Boston Optical Works.

CHARLES STODDER,

~~RIALTO, Room 36,~~

~~131 Devonshire, Corner of Milk Street.~~

IMPORTER,

AND AGENT FOR W. WALES' AND JOS. ZENTMAYER'S

MICROSCOPES.

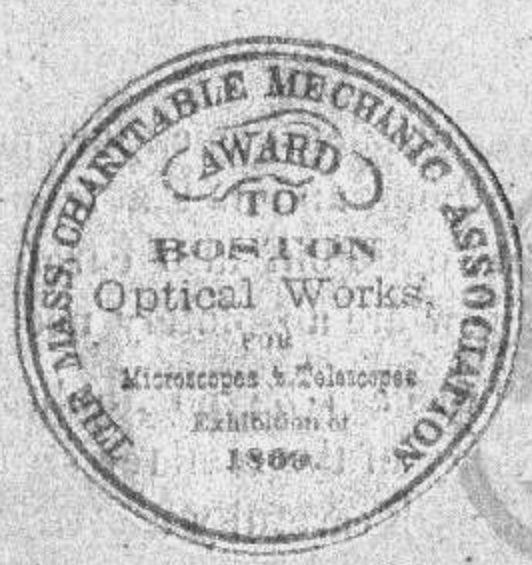
SOLE AGENT FOR THE SALE OF

MICROSCOPES AND TELESCOPES

MADE BY

R. B. TOLLES.

GOLD MEDAL OF THE MASS. CHARITABLE MECHANIC ASSOCIATION, 1869.



SILVER MEDAL OF THE EXPOSITION UNIVERSELLE, PARIS, 1867.

19th EDITION. - - - - - PRICE 15 CENTS.

BOSTON:
ALFRED MUDGE & SON, PRINTERS, 34 SCHOOL STREET.
1883.

"It must be remembered that by the modern microscope a realm of life and organization is opened up to us almost infinite in its extent and variety; and increased optical power, instead of exhausting, only widens out, intensifies, and renders it more entrancing. But as it required the aid of moderate lenses to understand exhaustively the mode of life and methods of growth of an oak-tree, large as it is, so it must require the magnifying power of our most perfect and powerful object-glasses to discover the modes of life, method of metamorphosis, and manner of origin of the immeasurably lesser forms, which are not seen at all until the lens needful to discover the germination of an oak-tree is used. As we pass downward we come to less and still lesser forms, all equally endowed for and adapted to their environments."—*Rev. W. H. Dallinger, in Northern Microscopist, Manchester, Eng., July*, 1882.

Extracts from the Annual Address of the Professor P. Martin Duncan, President of the Royal Microscopical Society, Feb. 14, 1883.

[Journal Royal Microscopical Society, p. 172.]

"A considerable experience impresses me that the majority of students and not a few professors not only use indifferent instruments, but also carefully avoid all those practices which we know are absolutely necessary for *correct microscopy*."

"There can be no doubt that the majority of the recorded histology of the minuter structures will have to be worked over again with carefully *corrected objectives*."

"Circumstances have brought me in contact with cheap microscopes; and certainly whilst it may be said that some of the objectives are fairly good, the eye-pieces are on the miserable 'par' with the rest of the apparatus."

A WORD TO PURCHASERS OF MICROSCOPES.

ALTHOUGH magnifying-glasses have been used for time immemorial, and valuable discoveries were made by them centuries ago, yet it is only within the last fifty years, when the method of constructing achromatic lenses was discovered, that the microscope began to be an instrument of real scientific value. Since that time, from the united labors of skilful opticians and accomplished scientists, there has been a continual series of improvements and new inventions of apparatus, the end of which is not yet.

Of all instruments of scientific research, there is no one which requires greater skill in its construction, and no one of which there is such an almost endless variety of forms, shapes, and quality, of both the optical and mechanical construction. On the continent of Europe great advance in construction had been made by eminent opticians; but it is not too much to say that nearly all the really valuable improvements made during the last five decades, in the form of the instrument, and in the *quality of the optical parts*, have originated either in England or America, and that the best work of many of the continental opticians, who yet have a good reputation there, is twenty-five years behind the times, while they still continue to produce quantities of instruments that are absolutely worthless, except as toys.

There are certain qualities absolutely necessary to a microscope, if it is to be any other than a plaything, which every purchaser should see that his instrument possesses. First, the optical part, the lenses, should be at least of good quality. The all-important requisition is good definition, freedom from color and flatness of field included. There are various qualities in lenses; some are adapted best for one class of studies, some for another. No novice can judge of the performance of a microscope; it requires long experience.*

Secondly, the mechanical work must be simple, of the fewest possible number of pieces, not liable to get out of order. The stand must be well made, or it will not keep in working condition, but require frequent repair. It must be heavy enough to stand firmly, not easily moved or upset. Not less than five to six pounds weight is efficient. Fifteen pounds is desirable.

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* For the qualities to be looked for in a first-class objective, see quotation from Dr. Richardson, p. 12.

As the average distance of distinct vision is about ten inches, that has been adopted as the standard length; *i. e.* the distance between the eye and the object, or more exactly, between the optical centre of the objective, and the optical centre of the eye-piece: many cheap instruments have tubes of only four or five inches; as a length of ten inches magnifies twice as much as one of five inches does, all that increase of power is lost by a short tube. The instrument should be made so as to admit of inclination at any angle, from vertical to horizontal. The best position for the microscope is such that the observer may sit at his ease in a chair, at a table. The vertical position of the tube is "the very worst that can be adopted." — *Carpenter.*

Many novices think that the value of a microscope depends on how much it will magnify. This is a great error; the most worthless instrument may magnify highly. More can be seen with a good instrument with a power of one hundred diameters than with a poor one of five hundred.

Every microscope consists of two essential divisions, — in a sense independent of each other, — though either is useless alone; viz. the mechanical part, or stand, and the optical parts, or lenses. One of these parts may be good, and the other inferior. The optical part consists of the *objective* and *eye-piece*. Each instrument may be furnished by the maker with any number and power of objectives and eye-pieces that the purchaser requires for his special use, or is willing to pay for.

Finally, every *beginner* should have a standard *recent book* on the microscope, or he will have to feel his way blindly over roads that have been already travelled. What would be thought of a man who should attempt to make a watch who did not first ascertain how watches have been made? With "Carpenter" or "Hogg" in his hands, the novice may learn in a short time what it might take him years to discover by his own unaided efforts.* It is more economical to purchase an instruction book than to pay a teacher, not meaning, however, that a good instructor is not desirable.

As there is want of information as to the meaning of the magnifying power of lenses, some explanation of the principles will be of service.

The "power" of a lens is not a fixed mathematical fact, but the power is calculated from an arbitrary standard; *i. e.* what a lens would magnify an object ten inches from the eye, *if* natural vision was just ten inches. Any change of this distance will change the nominal power. Objectives and eye-

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"How to Use the Microscope," by John Phin, can be recommended to beginners as the best book at a low price.

pieces being made up of combinations of lenses, they are named as they magnify equal to a single lens; that is, if a combination of lenses magnifies the same as a single lens of one inch focus it is *called* a one-inch; if the same as single lens of a quarter-inch focus, then it is a "quarter-inch," and so for all others.

Now a one-inch lens, or objective, is said to magnify an object ten diameters, if the object is ten inches distant, and a $\frac{1}{10}$ will magnify 100 diameters. The number of times the focal length is contained in ten inches is the power; but the image formed in the microscope by the objective is again magnified by the eye-piece, consequently, the power of the objective must be multiplied by the power of the eye-piece. Thus a $\frac{1}{10}$ objective power 100 × by one-inch eye-piece 10 = 1,000 diameters. With the ***new nomenclature of eye-pieces***, every owner can calculate the theoretical power of his own instrument. If the distance between the optical centre of the objective and the optical centre of the eye-piece varies from ten inches, the resulting power will vary in proportion.

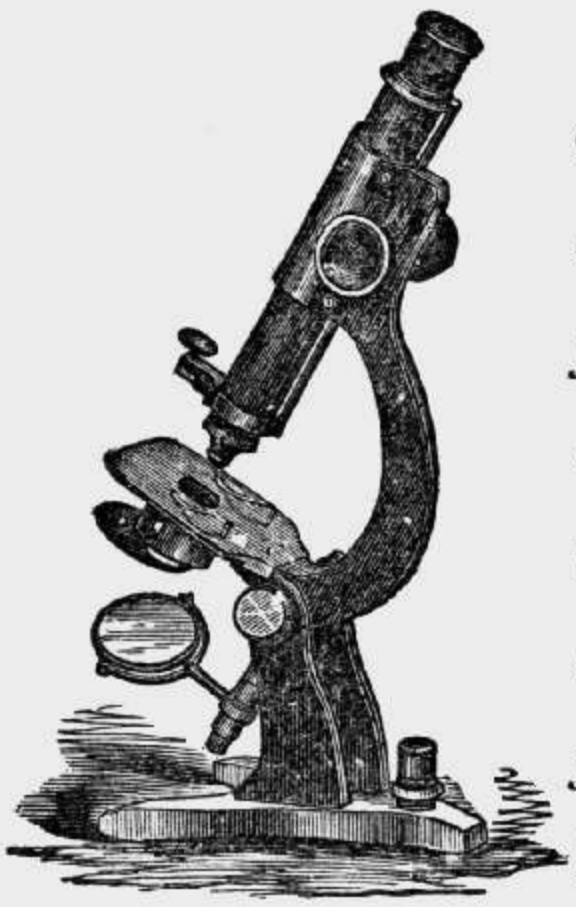
TOLLES'S STUDENT'S MICROSCOPE.

15 INCHES HIGH, WEIGHT SIX POUNDS.

This instrument, designed under the advice of several of the Professors of the Medical School of Harvard College and other well-known Microscopists, is of the pattern and size most approved by experts. The base, uprights, and curved arm are of iron, handsomely japanned; on a trunnion joint, made on a new plan to wear well, by which the instrument can be placed in any position, from vertical to horizontal, with a stop to prevent movement in either direction beyond these points. It is furnished with a 1-inch Eye-Piece, two *second-quality* Objectives, of about 1 inch and 1-4 inch power, giving *about* 80 and 350 diameters, a plain Stage with spring clips for holding the object slides, revolving Diaphragm, concave Mirror, with movement to give oblique light; for illumination of opaque objects, the mirror is removed to an upright stand; coarse adjustment for focus is effected by sliding the compound body which is held in its place by a spring, fine adjustment by a movable plate and screw on the stage, which is efficient with high powers. The stand is made with all the care bestowed on his first-class instruments, and proves satisfactory for the use of amateurs, students, and the ordinary work of the medical profession. The work-

manship is superior to that of any instruments of the class made in Europe. The form is the Jackson pattern recommended by Dr. W. B. Carpenter as the one least liable to tremor, and is the one most approved by all American microscopists. Price, in an upright Black Walnut Case, $50. Stand and Case alone $28.

VARIATIONS AND ADDITIONS. — Extra Eye-Pieces, 2 in. 1 1-2 and 3-4, $4 each; a superior Camera Lucida, $5: Sub-Stage for accessory apparatus, $5; a Sliding Stage, giving vertical and horizontal motions by the hand, and adapted for the use of Maltwood finder, $15. Fine adjustment by lever and micrometer screw, $16. Rack and Pinion for coarse adjustment, $12, draw tube, $4. Plain Mirror, $3. Thin glass stage to rotate on the optical axis, $10. The stand all brass, $10. Any of Tolles's first quality Objectives may be used on this instrument, and can be added to order at list prices. Packing boxes for transportation, $1.



Student's Microscope, with 1-*inch and* $\frac{1}{4}$*-in. Objectives, one ocular, rack and pinion, lever fine adjustment for focus, sub-stage for illuminating apparatus, revolving diaphragm, plain and concave mirrors, side-stand for illuminating opaque objects, black walnut case. Price,* $85.

TOLLES'S STUDENT'S MICROSCOPE.

From DR. GEO. E. BLACKHAM, *President Dunkirk Microscope Society.*

AUGUST, 1875.

MR. CHAS. STODDER:

Dear Sir, — As to the Student's Stand, I am simply delighted with it. It is remarkably steady on its feet, and shows no inclination to kick up its heels when the body is placed horizontal for drawing. This cannot be said of many higher-priced stands that I know of. 2d. The Jackson model and full length of tube meet my hearty

approval. Wenham's new model Ross stand is about the clumsiest-looking affair I ever saw. 3d. The arrangement for controlling the movement of the sliding tube is the only one in which I have ever been able to take any comfort. Proof: I used my duplex $\frac{1}{6}$th on this stand, and I would not risk it on any other sliding-tube stand I have ever tried so far. As to its superiority over the rack and pinion, that depends. That it is better than a poor or even moderately good rack and pinion, there can be no doubt. I can do just as good work with this, but it is a little more trouble. 4th. The fine adjustment is eminently satisfactory, though I have been much prejudiced against fine adjustment moving the stage. 5th. The joint for inclination works with a perfection unsurpassed by any first-class stand I ever saw, and appears to be a triumph of mechanical simplicity.

As to the objectives, I was pleasantly surprised at their excellence; I knew of course that Tolles never sent out any work that was not good, but had no idea that these low-priced lenses were so good. Compared the $\frac{3}{4}$ last night with a $\frac{2}{3}$ furnished with . . . "physician's microscope" bought for the schools here at $90, and the superiority of the $\frac{3}{4}$ was very marked. The object was a cluster of living vorticella, a legitimate natural-history application — no diatom. The $\frac{3}{4}$ *defined* and showed the cillæ, and the $\frac{2}{3}$ did not. The $\frac{1}{4}$, too, is a fine lens, and excited considerable admiration by the clearness and sharpness of images. The one-inch is also remarkably good; and in fact I should be inclined to rate all these objectives as first-class, had not my experience with Tolles's $\frac{1}{6}$th and one-inch of 30° taught me what real first-class work is.

The camera, too, is excellent: altogether, I am delighted with the outfit.

THE POCKET MICROSCOPE

For clinical and field or seaside use is a simple tube 6 inches long, with a one-quarter inch Objective and B Eye-Piece, — fine and coarse adjustments for focus, — a Stage with spring-clips to hold the object, which can be removed when not in use, and the Objective covered with a brass cap, making the most compact and efficient *portable* instrument in use. Price, $25; with a draw-tube for increasing the power, $29. As the same Eye-Pieces and Objectives are used for the Student's Microscope, those who want both instruments require but one set of the optical parts. All the other Objectives on the list can be used with both instruments, and can be supplied to order.

The Objectives and Eye-Pieces supplied to these instruments are in all respects equal to those sent to this country, with many so-called first-class instruments from Berlin, and with those from many of the well-known opticians of Paris and London.

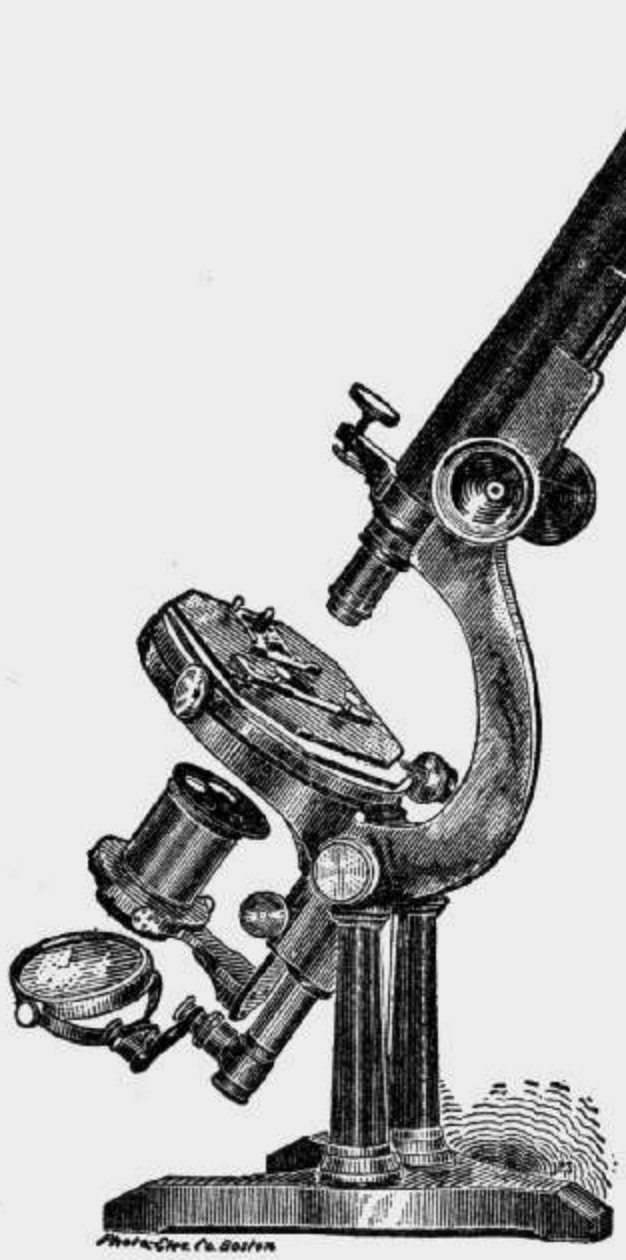
THE PROFESSOR'S MICROSCOPE.

This is an instrument similar to the clinical. It is intended to pass around a class of students. Is provided with a means of clamping the object slide to the stage, so that the particular object the lecturer is explaining cannot be moved out of the field, while each observer can adjust the focus to his own eye. Price without objectives, $25. This instrument and the "Pocket" are used without a stand by holding it in the hand and looking at the light.

TOLLES'S LARGE MICROSCOPE.

B.

This instrument is intended to meet the wants of the highest scientific investigation; to attain everything that the microscopist can accomplish, without sparing the cost, and to permit the use of all the modern accessory apparatus. Like all of Tolles's microscopes, it is constructed on the curved arm (Jackson) model, which Dr. W. B. Carpenter, in his elaborate work on "The Microscope," fourth edition, 1868, preferred over all other models; and in 1870, at a meeting of the Royal Microscopical Society, of London, still more emphatically approved in a special communication, giving his reasons for thus indorsing it. The instrument is eighteen inches high, weighs about fourteen lbs., thus giving a stability and freedom from tremor that cannot be obtained with stands of little weight. It is of simple construction, with fewer screws and pieces than any other first-class micro-



scope. The curved arm is supported on a steel arbor between two strong brass pillars, made for durability, and not liable to get out of order, and provided with a method of compensation for wear. The arm is easily clamped and held in any position, and is readily removable. Has rack and pinion for coarse, and micrometer screw for fine adjustment for focus; graduated draw tube; sub-stage with rack and pinion, and centring screws for accessory apparatus; plain and concave mirrors, on double-jointed arm, Tolles's thin stage, admitting light of great obliquity, with rectangular movements by screw and rack and pinion, and *rotation on the optical axis* of about 325°, — all that is essentially necessary. Price, $225.

N. B. — A newly devised mechanical stage, with rectangular movements throughout one inch of field, with rotation 360° in the optical axis. Price, $200.

TOLLES'S LARGEST MICROSCOPE.

A.

This instrument is one of the largest yet produced anywhere. It is similar in all respects of style and construction to the B instrument, but larger and heavier, weighing 20 lbs. The stage is six inches in diameter, and makes a complete revolution on the optical axis. The whole instrument rotates on a stout plate graduated to degrees. Price of stand, $300. Can be furnished with radial arm, with axis in the focal point, to carry accessory apparatus at any angle. A graduated arc registers the obliquity of the incident light. This method of reading the angle of incident light and angular aperture was devised more than seven years ago. Other models of stands are now made.

TOLLES'S LARGE STAND C, Price, $160.

This stand has Tolles's patent radial arm, which carries the illumination above the stage, and measures the angle of incidence of the light. Tolles's patent traverse lens for utilizing balsam angles beyond 82° can be added to order on all the large or small stands. With the new mechanical stage, No. 1, $210.

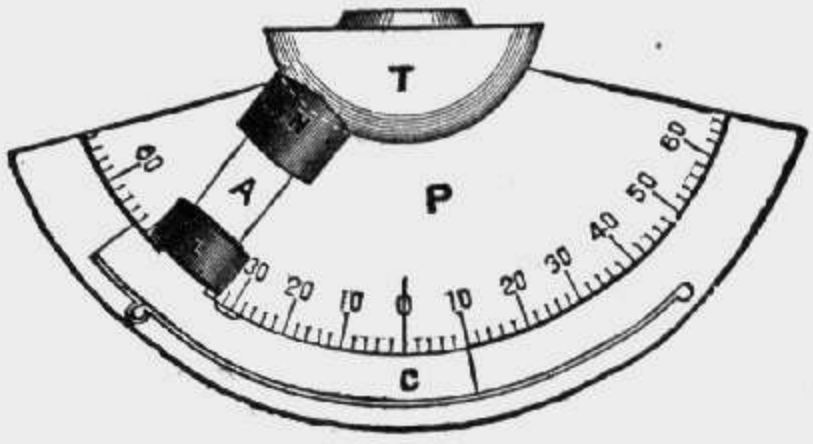
Dunkirk, N. Y., Dec. 3, 1878.

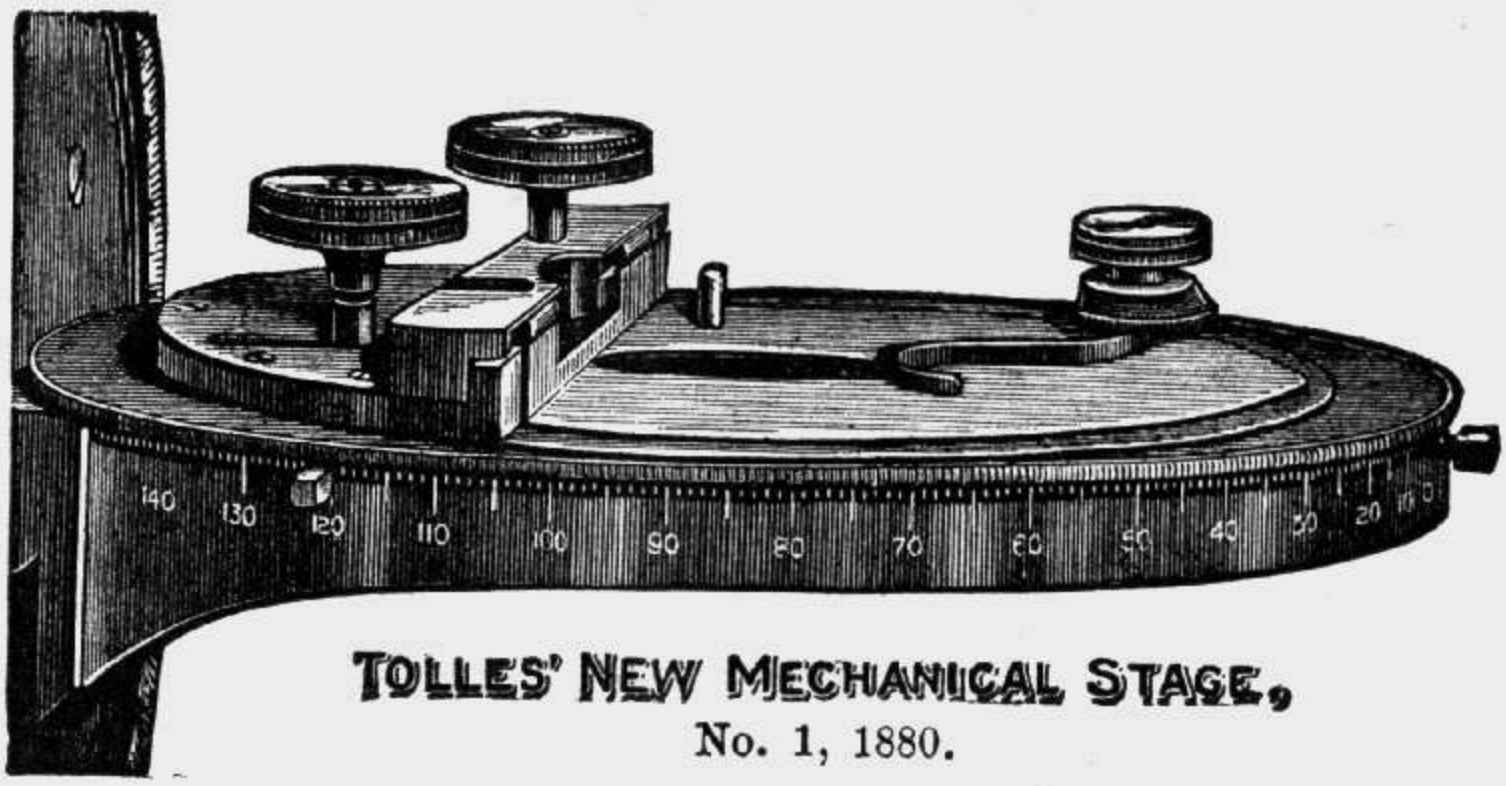
As to the stand, I am more than pleased, — I am delighted. It is much handsomer to look at than I expected, and the workmanship is, as far as I can see, *absolutely perfect*. Such a rack and pinion and

TOLLES'S PATENT

TRAVERSE LENS, RADIAL ARM, AND CONDENSER.

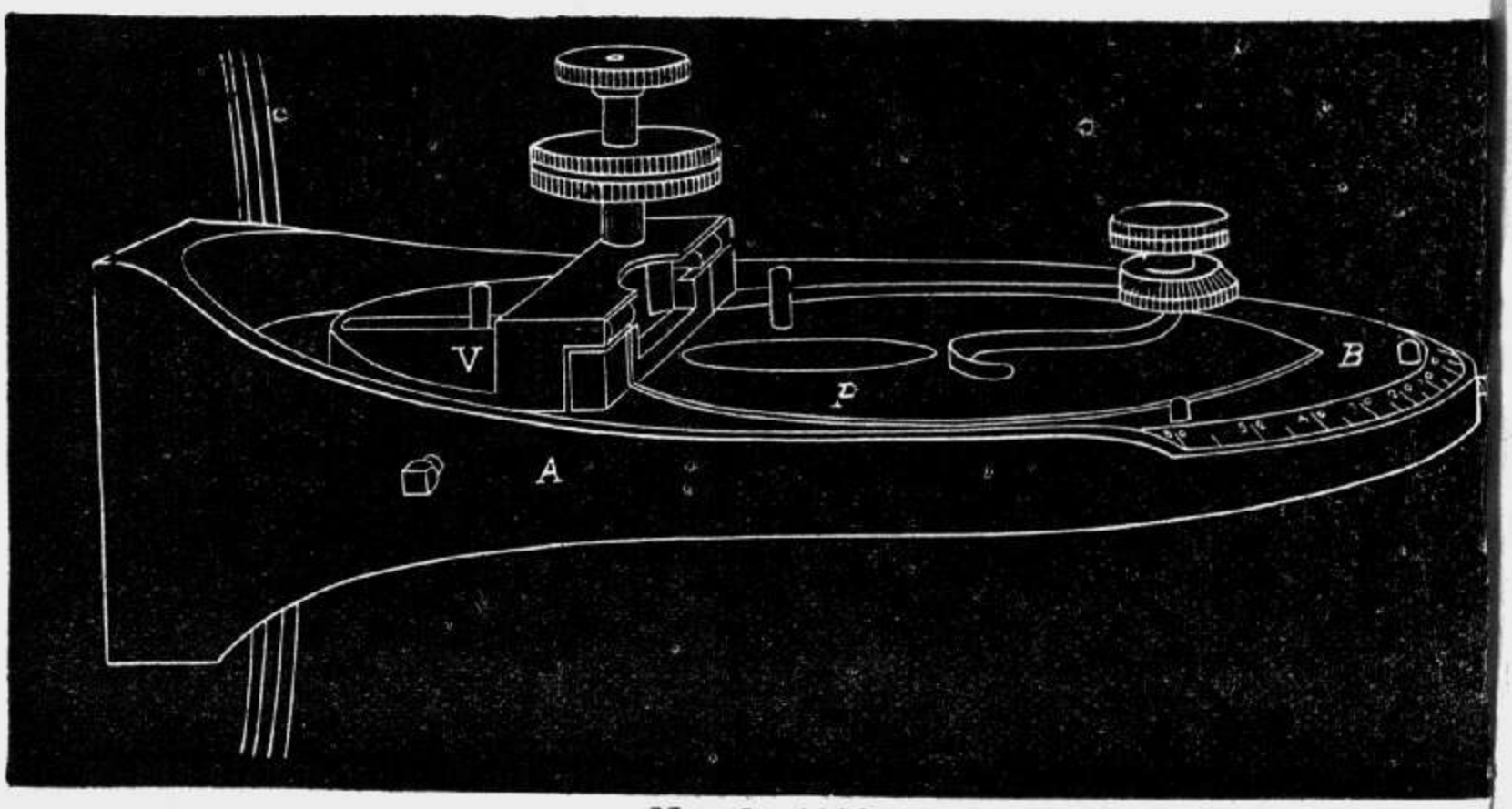
Price by special contract.





TOLLES' NEW MECHANICAL STAGE,

No. 1, 1880.



No. 2, 1882.

PRICES OF TOLLES'S INSTRUMENTS.

SOLD BY CHARLES STODDER.

HUYGHEN'S NEGATIVE EYE-PIECE, 2 in., 1 1-2 in., 1 in., 3-4 in., $8 each.
" " " " for Student's Microscopes, $4 each.
TOLLES'S PATENT SOLID EYE-PIECES, 1-2 in., 1-4 in., 3-8 in., $8; 1-8 in., $12.
" " " " " for Student's Microscopes, $6.
TOLLES'S SOLID ORTHOSCOPIC EYE-PIECES, 1 in., $15, higher powers, $12.
This Eye-Piece makes an excellent achromatic condenser.
TOLLES'S BINOCULAR EYE-PIECE, $80. See pp. 17, 18.
TOLLES'S AMPLIFIER, to double the power of any specified Objective and Eye-Piece without disturbing the "corrections," $12.
Higher power amplifiers of another construction by special arrangement.
TOLLES'S ACHROMATIC TRIPLETS for the pocket, in Silver cases, 1-2 in. and 3-4 in. $12; 3-4 in., extra large mounting, $14; 1-4 in., $14.
1-in. do., do., with 6-10 in. field, $16.
DOUBLE NOSE-PIECE, $8 to $16.
CAMERA LUCIDA, $5.
TOLLES'S IMPROVED TELESCOPES,
1 in. lens, 4 or 5 in. focus, on stand, with pancratic Eye-Piece, $70.
2 1-2 in. lens, 22 to 27 in. focus, on iron tripod, $175 to $250. See pp. 19, 20.
2 1-2 in. do. on Engineer's tripod, $150.
4 in. do. on iron tripod, $300.
TELESCOPES OF ANY APERTURE, of unusually short focal length, made under special contract.
Wenham's Reflex Illuminator, $10.

MICROSCOPE OBJECTIVES.

TOLLES makes four classes of microscope objectives, viz.:—

FIRST QUALITY OF LARGE ANGULAR APERTURE. These are made for the highest requirements of the microscopist and histologist, as tracing nerve fibre, cell formation, resolution of Nobert's lines, etc., etc.

1-2 inch	ang. ap.	60° to 80°	$40
4-10	"	" 90° to 115°	45
4-10	"	" 135° to 145°	65

This objective may be used as an achromatic condenser, with special advantage.

1-4 inch or 1-5	ang. ap.	120° to 130°	$45
1-4 "	" "	up to 150°	55
1-4 "	" "	" 180°	70
1-6 "	$5 advance on 1-4.	180°	70
1-8 "	ang. ap.	to 160°	70
1-8 "	"	to 180°	80
1-10 "	$5 advance on 1-8.	180°	85
1-12 "	ang. ap.	under 140°	80
1-12 "	"	up to 160°	90
1-12 "	"	" to 180°	110
1-15 "	"	" to 160°	110
1-15 "	"	" to 180°	120
1-20 "	"	" to 180°	150
1-25 "	"	" to 180°	175
1-50 "	"	by special contract.	
1-75 "	"	" "	

All objectives of 180° may be duplex front, or three systems, at option.
These duplex or four system lenses have been made since 1871–3, marking the period of the great advance in the construction of objectives by utilizing rays beyond 41° of obliquity to the optical axis (82° of angle) in balsam or crown glass.

FIRST QUALITY OBJECTIVES having less angular aperture, more penetration with first-class adjustment for cover.

1-2 inch	ang. ap.	60° or less	$35
2-3 "	"	65° "	60
4-10 "	"	85° "	40
1-4 and 1-5 "	"	100° to 120°	40
1-6 "	"	100° to 120°	45
1-8 "	"	100° to 130°	45
1-10 "	"	100° to 135°	50
1-12 "	"	120°	55
1-15 "	"	120°	60
1-20 "	"	140°	80

All of 1-4 inch or higher powers will be made either dry or immersion at the same price, or to work both ways with the same lens. All objectives of 180° may be made for dry, oil (*i. e.*, HOMOGENEOUS), glycerine, or water immersion, at purchaser's option, at the above prices. With an extra "front" lens, $10 to $25 extra. All the foregoing have Tolles's adjustment for covering glass, which does not move *the front lens*, and has no back lash.

FIRST QUALITY OBJECTIVES, without adjustment for cover.

4 inch adjustable to 3 inch	$35
2 inch	8
2 inch higher ang. ap.	20
2 inch 20°	40
1 1-2 inch and 1 inch in one	25
1 inch 14°	10
1 inch 25°	23
1 inch 30°	30
2-3 inch 36°	30
1-2 inch 25° to 50°	23
1-2 inch *specially constructed for viewing opaque objects* } *	23
1-4 inch 40° to 70° adjusting by front lens do. do. }	

FIRST QUALITY HOMOGENEOUS OBJECTIVES, numerical angle at least 1.0, will resolve amphipleura pellucida. No adjustment for cover-glass.

1-6, 1-8, or 1-10 inch focus	$40

The same of higher grade, wider numerical angle.

1-6 inch	$50
1-8 inch	60
1-10 inch	70

SECOND QUALITY OBJECTIVES, without adjustment for cover.

1-8 inch immersion 120°	$25
1-10 inch immersion 120°	30
1-6 inch 90° to 100°	18
1-4 inch or 1-5 inch 70° to 90°	15
Will resolve well Pl. Angulatnm.	
1-4 inch 40° to 50°	12
Has a long working distance for opaque objects.	
1-2 inch	12
2 inch and 1 1-2 inch	8
1 inch	6

All objectives are made with the "Society" screw, so as to fit all recent English or American stands, unless ordered otherwise.

But few microscopists need references in regard to Mr. Tolles's optical instruments. But as there are yet some people who think it is necessary to go or send to Europe for *good* instruments, a few letters from those who know what good instruments are, are inserted, for their information. The selling agent prefers to let purchasers see what is said by those who use Tolles's microscopes, rather than to make claims for superiority himself.

From Henry Sharp, Green Hills, New South Wales, July 13, 1879.

MR. C. STODDER, — So far as I have yet tested the Tolles 1-10th objective I am more than satisfied with it, and have much pleasure in saying that I consider it by far the finest objective I have yet seen, and I neither expect or hope ever to see a better. It is truly a grand objective. Please convey to Mr. Tolles my best thanks for the care he has taken in its construction. I remarked that the prices of Mr. Tolles's lenses were high. I beg now to correct that, and I say that they are *apparently* high, but in *reality* are not so, as I consider this 1-10th I have to be the cheapest objective I have ever bought.

From Prof. Bessey, Iowa State Agricultural College, Ames, Jan. 9, 1871.

The instrument (Tolles's Student's) is just what I want. I have tested it as much as my limited time would permit, and can assure you that so far it is perfectly satisfactory; I regard it as just the microscope for class use.

Very respectfully,
CHAS. E. BESSEY.

From W. H. Walmsley, Philadelphia, December, 1870.

You ask my opinion of the objective (three quarter inch); it is *simply glorious*.

Museum of Comparative Zoölogy, Cambridge, Mass., January, 1871.

I have no hesitation in saying that Mr. Tolles's first-class microscope objectives (I have used and examined *critically* a great many of them) are the best I have seen, either of American or foreign make. The large microscope stand now being finished is, in my opinion, the best first-class stand made, and it meets more of the requirements that are called for in a first-class instrument than any other that I have seen. The stage being roomy, extremely thin, very firm, and making an entire revolution

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*These are a new construction of a conical front lens, by the use of which a beam of light may be thrown directly on the object, permitting the use of higher powers and larger angular aperture than heretofore

on the optical axis, having the milled heads of the stage movements at the side, *with nothing to interfere with the utmost obliquity of illumination*, makes it the *best stage in existence*. In all first-class microscopes that I have heretofore seen, there has been one or more of the above requirements wanting. No one who wants a *strictly* first-class stand can do better than to procure the above.

I have a one-inch telescope of Mr. Tolles's make of *four* inches focus, 15° ang. ap., which I have used on terrestrial objects with from 16 to 30 diameters, with fine effect; and I have used it with 25, 50 and 100 diameters on celestial objects with fine effect also. All of Mr. Tolles's larger telescopes that I have seen, have been equally good.

Very truly yours,
EDWIN BICKNELL.

From letters from the late Dr. Th. Eulenstien, formerly of Dresden, lately of Berlin, N. Germany.

DRESDEN, July 15, 1868.

"Mr. Green has delivered to me the one-sixth immersion. I can pronounce it one of the finest objectives I have seen for definition, richness, and blackness of the images. I shall expect your statement whether the highest powers now made by Tolles progressively excel the corresponding powers of other makers, same as his one-sixth *certainly* excels any lens of that power I have yet seen."

DRESDEN, Feby. 11th, 1870.

"I have sent the Tolles's 1-6 objective to Nobert, and he has closely examined it. We have both seen the lines of the 17th band of his test-plate; no more at present. This, however, is an extraordinary feat for a sixth; and more than any other lens that I know of, of that power, can possibly be stretched to do. I am sorry I cannot see one of Tolles's highest powers to enter into a comparative list I am preparing."

TH. EULENSTIEN.

This objective is now owned by Prof. Van Huerck, of Anvers, Belgium, who in December, 1876, calls it "admirable."

Within a few years, very low power objectives have received much attention in London; and a great many four (4) inch objectives have been made, and used with satisfactory results. A difficulty in the use of them arises from the long working distance which prevents their attachment to all microscopes. Mr. Tolles has recently constructed an objective which is either 3 or 4 inch at user's option; and with a working distance of one and three-quarters of an inch only, which can be reduced to one inch if so ordered.

The following, from a well-known microscopist, corresponds with the opinion of all other experts who have seen the instrument.

PHILADELPHIA, March 19, 1870.

"I have had but a few moments to devote to the 4-inch lens, but those few enable me to say emphatically, that it is the best low power I ever saw and is far superior to Ross's 4 inch. The latter I have used very much, and liked, but found it to possess very considerable spherical aberration which is entirely corrected in Tolles's objective.

"I shall keep it, most decidedly, and sell my Ross. I hope you will send one to London without delay." "Had it no other superiority, its short working distance would give it the preference; altogether, I am delighted with it. Ross's is a triplet, and also a single combination. The whole length is 11-16 of an inch; while its extreme diameter is 1 1-16 inch; giving it a very awkward look. The actual aperture

of the front is 1-8 of an inch greater than Tolles's. The size of the field and magnifying power of the two are precisely the same. Fields equally illuminated, but while Tolles's shows all portions of an object, such as sections equally well, only the central portion of Ross's is clearly defined; with opaque objects the difference is even more strongly marked. I showed the four inch to a number of the members of our society on Monday evening, in comparison with Ross's; and there was but one expression of opinion, and that of unqualified preference for the Tolles's objective. This is a triumph, I think, since Ross's is undoubtedly a very good lens."

Yours truly,

W. H. WALMSLEY.

Extracts from letters from Mr. John Mayall, Jr.

"LONDON, Dec. 13, 1875.

"MR. CHAS. STODDER:

"*Dear Sir*, — On taking the lens out of its box a thorough overhaul of the whole objective gave me a very favorable impression of the care and precision of the workmanship. On that score I don't think that Mr. Tolles has anything to fear from any one here. The setting of the lenses, and the correction adjustment, seemed to me to be first-rate."

"LONDON, Jan. 12, 1876.

"I am not going to enter into a mass of details of the various trials I have made with Tolles's 1-4th and 1-8th. Suffice it to say that no lenses that have been in my hands have ever been so thoroughly tested against the best lenses by English, French, and German opticians. [He gives a list of seventeen recent immersion objectives by the most renowned makers in Europe.] Without reserve of any kind I say these lenses, Tolles's 1-4th and 1-8th, are the finest I have ever seen. . . . I affirm, then, that with central and oblique light on all the objects that are known here as tests, Tolles carried the palm! I find on the most severe tests there is in Tolles's lenses a better correction for spherical aberration. The image is more *crisp* and *clear*. By difficult tests, I mean, for instance, surirella gemma with central light, or amphipleura pellucida with oblique light. On these diatoms the definition is all that I have ever hoped for with lenses of their focal length. While on Podura the clearness and perfect achromatism are beyond anything I can obtain with ——'s similar powers. . . . The lenses have been tried by every means known to me. [Here follows the enumeration of thirteen methods of illumination.] By all these means I have worked out the problem that these lenses of Tolles are first-rate. . . . The lenses have a very precise focus, and a particularly best point of adjustment, therefore I say, in my hands, I find them easier to manipulate than any lenses I know of, with which any such images can be obtained. . . . I urge that low angle lenses will not exhibit the definition these lenses will show, and that if one takes a higher power that will show the images, he will find, by comparison, the higher power will be more difficult to manage. The whole question turns upon results: if you are content with medium images, use medium or low angle objectives; if you train your eye for fine images, you must use high angle objectives. I find these lenses fairly obey my will, showing images at once such as have generally required some minutes of manipulation."

From Dr. J. G. Hunt.

"PHILADELPHIA, July 27, 1876.

"The 1-5th that you sent to me two years ago is now in England. It combined in the greatest degree resolution of lined objects with penetration. It was the best lens, in all respects, for the histologist I ever saw."

"PHILADELPHIA, Dec. 26, 1876.

"I can now report that the 1-10th you sent to me is grand. It contains more good qualities than are to be found in many first-class lenses. Perfect mechanical workmanship, large field, gives sharp image on the margin of field, decision of definition leaving nothing doubtful or foggy, equal penetration with resolution, thus being superior for histological work. I could engrave it all over with marks of admiration! . . . For the best work of the botanist or histologist it has a definition which can be retained, with an amplification such as I have not yet seen in any 1-25th or 1-50th that has come under my notice. It is plainly seen that its organization was not accidental but designed. I see in its construction more finger-skill, more time and conscious brain patience, than mathematics, hence its character. It has no precedent, but is wholly original and unlike any other make, English or Continental. Thanks."

Extract from a letter from an eminent scientist.

"BIRMINGHAM, ENGLAND, Dec. 20, 1876.

"It is one of the characteristics of a real work of art that the more closely examined the more its beauties shine forth. Surely few modern lenses have been as carefully

looked at as this 1-25th you sent me, and I should assuredly say that few have come so well out of the ordeal.

"Four persons, living hundreds of miles apart, have passed independent judgment upon it, and I am very glad to be able to tell you, that to make a summary of their opinions, *all* consider that the lens is superior to any objective of similar high power yet seen in England. The images are 'bright' and 'robust,' instead of having the poorness and flatness usually recognized in most 1-16ths and I may say in every glass beyond that power. There is an absence too of colored fringes, which shows how carefully you have made the chromatic correction."

From the Journal of the Quckett Microscopical Club, London, Dec. 22, 1876.

"Mr. Crouch said he hoped it would be thoroughly understood that, in his remarks upon the productions of the American opticians [at the centennial exhibition], he spoke not as a maker but entirely as individual observer. He had seen some of Mr. Tolles's objectives, which he had not seen surpassed in performance anywhere."

From Prof. Chas. E. West.

BROOKLYN, N. Y., Feby. 15, 1872.

I have a 1-10 objective made by Tolles. I like it very much. I have resolved the amphipleura pellucida with it, which I have never been able to do with any 1-10 in my possession (and I have several). I look upon it as a very remarkable lens.

From the Boston Transcript, March 21, 1872.

Rev. E. C. Bolles, of the Rust Street Universalist Church, Salem, late of Portland, a naturalist of eminence, began his course of lectures last evening. He discoursed in an agreeable, off-hand manner upon the microscope, considered historically and mechanically, covering in his remarks the two centuries just passed. . . . Robt. B. Tolles, of Boston, was pronounced to be, on the whole, and from a most extended examination of the field, the most successful maker of microscope lenses, now living, in any country of the world.

From Dr. Jos. G. Richardson's Handbook of Medical Microscopy, Phila., 1871, p. 26.

"I had an opportunity, not long since, of examining and working for a short time with an immersion 1-10 made by Mr. Tolles, which performed better than any other objective of its focal length that I had previously seen. When accurately focused, the working distance, although small, was ample, being nearly twice that of the 1-25; the magnifying power was fully equal to the standard (500 diameters); the definition very superior; the penetrating power, as tested upon a light Podura scale, very good; its field perfectly flat, and the image formed by it entirely free from chromatic aberration. It was mounted for use either dry or immersed, and when employed in the latter condition defined well with deeper eye-piecing than any lens I ever saw before, showing upon my Powell & Lealand stand, with their No. 4 eye-piece, the limiting membrane and revolving molecules of the salivary corpuscles with remarkable clearness. The price of such a glass of 160° angle of aperture is $80."

Extracts from the proceedings of the Boston Society of Natural History, vol. xii, *p.* 359. *Dr. Hagen, of Cambridge, said:*

"All over the world, first-class microscopes have resolved the fourteenth, or even the fifteenth [?] band of Nobert's test plates; but should it be found that American microscopes, even with a one-eighth objective, have resolved perfectly the nineteenth band, the superiority of these instruments would be so ENORMOUS that it could be easily proved at any time and place."

This had been done repeatedly with several objectives made by Tolles, at the time Dr. Hagen made the above remarks. It has often been done since with other objectives made by Tolles, and can be repeated at a *suitable* time and place; but not with

any objectives taken at random, but only such as are made for that kind of work, — not *easily*, for it requires the most delicate manipulation.

Since that time, Dr. Hagen has himself seen and counted "about forty" of the lines of the 19th band, with a Tolles's 1-10 immersion objective. "The lines were well defined."— *See his communication to Max Schultz's Archive for Microscopische Anatomie*, 1870, *No.* 2.

***Extracts from** "Remarks on Resolution of the XIXth band of Nobert's Plate, by certain objectives, especially by a new Tolles's immersion 1-18th." By Dr. J. J. Woodward, U. S. Army. Monthly Microscopical Journal, London, Nov. 1872, p. 227.*

"This objective is so surpassingly excellent on the plate, that I hasten to make the facts public, as promised." "With regard to the performance of the dry combinations of this objective, I will merely say that they gave me the striæ of *Amphipleura pellucida* rather better than any dry objective I have ever tried" "The behavior of the objective when used wet, is certainly admirable. In illustration I forward a series of views of Nobert's plate from the lowest to the highest taken by it. These pictures certainly excel all my former work on the plate." "It will, of course, be expected that I should say something of the comparative merits of this new objective of Mr. Tolles, and the immersion front of the Powell & Lealand 1-16th, which has done such good work for me since 1869. "Certainly I must give the new Tolles's objective the preference on the plate, and on *Amphipleura pellucida*, both by sun and lamp light." "I have next to state that Mr. Tolles having been kind enough to send to me during the past year a number of objectives from 1-10th to 1-20th, for study, I have since Feby. of the present year satisfied myself that several of them resolved the 19th band in a very satisfactory manner."

Extract from a letter from a well-known microscope maker.

LONDON, Sept. 25th, 1872.

"One of my customers has requested me to procure for him your 1-10th objective.

Prof. Markoe, of Boston, was kind enough when at my place a few weeks ago, to show me the performance of this lens, which I believe, from what I saw of it, to be the finest objective of this description I ever had the pleasure of looking through."

J—— S ——.

From a letter from the Register General, Melbourne, Australia, July, 1873.

"My interest has been much excited accidentally by a chance conversation with a gentleman I met recently, who told me that he had heard at home that in mechanical and optical skill Mr. Tolles was bearing away the bell against the first of European competitors."

REPORT OF THE JUDGES ON PHILOSOPHICAL APPARATUS, *eleventh exhibition of the Massachusetts Charitable Mechanic Association held in Boston, September*, 1869. *Joseph M. Wightman, Esq., Josiah Curtis, M.D., Chas. K. Stevens, Esq., Judges.*

Nos. 297 and 460. BOSTON OPTICAL WORKS, *Boston*. Robert B. Tolles, Superintendent; Charles Stodder, Treasurer. Microscopes and Telescopes. The Microscopes exhibited comprise a variety of instruments and accessories, embracing much that is original and ingenious, and characterized by nice workmanship and elegance in appearance.

One large microscope, with A and B Huyghens' eye-pieces, and Tolles's patent solid C eye-piece, with micrometer, has a very ingeniously constructed rotary stage, devised by Mr. Tolles, which is only one-sixteenth of an inch thick. Its rotary movement is concentric with the axis of the objective. It has, also, lateral movement by friction rollers, and a sub-stage, movable by rack and pinion, for accessory apparatus.

In the list exhibited we find a binocular eye-piece and a solid eye-piece, both invented by Mr. Tolles; and although the latter was patented in this country by him several years ago, we were shown a similar device, in fact nearly identical in every essential particular, by a scientific friend who has just returned from a sojourn in Europe, where he purchased it as a new and valuable *oculaire*, one of the latest improvements just invented by a microscope maker of celebrity in Paris.

The judges took as much pains as circumstances permitted to compare the workings of the instruments on exhibition with others of the most reputable makers in this country and Europe. The objective of the highest power was the one-tenth immersion, whose angle of aperture is 175°. Under the observation of the judges, and others whose assistance was invited, this objective defined test objects better than any objective of the same power, and as well as many others of higher powers, from other makers which were at their command. The usual tests were resorted to, such as the *Pleurosigma angulatum*, *Surirella gemma*, etc., etc., among the *Diatomaceæ*, and Nobert's test plate from artificial sources. The latter is, *par excellence*, the test of the quality of objectives. It consists of straight lines uniformly ruled on glass, and is not subject to the variations which prevail in different individual specimens of the same species among natural objects. The test-plate used was one of Nobert's later make, containing nineteen bands, the last of which, on the nineteenth band, was composed of lines so fine and close that it requires over 112,000 to occupy the space of one inch. These were clearly resolved by direct* light illumination from a kerosene lamp, with the one-tenth immersion objective† and a B eye-piece. Among those invited who witnessed this performance may be named Prof. Walcott Gibbs and Dr. B. A. Gould, of Cambridge. The true lines of this

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*Direct light should not be confounded with central light. The light was direct from the lamp, unmodified; of course it was very oblique.

† This is the same instrument referred to by Dr. J. J. Woodward, in his paper in the "American Journal of Science" for September, 1869, and in a communication to the "Monthly Journal of Microscopical Science," London, for December, 1869, and called by him an eighth only.

nineteenth band have never yet been seen by Nobert himself, and their resolution has been pronounced, both by him and many European microscopists of eminence, as physically impossible. We cannot learn that any one in Europe claims to have seen them, if we except, perhaps, Nachet, of Paris. At the U. S. Army Medical Museum in Washington, D. C., with a one-sixteenth immersion objective, made by Powell and Lealand, of London, the sunlight being controlled by a heliostat and rendered monochromatic, excluding all rays of the spectrum except those of the shorter-wave length, and condensed with a one-inch objective of Tolles's make, the lines in question have been photographed.

The binocular eye-piece is also the invention of Mr. Tolles. It not only seems to do well what any other form of binocular microscope will do, but it is also suitable for use in those cases where all other binoculars fail, their uses being limited to the lower powers in consequence of the relationship of their binocular arrangement to the objective. Mr. Tolles's arrangement connects it with and makes it a part of the eye-piece. It may also be used with telescopes.

The telescopes on exhibition by the Boston Optical Works comprise one Improved Equatorial Telescope, having five inches aperture and thirty-five inches focal length with two eye-pieces having powers of 80 and 160 diameter respectively; and two smaller improved short-focus telescopes. Of the latter, the lens or object-glass of one is one inch in diameter, and has a focal length of four inches. The extreme length of the instrument is twelve inches. It has a pancratic eye-piece, varying the power at will, and is reported to have borne one hundred diameters with full satisfaction. The other has one and a half (1.45) inches aperture, and six inches focus.

It will be at once observed that the shortness of lengths for such apertures is novel, if not unique. It is believed to be without a parallel in instruments from any other maker.

In conclusion, it should be stated that none of the articles above noticed were made for exhibition, but faithfully represent such as are put into the market. Indeed, nearly all of them have been sold, and were loaned by their owners for this occasion. It may also be added that the opinion of the owners, as well as others eminently capable of judging correctly and impartially, emphatically justify the conclusion of the judges in deeming the articles from the Boston Optical Works worthy of the highest reward, a —

GOLD MEDAL.

Extracts from the report of Dr. F. A. P. Barnard, LL. D., President of the Columbia College, N. Y., Commissioner of the United States to the Exposition Universelle, Paris, 1867.

P. 152. "In no branch of physical investigation has the number of zealous devotees in recent years more rapidly increased than in the study of microscopical organisms; and no instrument of optics has occupied in its construction a larger amount of practical skill of the *highest order*, or has received more numerous and more important improvements than the microscope itself. It is, indeed, the high perfection and wonderful power of this instrument *as at present constructed*, which, by affording clear and satisfactory views of the structure of only recently esteemed excessively difficult and doubtful objects, and by thus diminishing immensely the labor of microscopic research, has given to it its present great and rapidly increasing popularity."

P. 534. "THE OBJECTIVES OF MR. TOLLES ARE UNSURPASSED BY ANY IN THE WORLD."

P. 237. "It is *not necessary for Americans any longer to go abroad* in order to obtain microscope glasses of any description of the *highest order of excellence*."

P. 541. "Mr. Tolles has constructed an instrument on the stereotomic principle, designed to remedy the difficulty attending the original binoculars, while at the same time it secures the incidental advantage of permitting any ordinary single-tube microscope to be used as a binocular. . . . This eye-piece works with *objectives of all powers* with perfect equality of illumination in both fields.

"Mr. Tolles has also produced very fine stands. A masterpiece of this kind, constructed by him from designs furnished by the present reporter, possesses some important and peculiar advantages."

No instruments were sent to the Exposition by Mr. Tolles; some of his friends contributed their objectives of his make, all "dry working," but there were no "stands" provided on which to exhibit them. Notwithstanding this great disadvantage, **the jurors awarded to Mr. Tolles for the objectives the —**

SILVER MEDAL.

TOLLES'S DUPLEX ONE-TENTH.

From the "Journal de Micrographie." PARIS, March, 1878.

We have received a great many demands for particulars regarding the famous 1-10th objective of Mr. Tolles. . . . As to the optical quality of this objective we have but a word to say about it: it is the finest that we have ever seen. It resolves with *incomparable clearness* all the known tests. . . . To conclude, we do not hesitate to affirm that we consider this instrument the finest objective in the world; also, we think its high price ought not to be an obstacle to its being made common among French microscopists, to whom we recommend it in preference to any other.

TOLLES'S ONE INCH AND FOUR TENTHS OBJECTIVES.

From the "Journal de Micrographie." PARIS, May, 1878.

We were astonished for a time at the high prices of the low-power English and American objectives from four inches to one third of an inch; we confess we could scarcely comprehend that such low powers should necessitate such costly instruments; that we could only with difficulty admit that one should devote from 100 to 200 francs in purchasing objectives that one could buy for 20 or 30 francs of Hartnack, or Zeiss, or Nachet. *For a long time we have seen our error,* — in part, at least, — and we have already many times confessed it, in regard to the 4-10 of 90° of Beck, — but we see every day how greatly we were deceived, and in examining some of the preparations of Chas. Zentmayer with the 1 inch and 4-10ths of Tolles, we have had a new and startling demonstration of our mistake; of the 4-10ths of 80° we have not more to say, except that in rivalry with Beck's (which is a true 1-3, and therefore gives a larger amplification) it gives a fineness of image incontestably superior and a penetration still greater than the fine objective of Mr. Beck.

But the one-inch of eight lenses of Mr. Tolles has veritably astonished us by its totally unexpected qualities.

If one examines with one of *our* (French) *best* objectives by one of *our best* makers a preparation of a certain thickness, one of two things happens: either the objective is of small angle and permits more or less incomplete view of a certain depth of the preparation of which the contours are not sharp nor the illumination brilliant, or the objective is of large aperture and one sees a very slight depth or plane (if the instrument is good), of which the outlines are sharply shown and the illumination brilliant; to observe the different layers, it is necessary to focus, and one thus sees a series of superposed planes showing perfect inages, but *spiritless.*

But with the one-inch of Tolles we see not a plane, but a picture with a deep perspective, with the outlines finely engraved and brilliantly illuminated; that is to say, this is one of the objectives called penetrating; but objectives can only have penetration with a narrow aperture — this has 30°. We have, then, an object-glass of very wide angle (for 30° is the widest angle possessed by any one-inch, of our acquaintance at least), consequently giving a large, brilliant field, an image of which the details are as visible as is possible with so low a power, of which the contours are of an extreme fineness and sharpness, and which with all this possesses "a penetrating power" such as to produce the effect of a binocular.

"It is impossible!" one will say. Yes, it is impossible, we know it well; but it is none the less real. And we now see why we have reason for saying that this objective has plunged us into a profound astonishment.

TOLLES'S STEREOSCOPIC BINOCULAR EYE-PIECE.

To the Editor of the "Monthly Microscopical Journal."

HOBART COLLEGE, GENEVA, N. Y., U. S., May, 1871.

SIR: — I wish to correct as widely as possible, a statement in regard to the stereoscopic binocular eye-piece, which attributes the invention to me instead of Mr. Tolles, to whom really the whole credit belongs. Dr. Carpenter * has made, unintentionally, such a statement, and it has also been made by others.† I doubt not it will be rectified in future editions. This misstatement was unknown to me until within a few weeks. If it had been known I should have made the correction promptly. It is not difficult, perhaps, to account for the mistake, inasmuch as I first exhibited this eye-piece in England at the soirées of the Microscopical Society and the Royal Society, and to numerous individuals, among them Dr. Carpenter himself, who expressed his satisfaction at its performance. Mr. Ladd, the well-known philosophical instrument maker, 11 and 12 Beak Street, Regent Street, had it for some time in his possession, and indeed made one, which, however, was much inferior to Mr. Tolles's, as Mr. Ladd had not time to determine the proper curves, if indeed the lenses were achro-

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* "The Microscope," 4th ed. p. 35. † "The Microscope," by J. Hogg. 7th ed. p. 119

matics at all. He understood, however, that it was Mr. Tolles's eye-piece; and I have by me the original "exhibitor's card," and at one of the soirées named, reading distinctly, "Tolles's binocular eye-piece, exhibited by Prof. Smith." I feel very anxious to have the mistake corrected.

The first eye-piece of this form which Mr. Tolles ever made was purchased by me, and I gave some account of its performance and peculiarities in the "American Journal of Science," July, 1864, p. 111. And, in the same journal shortly after, Mr. Tolles himself described its construction. Now, although we cannot expect every one to read an American journal, or to be posted in all that is done this side of the Atlantic, even in the microscopic line (except to notice the trash, *e. g.* the mean little sheet issued by manufacturers and sellers of the Craig microscope! ! ! recently attempted to be palmed off as the organ of the Illinois Microscopical Society), it is a little surprising, considering the length of time these two articles have been published in a most prominent journal, that such a blunder should occur. Of course it is inadvertence. Dr. Carpenter, I am quite sure, is ready and willing to do full justice, and in so doing, it will be proper to state the *real principle* of the eye-piece in question. It is not, as he has stated, *l. c.* merely an arrangement of prisms, similar to MM. Nachet's, for in reality the prime part of the eye-piece may be this, or Riddell's, or Wenham's; and, in fact, in the first eye-piece made for me was different from either of these. Mr. Tolles finally — partly at my suggestion, though I believe he had already decided upon it — adopted the Nachet form, and he claims nothing for this. What he does claim, and is justly entitled to claim, is the construction of a first-class achromatic *erecting eye-piece*, and a division of the pencil, for stereoscopic vision, at or very near the point of crossing of the rays in such a combination. Now it is well-known that the difficulty in using the Wenham or Nachet arrrangement with high powers, arises from the necessity of dividing the pencil so far behind the objective, a difficulty it seems cannot be got over, except upon Mr. Tolles's plan, viz.: making a secondary image, and dividing the pencil here, or near the point of crossing of the rays. The binocular eye-pieces invented by President Barnard, and by myself, are simply binocular, like Powell and Lealand's arrangements for high powers; though superior as to equality in illumination of the two fields, they are not stereoscopic. Perhaps the fact of my having made such an eye-piece, and published an account of it, as also Dr. Barnard's notice of it, in his report upon the Paris Exposition, may have assisted to mislead in attributing the really stereoscopic binocular of Mr. Tolles to me. If I had been the originator of *this* eye-piece, which is yet destined to replace most binoculars, I should feel I had contributed a much greater boon to microscopy than any I have yet done. The instrument as made now by Mr. Tolles is very perfect; the loss of light is trifling, easily remedied by a little more illumination. The loss in definition is not so much as in the Wenham and Nachet forms; not merely from the care with which Mr. Tolles works the prisms, but owing to the much shorter distance which the reflected ray has to travel. This part of Dr. Carpenter's objection is practically without force. The eye-piece is expensive. Not only is it, at least so far as regards all below the prisms, perfectly achromatic, but of very peculiar and perfect construction, and as to liability of derangement, I can safely say it is as firm as any binocular arrangement now known, and easily adjusted if it should become deranged. I am told that M. Hartnack has made a similar eye-piece. During the Exposition, I placed Mr. Tolles's eye-piece in his hand for inspection, and it remained with him for several days. I cannot say whether he copied it, or whether his arrangement is different in principle, or the same, as I have not seen it. M. Hartnack appeared to me to be far too honorable a man, as MM. Nachet, to whom also I showed it, most certainly were, to take any credit for an invention truly belonging to another.

H. L. SMITH,
Formerly of Kenyon College.

[*From the "English Mechanic," London, May* 9, 1873.]

A correspondent says:—

"I AM sure that "Binocular" will be glad to learn that there is a binocular eye-piece that is in my opinion infinitely superior to Mr. Wenham's arrangement, both for the microscope and telescope. The binocular eye-piece I refer to is the invention of Mr. Tolles, of Boston. It differs from Mr. Wenham's in that the cone of rays from the object-glass is divided at its apex by a prism placed just in front of the field-lenses of the two eye-pieces. . . . I wrote on this subject in the "Astronomical Register," some years ago, as also did Dr. Huggins, I think, in the third volume. . . . I tried to get some of our opticians to adopt this plan, but they had been putting double bodies to their microscopes, and evidently *did not wish to have to take them off again.* I have tried Mr. Tolles's eye-piece with my telescope, and found it to answer admirably, especially on the moon."

(Signed) VICAR

REPORT ON TOLLES'S $\frac{1}{50}$th OBJECTIVE.

WAYLAND, STEUBEN Co., N. Y., Sept. 23, 1873.

DEAR SIR: I commenced using the Tolles's 1-50th objective by thinking well of it, and find it improves on acquaintance. This lens has remarkable flatness of field combined with excellent defining and resolving power, plenty of light, and good working distance. It works well through covers 1-200th of an inch thick. To-day, with a small German student lamp, and the beam direct from the lamp, without mirror, prism, or condenser, and *no tricks*, I resolved with the 1-50th *Amphipleura pellucida* into the transverse *striæ*, seeing the lines with No. 1 eye-piece x 2,500; No. 2 eye-piece x 4,000; and finally, with No. 3, power 7,000 diameters. With the deep eye-pieces, the edges of such tests as *Pleurosigma angulatum* are well defined, without the indistinct and woolly appearance usual with such high powers.

In examining the organisms in water, the concave mirror gives ample light. The ultimate resolution of *A pellucida* and the various varieties of *Navicula rhomboides* into dots and squares, using blue light gives further proof of the exquisite performance of the lens. Its superiority is equally marked in the study of the *structure and growth of minute living organisms.*

Many more facts might be given in praise of this glass.

GEO. W. MOREHOUSE.

TOLLES'S IMPROVED TELESCOPE.

THE PEDESTRIAN'S TELESCOPE. — An instrument not too bulky to be carried in the pocket, and of sufficient power and definition to be worth the trouble of carrying, has always been a desideratum with the tourist. Mr. Tolles has now produced such an instrument, on his improved system; it has a 1-2 inch object glass, with his patent solid eye-pieces; 4 inches long closed, 6 1-2 inches open; and weighs with a stand, and screw for attaching it, four ounces only. Power 10 to 18 diameters, being, it is believed, the most portable and efficient instrument yet produced. Price $25. With stand, $33.

THE ONE INCH TELESCOPE is only 4 to 5 inch focus, has a pancratic eye-piece, varying the power from 12 to 24 times (to which higher powers can be added at an additional expense). This terrestrial telescope, in virtue of the plan of construction, gives increased light, — on a stand with universal motions, — to screw into any wood structure. Price $70.

THE HIGH SCHOOL TELESCOPE. — A most desirable instrument for residences on the sea-shore or mountains, and for high schools. Tolles's Improved Telescope; 2 1-2 inch object-glass, 23 to 27 inch focus, on iron tripod, with motion in altitude, and azimuth. Price, with pancratic eye-piece, giving variable powers from 23 to 46 diameters, $175; with two astronomical eye-pieces, amplifier, diagonal prism, and sun-glass, powers from 23 to 130, $250. Telescopes have been supplied to Washington Academy, East Machias, Me.; Dr. J. R. Nichols,

Haverhill, Mass.; Howland School, Union Springs, N. Y.; J. R. Lowrie, Warriorsmark, Pa.; A. C. Berry, Boston; New Bedford, Mass., High School; M. Moore, Trenton Falls, N. Y. Ed. E. Rice, Chas. W. Parker, N. J. Bradlee, and John Quincy Adams, Boston; J. J. H. Gregory, Marblehead, Mass.; C. H. Bassett, Boston, and others.

A NEW TELESCOPE.

Having been engaged in telescopic observations for the past eight or ten years, with instruments of various apertures, between 1-2 and 3 1-4 inches, I thought that I would communicate to you the results of a few observations which I lately made, with one of the new, improved, short-focus telescopes of 2 1-2 inches aperture, 23 inches focus. with a celestial eye-piece magnifying 45 diameters, constructed by Mr. R. B. Tolles. This telescope readily shows Polaris double; it appears as steady as Titan does in my 48-inch achromatic, with a power of 81. It shows very finely the four principal stars in the trapezium of Orion, also Mizar, Beta Cygni, and other superb double stars. The view it gives of the great nebula of Orion is magnificent. The elliptical nebula in Andromeda was well seen. Various clusters of stars in the milky way were exhibited in great splendor. Rigel I saw double, which I consider a pretty severe test. The planet Jupiter was a beautiful object, its oblate figure being so very apparent that one unaccustomed to telescopic observation would readily perceive it; the equatorial belts were shown very distinct and sharp; the satellites appeared round and very distinct, the difference in their size very apparent. Saturn is also a splendid object; the principal division in the ring is shown all round. I saw the inner dark ring where it crosses the ball; also the equatorial belts and the shadow of the ball, on the ring; two satellites, with a glimpse of a third, that I am confident of.

The short focal length of this telescope I consider to be a great advantage, making it more portable, and much more easily directed to a celestial object. The instrument is mounted on a firm cast-iron tripod, with appliances for keeping it in position. It shows all the objects enumerated here far better than a similar power in my 48-inch glass, which has a clear aperture of 3 1-4 inches, and which I consider a good glass. Since making these observations I have had the loan of another telescope, made on the same principle, but with an object-glass only 1 inch in diameter, and 6 inches focal length, furnished with a pancratic erecting eye-piece, magnifying 24 times. Its performance is wonderful. It shows Saturn well, but with terrestrial objects, its definition is superb. It is mounted on a universal joint, with a gimlet screw to fasten it to a tree, fence, etc.

I should have made a comparison between these two large instruments with the same eye-piece, but had no appliances convenient to fit the Tolles eye-piece on my instrument; but from my experience, I consider the Tolles glass the superior instrument, the field being very dark, instead of gray, as in other instruments. I have never seen any small telescope perform equal to the 2 1-2 or 1 inch.

WILLIAM H. PHELPS.

— *Boston Journal of Chemistry, October*, 1870, *p.* 40.

TOLLES'S FIVE-INCH TELESCOPE.

Extract from a letter of Dr. B. A. Gould, Cordoba, S. A., April 24, 1871.

"The star of *Eta* Argus has naturally attracted a good deal of my attention. It is at present not far from the 6 1-2 magnitude and recognizable with great difficulty by the naked eye. In the field of my small Tolles's telescope of 5-in. aperture, and 35 in. focal length, it is a conspicuous object, and prominent by its ruddy color among the cluster of which it forms a part. . . . With this telescope, the same one which I employed for observing the total eclipse of 1869, I have been examining the whole group; and have found to my astonishment that it exhibits with distinctness a considerable number of stars, which are recorded in Sir J. Herschel's catalogue of this cluster, as being of the 15th magnitude.

The magnificence of the milky way in this vicinity is indescribable, surpassing the Pleiades or the Præsepe in richness, and exhibiting numerous huge clusters, the sight of which through the Tolles telescope evokes exclamations of astonishment and delight from every beholder, young or old, whether with or without astronomical information." — *Am. Jour. Science, July*, 1871, *p.* 80.

BOSTON, Nov. 30, 1874.

MR. CHARLES STODDER:

My Dear Sir,—It will give me much pleasure to have the telescope which Mr Tolles has just made for the Argentine Observatory exhibited publicly, provided it can be ready for shipment when needed. The similar instrument which he made for me about a dozen years ago has been and is to the best of my belief unequalled in its peculiar advantages. For telescopes of five-inch aperture about fifty-five to fifty-eight inches has been deemed the shortest focal distance compatible with good achromatism and sharp definition. But this one, although it has the wonderfully small focal distance of only thirty-four inches, possesses great excellence of definition and a portability unexampled for an instrument of its optical power.

Its field of view, when used with its lowest powers, is 2° in diameter, and this singularly large area proved of special importance in observing the total eclipse of the sun in 1869, enabling me to see not only the whole corona with the advantage of an amount of light probably 1,500 times greater than would have entered the pupil of the unaided eye, and to take note of its variations of form during the progress of the eclipse, but at the same time to subject the region around the eclipse to a survey sufficiently careful to assure me that no star so bright as the four and one half magnitude was to be seen within the orbit of Mercury.

The telescope has been in frequent use since I obtained it, and has rendered important service in both hemispheres. Its value for examining nebulæ and star clusters with low powers is unsurpassed, and I have never seen a portable instrument which could compare with it in efficiency. Not more than a couple of minutes are required for taking it from its box and placing it in adjustment upon the posts which are always standing ready to receive it, on or near whatever house I may inhabit. Its equatorial mounting permits it to be directed without delay to any celestial object whose place is known

My attachment to and pride in that instrument are so great that, although it is now at the Cordoba Observatory, I am unwilling to part with it permanently, and have therefore induced Mr. Tolles to construct for the Argentine Government this new one, as nearly similar as may be. I anticipate for it equal excellence, and doubt not it will prove its eminent maker capable of attaining in the construction of telescopes a reputation not inferior to that which he enjoys throughout the scientific world as the maker of microscopes which, to say the least, are inferior to none.

I am very sincerely yours, B. A. GOULD.

TOLLES'S FOUR-INCH TELESCOPE.

CANANDAIGUA, N. Y., Aug. 2, 1878.

MR. CHARLES STODDER,—Last December I purchased of you one of Tolles's Improved Telescopes, 4 1-10 inch object-glass, focal length 42 inches, mounted on iron tripod, with motion in altitude, and azimuth. I wish to say that I am highly pleased with its performance. I consider its short focal length as great advantage; it is so easily handled, and readily turned upon any object. Its mounting I consider perfect, motion perfectly smooth, and it is easily adjusted to any position.

I mention a few of the objects which I have seen. Its definition of Venus in its crescent pleased me very much. I can plainly see five stars in the trapezium of Orion, and when the air is very favorable, I am confident that I have seen six. Rigel's companion is quite conspicuous, and I have seen Aldebaran double. Jupiter is a magnificent object, belts and satellites very distinct. I have not had an opportunity to test it on the rings of Saturn, though I saw them as a line of light until within three days of their predicted disappearance. With eye-pieces of low power it presents star-clusters beautifully. I enjoy it very much, and prize it highly.

Since writing the foregoing I have had an opportunity to look through one of ****'s 6-inch telescopes. I think my Tolles 4-inch is superior to it in defining power, and very nearly, if not quite equal to it in other respects. I prize mine still more highly by reason of the comparison.

Respectfully yours,

D. SATTERTHWAITE.

MARSHALL, TEXAS, Sept. 25, 1880.

MR. CHARLES STODDER:

Dear Sir, — I take pleasure in complying with your request to give you a report of the performance of the telescope of 2½ inch aperture, 24 inch focal length, recently constructed for me by Mr. R. B. Tolles. On the evening and night of the 19th instant the atmosphere was unusually steady, and, with the exception of a full moon, everything was favorable for observation and test. With the 1 inch eye-piece, power of 24,

the instrument shows well such stars as Mizar, Beta Scorpii, and Beta Cygni. With the ½-inch eye-piece and power of 48, it shows the minute companions of ε Lyræ and Polaris, which is all that could be reasonably expected of such an instrument. On the same night I also saw the quadruple star ε Lyræ, and the exceedingly faint intervening stars. The view it gives of the planet Jupiter is exquisite. The bands on the disk of the planet and the disks of the four moons are clearly defined. The oblate figure of the planet is apparent. The view of Saturn is also equally beautiful, the rings being brought out, and five of the eight moons being in view. On the same evening I also saw the disk of some asteroid (unknown to me), about 2° west of Saturn (I have no means of measuring). Saw fixed stars with spurious disks clearly defined, and no diffraction rings. The view it gives of the moon is exceedingly satisfactory, every mark, elevation, depression, crater, or peak being most beautifully shown; verbal description can convey but a feeble idea of it. So much for celestial, a few words in favor of the terrestial performance. With the aplanatic eye-piece I have read distinctly one-inch letters at the distance of 2,000 feet. The corrections are carried to a high state. In fact I can state emphatically that this instrument approximates perfection, both in its mechanical and its optical parts.

Yours truly, N. VAN WERT.

From "Science Observer," Vol. III., Boston, page 26. Report of Hamilton L. Smith, Professor of Astronomy, Hobart College, Geneva, N. Y.

On an achromatic refractor of 37-inch solar focus, and 4¼-inch clear aperture, made by Tolles, the very short focal length for the aperture gives such minute images of the stars that even quite close pairs are shown readily with low powers; *e. g.*, a power of 60 divides easily enough 4 and 5 ε Lyræ, ε Bootes, and stars of this grade; and a power of 110 shows them admirably. The latter power also clearly separates λ Ophiuchi; and in a clear atmosphere the close pair of χ¹ Scorpii, ι Cassiopeia, triple, is also very well shown with this power; and 180 widely separates them all, and distinctly elongates η Coronæ. With 270 the two components of this last-named star are clearly shown, and γ² Andromedæ is well elongated. The views of Jupiter, Saturn, and the moon are of course all that could be expected, — sharp and brilliant. I cannot say whether more minute points of light can be seen with one of these short-focus telescopes than with an equal aperture of longer focus; but from my recollections of the performance of a very fine 4-inch object glass of 5 feet focal length, formerly in my possession, I think the "dumpy" has some advantages. The two faint stars (Debelissima) between 4 and 5 ε Lyræ I have seen steadily, with the moon half full, and the companion of Polaris before the star was visible to the naked eye, and with so low a power as 27. With a low power, and field of nearly two degrees taking in at the same time both groups of the cluster of Perseus, the view is wonderfully fine, always eliciting exclamations of surprise. I have had many telescopes, and some very fine ones, and I can truly say that the instrument I have just described, with stand and telescope, gives me more satisfaction than anything I have heretofore used.

Extract from a letter dated London, July 19, 1878.

MR. CHARLES STODDER:

Dear Sir, — The ½ and ⅛ objectives that were in Mr. Mayall's hands were purchased by me. . . . Both these lenses are, in my judgment, superior to anything made this side of the Atlantic. . . . Still I am wanting a fine high-power lens, and if there is anything better in the world to be had, I think Mr. Tolles is the man to do it.

From "Mount Washington in Winter," Prof. J. H. Huntington.

"That bright line extending so far along the coast is the ocean; but we can rarely see it with the unaided eye, except where the waters reflect the sunlight; and then with a Tolles telescope, having an object-glass of one inch, and focal length of four inches, we can not only see vessels as they sail along the coast, but can distinguish their rig."

From Thos. Birt, Troy, N. Y., Jan. 9, 1871.

"I have used the 1-inch telescope a number of times, and find it a complete thing. The glass for terrestial observation is superb; for celestial, very good for so small an one."

From Buletin Société de Belgique de Microscope, Session July 30, 1881.

"Dr. Henri Van Heurck exhibited to the society an objective homogeneous immersion 1-10 of Tolles. It is without contradiction one of the very best (*plus excellente*) objectives which exists upon the homogeneous immersion principle, and has this peculiarity of construction, that it has correction for cover glass, so that it is not necessary to employ a definite length of tube. Many slides, among them Nobert's test of 19 bands, and the amphipleura pellucida, of which the resolution was perfect, were passed in review. The same member showed also the use of the amplifier of Tolles. This is a concave glass of peculiar construction, which is introduced into the tube of the microscope, which doubles the size of the image without noticeably injuring either the definition or brilliancy."

All correspondence and orders for Tolles's instruments must be addressed to

CHARLES STODDER, 131 Devonshire St., Boston.

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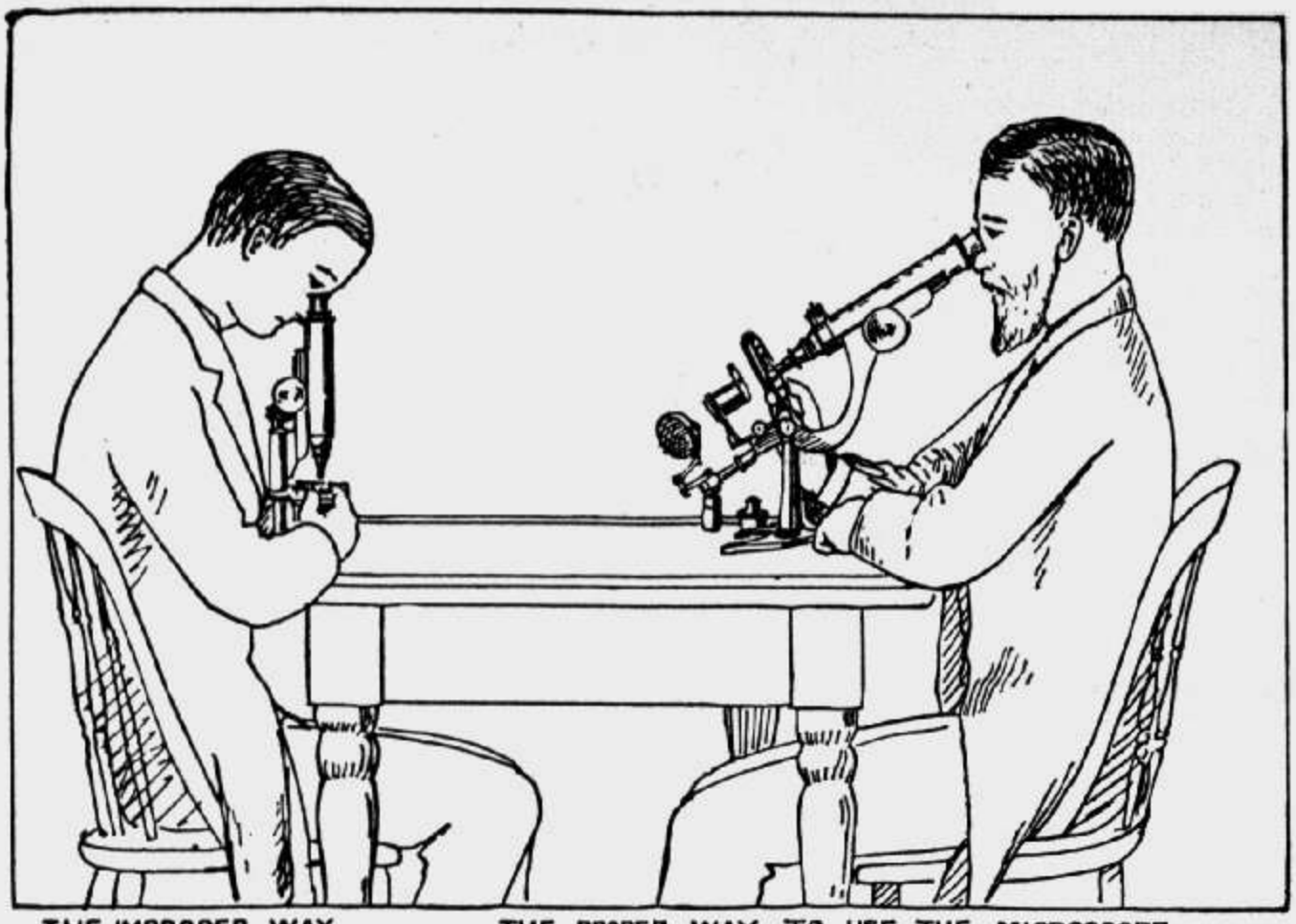

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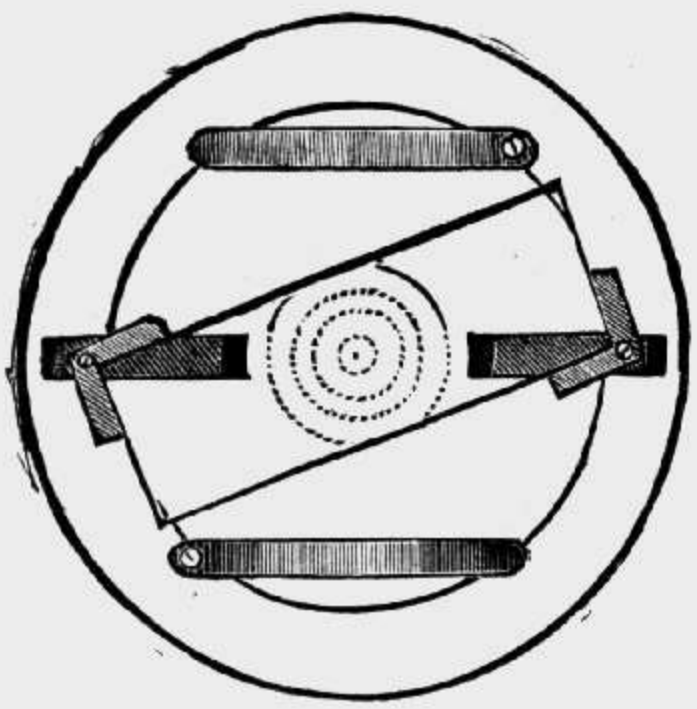

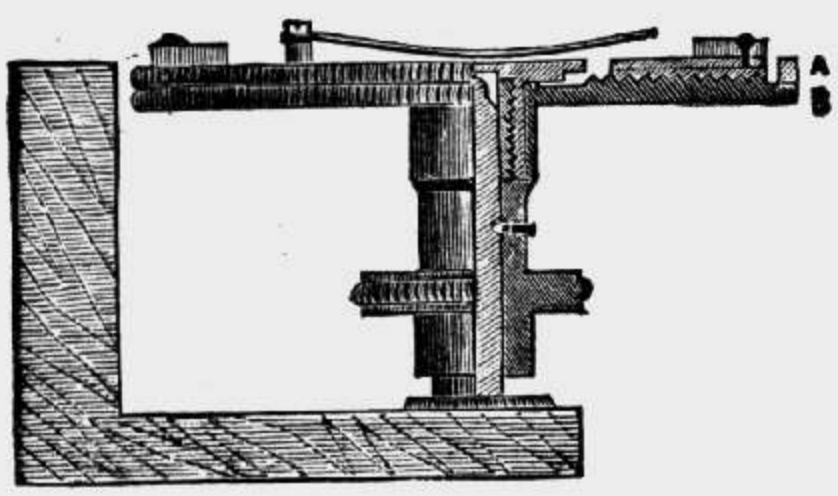

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