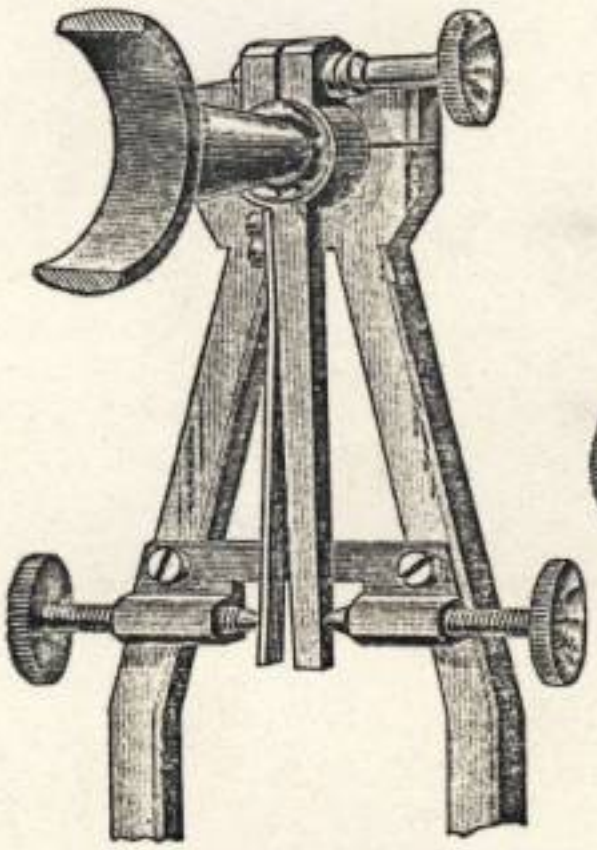
The Improved Eye Piece adjusts the focus to web with great precision and smoothness. It is so made that the eye piece does not turn as it moves out and back, but moves in same straight line, preventing rotation of eye piece upon image.

An incorrect focusing of eye piece produces parallax in sighting, throwing object to one side or other of web. An accurating focusing or eye piece is of as much importance as power of telescope; and as power increases it is the more difficult to focus with the usual slide—with extreme high power almost impossible—hence, importance of this improvement.

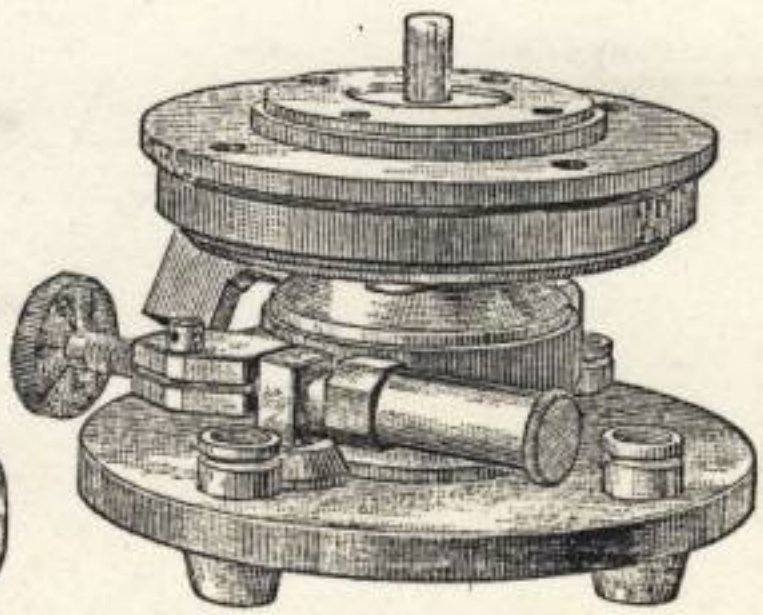
Opposing Piece.

Wherever the opposing piece is used we now attach a strong German-Silver spring, as shown in the engravings.

This spring has sufficient tension to keep the clamp firmly in position, and insures a steady movement while in use, *it being necessary to use only one of the opposing screws at a time.*



SHOWS CLAMP AND OPPOSING PIECE ATTACHED TO THE AXIS OF TELESCOPE.



SHOWS CLAMP AND OPPOSING PIECE ATTACHED TO THE CENTRE OF TRANSIT.

---

*The original adjustable eye piece we believe to have been made by Messrs. Kubler & Seelhorst. We believe our method to be an improvement.

Improvement for Reading Verniers.

Patented.

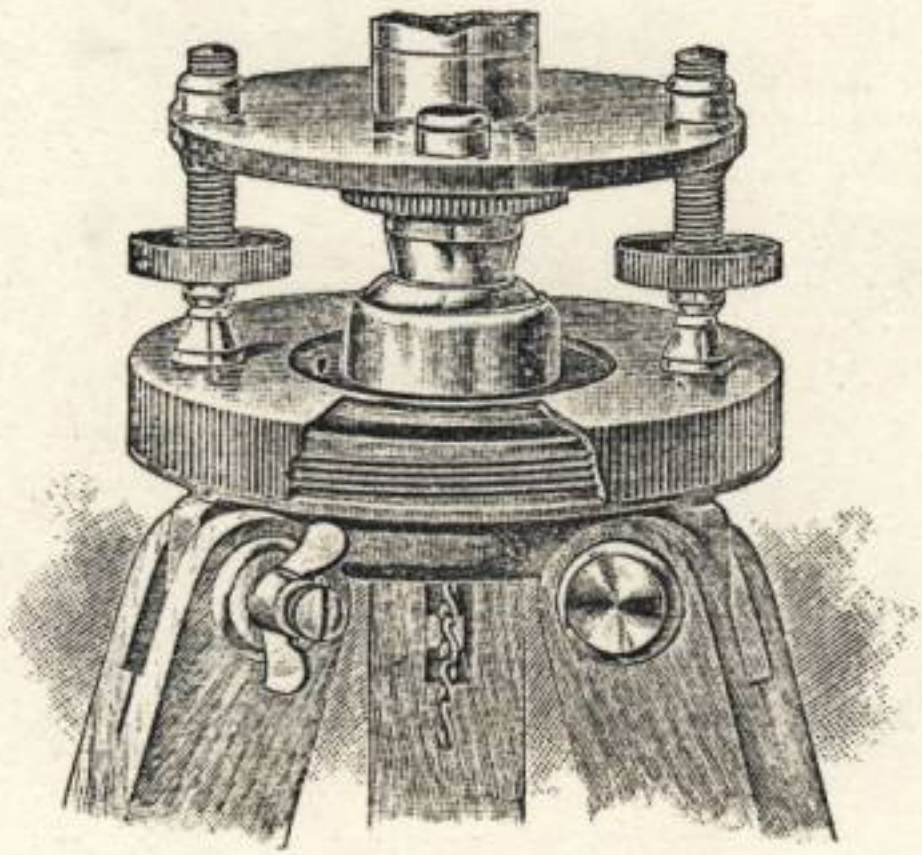
This improvement consists of etching the glasses covering the vernier, with divisions to correspond with the divisions on the graduated plate of the Transit. In reading the vernier, by bringing the eye in the range of the etched division on the glass and the corresponding division on graduated plate, the eye must necessarily be in proper position to obtain the correct reading, and the differences of readings, as the eye is moved from one side to the other, are eliminated, and the error of parallax is destroyed.

An extra charge of $10.00 is made when this improvement is placed upon our Transits.

Leveling Screws.

Leveling screws pass through nuts, and are provided with non-detachable, anti-friction cups.

By passing the screws through nuts the male and female threads wear even, and when much worn, both can be replaced. Having the screws pass through a four arm piece, either split or solid, has been discarded by us, as new screws mean a new centre; not only a useless expense, but the Engineer is under a decided disadvantage in case of accident.



ATTACHMENT TO TRIPOD.

Patent Shifting Tripod.

(*Patented July 13, 1858.*)

By simply loosening the level screws, the instrument can be shifted a small distance in any direction, after the instrument has been set approximately.

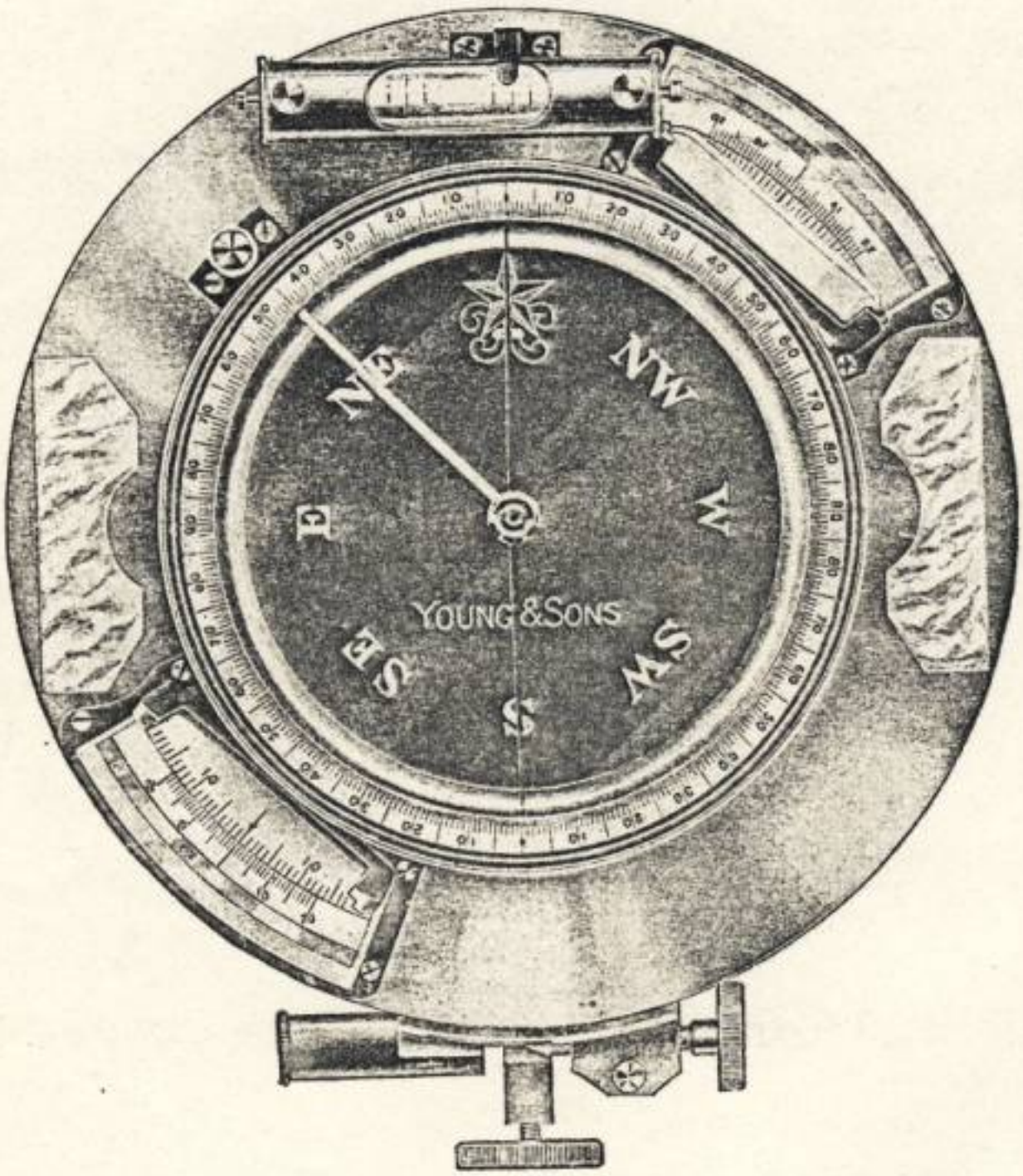
The great convenience of this is evident to every Engineer. It is preferable to all imitations, inasmuch as it may be called self-acting, the wire leveling up screws to ordinary tension holds instrument firmly in its place.

Young & Sons' Non-Extension Telescope.

(*Patented by John W. Nystrom and Alfred Young.*)

The advantages of a Non-Extension Telescope are: Its uniform length, stationary postion of the object glass and complete closing of the Telescope.

The disadvantages are: Loss of light and the impossibility to use stadia hairs.



The above engraving shows main plates of our Transit, and their relative working parts, including the position of verniers to one side of standards, so decidedly preferable where the Engineer is working in confined positions, and so much more favorable for throwing light upon graduations.

Placing the verniers to the side of the standards, to facilitate reading of the verniers, originated on Young & Sons' Transits.

Descriptive Details of Young & Sons' ENGINEERS' TRANSITS

Telescope

Carefully balanced, clear field, plenty of light, splendid definition.
Particularly adapted for Stadia work.
Vertical adjustment of Telescope axis.
Axle bearings working in hard metal.
Collimation, correct for all distances.

Telescope Standards

Improved, with well-braced supporting base.

Centres

Extra long, tapering, with large flanges.
Inside centre made of Bell metal from our own secret composition. Middle centre of Red metal, and the outside of hammered yellow brass.
All recalculated to allow for expansion and contraction, and reducing wear and friction to a minimum.

Graduations

Made by our large Automatic, roller-bearing Engine, on a specially prepared plate, centred on the Engine by an angle reflecting mirror.
The graduations on Young & Sons' Transits are not made on a casting, which is always more or less spongy, but on a hard-rolled and trip-hammered plate, whereby we obtain a density and stiffness of metal to be obtained in no other way.

Verniers — Two Double Verniers, reading to single minutes, placed at 42° to the line of sight. Wide opening extending to the edge of the plate, allowing plenty of light. Covered with crystal plate glass.
Provided with light-diffusing, porcelain shades.

Level Vials — Extra long and sensitive, ground accurately, barrel shape, to uniform value. Carefully rated on our Level Tester. Etched Graduations.

Leveling Screws — Passing through nuts and provided with non-detachable, anti-friction foot cups.

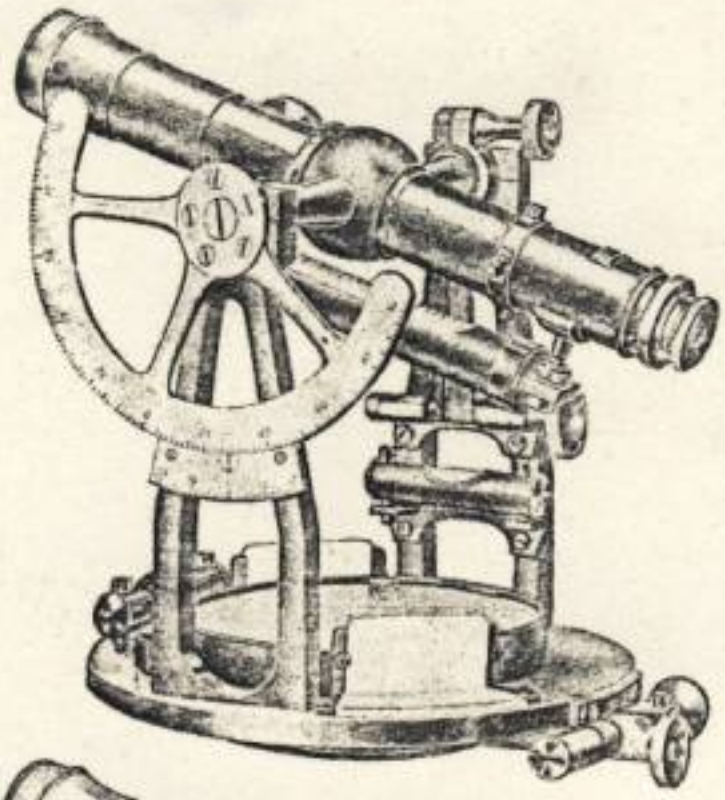
Finish — All Young & Sons' instruments are bronzed and lacquered to prevent reflection of the sun's rays. Compass graduations silvered, face of compass bronzed, screws only are polished.

Clamp and Tangent — In our new models the upper clamp, clamps on a special flange of the middle-centre. Positive and Direct. Improved box spring tangent on the outer edge of plate.

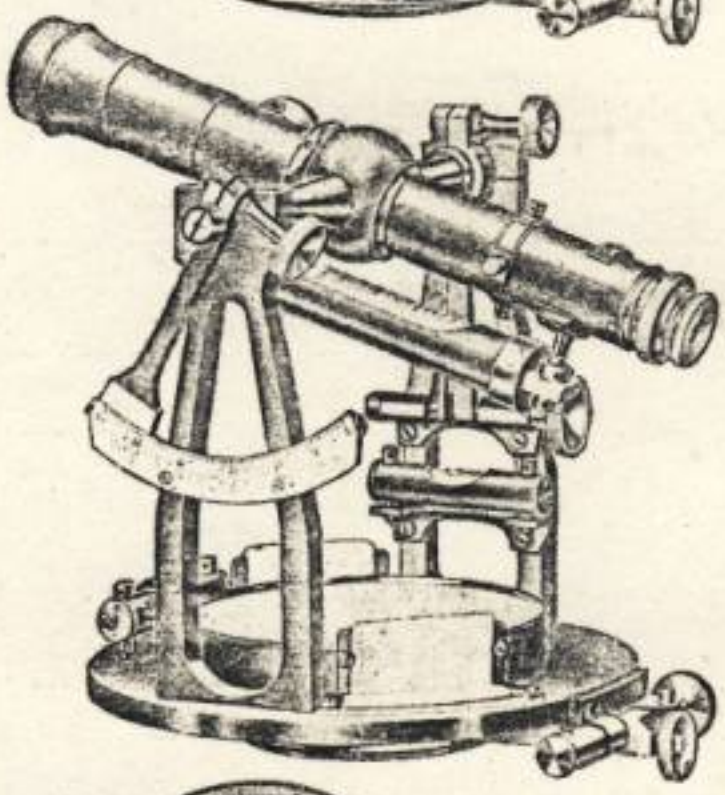
****Tripod Legs** — Each leg made of one piece, either split or round pattern. Wing Nuts. Shoes made of pressed steel.

*The original patent Shifting Tripod was invented, patented, and introduced by Young & Sons in 1858. Has since been adopted by all instrument makers.

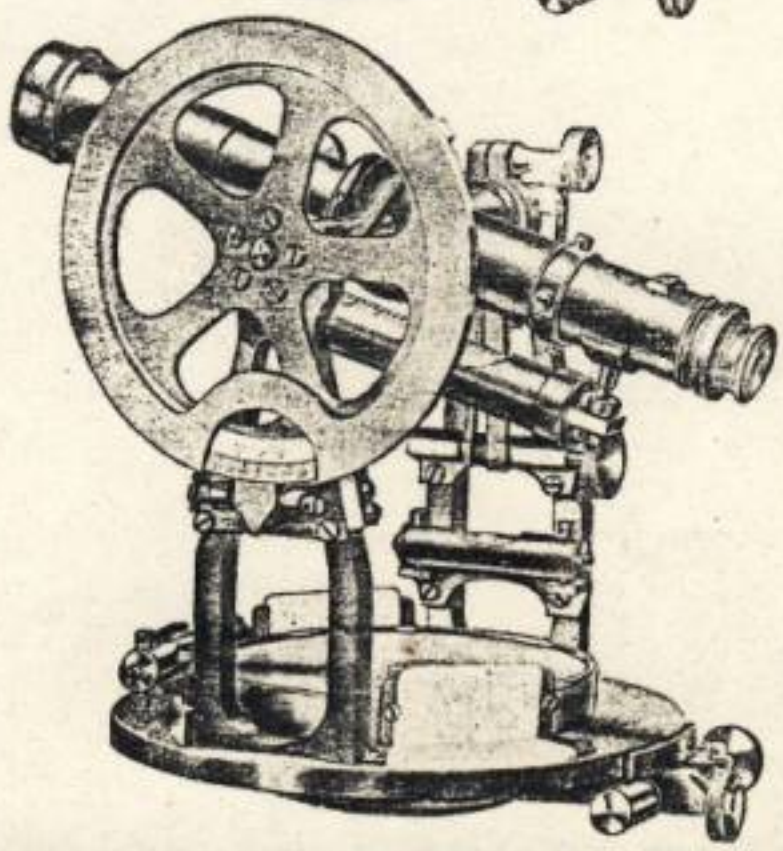
**Tripod Shoes made of pressed steel will remain sharp on the point for years, being smooth inside a perfect fitting with the leg is insured.



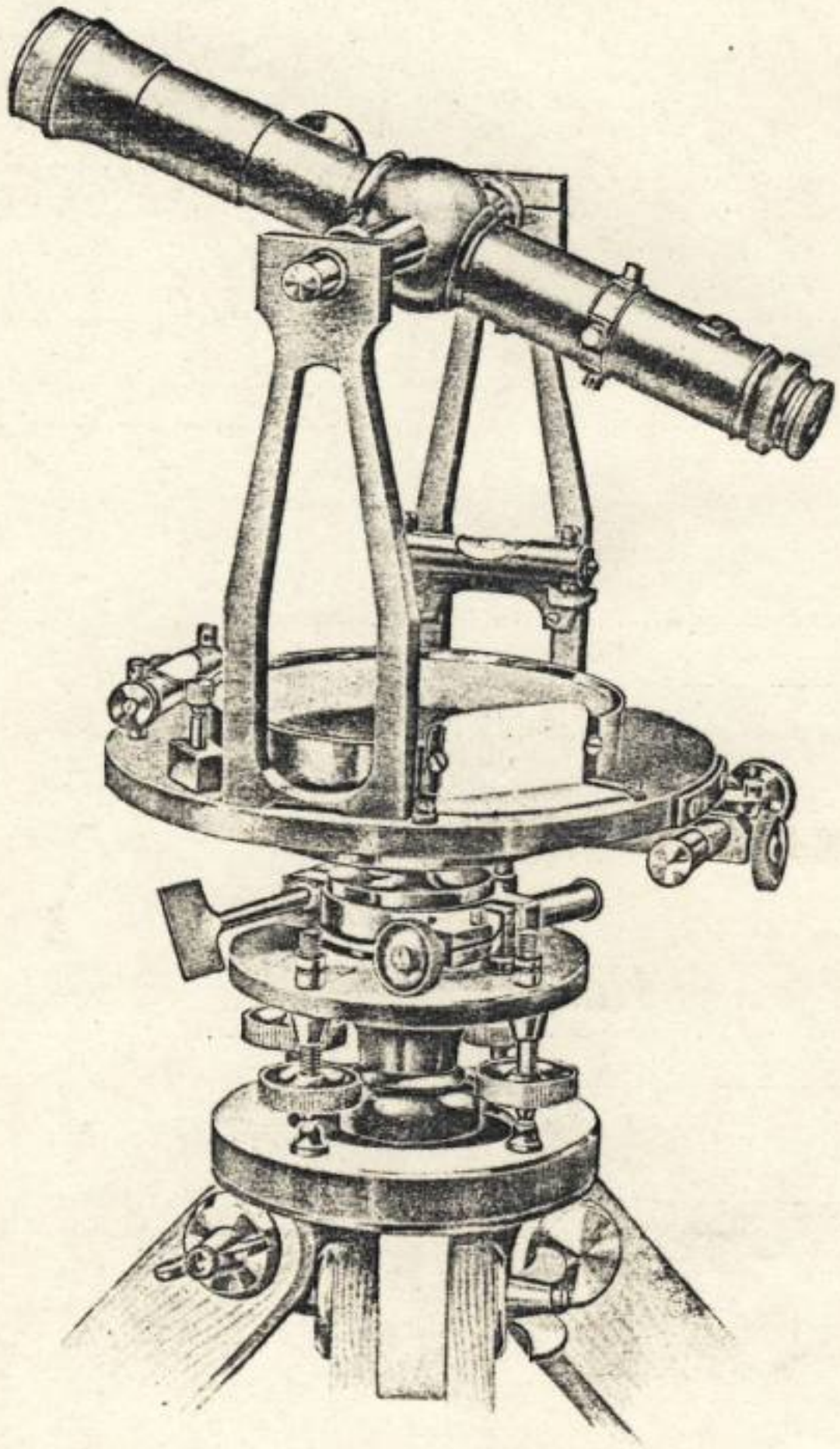
No. 6-TRANSIT
With Level to Telescope and 180° Swinging Arc.....$225 00
Code Word—Ivy



No. 6-TRANSIT
With Level to Telescope and 60° Fixed Arc
.....$225 00
Code Word—Spruce



No. 6-TRANSIT
With Level to Telescope and Full Vertical Circle with Spring Vernier and Guard..$240 00
Code Word—Palm



NO. 6-PLAIN TRANSIT

Price, as shown above, with 4½ in. Needle, 6¼ in. Graduations.....$185 00

Code Word—Oak

No. 6 Transit

This is our Standard Transit; it is designed for the highest class of Engineering work. We consider it the best adapted for general practice and Railway work.

In the important point of graduation, all work is done under personal superintendence, upon our large Automatic Engine, which is capable of graduating circles of 54 inches diameter, reading with miscroscopes to tenths of a second. *Our No. 6 Transit is graduated upon this engine.*

The graduations on Young & Sons' Transits are made on a hard-rolled, trip-hammered brass plate.

Power of telescope, 24 to 26, 1¼ inches diameter.
Objects erect-clear field and splendid definition.

Long tapering centres.
Hard metal. Heavy flanges.

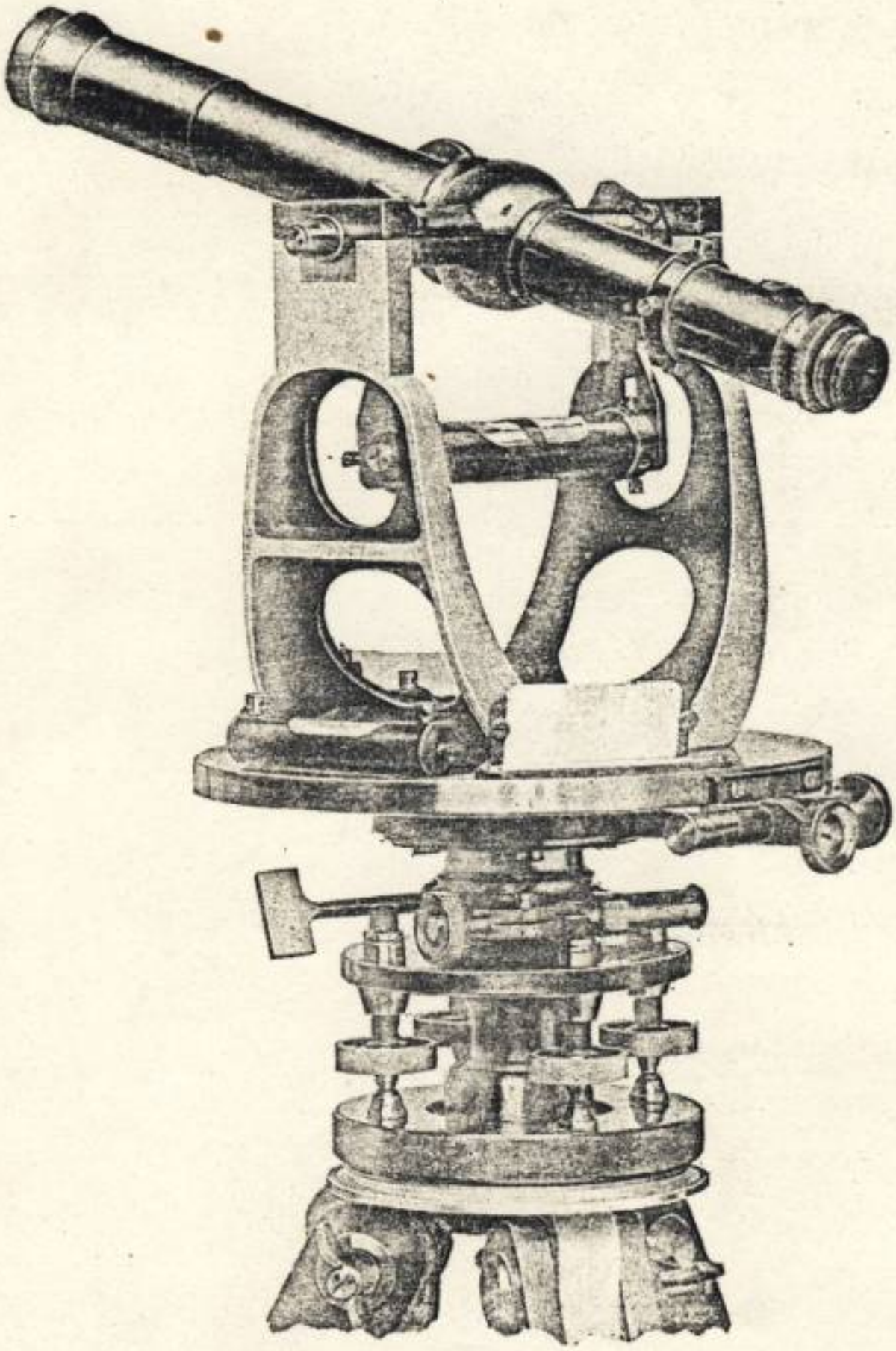
Needle 4½ inches long.

Plate graduated to twenty minutes,
Reading by two double verniers to single minutes.
Graduations 6¼ inches. Silvered.
Numbered o to 180 to o. Unless otherwise ordered.
No extra charge for special numbering.

Vertical adjustment to telescope.
Line of collimation correct for all distances.
Instrument centre on top of axle to telescope.
Bronze finish.
Transit packed in box, supported above
Leveling screws to protect it in transportation. **$185.00**

These instruments are furnished with

Young's Improved Eye Piece,
" " Slide Protector,
" " Tangent,
" " Flange-Clamp,
" Patent Shifting Centre
" Tripod, Open Ash Legs, Wing Nuts.
Pressed Steel Shoes



No. 7-CITY AND BRIDGE TRANSIT

Plain, as shown above, Price.....$210 00

Code Word—"City"

Our No. 7 City and Bridge Transits will be furnished as ordered, either with regular standards and compass or with "U" shaped standards without compass, for the same price.

When "U" shaped standards are desired add the word "gun" to the code word of regular standards.

Regular Standards	Code Words
No. 7 City and Bridge Transit, Plain	City
With Level and Clamp to Telescope	Villa
With Level and 60° Arc	Bridge
With Level and 180° Arc	Hamlet
With Gradienter and Level to Telescope	Burg

No. 7

For City and Bridge Engineering.

The improvements on these instruments are adapted to use of Railway and other Engineers.

A large proportion of our business, within late years, having been in the construction of City Instruments, we have placed upon them several improvements, bringing them so near perfection, both in steadiness and delicacy, as to merit the attention of City Engineers.

In the important point of graduation, all work is done under personal superintendence, upon our large Automatic Engine, which is capable of graduating circles of 54 inches diameter, reading readily with miscroscopes to tenths of a second. *The City Transit made by us is graduated upon this Engine.*

The essential difference between the No. 6 Standard Transit and the No. 7, City and Bridge Transit is, that the latter is provided with

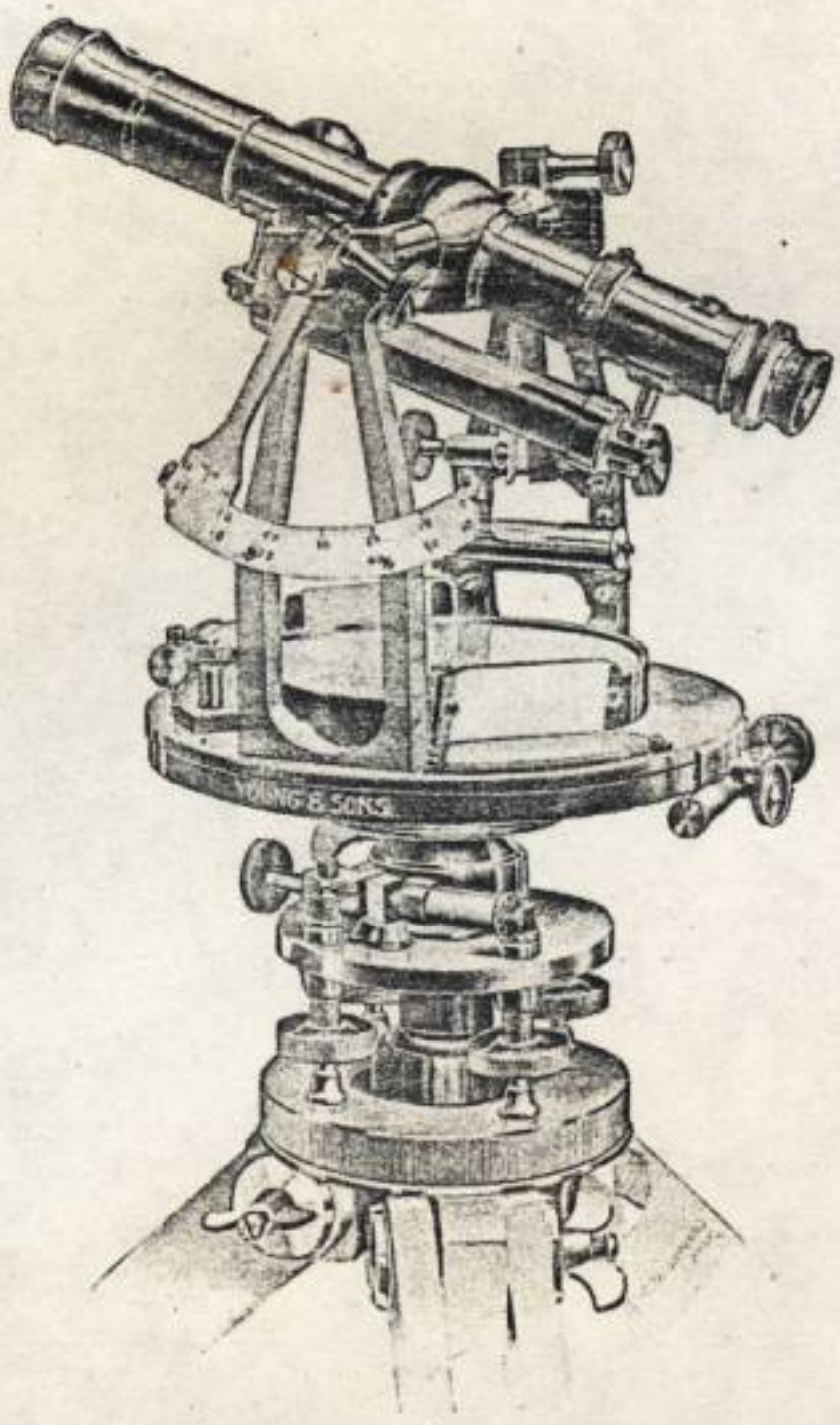
Larger graduations, reading finer.
The graduations are on solid silver,
Inserted in a hard-rolled, trip-hammered brass plate.
It has a "striding-level" suspended from cross-axis
Of telescope to test the motion of telescope in a
Vertical plane.

Telescope erect (or inverting). Power 24 to 26.
Graduations 6¼ inches, on solid silver,
Reading by two double verniers to single minutes,
30 or 20 seconds.
Striding-level suspended from cross-axis.
For further particulars consult description of
No. 6 Transit.

$210.00

These instruments are furnished with

Young's Improved Eye Piece,
" " Slide Protector,
" " Tangent,
" " Flange-Clamp,
" Patent Shifting Centre,
" Tripod, Open Ash Legs Wing Nuts,
Pressed Steel Shoes.



NO. 10-MOUNTAIN OR MINING TRANSIT

Needle 3½ inches long, Graduations 4¾ inches, reading to minutes, Level to Telescope, Clamp and Opposing Screws, and Vertical Arc, Price $225 00

Price, Full Vertical Circle with Guard 240 00

Extension Tripod, extra 10 00

	Code Words
No. 10 Mountain or Mining Transit, Plain	Mountain
With Level and Clamp to Telescope	Ravine
With Level and 60° Arc	Hill
With Level and 180° Arc	Valley
With Level and Full Vertical Circle	Mound

No. 10
Mountain or Mining Transit.

This instrument is designed for Engineering as needs a light, portable instrument. In workmanship, graduations and proportionate strength, it is as reliable as larger instruments, principal difference being in weight. It has simply, in construction, the disadvantage of smaller circle and smaller needle.

It is equal to performance of all the ordinary duties of Railway work. It is a reduced model of our No. 6.

The verniers are wide, extending to edge of plate, to allow extra amount of light. They have advantage of being so placed that the Engineer can read the plate without changing his position, risking the disturbance of instrument. The graduations on Young & Sons' Transits are made on a hard-rolled, trip-hammered brass plate.

Power of telescope 22, diameter of object glass 1.1 inches.
Objects erect with a clear field and splendid definition.

Long tapering centres.
Hard metal. Heavy flanges.

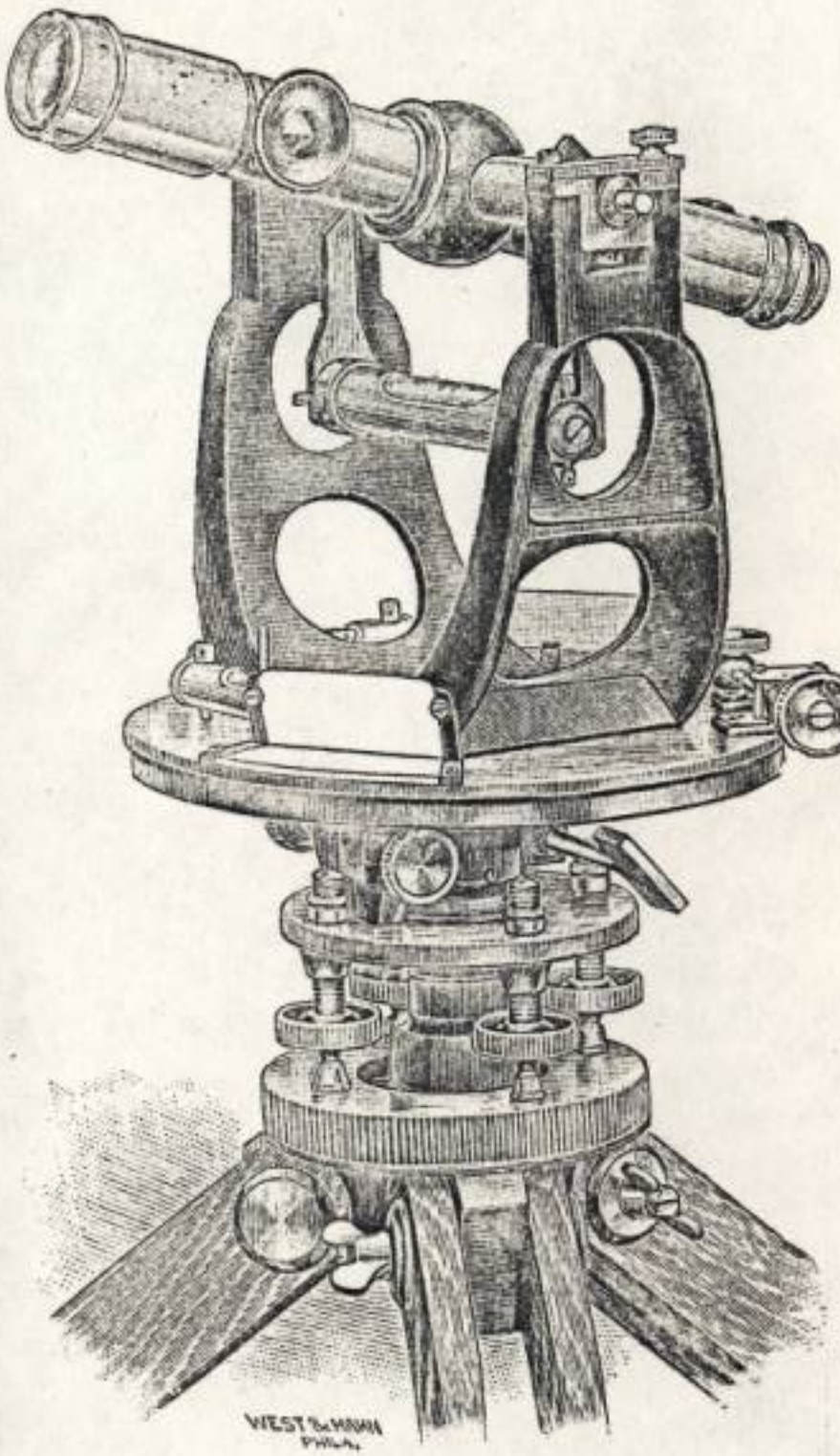
Needle 3½ inches long.

Plate graduated to thirty minutes,
Reading by two double verniers to single minutes.
Graduations 4¾ inches. Silvered.
Numbered 0 to 180 to 0. Unless otherwise ordered.
No extra charge for special numbering.

Vertical adjustment to telescope.
Line of collimation correct for all distances.
Instrument centre on top of axle to telescope.
Bronze finish.
Transit packed in box, supported above
Leveling screws to protect it in transportation. **$185.00**

These instruments are furnished with

Young's Improved Eye Piece,
" " Slide Protector,
" " Tangent,
" " Flange-Clamp,
" Patent Shifting Centre,
" Tripod, Open Ash Legs, Wing Nuts,
Pressed Steel Shoes.



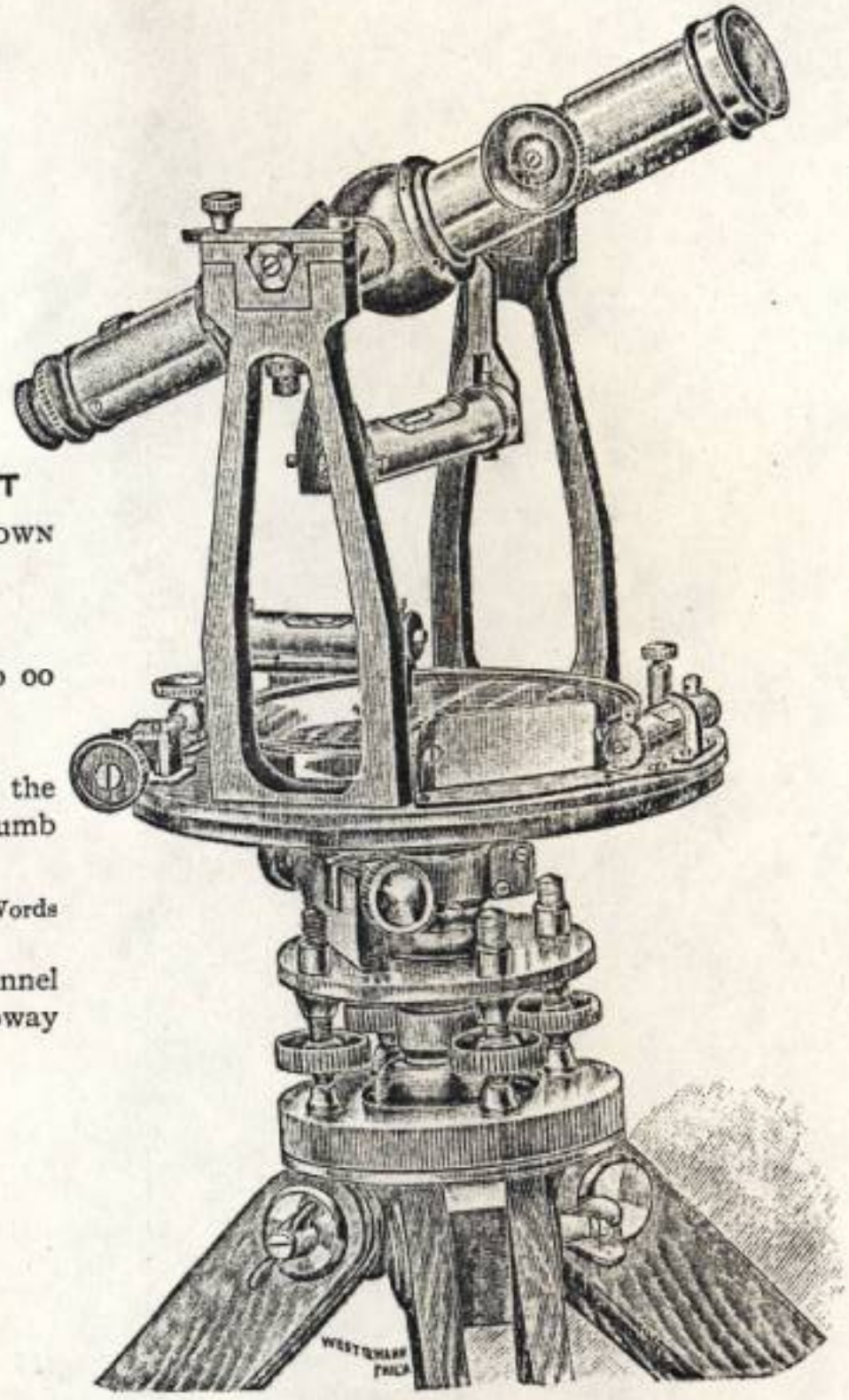
No. 13-TUNNEL TRANSIT

PRICE, CHOICE OF DESIGN AS SHOWN HERE:

Needle 5 inches long, Graduations 6¾ inches.....	$250 00
"U" shaped STANDARD of Aluminum, no needle...	

Centred on top of the axis of the telescope so as to be able to plumb from the roof of the Tunnel.

	Code Words
No. 13 Tunnel Transit, with regular standards.....	Tunnel
With "U" shaped standards..	Subway



No. 13

City and Tunnel Transit.

Adapted especially for Straight Lines.

The axis of telescope is set upon Y bearings, and the telescope accurately balanced that it may move easily and not risk disturbance in revolving it. The axis bearings are cylindrical, that the telescope may be reversed on these bearings as well as revolved on them. This affords opportunity for testing adjustment of collimation speedily without change of instrument, or if not in adjustment, of making two points the mean of which is correct.

A striding level suspended upon the axis tests motion of the telescope in a vertical plane. For tunnel work, the eye piece is made inverting to obtain light when desired.

We frequently make them with "U" shaped standards and without needle, the advantage gained is increased steadiness.

These instruments are sometimes made with hollow telescope axis and reflector illuminating web, on inside of telescope tube.

No. 13 Transit is our City and Bridge Transit
with above described modifications.
For full details see No. 7 Transit.

5 inch needle,
6¾ inch graduations,
Reading to minutes,
30 or 20 seconds.
Telescope axis set in Y bearings.
Striding level suspended from
Axis of telescope. **$250.00**

Young & Sons' Improved Mining Transits.

Our Mining Transits are in all essential features the same as our Engineers' Transits; the larger size corresponding to our Railway, and the smaller to our Mountain, Transits, with only such modifications necessary to adapt them to the wants of the Mining Engineer.

Our Improved Non-Extension Dust Proof Telescope makes a valuable addition to all Mining Transits, as it totally excludes dust, grit and foreign matter, preventing all wearing of the object slide. Stadia hairs, however, cannot be used with these telescopes, and when it is essential that the telescope be provided with the stadia-hairs, we use the regular style telescope with improvements where the wearing of object slide is brought to a minimum and provided for.

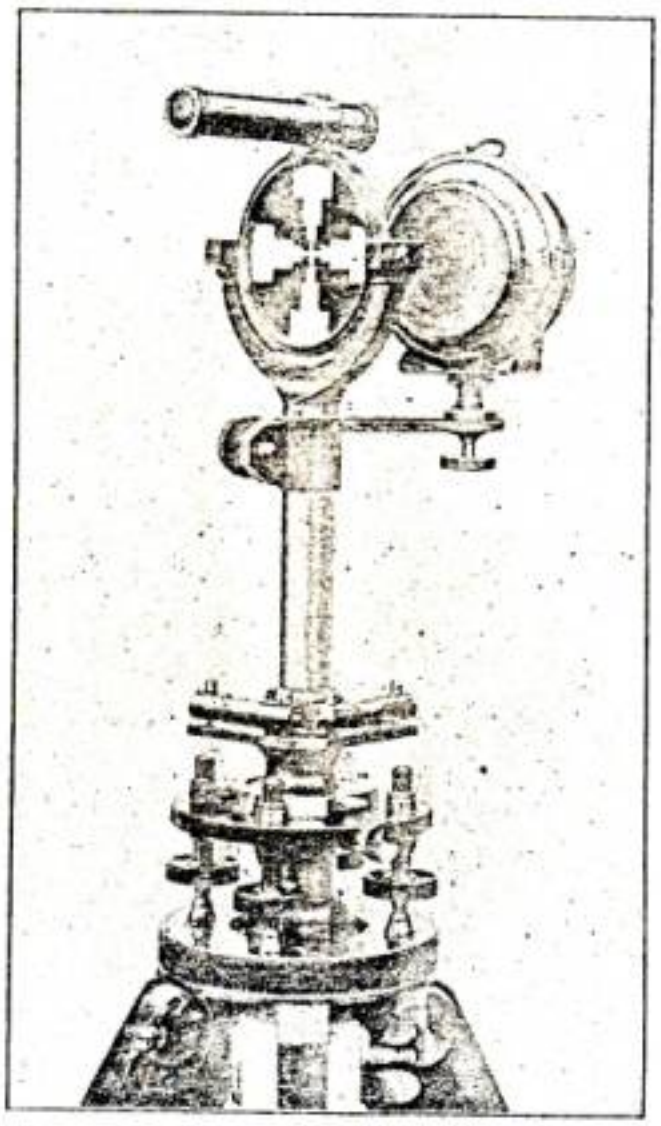
The Graduated plates are not made from castings, but from our specially made hard-rolled and hammered plates, upon graduating engines of our own design and manufacture. The graduations themselves are sharp and distinct and numbered with two rows of inclined figures from 0 to 360, in contrary directions.

The verniers are waterproof, placed at 45° to the line of sight, are extra wide to admit light and are provided with opaque glass reflectors.

Tripods are furnished with extension legs of our own special pattern, remarkably steady. The shoes are made from Disston's rolled steel, insuring perfect fit with the leg and remaining sharp for many years.

Both Transit and Auxiliary telescopes are provided with reflector for cross-hairs and an interchangeable diagonal (prism) eye-piece.

Mining Transits with Lamp-Targets.



Mining Transits Numbers 1, 2, 3, 4 and 5 are furnished when so ordered, to be used with Mining Lamp-Targets, detachable above the leveling screws and interchangeable with the instrument, so that in sighting forward the Target is placed in position, the instrument taken from tripod and moved into forward tripod, while Lamp-Target is substituted on one left by instrument.

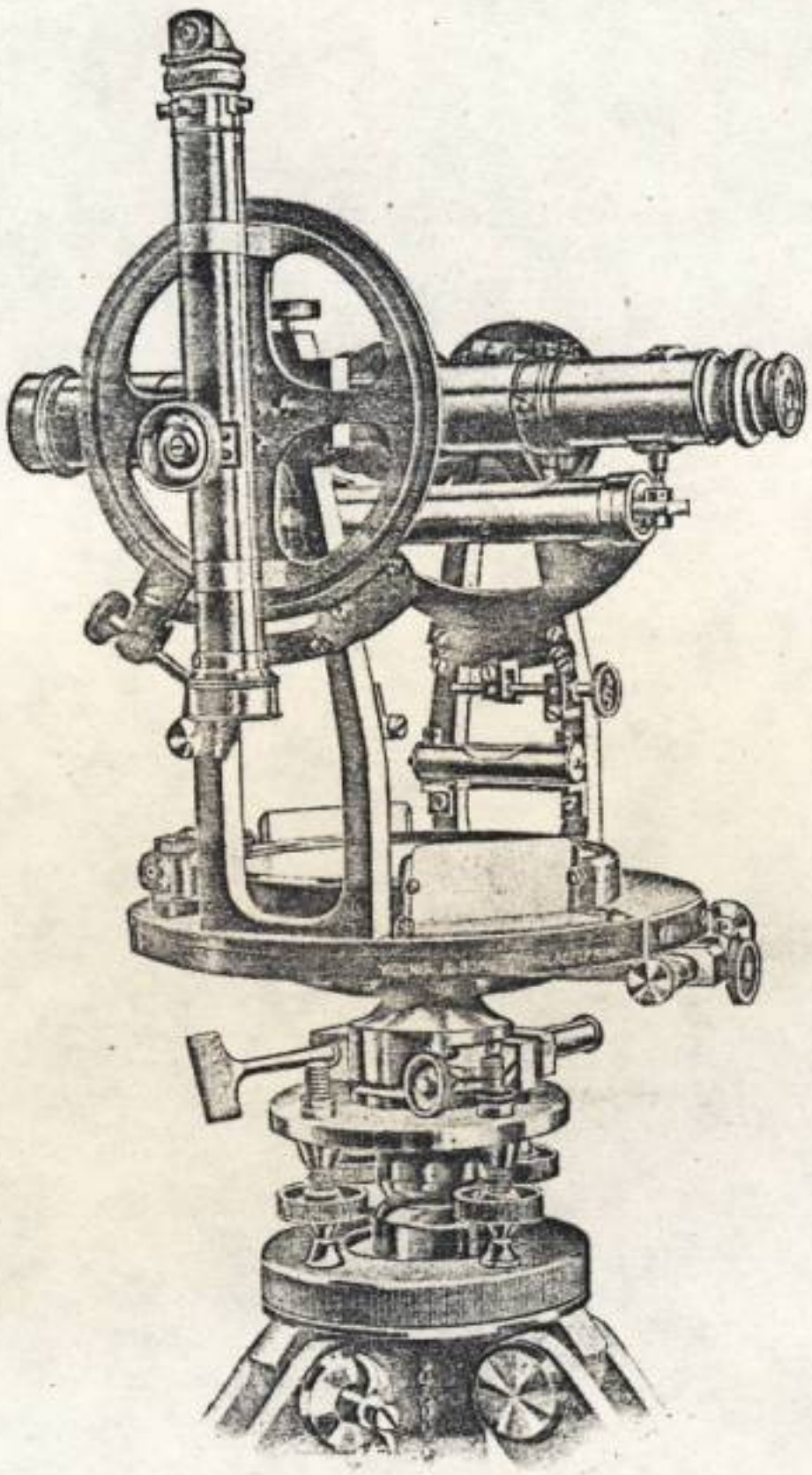
The Target is the same height as the Transit, measured from the parallel plate to the line of sight, and being provided with two spirit levels set at right angles and having both horizontal and vertical motion, it is quickly set to the proper angle of the line of sight by means of the sight vane. The face of the Target is made of milk-white glass (on which is painted a suitable figure), and illuminated from the back by a bull's-eye lantern, which can be thrown in and out of position as desired. It is essential that lard oil be used with lamp.

As it is evident to the Engineer that the centers of the Transit and the Lamp-Targets must be fitted with that degree of accuracy as to be interchangeable, they cannot be furnished separately and it is necessary that the question of one or two Lamp-Targets must be decided at the time of placing order for Transit.

Prices.

Two Lamp-Targets, complete, with Extension Tripods, $175 00
One Lamp-Target, complete, with Extension Tripod . 90 00

These prices are in addition to those given for the Transit.



YOUNG & SONS' IMPROVED MINING TRANSIT-No. 1

Price, complete—$350 00

Including clamp and opposing screws to axis of telescope, not shown

Code Word—Yellow

Young & Sons'
Improved Mining Transit No. 1.

A complete Mining Engineers' Transit. Auxiliary Side Telescope attached to large Vertical Circle, with counterpoise. Detachable.

TRANSIT has compound long centres, needle 5 inches long; Graduations 6¾ inches, reading to single minutes; improved tangent to plates and opposing-piece to centre. Vertical adjustment to telescope and instrument centered on top of axis to telescope, and furnished with Diagonal (Prism) Eye-piece and Reflector for cross-hairs; and will focus to objects five feet distant; Reflectors to verniers. Level to telescope, clamp and opposing screws and Vertical Arc. Telescope with improve eye-piece and dust cover to object slide. Tripod with shifting motion and extension legs.

MINING ATTACHMENT.—Consisting of an Auxiliary Side Telescope, Non-Extension pattern, 7 inches long, ⅞ inch object glass, attached to a full Vertical circle, 5 inches in diameter and reading to single minutes, with counterpoise; all detachable and packed in instrument box when not in use. Auxiliary telescope revolves independent of Transit telescope and is provided with a Diagonal (prism) Eye-piece and Reflector for cross-hairs.

Both telescopes in these instruments are made to show objects erect unless otherwise ordered. The verniers are wide, extending to the edge of plate to allow extra amount of light, and have the advantage of being so placed that the Engineer can obtain readings without changing his position, risking disturbance of instrument.

Young & Sons'
Improved Mining Transit No. 2.

A complete Mining Engineer's Transit. Auxiliary Top Telescope with counterpoise. Detachable.

TRANSIT. Made in two sizes, having compound long centres. Graduations reading to single minutes, improved tangent to plates and opposing-piece to centre. Vertical adjustment to telescope and centered on top of axis to telescope, and furnished with Diagonal (Prism) Eye-piece and Reflector for cross-hairs. Level to telescope, clamp and opposing-screws and Vertical Circle. Telescope with improved eye-piece and dust cover to object slide.

Tripod with shifting motion and extension legs.

Mining Attachment.

Consisting of an Auxiliary Top Telescope with counterpoise. This telescope is provided with a Diagonal (Prism) Eye-piece and Reflector for cross-hairs.

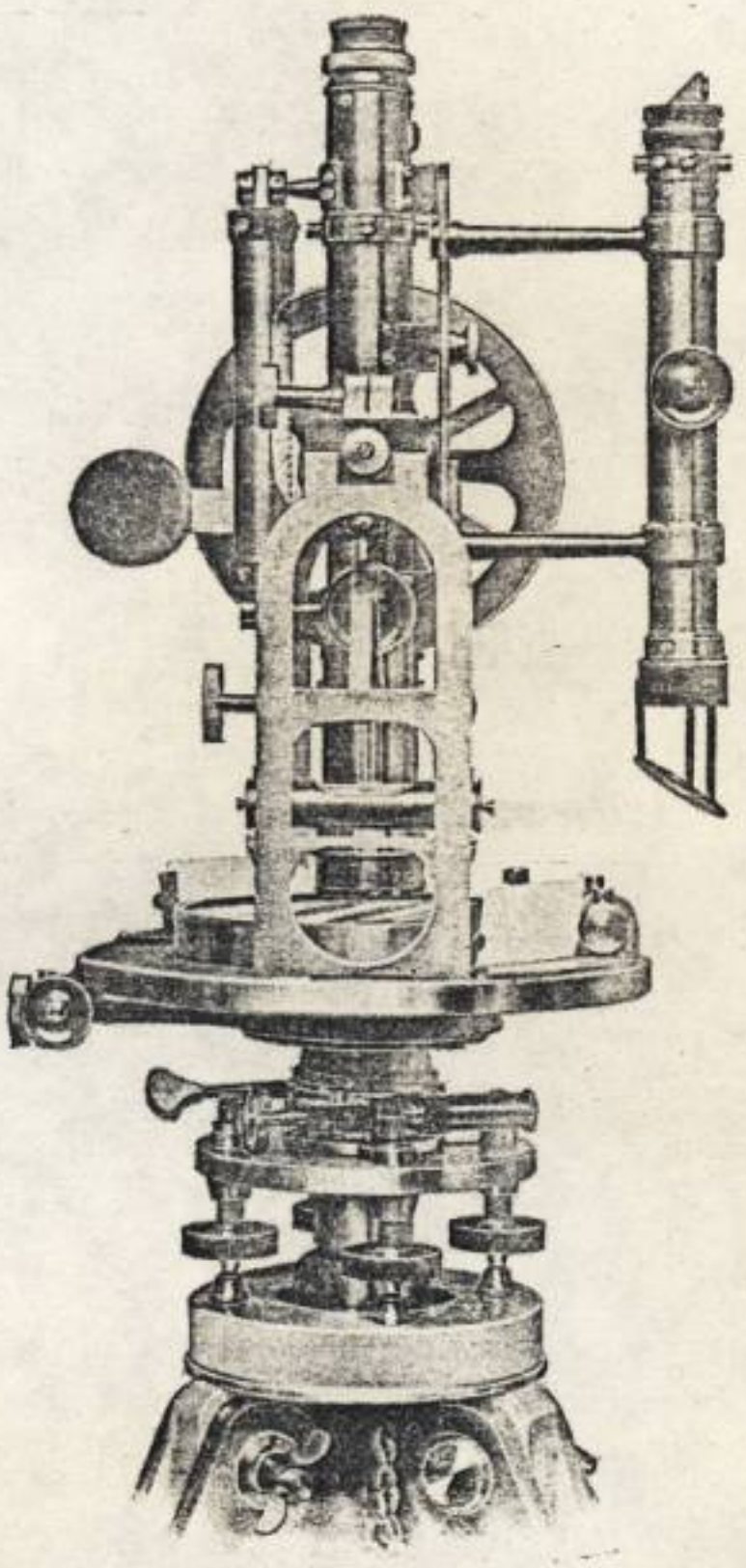
The objection heretofore to this style of Auxiliary telescope has been owing to the method of attaching to the main telescope. When pillars were made detachable, there was difficulty in keeping the telescopes truly parallel. When pillars were attached permanently to the main telescope, they were liable to be bent and the transit was awkward to handle. By our improvement of mounting the pillars on a base and attaching to the main telescope by means of "Y" bearings, the same as used on our solar attachments to telescopes, these objections are entirely overcome, making this form of a Mining Transit (where an auxiliary telescope is desired) decidedly preferable.

Mining Transit No. 2.

Is Made in Two Sizes.

	NO. SIX LARGE SIZE	NO. TEN SMALL SIZE
Needle	4½ inches.	3½ inches.
Graduations	6¼ "	4¾ "
Vertical circle	5 "	5 "
Telescope will focus to	5 feet	5 feet
Price complete as shown in engraving	$275.00	$275.00

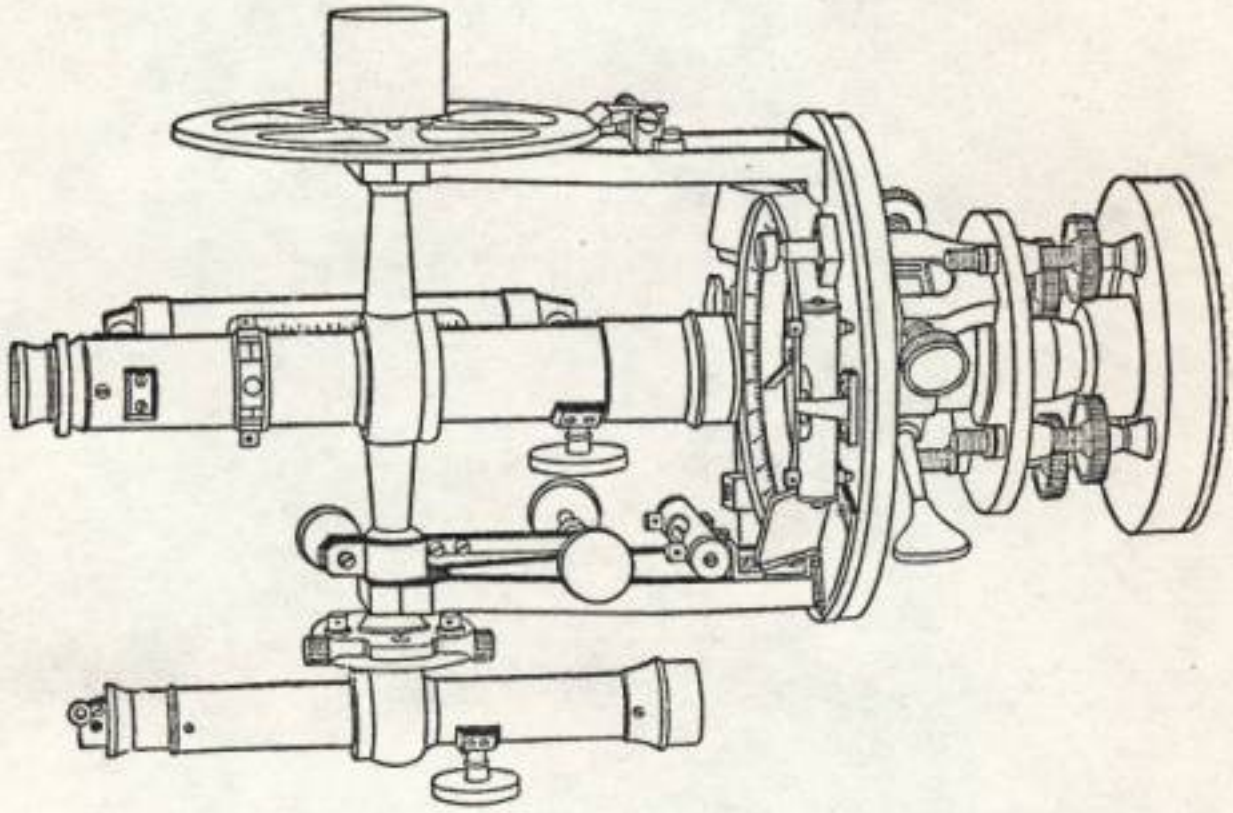
Both telescopes in these instruments are made to show objects erect unless otherwise ordered. The verniers are wide, extending to the edge of plate to allow extra amount of light, and have the advantage of being so placed that the Engineer can obtain readings without changing his position, risking disturbance of instrument.



YOUNG & SONS' IMPROVED MINING TRANSIT-No. 2

Guard for Vertical Circle included

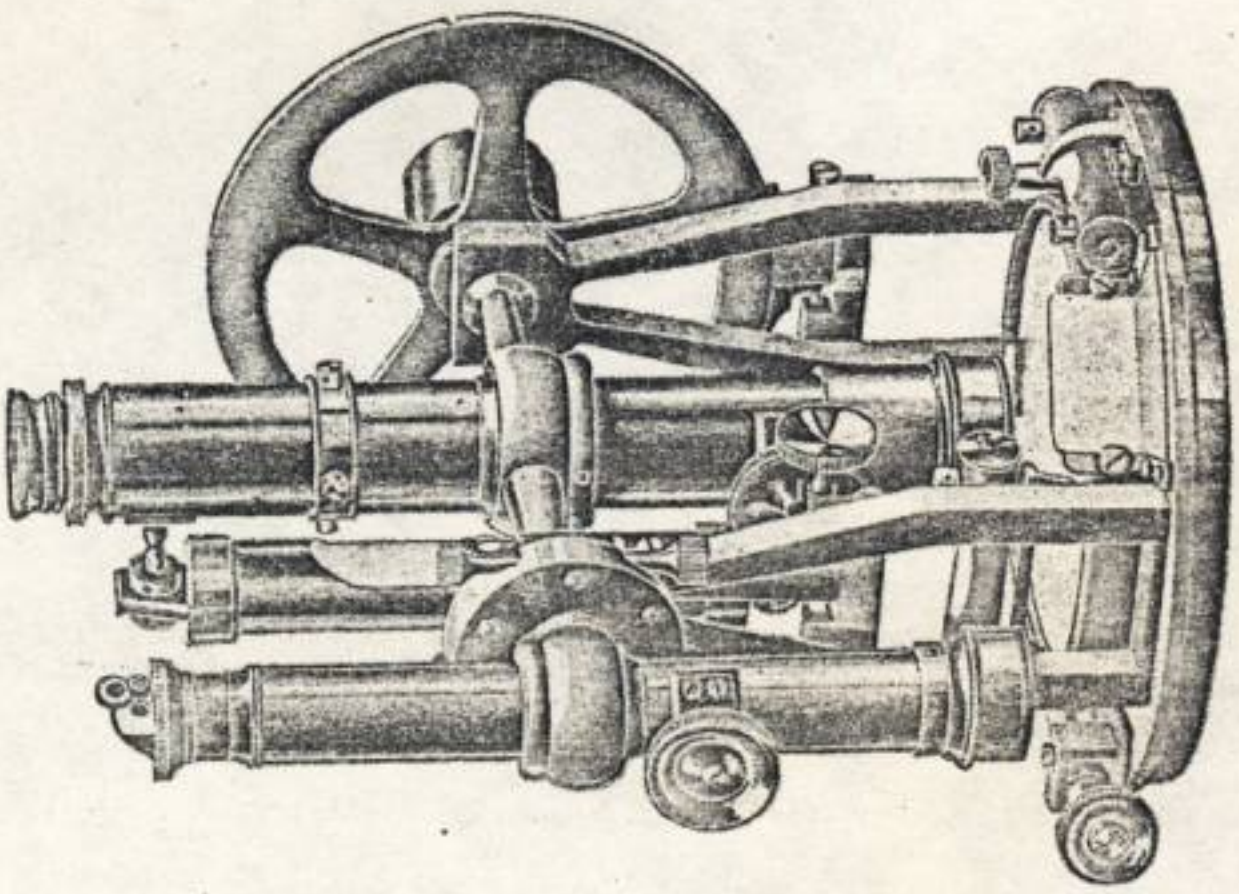
Code Words—Large size, Blue; small size, Green



YOUNG & SONS' IMPROVED MINING TRANSIT-No. 3

Guard for Vertical Circle included.

Code Words—
Large size, Red
Small size, Black



Young & Sons'
Improved Mining Transit No. 3.

A complete Mining Engineer's Transit. Auxiliary Side Telescope with counterpoise. Detachable.

TRANSIT. Made in two sizes, having compound long centres. Graduations reading to single minutes, improved tangent to plates and opposing piece to centre. Vertical adjustment to telescope and centered on top of axis to telescope, and furnished with Diagonal (Prism) Eye-piece and Reflector for cross-hair. Level to telescope, clamp and opposing-screws and Vertical Circle. Telescope with improved eye-piece and dust cover to object slide.

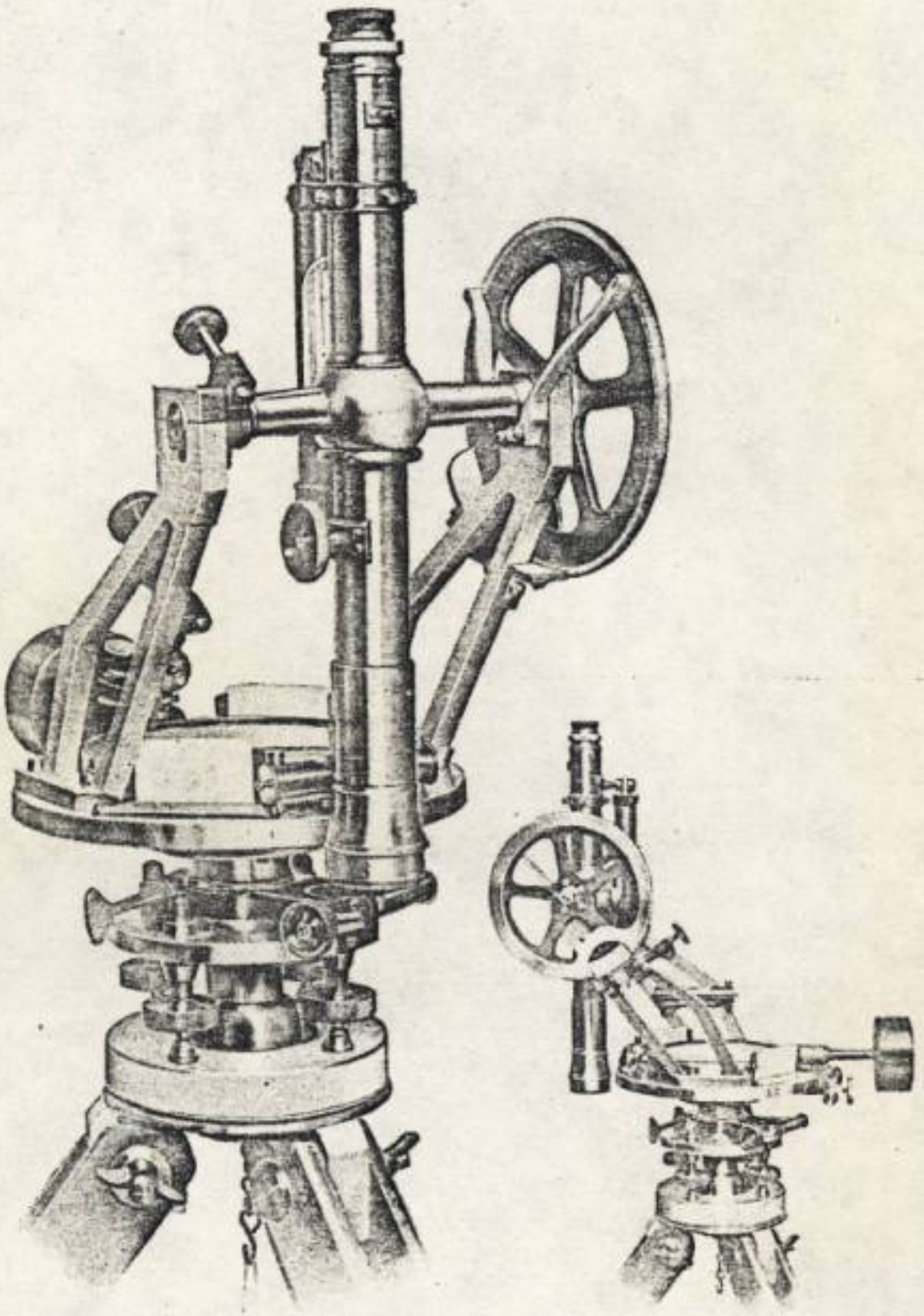
Tripod with shifting motion and extension legs.

Mining Transit No. 3.

Is Made in Two Sizes.

	NO. SIX LARGE SIZE	NO. TEN SMALL SIZE
Needle	4½ inches.	3½ inches.
Graduations	6¼ "	4¾ "
Verticul circle	5 "	5 "
Telescope will focus to	5 feet	5 feet
Price complete as shown in engraving	$275.00	$275.00

Both telescopes in these instruments are made to show objects erect unless otherwise ordered. The verniers are wide, extending to the edge of plate to allow extra amount of light, and have the advantage of being so placed that the Engineer can obtain readings without changing his position, risking disturbance of instrument.



YOUNG & SONS' IMPROVED MINING TRANSIT-No. 4

Guard for Vertical Circle included

Code Words—Large size, Pink; Small size, White

Young & Sons'
Improved Mining Transit No. 4.

The principal novelty of this Mining Transit is in the arrangement of the Inclined Standards by which the Engineer is enabled to range the telescope to a vertical line. The result is obtained without any additional telescope, while the line of collimation remains on a line passing through the centre of instrument, consequently all measured horizontal angles have their vertices over a centre point, and no correction for offset is necessary, avoiding the inconvenience and liability of error of double telescopes.

By means of longer centres, a light counterpoise and arrangement of details the overbalance of telescope is entirely destroyed.

The No. 4 Mining Transit is the widely known Inclined Standard, standing alone as the only instrument of its kind that has stood the test of time, in which the telescope can be ranged in a Vertical Line.

TRANSIT. Made in two sizes, having compound long centres. Graduations reading to single minutes, improved tangent to plates and opposing-piece to centre. Vertical adjustment to telescope and centered on top of axis to telescope, and furnished with Diagonal (Prism) Eye-piece and Reflector for cross-hairs. Level to telescope, clamp and opposing-screws and Vertical Circle. Telescope with improved eye-piece and dust cover to object slide.

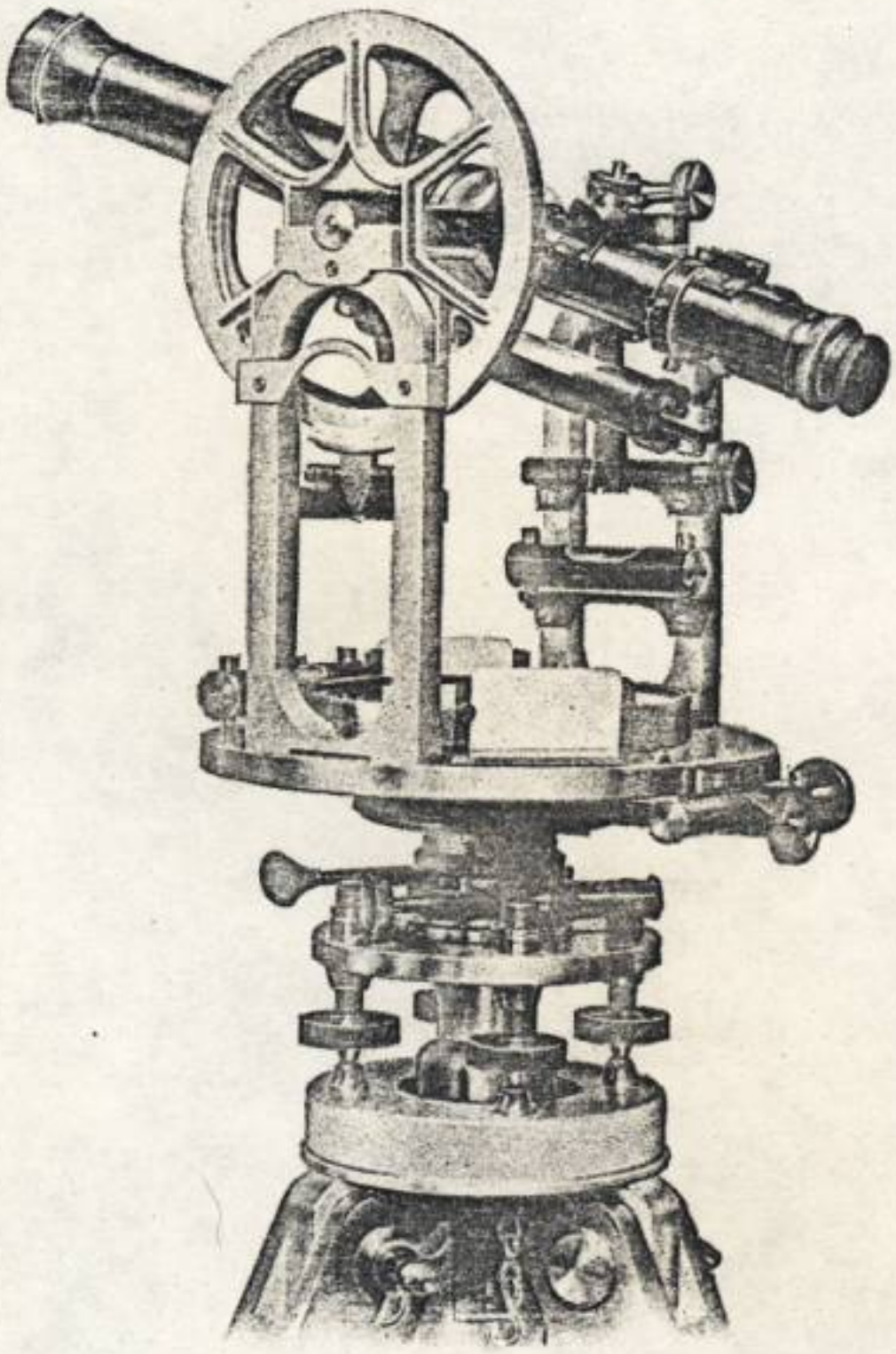
Tripod with shifting motion and extension legs.

Mining Transit No. 4.

Is Made in Two Sizes.

	NO. SIX LARGE SIZE	NO. TEN SMALL SIZE
Needle	4½ inches.	3½ inches.
Graduations	6¼ "	4¾ "
Vertical circle	5 "	4¾ "
Telescope will focus to	5 feet	5 feet
Price complete as shown in engraving	**$260.00**	**$260.00**

Telescopes in these instruments are made to show objects erect unless otherwise ordered. The verniers are wide, extending to the edge of plate to allow extra amount of light, and have the advantage of being so placed that the Engineer can obtain readings without changing his position, risking disturbance of instrument.



YOUNG & SONS' IMPROVED MINING TRANSIT-No. 5

Guard for Vertical Circle included

Code Words—Large size, Gray; small size, Brown

Young & Sons'
Improved Mining Transit No. 5.

TRANSIT. Made in two sizes, having compound long centres. Graduations reading to single minutes, improved tangent to plates and opposing-piece to centre. Vertical adjustment to telescope and centered on top of axis to telescope. Level to telescope, clamp and opposing screws and Vertical Circle. Telescope with improved eye-piece and dust cover to object slide.

Tripod with shifting motion and extension legs.

Mining Attachment.

The telescope is provided with a Diagonal (Prism) Eye-piece and Reflector for cross-hairs.

Mining Transit No. 5.

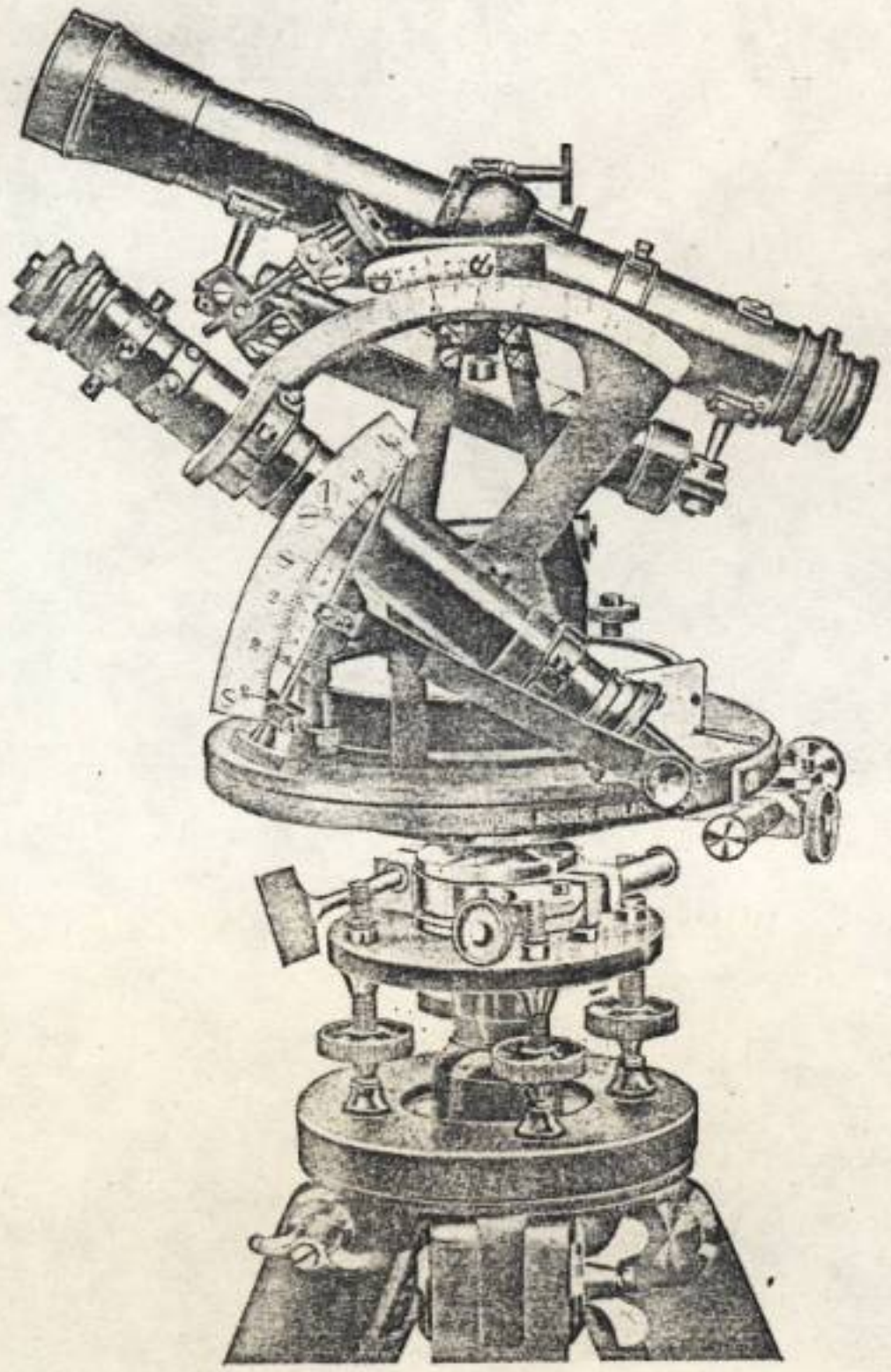
Is Made in Two Sizes.

	NO. SIX LARGE SIZE	NO. TEN SMALL SIZE
Needle	4½ inches.	3½ inches.
Graduations	6¼ "	4¾ "
Vertical circle	5 "	5 "
Telescope will focus to	5 feet	5 feet
Price complete as shown in engraving	**$250.00**	**$250.00**

Mining Transit No. 5. Without Diagonal Eye-piece and Reflector for cross-hairs and with 60° vertical arc in place of a vertical circle, is the Mining Transit generally selected for work in the bituminous coal regions. This style is $20 less than above prices.

Telescopes in these instruments are made to show objects erect unless otherwise ordered. The verniers are wide, extending to the edge of plate to allow extra amount of light, and have the advantage of being so placed that the Engineer can obtain readings without changing his position, risking disturbance of instrument.

Patented September 14, 1880
Patented September 16, 1902



IMPROVED MOUNTAIN SOLAR TRANSIT

Showing enlarged Latitude and Declination Arcs, Improvements in Solar Telescope, and Verniers to one side of Standards

Code Word—Mount-Solar

Solar Transits.

A Solar Transit on which the Solar Attachment is independent of the Transit, consequently the Solar does no require readjustment at every observation.

It can be used in hazy weather, when other Solars are useless. Used by the U. S. General Land Office for survey of public lands.

The distinctive feature of the Solar Attachment of Benjamin H. Smith, C. E., as introduced by us in 1880, consists in the use of a Reflector moved by a declination arm, whereby the sun's image is reflected into the focus of a short telescope, the axis of which corresponds to the polar axis of other forms of Solar Attachments. The clear limb of the sun's image can be brought between the equatorial wires with greater exactness than in other forms of solar attachments; hence the meridional result is more accurate, and the arrangement of the arcs permits observations to be made with greater rapidity. The Solar Attachment is made detachable.

Recent improvements, Patented 1902, by means of which the radius of the Latitude and Declination Arcs is increased, the solar telescope enlarged and provided with micrometer adjustment to the cross-hairs, and placing the verniers to one side of the standards, have materially increased the efficiency of the instrument.

The original Smith Solar Attachment was distinctive, in that it called for a reflector moved by a declination arm, throwing the reflected sun image into the focus of a short telescope, and was intended to be mounted on a Transit Telescope. Mounting the attachment on its own Latitude Arc, and all other details are distinctly Young & Sons' improvements.

Specifications.

Needle, 3½ inches long.
Graduation, 4¾ inches, reading minutes.
Power of telescopes, 22.
Variation plate, for setting off local variation of needle, moved by rack and pinion movement.
Level to telescope.
Clamp and opposing screws.
Vertical arc.
Fixed stadia-hairs.
Extension tripod.
Solar attachment on side of standard as illustrated. **$300.00**

The descriptive details of our Mountain Solar Transits are the same as our Mountain and Mining Transit, No. 10.

Valuable assistance in perfecting the improvements to the Solar Attachment was given us by Mr. W. O. Owen, Examiner of Surveys of the General Land Office, Washington, D. C.

Tables of Refractions in Declinations for use of U. S. Deputy Surveyors, by Hon. Cortez Fessenden, formerly Surveyor-General of Dakota. Revised 1902, Mailed upon application.

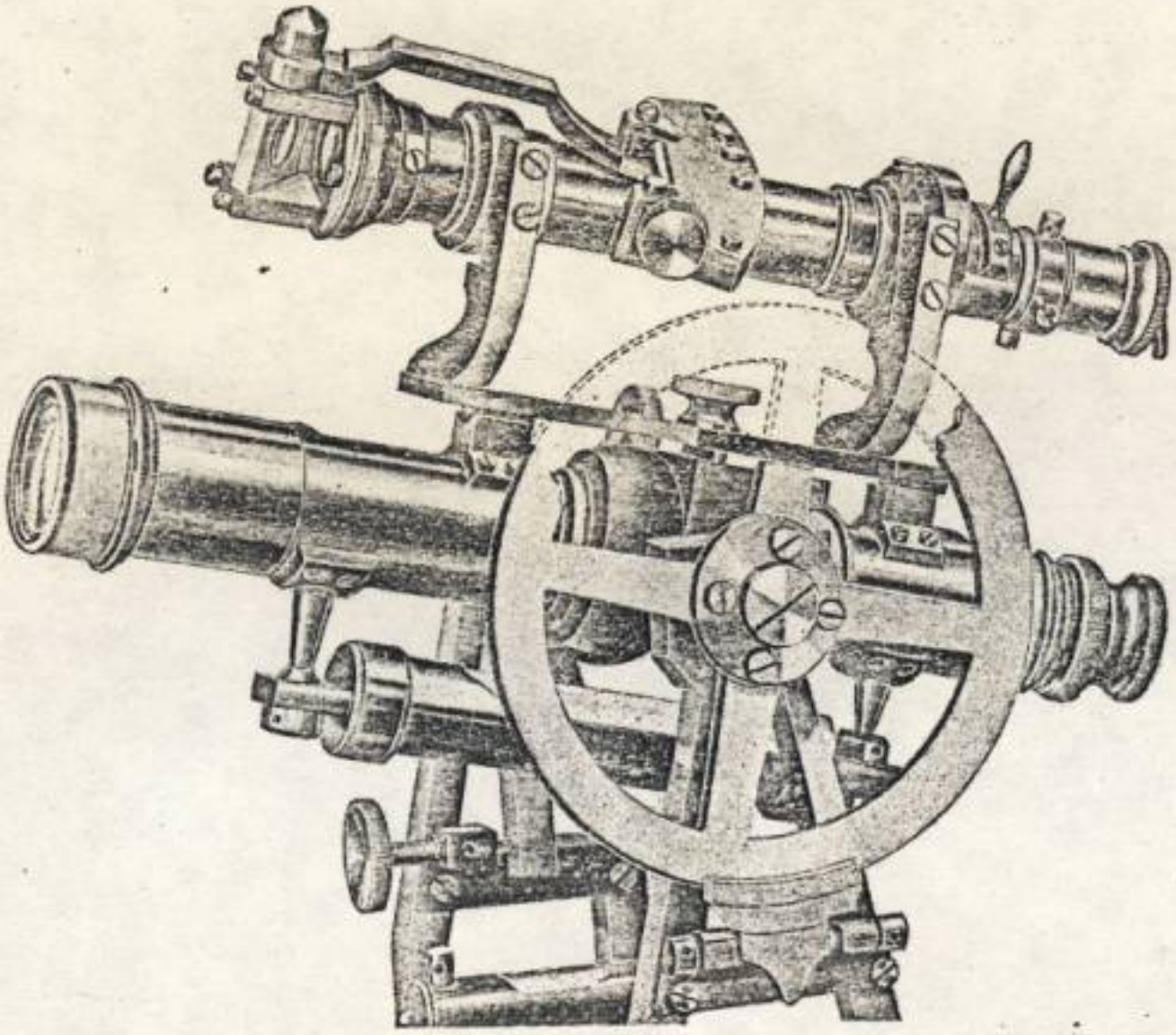
Solar Attachment upon the Telescope.

The Smith Solar Attachment somewhat modified in form but retaining all its essential features, we now place upon the telescopes of our Transits. Complete descriptions of this Solar being given in this catalogue, it is not necessary to repeat it here except to state that in this form the Latitude is set off on the Vertical circle, and the Declination in the usual manner.

This form of Solar having *separate arcs* for Latitude and Declination, combined with its extreme accuracy and simplicity, and the rapidity with which it can be set up, commend it to many.

The improvements consist in the attachment to the Transit telescope, large Solar telescope with micrometer movement to eye-piece and larger declination arc.

Price, when ordered with a new Transit, ... $60 00



YOUNG SOLAR COMPASS.

PATENTED.

(PHOTOGRAPHS UPON APPLICATION.)

This Compass is the Smith Solar Attachment, mounted upon plates in the same manner as the Burt Compass. Much closer results can be obtained with this Compass than with the old form, and combined with the advantage that it will work in hazy or cloudy weather, when other Solars are useless, make it a very desirable instrument.

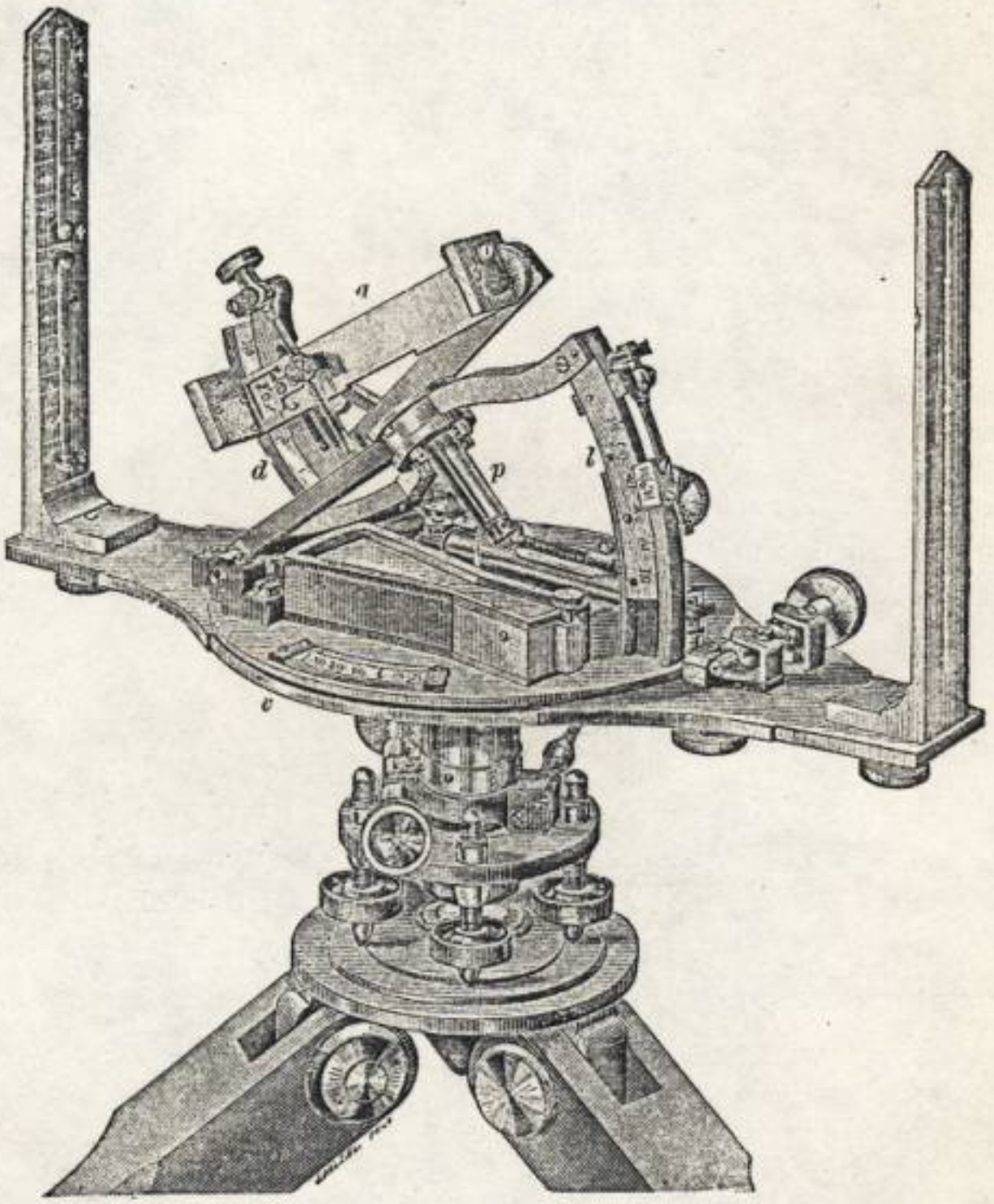
Graduations on silver.
Sights detachable.
Needle box for variation, ... $300 00

Telescope for Solar Compasses.

In both these attachments Telescopes are in line with the centre of instrument.

Telescope No. 1.—Single standard plain telescope, with the counterpoise, attaches to the end of plate same as the sights, detachable, packed in box. Price, $30.00.

Telescope No. 2.—Double standard. Level to telescope, with clamp and opposing screws and vertical arc, with counterpoise, attached to end of plates same as sights, detachable, and packed in box. Price, $75.00.



YOUNG & SONS' BURT'S SOLAR COMPASS

Showing Tangent Screws to Plates, Latitude and Declination Arcs

All Graduations on Solid Silver

No. 19.

BURT'S SOLAR COMPASS.

This beautiful instrument, unquestionably the greatest invention in nature of instruments, deserves to be more widely known and more properly appreciated. The mineral deposits, with their local magnetic attractions, of the Lake Superior country, where it was found impossible to survey the government lands by any known method, the expense of which would not forbid its use, gave rise to the invention of Solar by Burt.

The principle consists in a practical scientific application of the principles which govern the motion of the sun, that when instrument is placed in adjustment, and the sun's image brought to a certain place, the instrument must necessarily be in the meridian. This is indicated by zeros of horizontal plates, and any other angle can be read off by graduated plates.

Solar work can only be performed in clear weather; the instrument is, however, furnished with needle and graduated plates.

As first made the Solar was without tangent screws, and with an ordinary ball and socket motion being made, in accordance with Mr. Burt's judgment, as simple as possible for use in the wooded brush country where the government surveys were then made. Since then, and with progress of surveys into more open country, the tangent screws and the transit tripod have been added.

When weather is clear the Solar Compass works with much greater rapidity than either compass or transit. With ordinary care, and instrument in adjustment, its result should not vary in rapid work more than from one to two minutes from correct line, a result unattainable in the ordinary compass, and requiring careful work to ensure in long continued lines with transit.

The original manufacturers of the Solar Compass, our forms of solar construction as designed by us, in consultation with the inventor, have stood the test of thirty years. No material change in shape or proportions have been made by the manufacturers who have attempted this work.

In these, as in our engineering instruments, we find instances where some after thirty years service are doing good work.

By a late improvement in the method of adjustment, we have secured greater accuracy than heretofore.

We make either transit tripod, which is most steady, or compound ball and socket, which works more speedily.

All graduations on silver.
Tangent to plates, declination and latitude arcs, and needle box for variation.

All arcs reading minutes, ...	$260 00
Graduations on arcs to 20 or 30 seconds, extra, ...	20 00
Solar, large size, declination and latitudes arcs 6 inches radius, readings 20 or 30 seconds, plain, ...	300 00

MINING LAMP AND PLUMMET

This Plummet is made large, with upper part hollow to receive oil and form lamp. It is suspended directly to sides by a Gimbal Ring, and hung from a point in the roof of the mines. The sight is taken to centre of flame.

Single Lamp, packed neatly in box, $13.00
Two Lamps, packed in box, . . . 25.00

We believe the first of these lamps in this country were made by us for Eckley B. Coxe, M. E., from drawings furnished by him.

COMPASS TRIPODS

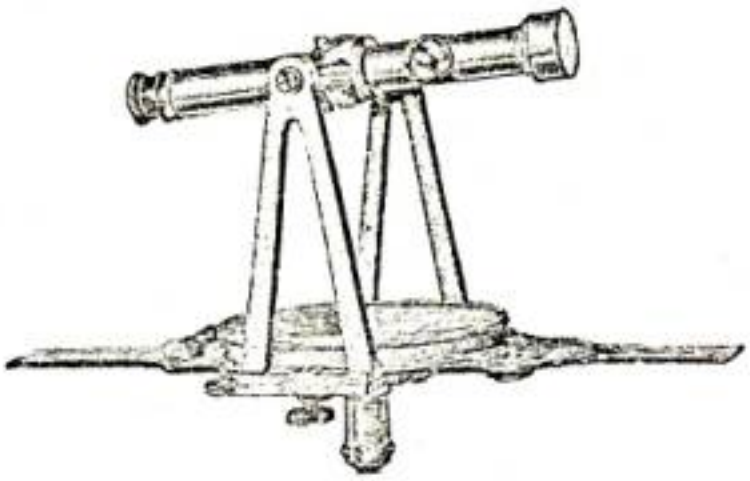
No. 1

No. 2

Compass Tripod No.	1,	as shown in engraving, ...		$6.00
"	"	" 2,	without ball-spindle, ...	7.00
"	"	" 2,	with " as shown in engraving, .	8.50
"	"	" 3,	with ball and socket and leveling screws, .	18.00
"	"	" 4,	with leveling screws, clamp and tangent, .	20.00

TELESCOPIC ATTACHMENTS FOR COMPASSES

The below engraving represents our New Telescope Attachment for Compasses. It is attached by fastening a brass plate to the under side of the Compass, allowing the ends to project about one-fourth of an inch beyond the plate on the side, by which the standards and telescope are held in position by a clamp screw and steady pins. The advantage of this Attachment is, that the telescope is always in adjustment and directly over the centre of the instrument.

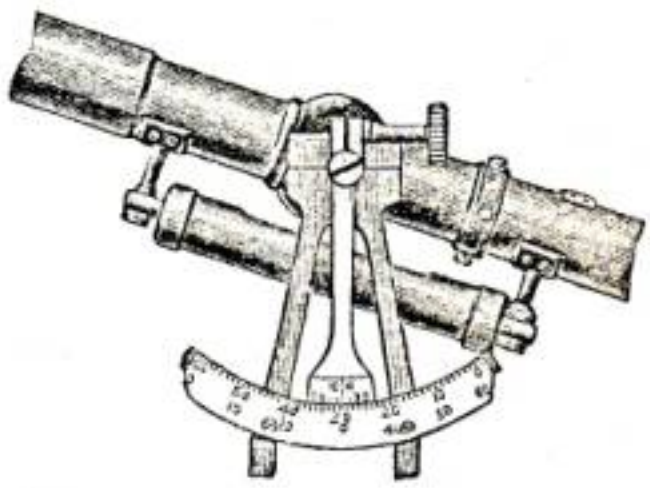


Compass can be used with either the sights or telescope.

Price, attached to any Compass, . . . $30.00

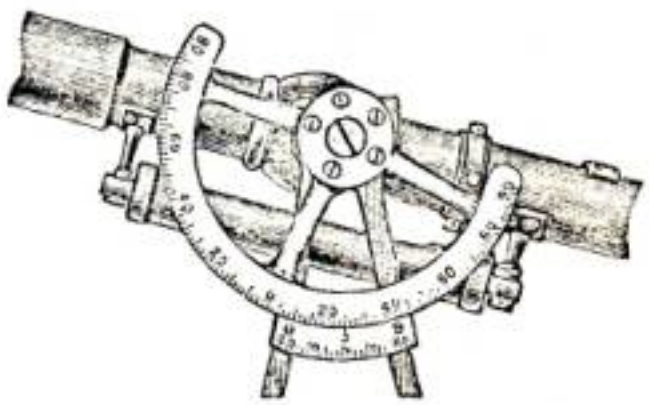
Same, with level to telescope, vertical arc, clamp and opposing screws, ... $50.00

VERTICAL ARCS AND CIRCLES.



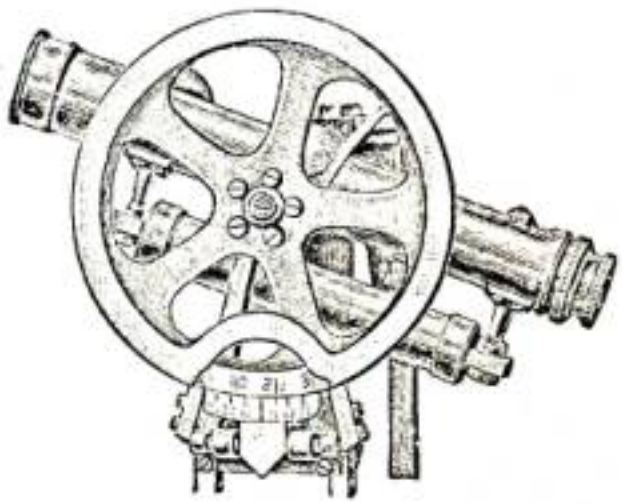
For ordinary work, we believe our 6-inch, 60° fixed Vertical Arc, with swinging flush vernier, has no superior, and we place it upon all Transits where an arc is desired unless otherwise ordered. Arc numbered from 0 to 60°, from each end, two rows of figures; one double vernier reading to single minutes.

Price. $15.00



For work requiring a larger arc, we recommend a 5-inch, 180° swinging arc, numbered 0 to 90°, each way from centre, fixed double flush vernier, reading to single minutes. This arc is a favorite for stadia work.

Price. $15.00



Full vertical circle, 5-inch, with one double beveled spring vernier, reading to single minutes.

Price, without guard. . . $18.00

Full vertical circle, 5-inch, with two double flush verniers, reading to single minutes, with Aluminum guard to protect graduations.

Price. $40.00

Same, with level, price . $50.00

EXTRAS—Aluminum Guard to protect graduations on Vertical Circle.

Price $4.00

Graduations on solid silver, arc or circles. Price $5.00

Extra Attachments for any of the Preceding Transits.

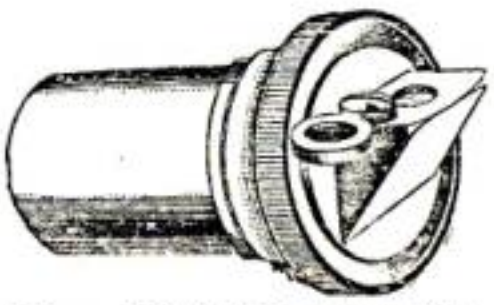
			CODE WORD
1.	Graduations, reading 20 or 30 seconds, on plate, { 20 ″ . . / 30 ″ . .	$10 00 / 10 00	Abductor / Angel
2.	Graduations, reading 20 or 30 seconds, on vertical circle.	5 00	Animal
3.	Vertical Arc,	15 00	Arcade
4.	Vertical Circle,	18 00	Arena
5.	Level to Telescope,	15 00	Aroma
6.	Clamp and Opposing Screws to Telescope	10 00	Baron
7.	Level to Telescope, with clamp and opposing screws, or Tangent,	25 00	Burro
8.	Level to Telescope, with clamp and opposing screws, and vertical arc	40 00	Cabal
9.	Level to Telescope, with clamp and opposing screws, and vertical circle,	43 00	Cacao
10.	Gradienter, including Level to Telescope,	40 00	Canon
11.	Gradienter, including Level to Telescope and vertical arc,	55 00	Carnage
12.	Gradienter, including Level to Telescope and vertical circle,	58 00	Charlatan
13.	Stadia Hairs, fixed,	3 00	Civil
14.	" " adjustable,	10 00	Data
15.	Diagonal Eye Piece,	8 00	Dogma
16.	Reflector for Cross Hairs,	4 00	Embargo
17.	" for Graduations on Plate,	4 00	Dixie
18.	Folding Telescopic Sights,	8 00	Gondola
19.	Folding Telescopic Sights, extra long for vertical sighting in mines,	12 00	Hospital
20.	Right Angle Sights,	5 00	Judas
21.	Variation Plate,	15 00	Lance
22.	Graduations on Solid Silver, except No. 7,	10 00	Mania
23.	Waterproof Cover for Transit or Level,	1 50	Mosquito
24.	Tripod, with three Leveling Screws, for Transits No. 6, 7 and 13,	20 00	Polar
25.	Tripod, with three Leveling Screws, for No. 1 Levels,	10 00	Regimer
26.	Quick Leveling Tripod Head,	10 00	Rival

Extras for Instruments sent for Repairs.

We make a specialty of repairing instruments of any make. Our facilities are the best, and our prices as low as consistent with good work.

Instruments must be sent to us for estimates, as we cannot, either in justice to our customer or ourselves, give any prices without an examination of the instrument.

New Cross Wires,	$3 00
Reflector for Graduations on Plate,	4 00
New Needle, best pattern,	5 00
" Centre Pin,	1 00
Adjustable Stadia Hairs,	10 00
Fixed " "	3 00
Ground Glass Level for Transit Telescope,	5 00
" " " " " Plate,	1 25
" " " " Level Telescope,	10 00
" " " " Compasses,	1 00
Cap for Object Glass,	75
Shade " "	75
Variation Plate,	15 00
Regraduating Horizontal Plate,	15 00
" Arc and Vernier,	7 00
New Compass Glass,	1 00
" " Sights, each,	3 50
Jacob Staff Mountings,	5 00
Clamp Screws for Transits or Levels,	1 00
Mahogany Tripod Legs, each, $2.25; per set,	6 00
Targets for Young's Self-Reading Rod,	5 00
Clamp Screws for Young's Self-Reading Rod,	25
Steel Shoe for Jacob Staff,	75
" Shoes for Tripods, per set,	1 50
Rebronzing Transit,	$15 00 to 20 00
" Levels,	12 00 to 15 00



Diagonal (Prism) Eye-Piece, $8.00

To facilitate observations of the sun or stars for meridian, and for taking large vertical angles in mines, a plane reflector or prism is placed in an eye-piece by which the direction of the pencils of light are turned at right angles to the eye-lens.

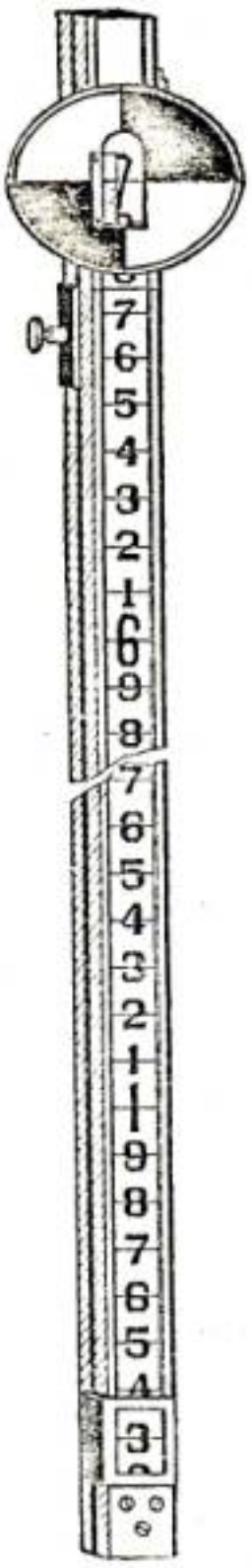
Such an eye-piece is called a Diagonal Eye-Piece and is highly recommended as being convenient and expeditious.

YOUNG'S SELF-READING LEVEL ROD

Its imitation is known as the Philadelphia. This rod, introduced by us in the early "Fifties", is a Self-Reading and Sliding Target Rod combined; all faces are *recessed* and *figures stamped*. The tenths figures are six-hundreths in size, placed central over tenths divisions, so that top and bottom of figures are exactly three-hundreths above or below, and form data by which the nearest hundreth can be read without confusion to the eye.

The Rod is 7 feet when closed, 12 feet when extended, ... $16.00

For Stadia work, order an extra target, . . 5.00



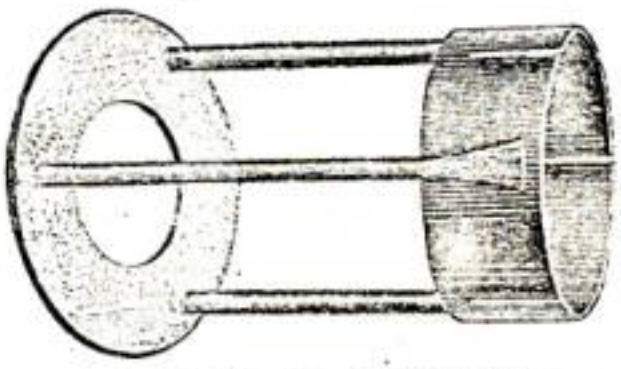
MINING ROD

Similar to the above, but reduced in length to 3, 4 or 5 feet, extending to 5, 7 or 9 feet.

The principal difference is in target, along the center of which we cut a slit. The lamp is held behind target, and cross-wires readily subdivide this, $15.00.

REFLECTOR PLATE

Reflector Plates, for illumination of cross-webs for observation on stars for meridian or for work in mines where light received is not sufficient in itself, are attached to the object end of telescope by means of a framework holding a reflector plate of polished aluminum and placed at right angles with axis of instrument. The plate is perforated at centre to allow observation of object, while the light of a lamp held backward and sideways is reflected upon cross-web.



Reflector for Telescope to illuminate Cross-Hairs $4.00

TRIPODS

The shoes on Young & Sons' Tripods are made of *pressed steel*, smooth inside, which insures perfect fitting with the leg. These shoes remain sharp for years.

REGULAR TRIPOD

For Transit or Level, ... $16.00
Round legs, code word "Berg"
Open " " " "Cake"

LIGHT WEIGHT TRIPOD

For Mountain Transit and Light Level, ... 16.00
Round legs, code word "Sty"
Open " " " "Air"

EXTENSION TRIPODS

YOUNG & SONS' IMPROVED. Legs shorten half-length. Two clamp screws for each leg. Clamping arrangement superior and firmer than heretofore made.

REGULAR EXTENSION TRIPOD

For Transit or Level, ... $20.00
Code word "More"

LIGHT EXTENSION TRIPOD

For Mountain Transit and Light Level, ... 20.00
Code word "Ray"

HALF-LENGTH TRIPODS

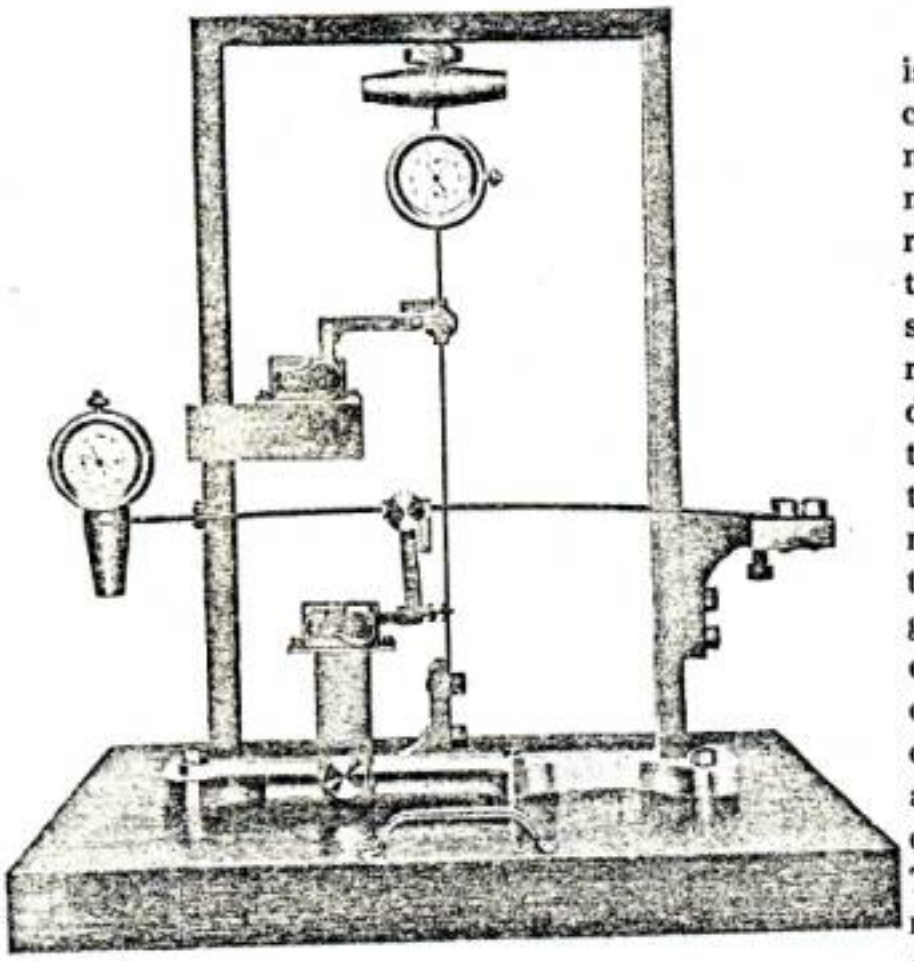
Tripod legs halved and screwed together firmly in centre. When lower half is unscrewed, the upper presents a sharp pointed steel shoe. This tripod is not so heavy as an Extension Tripod, and is firmer when at full length, but is not as convenient, perhaps, in setting the instrument on irregular ground.

Full Half-Length Tripod $20.00
Code word "Jet"

Non-Extension Half-Length Tripod 14.00
Code word "Vex"

RICHARDS' TRACK INSPECTION AND REGISTERING INSTRUMENT.

PATENTED NOVEMBER 29TH, 1898



This instrument is intended to indicate by the movements of the hammer stems and its registering apparatus, the relative smoothness of railroad tracks, by indicating and registering the motion of the car. The instrument is placed on the floor of the car—generally at the rear end of the rear car of the train—but it can be placed in any other position of car on the train. The pedometer registers the number of vibrations; the cyclometer registers the distance traveled by the hammer stem. These two instruments on the vertical stem show particularly the swaying of the car, due to the tracks not being level in cross-section on tangents, or irregular in elevation on curves. The horizontal bar, in like manner with the pedometer and cyclometer, registers, and will show the vertical movement of the car, due to bad surface and irregularities of track, low joints, etc., causing an up and down motion of the car, so that the two parts of the instrument will take the motions of the car in the two directions. When the registering instrument shows very little movement the track is in better condition than when it shows a high register by greater movements. Record of the reading of the instrument is made at the beginning and end of a section of track; that is, a Supervisor's sub-divisons of track, and as a comparison one will show better than the other. These facts can be established better by this instrument than by the eye.

PRICE, packed in hardwood case, . . $150.00

THE HANGING LEVEL.

A CROSS-LEVEL, NOT PERMANENTLY ATTACHED TO THE AXIS OF TELESCOPE, BUT IS ADJUSTED AND FITTED STRIDENT WITHOUT CLAMP, READILY REVERSIBLE AND REMOVED FROM INSTRUMENT IN PACKING.

For Transits with horizontal Vernier reading to single minutes, the ordinary plate levels are sufficiently accurate to insure good results. For graduations reading 30 seconds, or finer, we would recommend the Hanging Level. This level, which is ground as sensitive as the level attached to the telescope, not only insures a perfect leveling of the horizontal plates, but tests the motion of the telescope in a vertical plane.

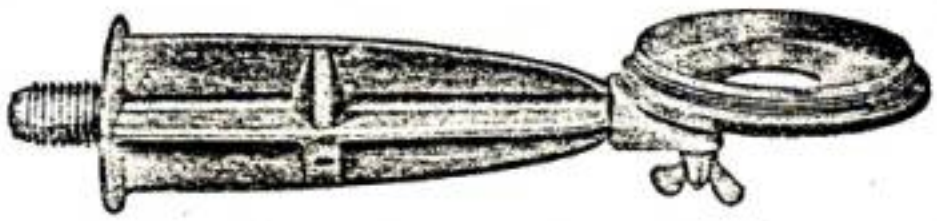
It is suspended from collars of equal diameter on the axis of telescope, and is furnished with our Nos. 7 and 13 Transits.

Price, attached to other Transits, $20.00.

Adjustment of Hanging Level.

Level the Instrument and clamp the plates. with the telescope over one pair of leveling screws. Hang the level on the axis of telescope, and notice the position of the bubble—if not in the centre of divisions, bring it there by means of leveling screws. Remove level, and reversing it end for end, replace it; and if the bubble does not take the same position, correct it, one half by means of leveling screws, and the balance by means of two capstan head screws, at end of level, working in a perpendicular direction; repeat this operation until the correction is made. Now swing the level slightly on its bearings, and notice if the bubble retains its position in centre of divisions; if not, correct by means of two capstan head screws at the other end of level, working in a horizontal direction. If this correction has to be made, it will be necessary to go over the first part of the adjustment. to see that it is still correct.

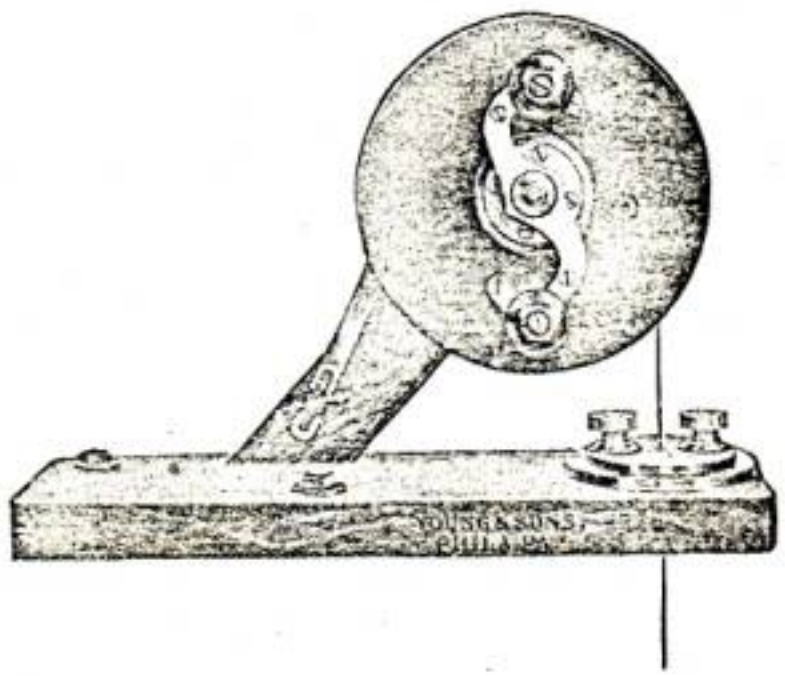
Mine Bracket



Made of aluminum, very light and strong, with lever and auger; in carrying case $16.00

Large size . . . Rose
Small size . . . Bud

Shaft Plumbing Reel

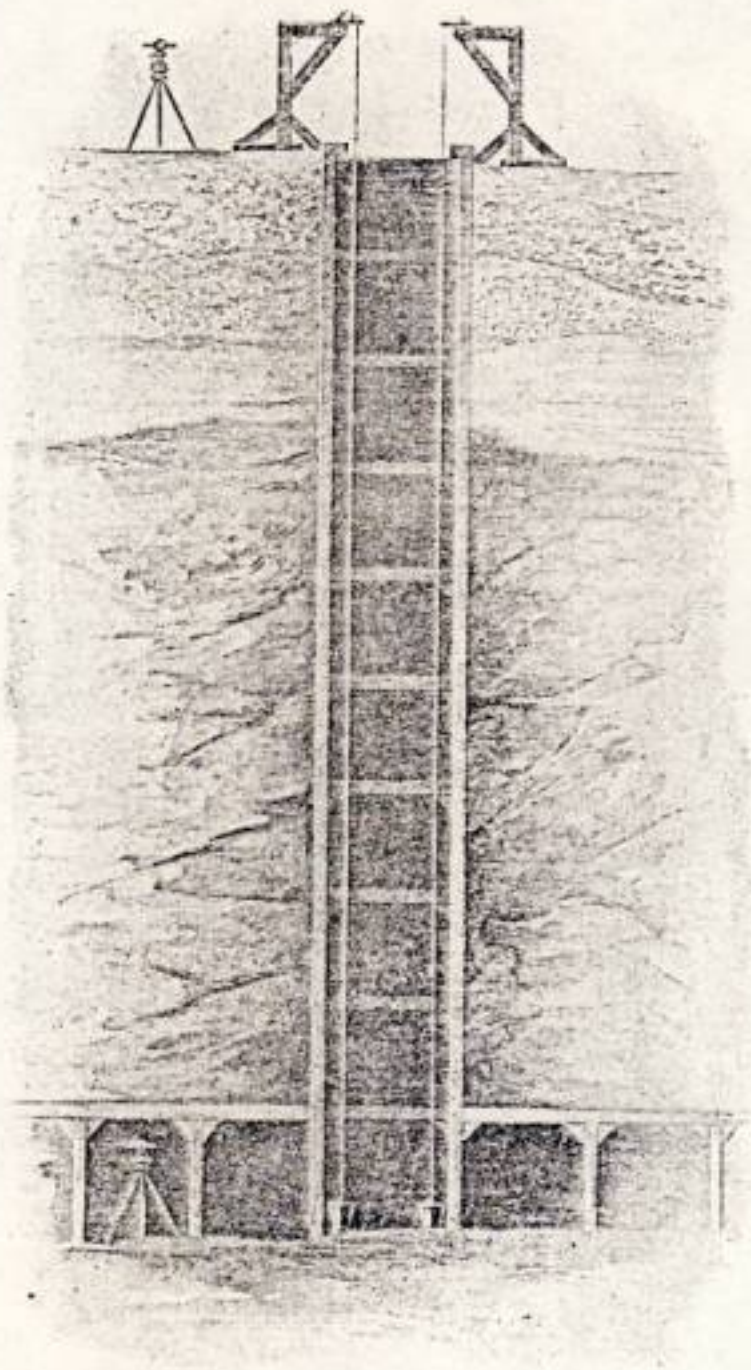


The accompanying illustrations show a *method* of plumbing down deep shafts, and a device for lowering the plummet. The Reel is fastened to the lattice work at the mouth of the shaft by means of iron clamp screws. The Reel will hold several hundred feet of music wire, and is provided with means for carefully lowering the plummet down the shaft and clamping it at any point. It is also provided with a shifting motion for centreing the plummet over a given point and clamping it there.

Price, complete with bolts and wire, without plummet, per pair $25.00

Lily

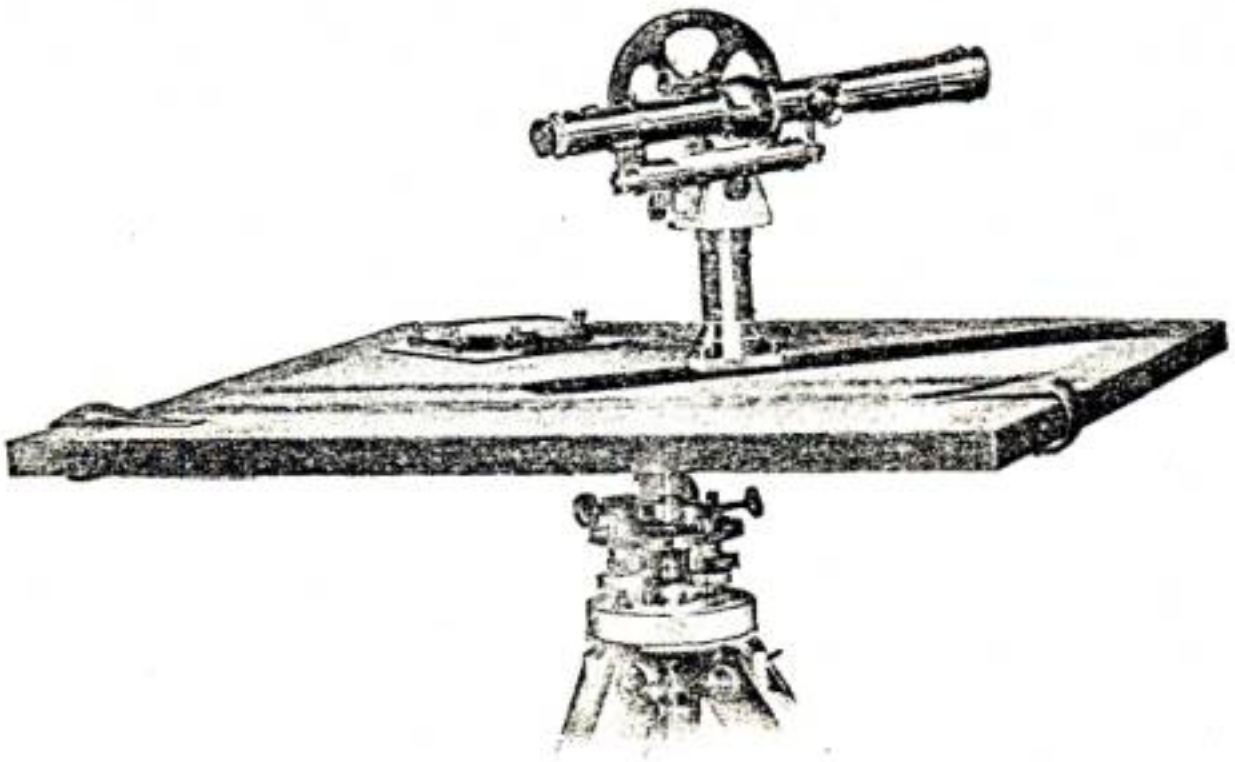
Plummets for Plumbing Down Deep Shaft.



Brass, 3 lbs. . . . . $4.00 Ring

Brass, 4 lbs. . . . . $5.00 Yost

Cast Iron, 25 lbs. . . . . $6.00 Zone



No. 1 PLANE TABLE

Young & Sons' Plane Tables for rapidity and efficiency in making topographical surveys are unequalled.

Their use effects great economy in preliminary surveys and their adaptability for obtaining accurate data quickly is a great aid in solving many problems that confront the Engineer. Their general utility entitles them to a place in every Engineering office.

Our complete Plane Table comprises every improvement. The smaller size will be found light and convenient, while the larger, more substantial and heavier. In both models, the telescopes reverse and the line of sight is true to the beveled edges of the 18 in. rules.

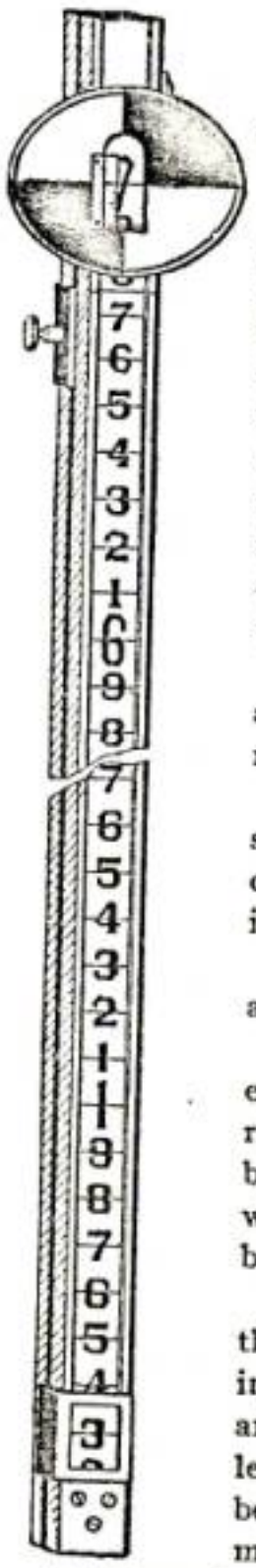
No. 1.—Board 24 x 26 inches, in carrying case with handles. Provided with paper clamps, plumbing bar and plummet, compass with 4½ in. needle, square base and two straight levels. Engineer's level tripod head with four leveling screws, clamp and tangent movement.

Alidade, with telescope 11¼ in. long, showing objects erect, power 24 to 26 diameters, 1¼ in. aperature. Fixed stadia hairs, level to telscope, with clamp and opposing screws, full vertical circle, 5 in. graduations on solid silver, beveled spring vernier reading to single minutes. **Price $200.00.**

No. 2.—Board 24 x 26 inches, in carrying case with handles. Provided with paper clamps, plumbing bar and plummet, compass with 4½ in. needle, sqare base and two straight levels. Improved tripod head, large base, with leveling screws, clamp and tangent movement.

Alidade with telescope 11¼ in. long, showing objects erect, power 24 to 26 diameters, 1¼ in. aperature, gradienter, level to telescope, full vertical circle, 5 in. graduations on solid silver, beveled spring vernier reading to single minutes. **Price $300.00.**

YOUNG'S SELF-READING LEVEL ROD



Sometimes called "The Philadelphia Rod."

This Rod was introduced by us in the early "fifties," and sales are increasing every year.

As made by us, all the faces are recessed and painted clear white. The figures are stamped deeply and then painted, so that they will not rub off. The feet are painted red, the tenths black. The latter figures are six hundredths in size, placed by gauge, generally over centre of tenth division, so that the top and bottom of figure indicates exactly three hundredths above or below. By this arrangement it has been found the top and bottom form data by which on fair distances the hundredths can, without confusion to the eye, easily be read. Placing them central over divisions enables the nearest tenth, for surface levels, to be more easily read.

The rod is 7 feet long, and when readings are desired above this, it slides up and forms a continuous self-reading rod to 12 feet.

The target when used above 7 feet comes against a stop, so that the error arising from this reading being wrong, or of being knocked from its correct reading without discovery, is avoided.

In addition to the self-reading characteristic, it is equally a SLIDING TARGET ROD.

By combination of the two qualities the Engineer is enabled in target readings to give the rodman the reading of rod to nearest hundredth at once, so that exact reading may be obtained in one or two shiftings, as well as to know whether any error exceeding one or two hundredths has been made by rodman.

For rapidity of readings on surface levels, for checking the rodman on turning points, and on more accurate readings, we believe it superior to all other forms. Cross section and similar work on railroading can be performed with at least twice the rapidity and with much greater certainty, besides relieving both the instrument man and rodman or much exhausting, irritating labor.

Lately we have introduced several improvements in the mountings, by which the rod is made more durable. Our name is cast upon target and stamped upon the wood.

Price, ... $16 00

For stadia work use an extra target, $5.00

New York Level Rod, Best Pattern $16 00

Boston Level Rod, ... 16 00

TRANSIT SIGHT POLES.

Made of well seasoned ash, octagonal, with long steel pointed shoes. Every precaution taken to ensure rod remaining straight. Pole divided into feet, and colored red and white alternately.

Transit Poles, 8 feet, flat or octagon,	$3 00
" " 10 feet, flat or octagon,	3 50

HAND LEVELS.

These little instruments, five inches long by one inch in diameter, intended for reconnoissance, and numerous instances where approximate levels are desired, is held in the hand, the reflected image of bubble brought over wire in tube, and line of level carried out by the eye.

Lock's Hand Level, German silver, in case,	$10 00
" " " brass, in case,	9 00
Abney Level and Clinometer, combines Lock's Level with Clinometer, giving angles of elevation and depression, in wooden box,	15 00

SLOPE LEVELS.

Mining Pattern.

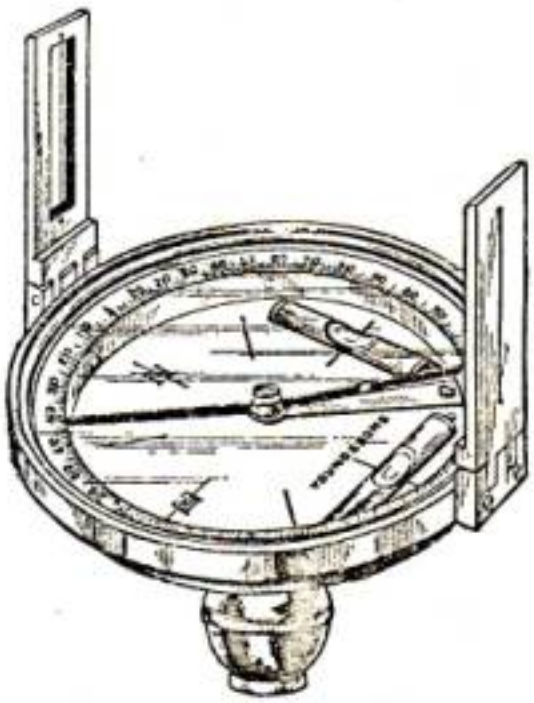
Square. Packed in strong wooden box.

4 inch square,	$10 00
4½ inch square,	12 00

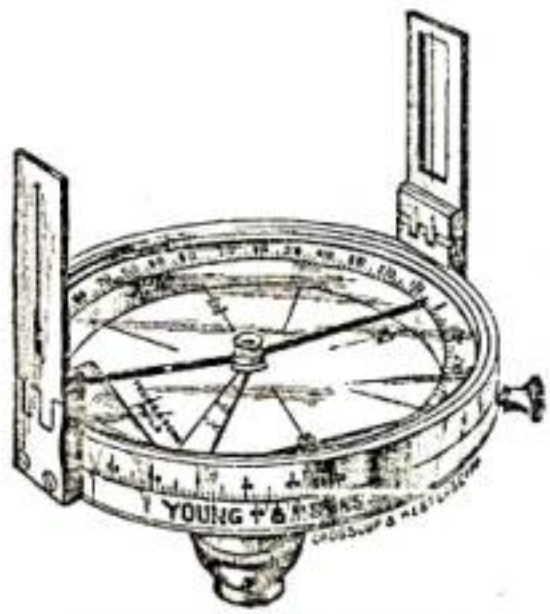
Engineer's Pattern.

Base 8 inches long, folds into box 2½ inches wide,	$12 00

Pocket Surveying Compasses.



POCKET COMPASS, NO. 2.



POCKET COMPASS, NO. 3.

Pocket Compasses.

1.	Pocket Compass, 3½ inch needle, Jacob staff mountings, foiding sights,	$12 00
2.	Same as above, with two straight levels,	13 50
3.	Pocket Compass, 3½ inch needle, folding sights, Jacob staff mountings, with two straight levels and variation plate,	16 00
4.	Same as No. 3, but with needle 4½ inches long,	18 00
5.	Small Extension Tripod for Pocket Compasses,	5 00
6.	Leveling Screws for any of the above,	5 00
7.	Clamp and Tangent for Spindle,	5 00

Rolling Parallel Rule.

Edges beveled in contrary directions. Two inches wide.

12 inches long,	$12 00
14 " "	14 00
15 " "	15 00
18 " "	18 00
24 " "	25 00
Morocco or wooden cases,	2 75

GONIOMETER.

In transits ordinarily designed for Triangulating provided with a single telescope, there is always when reading the angle, an uncertainty of knowing if the instrument has moved from its initial position. In order to overcome this, our Goniometer is provided with double telescopes each acting independently of the other; in practice both telescopes being set on the same object in the first observation, the lower one is clamped there while the upper one is moved to the second object. If any disturbance to the instrument has occurred, it can be detected by the lower telescope.

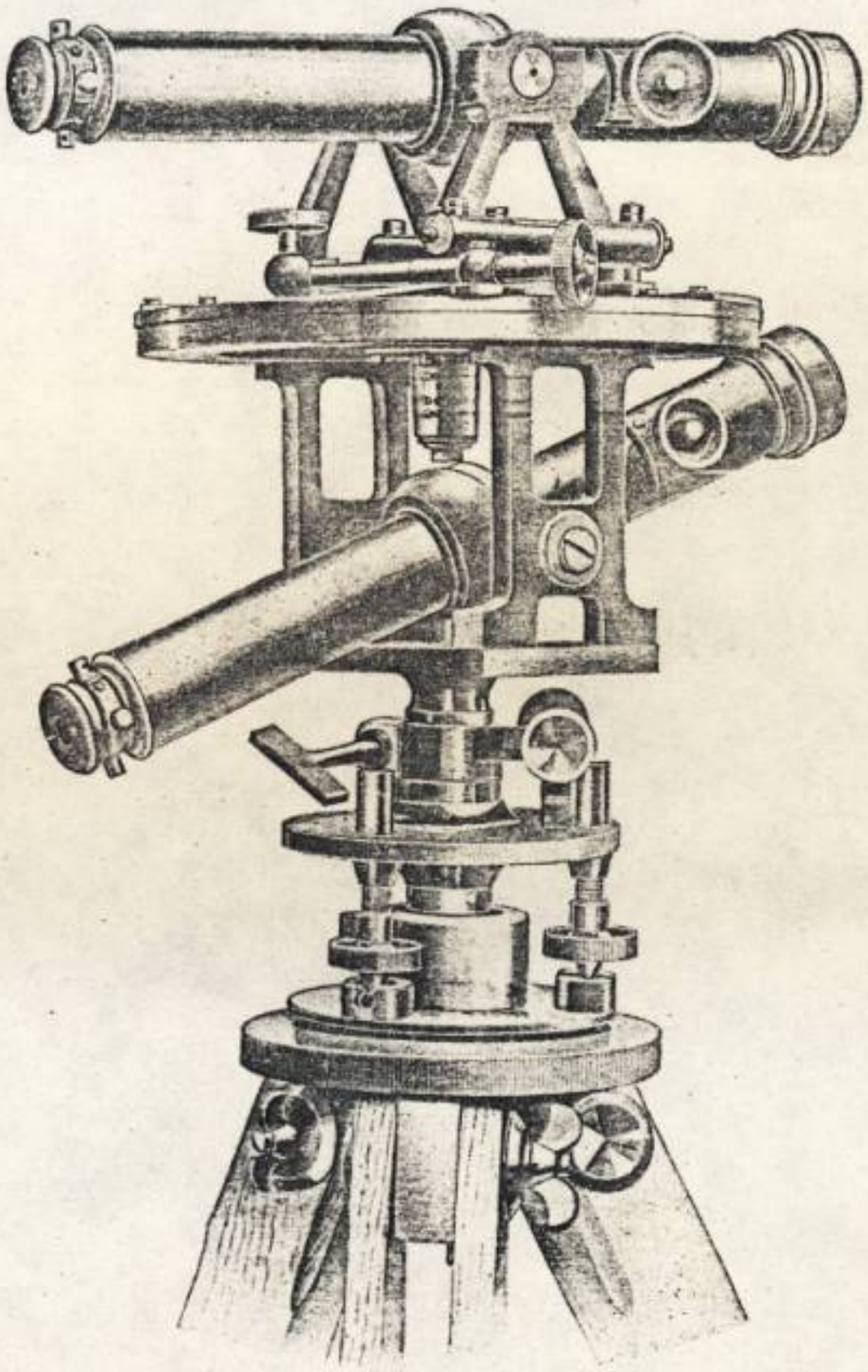
The graduated plate is numbered from 0 to 360 in both directions, and while the two telescopes are clamped on two different objects, the angle can be read from both directions, the sum of which should be 360. To facilitate readings, the verniers are provided with our improvement for obviating the error of the parallax as described on page 23.

Horizontal Plate—6¾ inches, graduations on solid silver, reading 20 seconds.

Telescopes—11 inches long; 1¼ in. objectives.
Erect or Inverting.
Power, 24 diameters.
Young's Improved Eye-piece and Slide Protector.

Long Centres, with three leveling screws and shifting motion.

Price,	$275 00
Reading Glasses, attached, extra,	15 00
Graduations, 7 inches, reading 10 seconds, extra,	50 00



GONIOMETER

Engineers' and Surveyors' Stake Tacks.

Original Dent Head.

The invention of Howard Taylor, C. E. Formerly Assistant Engineer of Pennsylvania Railroad.

The Franklin Institute says of it: "Thus another, although trifling, source of error has been eliminated."

PRICES:

Packed in 1-pound cans.

One	(1)	Pound, ...	$ 60
Two	(2)	Pounds, ...	1 10
Three	(3)	"	1 50
Ten	(10)	"	5 00

Mail or express paid to all points in the United States.

Engineers' Marking Crayons.

For Marking Stakes.

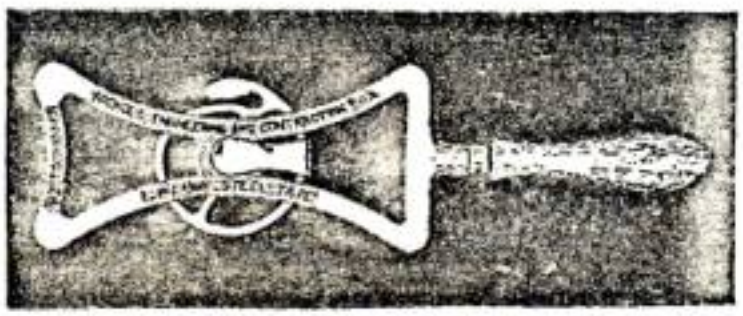
Made in four colors: Red, Yellow, Blue and Black. Will mark on any surface, Wet or Dry, and will not rub off.

Box (One dozen sticks) by mail, . . 60 cents.

Engineers' Pocket Rules.

Pocket Rules for Engineers, divided on one side to feet and tenths and hundredths of feet; on reverse side to feet and inches.

Two feet, four fold, by mail to any address, . 50 cents.



Chicago Steel Tape.

A SERVICEABLE TAPE, RECOMMENDED FOR GENERAL USE.

This tape is 3/10 of an inch wide, and of suitable thickness and temper. The graduations are stamped in plain figures on solder attached to the tape in a substantial manner.

It is claimed that this tape combines the toughness of the chain and the accuracy of the tape.

PRICES:

Standardized at a temperature of 70 degrees.

End foot marked in tenths.

100 Foot Tape,	graduated	and	numbered	at	every	foot,	$3 75
50 Foot Tape,	"	"	"	"	"		3 00
100 Link Tape	"	"	"	"	link,		3 00
20 Meter Tape	"	"	"	"	meter,		3 00
20 Meter Tape	"	in decimeters,	numbered	at	every	meter,	4 00
20 Vara Tape	"	and	numbered	at	every	vara,	3 00

Any length up to 1000 feet made to order.

Reels.

Reel for 66 and 100 feet Tapes,	$1 25
" " 300 to 500 " "	5 00

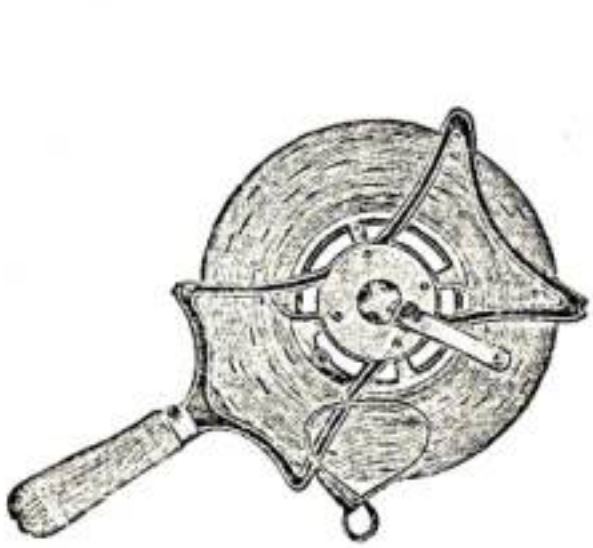
Lucas Steel Tapes.

Narrow Steel Tapes

One-tenth inch wide and 0.022 inch thick. All tapes plated with anti-rust coating. Graduations and figures being on brass or German silver bands, clasped and soldered around the tape. For tapes 100 feet to 1000 feet.

Style M.	100 Feet,	marked by bands every foot,	$ 7 00
" N.	200 Feet,	marked every 25 feet, end 25 to 5, end 5 to feet	5 00
" "	300 Feet,	" " " " " "	7 00
" "	400 Feet,	" " " " " "	9 00
" "	500 Feet,	" " " " " "	11 00
Style O.	200 Feet,	marked every 10 feet, end 10 feet to feet	6 00
" "	300 Feet,	" " " " " "	8 50
" "	400 Feet,	" " " " " "	11 00
" "	500 Feet,	" " " " " "	13 50
Style P.	200 Feet,	" " 5 feet, end 5 feet "	7 00
" "	300 Feet,	" " " " " "	10 00
" "	400 Feet,	" " " " " "	13 00
" "	500 Feet,	" " " " " "	16 00

Extra end foot at each end marked in tenths on all the above tapes, unless otherwise ordered.



Tape Reels.

No. 101. **Frame** Cast Brass Reel for 50 to 100 feet tapes. This reel is very durable and strong, as well as light. Tape is easily removed when reel is not needed . $2 00

No. 104. Improved Bell Metal Reels, for tapes 200 to 500 feet long. Friction brake and stop to hold tape at any point. Weight about 4 pounds 10 00

No. 105. Aluminum Reel, same as above. Weight ⅓ bell metal 11 50

No. 106. Special Reel, for tapes 200 to 500 feet long, made from spring brass. Style of construction same as No. 104, but sides from spring brass instead of cast brass. No friction brake, but stop same as No. 104 . . . . . 6 00

Tapes for Standards.

Steel Lines, 50 foot Standard Line, marked at points 1, 5, 10, 25, 33 and 50 feet, for $1.00 each. 100 foot line as above, and marked 66, 75 and 100 feet, for $1.50.

The Standard can be sent to the Department of Weights and Measures at Washington, and have a comparison made with the Government Standard, and receive a certificate in your own name. The cost of the comparison will be $1.00 for 50 feet; $1.30 for 100 feet.

Steel Chain.

No. 12 Wire. Brazed Links.

50 feet	$ 6 00	10 Meters	$ 5 50
100 "	11 50	20 "	10 00
33 "	5 50	10 Vara	5 50
66 "	10 00	20 "	10 00

Chesterman Steel Tape.

⅜ inch wide; 10ths or inches. Leather Case.

50 feet	$ 6 00	33 feet	$5 00
100 "	11 00	66 "	8 00

Paine Steel Tape.

¼ inch wide; 10ths or inches. Leather Case.

50 feet	$ 6 00	33 feet	$ 5 00
100 "	11 00	66 "	8 00
100 " feet and tenths on one side and centimeters on the other			15 00

Lufkins Steel Tape.

⅜ inch wide; 10ths or inches. Leather Case.

50 feet	$ 6 00	100 feet	$11 00
50 " ¼ inch wide, vest-pocket size			4 00

Chain-Pins.

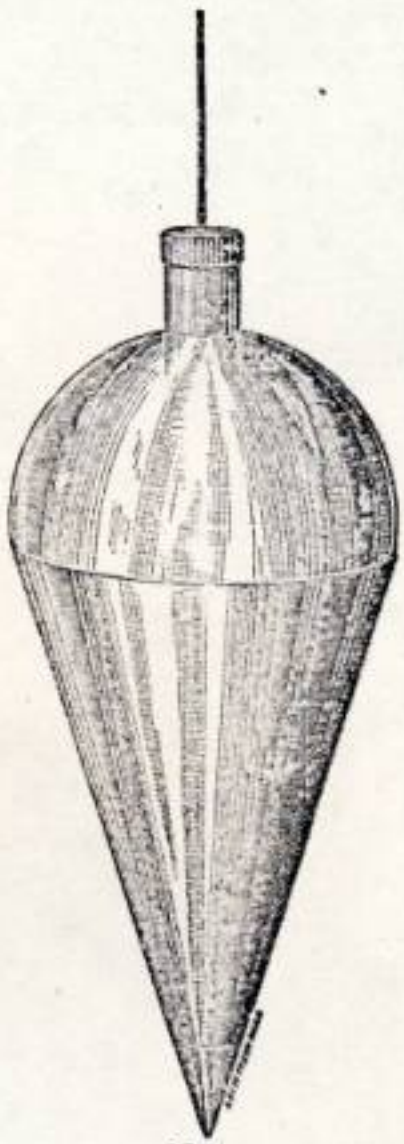
Made of forged steel, tapering, 12 inches long; very superior.

Per set of 11 . . . . . $2 00

Plummets.

No. 1.

No. 2.



No. 3.

Plummet No. 1, weight 10 oz.,	. . . . .	$2 50
" " 2, " 15 "	. . . . .	2 50
" " 3, " 3 pounds, for plumbing down deep shafts,		4 00

No. 4.

No. 5.

Adjustable Plummet, No. 4, weight 8 oz.,	. . . . .	$2 50
" " " 5, " 8 "	. . . . .	1 75
" " " 5, " 13 "	. . . . .	2 25
Plummet Cord, per yard,	. . . . .	06

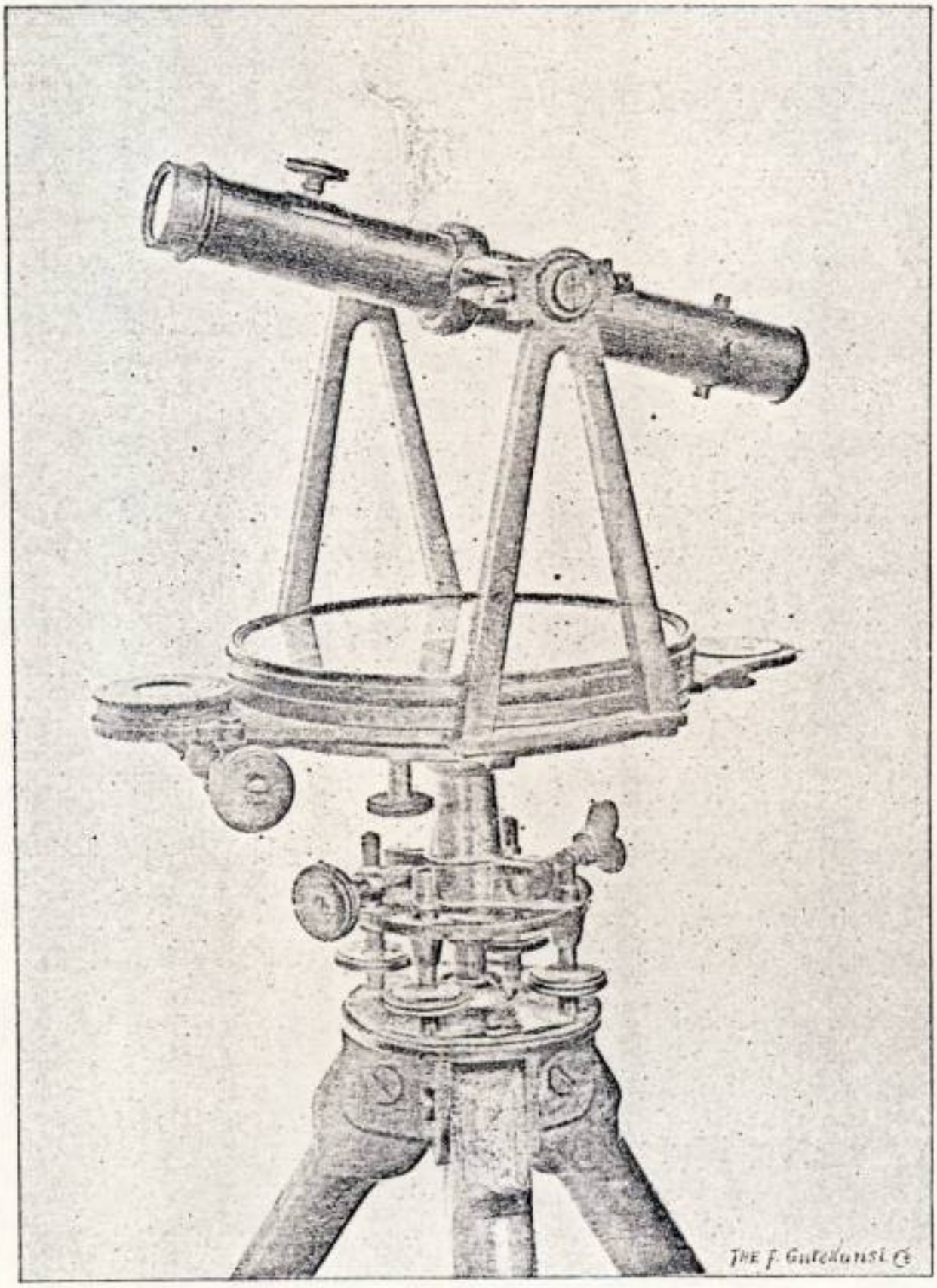
Invention and Introduction of Engineer's Transit.

The first Transit instrument was made during year 1831. It was a long stride in the improvement of Engineering instruments; and that it should to-day retain its almost identical first form, proves the value of its introduction and the good judgment of the inventor.

The English Theodolite, capable of performing the same work, found, if we are to credit the traditions of earlier members of the Engineering profession, but little favor with the American Engineers. Its workings were slow and inconvenient. Few cared to trust the prolongation of a straight line by reversing the Theodolite on its centre, and trusting to the vernier readings; and as few fancied the trouble of reversing telescope on its Y bearings, "end for end." Forgetfulness in fastening of clips resulted in fall of telescope, while if clips were too tight there was the danger of shifting the instrument in fastening, or if too loose the telescope rattled. Such were some of the discomforts attending use of the Theodolite, an instrument well fitted for many purposes, and whose peculiar merits still cause many of our English brethren to cling to its use.

From the Theodolite the change was to the Magnetic Compass. This, in its simplest form, or in its modified form made to read full circle angles independent of needle, was high in favor with many, especially those Surveyors who, from their local knowledge, (and some with naught besides), were selected to "run" the preliminary lines of railroads. By dint of labor, these Surveyors mastered the intricacies of the vernier, but could never be brought to doubt the superior virtues of compass-sights in seeing past a tree or other obstruction. With the transit the tree had to come down; they would not undertake to say the staff on other side of tree was in line of cross web, but were sure they could make it "just right" with the line of sights. Nevertheless, though frequently doing close work, the needle would play pranks that produced much trouble; and though to be commended for speed on the preliminary, was rather too uncertain for location.

In the year 1831, the first Transit was made by William J. Young. It was graduated to read by vernier to 3 minutes, it being in early days a favorite idea of inventor that graduations of 3 minutes could be easily read to one minute, and was less perplexing to use. The instrument had an outkeeper for tallying the outs of the chain, and a universal or round level. The needle was about 5 inches; the telescope 9 inches, of low power. The standards were of almost identical pattern now used by some makers. The centre between plates was of flat style, vernier on inside of needle ring, and the plates moved upon each other by rack and pinion. The plates and telescope detached from tripod, fastened, we believe, when attached, by a snap-dragon, as in later instruments.



THE FIRST AMERICAN TRANSIT

Invented and introduced by YOUNG & SONS, of Philadelphia, in 1831

For whom the first Transit was made, the records, as far as we can find them, do not positively show; as well as it can be gathered from them, and from other data, the first one was used on the State works of Pennsylvania, but whether on the Mountain Division or on the Inclined Plane of Columbia R. R., is uncertain.

The distinguished Engineers of the Baltimore and Ohio R. R. also claim the use of the first Transit; and as illustrative of their belief, we append the following extract from RAILROAD JOURNAL of December, 1855:

"The Transit is now in common use in this country, and is a comparatively cheap instrument. Such, however, is not the case in Europe. In England, the old mode is still in vogue, to a great extent, of laying out curves with the use of Ordinates; we are not sure, indeed, that any other course is not an exception."

"Some years since, Mr. Charles P. Manning, an accomplished American Engineer,—now the efficient Chief of the Alexandria, Loudoun and Hampshire Railroad,—went to Ireland, and on the Limerick and Waterford Railway, initiated the method, so common in this country, of laying out curves with the Transit."

"The first instrument of this name was made by Mr. William J. Young, the accomplished Mathematical Instrument Maker, of Philadelphia, for the Baltimore and Ohio Railroad Company, the Engineers of which made the first suggestions modifying the old Theodolite. We have in times past used this instrument, which is much like those made at the present time by the same manufacturer, and is, if we are not mistaken, still in the field."

"Since then, Transits have been little improved, but have been changed in the wrong direction. They are generally much heavier than formerly, containing as much brass and mahogany as one man can well stand under. This great weight is not only useless, but dangerous. Heavy instruments are much more liable than light ones to get out of adjustment on transportation—even in the ordinary field service. They are not a whit steadier in the wind; being generally made with clumsy tripods and large plates, they expose a greater area to the breeze. *If the feet of the tripod be firmly planted*, the instrument is rarely disturbed by the wind. Besides this, a heavy instrument is much more liable to danger from accident in a rough country."

And the following, from same Journal of January 5, 1856:

THE FIRST TRANSIT COMPASS.

"In our issue of the 15th of December, 1855, in noticing the field book of C. E. Cross, C. E., we took occasion to state some facts concerning the first Transit Compass, an instrument made by Young, of Philadelphia. We have since then received an interesting letter from Mr. Charles P. Manning, whom we mentioned as having initiated in Ireland the American method of laying out curves. Mr. Manning disclaims the honor in favor of 'Richard B. Osborne, Esq., an Engineer who received his professional

education in the service of the Reading Railroad Company, under Messrs. Moncure and Wirt Robinson (where he finally occupied the responsible position of Chief of the Engineer Department, during the early struggles of that Corporation, in its competition with its rival, the Schuylkill Navigation Company), and from which road he went to Ireland, and took charge of the location and construction of the Waterford and Limerick Railway in 1846.'

"Mr. Manning says further: 'I obtained from Mr. Young, and sent to Ireland, probably, the first Transit Compass ever known in that country or in England; and soon afterwards joined Mr. Osborne as his Principal Assistant, for the purpose of aiding him in the effectual introduction, at least upon that road, of the American system of location and construction.'

"We were familiar with these facts when we made the statement which Mr. Manning desires corrected. But our object was not so much to mention the party to whom the credit of introduction was due, as to state a few facts immediately connected with the history of the instrument. Mr. Osborne introduced the instrument into Ireland, Mr. Manning initiated its use among the junior assistants.

"'Mr. Osborne was the first to construct an Iron Bridge upon the plan of Howe's Patent Truss—several of which he put upon the W. & L. Railway; and, I believe, he also built and placed upon the same road, the first eight-wheeled, double-truck passenger and freight cars (American plan) that were ever used in Great Britain.'

"Mr. Manning gives us a very entertaining sketch of the history of that first Transit, made by Young, of which we remarked that we had in times past made use.

"'Twenty and odd years ago—when a mere boy—I saw that instrument upon a lawyer's table, and afterwards in a court-room—a dumb witness in behalf of the patentee. Nineteen years ago, after considerable service in tracing the centre line of the Washington Branch of the B. & O. R. R., it was used in making surveys for the extension of the last named road, westward from Harper's Ferry, and your humble servant carried and used it at that time in Washington County, Maryland, and in Ohio County, Virginia.

"'In the last seven years the instrument accompanied me as a duplicate, and was occasionally used upon the location and construction of the B. & O. R. R., through the wilderness, west of Cumberland, and now rests upon its laurels in the office of the Baltimore and Ohio R. R. Co. in Baltimore.

"'It was *instrumental* in setting the first peg that was driven for the extension of the B. & O. R. R. west of Harper's Ferry; and it was 'hard by,' and able to do duty, when the last peg was set for completing the track of that road upon the banks of the Ohio river.

"'In all material points Mr. Young has never been able to improve upon this original work of his hand, but in some of its minor parts he has effected desirable changes—such as the tangent screws connected with the clamp of the tripod—the substitution of a clamp and tangent screw for the old rack and pinion movement of the two compass plates—the subdivision of degrees into minutes, by an improved graduation of the vernier, &c., &c.

"'The original instrument had an index for counting the number of deflections made at one sitting; also a small bubble upon the exterior of the telescope, for the purpose of defining a horizontal line, without resorting to the aid of its companion, the ordinary Level,—but these superfluities were soon thrown aside; and one of its peculiar features was, and is, a Vernier, graduated only to *three* minutes.'"

Mr. Manning but expresses the facts when he says, that in all *material* points but little change has taken place. The changes that have taken place, have been those called for by peculiar circumstances—modifications, which, while retaining the characteristics of the Transit, have approached more nearly to the peculiarities of the Theodolite. Transits in after years became divided into the two distinct classes, FLAT CENTRE, as first introduced, and LONG CENTRE, with centres as previously used on Theodolite; but it was not for many years that the long centre—for accurate work the best construction—became other than the exception. It now is the rule, and the flat centre the exception.

Engineers of the present day, unaware of the actual difference in these two styles, and unacquainted with the circumstances of early introduction of instrument, are apt to treat the flat centre with a disrespect it is far from deserving.

For the same strength, the flat centres are far the lightest. Says an experienced and competent Engineer to us, within the few days past, "The first requisite of a Transit is lightness and portability." Judged by these requisites, the Flat centre is the instrument of to-day. But he spoke for his own peculiar branch—railways; and while we are by no means ready to endorse this opinion, we have no hesitation in saying that the circumstances existing at the time of first use of Transit were such, that had the instrument been constructed with the long centre, its usefulness and general introduction would have been very much retarded. The great peculiarity of the first made Transits was their ability to stand hard usage, and non-liability to get out of order under ordinary usage. The centre is a broad metal plate—thick, which it is impossible to bend, or injure in any manner, except by wear; the plates were thick, not easily bent, and the spring vernier, in case of bending of plates, followed their motions and allowed the readings to be made sufficiently accurate to continue work. The rack and pinion had nothing that could break, while the tangents, as then constructed, were equally simple. If the standards, by a fall, were bent so that the telescope would not revolve in a vertical plane, the construction was such, that with the axe as a screw driver, the standards could be loosened, and a piece of paper inserted to correct them.

"In fact, the opinion of the writer, with means of observation, and the use of such an instrument, is: *That a flat centered Transit, rack and pinion, and spring vernier, cannot be made totally useless by any accident short of absolute breakage of parts.*

Not so, however, with the long centre. There, the least injury to centres or plates ends the usefulness of the instrument for its work, and it can stand comparatively little rough usage without receiving this injury.

Of the good judgment of the first form of construction, the length of time that many of them have been in use—for some are still doing duty—is the best of evidence. Twenty-five years ago, as rodman, we followed and worked with a flat centre Transit, that to us then looked old enough to retire upon its laurels. So constant had been its use, that its corners, of hard hammered brass, the edges of its standards, and other parts, had then been rounded in carrying against clothing. Ten years afterwards we followed behind it, on the location of one of our main lines across the mountains, where, for a long time, it had been the sole available instrument; and one year ago it was in the shop for repairs, the owner still believing that for Railway work it had no superior. This instrument was light, weighing between fifteen and sixteen lbs.; had seen at least 40 years' service, large part of the time in the hands of Assistants, and in rough, wooded country. We doubt the possibility of a long centred instrument leading an equally long life.

While in charge of some Railway works, we kept in office, where there were several Assistants, both styles of instruments, and the Assistant's choice, in all cases, was for the flat centre.

It is not our intention to argue any superiority in the first form of Transit. It is not the equal, for accuracy and smoothness of motion, of the long centre. Its day of universal application has passed, and its field of usefulness narrowed; but it yet *has* its field, and the Engineer will do well in making selections to give it fair considerations. Our desire is simply to do it justice, and to offer for it a slight defence to our younger Engineers, who, having never seen or used it, can know but little of its faults or merits.

In the Transit's early days, no Express, on call, drove to the door, receipted for the boxes, and relieved all anxiety, no matter how many thousand miles away, nor what obscure point was the destination. Instead of this, they had in many cases to be consigned to the top of the stage, or to the Connestoga wagon, unless the destination was near the coast, when the sea became the best route. Thus we find the following extracts, looking at random into the books of shipment:

1833. Aug. 13. Sent, per ship Chester, to F. Beaumont, Natchez, care of Florchell & Co., New Orleans.

1833. Aug. 16. Sent, per brig Mohawk, to Boston, to W. G. Neil, for Boston and Providence R. R.

There is no difficulty in understanding why the call was for a Transit that nothing much short of entire annihilation would render necessary to send back, over its slow, long and uncertain journey, for repairs.

The spread of Internal Improvements in this country had, at this time, fairly commenced, and with it the demand for the new instrument increased rapidly. So great was this increase, and so much did it outgrow the facilities of manufacture, that the inventor was compelled to send to England an order to have the greater part of a limited number of transits made. This was in 1835, and these were the first Transits, or parts of Transits, made in

England. About three dozen were thus obtained, the more particular parts being made here. They proved far from remunerative; some few were passable, others more troublesome, requiring alterations and repairs; while a fatal fault to a needle instrument, iron in the metal, was found to exist in nearly a dozen.

Of the latter, most were broken up; several remained in the establishment, in an unfinished condition, until recently, one of the last being taken to adorn the monument of a Civil Engineer, in Laurel Hill Cemetery, Philadelphia.

The earlier manufacture of the Transit instrument was, for want of conveniences, attended with many difficulties. The art of Graduation had as yet made but little progress, and the introduction of the Transit called for nearer approach to perfection. The first Graduating machines were extremely primitive, consisting simply of a circular plate of about 18 inches diameter, upon which degrees and half degrees were marked off, either by mechanical sub-divisions, or from a similar plate. The one in the establishment of W. J. Young, bears the name of ADAMS, Maker, LONDON, and consists of such a plate as we have described.

Such were the means of graduation in 1820. Mr. Young started, as soon as he commenced business, the construction of an engine of 24 inches diameter, wo-ked by the endless screw and treadle; and shortly after introduction of Transit commenced another of 26 inches diameter, for finer work, in which a new and important principle of construction for these engines was introduced. A few years afterwards, this same machine was rendered Automatic, and is yet doing active duty, second to none outside of the establishment for accuracy. About the same time, Mr. Edmund Draper constructed a graduating engine, which, amongst those acquainted with it, has a high reputation for accuracy.

The completion of the large 48 inch Graduating Engine, by W. J. Young, which he intended to be the perfect engine of the world, completed a line of Graduating Engines, which, for completeness of range, is certainly not equalled here, perhaps not in any establishment in Europe.

As Transits advanced to perfection, these advances in graduation became necessary. That they were not made at once, but were the result of almost a life of thought, work and patience, and source of expense, is evident from the fact, that from the year 1821 to 1860, or but 10 years before his death, W. J. Young was almost constantly engaged upon the making or perfection of these engines.

Another serious difficulty arose from want of opticians of ability. The first glasses used were imported principally from England. With the slow communication across ocean at that period, it was long before an order given could be received; and the purchase of all glasses to be found here, of proper size and focal length, furnished but a short supply. What was more troublesome, was the next supply differed in size and length from the last. When an inquiry for a larger instrument, or one of different construction, came, the question which determined the practicability of its manufacture, was the capability of making the telescope.

About 184?. an optician named Worth, commenced in New York the manufacture of glasses of telescopes for Engineers' Instruments, and they proving so much better than those otherwise obtainable, the writer of this was sent to learn, under Worth's instructions, the optical art. Before long, arrangements were made, Mr. Young purchased the tools and machinery, and it was removed to Philadelphia, along with the workmen, and connected with his establishment, with which it continued connected for many years, until, from increasing business, the tax on personal attention became too onerous; the tools and machinery were retained, and Mr. Worth placed in position to start for himself. From the optical department, as carried on during this period, came the majority of those now engaged in the manufacture of glasses for Engineering instruments. It gave the impetus which established the business permanently in this country. Fitz, of New York, and one or two others, had been quite successful in making the larger glasses for Astronomical Telescopes, but we believe had not turned their attention to the others.

The Transit instrument having thus been brought nearer perfection, in graduation and optical performance, received but few more changes in construction. The decimal graduation of vernier, suggested at an early day, by S. W. Mifflin, C. E., proved great advantage in the turning off deflection angles for curves, and was adopted by many, notably by the Engineers of Pennsylvania R. R., all of whose instruments were graduated in that manner.

The *loose* vernier and arc, for vertical angles, applied by the writer, about year 1850, was an improvement over the much liable to be injured full circle.

The Shifting Staff-head, patented by W. J Young, in 1858, was another of those little improvements which increase the value of instrument much.

The many varied uses to which, from progress of science in this country, the instrument has been called, has brought forth instruments of greater delicacy and different constructions, until, to-day, the finest Transit of the conscientious instrument maker is a splendid instrument, not surpassed in its performances by the production of any other country.

Of later minor improvements, some beneficial, some the exploded humbugs of by-gone days, we are not now to speak. The profession have other, perhaps less partial means of discovering them. Our desire is simply to keep from oblivion, the dates and circumstances of introduction of the instrument which has played so important a part in the ever memorable forty-five years of American Railroad construction, and which might, perhaps, be lost in the whirl which has been crowding the Railroad mind ever forward, leaving it no time to look back to the earlier laborers.