BAUSCH & LOMB OPTICAL CO.—ITS HISTORY AND DEVELOPMENT

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THE immense and complicated institution in Rochester, N. Y. which bears the name of The Bausch & Lomb Optical Company had its origin in the brain of John Jacob Bausch, a German immigrant boy, who came to the United States in 1849 to escape the poverty and political unrest following the abortive revolution of 1848.

His capital consisted of a good character, tireless energy, mechanical ingenuity, and his thorough training as an optician under the tutelage of his brother. In 1853 he rented a window in the old Reynolds Arcade and filled it with a small array of optical products obtained from his brother. Spectacles, his chief stock in trade, were regarded as mere articles of adornment, but he persisted in his efforts to persuade people that they were also useful.

During one of the numerous financial stringencies which marked his early struggles, John J. Bausch borrowed sixty dollars from Henry Lomb who received an interest in the business. Both men, however, shared more vicissitudes than income for many years. It was the chance discovery of a piece of vulcanized rubber that put their feet on the first rung of the ladder of progress. Bausch's experiments with this new product soon convinced him that it was vastly superior to bone or steel for spectacle frames. It was light, tough, and easily molded into a great variety of shapes. The rushing waters of the Genesee next drew his longing attention and he soon devised lens grinding machines that could be driven with this power.

These small successes were hardly under way when the Civil War broke out and Henry Lomb enlisted in the 13th Regt., New York Volunteeers. He saw action in twenty engagements and was promoted to a captaincy before being mustered out in 1863. In the meantime, the business struggled on, aided by Captain Lomb's pay as a soldier.

The firm's products slowly gained in quality and demand so that retail sales were given up for manufacturing. Bausch had begun business with the ambition of grinding lenses for the whole field of optics. Early possession of a good microscope had whetted his desire to produce such instruments but time and money required to develop them were not available.

With the entry of his eldest son, Edward Bausch, into the business in 1874, the development of the microscope was taken up energetically. The first models were shown at the Philadelphia Centennial of 1876. Edward, with his brothers, Henry and William, were immensely gratified when their new microscopes won awards. From then on, a succession of improvements and patents on instruments and optical machinery marked the firm's progress.

The evolution of the business to its present size and importance is due to the unique service it renders industry and science. Few industries reach into so many fields—medicine, biology, bacteriology, metallurgy, astronomy, spectroscopy, spectrophotometry, ophthalmology, microscopy. Some 4,000 different instruments are built by Bausch & Lomb for the study of everything from a blood cell to armor plate for a battleship or the light from a nebula.

It was apparent for many years that the amount, types, and quality of optical glass being used by the company should be under its own control, since this material is a prime requisite of nearly all optical instruments. With this in mind, William Bausch began some experimental work in 1903. The literature on this subject was extremely meager. Although Germany and France were successfully producing this glass, and England to a lesser extent, its production was shrouded in secrecy. Bausch & Lomb's efforts were more determined in 1912. The initial work was started with oil-fired furnaces. When these failed to hold the required temperatures, various other types were tried. In the winter of 1914–15 two new gas-fired regenerative furnaces supplied the answer.

The first melt of barium crown glass was produced in May, 1915, followed three weeks later by dense flint. Several other types were produced in 1916 from

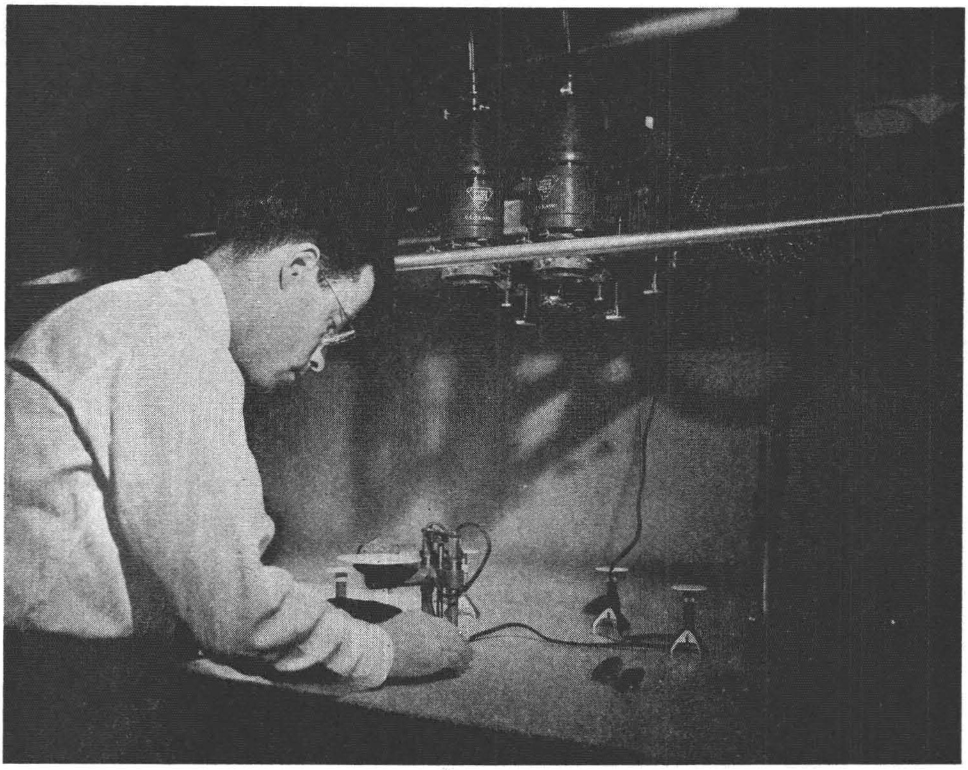
A circular dividing engine on which protractor scales for rangefinders are engraved.

which several hundred fine anastigmat photographic lenses were made. The purchaser pronounced them superior to lenses of Jena glass previously imported.

With the entry of the United States into the war in April, 1917, the Naval Consulting Board called on the National Research Council for a survey of the possibilities of optical glass production for fire-control instruments. This inquiry was conducted by Dr. Arthur L. Day, director of the Geophysical Laboratory of the Carnegie Institution.

It was quickly apparent that optical glass of the desired quality could be turned out in quanity only at the Bausch & Lomb plant, although efforts were quickly made to bring others into production. A staff of thirteen silicate chemists, headed by Dr. F. E. Wright, was sent to Rochester to help in the solution of numerous problems confronting the management. One of these problems was the inability to secure crucibles of sufficient purity to prevent contamination of the glass. A survey of the United States by the Geological Survey uncovered clays of sufficient purity and of the proper varieties to make a pot able to withstand the high melting temperatures and corrosive properties of the glass.

Long before the production of optical glass, however, Bausch & Lomb had acquired a reputation for painstaking workmanship in making lenses. This was recognized in Germany where optical science was at its zenith. While visiting Prof. Ernst Abbe at Jena in 1890, Edward Bausch had come to an arrangement whereby Zeiss products would be manufactured in America by Bausch & Lomb.

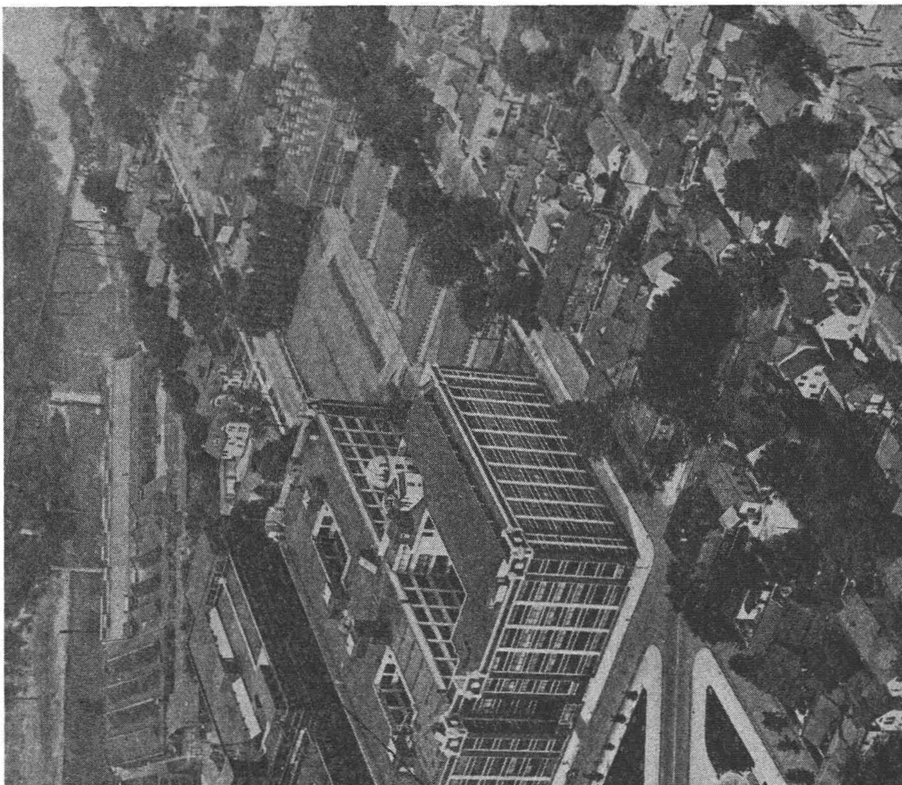


Innumerable tests and inspections mark the production of the Multiplex Projector.

Photographic anastigmats based on Abbe's formulas were among the first items made. The first lens on this formula, computed by Dr. Paul Rudolph, was the Protar series. A number of the new lenses were made with apertures from f/4.5 to f/18 covering fields from 20° to 45° from the axis. The covering power and excellent correction for flatness of field and astigmatism were immediately recognized in this design.

In 1902 Rudolph designed the Tessar, which was improved by Wandersleb in 1907. The Tessar, an unsymmetrical lens composed of four elements, two of which were cemented, has never been surpassed among anastigmats of this type. Its high speed at all focal lengths is maintained at no sacrifice to other important optical properties. This type of lens was in such demand for aerial work in 1918 that the Signal Corps advertised to the public for Bausch & Lomb Tessars of $8\frac{1}{4}''$ and $20''$ focal lengths with a speed of f/4.5.

Most of the lenses in the Air Corps at the close of the war were of the Tessar



Aerial view of Bausch & Lomb plant.

design. In 1921 Bausch & Lomb continued to make them for aerial use in 300 mm and 500 mm sizes. Some of them in 7½″ size, carefully matched in sets of three, were made for the new tri-lens camera invented by Major Bagley. This camera used a 6½″ f/4.5 Tessar for the center lens, while the 7½″ lenses were used for the oblique views.

Bausch & Lomb has designed many types of aerial lenses for reconnaissance and mapping. The trend in the latter field has been toward a single photograph with a wide angle, to economize in the number of photographs and the expense of radial control and map compilation. Such work requires a lens of the widest angle obtainable and with the least distortion possible.

This has brought about the development of the Metrogon, which is based on Topogon design, although considerable work has been done in redesigning to secure improved definition and better correction for distortion. Although this lens is composed of only four meniscal elements arranged in pairs on either side of a diaphragm, it is difficult to make because of the extremely close tolerances permitted. The thicknesses and spacings are held to .01 mm, the surfaces are true spheres to a small fraction of a wavelength, and the correction for distortion is held to a constant value within a few hundredths of a millimeter.

To obtain the wide angle of 90° or better, which is accomplished in this lens, and to avoid distortion, one pair of its elements is made symmetrical and the other pair disymmetrical. Each of the pairs is made up of one diverging member and one converging member. In order to meet the need for short focal length to cover a larger negative than 7″×9″, Bausch & Lomb has designed a 6″ lens to cover a 9″×9″ negative and a 5.2″ which covers a 10.4″ circle. In cooperation with Mr. Virgil Kauffman of Aero Service Corporation, a Metrogon of 4″ focal length was made by which an area of fifty square miles within the 90° field angle has been secured in an 8″ circular picture at a scale of 1 to 72,000. By enlarging a section of the center of this negative to a scale of 1 to 20,000 corresponding to a 5 minute quadrangle, reconnaissance photographs can be rapidly prepared.

In 1935 production of the Multiplex Projector was begun, under Zeiss license, and Bausch & Lomb has since built a number of these instruments, embodying various improvements which have been suggested from time to time by its users.

The Zeiss design utilized diapositive plates of 69° in the narrow-angle and 90° in the wide-angle projectors, the principal distances of which were 46 and 22 millimeters respectively. In the narrow-angle projectors the enlargement of the diapositive image is about 7.8 diameters; in the wide-angle type the enlargement is more than 16 diameters. While the quality of the stereoscopic image was better with the small projector, differences of elevation can be measured more precisely with wide-angle projectors, and at lower cost.

The Scientific Bureau of Bausch & Lomb, therefore, has worked out a decrease in the amount of enlargement of the diapositive in the wide-angle projector to improve the definition of the stereoscopic image. A change was made in the principal distance of the projectors from 22 to 30 millimeters with a resulting increase in the size of the diapositive. This increase in size necessitated a condensing system of much greater diameter which meant an increase in the size of the projector and an increase in its weight. However, by redesigning some of the mechanical parts it has been possible to reduce the overall diameter of the projector despite the fact that the new condenser housing has a greater diameter than that of the Zeiss model.

With the change of principal distance a corresponding change in the size of the reduction printer has been made necessary. While this was being done an improvement was effected over the old Zeiss models, in which it was found that one of the principal factors affecting mapping errors was the distortion of the 100 mm Topogon lens. A new reduction printer was, therefore, designed to introduce compensating distortion in the lens of the printer to offset, to a great extent, the distortion in the aerial camera lens. A double micrometer device in the head of the instrument was also devised by which given reduction ratios can be made easily, a provision which was lacking in the Zeiss model. Where it was formerly necessary to do considerable checking and figuring to overcome the sources of error contributed by distortion of the camera lens, a degree of compensation has now been worked out whereby the operator may assume that the aerial camera lens, the reduction printer and the projector are all, to a great extent, distortion free.