Dr. Woodward

BOSTON OPTICAL WORKS,

B. TOLLES, Supt. CHARLES STODDER, Agent and Treas.

75 KILBY STREET, BOSTON.

MICROSCOPES AND TELESCOPES.

Will make to order first-class A and B Trunnion Microscopes and Prof. J. Lawrence Smith's Inverted Microscopes, Improved, for Chemists, — by special contract.

TOLLES'S STUDENT'S MICROSCOPES (see page 3), $50 to $100

CLINICAL MICROSCOPES (see page 4) . $25 to $30

TOLLES'S PATENT BINOCULAR EYE-PIECE, adapted for both Microscope and Telescope . . $80

TOLLES'S PATENT BINOCULAR EYE-PIECE, for Microscope only, price not determined.

HUYGHENS' NEGATIVE EYE-PIECES, A, $10; B, $8; C, $7

TOLLES'S PATENT SOLID EYE-PIECES, D, $8; G, $8; E, $7; F, $6

TOLLES'S SOLID ORTHOSCOPICAL EYE-PIECES . . B, $15 each; C and higher powers, $12

These can have a micrometer engraved in the solid glass at an additional charge of $5

TOLLES'S AMPLIFIER, which doubles the magnifying power of any given Objective and Eye-Piece . . $12

TOLLES'S POCKET ACHROMATIC TRIPLETS, in silver mountings, $\frac{3}{4}$ inch and $\frac{1}{2}$ inch, each, $12 (large mountings, $13); $\frac{1}{3}$ inch, each, $14

TELESCOPES, $2\frac{1}{4}$ inch object glass, on stand, with azimuth and altitude motions $125

TELESCOPES, 1 inch object glass $50

TELESCOPES, of any size, of *unusually* large angle and efficiency, made under special contract.

TELESCOPES, $2\frac{1}{2}$ inch object glass, on stand, with azimuth and altitude motions $150

SPENCER'S CAMERA LUCIDA . . . $8 and $15

SPENCER'S CAMERA LUCIDA, for Student's Microscopes $5

TOLLES'S first quality OBJECTIVES, with adjustment for thin glass cover,

$\frac{1}{20}$th	inch, angular aperture,	175°	$180
$\frac{1}{15}$th	" " "	over 160°	$125
$\frac{1}{15}$th	" " "	160° or less	$120
$\frac{1}{12}$th	" " "	over 165°	$115
$\frac{1}{12}$th	" " "	160° or less	$80 to $100
$\frac{1}{10}$th	" " "	$5, adv. on list of $\frac{1}{8}$th inch.	
$\frac{1}{8}$th	" " "	160° to 175°	$80
$\frac{1}{8}$th	" " "	140° to 160°	$75
$\frac{1}{8}$th	" " "	less than 140°.	$65
$\frac{1}{4}$th	" " "	90° to 110°	$40
$\frac{1}{4}$th	" " "	130°	$50
$\frac{1}{4}$th	" " "	150°	$60
$\frac{1}{4}$th	" " "	170°	$70

$\frac{1}{5}$th and $\frac{1}{6}$th inch, same price as $\frac{1}{4}$th;

$\frac{4}{10}$th	inch, angular aperture,	under 90°	$40
$\frac{4}{10}$th	" " "	90° to 110°	$45
$\frac{4}{10}$th	" " "	135° to 145°	$65
$\frac{1}{2}$	" " "	60°	$35
$\frac{1}{2}$	" " "	60° to 80°	$40

OPAQUE ILLUMINATOR, additional . . . $15 to $25

IMMERSION OBJECTIVES, same prices.

FIRST QUALITY, WITHOUT ADJUSTMENT FOR GLASS COVER.

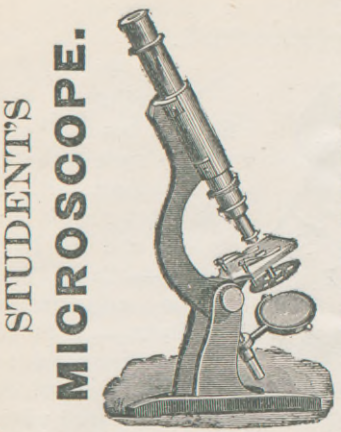
1	inch, angular aperture,	17°	$20
1	" " "	25° to 30°	$23
1	" " "	35°	$28
1	" " "	40°	$35
2	"		$23
$\frac{1}{2}$	"	25° to 40°	$23
$\frac{1}{4}$th	"	40° to 70°	$26
$\frac{1}{8}$th	"	angular aperture, about 70° to 80°	$35

Second quality OBJECTIVES, 2 inch and 1 inch, $8; $\frac{1}{4}$th inch, $15 to $20.

These are all made with the Microscopical Society's Screw, unless specially ordered otherwise.

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 those points. It is furnished with a B Eye-Piece, two *second-quality* Objectives, of about one inch and $\frac{1}{4}$ inch power, giving about 60 and 280 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 steel spring, fine adjustment by a new construction which is efficient with high powers. The stand is made with all the care bestowed on their first-class instruments, and proves satisfactory for the use of amateurs, students, and the ordinary work of the medical profession. The workmanship is superior to that of any instruments of the class made in Europe. The form is that best adapted for easy and convenient use. Price, in an upright Black Walnut Case, $70. The same instrument with fine adjustment on the Stage, $50.

ADDITIONS. — Extra Eye Pieces, A and C, $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. Rack and Pinion for coarse adjustment, $12. Any of Tolles's

first quality Objectives may be used on this instrument, and will be made to order at list prices. Packing boxes for transportation, $1.

THE POCKET MICROSCOPE.

For clinical and field or sea-side 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, $30. 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 other Objectives on the list can be used with both instruments, and can be supplied to order. For sale by Instrument dealers everywhere.

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

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.

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.*

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' 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 movements by friction rollers, and a sub-stage, movable by rack and pinion, for accessory apparatus.

There are several other instruments intended for students, which are much less elaborate. These are supplied with a one-inch and a one-fourth inch objectives, both of second quality, and have coarse and fine adjustments, and also the means for applying accessories. We should also here mention a pocket achromatic triplet.

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.

Among the instruments on exhibition, we find first-class objectives, as follows: a one-inch, having an angle of aperture of 27°; a half-inch, with 60° angle of aperture; a one-fourth, with 70°

angle of aperture, and constructed with a Tolles' illuminator for opaque objects; a one-sixth immersion, with 150° angle of aperture; and a one-tenth immersion, having an angular aperture of 175°.

It is mainly to improved object-pieces or objectives, as they are more frequently termed, that the world is indebted for the means of extending the limits of our knowledge through the revelations of this valuable instrument. Since the middle of the present century, improvements have been made, and a degree of perfection approximated in the construction of microscopic objectives, which twenty years ago were pronounced by the best authorities as utterly unattainable.

Messrs. Powell and Lealand, Smith and Beck, and Ross, and others of England; and Nachet, and Hartnack, and others of France, besides many very reputable makers in Continental Europe, have honorably vied with each other in advancing improvements upon the higher order of objectives. But while such eminent practical skill has endeavored to meet the wants of scientific men abroad, in pushing their research beyond that of their predecessors, there has been no less demand by restive intellects in this country for the very best instruments, and no less intelligence and skill in successful efforts to meet such demand. Among those practical photonomers who have been the most successful, whether at home or abroad, in the scientific construction of the highest order of optical instruments, the samples on exhibition from the Boston Optical Works well warrant the assertion that their superintendent has advanced to the foremost rank.

In microscopic objectives, it is obvious that the extent of amplification, and the character of the light as well as the kind and degree of illumination, are more or less common to all makers. Other things being equal, the relative as well as the absolute merits of objectives are commensurate with their degree of distinctness of delineation or definition. This quality must not merely cover the outline of infinitesimal objects, so to speak, but extend to the minute details of their structure and coloring. The higher powers of course more largely magnify, any and all defects or imperfections due to their own imperfect construction; hence the true merits of objectives are in favor of those of the lower powers, which under like circumstances give equal distinctness in definition or resolution.

The obstacles to perfection in this direction were various, numerous and enormous, so much so that those savans most

familiar with them were generally the most decided in pronouncing them all but insurmountable. But for the high degree of perfection in our present make of instruments, as well as our hopes for still better ones, we are largely indebted to practical opticians, whose perseverance in their study of the laws of light and the principles which prevail affecting the same; in the material of which the lenses are made, as well as mathematical precision in giving them form, relationship and combination, was coupled with long series of laborious, but patient trials, studded with discouraging failures, while on their tedious way to eventual success.

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, or 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 eyepiece. Among those invited who witnessed this performance may be named Prof. Wolcott Gibbs and Dr. B. A. Gould of Cambridge. The true lines of this 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

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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 referredto 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.

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 & 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-sixth objective of Tolles' make, the lines in question have been photographed.

The one-inch objective on exhibition is constructed for use in water, and seems admirably adapted for tank work where minute dissections are to be performed. The prism arrangement of the one-fourth objective for illuminating opaque objects through its anterior combination lens is new and worthy of special consideration. It is simple, its use employed or readily cut off, and is free from the glare and other objections which have rendered nearly useless all former efforts to improve the illumination of opaque objects under high powers.

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 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' 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 focal lengths for such apertures is novel if not unique. It is believed to be without a parallel in instruments from any other maker. In a very large class of uses, this quality gives them especial value. The superiority of this form over those of ordinary construction, particularly in the largest instrument exhibited, is reported to have been very manifest by the side of telescopes of other

makers, in observations during the great eclipse of August 7, 1869.* By rendering the use of eye-pieces of lower power admissible, and especially in the great augmentation in the field with distinct vision, this form of telescope will quite easily accomplish what is absolutely impossible with those of the same size constructed upon the usual formulæ. Besides such signal service, their portability and facility of manipulation should be mentioned.

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 had been sold and were loaned by their owners for this occasion. It may also be added that the opinions 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 award, a

GOLD MEDAL.

Extracts from the report of Dr. F. A. P. Barnard, L.L. D., President of 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." . . . . "The modern microscope may be said to date from the year 1829, the date of the publication by Mr. J. Lister, of

* Special search was made for intra-Mercurial planets by Prof. Newcomb at Des Moines, according to the plan suggested by him in the April No. of this (Silliman's) Journal, with two six-inch object-glasses, having a field of about one-third of one degree each, and previously clamped to the desired position. A similar scrutiny of the ecliptic near the sun was made by Dr. Gould at Burlington in connection with Prof. Coffin's party, using a Tolles' telescope of five inches aperture and a field of nearly two degrees, provided with occulting discs at the focus. — *Silliman's Journal*, Sept. 1869, p. 288.

his well known empirically discovered laws governing the aberrations of lenses."

Page 533. "The effect of the introduction of Mr. Lister's improvements was immediately to throw nearly the whole class of what had been called *test objects* into the category of common objects; but it created a new set of tests, or a new succession of tests, of constantly increasing difficulty; and in the active rivalry which has grown up between the many accomplished opticians of recent years, who have devoted themselves to the improvement of this instrument, the chief contest has been, which should most satisfactorily resolve the most difficult of these tests."

P. 534. "The constructors of microscopes, whose instruments have been in the highest repute since the introduction of Mr. Lister's improvements, have been in England Messrs. Smith, Beck & Beck, a house now only represented by Mr. J. Beck, nephew of Mr. Lister; Mr. Andrew Ross, who has been succeeded by Mr. T. Ross, his son, and Messrs. Powell & Lealand; and in France, Mr. Oberhauser (who has given place to E. Hartnack), and Messrs. Nachet & Son, whose excellent instruments are well known in this country.

Of American constructors, there are several whose objectives will bear severe comparison with those of the best foreign makers. The earliest among those to secure for our country a distinguished position in this honorable rivalry was Mr. Charles A. Spencer, of Canastota, N. Y. There was claimed for Mr. Spencer's microscopes, it is believed with justice, a *decided superiority to any that had been previously constructed abroad, in respect to resolving power;* and they still continue to compare favorably with the best: but it is now some years since Mr. Spencer voluntarily abandoned a field in which he won so distinguished laurels, and in the mean time there has been sensible improvement in the work of foreign makers. Fortunately, however, the retirement of Mr. Spencer did not leave our country unrepresented in this important branch of constructive art. A worthy successor to his skill and inheritor of his honors presently appeared in the person of Mr. Robert B. Tolles, also originally of Canastota, but at present superintendent of the Boston Optical Works, WHOSE OBJECTIVES ARE UNSURPASSED BY ANY IN THE WORLD.

Mr. William Wales, of Fort Lee, near New York, contests closely with Mr. Tolles the palm of superiority."

P. 537. "The great superiority in resolving power between the 'wet' and 'dry working' lenses was very manifest in the com-

parisons made at the Exposition. The result has been to induce many makers to adopt the *Amician* principle in their more recently constructed high power objectives, and among these Messrs. Tolles and Wales in this country, and Messrs. Powell and Lealand of London, have been pre-eminently successful. 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.* The objectives of Messrs. Tolles and Wales, whether construed for working wet or dry, will stand the severest comparison with those of the most successful constructors of England or France."

"Several important improvements in the form and accessories of the microscope have originated in the United States. The stage indicator for finding minute objects with high powers, . . . was invented by the late Professor J. W. Bailey of West Point, . . . and the inverted microscope of Professor J. Lawrence Smith of Louisville, Ky., furnishes to the chemical investigator a most important addition to his researches, preventing as it does the obscuration of the view by the condensation of the vapors, and securing the instrument against injury from the action of corrosive fumes. Microscopists have also been much indebted to Professor H. L. Smith, now of Hobart College, Geneva, N. Y., for various ingenious improvements of microscopic apparatus, among which may be mentioned his illuminator for opaque objects, . . his mechanical finger for picking up on the point of a hair objects invisible to the naked eye," and his mode of binocular vision.

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 the *objectives of all powers* with perfect equality of illumination in both fields."

"The neglect of the American exhibitors to send out stands was the more to be regretted, inasmuch as the stands made by some of them are admirable in design, convenient in use, and superior in workmanship. Nothing could be more tasteful or elegant than the first-class stands constructed by Zentmeyer. 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 microscopes 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 for the objectives the

SILVER MEDAL.

From a letter from M. Th. Eulenstien, of Dresden, N. Germany, 15th July, 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 higher 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."

Mr. Eulenstien's opinion is of the more value as he is an accomplished microscopist, and has the finest objectives of high power, made by Ross, Powell & Lealand and Hartnack, admittedly the best makers in Europe.