SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY, AND MANUFACTURES.

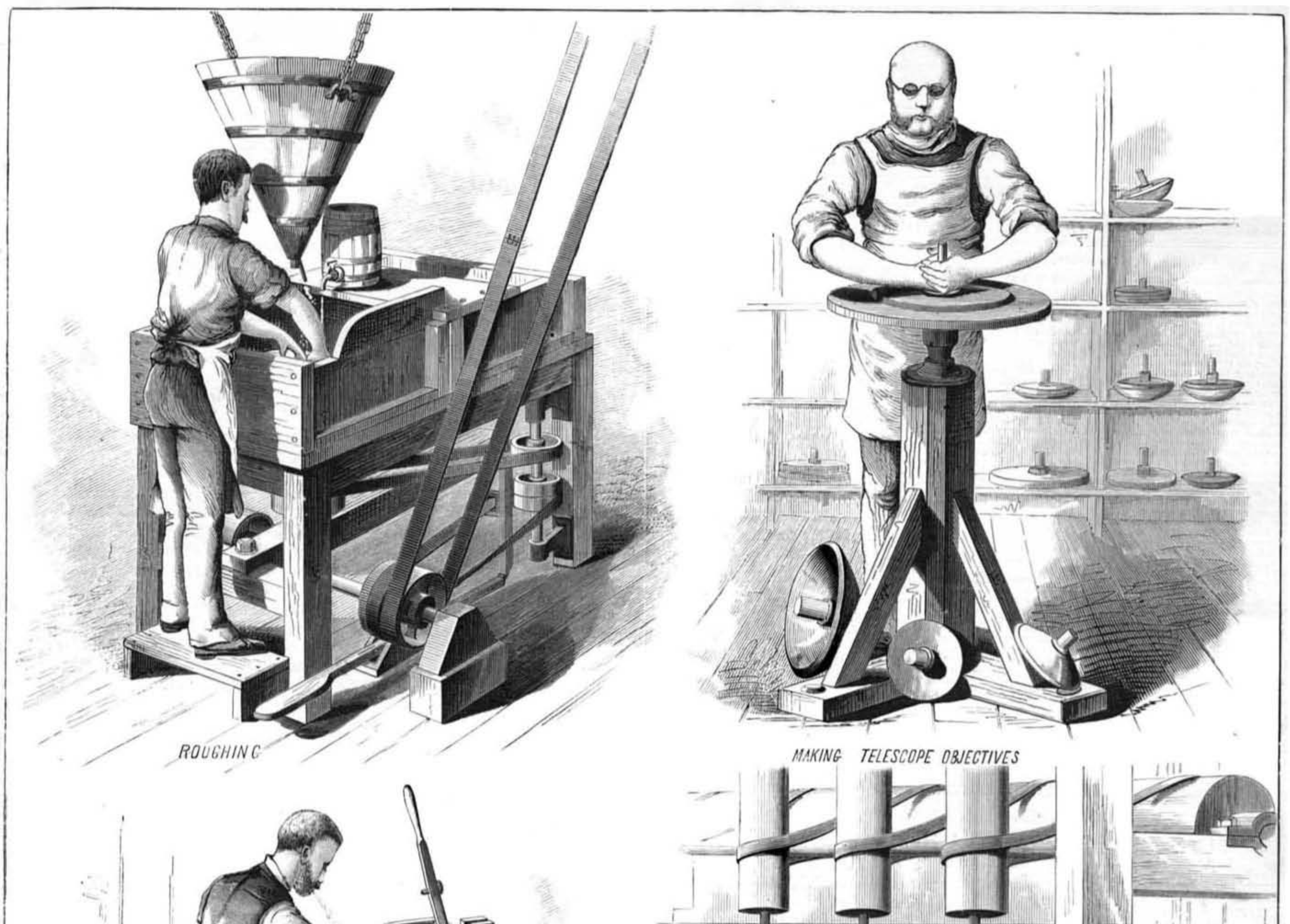
Vol. XLI.—No. 11. [NEW SERIES.] | NEW YORK, SEPTEMBER 13, 1879. | [$3.20 per Annum. [POSTAGE PREPAID.]

LENSES.

There is scarcely anything more admirable than a bright, well finished lens; to the art that produces these beautiful objects we are heavily indebted, for it has enabled us to peer into other worlds. It gives us the means of seeing objects so minute that without some visual aid their existence would be unknown. It has prolonged the usefulness of our failing eyesight, and has, in many other ways, contributed to our comfort and pleasure, and to the advancement of knowledge.

The process of making a lens is extremely simple, so much so, indeed, that a person observing the manipulations of an optician might conclude that almost any one could make a passable if not a perfect lens; but this is not so. It requires a great amount of practice, and a peculiar adaptability to fine mechanical work. The glass used for fine lenses is mostly imported from Europe. That used for achromatic lenses is made by the celebrated firm of Chance & Co., of Birmingham, England. It comes in pairs of disks, one of flint and one of crown glass. These disks are tested as to their refractive power, and

[*Continued on page* 162.]



THE MANUFACTURE OF LENSES.

LENSES.

[*Continued from first page.*]

classed according to the use to which they are applied. The flint glass for telescope objectives is more dense than that used for the achromatic lenses of photographic cameras.

The disks are cut to the required size, either by means of a diamond or by a revolving iron hoop supplied with sharp sand and water; they are then roughened into shape in the machine shown in one of the upper views in the large engraving on our front page. The hopper suspended from the ceiling contains sharp sand and water, which are allowed to flow out upon the form or tool on the upper end of the vertical spindle. This form, or tool as it is called, has the same curvature as the lens to be made. It is convex for a concave lens, and concave for a convex lens. A disk of glass held upon this tool, charged with wet sharp sand and water, soon assumes the desired curvature, and is ready for the next step, which consists in grinding the lens in another machine with three different grades of emery on as many different tools.

The emery ranges from No. 90 to No. 150, the last grade leaving a surface sufficiently fine to be at once polished with rouge. To the back of each disk of glass a hub is cemented with pitch. In the center of this hub there is a conical hole of sufficient depth and size to receive the point that projects from the lever by which the disk is held down upon the finishing tool. When small lenses are ground, an ordinary handle, having a steel point, is used, instead of the lever, as shown in the lower left hand view. When lenses are ground in this way the tool is much larger in diameter than the disk, and the latter is held eccentrically in relation to the axial line of the tool, so that as the tool revolves the disk is also made to revolve, thus continually changing the relation of the surfaces in contact, thereby insuring greater accuracy in the form of the lens.

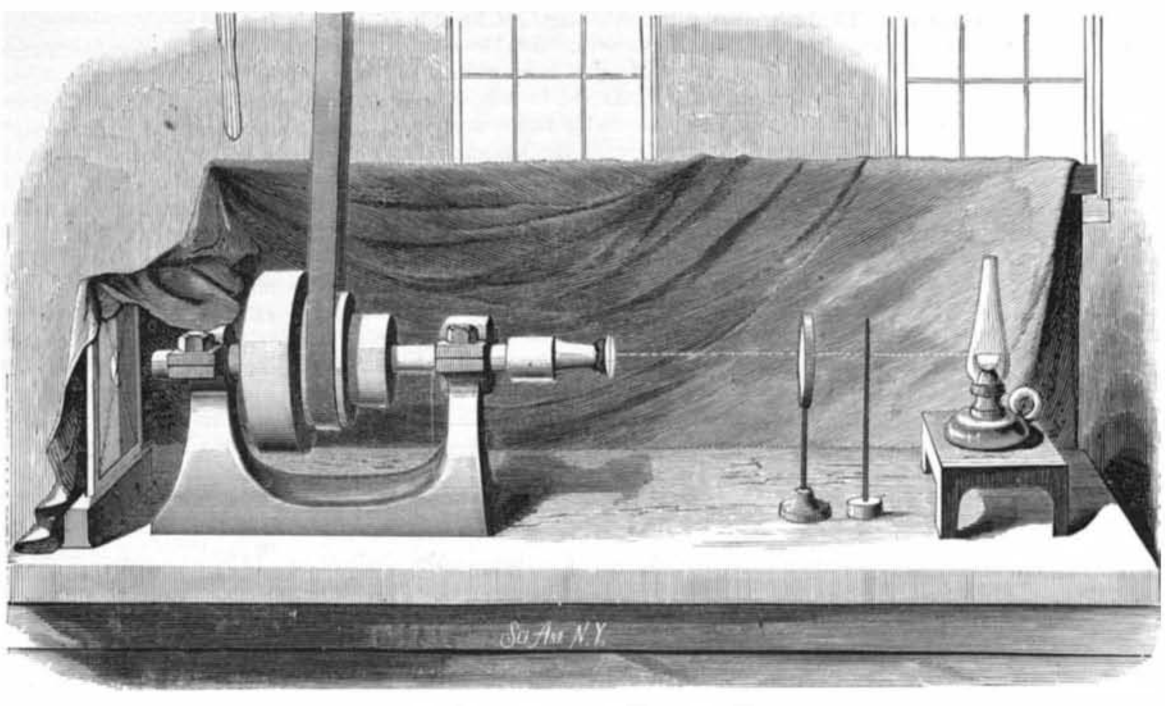


Fig. 2.—CENTERING LENSES.

Between the applications of the several grades of emery the disk is thoroughly washed, and great care is exercised to prevent any particles of the coarser emery from becoming mixed with the finer.

After the application of the finest grade of emery the glass disk and the tool are both thoroughly washed, and the face of the tool is covered with fine woolen cloth similar to broadcloth, which is made to adhere by a thin coating of melted pitch applied to the face of the tool before putting on the cloth. The tool thus prepared is wet by blowing on water from the mouth in a thin spray as represented in the engraving, and the workman applies to the cloth surface a ball of fine rouge, forming on the face of the cloth a thick paste of rouge and water. The lens, if large, is held upon the tool with the lever in the same manner as in grinding. If small, it is held by the steel-pointed handle. A gentle pressure is applied, and, should the tool become too dry before the required polish is secured, water is blown over it with the mouth, as before described. After having finished one side of the lens the other is proceeded with in precisely the same way. The treatment is the same for both convex and concave lenses. In grinding the best quality of telescopic objectives the operation is wholly performed by hand. This is done in the manner shown in the upper right hand figure of the engraving. The tool is supported by the post, and the disk is moved in a series of small circles, and at the same time turned as the operator moves slowly around the post. In the case of telescope lenses, the final finish is secured by a pitch surface formed on the tool, and traversed by grooves running across it in different directions.

Very small lenses are formed from pieces of glass cemented to the end of a stick. The roughing is done upon a common grindstone. The grinding is done in much the same way as already described; the polishing, however, is somewhat different; the tool being covered with a mixture of rouge and beeswax, the amount of rouge being sufficient to render the beeswax quite hard. The form is given to the wax surface by pressing the unpolished lens into it. A thin paste of rouge and water is applied to the tool occasionally.

Ordinary spectacle lenses are ground in quantities in the manner represented in the lower left hand view in the front page engraving. Here a great number of pieces of glass are cemented to a form with pitch, and the tool is moved over it by a short crank on the lower end of the vertical spindle. The workman dashes emery and water or rouge and water over the form; and the upper tool, in addition to receiving an oscillatory movement, is slowly rotated by the action of the crank in the socket at the back of the tool. Generally a series of forms are operated in a single bench and attended by one man. The steps in the operation of grinding spectacle lenses are about the same as when single lenses are ground. After they are ground and polished upon one side they are removed from the form and turned over, cemented to the form, and ground and polished upon the other side.

For many purposes it makes little or no difference whether the axis of a lens corresponds with its geometrical center, but for telescopes, opera glasses, photographic cameras, and other instruments of accuracy, their optical and geometrical centers must correspond. The manner of testing lenses to ascertain if the optical center and the geometrical center coincide, is illustrated in Fig. 2. The lens is cemented to a chuck upon one end of a hollow lathe mandrel; near the opposite end there is a ground glass surface, and in front of the lens being tested there is another lens supported on a standard, beyond which there is a small vertical rod and a lamp. These different pieces are all in line with the axial line of the mandrel, and an image of the rod is cast upon the ground glass screen. If the image remains stationary while the lathe revolves, the optical center of the lens coincides with the center of rotation, but if the image moves, the optical center is out, and the lens must be centered while the cement which supports it is still warm and soft. This is easily done by holding the hands against the edge and sides of the lens as it revolves. When the lens is optically centered, if its periphery is out it must be ground down. This is readily done by placing under it a piece of sheet iron bent into semicircular shape, and forced upward against the edge of the lens by means of a screw passing through a board that supports it. The sheet iron is charged with sand or emery and water, and as the lathe revolves the lens rapidly assumes a circular form.

The matter of testing the different qualities of glass used in the manufacture of fine achromatic lenses has been omitted on account of the abstruseness of the subject and the amount of space required to properly treat it.

For many of the points given above we are indebted to Mr. Chas. F. Usner, a practical optician of this city, from whose factory, at 128 and 130 Fulton street, we have taken the majority of our sketches.

H. W. BUTTERWORTH & SONS' DRYING MACHINE.

DRYING MACHINES.

The lower engraving on this page represents one of Messrs. H. W. Butterworth & Sons' drying machines, such as are used for printworks, bleacheries, and for drying cotton warps and finishing tickings, osnaburgs, etc. This machine is arranged with twenty-four cylinders, supported by a framing, eighteen of them being on a horizontal and six on a vertical frame. The grouping of these cylinders in a horizontal, vertical, or other direction may be modified to suit special requirements; and where the floor space is contracted, the vertical arrangement is preferred.

The frames of the machine are made of cast iron, being quite heavy in their construction, with broad planed surfaces; and hollow passages are cast in them for the transmission of the steam used in heating the cylinders and the return of the condensation, thus dispensing with outside pipes and connections. The steam passes into each cylinder and leaves it again by means of branch passages cast on to the frames and connecting with journals in which the axes of the cylinders run. The stuffing boxes for the journals are packed from the front by an arrangement introduced by this firm in 1867, this packing, however, forming no part of the bearing. The advantages derived from this method consist in the easy access given to the packing, which also lasts longer than in the ordinary arrangement; in an allowance of greater freedom for expansion of the cylinders than can be attained in any other way, and in furnishing an abundant length of bearing for the axles. This firm formerly packed the stuffing