attached to an extra stage-plate, one set of three achromatic object-glasses, condenser with arms to support from stage-plate, fluid-cell, dissecting instruments, pair of forceps, and three test-objects. Price $25.00.

Microscope, same as above, but having 3½ inch base, 3 inch stage-plate, and one extra eye-piece of greater power. Price $35.00.

Microscope, same as last, with the addition of the moveable stage, D. Price $45.00.

Microscope, with 3½-inch base, 2¾-inch stage-plate, 8-inch compound body, 3 eye-pieces of different powers, 2 sets of achromatic object-glasses, condenser with arms to support from stage-plate, fluid-cell, dissecting instruments, forceps, 3 test-objects, moveable frame below stage-plate, camera lucida, and polarizing apparatus. Price $75.00.

Microscope, with 4-inch base, 3-inch stage-plate, 8-inch compound body, 3 eye-pieces, 3 sets of object-glasses, condenser on brass foot, fluid-cell, dissecting instruments, forceps, 6 test-objects, micrometer, moveable frame, H, below stage-plate, and moveable stage-plates, D.
Price $85.00.

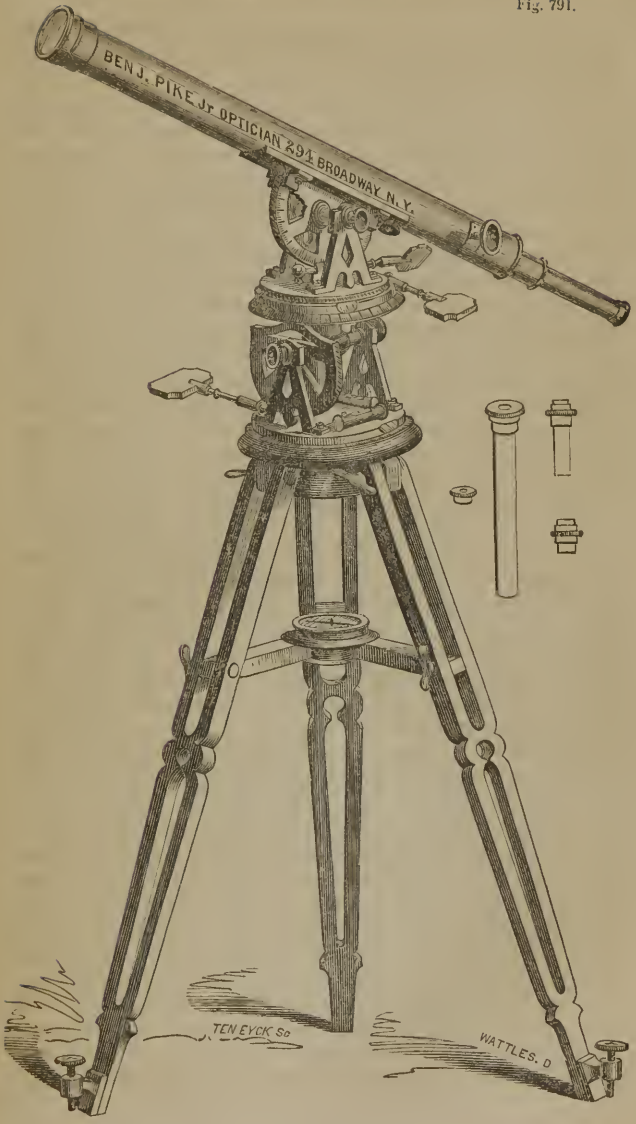
Microscope, same as last, with the addition of the camera lucida, and polarizing apparatus; this instrument includes all the parts and appendages described, fig. 790.
Price $105.00.

Microscope, same as the preceding, but extra large size, 5-inch base, 4-inch stage-plate; extra part with prism to incline eye-piece, and one additional set of three achromatic object-glasses. Price $135.00.

Microscopes of Ross's, and Smith and Beck's, more expensive constructions, from $150.00 to $200.00.

The Equatorial Telescope.—The equatorial instrument is intended to answer a number of useful purposes in practical astronomy. Besides answering the general purposes of a quadrant, a transit instrument, a theodolite, and an azimuth instrument, it is almost the only instrument adapted for following the stars and planets in their apparent diurnal motions. Many of these instruments are somewhat complicated, and very expensive. The author to supply the wants of his many patrons, has constructed the following instruments, which may be purchased at a moderate cost. They may be made use of in any steady

Fig. 791.



room or place, and are well adapted for general observations, and performing most of the useful problems in astronomical science.

The basis of all equatorial instruments is a revolving axis placed parallel to the axis of the earth, by which an attached telescope is made to follow a star, or other celestial bodies, in the arc of its diurnal revolution, without the trouble of repeated adjustments for changes of elevation, which quadrants and circles with vertical and horizontal axes require. Such an instrument is not only convenient for many useful and interesting purposes in celestial observations, but is essentially requisite in certain cases, particularly in examining and measuring the relative positions of two contiguous bodies, or in determining the diameters of the planets when the spider's line micrometer is used. The great cost of these instruments has hitherto prevented their coming into very general use, though it is one of the most pleasing and useful instruments connected with astronomical science.

The principal parts of the equatorial instrument (fig. 791) are: The lower or horizontal plates, the semicircle of altitude, the equatorial plates, and the semicircle of declination on which the telescope is mounted. The lower horizontal plate is nine inches in diameter, and fastened to the round head of the mahogany stand; it is divided into 360 degrees, which are subdivided into half degrees or 30 minutes, and numbered from 0 every 10 degrees, the upper horizontal plate is fitted to the lower by a conical axis, passing through the lower plate and having a large winged-screw nut on the inner side of the stand, by which it may be firmly held in any position it may be set. On the top of the upper horizontal plate are two levels at right angles to each other, having adjustments at their ends, by which they may be accurately set, and by means of the three screws on which the instrument is supported, the horizontal plates may be accurately leveled. The semicircle of altitude is seven and a half inches in diameter, is attached to a horizontal axis, and supported by two standards fastened to the upper horizontal plate; it is divided into two quadrants of 90 degrees each, subdivided into half degrees, and numbered from 0 to 90 each way, a vernier reading to single minutes, and a tangent-screw, by which the vertical arc

is moved up or down; the centre part of the axis of this arc is enlarged, and has an opening for receiving the axis of the equatorial circles, to which they are firmly secured. The equatorial circles are eight inches in diameter, and consist of two brass plates with shampered edges, the upper or vernier-plate turning freely on the lower or graduated circle, having a horizontal motion by means of a vertical axis; this axis consists of two parts, external and internal, the former secured to the graduated hour-circle, and the latter to the vernier-plate. Their form is conical, nicely fitted and ground into each other, having an easy and steady motion when turned. The equatorial hour-circle is divided into 720 parts, and numbered into degrees and half degrees, from 0 to 360; also into twice twelve hours, with the subdivisions reading to two minutes; these are subdivided by the vernier into single minutes for the half degrees, and into four seconds for the hour circle. In the upper edge of the vernier-plate is cut, in its entire circumference, a thread, into which works an endless screw, by which a slow and steady motion may be given to the upper plate for any number of revolutions.

The semicircle of declination, $7\frac{1}{2}$ inches in diameter, is attached to an axis, and by two standards supported and fixed on the upper equatorial plate; it is divided into two quadrants of 90 degrees each, subdivided to thirty minutes, and having a nonius by which it may be read to single minutes; it has also a slow-motion endless screw, by which it may be elevated or depressed; on the upper edge of this semicircle there is screwed a broad plate, about twelve inches long, to which the telescope is attached, by means of two milled-head screws; the body of the telescope is about four feet long, and the terrestrial or long eye-piece about one foot long; the diameter of the object-glass is three inches; the power of the terrestrial eye-piece is 50 times; two celestial eye-pieces also accompany the instrument, having powers of 120, and 180 to 200 times. Extra eye-pieces of intermediate powers of 80 and 150 times may be had at an additional cost. The adjustment of the eye-pieces to the focus of the object-glass, is made first by sliding into a closely fitting tube, as near as convenient for distinct observation; and then for fine adjustment, the eye-piece is moved in or out

by a tooth-and-pinion arrangement, moved by turning a milled-head at the side of the main tube. Two brass cells, with screws fitting the ends of the celestial eye-pieces, containing dark glasses for solar observations, are sent with the instrument.

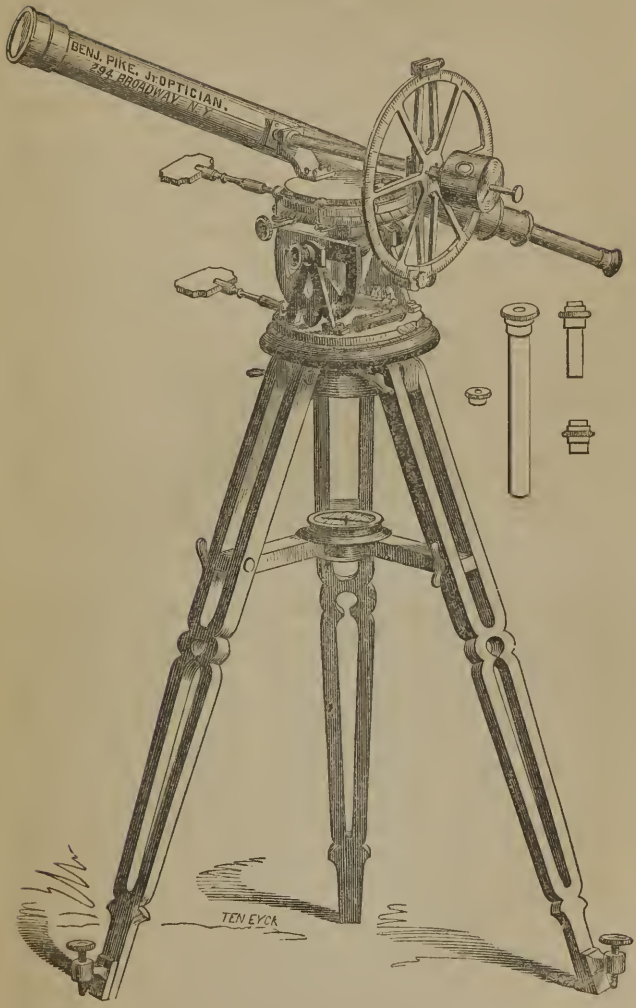
The stand on which the telescope with its equatorial parts are mounted, is of mahogany, well polished, and is formed of three stout legs, about four and a half feet high, cut out at the upper portions to form two branches, which are jointed to the circular top, and also to the triangular arms from the centre-piece, and secured firmly together by brass bolts with winged-screw nuts that can be tightened as required. At the bottom of each leg there is a brass socket, with a large milled screw—by the adjustment of these screws the instrument is levelled. On the centre-piece which braces the three legs firm, there is an accurate compass, 4 inches in diameter, divided into 360 degrees, and numbered from north and south points to 90 degrees each way, having the usual points of the compass engraved on its face; the compass is fastened by a bolt passing through the wood, with screw beneath, and can be removed, if occasion requires it, for other uses.

Price $300.00.

Additional eye-pieces, each $5.00.

Equatorial Telescope.—(Fig. 792.)—This instrument differs from the previously-described one in having the telescope at the side of the equatorial plates, supported at one end by a long axis fixed across the equatorial plates, and at the other end of the axis an entire circle in place of the semicircle of declination; by this arrangement the telescope can be revolved freely and observations made in the highest altitudes, which the construction of the previously-described instrument does not admit of. The axis is fixed across the centre of the equatorial plates, and supported by two standards; to one of these standards is screwed a frame, one end carrying the vernier, and the other the clamp and screw for tightening the circle, and the tangent-screw for slow motion; at this end of the axle there is a counterpoise-weight for balancing the telescope. The divisions on the vertical circle are degrees and half degrees, numbered each way from 0 to 180, and the vernier subdividing the divisions on the

Fig. 792.



circle into single minutes. With these differences the instrument is the same as the previously-described one.

Price $350.00.

Fig. 793.

Wheatstone's Sterescope.—(Fig. 793.)—The sterescope is an instrument by which two perspective diagrams, being right and left eye-views of the same solid, are seen at one view as solid as the object itself, or small drawings having a little difference in their perspective, are made to represent the complete effect of reality. This instrument is considered as one of the most curious and beautiful in the entire range of experimental optics.

The body of the instrument is usually of mahogany or rosewood, but the commoner ones are of tin, japanned. At the bottom there is an aperture for sliding in the views, and at the front a door for admitting and regulating the quantity of light. The eye-tubes are of brass, about the form of those used in double opera-glasses, having prismatic convex lenses so arranged that they refract or throw the images out of the direct line to the centre between the eyes, and each image being in this way removed in a direction toward each other, so as to combine