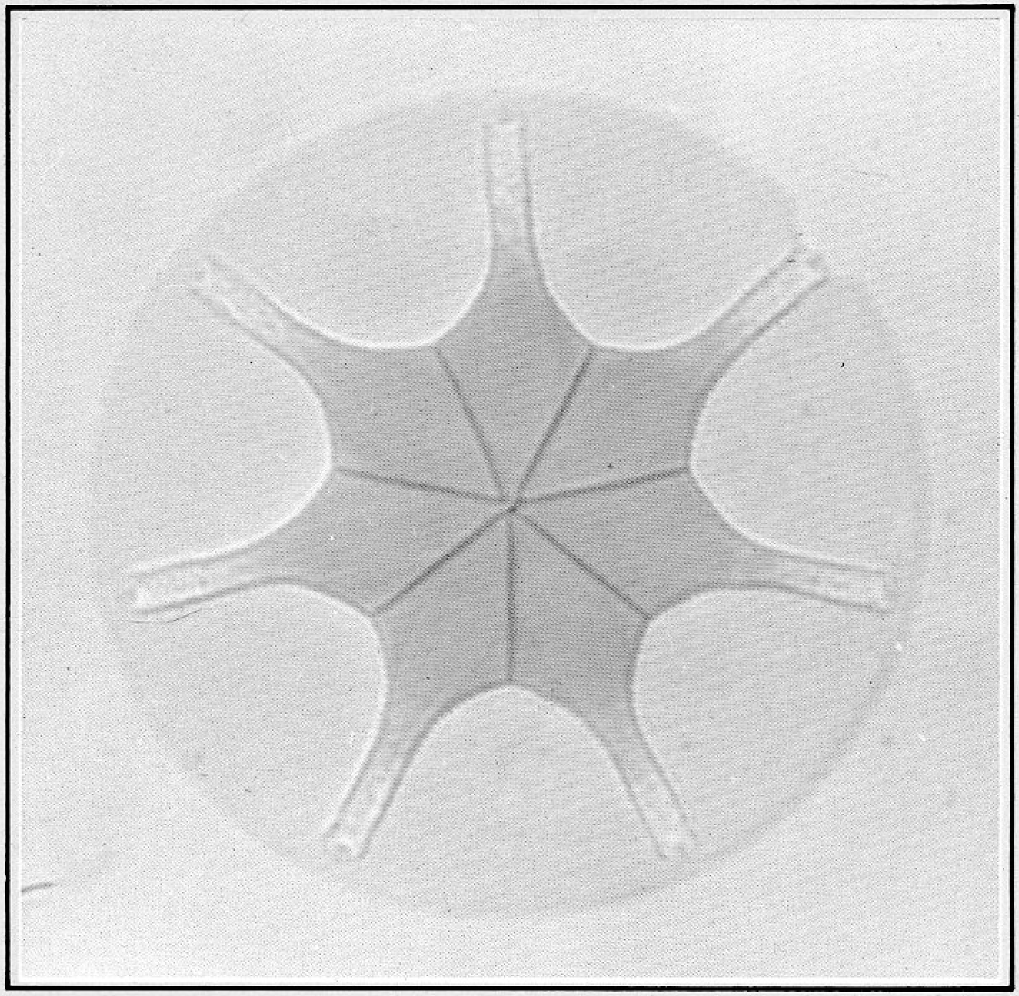


New York Microscopical Society

CENTENNIAL YEARBOOK

1877-1977

One Hundred Years of Microscopy in the United States

Oscar W. Richards Ph.D., FBPA, (Hon.) FRMS, FAAO

Pacific University, Forest Grove, OR.

Pre-1887

Microscopy was a well established, increasingly important activity when the New York Microscopical Society was founded in 1877, fig. 1. The American epoch of microscopy, which had seen the development of larger-aperture objectives for increased resolution, was drawing to a close, and the very large stands were giving way to smaller ones because the then-new immersion objectives and condensers no longer required the substage mirror to provide extremes of oblique lighting. Woodward's photomicrograph of the 19th band of Nobert's Test Plate had established the value of large-aperture objectives. Some 17 United States Patents had been granted for microscopes.

Many books of the time dealt with microscopy. The Smith, American edition of Carpenter's *Microscope and its Revelations* had been published in 1856. Hogg's book was in its 7th edition. Grunow (New Haven) had made H.L. Smith's Inverted and Riddell's Binocular microscopes, both American inventions, and during 1875 had published a 104-page catalog listing 10 standard microscopes. Sorby's microscopy of metals was gaining industrial use. Custer had just lost the Battle of the Big Horn, and the first telephone exchange had been established in New Haven, Conn.

The use of the microscope brought togethei people with similar problems and a wish to compare results. There were no inexpensive photomicrographs for exchange, and the high cost of illustrations precluded common use. The Illinois State Microscopical Society was begun in 1869, the Leidy in Philadelphia in 1858, and the American Society of Microscopists in 1878. Microscopical societies were going strong in Boston, Buffalo, San Francisco and other cities. At the 1876 Philadelphia Centennial Exposition, 18 American, 50 English, 6 French, 1 Japanese, and a few German and other makes of microscope were exhibited, according to Crouch (1877). Impressed by this need for microscopes, Edward Bausch began factory production methods for microscopes on his return to Rochester from the exposition. This was the beginning of the end of the small shops and custom-made instruments; their demise was hastened by the deaths of Charles Spencer, Bulloch, Tolles, and Zentmayer during the next few years. However, during the 1880's there were some 20 makers of microscopes in the United States (Padgitt 1975) and another 30 United States Patents were issued on microscopes.

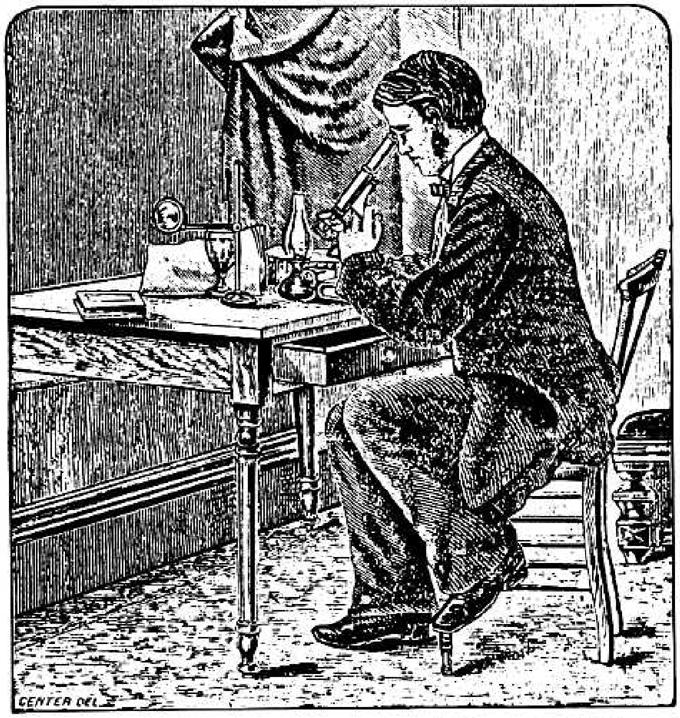


Fig. 1. Microscopy, 1880. Frontispiece of J. Edwards Smith, "How to see with the Microscope."

1877-86:

During the first ten years of our Society the discovery of new infectious agents — cholera, gonococcus, tuberculosis, typhus, and others — pointed the way to medical-laboratory microscopy. The need for less costly microscopes led J. Edward Smith and John Sidle to design the Acme instruments, fig. 2, manufactured by Sidle & Poalk until that firm was brought by Queen in 1881. McAlister used chain drive focusing and Yawman a differential screw fine adjustment. Bausch & Lomb's catalog listed the Excelsior, Family, Harvard, and Investigator's compound microscope, and several simple dissecting microscopes; later B & L purchased and made George Wale's concentric microscope, fig. 3. Fasoldt began ruling micrometer slides during 1884 at Albany, N.Y. Pfeiffer's 1879 invention of the Rotary Microtome at the Johns Hopkins University and Minot's invention of the Rotary-stroke type Microtome at Harvard in 1886 made serial sections from paraffin embedded material an easy process, thus advancing embryology and histology.

Mayall delivered his well-known Cantor Lectures on the Microscope in 1886. Schott, Abbe and Zeiss started the glass works at Jena, making possible the major development of this decade, Abbe's apochromatic objectives corrected simultaneously for three wavelenghts of light. Somewhat earlier, Abbe's theory of the microscope image ended arguments on the importance of large-aperture objectives.

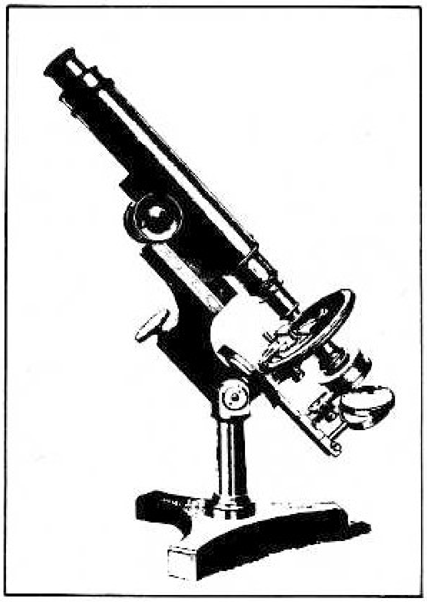


Fig. 2. The Acme Number 3 microscope of Sidle & Poalk.

Fig. 3. The Bausch & Lomb model of George Wale's Contric microscope.

1887-96:

Malta fever and smallpox organisms were added to the known disease agents, X-rays were discovered by Roentgen, the Kinetoscope was invented by Edison, and Marconi's wireless became a communication possibility during the 1887-96 decade. Reeves (Chattanooga) contributed a handbook of medical microscopy and Matthews and Loft's *Microscopy in the Brewery and Malthouse* continued the expansion of microscopy into industry. The *Biblioteca Debyana* appeared, listing 102 periodical and bibliographic references and some 220 books and papers on microscopy in this notable private library.

Brass microscopes with top fine adjustments were in common use, fig. 4. Fusion methods and hot stage microscopy were pioneered by Otto Lehman. Polarized light microscopy was aided by Dirk's synchronously rotating polarizer and analyzer and Federov's Universal Stage for crystal measurement. Bratuchek approached phase microscopy by absorbing some of the light in the direct beam within the objective to increase the contrast and visibility of phase differences within a specimen. Nelson published his important paper on illuminating the specimen with the microscope condenser.

Microscopy in eight departments of the United States Government was described by Lamb. Greenough, an American living in Paris, invented the stereoscopic bi-objective microscope in 1892, marketed by Zeiss in 1897. Rheinberg published his use of colored area stops in the condenser of the microscope to provide differential, optical staining. The 1893 translation of Van Heurck's *Microscope* lists 2 U.S., 6 British, 3 French, 5 German, 1 Italian and 2 Viennese microscope manufacturers, 6 journals, and 21 books on microscopy. H.R. Spencer started the H.R. Spencer Optical Company in Cleveland in 1889, then moved on to Buffalo, forming in 1892 the Spencer-Smith Optical Company, which became the Spencer Lens Company during 1895.

1897-1906:

During this decade the Wright Brothers made the first air flight, Madam Curie discovered radium, and infectious agents were found for dysentery and syphilis. Chamot started chemical microscopy at Cornell University. Wright used the selenite wedge in polarized light microscopy of crystals. Barber's spore picker could isolate a single microorganism for initiating pure cell lines. Wood discovered the composition for an ultraviolet radiation filter. Guyer's *Animal Micrology* appeared, destined to be a text for animal histological procedures for some 60 years.

Golgi and Cajal received the Nobel Prize for their work on the nervous system. Ultramicroscopy by Siedentopf and Zsigmondy (Zeiss) applied the microscope to investigation of the colloidal state of matter. Conrady and Rheinberg had a simple phase microscope. Typical large-aperture objectives were: Powell & Lealand, N.A. 1.45; H.R. Spencer, 1.50; and Zeiss, N.A. 1.63.

The major advance was objectives for use with ultraviolet radiation, to gain the increased resolution from shorter wavelength radiation, by von Rohr and by Kohler (Zeiss). The difficulties of using the metallic arc sources then available for producing this radiation unfortunately delayed further advance for years.

Another gain in microscopy at this time was the availability of the Woodbury process for inexpensive illustrations for books on microscopy. Until then prints from engravings were used, an expensive process that hindered the spread of information needed by microscopists. Autochrome glass plates were invented for color photography, but attained only slight use in photomicrography.

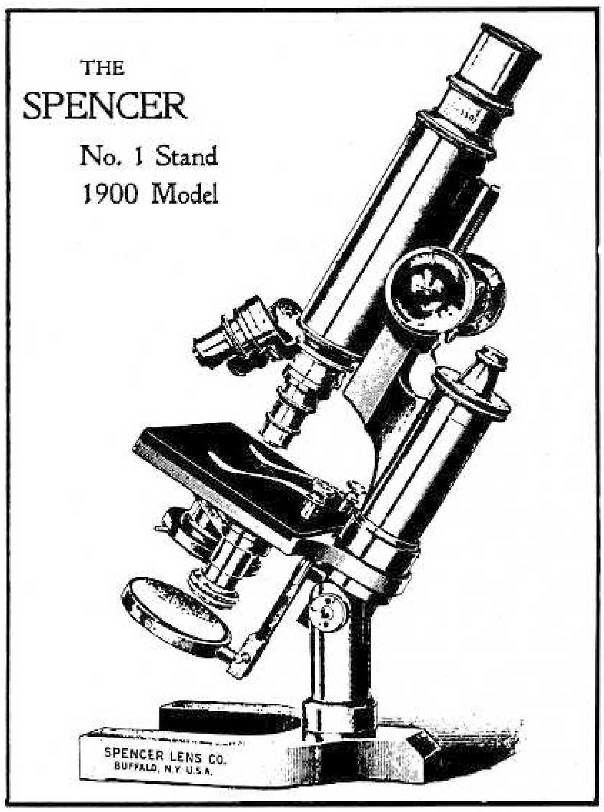


Fig. 4. A typical early 20th century American microscope.

1907-16:

Microscopy made little advance in the United States during this decade, which started with an economic panic and ended in World War I. Winton translated Hanusek's *Microscopy of Technical Products* and Winchell published his *Elementary Optical Mineralogy.*

Abroad, Lisegang developed microincineration, Ignatowsky designed the bispheric condenser and Siedentopf the cardioid darkfield condenser. Kohler, Siedentopf, and Lehman reported that fluorescence was a nuisance in ultraviolet microscopy. During 1911 Heimstadt (Reichert) started fluorescence microscopy, advocating the use of a darkfield condenser, and in 1913 Lehmann (Zeiss) began brightfield fluorescence microscopy. Kaiserling investigated the innate autofluorescence of bacteria. Fluorescence microscopy was established in 1914 when Provazek discovered that fluorescent chemicals could be used, as with staining, to reveal differentially cellular details. Golay used contact X-ray pictures in the study of fossils and minerals, an early form of unit magnification microscopy.

1917-26:

Chambers (New York U.), using methods of Pterfi, began his long series of microdissection studies of cells and tissues and by 1926 had patented his improved micromanipulator. McEwing revived microengraving, showing that a square, 1/100 inch on a side, was large enough to write 70 to 80 26-word Lord's Prayers with ample margins around each. Gage revived darkfield microscopy, demonstrating the fatty chylomicrons in the blood following digestion. Spierer invented an objective with absorption over the center of the front lens, which was alleged to resolve greater detail and was made by Zeiss on special order only. Pterfi coined the term micrurgy for biological microdissection.

The importance of polarized light microscopy in biology was emphasized by the publication in Germany of W.J. Schmidt's *Die Bausteine des Tierkorpers in polarisiertem Lichte* (1924) showing new information about the structure of living organisms, and by Köhler's monograph in the *Abderhalden Arbeitsmethoden* series.

In England, Bernard designed a microscope for use with ultraviolet radiation, manufactured by Beck, which revived interest in the greater resolution obtainable with this radiation than with light. Nelson described the Cassegrain, large-aperture, darkfield condenser, and Hartridge called attention to the visual problems when interpreting the image in microscopy. Spitta's 1920 *Microscopy* was the classic text for several years.

1927-36:

Ultraviolet microscopy was active in the United States with Barnard-Beck instruments in use at Columbia and Harvard Universities, the Rockefeller Institute and the National Institutes of Health. Wyckoff and Ter Louw began an atlas of UV tissue photomicrographs, but gave it up about 1933. Tivelli and Foster (Bausch and Lomb) designed a 365-546 um, dichromate objective which could be focused visually with the green light and also be in focus for the 365 um ultraviolet radiation. Lucas began investigating living cells with ultraviolet microscopy.

Chamot and Mason (Cornell) published their two-volume *Chemical Microscopy*, which served as a basic text, as well as making the new methods available for analytical use on micro-size samples. Harvey built and used his centrifugemicroscope to study the effects of force on dividing cells. Scott and Gage extended Policard's methods for microincineration and mineral study of cells and tissues. Emerson, Fitz, and Fonbrune designed micromanipulators, the latter also a microforge for making special miniature tools for micrurgy and chemical microscopy. Land invented means for making sheet polarizers. Graton and Dane designed a research type of microscope with a very slow, controllable, fine adjustment. While this did not increase the resolving power, as was first thought, it did point to the need for better fine adjustments and sturdier stages and mountings to avoid loss from vibration.

The electron microscope was started during 1931 by Knoll and Ruska in Germany. In 1934 Marton had one in Belgium and in 1938 Prebus and Hillier built an electron microscope in Toronto. Shortly after, another one was made at the Eastman Kodak Co., in Rochester, and by 1940 the Radio Corporation of America was making them commercially in the United States. Knoll suggested a scanning electron microscope in 1935.

Replicas of a Leeuwenhoek microscope were made for the 1933 anniversary observance by Bausch and Lomb of that great microscopist's 300th birthday. In 1928 the Royal Microscopical Society published Disney's *Origin and Development of the Microscope* and in 1932 *The History of the Microscope* by Clay and Court appeared. Beck's *Microscope, Theory and Practice* served as a text and was notable for calling attention to the possibilities of misinterpreting what is seen in the microscope image, especially when oblique illumination is used. B.K. Johnson revived interest in mirror objectives, using a single mirror plus a correction plate. Leitz produced the Ultropak epi-illumination system.

Muller's Field Ion microscope appeared in 1936, and at M.I.T. Schmitt used his Leptoscope Microscope in the study of red blood cell ghosts. Kodachrome film became available for photomicrography in color. Barnard and Welsh used primulin fluorescence to reveal a virus.

Mega-microscopes, as Gage called the larger, more solid research-type microscopes of the early 1930's, included the back-side-to Bausch and Lomb DDE, fig. 5A; and the Spencer No. 8, fig 5B, instruments with the focusing controls away from, instead of on the side toward, the microscopist. The Spencer Nos. 3 and 5 Microscopes appeared with new low fine adjustments and tilting binocular bodies which added to comfort during long observation periods, fig. 6. The Biological Photographic Association, was started in 1931. The American Society of Amateur Microscopists, founded by Corrington in 1939, was to last over 10 years.

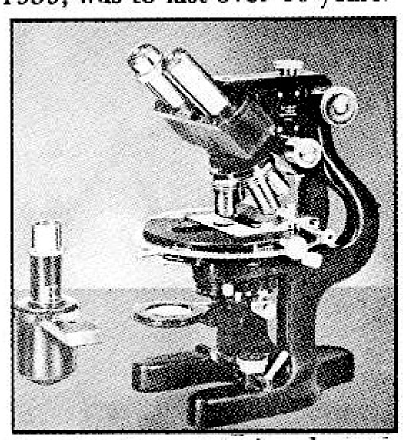


Fig. 5A. Bausch & Lomb DDE microscope.

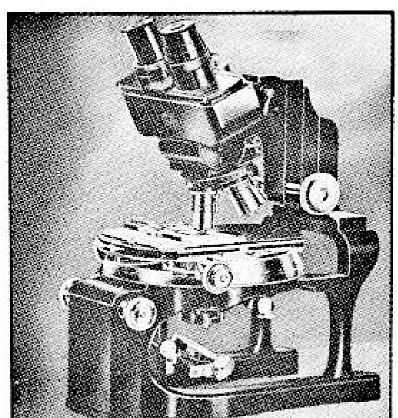


Fig. 5B. Spencer microscope Number 8.

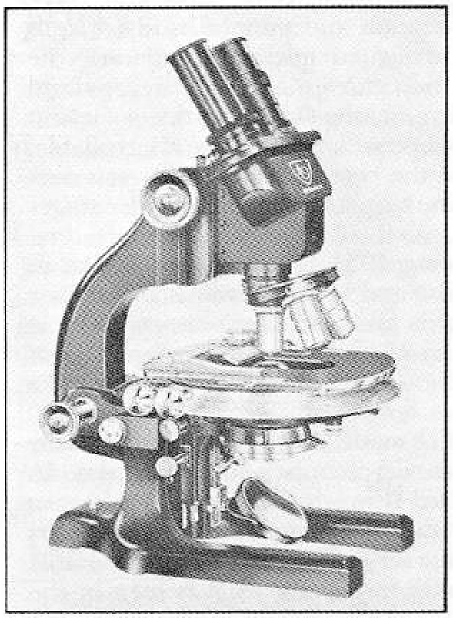


Fig. 6. Spencer microscope Number 5.

Interference microscopy was initiated in Europe in 1931 by Linnick, by Lebedeff and by Frederikse in 1935. Ultraviolet microscopy found its main use when Caspersson (Stockholm) demonstrated the specific absorption spectra of proteins and their derivatives, a procedure that was soon to expand into microspectrophotometry. He built a large universal microscope and both Leitz and Zeiss soon marketed large universal instruments. Galileo pioneered with a table model research microscope in 1935 and Wild founded a new optical firm in Switzerland.

Fig. 7. The First American Phase Microscope, Spencer Lens Company. L. to r:A.H. Bennett, H. Osterberg, Helen Jupnik, O.W. Richards.

1937-46:

Despite the considerable diversion during World War II (1940-45), microscopy continued to advance. The first American phase microscope, fig. 7, was demonstrated December, 1944 by Bennett and Richards. It showed three of the four possible kinds of bright and dark contrasts at three levels of contrast. A number of applications were discussed for the examination of materials of biomedical and industrial importance too transparent for the usual brightfield methods. The following year Hofer and the author demonstrated a virus, and in 1946 Angulo and his associates demonstrated virus inclusion bodies with this phase microscope. Foster, Wennemark (Eastman Kodak) and I first used high speed, electronic flash in 1945 for making photomicrographs of living microorganisms with edges sharp enough for accurate measurement. Osterberg published designs for a Polanret microscope with both variable phase and amplitude contrast, and Bennett and Kavanagh took phase photomicrographs using ultraviolet radiation.

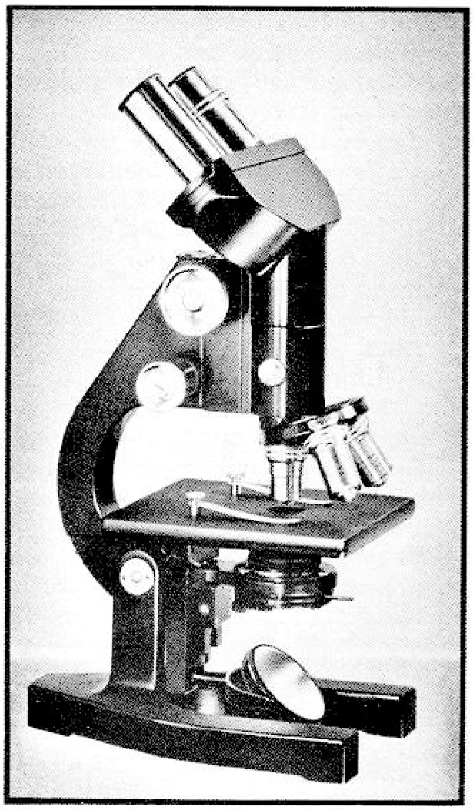
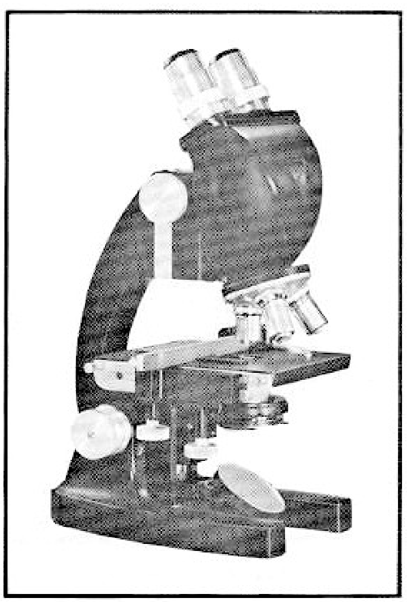


Fig. 8A. (above) Bausch & Lomb microscope, Model HSET.
Fig. 8B. (left) Bausch & Lomb microscope, Model TVBA.



Harvey and Chase described the use of a phosphorescence microscope. Schulman modified the half-aperture method of stereoscopic seeing with a monobjective microscope, by using Polaroids for separating the images for the two eyes. The American Optical Company produced a polarized light microscope using H-grade Polaroid instead of crystals for the polarizer and analyser. Bailly (St. Louis) used infrared radiation for orthoscopic and conoscopic observation of minerals opaque to light. Resinography became an established branch of microscopy, largely from the work of Rochow. Dempster called attention to improved seeing made possible by controlling glare through proper illumination and use of the microscope. A typical laboratory microscope was now a binocular, fig. 8A, B. Bausch and Lomb introduced the dynoptic microscope, fig. 8B.

New means for making ultrathin sections needed for electron microscopy appeared. Fullam and Gessler used a very high speed rotary drive system and selected the best from the thousands of sections produced in a few seconds. Pease and Baker modified the Spencer number 820 Microtome by using a feed with less slope to reduce the section thickness, and Newman, Borsyko and Swerdlow devised an inenious thermal mechanisms to slowly advance the specimen by nanometer increments.

In Germany, Hagemann used carbol-auramine 0 fluorescence for localization and identification of tuberculosis bacteria, which proved to be a more sensitive method than Ziehl-Neelsen staining. Keller showed that filtered tungsten light could be used to activate the auramin fluorescence. Miller and the author verified this work, and in 1941 I extended it to the demonstration of a potato scab fungus. During 1941 the American Optical Company marketed equipment for this method, fig. 9, and Graef and I showed that the carbol-suramine fluorescence revealed the lipid pneumonia membranes in human lung tissue.

Köhler and Loos described the advantages of phase microscopy in 1941, and the dark-contrast equipment of Zeiss. In England, Burch and Stock demonstrated a phase microscope in 1942 using a slit instead of an annulus to limit the aperture. Brumberg showed in 1943 that photomicrographs could be taken separately with three different wavelenghts of ultraviolet radiation, projected in three different colors of light to superimpose into an image

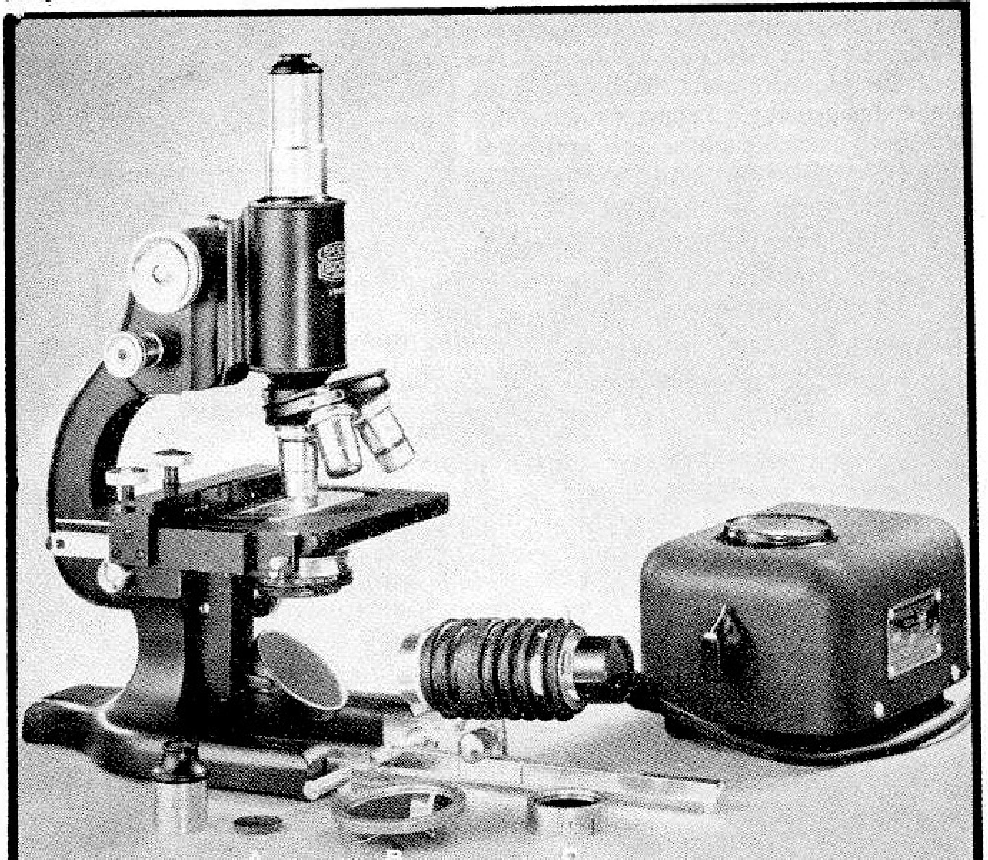


Fig. 9. Spencer Equipment for Fluorescent Demonstration of Tuberculosis and Other Microorganisms.

showing the absorption of the short wavelength invisible radiation, initiating the color translation technic. Wild began the manufacture of microscopes in 1939 and McArthur designed a folded-optical-path, pocket microscope for use on expeditions and fieldwork.

1947-56;

Phase microscopy flourished during the 1947-56 decade. Bennett, Jupnik, Osterberg and Richards published *Phase Microscopy*, which described many applications. By 1954 Richards had reviewed some 205 new references and by 1956 counted an additional 178 references. Continuously variable phase and amplitude were combined in 1946 in Osterberg's Polanret Microscope, which was built with 16 and 8 mm objectives the following year. The advantage of variable contrast, rather than fixed contrast objectives, was demonstrated, but commercial production was not possible until some 15 years later. The Microstar Microscope, fig. 10, with the bar-mount type body appeared.

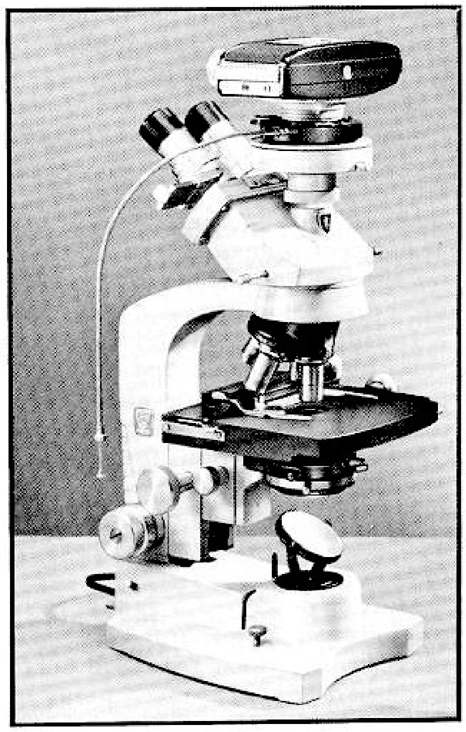


Fig. 10. American Optical Company, Microstar microscope.

Fluorescence microscopy advanced rapidly with the application of Coon's 1950 discovery that fluorescein could be used for labeling of immune bodies, so that immunochemistry became possible in tissues and many infectious organisms could be identified rapidly and with specific certainty. Strugger (Münster) used acridin orange in 1947 to differentiate living from dead organisms, and by the end of the decade Bertalanffy and Bickis (Ottawa) used acridin orange fluorescence for identifying DNA and RNA. By 1951 Mellors and Silver (Sloan-Kettering Institute) were using a scanning fluorescence microscope for automatic counting of atypical cells. Loesser and Berkley pointed out the advantages of fluorescence for quantitative microscopy. Marts (Forest Products Lab.) studied woody tissue fluorescence activated by incident radiation from a vertical illuminator.

Kirkpatrick and Baez (Stanford) used mirrors in 1947 to focus X-rays for microscopy, and Nixon improved projection X-ray microscopy and by 1954 General Electric and Philips were both selling X-ray microscopes. Castaing recommended using the X-rays given off from a specimen as it is scanned by an electron beam for further analysis of the specimen, thus forecasting probe systems.

Land's (Polaroid) 1949 ultraviolet microscope used the Polaroid rapid processing system to show in combined color the three photomicrographs made with three different wavelengths of ultraviolet radiation. During 1952 Zworykin and his associates (RCA) obtained similar pictures using electronic means and a television viewer. Neither system proved useful for cancer diagnosis because of the difficulties of interpreting the metameric colors obtained by the color superimposition methods.

Autoradiography for locating radioactive materials in tissues became active during the 1950's. Montgomery, Roberts and Young developed flying spot microscopes including UV and TV technics. Zirkle and Bloom used ultraviolet from a Van de Graff generator for selective destruction of cellular elements under the microscope. Kehl published *Principles of Metallography.* Gray designed catadioptric objectives, and Bennett and Richards patented a Variable Stereoscopic Microscope.

Television microscopy was initiated by Parpart (Princeton) and patented by Zworykin and Flory (RCA) in 1951. Later a TV microscope was built at the Armed Forces Institute of Pathology which was interconnected with neighboring institutions. In 1953 Deevey described an Acoustic Microscope and Perkin-Elmer marketed an Infrared Microscope. The MIT Conference on Microspectrophotometry of Cells (1951) recorded the growth of this kind of microscopy and the beginnings of automation for microscopy. Crossmon (B&L) used dispersion optical staining and darkfield for stained slides.

During 1950 Latta and Hartman proposed using glass knives for cutting the very thin sections needed for electron microscopy and Jenkins and I got rid of the troublesome static electricity sometimes formed on paraffin ribbons by discharging it with a simple B-radiator. Gettner and Ornstein used alternate thick and thin sections for light and electron microscopy. The Bush Automatic Microtome with thermal advance appeared in 1952 and the following year the Porter-Blum Ultramicrotome. Abroad the Sjostrand Ultramicrotome became available and diamond knives were pioneered by Fernandez-Moran for microtomy.

Merton described a simple technic in 1947 for making partially reflecting coatings on slides and cover glasses needed for multibeam interference microscopy, which was used successfully by Mellors and by me. Greenham published in 1947 observations of the surface of an apple leaf made with multibeam interference microscopy. The Smith two-beam interference microscope appeared in 1950, and in 1951 the Dyson Inteference Ocular became available. Philpott published various designs for interference microscopes in 1948.

Gabor described his two-step imaging system. Engstrom and associates (Stockholm) were estimating dry weight of cells with X-ray microscopy. In England, Hallimond invented stop contrast and Burch was making reflecting objectives for multiwavelength microscopy. Kofler's book on fusion methods appeared in 1954 and when translated into English by McCrone in 1957 initiated another application of microscopy. Kerr and Gromberg developed a B-ray microscope. Leitz revived the bar-mounted microscope body in their Ortholux model.

1957-66:

During 1957 Bausch and Lomb introduced the Dynazoom stereoscopic microscope with a zoom variable magnifying system. Price and Christiansen (U. Minn.) combined phase and fluorescence microscopy, the following year and Dunn and Fry announced an Acoustic Microscope. Slight defocusing could increase resolution, according to Osterberg. Muller's field ion Microscope appeared, McLaughlin's Deep Field Microscope (Ohio State U.) was described and Osterberg and Van Ligten's Holographic Microscope with a laser beam of light to produce a hologram image which could be viewed in three dimensions.

The Microstar microscope (AO) appeared with concentric coarse and fine adjustments and built-in illumination. The Electro-Optical Light Modulation system to improve visual contrast for phase details was in use by Allen and his associates (Princeton). El Badry's *Micromanipulators and Micromanipulation* summarized much of this technic and described the equipment.

The Microscope Committee of the *American Society for Testing and Materials* published standards for the microscope objective screw thread, a compatible compromise between the British V-thread and the American round-base thread, and for slides and cover glasses for use in microscopy. Excitation and emission spectra for a number of chemicals used in fluorescence microscopy were measured and published by Porro and his associates (Perkin-Elmer).

Zeiss produced the Light Section Microscope for Measuring surface irregularities. Bosh made a Computing Microscope. Gregory (Bristol U.) invented his Solid Image Microscope in which the focus was varied at 50Hz with a tuning fork and the image was seen in depth on a similarly vibrating screen. Later he used a rotating glass wedge to vary the focus and a helix to move the viewing screen. The changing image summated in the observer's mind, showing the third dimension of the specimen, better than can be done by manual focusing.

1967-

The McCrone, Draftz, Delly, *Particle Atlas,* with some 500 color photomicrographs of some 400 particles and a systematic method for analysis, description and recognition of particles, advanced polarized light microscopy, and demonstrated the increasing importance of microscopy in industrial problems and for atmospheric pollution identification. Waters and I demonstrated an interference filter with a sharp wavelength cut off for improving fluorescein fluorescence microscopy.

McLaughlin's Deep Field Microscopy became available commercially, using two lateral beams to illuminate only the depth-of-focus volume in the specimen of the objective, giving a 6mm visual depth in a suitable specimen, at 100X. Later, the specimen was mounted at an angle on a vertically moving device.

Butterfield (Color-Tel. Corp.) patented a device using a television pickup and equipment for showing stereo-pair images. Korpel, et al. (Zenith Radio Corp.) announced an Acoustic Microscope with holographic ability. Dudley rediscovered and patented a half-aperture method for stereomicroscopy. Courtney-Pratt and Gregory (Bell Telephone Labs and Bristol U.) obtained greater third-dimension viewing by using the color images from a nonachromatic objective. Improved Vectrography by Mahler made possible a pilot model Polanret Microscope in 1972 and commercial production in 1974 for completely variable phase and amplitude phase microscopy.

A Modulation Contrast Microscope, of Hoffman and Gross (Waldemar Medical Research Foundation), images a slit at the back focal plane of the objective and superimposes on this image a filter with three different absorption densities, either neutral or colors, for viewing phase detail of a specimen.

Stereological methods for specimen-analysis microscopy, and for estimating third dimension shapes and volumes in quantitative microscopy, were discussed at the Third International Symposium, which showed considerable increased use.

The Microsonoscope Acoustic Microscope — using a 100MHz laser beam microphone, showing optical and sonic images on a screen — is available commercially. Lemons and Quate (Stanford U.) called attention to the additional information on the elastic properties of the specimen, especially in contractile systems, revealed by acoustic microscopy and the advantages gained when using them with other kinds of microscopes.

Very large microscopes continued to appear, Reichert producing an elaborate table model, Univar, and Zeiss the Axiomat, a very heavy instrument using a layer system for changing component parts. Leitz patented an automatic focusing mechanism for microscopes.

Many semiautomatic microscope systems appeared for counting sizing, comparing and analyzing specimens, one by Vickers included specimen preparation onto a plastic ribbon, scanning the specimens marking selected specimen areas and recovery of the marked areas for subsequent study by the microscopist. Some automated microscopes are custom built, others are commercially available and there are too many for listing. Several books and symposia cover their history. The high cost of labor and the declining number of people willing to become technicians will force increased use of automated microscopy, with its attendant problems of programmed vs. skilled, personal observation.

At present basic problem concerns materials and methods for standardizing quantitative microscopy. Hijmans (Leiden) is working with an international committee, on standards for fluorescence microscopy. Other standards committees should turn from the lesser problems of tolerance for parts of the microscope, to methods for evaluating the performance of the entire microscope system, including standard specimens and means for measuring the light or radiation at the eyepiece of the microscope from the reference specimen.

This is my biased selection of important contributions to microscopy during the 100 years' existence of our Society. I am sure each reader would choose some different discoveries and applications. None of us could cover all American microscopy of this century in one brief paper.

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Recent books on microscopy are reviewed in the *Transactions of the American Microscopical Society.* Clark's reviews in *Analytical Chemistry* and bibliographies in *The Microscope* are useful. Some of the material comes from *Applied Optics, Journal of Microscopy, Nature* and *Science.*