THE STORY OF BAUSCH & LOMB

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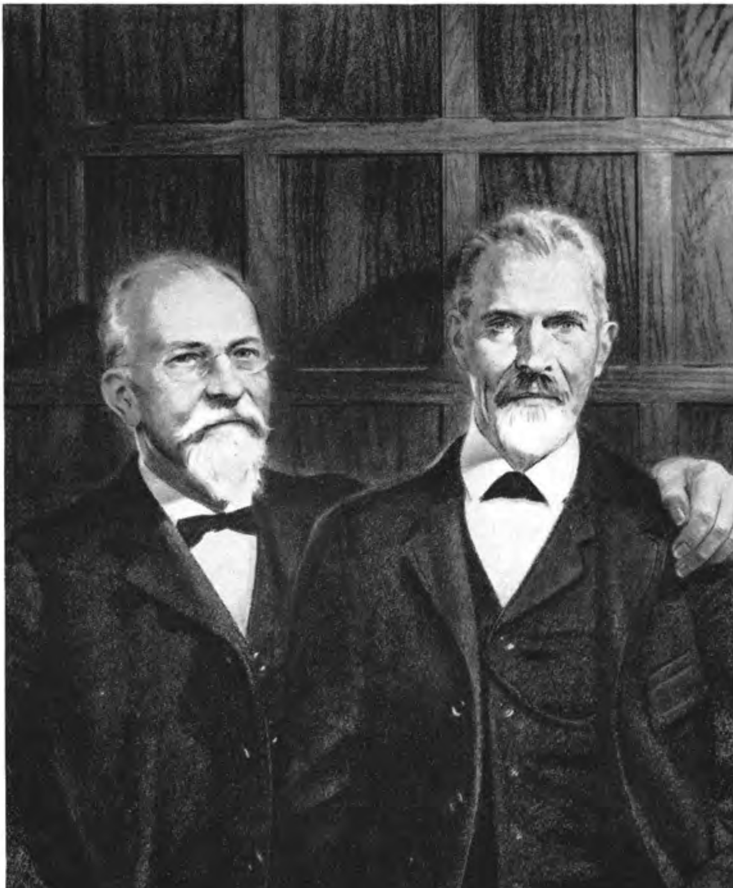
BAUSCH & LOMB OPTICAL COMPANY
ESTABLISHED 1853
ROCHESTER, N. Y., U. S. A.

NEW YORK - CHICAGO - SAN FRANCISCO - LONDON - TORONTO - RIO DE JANEIRO



John J. Bausch and Captain Henry Lomb founded the Bausch & Lomb Optical Company in 1853.

America is a country of alloys, not only of steel, nickel and tungsten, but of people. In America, of all places in the world, we have united and intimately fused the brain, brawn, and skill of all nations. We are more than a "melting pot." We combine the intelligence of Michael Pupin, a Serb, with the thrift and energy of Carnegie, a Scot; we blow on the spark of genius in a Steinmetz, born a German, or a Tesla, born in Austria. We welcome an Agassiz, from Switzerland, or an Augustus Saint-Gaudens, from France. John Stephenson, an Irishman; Ericsson, a Swede; Noguchi, a Nipponese, and Michelson, a German, gave us, respectively, our first street railway car, our first armored battleship, an approach to the cure of various infectious diseases, and a method of exact measurement of the speed of light. The list is endless; the achievements varied and rich. Thus, we have in America a composite civilization alloyed from all nations to give us the temper, the toughness, and the malleability to serve the strains and stresses of our day.

Various conditions in the social, political or economic life of Europe have been responsible for our gain. It was the German Revolution of 1848 that drove such men as Carl Schurz, John J. Bausch and Henry Lomb to the

United States, along with thousands of other thinkers, technicians, artisans, and farmers.

It was in April, 1849, that John J. Bausch set sail for America, on a sailing vessel which required forty-nine days to make the trip. He eventually arrived in Rochester. There was no work in the optical line for which he had been trained and temporarily he became a wood turner. His first venture into the optical business was unsuccessful and he went back to wood turning, but in 1853 he began again and with the aid of sixty dollars from Henry Lomb continued the struggle to introduce optics to America.

As you walk through the great mass of buildings that represent Bausch & Lomb today, it is hard to realize that the institution has grown since 1853 from a mere shop window in the Reynolds Arcade, in downtown Rochester, to one of the world's greatest optical establishments, all through the efforts of two immigrant

The Bausch & Lomb factory in 1880. The main building, erected in 1874, was the first built on the site of the present huge plant.

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The Spectrometer is used by B&L scientists for ultra-precise refractive index measurements, which are essential in optical science.

boys who came to America with no capital except high ideals, a penchant for hard work, skilled hands, and a love for fine workmanship.

The business had attained but a scanty and precarious growth when the Civil War broke out. Henry Lomb, a devoted citizen of his adopted country, enlisted in the 13th Regiment of New York Volunteers in 1861 and was active in the organization of Company C, composed of 600 men of German birth. He was successively advanced from first sergeant to lieutenant and then to captain for services in the field, where he participated in more than twenty engagements. More than a hundred members of his company gave their lives for the preservation of the Union.

It was the World War that gave Bausch & Lomb the opportunity for its greatest service to America. By the development of optical glass, a vital material for military instruments, the company solved one of the government's most pressing requirements, supplying 65% of its needs and aiding in the instruction of other sources. The result of this development has freed America from all European sources and eliminated one of the paramount concerns of our military branches.

The Raw Material of Optics

The raw material of the optical industry is glass—not the ordinary kind you see in bottles and windows but an unusual type

The raw materials for making glass are accurately weighed out according to definite formulas.

designated optical glass. It must have high transparency, durability to exposure; it must be homogeneous and its refractive index and ratio of dispersion must be constant. Refractive index is one of the most important characteristics of optical glass, since its power to bend light rays must be rigidly controlled in designing systems for precise optical instruments. Likewise dispersion, or the separation of light into its various colors, is important. Your familiarity with photographic lenses will afford some idea of these factors in focusing light rays. Optical glass must also be free from color, internal stresses, and strains. The waves, feathers, and striae frequently seen in window glass cannot be tolerated in optical glass.

The desired properties of optical glass can only be secured by pure ingredients. In the Bausch & Lomb glass plant you will see how sand, or silica, and soda are weighed and mixed with a number of alkaline materials, such as lead, lime, barium or zinc, to secure the physical properties demanded and the various combinations sought. Pick up a handful of this sand and note both its purity and the uniformity of the grain. It is a form of sand-

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Pots are built from several different kinds of clay, and require from six to eight months to make, dry, and season.

stone rock, known as Oriskany quartzite, which has been thoroughly pulverized. It is remarkably free from iron. Iron is the bugaboo of the glassmaker. It gives the green tint commonly seen through the edge of window glass. The percentage of iron in most optical glasses must be no greater than .0172, which may be illustrated by saying if 17 oranges in a carload of 100,000 were spoiled, the entire car load would have to be discarded.

The Importance of Pots in the Glass Making Process

As you watch a glowing pot being removed from the furnace and feel the blast of heat, you wonder how any container can sustain the weight of the molten mass. The truth is that the pot is just as important in making optical glass as the components in the pot. These are not ordinary pots. It requires from six to eight months to make one. The special clays come from six different states. They were found by the Geological Survey during the World War period. They are a mixture of kaolin, ball clay, and "grog," or burned clay. The proportions are mixed to a definite formula. These raw materials must also be selected for physical properties and be free from such impurities as iron and sulphur.

The grog and plastic clay are ground and screened to a fine dust and frequently a little fine feldspar rock is added to act as a flux so that when the pot is heated it will have a close texture to prevent the corrosive action of the glass. The clay must be thoroughly processed for homogeneity before aging. Before the pot is used it is air dried under controlled humidity and then placed in a pot arch where the temperature is gradually raised to 2,000° F. After several days of this it is ready for the glass batch and the big furnaces where it must stand a temperature of 2,600° F.

In making optical glass the

The pot of glass is placed in and removed from the furnace by means of this specially designed ten-ton truck.

The truck transports the pot of molten glass to the casting table, where the glass is poured and rolled into a sheet of desired thickness.

molten material is cooled under a hollow, double-walled, sheet-iron cylinder, insulated with diatomaceous earth, requiring about three days for a 36″ pot. The pot is then cracked away from the glass which separates along cleavage lines, leaving numerous chunks. Ophthalmic glass differs in the method of annealing. The molten material is poured onto a cast-iron table, rolled to a specified thickness, and thrust into a series of annealing ovens for gradual cooling. Before leaving the furnace hall all glass is inspected for striae, stones, color, seeds, and annealing. This is more important in instrument glass than in ophthalmic glass. Any striae in the latter are spread out in thin sheets and ribbons during the rolling process; they are parallel with the surface of the plate and hence do not appear after the plate is polished. But for such parts as large prisms, in which the light rays traverse the prisms in different directions, glass free from striae is essential.

A glance at the huge meters

Small squares of ophthalmic glass are sorted by automatic weighing machines.

in the furnace hall is enough to give the average householder a fit of economy when next she lights her gas oven. The daily gas consumption required to maintain the high furnace temperatures is enormous.

In a neighboring room you may see sheets of ophthalmic glass measured, cut, inspected, and automatically weighed. Various lots of glass are stained in different colors for identification. At a casual glance, one would assume that it was absorptive glass but actually this is a mere surface stain.

The pressing room is an important adjunct to the glass plant since it is here that the weighed pieces of glass are reheated and given their first form. Pressed into accurate molds in small gas furnaces, they are given the approximate curves desired so that grinding is reduced to a few millimeters on both sides.

Although Bausch & Lomb makes some twenty-six varieties of optical glass, this is not the only material required for optical systems. There are several valuable and comparatively rare minerals used. Among these are fluorite, used for achromatic and apochromatic objectives; calcite, used for polarizing optics; quartz, for the optical systems of monochromators and spectrometers, piezo-electric crystals for controlling radio wavelength; fused quartz, for microscope condensers and object slides; tourmaline, for radio short wave control; mica, for microscope retardation plates, and selenite for the same purpose; and rock salt, for instruments utilizing infra-red light. Some of the finest specimens in the world have been collected for Bausch & Lomb's mineral vaults.

The Eyeglass Lens

You have seen how the rough glass blanks are molded to approximate curves. When you enter the grinding rooms, where spectacle lenses are made, you see row after row of machines

At these furnaces the glass squares are molded into rough lens blanks, preparatory to grinding and polishing.


ARMY AIR CORPS PHOTO

Preparatory to grinding and polishing, the rough lens blanks are attached to grinding blocks by means of pitch and rosin.

constantly whirling what looks like the shell of a turtle. Actually these are lens blanks mounted in hot pitch on an iron block of definite curvature with a corresponding shell. Between the block and the shell is the abrasive substance.

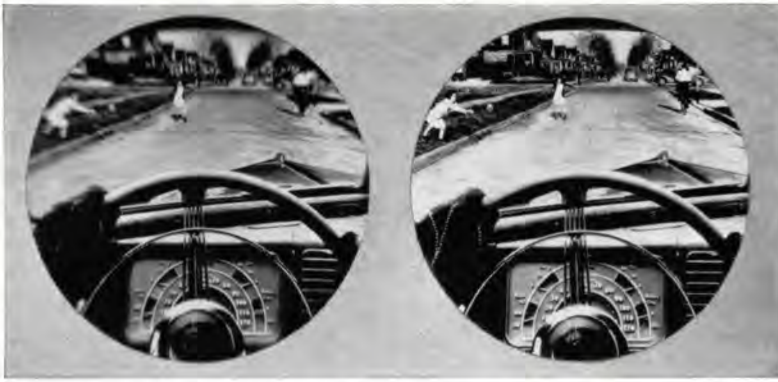
This all looks very simple. But let us consider the abrasive. An accurate lens surface depends very greatly on the grinding; it is next to impossible to correct errors by polishing. Poorly graded emery will give a surface filled with pits, so you see too much attention can hardly be given to the matter of abrasives. Bausch & Lomb has experimented for years to obtain the thirty grades of corundum now in use, nor has it ceased, for much work is still being done at the Mellon Institure by a Bausch & Lomb fellow ship. So renowned is the quality of these abrasives that they are used on extremely fine optical parts throughout the country. The 200-inch Mt. Wilson reflector is surfaced with these abrasives.

The corundum comes from Africa. It is a crystalline form related to such gems as the sapphire, ruby, and amethyst. It must be crushed and ground to very fine particles and these must have a definite conformation. The finest commercial grain size is 300 mesh with a diameter of 44 microns. Twelve finer sizes are made by Bausch & Lomb, down to a grain of 5 microns or .0002 inches diameter. A special grading process has been devised using the specific gravity principle, whereby grains of a certain specific gravity and volume will settle in a liquid of uniform temperature in a given length of time.

The red material you see in the polishing machines is rouge. No less care is employed to obtain unusual quality in this material. Its chemical composition is similar to common iron rust. It occurs in veins and is mined and refined to remove impurities. Bausch & Lomb reduces rouge to an impalpable powder with an average grain size of 0.85 micron diameter or .000034 inches. For special purposes synthetic rouge is made from scrap treated with acid to produce iron sulphate, which in turn is reduced to iron oxide by roasting. The polishing tool is covered with felt impregnated with wax and must be washed every time it is used.

The remarkable transparency of Bausch & Lomb glass, coupled with the highest skill in grinding and polishing, accounts for the fine surface quality and brilliance so noticeable in such lenses as the Orthogon, Panoptik, and Ray-Ban, likewise in all Bausch & Lomb optical parts for scientific instruments.

The lenses are ground by means of corundum and water, and the polishing is done with felt-covered tools, using rouge and water.



These pictures illustrate the superiority of Orthogon eyeglass lenses. Note the perfect clarity to the very edge of the picture at the right, photographed through an Orthogon lens, compared to the blurred image at the left, taken through an ordinary lens.

Metallurgy in Optics

All optics must be mounted in one way or another, from the frame of an eyeglass to the housing for a spectrograph. In this respect, as in all others, Bausch & Lomb maintains its reputation for quality by laboratory analysis and experiment of all metals used. The company also maintains a foundry with iron cupolas and brass and aluminum furnaces, since unusual exactness is required in many castings to meet the requirements of instrument designers.

Gold is one of the most widely used metals in the optical industry, and finds its chief use in spectacle frames and mountings for rimless lenses. It is, in fact, the foundation of quality in Bausch & Lomb eyewear. The basic material used in making Bausch & Lomb gold filled eyewear is solid gold bullion, which is 999.75 fine. It is a matter of common knowledge that pure 24K gold, because of its softness, is not practical for fabricating into articles that undergo constant wear or strain. Therefore, the solid gold bullion is diluted in equal parts with a special base metal alloy developed by Bausch & Lomb engineers after long experimentation. The resultant 12K gold filled metal, as produced by Bausch & Lomb for eyewear, retains the rich natural gold color, maximum strength, resistance to corrosive effects of acid, and sufficient hardness to withstand constant wear. The wide variety of eyewear types and styles requires that gold filled material be made in what is known as gold filled flat stock and gold filled wire. From these are fashioned spectacle bridges, rims for lenses, endpieces, temples (bows), and other parts. Recognized standards of excellence, Bausch & Lomb spectacle frames and rimless eyewear have been developed through years of experience and adherence to the highest quality standards. Great sums of money and untold time have been spent in experimenting to determine the ideal base metal for amalgamating with gold and to secure the proper hardness and temper of both gold filled wire and gold filled flat stock for the vast number of optical parts required to make Bausch & Lomb eyewear.

Rhodium, chromium, silver, stellite, platinum, and aluminum, as well as bronze, lead, and steel, have a variety of purposes in the optical industry, from supports to reflective backings for mirrors.

The Research Metallographic Equipment is used extensively in industries the world over for visual observation and photography of metals.

Applications of Optics

Nearly everybody is acquainted with some of the more common uses of optics, such as eyeglasses, goggles, mirrors, and photographic lenses, but the average person has no conception of the infinite variety of optical systems embodied in instruments, some 4,000 of which are designed and built in the Bausch & Lomb laboratories and shops. Prisms of the trapezoidal erecting type, the constant deviation type, rhombohedrals, roof, and pentagonal, built with the most exacting patience and skill, are made with a precision equalled in no other industry.

The micron, 0.001 millimeter, is a common measure in this industry and, although it is but 1/25,400 of an inch, it is too gross for many surfaces. The wavelength of light is the general standard for measuring the accuracy of optical surfaces. It is done with quartz test plates on the principle devised by Sir Isaac Newton, color fringes or rings denoting a departure from a true surface. The limit of tolerance in general use is a quarter wavelength of sodium light. The full wavelength is 0.0000232 inches, but is is usually expressed as 589 millimicrons or 5893 Angstrom units.

Light is the phenomenon with

In making gold filled eyewear stock, a cylinder of gold is soldered to a rod of optical metal, then drawn through diamond points into wire stock.

Loxit, the molded rivet construction, is an exclusive B&L design. It supplants the old-fashioned screw method of eyeglass mounting.

which optics works and there is hardly any branch of science which has not found a use for light and its power to make disclosures with the aid of optical instruments.

The microscope, so commonly thought of as a medical research tool, is now used in various forms in thousands of industrial research fields—textiles, paints, leather, foods, drugs, paper, metals, and so on, endlessly. Metallurgy, particularly, has found the metalloscope a useful tool in all the recent advances which relate grain size to the peculiar characteristics of various metals. Likewise, the spectrograph has become the chief tool of the metallurgist in detecting trace elements, elements that frequently occur in almost infinitesimal amounts affecting the quality and service of metal parts. So important has the field of spectroscopy become that the literature has increased by leaps and bounds. It ranges into agriculture, archaeology, astronomy, biology, blood chemistry, carbons and chemicals, dental research, die-casting, electroplating, lighting, foundry operation,

The modern Research Microscope and the Numont Ful-Vue in Loxit eyewear exemplify the B&L motto: To Greater Vision Through Optical Science.

geochemistry, gold and glazes, gas analysis, histology, naval ordnance, physiology, vitamins, water analysis, and criminology —an amazing field of usefulness for one instrument.

A brewery may call for a colorimeter to test the maturity of a mash; a sugar chemist asks for a saccharimeter to measure the amount of sugar in a solution; a glycerine manufacturer seeks a refractometer to test the purity of his product; a textile laboratory wants a projector to detect defects in fabrics; a paper maker puts in a hurry call for an opacimeter to test the opacity of his paper; an asbestos concern requires a dust counter to protect employees against the hazard of asbestosis; an aviation engine builder must have a contour measuring projector to check the accuracy of his parts; an automobile manufacturer seeks a photoelastic outfit to figure the stress in a plastic model of a new axle—this is the constant and continuous demand on the optical instrument maker.

But this is not all! Many research scientists must have special instruments, instruments for

One of thousands of optical instruments produced by Bausch & Lomb, the Abbe Refractometer plays an important part in science, industry, and education.

The Contour Measuring Projector is used to examine and measure small machine parts and products, more precisely and speedily than by any other method.

which there is no market, for a market presupposes a steady sale. Possibly he is a biologist or physiologist and requires a centrifuge microscope to complete his investigations on cell protoplasm. He must have a rotor with optics built-in and a speed of 10,000 revolutions per minute to secure separations of the structure by forces greater than gravity. Or possibly he is a cytologist and needs a micro-manipulator with delicate mechanical fingers to manipulate a tiny cell. Whatever it is, if it's optical, he visits the Bausch & Lomb Scientific Bureau where a corps of scientists are available to hear his ideas, discuss design, and tell him whether it can or cannot be successfully made.

Since the World War, Bausch & Lomb has been one of the two stations in the United States where the Navy Department maintains offices for the inspection of optical products. The company's military and naval design department is an important factor in keeping the United States abreast of developments in fire-control, navigation, and mapping instruments. Rangefinders, binoculars, telescopes, gun sights, searchlight mirrors, drift meters, bubble sextants, and stereo mapping equipment are among the items that are required.

B&L Binoculars, in a wide range of models, are known as "The World's Best—By Any Test."

Social Significance to the Community

Although Bausch & Lomb is the second largest industrial institution in Rochester, its influence on community life is not measurable merely by size. Its history, traditions, and public policies are strong factors in promoting the stability of the city as an industrial center. One of its unique organizations is The Early Settlers' Club, composed of some 400 employees each of whom has spent twenty-five years or more in the company's employ. The average number of years for these employees is about 35 years, while many of them have been continuously employed for more than fifty years and a few sixty years! More than 45% of all its male employees are 40 years of age or more. This is almost double U. S. Census figures for male employees in all industries. Furthermore, 22.7% are over 50 years of age and 7.5% are beyond 60 years. There is no discrimination against youth, but the optical industry requires skill, knowledge, experience, and responsibility which are the chief virtues of age. Such a policy has contributed to Rochester's reputation for labor stability. It has also been a factor in the city's Community Chest campaigns, invariably successful, and frequently headed by company executives.

It must not be supposed, however, that youth is neglected. Quite the contrary. Mechanics Institute of Rochester was founded by Captain Henry Lomb and largely supported in its early days by his generosity. Its purpose is to give practical technical training to youth in the useful arts and sciences. The company cooperates with the Institute in its training courses. Today an imposing black granite shaft stands in triangular Lomb Memorial Park, marking the usefulness of Captain Lomb to his city and the people he served. The monument faces the busy span of Bausch Memorial Bridge which was named after John Jacob Bausch, co-founder of an institution which has added to the city's lustre.

Higher education has also received some impetus from the Bausch and Lomb families, which jointly gave to the University of Rochester the magnificent Physics Building which houses The Institute of Optics. This unique institution offers an exceptional training in optics. Since its founding, in 1930, every one of its qualified graduates have found immediate employment. More could have been placed had they been available.

In its service to science, industry, the government, and its community, Bausch & Lomb endeavors to play a role of usefulness in the tremendous progress which has made the United States the greatest industrial nation in the world.

THE Bausch & Lomb Optical Company manufactures many types of optical equipment. Below are listed some of the many Bausch & Lomb products in regular production.

Microscopes and Accessories

Binocular Microscopes, Greenough Type
Chemical Microscopes
Dark Field Optical Systems
Euscopes (Exton)
Fluorescence Microscopes
Haemacytometers
Laboratory Microscopes
Metallographic Microscopes
Micro-Manipulator (Fitz)
Micro-Projectors
Microscope Accessories
Microscope Illuminators
Microtomes
Ortho-Stereo Camera
Photomicrographic Cameras and Accessories
Polarizing Microscopes
Research Microscopes
Shop Microscope
Slit-Ultra Microscope
Toolmakers Microscope
Ultra-Violet Photomicrographic Accessories

Instruments for Measuring Optical Properties

Abbe and Dipping Refractometers
Colorimetric Apparatus
Density Comparator
Opacimeter
Photometers
Polariscope
Quartz Monochromator
Saccharimeters
Spectrographs
Spectrographic Equipment
Spectrometric Equipment
Spectrophotometers

Instruments for Aerial Mapping

Metrogon Lenses
Multiplex Projection Apparatus

Projection Equipment

Contour Projectors
Micro-Projectors
Projection Apparatus (Balopticons and Accessories)
Sales Projectors
Super-Cinephor Projection Lenses
Textile Projectors

Ophthalmic Products

Binocular Ophthalmoscope
Clason Visual Acuity Meter
Diagnostic Instruments
Ferree-Rand Perimeter
Ferree-Rand Projector (Acuity Meter)
Greens' Refractor
Keratometer
Ophthalmic Hydraulic Chair and Unit
Orthogon Lenses
Orthogon Test Lens Set
Shop Equipment for the Optician
Spectacle and Eyeglass Frames
Stereo-Campimeter
Universal Slit Lamp

Miscellaneous

Binoculars
Finger Print Magnifier
Magnifiers and Readers
Microscope Equipment for Amateurs
Micro Tessar Lenses
Optical Glass
Photographic Lenses
Searchlight Reflectors
Special Lenses, Prisms and Reflectors
Spotting Scopes for Riflemen
Telescopes
Optical Instruments for Crime Detection—Glass Control—Metallography—Metal Working—Ceramic Research — Textile Inspection — Chemical Determination — Food and Drug Manufacture — Paper Makers—Paint and Varnish Makers

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