. . . THE . . .

CYCLOTOMIC TRANSIT

DESCRIPTION OF A NOVEL SURVEYING INSTRUMENT

. . MADE BY . .

THE A. LIETZ COMPANY

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THE CYCLOTOMIC TRANSIT

—BY—

OTTO VON GELDERN

THE PRINCIPLE OF THE INSTRUMENT.

The evolution of this instrument is due to a constant tendency to create a transit with *one spindle, i. e.*, having but one central cone turning within the leveling head, that shall, at the same time, sacrifice none of the advantages that the so-called compound center possesses.

It goes without saying that the principal advantage of the double spindle lies in the fact that, no matter in what direction the telescope may be pointed, the operator is enabled to make any azimuth of his graduated plate agree therewith. How this may be done without giving the lower plate an independent motion around the vertical axis of the instrument, is the problem to be solved.

The lower plate is the important member that carries the graduated azimuth circle, and if it be made a part of the rigid sub-structure—of the leveling-head and base-plate—the control of it in reference to known azimuths is apparently lost. If we were enabled, however, to shift the figure-series—the nomenclature of the circle—at will, so as to make any one of the graduation lines the zero, the advantage lost by having a rigid lower plate would be regained.

The novelty of the new transit lies in a floating exterior ring, placed around the periphery of the lower plate, upon which the figures from 0 to 360 are engraved. These figures are then no longer a fixed part of the circle, but possess that independent rotation which the lower plate had in the case of the double spindle. Instead of turning the whole plate around its vertical axis, we turn a narrow metal band around the stationary plate, which is the same thing.

As this band appears to be sliced from the plate, the name *Cyclotome* has been applied to it, from *κυκλος*, ring or circle, and *τεμνειν*, to cut, that is, a ring cut or severed as from a disk.

Since the object of the ring is merely to designate the graduated lines upon the plate by corresponding figures, absolute concentricity of the cyclotome is not a matter of importance.

THE CONSTRUCTION.

Attention is drawn to the illustrations herewith, figure 1 showing a vertical section through the plates, and figures 2 and 3 a top and bottom view respectively of the upper plate. In the vertical section the arrangement of the principal parts may be readily understood.

The lower plate and the leveling-head become one member, which is mounted upon the base-plate in the ordinary manner. The cyclotome *C* is fitted exteriorly around the plate, its top resting upon the graduation, of which it is a part.

The upper plate revolves upon the lower by means of its long and stout spindle, within the socket of the leveling-head. It carries the vernier *V*, visible through an opening in the plate, which also exposes a part of the graduated lower plate and a part of the cyclotome,

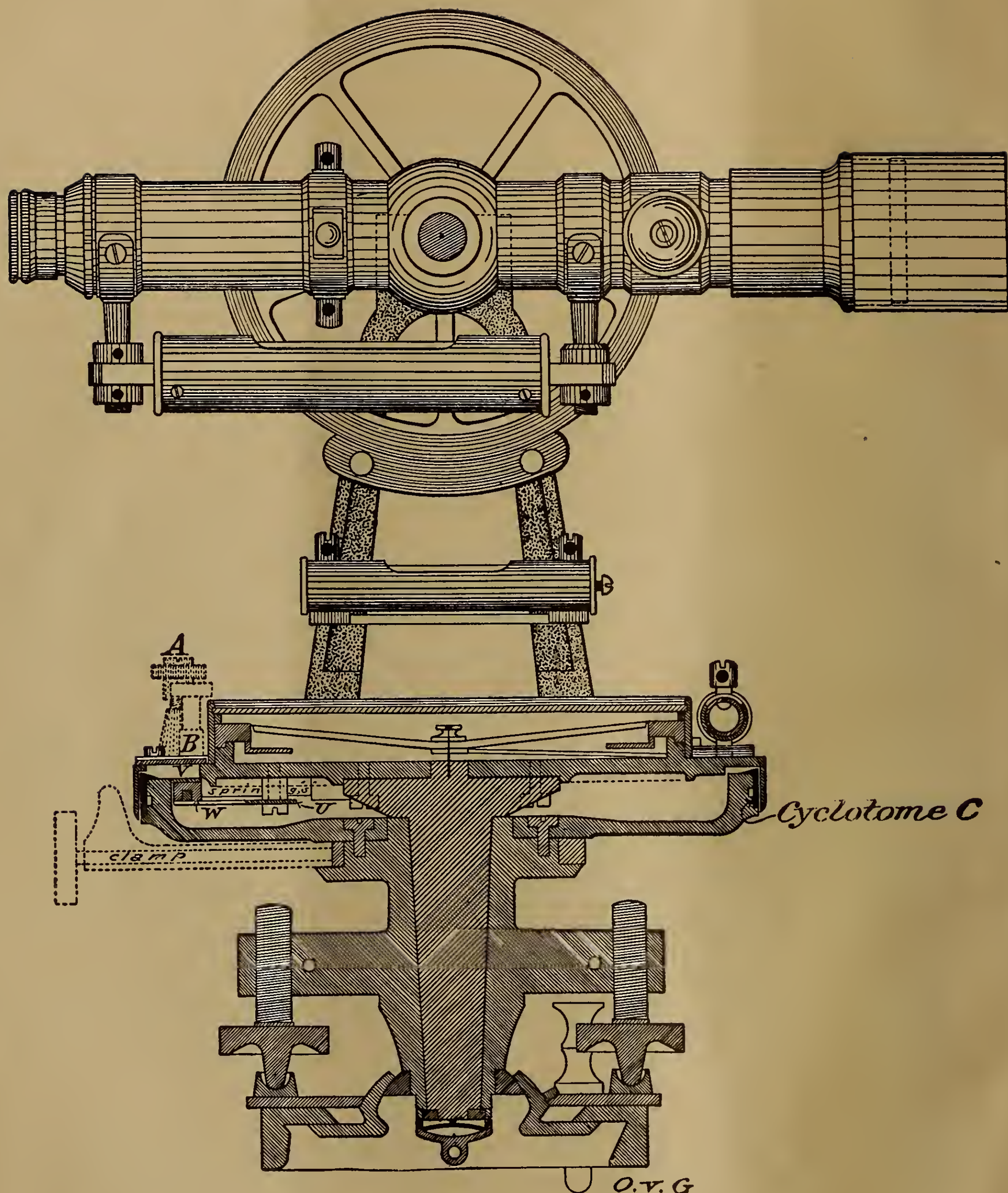


Fig. 1.

Section through Plates

on line X - Center - Y,
with side view of Telescope

PATENTED MARCH, 1896

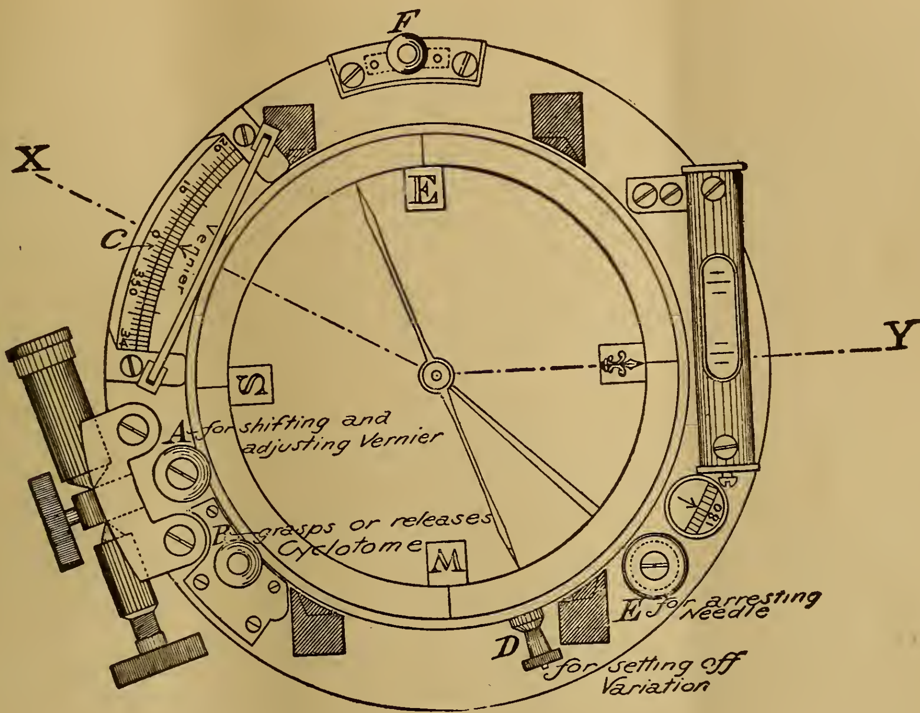


Fig. 2.

Top View of Upper Plate

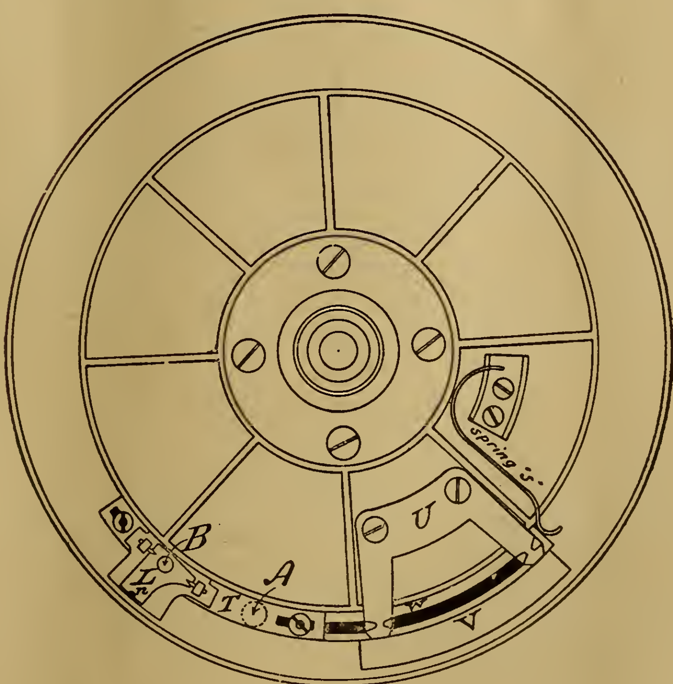


Fig. 3.

Bottom View of Upper Plate

PATENTED MARCH, 1896

The horizontal motion of the instrument is arrested by the clamp and collar, and the position adjusted by a tangent screw, as common to all transits.

Compass box and telescope are mounted on the top of the plate, as usual.

The flange forming the top of the lower plate is graduated into 720 even spaces of half-degree divisions. The vernier moves along the inner rim of this graduation, and is held whenever the line of collimation (the telescope) has the desired direction. In order to effect a coincidence between the vernier's zero and the nearest half-degree division line, the entire vernier may be shifted independently to the right or left by means of the screw *A*, shown in the illustrations, and in the manner presently to be explained.

And having thusly determined upon and indicated one of the 720 lines to be the initial or starter, it would be necessary only to bring the zero of the cyclotome—or any other reading for that matter—to match this line.

In the simpler form of the new transit, the exterior ring or cyclotome is revoluble by hand around the periphery of the plate, and the required azimuth is thus readily set off. In the improved form, as shown by the illustrations, the ring is encased, and so arranged that the upper plate in its rotation may or may not carry the cyclotome with it. It is picked up and revolved together with the telescope, or left at rest upon the lower plate in any desired position. It is within the power of the operator to manipulate this at will, and there are two means of doing so, as will be noted further on.

As it is generally required to place the *zero* upon the azimuth from which observations are started, an automatic catch *L* (see figure 3), having a small projecting pin *n*, is so arranged that whenever it is desired to make the cyclotome travel together with the upper plate, the pin *n* must be made to drop into a hole provided for it in the cyclotome; the moment this takes place, the two (plate and cyclotome) are connected, and—this is a peculiar feature of the device—in such a position that the zero of the vernier *V*, and the zero of the cyclotome *C* are brought together, separated, of course, by the intervening graduated flange of the lower plate. If the vernier be now revolved with the upper plate, the figure-system will travel with it, their respective zeros coinciding.

The bottom of the upper plate, figure 3, illustrates the mechanism with which all this is accomplished. *U* is a guide, fastened to the plate, for the arc *W*, carrying the vernier *V*. A strong spring *S* presses the arc against the slide *T*, the position of the whole being regulated by the exterior screw *A*, which allows the adjustment of the vernier already referred to. The catch *L* is poised in *T*. The screw *B* raises or lowers the catch, so that with it we may throw the cyclotome either in or out. A small spring under the catch *L* admits of this. The mechanism is so simple that it needs no further description.

With this device there is no difficulty in placing the zero of the horizontal circle so as to correspond with any pointing of the telescope.

USE IN THE FIELD.

The field manipulation is reduced to a minimum.

Having set the instrument over a point (1) in the usual manner, it is desired to direct the telescope to another point (2), and to make the zero of the horizontal graduation correspond with this azimuth. The main clamp being loose, the first operation is to turn the screw *B* so that the catch *L* is depressed; the upper plate is then turned, until a click indicates that the little pin *n* has caught the cyclotome and is carrying it along, with the zero in position, as explained. The operation is automatic to this extent, that the manipulator need not watch his plate to set the zeros. He will now direct the telescope to point (2), clamp the plate, and bisect the object with the tangent screw. His attention is thereupon directed to the vernier, for it is essential that its zero should correspond exactly with a line of the fixed graduation. He turns the screw *A* to the right, or left, shifting the vernier sufficiently to accomplish this. The cyclotome travels with the vernier, so that he does not need to watch it. The instrument is now oriented, the vernier indicating the starting azimuth, and measurements to other points may begin. Before commencing, however, the screw *B* is turned so as to release the catch and allow the cyclotome to remain in position. The instrument is now unclamped and ready for operation. Any subsequent reading will indicate directly in degrees and minutes the deflection from the starting point. The whole operation is simple and rapid, and will require less time than the setting of the compound-center instrument.

If it be desired to set any other azimuth to a telescope pointing, recourse is had to the clamp *F* (see top view of plate, figure 2), by which the cyclotome may be connected to the upper plate at any point.

The operation it as follows :

Set up instrument ; drop catch *L* by a turn of screw *B* ; revolve plate on center, click indicates that *L* has caught cyclotome *C*; point telescope, clamp plate and bisect object ; shift zeros to the nearest graduation line by screw *A* ; release cyclotome by screw *B* ; unclamp instrument and lay off the reading of the required azimuth to the nearest thirty minutes by means of the clamp and tangent screws, and then to the minute with precision by means of the screw *A* ; now turn down the screw *F*, which catches the cyclotome ; unclamp instrument, revolve on center, direct telescope to original object, clamp and bisect. The reading of the vernier will now indicate the azimuth wanted. Release the screw *F* and the cyclotome will remain in the position into which it has been brought.

The reason why the reading is laid off to the nearest thirty-minute mark only, and then adjusted to precise reading by shifting the vernier, becomes obvious, if we remember that it is always necessary to match the graduation lines of the plate with those of the cyclotome, and that any setting disturbing their coincidence (readings from 1' to 29' and 31' to 59') will have to be corrected by a vernier displacement.

This operation is rapid, although perhaps a trifle slower than the manipulation with the hand cyclotome, mentioned above, in which case the telescope is directed, plate clamped, object bisected, vernier zero brought to a line, cyclotome turned by hand to read within the nearest half degree of the line, after which the vernier is adjusted to the exact reading.

The principle remains the same in either method, the only difference being that in the case of the hand cyclotome one is able to set it irrespective of the motions of the uppe plate.

After these explanations it becomes very obvious that there are no advantages that the double spindle system can claim over the cyclotomic system in the ready manipulation of the horizontal arc.

ANGULAR REPETITION.

While the reiteration of an angle, resorted to in geodetic measurements, to obtain the value of an arc with its probable error to the fraction of a second, is not possible with the cyclotomic transit, because the main graduation is fixed and cannot be turned in reference to the direction of the objects observed upon, it is perfectly feasible to take the same angle on different parts of the plate. Since there are two verniers, located 180 degrees apart, two readings may also be had of each measurement and the mean taken.

Unless a double spindle transit be of the very best workmanship, that is, a first-class and therefore a high-priced article, all the reiteration and repetition will fail to reach a better result than that attainable with a well built cyclotomic instrument, which is made to read to half minutes directly, or to twenty seconds in the larger sizes ; and anything within the limits of this accuracy is guaranteed by the maker. As the reiteration of an angle is uncalled for in any but the most refined measurements, the cyclotomic transit does not lack completeness for the want of this particular feature.

ADVANTAGES OF THE CYCLOTOMIC TRANSIT.

The main feature is its single spindle. Its adoption obviates the necessity of the lower clamp and tangent screws, and simplifies this part of the transit very much. It affords an opportunity to bring the plates closer to the leveling-head, thereby lowering the center of gravity of the instrument. It sits directly upon the rigid substructure, fitted into it by a thick metal axis and must therefore be very steady. The main graduation, the most vital part of the transit, is fixed for all time. Once properly centered, the chances for eccentricity are reduced to a minimum. The instrument possesses a comparing vernier, opposite the reading vernier, (see figure 2) which shows through a circular opening in the plate. By means of the two, used in conjunction, the plate eccentricity may be accurately determined.

What is justly claimed for this instrument as more advantageous than the compound-center transit is included in the following:

Greater simplicity; reduction of parts and reduction of weight, with greater steadiness for instruments of the same size; greater solidity of the axis, and therefore greater rigidity, and the least liability to serious injury through accident; simple mechanism enabling a more rapid setting of the plates to the zero azimuth; avoiding the manufacture of an extra cone and socket, that is, reduction of prominent and costly parts to be made by the artisan, and a reduction, therefore, of the *price* of the article.

In its optical appointments and constructive details, the instrument is up to the standard of a first-class modern transit and surveying instrument; it is a tachymeter, and fitted for any possible expediency of modern engineering.

It has not been the object to replace the compound-center instrument with a cheap and inferior substitute, but rather to simplify the required parts and to improve, if possible, the stability and concentricity, without losing those features that have thus far made the double-center instrument the preferred one for meeting the manifold demands made by the profession upon a universal measuring tool.

THE MANUFACTURE.

The instrument in its present shape was designed in detail by Mr. Adolph Lietz, the original suggestion having been made to him by Mr. Luther Wagoner, civil engineer, of San Francisco, who had conceived the application of the floating ring or cyclotome.

All rights have been legally secured by the designer, who is also the manufacturer.

The instrument is made in San Francisco, in different styles and sizes. In their main and essential parts all styles are alike, but they may vary a little in the arrangement of minor detail. In appearance the instrument does not differ from any standard type, except that the bulky apparatus of clamp, collar, tongue, spring-case and tangent screw below the plates is missing, and that the plates sit a little closer to the base.

The cyclotomic transit is particularly adapted to aluminium construction, by placing a light superstructure upon a firm and solid base. This will insure very great steadiness even in a strong wind.

REMARKS.

It is very probable that the instrument will work itself into the favor of the profession, for while it has been much simplified, nothing has been sacrificed, and the item of cost has been reduced.

The principle here made use of may be extended with advantage to many forms of arc-measuring apparatus, and will undoubtedly find a much wider application in time. Although extremely simple and readily understood by anyone, it will require a little field practice to make the engineer an expert in the use of the cyclotome, which, like the slide-rule, will be appreciated all the more the longer it is used and its advantages become apparent.

ILLUSTRATED PRICE LIST

OF THE

CYCLOTOMIC TRANSITS

(PATENTED MARCH, 1896.)

GUARANTEED FIRST-CLASS IN EVERY DETAIL

MADE BY

THE A. LIETZ COMPANY

MANUFACTURERS OF

Scientific Instruments

422 SACRAMENTO STREET

SAN FRANCISCO

CAL.

THE CYCLOTOMIC TRANSIT.

(PATENTED MARCH, 1896.)

THE instrument is first-class in every particular, and made to correspond in all details to our high-grade transits; it is intended for any of the most accurate work the engineer is called upon to do.

It has but one spindle, but the simple arrangement of the Cyclotome admits of every evolution that the double center is capable of carrying out.

Its invention is the result of a constant aim on our part to create a simple long center instrument, against which it may not be said that the value of a horizontal angle cannot be determined at once, without taking two readings and obtaining a calculated difference.

The design is **novel**, but several instruments have been out in the field for months and **are giving absolute and perfect satisfaction.**

The instrument contains the best optical accessories, the most accurate plate divisions, and is guaranteed to give results to the limits of its vernier graduations, which may be had to twenty seconds of arc, if desired.

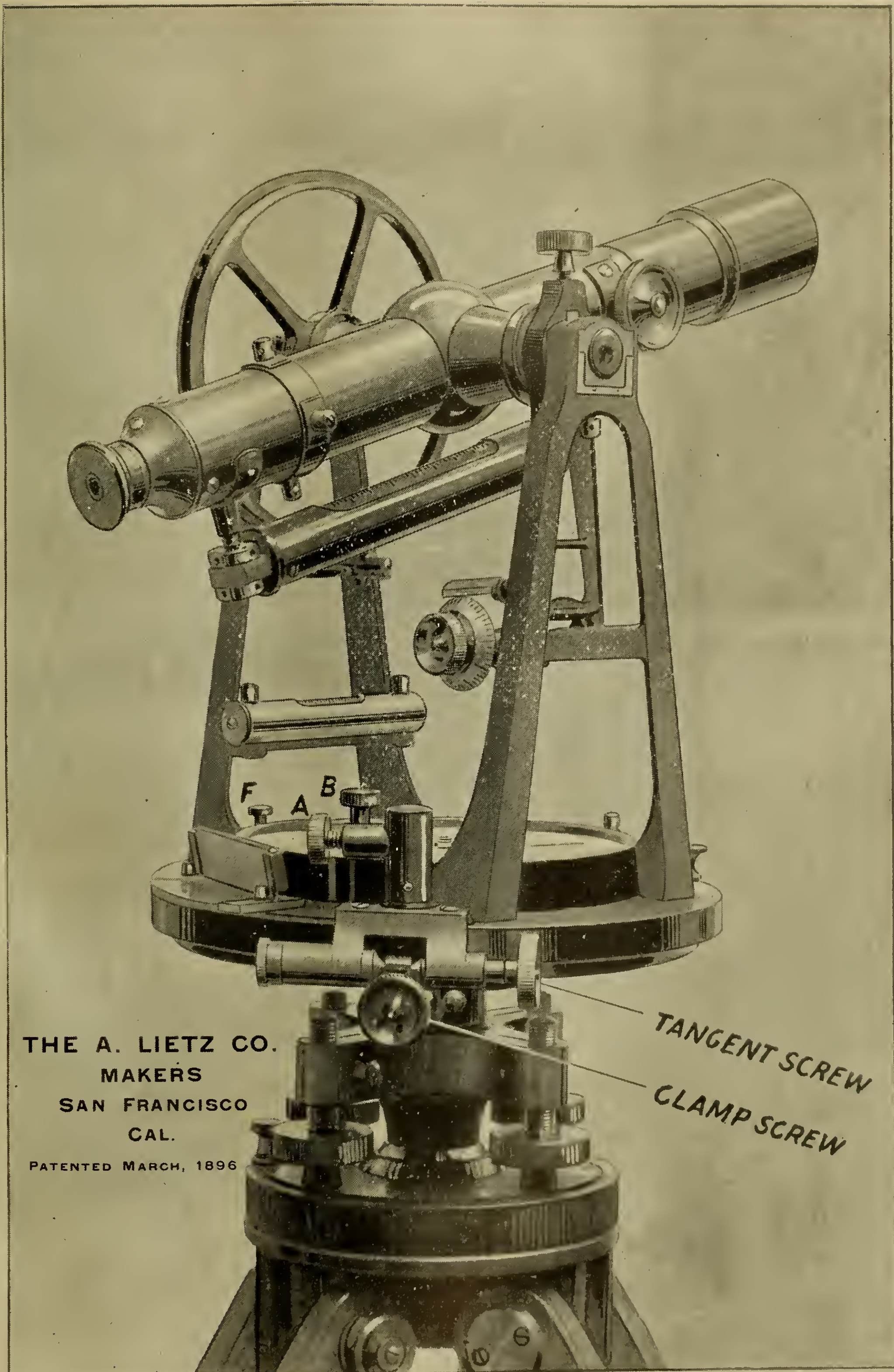
The high-grade **Cyclotomic Transit** is made in two sizes, of dimensions similar to our other transits, and these sizes are manufactured either in red metal or aluminium. They are numbered 18 for the larger and 18a for the smaller size.

A complete Cyclotomic Reconnoissance Transit, No. 18b, is also manufactured, in which the advantages of the system are combined to make a reliable instrument, complete in every detail, for **any work** in the line of modern engineering, at the **most reasonable cost.** See page 12 for details.

We recommend the **Cyclotomic Instrument** to the profession. Its use and manipulation are extremely simple, and the results of its work absolutely reliable.

Any special information, if called for, will be furnished.

After exhaustive trials we have the greatest confidence in the future of the cyclotomic method, and for this reason we have gone extensively into the manufacture of this novel design.



No. 18.

CYCLOTOMIC TRANSIT.

Price, as shown complete, but without Gradienter, $200.00.

For details and extras, see the following page.

No. 18.

COMPLETE CYCLOTOMIC TRANSIT.

(*Patented March, 1896.*)

Dimensions and Weight.

Horizontal circle (measured to edge of graduation)	6¼	inches diam.
Vertical circle " " "	5	" "
Compass needle	4½	" long.
Object glass	1⅛	" diam.
Telescope	11	" long.
Magnifying power	24	
Weight of instrument	15	lbs
" tripod	8½	"
" box	8	"
Weight of this instrument if made of hard aluminium	7½	"
The price of this instrument complete, as shown is		$200 00

And if made of hard aluminium, 15 per cent added.

No. 18a.

COMPLETE CYCLOTOMIC TRANSIT.

(The same as No 18, but smaller.)

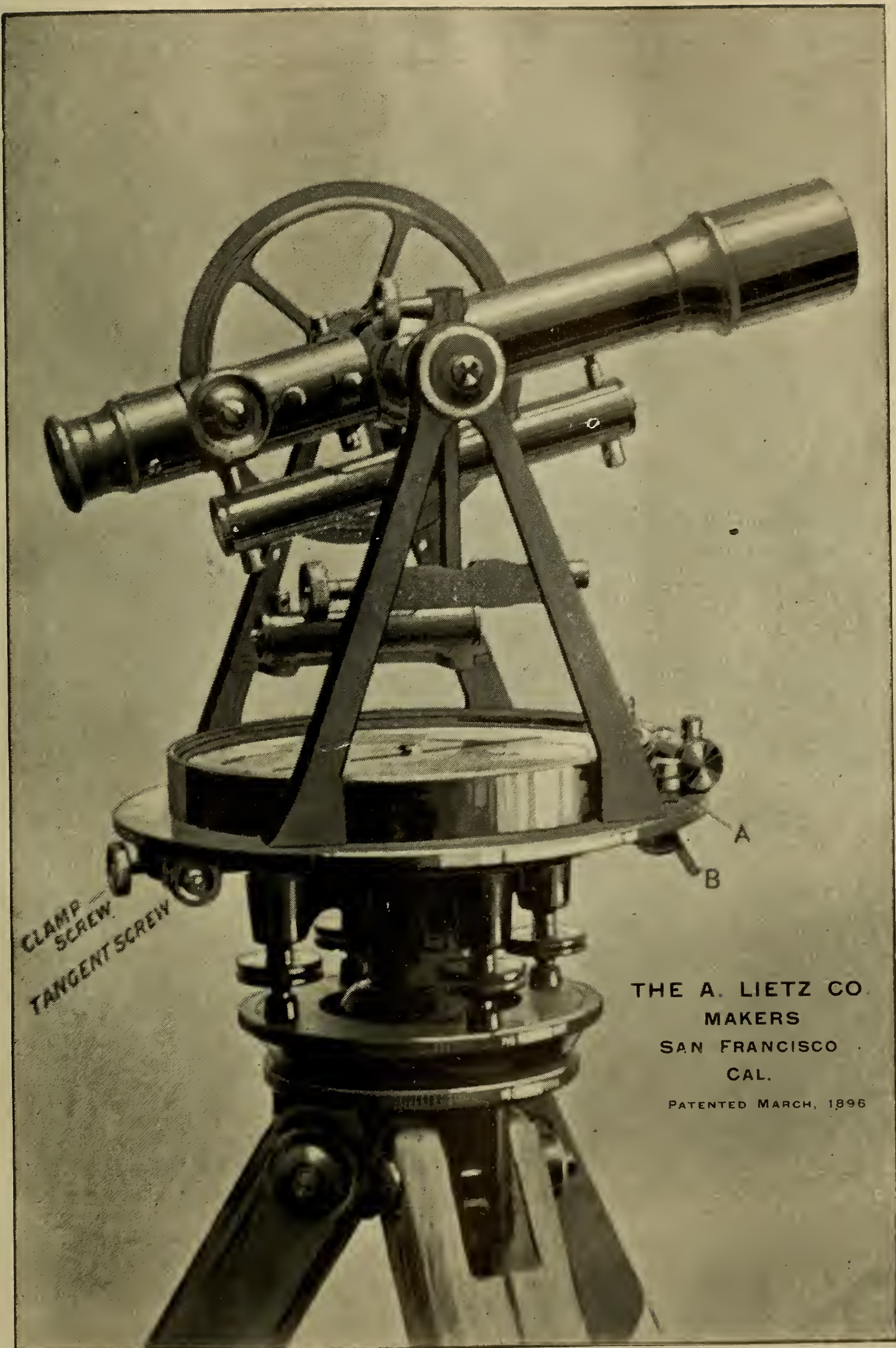
Dimensions and Weight.

Horizontal circle (measured to edge of graduation)	5	inches diam.
Vertical arc or circle (measured to edge of graduation)	4	" "
Compass needle	3½	" long.
Object glass	1	" diam
Telescope	8	" long
Magnifying power	18	
Weight of instrument	8½	lbs.
" tripod	6	"
" box	6	"
Weight of this instrument if made of hard aluminium	4½	"
The price of this instrument complete is		$195 00

And if made of hard aluminium, 15 per cent added.

The Extras, for which additional charge is made for either size, except where noted, are as follows:

Solid silver graduations:	
On horizontal circle	$10 00
On vertical arc or circle	5 00
Verniers (horizontal) reading to 30″ (No. 18)	10 00
" " " " 20″ (No. 18)	20 00
Gradienter attachment	5 00
Stadia hairs, fixed	3 00
" " adjustable	10 00
Variation plate	10 00
Arrangements for offsetting right angles	5 00
Striding level to axis of telescope	20 00
Reversion level (see slip 134A)	10 00
Constructed with three leveling screws on base plate, instead of four	10 00
Three leveling-screw shifting center	5 00
Prism, attachable to eye-piece	8 00
Extra extension tripod	15 00
Extra tripod, in lieu of the ordinary	5 00
Protection bag	1 00
Bottle of fine watch oil	25
Saegmüller solar attachment of aluminium	50 00



No. 18 b.

COMPLETE CYCLOTOMIC RECONNOISSANCE TRANSIT.

Price, as shown complete, $125.00.

For Extras and Details, see the following page.

No. 18b.

COMPLETE CYCLOTOMIC RECONNOISSANCE TRANSIT.

(*Patented March, 1896.*)

A field instrument of medium size, possessing a VERY LARGE NEEDLE, one horizontal vernier, verticle arc or circle, and every accessory to make the instrument a complete tachymeter for stadia work. For topography it has no equal in simplicity of operating parts, and full equipment for work of such character.

It admits of laying off horizontal and vertical angles correctly to one minute of arc; the starting azimuth may be made zero or any other reading, with as much facility as any other known transit, although the instrument has only one spindle. This spindle or center is of extra large dimensions in length and diameter, which affords great stiffness and rigidity to the whole structure.

Dimensions and Weight.

Horizontal circle (measured to edge of graduation)	4	inches	diam.
Vertical arc (or circle)	4	"	"
Compass needle	4½	"	long.
Object glass	⅞	"	diam.
Telescope	8	"	long.
Weight of instrument	7½		lbs.
" " tripod	6		"
" " box	5		"
Weight of this instrument if made of hard aluminium	4½		"
The price of this instrument, complete, is			$125 00

And if made of hard aluminium, 15 per cent. added.

The Extras, for which additional charge is made, are as follows:

Stadia hairs, fixed	$ 3 00
Variation plate	10 00
Extension tripod in lieu of the ordinary	5 00
Protection bag	1 00
Bottle of fine watch oil	25