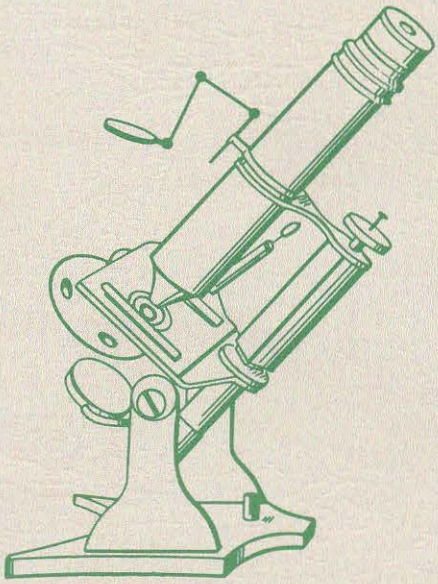
THE BILLINGS MICROSCOPE COLLECTION



SECOND EDITION

The BILLINGS MICROSCOPE COLLECTION

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Second Edition

National Library
of Medicine

JOHN S. BILLINGS
Lieutenant Colonel, United States Army
Curator, Army Medical Museum, 1883-1893

The BILLINGS MICROSCOPE COLLECTION of the Medical Museum Armed Forces Institute of Pathology

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SECOND EDITION

Published by

ARMED FORCES INSTITUTE OF PATHOLOGY

Washington, D.C. 20306

1974

Reprinted 1987

FOREWORD

The accomplishments of Lieutenant Colonel John S. Billings, medical officer of the United States Army, and Curator of the Army Medical Museum from 1883 to 1893, were many, but none has provided us with a singular heritage comparable to the Museum's collection of microscopes assembled principally through his persistent efforts.

The collection was begun in 1874 by Colonel Billings' predecessor as Curator, Lieutenant Colonel George A. Otis, also an Army medical officer, who acquired several historic microscopes from a Philadelphia instrument maker. It was Billings, however, who provided the impetus for expansion of the collection that is unique in the world. Assigned to the Army Surgeon General's Office in Washington, D.C. in 1864 to organize medical records of the Union Army, he was placed in charge of the Library of the Surgeon General's Office in 1865, and during the next thirty years endeavored to forge it into a national medical resource; he succeeded beyond expectations and the outgrowth is the National Library of Medicine in Bethesda, Maryland.

As Curator of the Army Medical Museum, he endeavored to create an institution of which the Nation would be proud. Colonel Billings personally undertook the expansion of the collection that now bears his name. While on a tour of Europe in search of historic medical items such as microscopes and books, Colonel Billings engaged the services of John Mayall, Jr. of London, England, a member of the Royal Microscopical Society and well-known collector of microscopes, to procure representative instruments to augment the collection. The first shipment of seventeen instruments arrived from Mayall in October 1884, to be followed by eight scarce models in 1886, and three rare Italian instruments in 1887; by 1888 Mayall had personally selected and purchased 141 instruments for the collection. Meanwhile, Colonel Billings searched Europe for antiquated microscopes, and through display of these foreign models stimulated collectors of early American instruments to contribute to the growing collection; until his death in 1913, Colonel Billings maintained his interest and was personally responsible for many of the noteworthy acquisitions.

Following the precedent established by Colonel Billings, his successors at the Museum added to the collection at every opportunity. Today it embraces nearly seven hundred instruments including microscopes used by Dr. Robert Koch, Dr. Rudolph Virchow, Lieutenant Colonel Joseph J. Woodward, famed Museum photomicroscopist, those used by Major Walter Reed, the conqueror of yellow fever, and the instrument made especially for the National Antarctic Expedition of Robert F. Scott in 1901, to name only a few.

In the more than 100 years since the collection was begun by Colonel Otis, and catalyzed by Colonel Billings, many individuals have been instrumental in assembling the collection as it exists today. For some it was a part of their assigned duties; businesses, organizations, colleges, universities, and individuals contributed many of the instruments; and for others the knowledge of the uniqueness of the collection prompted their support in various ways toward its growth. In 1965, Dr. A.J.W. Kaas of Oude Niedorp, Holland, offered for purchase his outstanding personal collection of 90 microscopes dating from 1675 to 1865 to the Medical Museum. Dr. Kaas' collection was acquired and made a part of the Billings Collection in 1966; they are pictured and described in Part II of this volume. Part III comprises instruments acquired since publication of the First Edition in 1967.

We are indebted to Dr. Oscar W. Richards, Hon. F.R.M.S., Consultant on Microscopes to the Medical Museum, AFIP, for his advice and guidance in the preparation of the manuscript, and

to all members of the Institute's staff who assisted in so many ways in the preparation of the First and Second Editions.

We are pleased to make particular mention of the work of Miss Helen R. Purtle, Museum Specialist, who had a long and distinguished career on the staff of the Medical Museum prior to her retirement in 1973. Miss Purtle, an expert on microscopes, particularly their history, mechanical components, and their part in the advancement of medical and scientific knowledge, was custodian of the Billings Microscope Collection. As Technical Editor of the First Edition of this volume, she prepared the entire manuscripts comprising Parts I and II, and prior to her retirement completed the manuscript for Part III of this Second Edition which comprises all microscopes acquired since the First Edition was published. Miss Purtle's expertise was a major factor in making the Collection the most comprehensive in the world today.

The Billings Microscope Collection herein described, therefore, is not simply a panorama of mechanical ingenuity and precision workmanship, but an historical insight into the advancement of medical and scientific knowledge brought about by each improvement in instrumentation; it is a fitting and enduring tribute to the foresight and determination of Colonel Otis, Colonel Billings, and their successors.

JAMES L. HANSEN
Colonel, MC, U.S. Army
The Director
Armed Forces Institute of Pathology

PREFACE

This historic Billings Microscope Collection, the facts and figures, including references to the makers, the types and models, dates, and the historical significance of specific accessories and appurtenances, are as accurate as it is possible to ascertain from all available records. The presence or lack of attractiveness of an instrument has not been permitted to interfere with the true description of its component parts and its scientific capabilities.

This account is not a definitive work on the history of microscopes, nor on the improvements in instrumentation over the years from the late sixteenth century to the present; it is simply a description of a unique collection of microscopes. While the collection contains nearly seven hundred instruments of many types, sizes, models, and by makers from many countries, there are gaps that would not be encountered in any complete history of microscopes; major advances in instrumentation are, however, in almost all instances represented by a specific instrument or accessory.

It is to be noted that in catalogues, reference works, and publications pertaining to microscopes, the manner in which pertinent words are spelled varies considerably. This is true with regard to the instruments, their accessories, the makers, and the cities where they were made. In compiling the information where the instruments are signed or otherwise identified, the actual spelling used by the maker is quoted. In all other instances present day terminology is employed for the sake of uniformity.

The majority of the descriptions are accompanied by a photograph of the instrument being described. Each photographic illustration is followed by a figure number, the name of the maker, the city, state, and/or country where made, the type of microscope, i.e., compound, simple, binocular, monocular or other, the year or approximate year of manufacture, the accession number in the collection, and the photographic negative number. The figure number of each photograph is repeated in the description of each illustrated instrument for ease of reference.

In instances where instruments are not illustrated, descriptions are preceded by the accession number, name of the maker, the city, state, and/or country where made, the type of microscope, year of manufacture, and the notation, "Not illustrated." Where instruments are duplicates of others in the collection, the corresponding figure or accession numbers are given for comparison purposes.

Covered in the descriptions are dimensions, special construction details, variations in lenses, pillars, bases, limbs, arms, focusing, and stages, how signed, and accessories such as eyepieces, oculars, condensers, and objectives. Also part of the collection are several hundred additional accessories not related to specific microscopes; these are not listed in the descriptions.

For ease of reference, instruments have been grouped according to date of manufacture in five separate categories, compound monocular, compound binocular, electron, simple, and dissecting microscopes; each group comprises one section of Part I.

In a number of instances where reproductions of early 17th century microscopes are pictured and described, it will be noted that they have been placed according to the dates of the original instruments, and not the dates when the reproductions were made; this avoids picturing these

instruments along with 19th and 20th century models.

The instruments pictured and described in Part II comprise the collection of Dr. A.J.W. Kaas of Oude Niedorp, Holland, acquired in 1966, and include a number of types not previously represented in the collection, as well as many similar to those listed in Part I.

The instruments pictured and described in Part III comprise those acquired and accessioned to the collection since the publication of the First Edition of this volume in June 1967. They also include a number of types not previously represented in the collection, as well as instruments similar to those listed in Parts I and II.

It has been said that the history of medical science may be written in terms of the invention and development of its instruments; the microscopes of the Billings Collection represent a significant segment of medical instrument development of nearly four centuries. Without the microscope it is not difficult to visualize medicine still existing within the realm of magic and the witch doctor.

We of the Armed Forces Medical Museum are proud of this splendid collection, grateful to those pioneer microscopists, generous donors, meticulous museologists and loyal staff workers who have created and maintained it. All serious and casual students and groups interested in understanding human and comparative pathology (disease) and who appreciate the scientific tools which have made possible the fascinating story of progress in medicine, are welcome to see this collection and many other outstanding medical exhibits on display in our public medical museum.

JOSHUA E. HENDERSON
Colonel, VC, U.S. Army
Curator, Armed Forces Medical Museum
Armed Forces Institute of Pathology

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HISTORY OF THE MICROSCOPE

Helen R. Purtle, F.R.M.S.

The following article was prepared by Helen R. Purtle, formerly assistant curator of the Armed Forces Medical Museum and Fellow of the Royal Microscopical Society of Great Britain, and was published in "Encyclopedia of Microscopy and Microtechnique" by Van Nostrand Reinhold Company, New York. This short history of the microscope is published here as a supplement to the Billings Microscope Collection narration, prepared in its entirety by Miss Purtle, but which is confined only to those instruments actually comprising the Billings Collection.

A number of histories of the microscope have been written; some limited in scope to specific geographic areas, others limited to scientific accomplishments in specific centuries. This history is based on an exhibit in the Medical Museum of the Armed Forces Institute of Pathology--"The Evolution of the Microscope"--which depicts some 250 historic instruments from the total collection of over 650. These instruments were selected for exhibit to show progressive improvements in design from the late sixteenth to the mid-twentieth centuries.

The word microscope was coined in 1624 by a member of the first Academia dei Lincei, a group of scientists that included Galileo, Cesi and Stelluti. Galileo, although better known for his work with telescopes, is credited with being the first scientific user of the microscope. However, Hans and Zaccharis Janssen of Middleburg, Holland constructed an instrument between 1590 and 1610 which is generally recognized as the first compound microscope. It was about 12 inches long and 2 inches in diameter, made of three tubes of tin and contained two lenses with focusing accomplished by a sliding tube.

The earliest Italian compound microscopes are of the sliding tube and screw-barrel forms, and were developed in the late seventeenth century. All of the extant examples conform to the same general appearance and optical structure.

Giuseppe Campani, born in Castel San Felice, Italy, in 1635, was noted for the perfection of his lenses and he invented a special lathe for grinding and polishing them without the use of molds, which he first introduced in 1664. He is credited with having been the first to construct the field lens from a design by Monconys, C. 1660, a form subsequently developed by Robert Hooke in 1665.

In 1662 Campani made an ivory compound microscope on a silver support, the optical system of which consisted of an ocular and an object-lens, without a field lens. His 1665 small wooden microscope with a brass stand, also without a field lens, which allowed transparent objects to be seen by directing the instrument toward the light, is considered to be the precursor of the pocket microscopes (Fig. 3, Billings Collection). It was also the model from which the Wilson screw-barrel and similar instruments were developed.

Histories of the microscope describe and illustrate the sliding-tube microscope using an example in the collection of the Museo Copernicano in Rome attributed to Eustachio Divini, C. 1668. Divini was an optical instrument maker who established himself in Rome at about 1646.

A replica of this microscope, made by John Mayall of England from the original, is also in the Billing's Collection. The socket-ring and feet are flat and made of tin, and the cardboard body tubes are covered with gray paper. The lower tube slides within the socket-ring for adjustment of the distance between the object-lens and the object. The ocular lens, enclosed in a metal holder at the upper end of the body tube, consists of two plano-convex lenses with the convex surfaces in contact.

William Homberg, a Dutch physician and scientist, constructed a microscope in 1715 which utilized a tripod support and a sliding tube focusing mechanism.

Robert Hooke (1635-1703), London, England, introduced coarse and fine adjustments, devised an illumination system, and used a stage for objects. His early instruments utilized a ball and socket joint at the base of the vertical pillar to allow inclination of the body tube. This was later replaced (1665) by a simpler method in an instrument made for him by Christopher Cock (Fig. 4, Billings Collection). Hooke also introduced a field lens. His "Micrographia; or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses with Observations and Inquiries Thereupon" was published in London in 1665, and was printed by Jo. Martyn and Ja. Allestry, printers to the Royal Society. This was the earliest work devoted to microscopical observations. It included the first reference to cells which were seen in cork when examined under a plano-convex lens.

Hooke placed a lens at the lower end of the body tube to the bottom of which the objective was attached; this was later (see Clay & Court, p. 21) found in a microscope made by Culpeper for Yarwell and adopted by Benjamin Martin about 1759. The objective consisted of a double-convex lens of very short focal length, mounted in a cell with a pin-hole diaphragm close to the lens. The ocular consisted of a large field glass and an eye lens with a cup to control the distance of the eye from the lens.

Malpighi of Italy, the discoverer of the anatomy of tissues and the creator of microscopic anatomy, was one of the first biological scientists to use the microscope. He discovered the existence of capillaries in the lungs of frogs in 1661 and he described blood corpuscles in 1665. An instrument in the Billings Collection appears identical to one described by Clay and Court as possibly Malpighi's own microscope made by Divini (Fig. 6, Billings Collection). The body is bell-shaped and is made of dark wood. The stand consists of a ring fitted with three brass, flat, bent legs and the nose is brass and screws for focusing. There is no adjustment for distance between the lenses. The objective is a biconvex lens 7/16-inch in diameter, and the 1-3/8-inch field lens is plano-convex. The eye lens consists of two biconvex lenses, the lower 1-1/16 inches in diameter and the upper 3/4-inch in diameter. John Mayall said that this instrument was constructed after 1665 by Divini as it has a field lens, and that the upper ocular lens probably was experimental.

Antoni van Leeuwenhoek of Leyden, Holland (1632-1723), one of the greatest early microbiologists, discovered protozoa and bacteria with microscopes he himself made and lenses he ground. In his instrument of 1673 the lens is mounted between two thin brass plates. His instruments were extremely simple and generally poorly finished, but the lenses were of excellent quality. As he used his microscopes for examining only one or two objects, the number he made was quite large, and it is estimated that at his death, there were over 550 microscopes. Of these, only nine are known to still be in existence. The Billings Microscope Collection does not have an original. Johan Joosten van Musschenbroek (1660-1707), a famous instrument maker of Leyden, Holland, made two different models of simple microscopes which were widely imitated. The first form had the objective mounted in a turned cell, pushed tightly on one end of an arm. Hinged to the arm by a ball and socket joint was a second jointed arm for the objects. Accessories included a number of rods of various patterns to which objects of different kinds could be affixed. His second form resembled a fairly complicated compass microscope. Each instrument had six convex lenses, and those with the first form were for low power. Musschenbroek marked his instruments with a small oriental

lamp and crossed keys.

A beautifully engraved French simple hand microscope made in 1686 by Depovilly consists of a single lens mounted between two thin brass plates hinged at the bottom, with focusing accomplished by a thin brass wheel containing eight lenses at the top of the instrument.

John Marshall of England, one of the great opticians of the latter part of the 17th century, introduced a bull's-eye condenser in an adjustable ring mount below the object holder. Focusing is achieved by a coarse adjustment attached to the upright support arm. The instrument may be tilted on a ball and socket joint after the design of Hooke.

Edmund Culpeper (1660-1740), a maker of mathematical instruments in London, constructed his first microscope C. 1720. He designed the three-pillar microscope which was produced in three forms: flat wooden stage, flat brass stage, and recessed brass stage. Fixation of the mirror in the optical axis was one of his innovations. The arrangement of the three pillars is peculiar to Culpeper, the upper tier being supported by the stage and not in line with the lower tier. He also made a screw-barrel instrument about 1720, which had been invented many years earlier and was greatly improved by James Wilson in 1702, whose modifications of the optical system popularized the screw-barrel and resulted in the association of his name with the instrument.

Modifications of Culpeper's instrument have been attributed to Edward Scarlett (1677-1743), London, such as a box base with a drawer for accessories and the use of long supporting columns instead of the alternating tiers of Culpeper.

Most of the Culpeper models were made with cardboard drawtubes, but some (1790) were supplied with brass bodies which made possible the use of a rack and pinion for focusing. Continued popularity of the Culpeper model following the development and improvements of the Cuff instrument is somewhat surprising from the scientific point of view. It is likely that most of the later Culpepers were for use by the leisured classes for the amusement of their guests. Science was fashionable and this was an attractive scientific instrument which anyone could easily operate.

John Cuff (1708-1772) of London introduced a newly designed stage in the form of a cross to allow free access in contrast to the obstruction offered by the three pillars of Culpeper. Coarse adjustment was by a sliding bracket on the vertical pillar; fine adjustment was by a screw working in the rectangular block on top of the pillar. He also fitted a Lieberkuhn to a sleeve which slipped over the objective cone. The Cuff model was copied by most makers for almost 100 years.

Nairne and Blunt of London, C. 1760, made a Cuff-type chest microscope, an important development in the hinged inclining pillar. Henry Pyefinch, also of London, made a Cuff-type after 1750 with a screw focusing fine adjustment, a system described by Johannis Hevelius in 1673 and reintroduced by Cuff in 1744.

Benjamin Martin (1704-1782) of London produced cabinets of optical instruments which usually included a telescope, screw-barrel microscope, and a solar microscope. He later introduced improvements in lens systems and focusing mechanisms.

Benjamin Martin of London was a scientific lecturer before becoming an instrument maker in 1738. He produced several types of instruments and contributed improvements in both the optical and mechanical systems. He adopted the "between-lens" at the top of the nosepiece (originally introduced in the Culpeper-Yarwell microscope) which served as a back lens for the objectives. He replaced the Hevelius clamp and screw focusing with a rack and pinion.

The drum microscope was popularized by Martin who often included one in his cabinets of optical instruments. Nicolai Bion of Nuremberg had first described the drum base in 1717. The

round base with its cut-out side later evolved into the horseshoe base of modern times.

A box microscope utilizing a Cuff model was probably made by George Brander of Augsburg about 1769. It could be used for opaque objects with direct lighting or for transparent objects with light reflected from a mirror within the box, in which case the condenser would be positioned beneath the stage.

L. F. Dellebarre, Leyden, Holland, made a variety of microscopes. His "Universal" (1777) was very popular in France (Fig. 29, Billings Collection). The ocular contained four biconvex lenses which could be used in pairs or altogether. Magnifications from 230 to 1,170 diameters were attainable. Focusing was by rack and pinion.

George Adams of London introduced his "Variable" microscope in 1771. Inclination was controlled by a large toothed wheel which was turned by a pinion. The objectives were constructed so that one could be screwed onto another to provide a compound objective lens. It could be used as a simple microscope by replacing the compound body tube with any of the simple lenses and Leiberkuhns (An illuminating mirror introduced in 1738 by Johann Nathaniel Lieberkuhn and named after him, which permits observation of objects under reflected light) which he supplied.

Henry Shuttleworth of London constructed a microscope in 1787 after the design of Martin, with a hinged mounting of the substage condenser which permitted it to be moved out of the optical axis. This type of mounting had been introduced by John Bleuler of London about 1780. In 1810 he made an instrument similar to the Adams' and Jones' models but did not include the "aquatic" movement feature. By removal of the body tube, it could be used as a simple microscope.

Earlier, John Bleuler made an instrument with the eyepiece equipped with a third biconvex lens, a feature which appeared several years later in Adams' "Universal."

In 1790 Dollond of London made a Cuff-type, introducing some features previously used by Martin and Adams, with a circular plate over the stage which was perforated with varying size holes to control the amount of light.

Dollond also made a solar microscope about 1790 with a movable mirror, a Cuff innovation of 1744, to permit the body to remain stationary. The solar microscope, a development from the camera obscura, utilized sunlight to project a magnified image onto a screen. This was used both for study and entertainment. Most microscope makers produced them from the early 18th century to the mid-19th century.

The business of George Adams of London was carried on by W. and S. Jones after 1795; they produced the "Jones Most Improved Microscope" in 1798. It is considered the final development of Cuff's original instrument. It brought into one microscope all the desirable features and improvements made prior to this time. Of particular importance was the positioning of the joint near the center of gravity.

The compass microscope derived its name from the draftsman's tool that it resembles. The compass joint usually carried a rod to which could be attached forceps, live-box, or other means of holding the object to be viewed. T. Harris and Son of London made such an instrument in 1820 and later most other makers produced them.

Jeremiah Sisson of London constructed a pocket (portable) microscope in 1776 after the design of Dr. Demainbray, tutor to the Prince of Wales (later George III), with the objective lenses on a sliding bar and the prepared objects on a revolving disc.

At the beginning of the 19th century, chromatic and spherical aberration were unsolved

problems which prevented clear, undistorted microscopic images. The lenses being used were little better than those found today in inexpensive toy microscopes. Unsuccessful attempts at correction with various lens combinations and diaphragms had been made by opticians and instrument makers for almost a century. "Achromatic" microscopes were produced but it was nearly 1850 before achromatic lens systems were generally accepted.

In 1825 Vincent Chevalier of Paris made the "Microscope Achromatique Perfectionne" (Fig. 55, Billings Collection). He and his son were leading opticians who contributed greatly to the development of achromatic lenses. A revolving disc of diaphragms beneath the stage was a Chevalier innovation, later adopted by most makers. Charles Chevalier of Paris brought out his "Microscope Universal Achromatique" in 1834, furnished with reflecting objectives, condensers and polarizers. The first instrument maker of the Chevalier family was Louis-Vincent Chevalier (1734-1804) who established a shop in 1765 in Paris. His third son, Vincent Chevalier (1770-1841) became one of the foremost makers of microscopes in the 19th century. Vincent Chevalier's son, Charles Chevalier (1804-1859) carried on the tradition of the family.

Jean-Gabriel-Augustin Chevallier of France (1778-1848) may have been related to Vincent and Charles Chevalier but was from another branch of the family. Trained in making optical instruments by his maternal grandfather, Francois Trochon, he inherited the business in 1796 in Paris and became well known for his optical inventions. He signed his instruments "l 'ingenieur Chevallier" and for many years his firm continued producing optical instruments under his name.

In 1825 S. J. Rienks of Friesland, Germany, made a reflecting microscope with concave and convex mirrors in place of objective lenses. The knowledge that a curved mirror, and that a mirror did not have chromatic aberration, led to popularity of the reflecting microscope for a number of years.

After 1820 Dollond made a simple microscope using a "Wollaston doublet," two plano-convex lenses in close approximation. This was an early attempt at achromatism. His instrument had a movable stage, the position of which was controlled by a screw on each side.

Giovanni Amici (1784-1863) of Modena, Italy, produced both reflecting and achromatic instruments. His achromatic horizontal microscope of 1827 employed an extremely fine micrometer to control movements of the stage.

Amici also made an achromatic instrument about 1833 with a prism which permitted horizontal positioning of the ocular while the stage and objective remained upright. It could also be used as a simple microscope.

John Cuthbert, an English telescope maker, produced a microscope in 1827 which could be used as a reflecting microscope, or, by attaching the achromatic objective lens disc, as a dioptric instrument. A slender tube above the stage contained an elliptic mirror which reflected an enlarged image to the ocular. A series of interchangeable tubes provided a range of magnification.

Dollond made a microscope after 1835, much along the lines popularized by Andrew Pritchard of London, although basically the old Jones design. The pillar telescoped to adjust the height of the instrument and a fine micrometer controlled the mechanical stage.

Froment of Paris constructed a horizontal microscope about 1839, probably in competition with the Chevaliers. Its workmanship was superior but probably its high cost prevented its success.

A drum microscope made by Georges Oberhauser of Paris before 1840 could be used in a vertical or horizontal position. By attaching the extra tube as a handle it could also be used as a

demonstration microscope; focusing was by drawtube.

Simon Plossl (1794-1868), an optician and the first maker of microscopes in Vienna, made an instrument before 1840. He used an antiquated type of fine adjustment until the late 1860's. A lever projecting beneath the stage controlled positioning of the condenser. One of his instruments, believed to have been used by Virchow, the father of modern pathology, is in the Billings Collection (Fig. 122).

In 1840 Andrew Pritchard of London made an instrument without a fine adjustment which could not be inclined. One side of the mirror was white plaster for white cloud illumination by sunlight.

Andrew Ross of London made a microscope about 1840 with fine adjustment by a short lever arm controlled by a milled wheel on top of the compass joint. The loosely mounted nosepiece was held in an extended position by an internally located spiral spring, to permit it to telescope into the body tube thereby preventing damage to the object being examined, should the body tube be accidentally moved too far downward.

A dissecting microscope by Georges Oberhauser of Paris after 1840, called "microscope a tambour a dissection," was copied by many makers with modifications mostly in the substage mechanism. It was equipped with a separate simple dissecting microscope.

A microscope of about 1841 by an unknown maker was a modification of an Oberhauser form originally introduced in the 1830's. Earlier models had a rotating stage and a fine adjustment, neither of which appeared on this instrument. Coarse adjustment was by rack and pinion. A second rack and pinion, attached to an inner drawtube that houses the ocular, provided variable magnification (a pancratic ocular).

In 1841 Andrew Ross of London came out with a radical change in construction. The Ross stand, two well-supported, connected pillars, suspended the instrument near its center of gravity. It had a 90° range of inclination.

In 1848 Oberhauser introduced the horseshow base, evolved from the drum, which is in general use today.

Before 1848, Powell and Lealand of London constructed a microscope after a design by Cornelius Varley with the fine adjustment mounted on the lower end of the body tube which functioned through a spring-mounted nosepiece. There was a lever action mechanical stage. It was designated the "iron" microscope and was intended as an economical student model.

Invention of the inverted microscope is credited to Professor Lawrence Smith of the University of Louisiana, New Orleans. A "chemical" microscope was made in 1850 by C.S. Nachet and Son of Paris. The elder Nachet had worked with the Chevaliers before establishing his own business in 1839.

James Smith, the founding father of the present day firm of Beck and Beck, London, began constructing microscopes in his own shop in 1829. Richard Beck was apprenticed to Smith about 1843 and in 1847 formed the partnership of Smith and Beck. Joseph, brother of Richard, joined the firm in 1857 and the name was changed to Smith, Beck and Beck. In 1869, Smith retired and the firm then became R. and J. Beck. Conrad Beck, son of Joseph, and William, son of Richard, joined the firm which then became known as Beck and Beck.

Smith and Beck made a student model about 1850. A milled wheel behind the vertical post activated a short lever arm that controlled the fine adjustment. A revolving Brooke's double nosepiece facilitated the changing of objectives.

In 1867-68, R.&J. Beck made a binocular with the racks and pinions at the upper ends of the

body tubes to control adjustment for interpupillary distance. Fine adjustment was by a short lever arm that acted on the nosepiece. Substage equipment included an iris diaphragm and a holder for a condenser.

Beck also made an "economic" model which was popular from 1875 to 1892. An 1878 model had the glass stage held in place by friction from a milled-head spring mounted at the base of the limb, which was easily moved in any direction on the polished stage surface.

The drum microscope enjoyed a popularity for more than 100 years. Over 70 years after Martin introduced it, Fraunhofer adopted and stabilized the pattern; Oberhauser, Lerebours and Hartnack perpetuated it. An 1850 model was quite similar in appearance to those of Martin's day. Refinements included a fine adjustment and a substage disc of diaphragms. Moreau of Paris introduced a functional compound "monkey" microscope in 1850.

About 1860 Nachet of Paris made a horizontal microscope, a type of demonstration or class instrument, with rack and pinion coarse adjustment. The eyepiece consisted of a single eye lens and the field lens. He also made an Oberhauser-type vertical demonstration instrument, one of which was used at the School of Medicine in Paris. In 1879 he made a binocular instrument in which each body tube prism box unit moved toward or away from the other to adjust to the user's interpupillary distance, a forerunner of the mechanism in modern instruments.

Charles Baker of London made a portable microscope about 1860 which was used in the Army Medical Museum's laboratories in Washington from the late 1860's to 1884 when it was placed on exhibit. It had a sliding coarse adjustment and a milled-head screw fine adjustment.

The main feature of a "Harley" model made after 1865 by Charles Collins of London was the sliding prism box which was designed by Dr. G. Harley of London. It contained both a Nicol and a Wenham prism and permitted the instrument to be used as either a binocular, a monocular or a polarizing microscope.

Dr. Carl Zeiss (1816-1888) founded a business in Jena, Germany, and began making microscopes in 1847. Today the Zeiss firm produces some of the world's finest instruments.

Pere Cherubin D'Orleans of France introduced in 1677 the first binocular microscope with two eyepieces and two objectives; there was no coarse adjustment, and focusing was achieved by moving the stage nearer to or further from the objective, the forerunner of the stage focusing used extensively during the 18th century and still used on metalurgical microscopes. J. L. Riddell of the University of Louisiana, New Orleans, was the first to discover (1851) and publish (1854) the optical principle (Two prisms placed behind the objective so that the light from the objective was split and deflected up the two parallel eyepiece tubes) on which depends all the really satisfactory binocular microscopes made prior to 1879. He was also the inventor of two efficient methods of applying that principle - - one suitable for the simple or dissecting microscope - - the other for the compound. J. and W. Grunow, New Haven, Connecticut, constructed a binocular instrument for Riddell in 1853.

No history of the microscope would be complete without specific mention of the accomplishments of the American microscope builders. One of the first American microscopes, made in 1850 by C. A. and H. R. Spencer of Canastota, New York and modeled after the Pritchard-type of instrument, is in the Billings Collection (Fig. 92).

Charles A. Spencer (1813-81) of Canastota, New York, published a trade circular in 1838 advertising reflecting lens microscopes and telescopes and a second list in 1840 adding compound, achromatic microscopes. By 1850 he was using fluorite and his own improved optical glass to make objectives of greater resolving power. Some of Spencer's objectives received a Gold Medal at the 1878 Paris Exhibition. Spencer's business was destroyed by fire in 1873. In 1875 he and his son Herbert joined the Geneva Optical Works and reestablished their

own business in 1877. After Charles' death, the business was continued by Herbert.

Herbert R. Spencer (1849-1900) established his own firm in 1880 at Geneva, New York. In 1889 he formed the H. R. Spencer Optical Company in Cleveland, Ohio. He and Fred R. Smith formed the Spencer and Smith Optical Company in Buffalo, New York in 1891. In 1895 a group of businessmen in Buffalo bought the Spencer and Smith Optical Company to establish the Spencer Lens Company. Herbert continued as superintendent until his death. In 1935 the American Optical Company purchased the Spencer Lens Company, and in 1945 changed the name to American Optical Company, Instrument Division. Spencer lenses earned a reputation at home and abroad; some experts considered them superior to any European product.

Robert B. Tolles (1821-83) became an apprentice to Spencer in 1843. He and Spencer corrected spherical aberration from the cover glass by using a ring to move the center lens elements of the immersion objective. He established his own business in Canastota, New York in 1858. The Boston Optical Works was established in 1867 with Tolles as superintendent. He made objectives with two fronts; one for use in air and the other for immersion. Tolles published the optical designs to prove that his lenses were of the high aperture (N.A. 1.25) stated.

Franz Miller, a workman for Tolles, established his business in 1867 in New York City, changed his name to Frank and was joined by his brother William about 1870. They made microscopes and objectives until 1899. Frank, Jr. was included in 1892.

The Bausch and Lomb Optical Company started in 1853, and a microscope department was added in 1876. Edward Bausch took over the department in 1877. His interest and understanding of production methods soon made available larger numbers of microscopes, more practical in size and construction than the massive models being produced in the United States. They adopted the continental type horseshoe base and made a concentric stand. Microtomes were added in 1885 and in 1887 petrographic microscopes.

George Wale, a cousin of William Wales, established a business in 1860. His concentric stand, patented in 1879, was copied by both Swift and Ross in England about 1881. He was probably the first to mark his objectives with magnification rather than only focal length and to have made low power water immersion objectives for use without a cover glass. Bausch and Lomb Optical Company acquired his business in 1880.

Ernest Gundlach (1834-) made 12 models of microscopes in Berlin in 1866. He designed a glycerine immersion objective which received a special medal at the Paris Exposition. He moved to Hackensack, New Jersey in 1872. In 1876 he became superintendent of Bausch and Lomb Optical Company's microscope department. In 1879 he established the Gundlach Manhattan Optical Company, Rochester, New York, which became the Gundlach Optical Company in 1884.

During 1852 James W. Queen joined with W. Y. McAllister who started in Philadelphia in 1783 one of the earliest optical firms in the United States. Queen and McAllister, 1853-1854, was taken over by J. McAllister. Queen started his own business in 1854 which became J. W. Queen and Company in 1860. About 1880 Queen retired and Samuel L. and Edward B. Fox continued the business. They acquired the Acme Optical Works in 1881. Eyepieces and objectives were made under the direction of Orford (Gowland). In 1898 the firm became the Queen-Gray Company, makers of electrical instruments.

Joseph Zentmayer (1826-88) came to the United States and established a shop in Philadelphia in 1848, and began making microscopes in 1853. His "Grand American Microscope" was made in 1859, followed by the "U.S. Army Hospital Microscope," the "Histological Microscope" and, in 1876, the "Centennial Microscope." Zentmayer's larger stands provided flexible lighting for testing objectives with graduated rotating bases, graduated counterable rotating stages and a substage that rotated about the plane of the specimen for measurement and

recording. He made a 1/10th-inch objective of N.A. 1.63.

Julius and William Grunow came to New Haven, Connecticut from Berlin in 1849 and began making microscopes in 1851. The Riddell binocular microscope was made in 1853. The J. L. Smith inverted microscope, with an erect image for dissecting, was made in 1867 for Major General George H. Thomas. A 128-page treatise and catalogue was published in 1857. Grunow moved to New York City about 1861.

John W. Sidle of Lancaster, Pennsylvania and Professor J. E. Smith designed a less expensive microscope in 1878 to meet the criticism that students could not afford the microscopes available. Five designs of Acme microscopes, except for the first, were made. Sidle and Poalk became John W. Sidle and Company, 1881, and in 1884, the Acme Optical Works. The Acme microscopes were sold exclusively by Queen & Co., who purchased the Sidle company in 1881.

In 1851 Benjamin Pike was selling imported Beck, Powell and Lealand, and Ross microscopes in New York City. In 1859 Benjamin Pike, Jr. was importing microscopes for sale, mostly of French make, and in 1881 the firm became Benjamin Pike's Son and Company. A two-volume catalogue of philosophical and scientific instruments was published in 1856.

L. Schrauer, 50 Chatham Street, New York City, manufactured microscope stands during the 1880's and 1890's, which were equipped with W. Wales' 3/4- and 1/4-inch objectives. Queen listed Schrauer's microscopes in his catalogues.

Walter H. Bulloch (-1891) came to the United States from England in 1851 and was foreman for B. Pike and Son to about 1864. He became a partner of William Wales; Bulloch making the stands and Wales the optics. He began making microscope stands in Chicago in 1867. After the Chicago fire in 1871 he worked with Tolles in Boston for a short period, then returned to Chicago and made stands until 1890; about 1884 he made microtomes.

By the end of the 19th century, the basic design of the microscope was firmly established. The increased demand for reliable high quality instruments generated by the rapidly developing scientific specialties could not be met by the individual craftsman, who until then was the principal source.

The 20th century, therefore, became a period of refinement of the product and improvement of manufacturing methods. Particularly noteworthy were the development of mass production and the establishment of standards which permitted the interchange of components and the introduction of a variety of accessories.

Neither time nor space permit mention of the hundreds of beautifully hand-crafted microscopes in the Billings Microscope Collection of the Medical Museum, AFIP; however, the collection does contain instruments that run the gamut from such artisans as Matthew Loft, George Sterrop, Francis Watkins, and Jan Paauw of the 18th century, Hartog van Laun, Harmanus van Deyl, Hendrik Hen, William Ladd, and James White of the 19th century, to the electron microscopes of the 20th century.

ELECTRON MICROSCOPES

Gunter F. Bahr, M.D.

The following article was prepared by Gunter F. Bahr, M.D., Chairman of the Institute's Department of Cellular Pathology. This short treatise has been included in this Second Edition because of the particular significance of these microscopes in the worldwide study of the nature, control and treatment of disease; they are an indispensable tool of the pathologist.

The Billings Collection of microscopes has been extended to include electron microscopes and accessories, foremost of which are the special microtomes required for preparing thin tissue sections. Electron microscopes are designed for two principal modes of operation, transmission or production of secondary radiation from the specimen in the so-called scanning mode.

Transmission Electron Microscopes

In the first mode a narrow ray of electrons is produced in an electron gun quite analogous to the production of electrons in a TV set, except that accelerating voltages are many times higher in an electron microscope. This electron gun is mounted on top of the microscope. Just below it is the first electron lens, the condenser that bundles the electrons into a thin ray less than $1/2\,\mu$ in diameter impinging upon the specimen.

Just below the condenser is the specimen chamber, which is of high-precision design. The specimen stage and its holder must remain absolutely still even at final magnifications of 300,000 times and must have the facility to be moved extremely small distances. Many specimen stages allow the specimen to be tilted in order that stereopairs may be taken. Since the entire interior of an electron microscope is evacuated for the unimpeded flight of electrons, it is necessary to bring a specimen into and out of high vacuum by means of an air lock. All modern microscopes have air locks; some of the older models in the Billings Collection require opening of the column for insertion or removal of the specimen and then repumping of the instrument.

The next lower part is the objective lens, an electromagnetic lens in which the first image is magnified. An image forms because the object scatters electrons out of their straight path with the result that the final image is formed by the remaining electrons only. This first image is further magnified by an intermediate lens and finally by a projector lens onto a fluorescent screen in the viewing chamber. A fluorescent screen converts electrons to photons and thereby makes the image visible for inspection, selection of fields, and focusing. Situated under the screen is a camera containing either photographic plates or film for recording of the electron-microscopic images. Also, fresh film can be put into the microscope via an air lock, and exposed film can be removed in the same way. Older models in the Collection require the entire microscope column to be brought to ambient air pressure for change of plates or film.

In the cabinet under the microscope column, directly attached to the column itself, is the more powerful of two pumps. This is the so-called diffusion pump, which is backed up by a small mechanical pump, the forepump, usually located in the cabinet or immediately behind it.

It is possible to change the power of magnetic lenses by changing the electric current through the

coil of each. There are buttons in easy reach of the operator that regulate these currents and thereby control functioning of the lens. Brightness may be controlled in the condenser. The objective lens serves to focus the specimen, and the other lenses help in selecting the desired magnification. Knobs on the outside of the microscope column help in the adjustment of interior microscope components such as apertures and, in some designs, pole pieces. Long rods or cables in back of the column extend the finely levered drives for the micrometers of the stage to easily accessible knobs at table level.

Easily read meters indicate the effective level of vacuum, beam current, and other vital functions of the instrument. Early models of transmission microscopes invariably had a built-in clock with a second sweep, because no automatic exposure systems were available and the operator had to count the seconds visually. High tension of from 40 to 100 Kv is used to accelerate electrons in the electron gun. The high-voltage generator, usually in oil, is located behind, above, or entirely separate from the instrument. A thick cable conducts the tension from the high-voltage tank to the microscope.

Electron microscopes require very small specimens, such as viruses or thin cuts of tissue. Tissue is fixed in contrast-enhancing fixative and embedded in plastic, which in turn is cut on glass or diamond knives to thicknesses of 0.01 to 0.1 μ. Such thin sections cannot be cut on conventional microtomes, of course, but are prepared on so-called ultramicrotomes, several of which are part of the Museum's collection.

Scanning Electron Microscopes

In the second type of microscope a very thin electron beam is directed towards the specimen. Secondary electrons resulting from the impact of the primary beam are collected by a sensitive collection system (scintillation counter). If the beam is moved across the specimen in a scanning fashion quite like the way in which a similar beam moves across a television screen, then the quantity of secondary electrons will vary with the properties of the specimen at each irradiated point. The quantity of secondary electrons is very much dependent on the angle at which the specimen is hit by the beam; therefore a complex three-dimensional object will have numerous planes that are not perpendicular to the beam and will thus produce intensities varying with the angle to the beam. Holes might be "black" because no secondary electrons escape the hole; surface areas in a suitable angle to the detector could be "white" because a maximum of electrons is collected by the sensor from there.

As the beam scans across the specimen, a beam in a television set (cathode ray tube) is scanning at the same speed and at a comparable location in the image frame. This beam in the television set now reproduces the same, varying intensity as the quantity of secondary electrons produced by the primary beam. In such manner a three-dimensional picture of the surface of the specimen appears. It can be photographed from the cathode ray tube.

A scanning electron microscope is a rather complex instrument, and in the beginning of scanning electron microscopy many functions could be individually controlled from a relatively large panel. Two cathode ray tubes are still being used, one for observation, and the other for photographing. The specimen is mounted on a special stage (goniometer) and can be tilted so that inspection from all angles is possible. It is usually coated on all sides with a very thin layer of gold in order to conduct electrons away and prevent charging of the specimen. It is not unusual to observe entire insects in the vacuum of the instrument, which emphasizes the fact that the scanning electron microscope possesses an unusually great depth of observation.

PART I

COMPOUND MONOCULAR

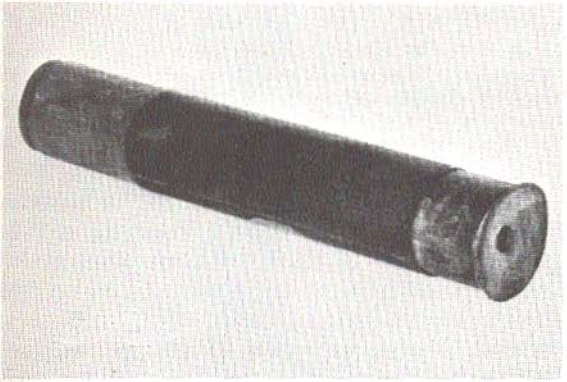

Fig. 1. Maker unknown; reproduction of a compound monocular microscope made about 1590 in Middelburg, Holland; reproduced in 1891. (AFIP 49000A - 60-4713-14)

One of the four perfect copies (Fig. 1) made under the supervision of John Mayall, Jr. of London, microscope maker, microscopist, and renowned microscope antiquarian, in 1891 from the original in Middelburg, Holland. For many years the original instrument was believed to have been made by the Janssens, but recent evidence tends to refute this.

Made of tin, 10-7/8 inches long when closed, it is 2 inches in diameter and consists of three cylinders. The main, or outer, cylinder is 6-15/16 inches long, the middle 6-1/8 inches, and the inner cylinder 4-1/2 inches, and each contains a lens. The inner cylinder also has a flange 2-1/4 inches in diameter at the bottom. Focusing is achieved by sliding one or both of the two inner cylinders. (Donated by Mr. John Mayall, Jr.) ■

AFIP 49000B. John Mayall, Jr., London, England; reproduction of a compound monocular microscope made about 1590 in Middelburg, Holland; reproduced in 1884. *Not illustrated.*

This is an imperfect copy of the original instrument in the Crisp Collection that was on exhibit in 1884 in the Science Museum, South Kensington, England. It is similar to that in Fig. 1 (AFIP 49000A), except that the sheets forming the tubes have been butt jointed and the edges do not overlap. ■

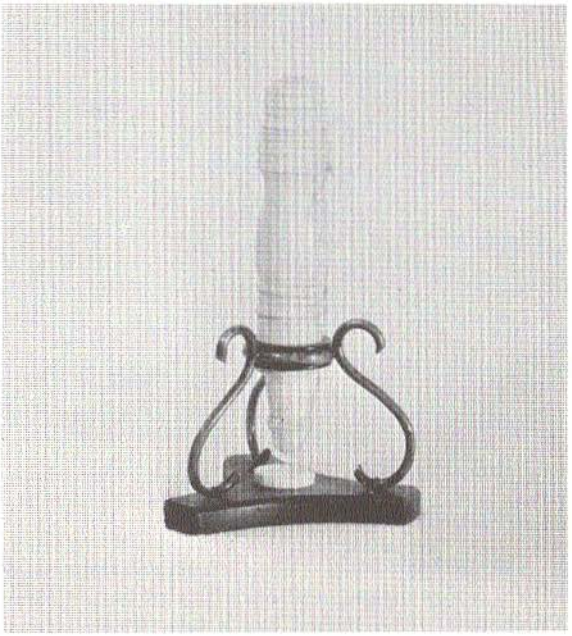

Fig. 2. Giuseppe Campani, Rome, Italy; compound monocular; C. 1662*. (AFIP 49002 - 60-4713-439)

The turned ivory body (Fig. 2) screws into a socket of horn within a silver ring, and three silver scroll legs connect the ring to a triangular ebony base with concave sides. A screw drawtube carries the eye lens, and a movable ivory stage in the center of the base serves as a screw cap for the lens. The optical construction is identical to that of the instrument in Fig. 3 (AFIP 49001) by the same maker.

The instrument is 7-3/4 inches high when closed, and 12 inches when open; there is no field lens. This microscope is rare, and so far as known, no duplicate has heretofore been described. ■

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*In instances where the exact date of manufacture of a microscope in the Collection is not known, the abbreviation "C." is used in the caption immediately preceding the date; the "C" is used in place of "circa", indicating "about that date." In instances where use of circa is not appropriate, the words "before" or "after" a given date are used.

Fig. 3. Giuseppe Campani, Rome, Italy; compound monocular; before 1665. (AFIP 49001 - 60-4713-412)

The entire body (Fig. 3) is of dark wood with a brass stand, and consists of two barrels. The lower, outer barrel has a fine screw adjustment on the outside for raising and lowering, and the inner barrel is 2 inches long and has a coarse thread adjustment at the lower 1-1/4 inches that provides for adjusting between the objective and the eye lens. There is also a wooden dust cap.

The objective is held in a wooden cell that screws on the nose and has a pinhole opening. The maker's name is incused around the upper ring that is attached to the disc forming the base by three narrow, flat brass pillars.

The slide holder consists of two rollers on opposite sides fixed to the upper side of the base. Below the base is a second disc the same size as the base that has two thin, almost vertical steel springs that press on the roller. The springs are bent slightly inward, and by pressure on the rollers tend to draw the lower disc up against the base. The use of the second disc suggests the spiral spring arrangement later devised by Filippo Bonanni, the 17th century Italian microscope maker. The central hole in the base and the lower plate indicates that the instrument was intended for examining transparent objects by holding them to the light.

There is an objective and an eye lens that are held by a screw ring. The absence of a field lens dates the instrument before Hooke (1665) at which time the field lens was claimed as a new improvement. Height is 4-1/2 inches and the base is 1-1/8 inches in diameter. John Mayall indicated that this was the first system of screw focusing applied to a microscope of which he was aware. ■

Fig. 4 (color plate). Christopher Cock, London, England; compound monocular; after 1665. (AFIP 49004 - 66-1836-1)

The base of this instrument (Fig. 4) is of dark wood 8-1/2 inches in diameter and 1-1/2 inches thick, with a round brass pillar 15 inches high fitted into its edge. The ring nut into which the nose of the microscope screws has a short rod attached that fits into a block sliding on the vertical pillar, and is clamped by a jam screw; a wing screw holds the rod in place.

The body tube is of cardboard covered with chocolate-colored leather ornamented with gold stampings. There are two drawtubes (a duplicate instrument in England has four) and the mountings are of wood. The cylindrical portion is 4-1/8 inches in diameter and 7 inches long, and the wooden eyepiece is 6 inches long; the field lens is mounted in the lower end.

The screw-on nosepiece is brass and is 1-3/4 inches in diameter and 2-1/2 inches long. The object carrier is a slotted brass fitting 6 inches long and is clamped to the bottom of the pillar by a wing nut working on a screw. This fitting has a circular plate at the opposite end that may be rotated, and which carries a short, upright stem with a transverse pointed rod. Height is 21-3/4 inches.

The instrument is not signed, but the gold stampings are identical to the description and illustration of the Robert Hooke microscope that was formerly in the George III Museum and later in the Crisp Collection, and last known to be in the Court Collection in the Science Museum at South Kensington, England. The stampings identify Christopher Cock as the maker, but the instrument was designed and used by Hooke. ■

AFIP 49003. Maker unknown; reproduction of a compound monocular microscope made in 1665; reproduced in 1888. *Not illustrated.*

This is a reproduction, made under the supervision of John Mayall in London, from Plate I of Robert Hooke's Micrographia. The illuminating apparatus was not duplicated. ■

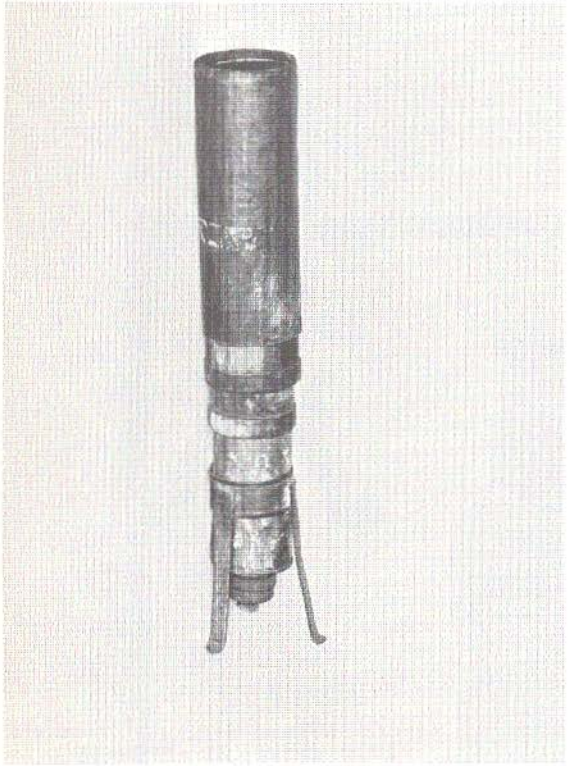

Fig. 5. John Mayall, Jr., London, England; reproduction of a compound monocular microscope made in 1667-68 by Eustachio Divini, Bologna, Italy; reproduced in 1888. (AFIP 49005 - 63-6536-8)

This reproduction (Fig. 5) was made by Mayall from the original in the Museo Copernicana, Rome. The body is of cardboard covered with gray paper turned brown, and has a tin cylindrical socket and a tripod base. The magnifications of each of the various lengths are marked on the four tubes. The lower tube slides within the tin socket of the tripod and carries the object lens in a thin cell of tin; the next tube slides over the former, and has an external collar at the lower end, apparently to serve as a stop for the next tube above; the third and fourth tubes are similar but progressively larger; there is a diaphragm at the upper end. It is 16-1/2 inches high extended, and 1-1/2 inches in diameter at the upper tube.

The original instrument from which this reproduction was made has a magnification of 41 to 143 diameters; the eyepiece consisted of two plano-convex lenses with the convex surfaces in contact. It was Mayall's impression that the optical construction of the instrument had been tampered with, and was not the work of the original maker, Divini. ■

Fig. 6. Eustachio Divini, Bologna, Italy; compound monocular; C. 1670. (AFIP 49006 - 63-6537-1)

The stand for the instrument (Fig. 6) consists of a ring fitted with three brass, flat, bent legs; the body tube is bell-shaped and of dark wood; and the nose is brass and screws for focusing. There is no adjustment for the distance between the lenses.

It is 6 inches high, and 1-3/4 inches in diameter at the field lens. The objective is a biconvex lens 7/16 inch in diameter, and the field lens is plano-convex and 1-3/8 inches in diameter, plane side to the objective. The eye lens consists of two biconvex lenses, the lower 1-1/16 inches and the upper 3/4 inch in diameter. John Mayall said in 1886 that this instrument was constructed after 1665 as it has a field lens, and that the upper ocular lens probably was experimental. ■

This Homberg model* instrument (Fig. 7) has a circular wooden base with a brass ring socket supported by three turned brass legs. The body is of cardboard covered with paper with a wooden mount. The lower portion, or nose, is focused

*Willem Homberg (1652-1715), Dutch naturalist, chemist and physician.

Fig. 7. Maker unknown; compound monocular; before 1686. AFIP 49008 - 60-4713-62)

by screwing into the socket, and is turned to about 1 inch in diameter; the outer or drawtube is 2-5/8 inches in diameter. When closed it is 12 inches high. The optical construction is identical to that of the microscope in Fig. 6 (AFIP 49006). ■

Fig. 8 (color plate). Maker unknown; compound monocular; before 1686. (AFIP 49007 - 66-1836-4)

The circular base of this microscope (Fig. 8), a modification of the Homberg model, is 5 inches in diameter, and supports three 3-1/2-inch-high turned legs that support a turned cone ring socket 1-1/4 inches thick and 2-1/2 inches in diameter; all of wood, probably pear.

The body is of cardboard covered with green vellum with gold stampings. At the top of the tube is fixed the 7/8-inch-diameter field lens. The drawtube, 1-1/2 inches in diameter, that carries the eye lens slides over the body tube; this varies the distance between the lenses (Homberg's system). Focusing is achieved by sliding the tube. The movable stage is made of horn.

It is 24 inches high extended, and 16 inches closed. The objective is inclosed in a wooden cell that screws to the nosepiece. John Mayall located the instrument in France in 1887, and it was reported to have been in the possession of one family since early in the 1700's. ■

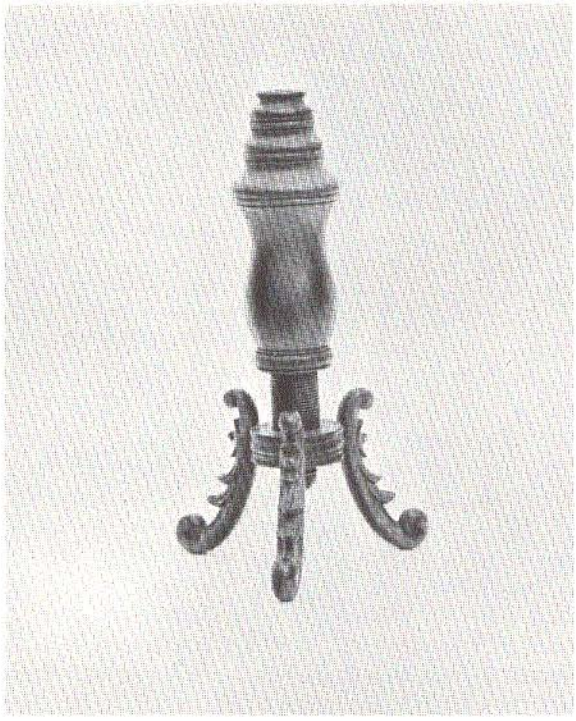

Fig. 9. Maker unknown; compound monocular; after 1686. (AFIP 49009 - 60-4713-441)

This instrument (Fig. 9) is made entirely of wood, probably pear, and is 12 inches high. The stand consists of a heavy ring socket supported by three curved and carved consoles. The body tube is turned and is 2-3/4 inches in diameter at its widest, and 2 inches at the lower end. The nose is 3 inches long and 1-1/4 inches in diameter, and screws into the socket ring for focusing.

The optical construction consists of a biconvex eye lens, a planoconvex field lens, and objective with the convex surfaces facing each other. There is no adjustment for distance between the lenses. It is of Italian make. ■

The body tube (Fig. 10), mounted in a hard wooden disc, is of cardboard covered with brown leather ornamented with gold stampings, and is 3-5/8 inches in diameter and 4 inches long. The drawtube is covered with white vellum and is glued at the upper end into a wooden mount. This forms the lower end of the eyepiece, that is 4-1/4 inches long and 3-5/8 inches at the lower end tapering to 1-3/4 inches at the top.

At the upper end of the drawtube is the biconvex field lens 2 inches in diameter. The 1-inch eye lens is in a mount 2 inches from the top. Above this is a cup and dust cap.

Figure 4

Fig. 10. John Marshall, London, England; compound monocular; C. 1700. (AFIP 49011 - 60-4713-297)

The brass nosepiece, 1-3/8 inches in diameter and 1-1/2 inches long, is screwed to the lower wooden mount. The nose screws into a brass ring at the end of the arm carried by a sleeve, that slides on the main pillar.

The square pillar is 11 inches high, with lines and numbers engraved on the side. The pillar terminates at the bottom in a 1-1/2-inch-diameter brass ball that works smoothly in a brass socket. The instrument may be used upright, inclined, or may be turned to overhang the back of the box base.

The brass socket screws into the top of an 8 x 6-inch hardwood, octagonal box base that contains a drawer for objectives and accessories. The base is weighted with lead on the side opposite from that to which the pillar is attached.

A second sleeve sliding on the pillar may be clamped at any height. It is connected to the main arm that carries the body of the microscope by an iron screw controlled by a brass octagonal nut with a substantial fine adjustment.

It does not have a stage and there are no objectives. There is a brass rectangular fish-plate trough, without a bottom, attached to a similar fork for clamping to the stem. The top of the ends of the wall of the trough are serrated. A condensing lens is attached to the side of the base by a hinged arm. Height is 16 inches.

The gold stampings are identical to those on the several Marshall microscopes that are signed. Apparently Marshall signed his instruments on the bottom of the drawer, but this cannot be verified in this instance because the drawer was missing when the instrument was acquired.

A new box and leaden weight were supplied by John Mayall as the originals were beyond repair. He also supplied the condenser and its mount, copying similar accessories of a model then in the Crisp Collection in the Science Museum, South Kensington, England. ■

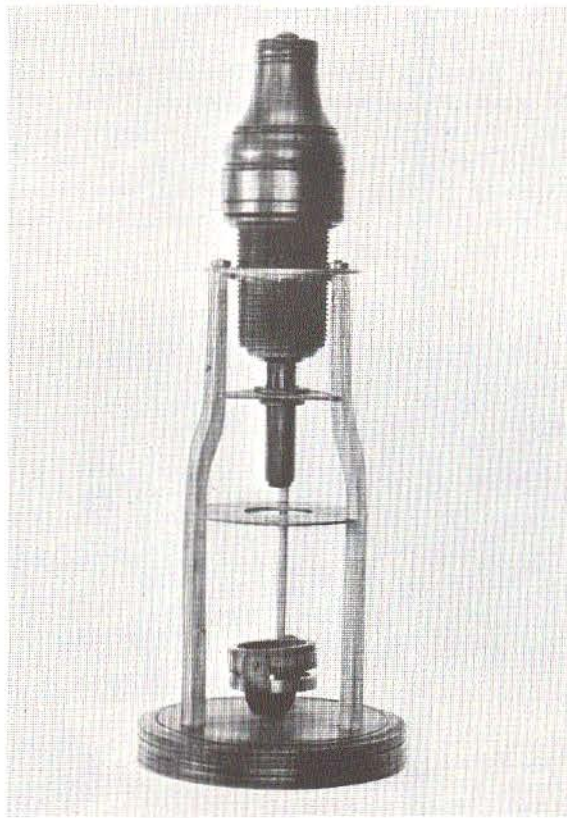

Fig. 11. Maker unknown; compound monocular; after 1716. (AFIP 49010 - 60-4713-236)

To the circular walnut base of this instrument (Fig. 11), which is 6 inches in diameter, is fixed a brass tripod, 1/8 x 3/8 x 10-1/2 inches, with the narrow external side inclining inward at the upper end, where the body tube is fixed with a coarse threaded screw into a

brass ring. Three inches below this point the body tube is set into a triangular brass plate that has an opening through which the nosepiece passes. Three inches below this it is set into a circular brass plate that forms the stage, and which has a circular opening, a hole for stage forceps, and a slot for a fish-plate.

The body tube is of dark wood, probably pear, 2-3/4 inches in diameter at its widest point, tapering to 2 inches at the lower half, and has a screw for focusing. The eyepiece is 3 inches long, and is turned to 1-1/2 inches at the upper end that has a dust cap. The wooden nosepiece is 3 inches long and 3/4-inch in diameter, and screws into the body tube. The mirror gimbal and case are of brass and fastened to the base. The objective is inclosed in a brass fitting and screws on the nosepiece. The field lens is 2 inches in diameter and the eye lens 3/4-inch. Height is 18 inches.

It is difficult to accurately date this instrument, but it is probably of Italian make. The focusing arrangement is apparently 18th century, and the tall tripod may have been copied from Culpeper or Loft of London. A mirror, which is missing from this model, was apparently a part of the original instrument, which would date it after 1716. ■

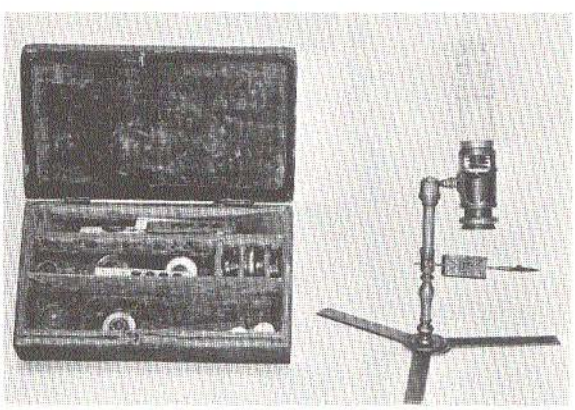

Fig. 12. Edmund Culpeper, London, England; simple and compound monocular; before 1730. (AFIP 49014 - 60-4713-17)

A Wilson screw-barrel type (Fig. 12), the base is a 4-inch sector slotted at the hinge with a similar arm inserted. The lower end of the turned pillar screws into the joint of the tripod, while the top is joined by ball and socket to a short arm that screws into the outer case of the screw-barrel; the objective screws into the top of this barrel.

There is an ivory handle that screws into the outer case when the instrument is to be held by hand; the knob of the handle is hollow and serves as a container for extra tubes and rings.

Also attached to the pillar is a long, knuckle-jointed arm that supports the condensing lens or a mirror; the joints turn in planes at right angles.

The beautifully turned, ivory compound body with drawtube screws over the back of the objective after the latter is screwed into the case; a simple lens is provided in a horn mounting with a carrier. It is signed, "Culpeper Fecit." Height is 10 inches.

Accessories include 5 objectives; condensing lens; animalcule slip; 4 cells; forceps; 6 ivory sliders; and fishskin box. ■

Fig. 13. Edmund Culpeper, London, England; compound monocular; C. 1730. (AFIP 49019 - 60-4713-446)

The upper portion of the body tube of this instrument (Fig. 13) is of dark wood, and the lower portion of cardboard covered with green vellum. The outer tube is also of cardboard covered with shagreen, with a brass rim around its upper edge.

The body tube slides into the outer tube for focusing. The concave mirror is fixed

Figure 8

to the base in optic axis. A stage condenser with several movements is mounted separately, and is secured in position by a locking nut. The nosepiece is brass and screws into the lower end of the body. The objective is a brass cell and screws to the nosepiece.

The wooden base is 5 inches in diameter. The brass stage has a recessed aperture and is supported by three slender, turned pillars of brass. Three similar pillars are located midway between the first three and support a brass plate to which is attached the base of the outer tube.

The biconvex eye lens is 7/8-inch in diameter, the field lens is plano-convex and is 1-5/8 inches in diameter and is separated about 2 inches. There is only one objective and one stage forceps with clasp. Height is 14 inches.

Although the instrument is not signed, the construction and workmanship are unmistakably Culpeper. The straight form of continuous pillars was introduced by Scarlett and varied by succeeding makers. This type of microscope became popular even after the introduction of the Cuff model, and was constructed with modifications by all makers for almost 100 years; some called it the "common three-pillar microscope." ■

AFIP 49016. Edmund Culpeper, London, England; compound monocular double reflecting; before 1738. *Not illustrated.*

This microscope (third form) closely resembles the instrument by the same maker in Fig. 13 (AFIP 49019) with the following differences: The wooden portion of the eyepiece is more delicately turned and has a dust cap. The body tube is of wood without the vellum cover. Attached are an objective, ocular, and a Bonanni spring holder. Height is 14 inches. It is to be noted that Culpeper's first form had a wooden stage, the second a plain brass stage, and the third a recessed stage. ■

This instrument (Fig. 14) has two vertical, rectangular pillars, one behind the other. The front pillar is fixed and is 10 inches high, 5/8-inch wide, and 1/4-inch thick. The body is carried by an arm attached to the shorter, sliding back pillar, that is 7 inches high and of the same width and thickness as the front pillar.

The lower 3 inches of each pillar is inclosed in a rectangular brass tube in which the

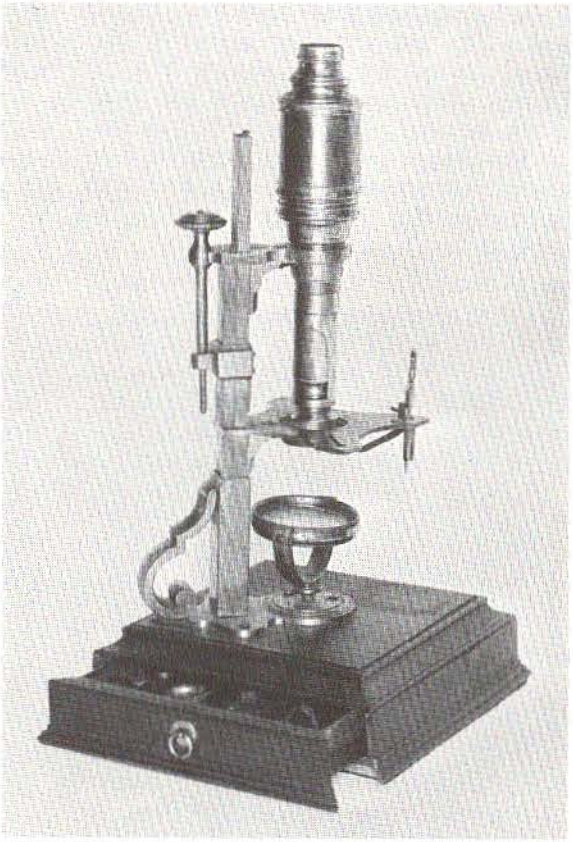

Fig. 14. John Cuff, London, England; compound monocular; 1744. (AFIP 49023 - 60-4713-20)

shorter pillar slides smoothly. At the upper end the pillars are held together by the arm that carries the body, and which fits tightly around the fixed pillar. Coarse adjustment is achieved by sliding, by hand, the movable pillar on the stationary pillar. The rectangular block that covers the pillars about 2 inches below the arm is clamped by the jam screw on the fixed pillar. Fine adjustment may be achieved by a fine screw operating in the block. The mirror is permanently mounted in the axis, as in the Culpeper model (Fig. 13).

The stage is in the form of a cross, an entirely new design. One arm of the stage is used for attachment to the fixed pillar, the opposite arm carries the condensing lens or forceps, and the right arm carries the fishplate. The instrument is mounted at one corner of a rectangular box that has a drawer for accessories. A scroll support to the sleeve in which the pillars are inclosed serves to increase the rigidity of the stationary pillar, as well as to form a handle for lifting the instrument.

The compound brass body has a conical collar which fits into the arm carried by the sliding upright pillar; the body may be lifted out of its fitting. The 3/4-inch, single eye lens is in a screw setting. Height is 14-1/2 inches.

The drawer in the base contains 5 additional objectives, a condensing lens, fish-plate, and 2 diaphragms for the mirror. It is signed, "J. + Cuff, Maker, London." ■

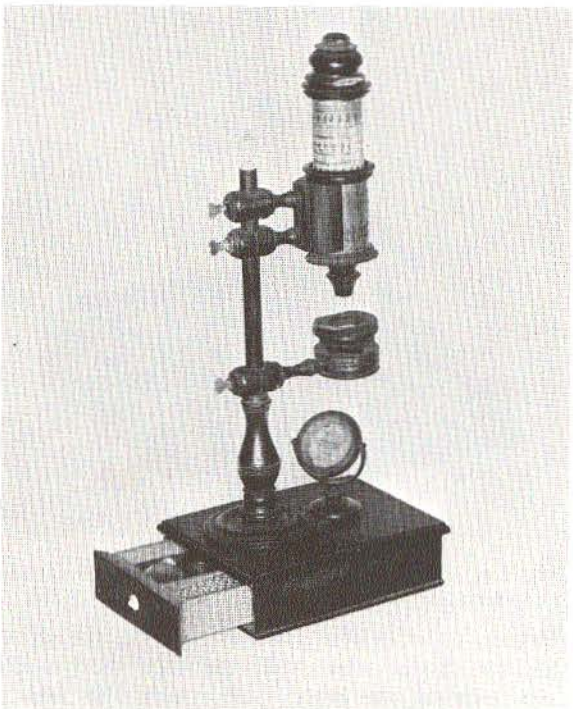

Fig. 15. "J.F.F.," Nuremberg, Germany; compound monocular; after 1744. (AFIP 49015 - 63-6541)

The frame of this instrument (Fig. 15) is well turned and substantially constructed of dark wood. The base is a 5 x 7-inch rectangular box with a drawer. The pillar is a turned rod 13 inches high with a turned ivory cap; the upper 7 inches is 5/8-inch in diameter. The lower section of the pillar fits into a circular base 3-1/2 inches in diameter, and is fastened to the box with a nut. The circular stage, 2 inches in diameter, is copied after Bonanni's spring fitting; its arm slides on the pillar and has a jam screw. There are two similar arms that screw into a block attached to the outer tube. The cardboard tube, covered with dark red paper and with two horizontal ornamental lines, is set in black wooden rings at the upper and lower edges.

The body tube is 7-3/4 inches long and 1-1/2 inches in diameter, and covered with ornamental paper and wooden fittings—eyepiece, nosepiece, and rings; it slides into the outer tube for focusing with no fine adjustment. The field lens is 1-1/4 inches in diameter and the biconvex lens 5/8-inch; the latter is fitted into the tube with a spring ring. The mirror has a wooden casing and the metal gimbal on a wooden base is screwed to the instrument's base in optical axis. The objectives are set in wooden casings with metal diaphragms. Height is 18 inches.

The signature comprises an outline of a heart with the letters, "J.F.F.," and is also found on another small Nuremberg instrument pictured in Fig. 19 (AFIP 49013). It is considered to be a very rare model. The drawer in the base contains 2 objectives and wooden and glass sliders. ■

This solar instrument (Fig. 16) is made entirely of brass. The plate is 4-3/4 inches square, and the disc is 3-3/8 inches in diameter and is rotated by rack and pinion. The mirror, framed in brass, is 2 x 7 inches and is inclined by a brass rod and arm.

The tube, 3-1/2 inches long and 1-1/2 inches in diameter, screws into the disc, and the condensing lens screws to the tube; at one end of the tube is a screw cap, that normally carries a 2-inch-long tube. On this tube slides another tube 2 inches long, to which is attached a Wilson screw-barrel microscope* with rack and pinion movement. In place of the usual 6 single objectives there is a brass slide bar of 6 lenses.

In all probability it was made by Cuff, and has the following characteristics: All brass rack and pinion movement, and brass wire to mirror (Cuff); condensing lens screwed to the

*Numerous instances will be noted herein where reference is made to a Wilson screw-barrel microscope being attached to the instrument being described. The screw-barrel microscope was the most successful of the early single microscopes, and was closely associated with the name of James Wilson of London. Wilson, a noted maker of optical devices, did not invent this form of microscope, but he did improve its optical performance, and its popularity and commercial success were undoubtedly due to his work. Used in conjunction with other instruments, such as solar and compass microscopes, the Wilson screw-barrel microscope greatly enhanced the capabilities of the former.

Fig. 16. John Cuff, London, England; compound monocular; after 1745. (AFIP 49048 - 66-1836-8)

tube instead of to the disc (Martin); sliding tube attachment for microscope (Cuff) later replaced by the drawtube; slide bars of lenses (Adams; Sterrop); Martin also used this method in instruments he made about 1770. ■

Fig. 17. George Adams, London, England; simple and compound monocular; 1746. (AFIP 49020 - 60-4713-15)

This all-brass, single and double microscope (Fig. 17), also referred to as the "new universal double," has a folding tripod with an upright octagonal pillar 3-1/2 inches high and 7/16-inch wide. At the top of the pillar, on an inner rod, and adjustable by a slide and screw clamp, there is a rotating objective carrier in the form of a wheel 2-7/8 inches in diameter. One objective is mounted at the end of each spoke so that any one of the objectives may be brought beneath the shield that is screwed into the upper wheel. For ease in focusing the stage may be raised or lowered by means of a screw that is rotated by the milled disc at the bottom of the pillar, the screw passing up through the axis of the pillar. The approximate position of the stage for each objective is marked on the pillar—single, double.

The plane mirror is single and in a brass case, and is carried on a short stem attached to the center of a large disc that screws into the front foot. The compound body is of blackened ivory and screws into a ring in the wheel.

An accompanying fishskin box contains accessories such as lenses, lieberkühns* and forceps. It is signed, "Invented and made by G. Adams at the Tycho Brahes Head in Fleet Street, London, Double-Single." ■

AFIP 49044. George Adams, London, England; compound monocular; after 1747. *Not illustrated.*

This solar instrument has a brass plate 4-3/4 inches square, and the disc is operated by the Cuff rack and pinion. The mirror is 7 x 2 inches and is inclined by a screw that works in a nut hinged to the bottom of the mirror; the screw is turned by a milled head on the disc, and is known as the "worm wheel" or "endless screw." The tube is 3-3/4 inches long and 1-5/8 inches in diameter; there is a drawtube with a cone tip 3/8-inch in diameter.

The accompanying Wilson screw-barrel type microscope, 1-1/16 inches in diameter, screws to the drawtube; the condensing lens screws to the back end of the tube. It is not signed, but the three condensing lenses, one regularly furnished, one a plane glass, and one with a long focus glass, point to George Adams as the maker. He is the only known maker to have used this combination in conducting experiments on light. This is the only microscope in the Collection with this combination and the only example known.

Accessories include an ivory handle for

*The name "lieberkühn" is derived from the fact that Dr. Johann N. Lieberkühn, a celebrated German early 18th century microscopist, made the method of illuminating opaque objects by means of a concave reflecting mirror generally known and popular. Despite the fact that Dr. Lieberkühn did not originate this means of illumination, his name became permanently attached to it because of his firm espousal of the method.

use when the instrument is employed as a hand microscope; 2 ivory sliders; metal sliders with 4 concave lenses; a condensing lens; 2 screw plates; and 5 Wilson objectives. ■

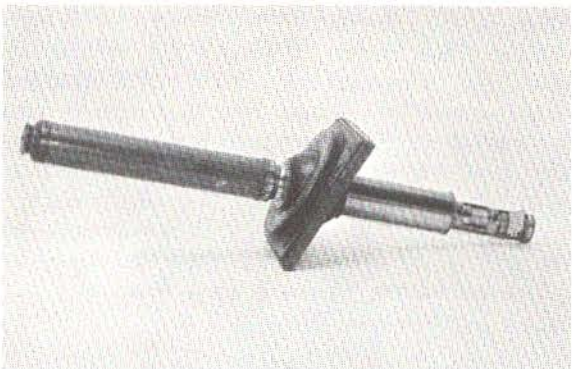

Fig. 18. Benjamin Martin, London, England; compound monocular; C. 1750. (AFIP 49052 - 60-4713-402)

The items comprising this instrument (Fig. 18) are from a cabinet of optical instruments introduced by Benjamin Martin about 1750. It consists of a Wilson screw-barrel microscope and a mahogany scioptric ball, 2-1/8 inches in diameter, and penetrated by a cylindrical hole. The ball is mounted in a 3-3/4-inch-diameter mahogany ring that screws into a 4-7/16 x 4-3/8-inch wooden base, with two 3/16-inch holes for mounting. A 7-1/8-inch-long wooden tube with brass rings at each end screws into the ball. A 7-inch-long brass drawtube containing the lenses screws into the wooden tube. A 5-inch-long tube, 1-1/2 inches in diameter, may be screwed into the opposite end of the scioptric ball; the 2-3/4-inch-long Wilson screw-barrel microscope fits into the tube. Accessories are 3 objectives. ■

AFIP 49012. Maker unknown, Nuremberg, Germany; compound monocular; C. 1750. *Not illustrated.*

Toymakers of Nuremberg, Germany, began making copies of well-known microscopes about 1750, and this instrument is believed to have been copied from Martin's pocket drum microscope, that had a round tube and base.

This model, similar to that in Fig. 19 (AFIP 49013), consists of a wooden box, 4 inches high and 2 inches wide, with top and bottom moldings and inserts. The tube into which the body tube slides is of cardboard with wooden rings at top and base, and is fixed to the box. The body tube is of paper with wooden nose containing the object lens held in by a spring ring. The wooden fitting at the top contains the eye lens and the field lens that slide into the outer tube for focusing.

The single mirror has a wooden casing and is attached by two wooden buttons to the lower section of the box, that has two slits in the sides into which the sliders are placed. The parts are glued together and construction is crude; there are no identifying marks or accessories. ■

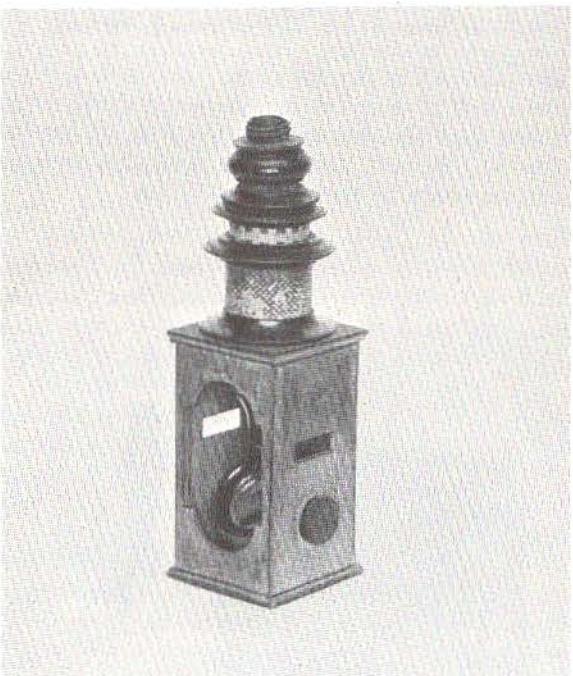

Fig. 19. "J.F.F.," Nuremberg, Germany; compound monocular; C. 1750. (AFIP 49013 - 60-4713-216)

Of excellent workmanship, the instrument (Fig. 19) consists of a wooden box 2-1/4 x 2-1/4 x 4-1/2 inches. The front section is cut away and slits are provided in the sides for introduction of slides.

The outer tube of paper-covered cardboard with hardwood ring at the top and at the base is secured to the box. The body tube is also paper-covered cardboard with hardwood ring at the top and a wooden nosepiece into which the 5/16-inch biconvex object lens is set and held in place by a spring ring. The upper section of the white, wooden drawtube is paper covered with the 1-inch field lens attached at the lower end. The upper end has a hardwood ring and

eyepiece with a 3/4-inch biconvex lens held by a spring ring. The plane mirror has a wooden casing and is fastened in the lower section by two wooden buttons. Height is 8-1/2 inches. Branded on the bottom is an outline of a heart and the letters, "J.F.F.," the same as on the other Nuremberg instrument pictured in Fig. 15 (AFIP 49015). ■

AFIP 49021. Henry Pyefinch, London, England; compound monocular; after 1750. *Not illustrated.*

This model is made along the lines of the instrument by John Cuff in Fig. 14 (AFIP 49023), with the following exceptions: The body tube screws to the arm, and the two-arm stage is of the type made by Mann and Ayscough. The Bonanni stage fitting is small and similar to that introduced by Samuel Johnson, successor to James Mann, in that there is a tube cut at the sides that carries a screw cone below the stage. This type was introduced to facilitate holding a small glass tube during examination. The mirror is single, and the instrument is mounted diagonally on the corner of a square box. The drawer in the box base contains objectives, ivory and metal sliders, condensing lens, stage forceps, and fish-plate. It is signed, "Pyefinch, London." ■

Fig. 20. "IM," Nuremberg, Germany; compound monocular; C. 1750. (AFIP 49025 - 60-4713-52)

Made of light-colored hardwood (Fig. 20), the workmanship compares favorably with that of "J.F.F.," the Nuremberg maker of the wooden model in Fig. 19. The circular base is 5 inches in diameter and rests on three wooden buttons. The stage plate is 3-1/2 inches in diameter and is supported by three turned legs 4-3/8 inches long.

The outer tube is of heavy cardboard covered with fishskin, 4 inches long and 1-1/2 inches in diameter, and is fixed to the stage plate; there is a Bonanni spring fitting below. The body tube is of white wood covered with paper, and is 4-1/2 inches long with a wooden ring at the top. The hardwood nosepiece is fixed to the body tube and has a screw end for a dust cap or for an additional lens. The object lens is 3/16 inch in diameter, and is fixed with a ring and has a diaphragm.

The drawtube is of wood covered with paper and 3-5/8 inches long; the 1-inch field lens is fixed at the lower end. The eye lens is 5/8 inch in diameter and is biconvex in a ring setting; there is a screw-on dust cap. The single mirror is in a wooden case and mounted obliquely on a wooden hinge. Height is 13 inches. Branded on the base is a circle with the letters, "IM." ■

Fig. 21 (color plate). Maker unknown; compound monocular; after 1750. (AFIP 49027 - 66-1836-6)

The base of this Culpeper-Scarlett model instrument (Fig. 21) consists of a 6-inch-square box with drawer, arising from which are three double, S-shaped scroll legs supporting the circular stage at 3-1/2 inches, tapering to 2-1/2 inches where a collar and tube carry the body; the concave mirror is mounted on the base.

The brass stage is 3-1/2 inches in diameter and has a central perforation. Beneath the stage are two spring clips for the tube, and there are openings for a stage forceps or stage condenser and for a fish-plate; a Bonanni stage fitting is attached.

The outer tube is 3-1/4 inches long and 2-3/8 inches in diameter, and covered with Morocco red leather with fleur-de-lis gold stampings. The upper end of the tube has a brass collar that extends 1 inch inside the tube. The upper portion of the brass body tube has a similar stamped leather covering. The object lens is in a brass cell and screws on, and the biconvex lens has a metal slide cover; there is also a field lens. The drawer in the base

contains objectives; lieberkühn; cone diaphragm; fish-plate; and ivory sliders. Height is 15-1/2 inches. ■

AFIP 49045. Francis Watkins, London, England; compound monocular; C. 1754. *Not illustrated.*

This solar model has a number of characteristics similar to other solar instruments herein described. Made entirely of brass, the plate is 5 inches square, and the disc has the Cuff rack and pinion movement. The mirror is 7-3/4 x 2-3/16 inches and is inclined by means of a brass rod in a friction fitting.

The tube is 4-3/8 inches long and 1-1/2 inches in diameter. The condensing lens is screwed to the disc as in the original Cuff model. There is a drawtube with a small end-tube 15/16 inch in diameter on which fits a slide collar, and to which a Wilson screw-barrel microscope may be attached. ■

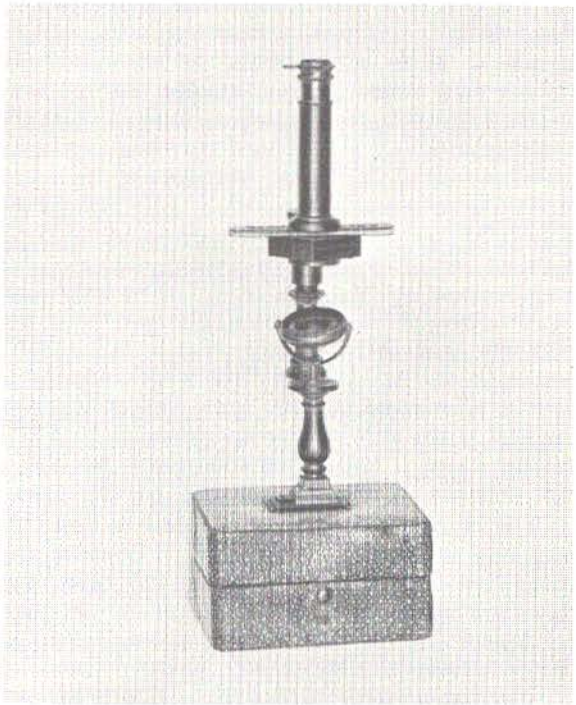

Fig. 22. Jeremiah Sisson, London, England; simple and compound monocular; 1756. (AFIP 49029 - 60-4713-421)

A fishskin box, 3-1/2 x 2-1/2 x 2 inches, on top of which is a brass dovetail fitting to which the instrument (Fig. 22) is attached when in use, serves as the base. The main pillar is turned and is 2 inches high; a rod slides into the pillar and carries a small concave mirror. Fixed to the top of the pillar is an arm 1-3/4 inches long, to which screws a second pillar 2 inches high. This pillar contains a sliding rectangular rod with coarse adjustment that carries another arm with a dovetail slide beneath a bar of lenses, and the eyecup screws in above. There is also a fine screw adjustment near the top of this pillar. The stage is fixed to the pillar and is 3/4 inch in diameter, with an opening for a spring box fitting for sliders, disc of objects, or a simple lens.

It has a compound body with drawtube 2-1/4 inches long, 1/2-inch in diameter, with sliding lens cap; there is no field lens. When closed it is 4-1/2 inches high as a simple microscope, and 6-3/4 inches as a compound.

The base box contains 6 objectives; a spring stage box for slides; forceps; a holder for disc or lens; an ivory disc of objects; fish-plate; a stage forceps with discs, and a single lens. It is signed, "Dr. Demainbray, Invent.," and, "J. Sisson, London." ■

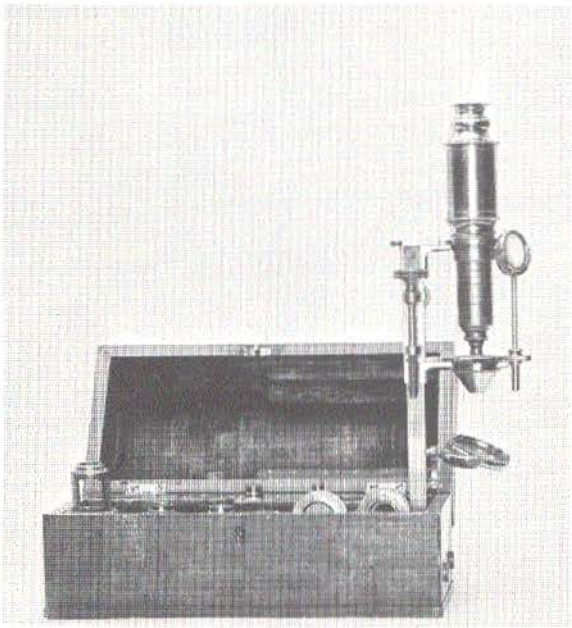

Fig. 23. Nairne and Blunt, London, England; compound monocular; C. 1760. (AFIP 49031 - 60-4713-417)

When introduced by Nairne, and later produced by Nairne and Blunt, this instrument (Fig. 23) was known as the "chest microscope"; its hinged, inclining pillar represents an important step in evolution of microscopes; it is known as a John Cuff type.

Figure 21

It has a square section pillar 8-1/2 inches high, and is hinged at one end of a plain mahogany box, 11 x 5-1/2 x 6 inches, and may be folded down into the box. The body fits into a short arm that is fixed at the top of the pillar, and is of the usual Cuff-type with single eye lens, slide dust cap, and field lens. The Cuff stage is fitted to the pillar by a collar and is focused by a milled-head screw on the side; the single concave mirror is fitted to the pillar by a swinging arm. Height 14-1/2 inches. Accessories include 4 objectives; live-box; Bonanni stage fitting; stage condenser; forceps; and cone. It is signed, "Nairne and Blunt, London." ■

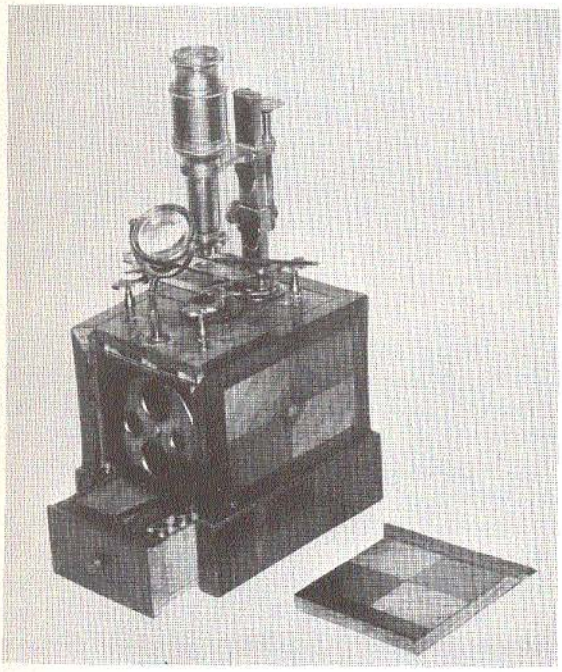

Fig. 24. George F. Brander, Augsburg, Germany; compound monocular; C. 1768. (AFIP 49028 - 63-6539)

The base for this microscope (Fig. 24) consists of a wooden box 6 x 4-3/4 x 4 inches, with a lower section, slightly larger, containing a drawer; the outer front of the grooved box must be removed to use the instrument.

The rectangular brass pillar is 5-1/4 inches high, and carries a fixed arm at the top into which screws the Cuff-type brass body tube, 4-3/4 inches long and 1-5/16 inches in diameter above the nose. It has a single eye lens, field lens, and a slide dust cap. The fine adjustment is the Cuff-type screw that focuses the body.

On top of the base are two narrow plates with spring clips supported on turned pillars that hold slides on the oblong brass stage that has ornamental cutouts; it has a metal slide on which is fixed the stage forceps.

The rectangular mirror is in a wooden frame that rotates on a horizontal axis that passes through the base from side to side. In front of the mirror on the inner front face is a brass disc of diaphragms. Height is 13-1/4 inches.

The drawer in the base contains 5 objectives; forceps; and fish-plate. This type of instrument was made in Italy, Germany and France between 1750 and 1780. Only five others of this type were known as late as 1932, and there are no known duplicates. Before 1820 this instrument was a part of the Dr. Goring Collection in London, England. ■

AFIP 49022. Peter Dollond, London, England; compound monocular; before 1770. *Not illustrated.*

This microscope shows little variation in construction from the characteristics of the Cuff microscope in Fig. 14 (AFIP 49023). The eye lens is single, which dates the microscope before 1770; the compound eye lens was introduced by Dollond that year. Height is 16-1/4 inches. The drawer in the base holds 5 objectives and a Bonanni spring stage. ■

AFIP 49018. Benjamin Martin, London, England; compound monocular; before 1770. *Not illustrated.*

This microscope has a brass tube 1-1/2 inches in diameter that is cut away above the stage at the back and in the front to include the mirror. It is covered with red leather and has gold stampings; there are slits at the sides for sliders.

The brass body tube slides into the outer tube; the eyepiece has a single lens; the oval mirror is fixed on an angle; and the base of the outer tube is a screw cap. Height is 7-1/2 inches. It is a part of a "cabinet of optical instruments," originally in the Dr. Goring Collection in London, and is signed on the eyepiece, "Benjn Martin Fecit." ■

Consisting of a cabinet of instruments (Fig. 25), embodying many features made only by Benjamin Martin, there is included a Martin universal microscope 13 inches high, and a folding tripod base with double mirror on the

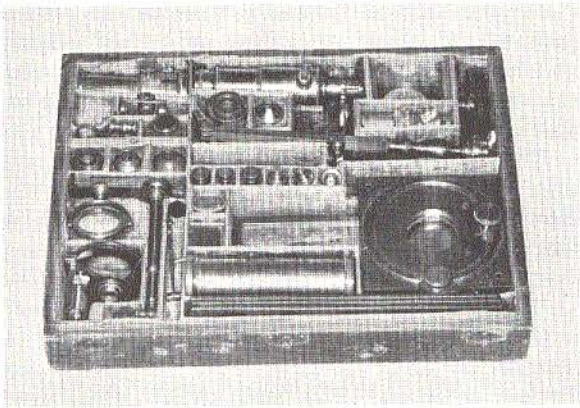

Fig. 25. Benjamin Martin, London, England; cabinet of optical instruments; C. 1770. (AFIP 49024 - 66-1836-15)

front foot. The pillar is fixed and turned at the lower end; the upper portion is square. At the top of the pillar is a short arm with hinged joint and a jam screw.

The body tube has a short arm that slides over the other and is held by a milled screw. The body tube may be removed and the Wilson microscope may be used as a simple microscope. The eye lens is compound with a sliding dust cap, and there is a field lens, drawtube, and a "between-lens."* The stage swings in an arc and is focused by a short screw.

There is a small folding tripod with a single mirror and hinged arm. The simple arm, Wilson microscope, or the large body may be used. There is also a Wilson rack-barrel microscope in which the powers are carried in a dovetailed sliding bar. In addition, there is a brass solar microscope with rack and pinion and endless screw movements, as well as a low-power projecting lens with screw focusing attached to the spring stage.

Accessories include 5 objectives for a large compound microscope; lieberkühn; cone; Bonanni spring stage; black and white disc; and an arm for a simple microscope. ■

*It was in his "universal" microscope of 1759 that Benjamin Martin first introduced the "between-lens," the only real optical improvement in the construction of the compound microscope from the time of Christian Huygens (1629-1695) until the beginning of the 19th century; Martin added the lens to all microscopes he made after that date. The significance of this lens is that it made the objective into a compound one, resulting in amplification of the field of view through use of a larger aperture, reduction of the spherical and chromatic errors of the objective, and a gain in definition.

Fig. 26. L. F. Dellebarre, Leyden, Holland; simple and compound monocular; C. 1770. (AFIP 49032 - 60-4713-53)

Although not signed, this instrument (Fig. 26) has features used in Dellebarre's signed models that were not copied by any other maker. It is an early model universal and the workmanship is equal to Dellebarre's largest signed instruments.

There is a flat folding tripod foot, with a rectangular brass pillar 5 x 5/16 x 5/32 inch, on a hinge joint with screw clamp. At the base of the pillar is fixed a single hinged arm and gimbal with a double mirror that folds upward. At the top of the pillar is a brass box that carries the single hinged, circular stage, 1-7/8 inches in diameter, with an arm for the stage forceps. Behind this pillar is a similar pillar that carries at its base a box with a screw fine adjustment. At the top is a double-hinged arm with slide-in holder for either the simple lens or the compound body.

The compound body tube is covered with fishskin, and is 3 inches long and screws to the holder. The drawtube is of paper and covered with green vellum, and has a central wood screw. The biconvex eye lens has a screw cap. All mountings are of blackened ivory. It is 12 inches high.

A fishskin box contains 4 objectives with ivory caps; 2 lieberkühns with ivory caps; 3

ivory sliders; ivory talc box; brass slide and tube holder; and a hollow ground slide in folding brass frame. The instrument is considered rare. ■

AFIP 174036. Maker unknown; simple and compound monocular; C. 1770. *Not illustrated.*

The folding tripod base of this instrument has a spread of 6-3/4 x 6-3/4 x 8 inches. The inclination joint at the base is attached to the 5-3/4-inch-long triangular pillar with a rack at the back. The gimbal for the 1-3/4-inch-diameter concave single mirror is screwed to the pillar. The 1-3/4-inch Bonanni spring stage has a 1-inch central aperture, and is controlled by rack and pinion on the pillar.

The 3-1/2-inch body tube has a drawtube and screws to the 3-inch-long arm attached to the top of the pillar. The simple microscope portion is a 1-inch-diameter lens that screws into the transverse arm. Accessories include a plane mirror that may be placed over the concave mirror, a stand with oil lamp, and a bull's-eye condenser. (Donated by Mr. Minor Worthington Tuttle.) ■

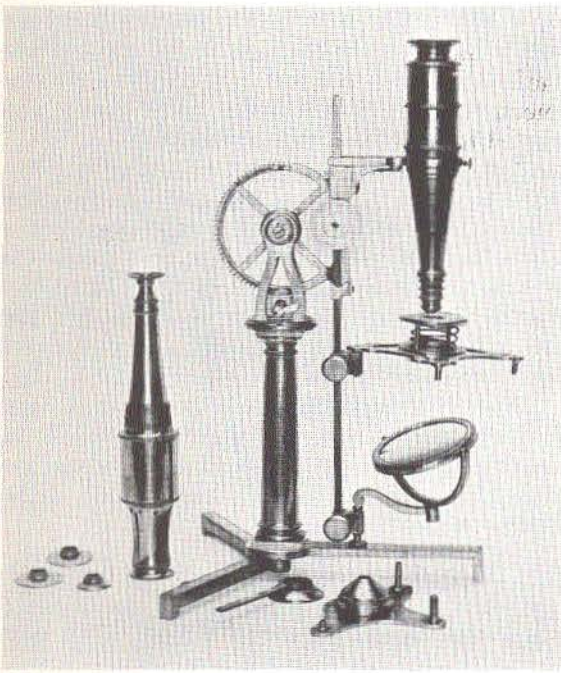

Fig. 27. George Adams, Sr., London, England; compound monocular variable; C. 1771. (AFIP 49033 - 60-4713-206)

This all-brass instrument (Fig. 27) is 20 inches high and has a folding tripod base. At the top of the 7-inch-high round pillar is a circular plate on which another plate rotates. This carries the 3-1/2-inch-high trunnion in which there is a large tooth wheel and a pinion that adjusts the inclination by means of an ivory-handled key.

The limb is a flat brass bar 13-1/2 inches long, on which is a sliding block and setscrew with a double 2-3/4-inch mirror in gimbal and curved arm. Above this is a sliding block and setscrew with a short arm carrying the detachable Cuff-type three-arm stage. At the top is a short, flat bar attached behind the limb that carries the rack and pinion coarse adjustment on one side, and the fine adjustment on the other. This bar is attached to the arm and terminates in a ring with a setscrew. The body tube fits into this ring by a bayonet joint.

The body tube has a compound eye lens, field lens, drawtubes, and the Martin between-lens above the objective. At the top of the limb is a box slide for the arm when used as a simple microscope. Three button-type objectives are screwed one into the other; they may be used singly or together. A Bonanni spring stage is attached to the Ayscough stage. Accessories include 5 lieberkühns; cone diaphragm; and an extra body tube. It is signed, "Geo. Adams, No. 60 Fleet Street, London." ■

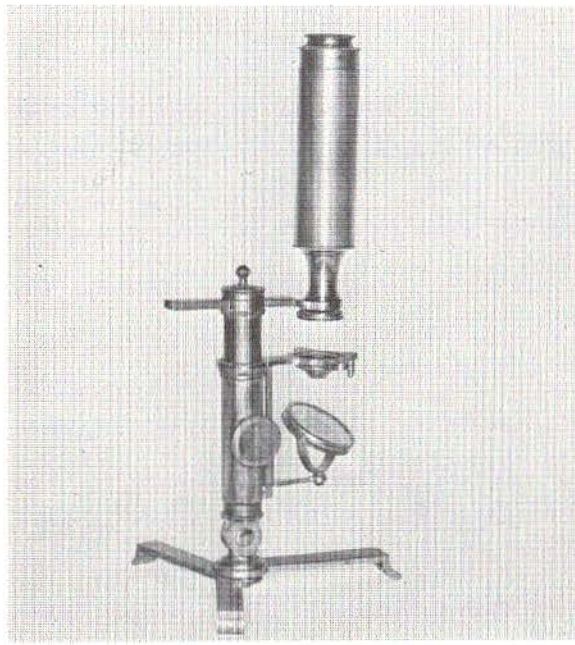

Fig. 28. Benjamin Martin, London, England; compound monocular; C. 1776. (AFIP 49017 - 63-6540)

The base of this microscope (Fig. 28), sometimes called the "new universal," is a folding tripod, and hinged to it by a compass joint is a tubular pillar 7 inches high and 1-1/16 inches in diameter. There is a second sliding tube that is operated by a rack and pinion. A third tube slides within the pillar and furnishes the coarse adjustment.

The body is 5 inches long and 1-3/4 inches in diameter, and is attached to the transverse arm sliding through a rectangular slot; there is a screw clamp cap. The arm and slot may be rotated or moved lengthwise, thus furnishing full aquatic motion.

The stage, fixed to the outer tube, is of the Ayscough type and has a central aperture for a Bonanni stage and openings for forceps and stage condenser. A circular plate with 6 objectives is screwed to the nosepiece that carries the between-lens. A rectangular bar is attached to the outer tube below the stage, and on this is a sliding block to carry the 1-7/8-inch-diameter double mirror. The eye lens is compound and is in an adjustable tube; it has a field lens. Height is 16 inches. In 1890 John Mayall sent a woodcut to the Medical Museum of a signed Martin microscope from the Crisp Collection, formerly in the Science Museum, South Kensington, England; it was identical to this instrument. ■

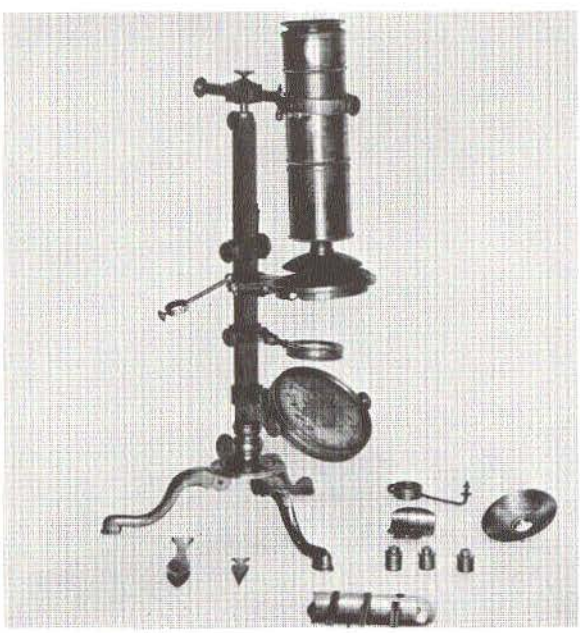

Fig. 29. L.F. Dellebarre, Leyden, Holland; compound monocular; C. 1777. (AFIP 49034 - 60-4713-21)

The tripod base of this microscope (Fig. 29) folds downward. At the center of the tripod a brass pillar, 10-1/4 x 1/2 x 9/16 inch, terminates in a pin that rotates in a socket and is fixed by a screw clamp. The double mirror is 2-7/8 inches in diameter, swings on a gimbal, and is attached by a double compass joint to the box that slides on the pillar with a screw clamp. Above this is a biconvex lens 1-1/2 inches in diameter with a double compass joint; it has a similar box and screw clamp.

The large diameter stage is recessed for plates. It is hinged to fold upward, is carried on a box slide with screw, and has attached a rack that is operated by a similar box slide above the stage that carries the pinion. Both may be moved up and down from the compass joint in the pillar and clamped into position. The compass joint, 4 inches from the top of the pillar, permits a horizontal position for the body. The top of the pillar terminates in a socket with screw clamp in which rotates the pin of the slotted fitting for the arm, thus allowing an arc movement. The sliding arm holds the body tube by a leather-lined, split ring with spring catch and screw clamp.

The body tube is in three sections, the first with screwed nosepiece for the lieberkühn and the objective, the second is the central portion of the tube, and the third supports the eyepiece tube. These may be independently separated to increase the tube length.

The eye lens has three sections, is biconvex, of large diameter, and each section separately bezeled into a cell and covered with a screw cap and sliding dust cap, all mounted in a tube for independent focusing. There is a Martin between-lens above the objective; the instrument is not achromatic, and was called the "universal" model.

Accessories include 3 objectives; 1 large lieberkühn that screws to and focuses on the nosepiece; fish-plate; 2 diaphragms for the mirror; and forceps. It is signed, "L.F. Dellebarre." ■

AFIP 49035. L.F. Dellebarre, Leyden, Holland; compound monocular; C. 1780. *Not illustrated.*

This instrument is similar to that in Fig. 29 (AFIP 49034) by the same maker, although probably made a few years later, with the following differences: The pillar is 10-1/4 x 1/2 x 7/16 inch, and the compass joint is 3 inches below the top of the pillar. The slide box with

pinion is below the stage box. The arm terminates in a short "U" fixed to a brass plate and is attached by two screws to the body tube. The eye lens is composed of 3 sections. It is signed, "L.F. Dellebarre." ■

AFIP 49036. Claude-Simeon Passemant, Paris, France; compound monocular; C. 1780. *Not illustrated.*

With the exception that the body tube screws to the arm, and the box base is of ebony veneer, this instrument is similar to the John Cuff instrument in Fig. 14 (AFIP 49023). A Bonanni stage and a condensing lens are attached. Accessories include 7 objectives; 3 ebony sliders; 3 ivory sliders; and a glass tube. Signed, "Passemant, Ingènieur du Roi, au Louvre, Paris," this microscope was made by Passemant before he went into partnership with L.F. Dellebarre. ■

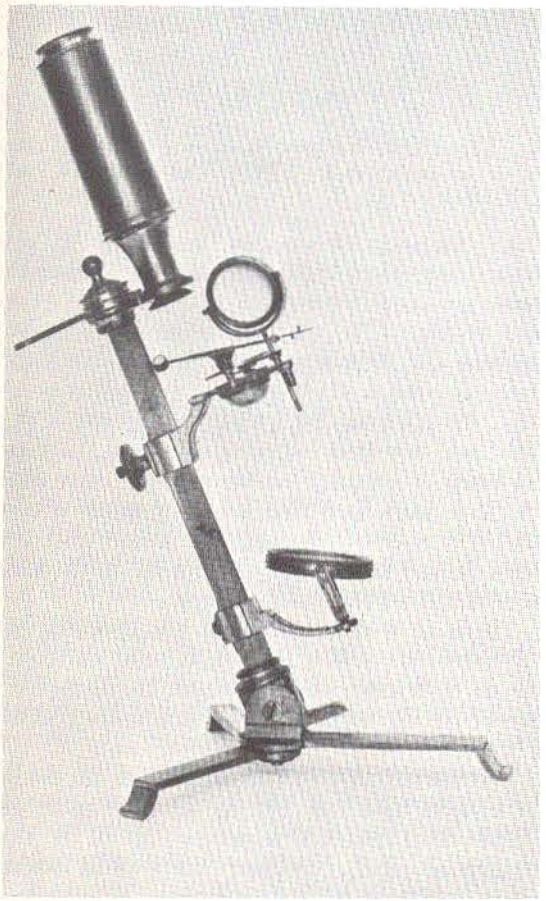

Fig. 30. John Bleuler, London, England; compound monocular; before 1782. (AFIP 49040 - 60-4713-212)

This instrument (Fig. 30) has a folding tripod base. There is a short extension at the base of the triangular pillar to prevent forward inclination. The double mirror is on a sliding arm; there is no substage condenser. The rack is cut into the back of the pillar and the pinion that protrudes from the back at a right angle moves up and down with the stage.

The body is fixed to an arm that moves backward and forward and in an arc. The objective screws in, and the eye lens is compound. There is a field lens and a Martin between-lens above the objective. It is known as the Benjamin Martin model. ■

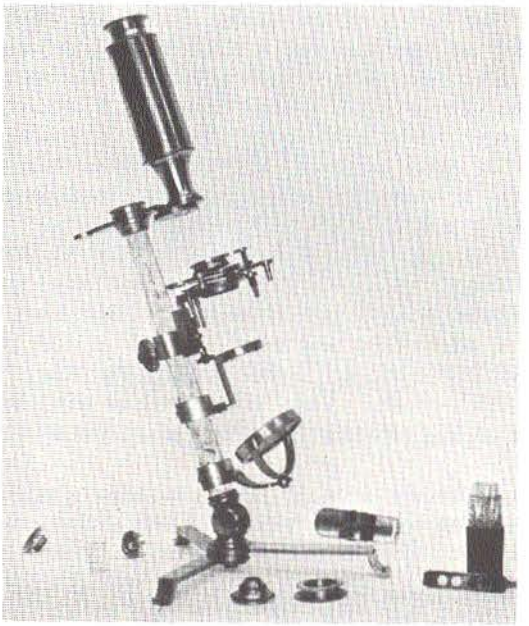

Fig. 31. Henry R. Shuttleworth, London, England; compound monocular; C. 1787. (AFIP 49057 - 60-4713-58)

A 10-inch-high triangular pillar arises from the tripod base of this instrument (Fig. 31) by a compass joint. On one side of the pillar the numbers 1 to 6 indicate the position of the stage with the 6 objectives. At the base is a 2-inch double mirror on a curved arm and slide clamp. Above this is a sliding substage condenser 1-5/8 inches in diameter on an angle arm that swings out of axis by means of a joint. A sliding stage with a Martin superstage is also attached to the pillar. A rack is cut in the back of the pillar, and the Cuff stage carries the pinion placed at right angles at the back; the fine adjustment screw is just below the lower portion of the stage. The body tube is

fixed to an arm which moves backward, forward, and in an arc. It contains a compound eye lens, field lens, a Martin between-lens, and a disc of object lenses. Height is 18 inches.

It is signed, "Shuttleworth, London," and was made by Shuttleworth, Sr. It closely resembles the Martin microscope in shape and design, and represents an important link between the 1782 Martin and "Joneses' Most Improved" of 1798. Accessories include 2 objectives; 3 lieberkühns; 8 ivory sliders; brass slider; talc box; fish-plate; and light cone. ■

AFIP 49047. W. & S. Jones, London, England; compound monocular; C. 1787. *Not illustrated.*

The 5-inch-square brass plate base of this solar microscope has a Cuff rack and pinion with endless screw and sector to the mirror. The tube is 3-3/4 inches long and 2 inches in diameter, with a drawtube; the back lens screws to the tube. The accompanying Wilson rack-barrel microscope is 1-3/4 inches in diameter, and the mirror is 7 x 2-5/8 inches.

It is signed, "W & S Jones, 135 Holborn, London." William and Samuel Jones were sons of John Jones, and succeeded John Jones & Sons after 1784 and were located at 135 Holborn St., London; before 1793 they moved to 30 Holborn St. This instrument is similar to that in Fig. 16 (AFIP 49048). ■

AFIP 49046. W. & S. Jones, London, England; compound monocular; after 1790. *Not illustrated.*

This solar microscope is similar to that in Fig. 16 (AFIP 49048). It is signed, "W. & S. Jones," but the address is 30 Holborn, London, rather than 135 Holborn which was the address prior to about 1793. ■

AFIP 194. Peter Dollond, London, England; compound monocular; before 1790. *Not illustrated.*

Very similar to the solar instrument in Fig. 16 (AFIP 49048), it has a 5-inch-square brass plate with a Cuff rack and pinion and endless screw and sector attached to the 7-1/2 x 2-inch mirror. The body tube is 4-1/4 inches long and 1-3/4 inches in diameter; it has a drawtube and the back lens screws to the tube. The Wilson rack-barrel microscope is 1 inch in diameter. The only accessories are 6 objectives; 3 auxiliary objectives on a bar; and 2 plates and screws. It is signed, "Dollond, London." ■

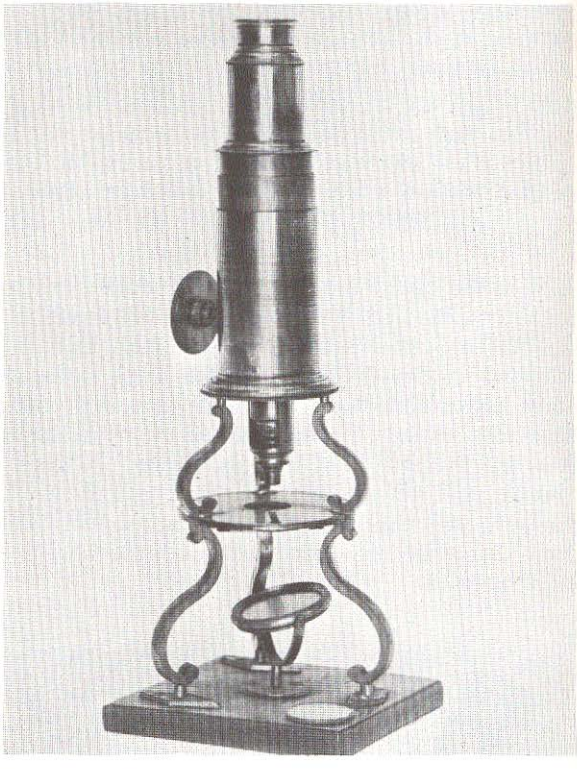

Fig. 32. Peter Dollond, London, England; compound monocular; C. 1790. (AFIP 49037 - 60-4713-209)

A 5-inch-square wooden base (Fig. 32) supports 3 scrolled legs that in turn support the stage; mounted separately on the base is a concave mirror. The circular stage has a central aperture for illumination by transmitted light. There is also a slide slot for fish-plate or forceps, and openings for a stage condenser. Three additional scrolled supports rise from the stage and carry a circular collar and the outer tube; a coarse rack is fitted to the outside of this tube. A 1-3/4-inch-diameter milled-head pinion, screwed to the body operating on the rack, furnishes the coarse adjustment.

There is a drawtube, and the eyepiece has a double lens and a field lens, and the objective in a brass cell screws to the nosepiece. Except for the wooden base, it is made entirely of brass.

The microscope is constructed on the design of Culpeper (see Fig. 13), as modified by George Adams, with double-S supports, and of the type designated the "common three-pillar microscope." Height is 16-1/2 inches. Accessories are 2 objectives; lieberkühn tube; and a stage forceps. It is signed on the stage, "Dollond, London." ■

AFIP 49050. Peter Dolland, London, England; compound monocular; C. 1790. *Not illustrated.*

This instrument is a duplicate of that in Fig. 32 (AFIP 49037) by the same maker, except that the base for this microscope is a square box with a drawer, and the milled head of the pinion is 1-1/8 inches in diameter. Height is 16-1/2 inches. Accessories include objectives; lieberkühn tube; 4 glass sliders; 6 ivory sliders; stage condenser; forceps; Bonanni spring stage; cone diaphragm; brass live-box; fish-plate; stage forceps; and ivory talc box. ■

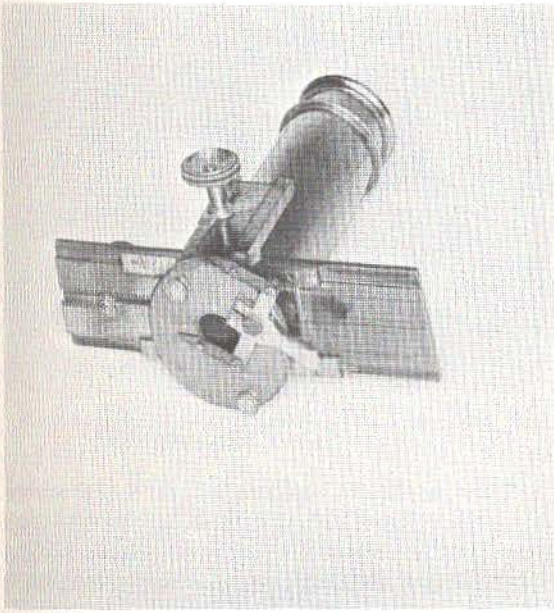

Fig. 33. Peter Dolland, London, England; compound monocular Eirometer; C. 1790. (AFIP 49038 - 63-6542)

The brass body tube (Fig. 33) is 3 inches long and 1-1/16 inches in diameter. The compound eyepiece screws to the tube, and there is a field lens. The body screws to a Rochon micrometer.

There is a 4-inch brass plate with divided glasses, with rack and pinion movement. The lower end of the tube has a rack and pinion that operates the circular stage carrying a double forceps for material. The only accessory is an objective that screws to the micrometer plate. It is an original type microscope used to accurately measure wool threads. ■

The walnut box base with drawer (Fig. 34) supports three triangular, sharply-curved legs with diamond-shaped plates; the flanges of the legs for the stage are 2-3/4 inches from the box base.

Fig. 34. Maker unknown; compound monocular; C. 1790. (AFIP 19460 - 60-4713-409)

The stage is three sided with scalloped edges, and has a 1-inch-diameter central aperture; there is a hole for stage forceps and a slot for fish-plate. The underside of the stage has a fixed ring with two sides cut away and two steel spring clips.

The upper ends of the legs are fixed to a brass ring, to which is fastened the brass tube. At the lower end of the tube is a wooden base to which is affixed the brass plate of the nosepiece. The brass eyepiece screws into the tube. The concave mirror is 1-3/5 inches in diameter and is in a brass cell with gimbal and fits into the base.

The instrument was brought to the United States in the 1890's from Holland, with a history that it had been made in that country. However, it appears to be an exact copy of an instrument signed, "G. Sterrop," in the Court Collection, Science Museum, South Kensington, England. Height is 15-1/2 inches. Accessories include 3 objectives in brass cells; ivory sliders; a Bonanni spring stage; lieberkühn tube; fish-plate; and cone diaphragm. ■

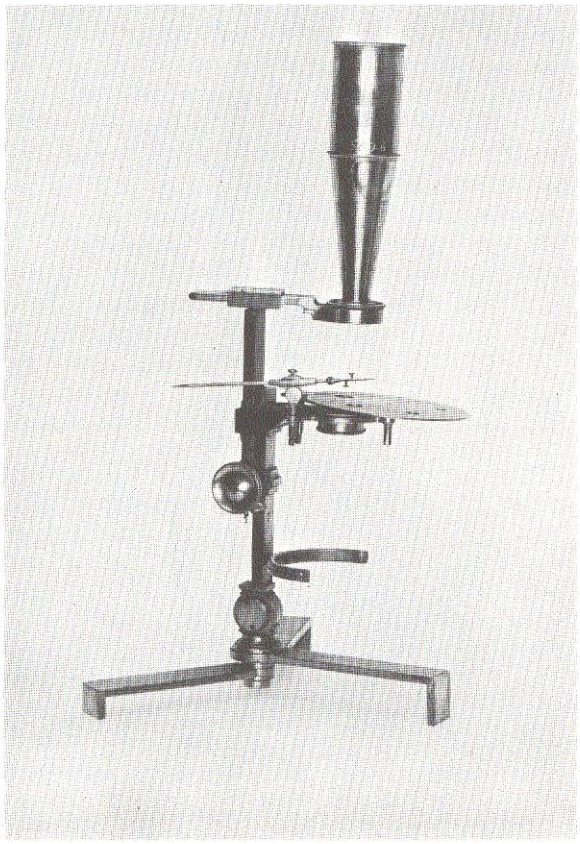

Fig. 35. Peter Dollond, London, England; compound monocular; after 1790. (AFIP 49030 - 60-4713-217)

The rectangular pillar of this instrument (Fig. 35), 4-1/4 x 7/16 x 1/4 inch, is attached by a compass joint to a folding tripod base with legs of equal width. Behind the pillar, and in a casing with pinion, is another pillar of the same size with a rack on the inner side. Another casing near the top holds the fixed circular stage that is 1-9/16 inches in diameter. There are three arms with openings for forceps, and a spring ring clip at the top of the stage.

At the top of the back pillar is a box casing with a sliding arm 3-3/4 inches long that moves in an arc. The body tube is 5 inches long, with the lower 3 inches cone-shaped, and screws into the arm. The eyepiece is 2 x 1-1/4 inches, has a compound eye lens, and a field lens at the lower end that slides into the body tube serving as a drawtube.

It is 11-1/2 inches high when closed, and appears to have features of the Cuff, Martin, and Adams instruments; it conceivably could date between 1790 and 1820. It is signed on the foot, "Dollond, London." ■

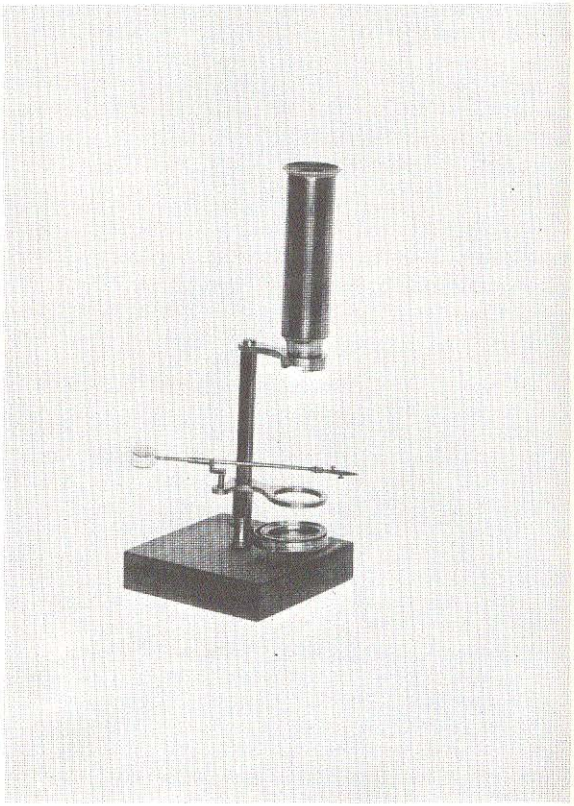

Fig. 36. Maker unknown; compound monocular; C. 1790. (AFIP 518704 - 60-4713-233)

This all-brass instrument is 7-3/8 inches high (Fig. 36). The body tube is 3-5/8 inches long and is attached to a flat brass upright 3-7/8 inches long. An arm for a 3/4-inch mirror and an object holder slides on the upright. A 7/8-inch-diameter swivel mirror encased in brass fits into the lower portion of the upright. (Donated by Dr. George M. McBean) ■

The folding tripod foot of this instrument (Fig. 37) is similar to that of the Adams and Martin microscopes. At the base is a square brass pillar, 10 x 5/8 inch, that is fixed by a winged screw. The pillar carries in a slide box the double mirror on a double compass joint. The condensing lens is on a short rod above the arm; the stage carries the pinion.

The arm socket movement is an aquatic type and the arm fits into the body tube with a dovetail slide. The body tube is in three sections, as is the eye lens. There are rings labeled D1 and D2, a screw cap, and a Martin between-lens above the objective. Height is 19 inches. It is signed on the body, "Dellebarre, 1797, Onderdewyngaart Canzius Confecit, Delft." ■

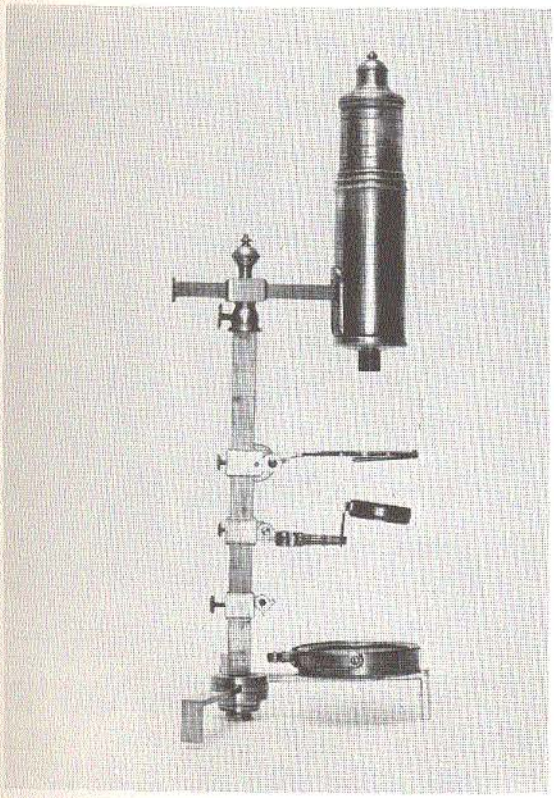

Fig. 37. L.F. Dellebarre, Delft, Holland; compound monocular; 1797. (AFIP 49039 - 60-4713-415)

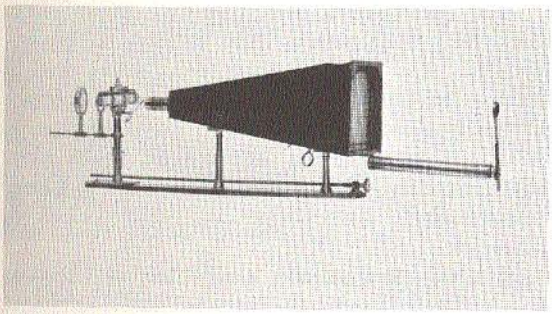

Fig. 38. W. & S. Jones, London, England; compound monocular; C. 1798. (AFIP 49043 - 60-4713-403)

The mahogany base of this lucernal instrument (Fig. 38) is 25 x 2-1/8 inches, is dovetailed and slides in a groove in a box when packed, and in a similar groove on top of the box when in use. The pyramidal body box is 16-3/4 x 7 inches and is supported by two circular brass pillars. At the base of the body are a wooden slide, ground glass in a frame, and two 5-inch biconvex lenses in a frame. At the front is the sliding tube nosepiece.

The objective and the observer's eye must conjugate with respect to the lenses. To fix the position of the eye there is a shade with a small aperture that is mounted on a telescopic tube, 9-1/2 x 1 inch, and screws to the underside of the body.

The 2-3/4-inch-square stage has a racked plate above and spring tube clips below. The plate may be moved horizontally and vertically by the long mahogany handle joined with Hooke's joints to the pinion. A brass slide holder is fixed to the stage, which in turn is fixed to a circular pillar with a dovetail plate, and is focused by a milled-head screw extending the entire length of the base. On the pillar is the radial swinging substage on an arm carrying a sliding 1-3/8-inch biconvex lens and a 2-inch double lens. The lamp with a sleeve fitting slides on the end of this arm and has a support to the pillar.

Accessories include 7 objectives; wooden, ivory, and brass sliders; focusing handle with Hooke's joints; fish-plate; and forceps. It is signed, "W. & S. Jones, 30 Holborn, London." ■

AFIP 49053. W. & S. Jones, London, England; compound monocular; before 1798. *Not illustrated.*

This lucernal instrument is similar to that by the same maker in Fig. 38 (AFIP 49043) with the following exceptions: The swinging substage has a 2-inch sliding single mirror on the arm, a 2-inch double lens, and is not equipped with a lamp. It is signed, "W. & S. Jones, 30 Holborn, London." ■

The conical pillar of this "Joneses' Most Improved" model microscope (Fig. 39) is 7-3/8 inches high, capped by a compass joint, and is affixed to a folding tripod base. From the compass joint a short arm extends that carries the limb that is 9/16-inch square and 11 inches long; a 5-inch rack is cut 1/8 inch from the top in the right side of the limb.

The stage sleeve carries the pinion, and the stage itself is 2-1/8 x 2-5/8 inches and has three projections for forceps. There is also a sliding piece with 2 spring clips above the stage. A condenser and cone diaphragm are on the stage.

At the lower end of the limb is a sleeve for the 1-7/8-inch-diameter double mirror. Above the mirror is the sleeve with a short arm for the 1-9/16-inch-diameter condenser. At the top of

Fig. 39. W. & S. Jones, London, England; simple and compound monocular; 1798. (AFIP 49041 - 60-4713-416)

the limb an arm, 4-7/8 x 5/8 x 3/16 inch, fits into a slot and has a cutout center with rack on the left side, and pinion at the top, and may be moved in an arc.

The body tube is 4-1/8 x 1-3/4 inches, has a 1-3/8-inch screwed-in, cone-shaped nosepiece, and screws into the arm. The compound eyepiece has a field lens and a Martin between-lens above the objective. When the body tube is removed this instrument may be used as a simple microscope. Height is 17 inches. It is signed, "Jones Fecit, 30 Holborn, London." ■

AFIP 193. W. & S. Jones, London, England; simple and compound monocular; 1798. *Not illustrated.*

This microscope is of the same size and general construction as that in Fig. 39 (AFIP 49041) by the same maker with the following exceptions: The rack is cut into the front of the limb, and the square stage moves in an arc by means of a milled-head tangential screw. There is no sleeve for the condenser, and a ring is fixed below the stage for a tube condenser. The rack on the arm is cut on the top with the pinion on the left side; the eye lens is single. It is known as the "Joneses' Most Improved" model. Height is 18 inches. It is signed, "W. & S. Jones, 30 Holborn, London." ■

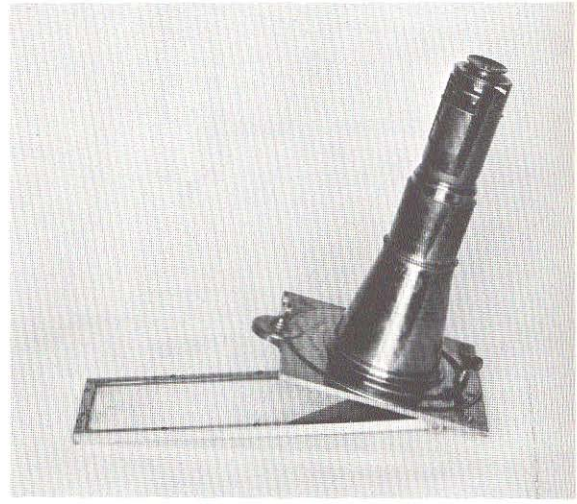

Fig. 40. Dudley Adams, London, England; compound monocular; C. 1799. (AFIP 49049 - 66-1836-7)

Dudley Adams' solar microscopes are extremely rare, in fact, this is the only one known to be in existence (Fig. 40). It embodies many of the features of those made by Benjamin Martin in London in the late 18th century.

The instrument has a 6-inch brass plate, Cuff rack and pinion, and endless screw and sector. The conical tube is 5 inches long, 3 inches in diameter at the base, and 2 inches in front; it has a drawtube. The back lens is 3 inches in diameter and screws to the tube. The mirror is 3-3/4 x 10 inches, and the Wilson screw-barrel microscope is 1-3/4 inches in diameter.

Accessories include a slide bar of 6 lenses; 3 wooden sliders; 5 ivory sliders; talc box; brass collecting tube; brass trough; and a mahogany box. It is signed on the plate, "D. Adams, London." ■

The oval brass base (Fig. 41) is 2-5/16 x 3-5/16 inches, and has two holes for securing to a box or table; it also has 4 screw-in receptacles for objectives. A 1-1/8-inch-diameter double mirror is attached to the base in optical axis.

The circular pillar is 5-1/4 inches high and 9/16 inch in diameter and carries a hollow pinion at the top. The stage plate is 1-1/2 inches

Fig. 41. G. Brock, London, England; compound monocular; C. 1800. (AFIP 49042 - 60-4713-240)

x 2-9/16 inches and is fixed to an outer tube 3-1/8 inches long to which the rack is attached. There is a spring clip below the stage and openings for forceps and condenser. The arm with a spring tube fits into the pillar and moves in an arc.

The body tube is 3-1/2 inches long and 1 inch in diameter and screws to the arm; the objective screws into the body tube. Height is 10 inches. The eye lens is compound, and there is a field lens.

Accessories are 4 objectives. It is signed on the body, "Brock Invenit et Fecit, London." As far as it is known, this instrument has not been described in the literature. ■

This pocket microscope is called "The Acorn" (Fig. 42). It consists of a brass cylinder 1-1/8 x 1-1/8 inches with the sides cut away. The lower end has a screw-on base that serves as a cell for objects. Inside is a slightly cone-shaped tube with an eye lens and a field lens.

When in use the tube is placed in a reversed position in the cylinder. The upper section of the cylinder is a screw cap that protects the biconvex lens that serves as a condenser. The upper part of the cap carries an object pin and lens on a stem to form the simple microscope. There is a rounded cap screw on the cover 3/4 inch in diameter.

Fig. 42. T. Harris, London, England; simple and compound monocular; after 1800. (AFIP 49440 - 66-1836-11)

Height is 1-3/4 inches. John Mayall said this and the microscope in Fig. 43 were made by Harris, although neither instrument is signed. Both differ from any described before 1800, but in all probability were made before 1815. ■

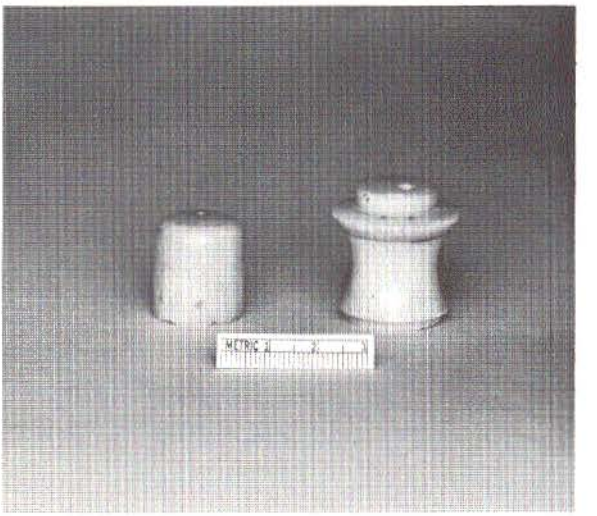

Fig. 43. T. Harris, London, England; simple and compound monocular; after 1800. (AFIP 49441 - 66-1836-10)

This microscope (Fig. 43) is a duplicate of that in Fig. 42 (AFIP 49440) except that it is made of ivory, and there is no base plate. It is also attributed to T. Harris of London. ■

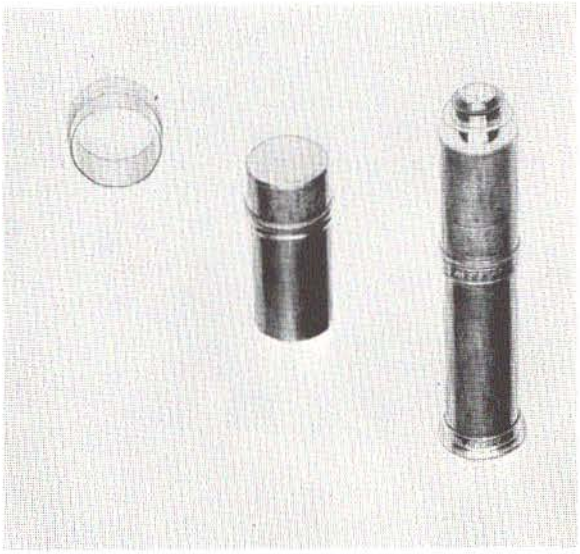

Fig. 44. T. Harris, London, England; compound monocular; after 1800. (AFIP 49054 - 63-6543)

This instrument is of a type called "demonstrating microscope" (Fig. 44). It has a brass body tube 4-1/2 x 7/8 inch, a short nosepiece, and a lower section that is covered with a sliding tube containing a glass cell for objects. The eyepiece slides within the body tube and contains two lenses 1 inch apart. Height is 4-1/2 inches. ■

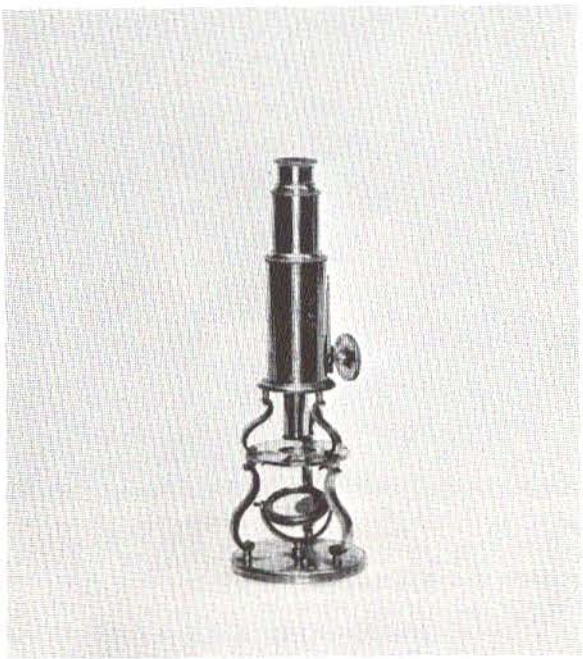

Fig. 45. Maker unknown; compound monocular; after 1800. (AFIP 49051 - 60-4713-215)

This Culpeper model (Fig. 45) has the Adams-type supports and is very similar to those made by Dollond of London. When closed it is 10-1/2 inches high. The stage is 2-1/2 inches in diameter and has two openings for forceps. The single mirror is 1-1/4 inches in diameter.

The sliding body tube is 7 inches long; the circular base is brass; the nosepiece is conical; and it has a rack and pinion adjustment. The eyepiece has a compound lens, and there is a field lens.

Included in the drawer of the instrument's pyramidal case are 4 objectives; stage forceps; fish-plate; ivory talc box; cone diaphragm; and Bonanni stage. (Donated by Dr. Thomas F. Murdock) ■

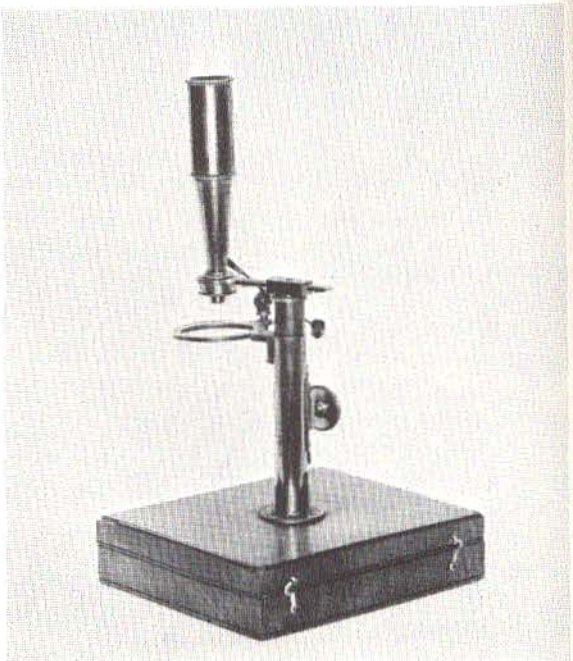

Fig. 46. Maker unknown; simple and compound monocular; C. 1810. (AFIP 49058 - 60-4713-207)

The circular pillar, 4 inches high and 5/8 inch in diameter, of this instrument (Fig. 46) screws into the top of a hardwood box base 6 x 5 x 1-1/2 inches. The single mirror is 1-1/2 inches in diameter and has a push-in stem to the pillar. There is a rack and pinion adjustment on an inner tube.

A circular stage, 1-7/8 inches in diameter, has a dovetail fitting to the pillar, is recessed for a glass disc, and has an arm for a stage forceps. The arm is 3-1/4 inches long, moves in an arc, and slides into a box fitting at the top of the inner tube.

The compound body tube is 4 inches long, is cone-shaped at the lower end, and screws to the arm. The eye lens is compound; there is a field lens; and the objective screws in below the tube. Height is 10-1/2 inches.

In the drawer of the base are 2 objectives; 2 objectives with lieberkühn; ivory and cork stage disc; and plane and concave glass discs. This instrument is a duplicate of the "Joneses' Improved Aquatic Microscope," except for the compound body and the box base. ■

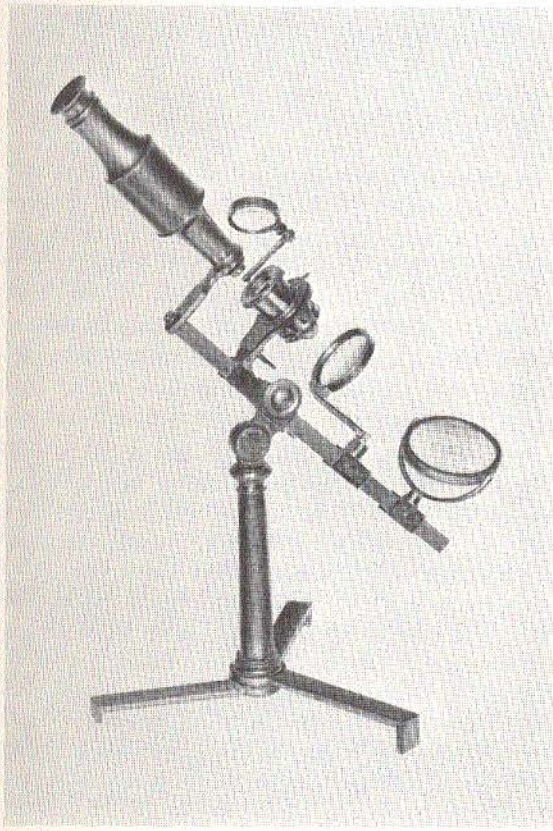

Fig. 47. Henry Shuttleworth, London, England; simple and compound monocular; C. 1810. (AFIP 49056 - 63-6544)

The circular section pillar of this instrument (Fig. 47) is 7 inches high, and is attached to a folding tripod base. At the top of the pillar is a compass joint and a block attached to a square section limb 11-1/2 inches long. Cut into the front of the limb is a rack and pinion that focuses the stage. At the lower end of the limb is a 2-3/4-inch double mirror on a slide box with two setscrews. Above this is a 2-inch condensing lens on a hinged angle arm with similar box and screws.

The stage is a two-arm Ayscough. The arm that carries the body tube is fixed with a large screw to the top of the limb. There is a double screw ring at the opposite end into which the tube screws; the objective is screwed into the lower side.

The body tube is 7 inches long, the central portion of which is 2-3/8 x 1-13/16 inches. The upper and lower ends are cone shaped; it has no drawtube. The eyepiece screws and carries two upper and lower lenses. By removing the tube the instrument may be used as a simple microscope. Height is 20 inches. It is signed on the stage, "H. Shuttleworth, Ludgate Street, London." ■

Fig. 48. Gilbert & Sons, London, England; compound monocular; C. 1820. (AFIP 49064 - 60-4713-237)

Set on a folding tripod base, this instrument (Fig. 48) has a rectangular pillar, 4 x 7/16 x 7/32 inch, attached to the base by means of a compass joint. The double mirror is 1-3/16 inches in diameter and has a push-in stem to the pillar. The rear pillar is held in place by a box fitting with a pinion; the rack is on the inner side. Another box fitting near the top holds the fixed stage, 1-1/2 inches in diameter, with three arms with openings for forceps and a ring spring clip on top of the stage.

The body tube is 4-1/2 x 1-1/4 inches with the lower 2-1/4 inches cone-shaped, and a wheel of six objectives is attached at the base. The tube screws to the 4-inch arm that moves in an arc and slides into a box fitting at the top of the pillar. The eye lens is compound and the field lens is at the upper end of the cone; it has no drawtube. Height when closed is 11 inches. It is signed, "Gilbert & Sons, London," and, "Sold by E. and W. Smith & Co., Liverpool." ■

AFIP 49066. Gilbert & Sons, London, England; compound monocular; C. 1820. *Not illustrated.*

This instrument is a duplicate of that by the same maker in Fig. 48 (AFIP 49064) with the following minor modifications: The folding tripod base has one wide and two narrow feet. The single mirror is 1-5/8 inches in diameter, and the arm is 3-3/4 inches long.

The body tube is 4-1/2 inches long and 1-1/8 inches in diameter; the lower 2-1/4 inches are cone shaped. The eye lens is single and there is a field lens. At the lower end of the tube above the objective there is an additional screw-in lens, and a wheel of six objectives. Height is 12 inches. There is a Martin superstage with 3 openings; a cylinder condenser on rod; and a stage forceps. It is signed, "Gilbert & Sons, London," and, "Sold by E. & W. Smith & Co., Liverpool." ■

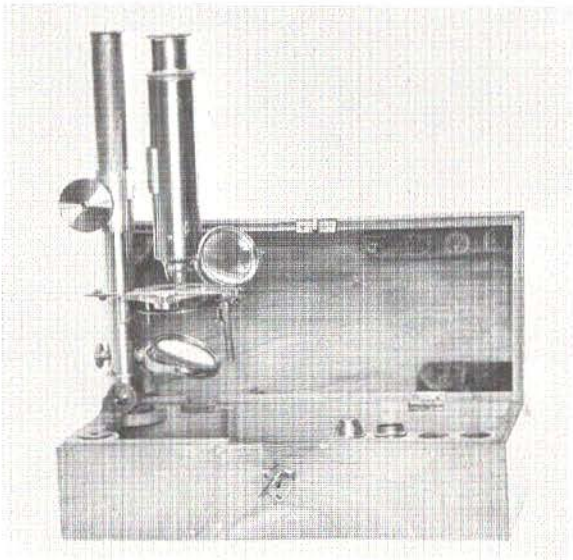

Fig. 49. Utzschneider, Reichenbach and Fraunhofer, Munich, Germany; compound monocular; C. 1820. (AFIP 49060 - 60-4713-419)

A rectangular mahogany box, 10 x 5 x 4-1/2 inches, serves as the base for this instrument (Fig. 49). Hinged to the left end of the box, but not inclinable, is a circular pillar 3/4 inch in diameter and 8-3/4 inches high, with rack set in at the upper back. The single mirror, 1-3/8 inches in diameter, fits into the pillar and has a milled head at the back. The circular stage is 2-1/8 inches in diameter and is fixed. There is an arm at the right for forceps and a swinging arm at the front for a condenser; there is also a spring plate beneath the stage. A 1-1/2-inch box collar holds the pinion and the 5/8-inch arm with a plate screwed to the body.

The body tube is 1-1/8 inches in diameter and 5-1/2 inches long and has a short nosepiece. The eyepiece screws in and the field lens is at the lower end; the ocular screws in the upper end. Height is 13 inches.

Accessories include 3 objectives; ocular; and 2 wooden sliders. It is signed on the stage, "Utzschneider, Reichenbach und Fraunhofer in Benedictbeurn." The instrument is rare, with only one other known, a duplicate formerly in the Crisp Collection in the Science Museum, South Kensington, England. ■

This instrument (Fig. 50) has a 2-5/8-inch-diameter brass ring base and a tubular brass stand 7-1/8 x 2-1/16 inches; the front and back are cut away about 5 inches. A rack is fitted within the top 2 inches that carries a 1-3/4-inch-long inner ring top tube with pinion. A single mirror is on a pivot and is 1-5/8 inches in diameter. The fixed circular stage is 1-15/16 inches in diameter, has a central aperture, and openings for forceps and condenser. There are slits in the sides of the stage and a spring plate beneath the stage for sliders; there are holes in the sides below the stage for a glass tube.

The body tube is 1-9/16 inches in diameter and 6-3/4 inches long and slides into an inner tube. There is a short nosepiece, and the 2-1/2-inch-long eyepiece slides into the body tube. The field lens is at the lower end, and the eye lens is compound and screws in. Height is 10 inches.

Accessories include 6 objectives; 6 ivory sliders; 2 glass stage cells; ivory stage cell; condenser with arm; brass cell with glass bottom; forceps; glass tube and dissecting needle; camel's-hair brush; and a mahogany box, 3 x 5 x 10-7/8 inches. It has significant Dollond characteristics. ■

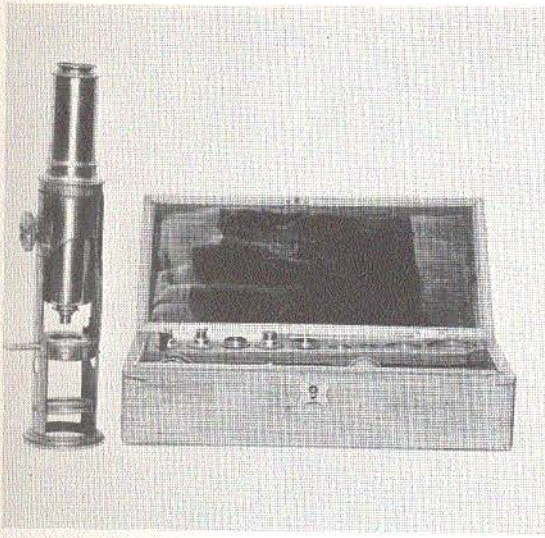

Fig. 50. Maker unknown; compound monocular; C. 1820. (AFIP 49068 - 60-4713-418)

AFIP 49067. William Cary, London, England; compound monocular; C. 1820. *Not illustrated.*

A rectangular pillar, 2-3/4 x 1/4 x 1/8 inch, with rack cut at the back, screws to the front edge of the mahogany box base. The single 3/4-inch-diameter mirror fits into the pillar with a pin.

The 1-inch-diameter circular stage has a bar at the front, with an opening for forceps. The stage is fixed to the box casing that carries the pinion. The arm is 2 inches long and is fixed to the pillar by a thumbscrew.

The body tube is 3 inches long, and 3/4 inch in diameter; the lower 2 inches are cone shaped; the eyepiece does not unscrew, and the eye lens is compound and screws in; there is also a field lens. The objective screws to the tube and the tube screws to the arm. Height is 6-1/2 inches. It is signed, "Cary, London."■

This instrument (Fig. 51) has a box, 5 x 4-1/2 x 1-1/2 inches, for a base to which is attached the rectangular pillar, 3-1/4 x 1/4 x 1/8 inch, with a rack cut at the back. The single mirror is 1-5/16 inches in diameter and fits into the pillar with a pin.

The semicircular stage is 1-1/16 inches in diameter and is square at the front; it has an opening for forceps. The stage fits into the pinion casing on a pivot and may be moved in an arc. There is a 1-3/8-inch arm in front for the condenser that is fixed to the pillar with a screw.

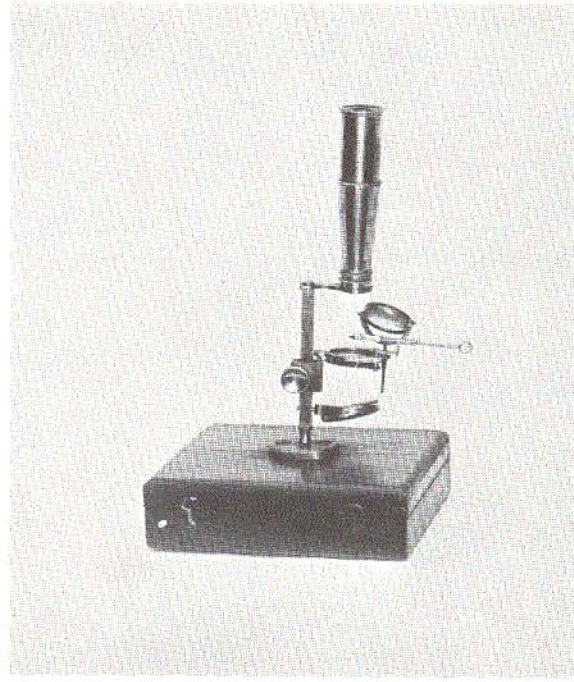

Fig. 51. William Cary, London, England; compound monocular; C. 1820. (AFIP 49065 - 60-4713-54)

The cone-shaped body tube is 3-3/4 inches long and 3/4 inch in diameter. The eyepiece unscrews, the eye lens is single, and there is a field lens. The objective screws to the tube and the tube screws to the arm. Height is 7 inches. Accessories are an objective; 3 ivory sliders; forceps; and dissecting needle. It is signed on the pillar, "Cary, London." (Donated by Miss Nora Chadwick) ■

This Cary- or Gould-type* microscope (Fig. 52) screws to the top of a box, 6-1/4 x 4-1/2 x 1-3/4 inches, that serves as the base. The rectangular pillar is 3-1/2 x 5/16 x 3/16 inch and has a rack cut at the back and a compass joint at the base. A single mirror is 1-1/4 inches in diameter and is attached to the pillar with a pin.

The circular stage is 1-3/16 inches in diameter and is fixed to the pinion casing, with a similar plate fixed beneath and a spring fitting between the plate and the stage; there are openings for forceps and condenser. The arm is 1-1/4 inches long and is screwed to the pillar.

*William Cary, a mathematical instrument maker, was succeeded by Charles Gould under the name of Gould and Porter.

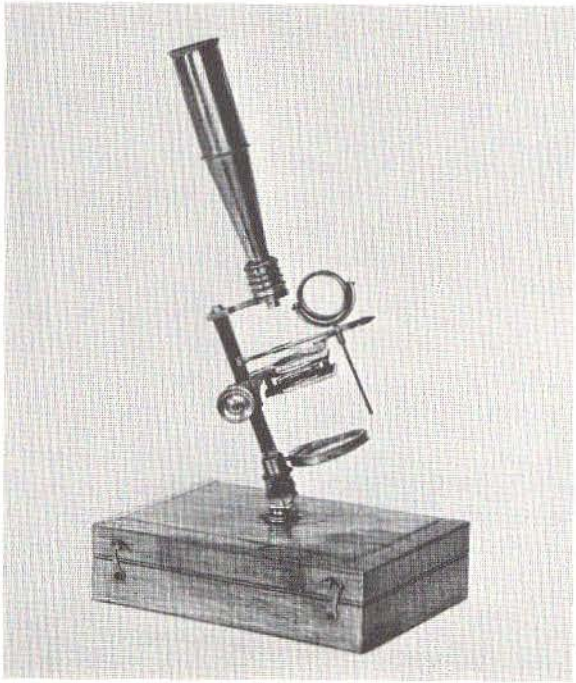

Fig. 52. Maker unknown; compound monocular; after 1820. (AFIP 49059 - 60-4713-239)

The body tube is 5 inches long and 1 inch in diameter, with the lower 2-3/4 inches cone shaped. The eyepiece does not unscrew, and the eye lens is compound and screws in; there is also a field lens. The objective screws to the tube and the tube screws to the arm. Height is 12 inches.

Accessories are 3 button-type objectives; 2 glass stage discs; 3 ivory sliders; forceps; and live-box. The instrument is of precision workmanship, and similar in many respects to the signed William Cary microscope in Fig. 51 (AFIP 49065); the chief difference is that this model is somewhat larger. ■

This microscope represents the best instrument made (Fig. 53) prior to achromatism. The general construction is on the original lines of the "Joneses' Most Improved" model with Dollond's fine workmanship. It has a folding tripod base to which is attached a circular pillar 7-3/4 inches high surmounted by a compass joint. A short arm carries the 10-1/2 x 9/16-inch-long limb with rack cut in front, and a pinion on the stage sleeve.

The stage is 2-1/8 x 2-3/4 inches, has three projections for forceps, and spring clips above. The double mirror is 2 inches in diameter and is clamped on a sleeve that is screwed to the

Fig. 53. Dollond, London, England; compound monocular; before 1824. (AFIP 49061 - 60-4713-10)

lower end of the limb. Above this is a sleeve with two screws that carries a 1-1/2-inch-diameter condenser on an adjustable angle limb. The arm moves in an arc and slides in the slot with a cork cushion.

The body tube is 4-1/8 inches long by 1-7/8 inches in diameter, has a 1-3/4-inch screw in the conical nose, and screws to the arm. One screw-in eyepiece has three lenses, and there is a field lens, but no drawtube. It is signed on the base, "Dollond, London." ■

The 3-inch-high rectangular pillar of this Cary-model instrument (Fig. 54), with a rack at back, screws into the top of a mahogany box base, 5-1/4 x 4-1/4 x 1-3/8 inches; the 1-3/8-inch-long arm is screwed to the pillar.

The cone-shaped body tube is 1-3/4 x 1-3/16 inches and screws to the arm. The stage is 1 inch in diameter, has a rounded back, a spring clip, and rotates on a pivot; the sleeve carries the pinion. There is a field lens and a single

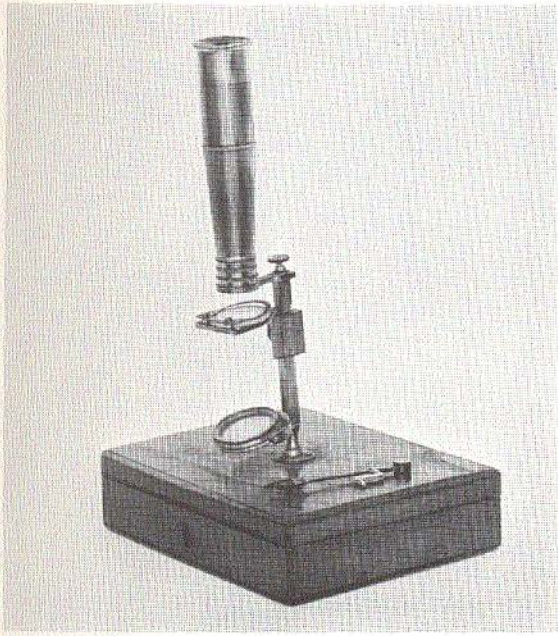

Fig. 54. John Tuther, London, England; simple and compound monocular; C. 1825. (AFIP 171 - 60-4713-299)

eye lens; the single mirror is 7/8 inch in diameter. Height is 9 inches. Accessories include a button-type objective; stage forceps; live-box; and glass disc. It is signed on the pillar, "Tuther, 221 Holborn, London." ■

This instrument (Fig. 55) is mounted on a folding tripod base with a conical pillar 9-1/2 inches high surmounted by a compass joint. The arm is 5-1/2 inches long and has attached to it a 2-3/8-inch ring into which the body tube screws. The 9-1/2 x 1/2-inch limb is solid, cast with the arm, and is held to the pillar at the base by a slot and pin; a rack is cut at the back.

The single mirror is 2-3/4 inches in diameter and is on a sleeve. The stage is 3-3/8 x 3-1/2 inches and is incurved at the back to 7/8 inch, and is fixed to a sleeve that carries the pinion. It has a spring clip and a screw-in cone that carries the revolving diaphragm.

The body tube is 5 x 1-5/8 inches and has a cylinder nose, 2-1/4 x 1-1/16 inches, with a bull's-eye condenser 1-3/8 inches in diameter; it is on a jointed arm with a spring clip. There is a drawtube, and the compound eyepiece screws in. Height is 17 inches. It is signed on the tube, "Vincent Chevalier, Achromatique Perfectionne, Ingr Brevte, Quai de Cholege 69, Paris;" and on the arm, "Vincent Chevalier." ■

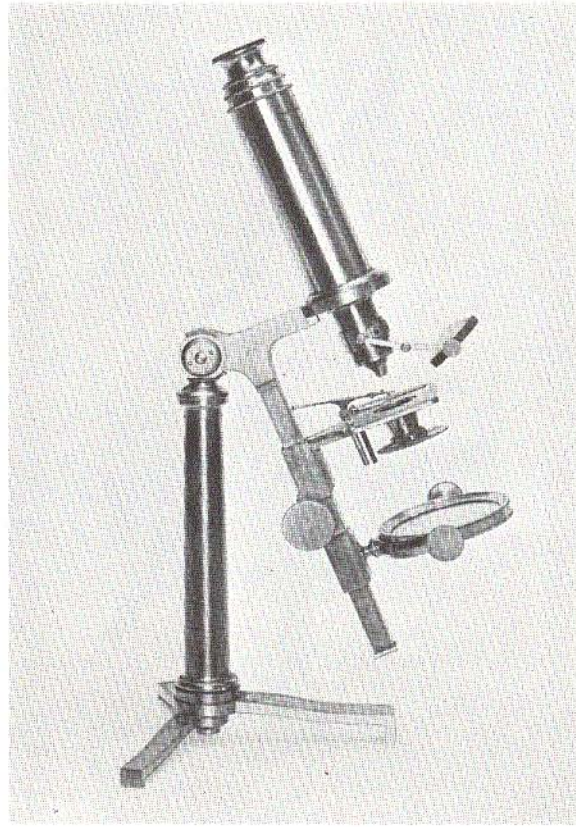

Fig. 55. Vincent Chevalier, Paris, France; compound monocular; C. 1825. (AFIP 49062 - 60-4713-231)

Mounted on a folding tripod base, this instrument (Fig. 56) has a conical pillar 7-1/4 inches high surmounted by a compass joint, and a short arm that carries the 10-3/8-inch limb; a rack is cut in front and the pinion is on the stage sleeve. The stage is 2-1/8 x 2-5/8 inches and has three projections for forceps; the spring clip is above the stage; there is also a Martin superstage and disc.

The double mirror is 1-5/16 inches in diameter and is fixed to a sleeve. The 1-5/16-inch condenser is also on a sleeve and has an adjustable angle arm that moves in an arc and slides in a slot with a cork cushion.

The body tube, that screws to the arm, is 4 inches long and 1-13/16 inches in diameter, and has a screwed-in conical nose; at the base of the body tube is a wheel of six objectives. The screw-in eyepiece has three lenses; there is a field lens, but no drawtube.

Accessories are 6 objectives on a wheel; 9 ivory sliders; brass slider; 2 glass tubes; 3 lieberkühns; 2 brass live-boxes; ivory and glass

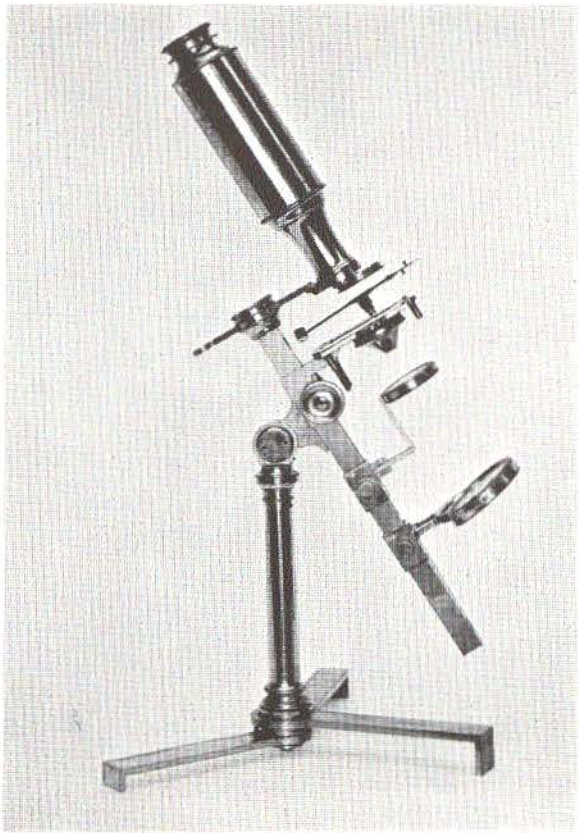

Fig. 56. Dolland, London, England; compound monocular; C. 1825. (AFIP 49069 - 60-4713-232)

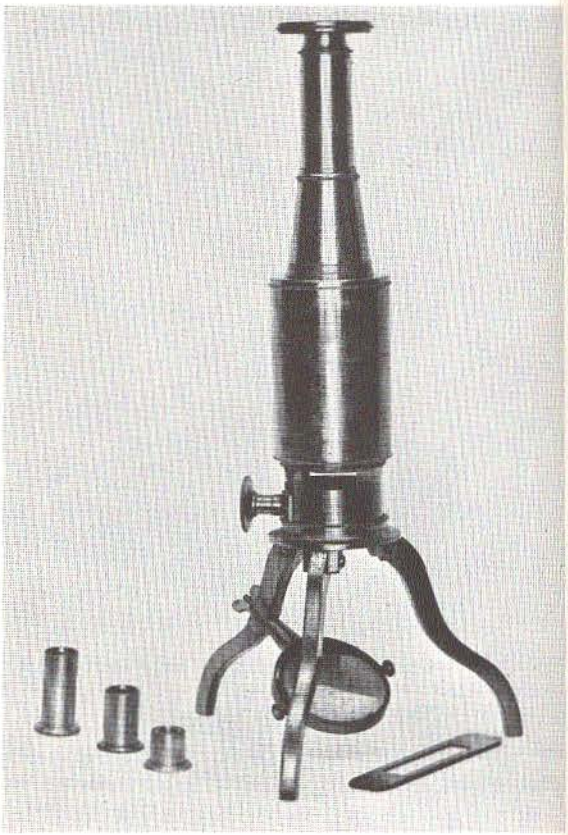

Fig. 57. S.J. Rienks, Leyden and Friesland, Holland; compound monocular; 1825. (AFIP 49063 - 60-4713-112)

stage discs; brass ring and key; stage forceps and condenser; a Martin superstage and discs; fish-plate; ivory talc box; lieberkühn on arm; cone diaphragm; and a mahogany case. It is signed on the foot, "Dollond, London," and is constructed along the lines of the "Joneses' Most Improved" model. ■

In the upper end of the body tube of this instrument (Fig. 57) there is a large concave mirror, and at the lower end a small convex mirror, the underside of which is ground to form a concave mirror to act as a lieberkühn. A stop supported on a wire in the axis of the microscope prevents direct light from passing to the eyepiece.

The instrument is constructed along the lines of the Dr. Robert Smith* reflecting microscope with a folding telescopic tripod base, a ring top 2-1/2 inches in diameter, and a short tube that carries the spring stage; it is focused by rack and pinion.

The body tube is 3-1/4 inches long and 2-1/2 inches in diameter and screws to the stagetube. The eyetube is a cylinder 2-1/2 x 1-5/16 inches with a 2-inch cone above that screws to the body tube. The double mirror is 1-15/16 inches in diameter and is attached by thumbscrew to one leg; the mirrors are of speculum metal. Height is 13-1/2 inches. Accessories are 4 compound oculars; slide holder; and forceps. It is signed, "S.J. Rienks, Friesland, 1825." ■

This instrument (Fig. 58, left) is mounted on a folding telescopic tripod base to which is attached a double circular pillar 4-3/4 x 1-3/16 inches; the height may be varied by adjusting the sliding inner pillar. There is a cradle joint with spring ring and clamp.

The body tube, 4-3/4 x 1-1/4 inches, has a cone-shaped nose. The triangular limb is 4-1/2 inches long, with the back side of the triangle planed; the limb fits to the nose with a spring

*Dr. Robert Smith (1689-1768), English microscope maker and author of "System of Optics," published in London, 1738.

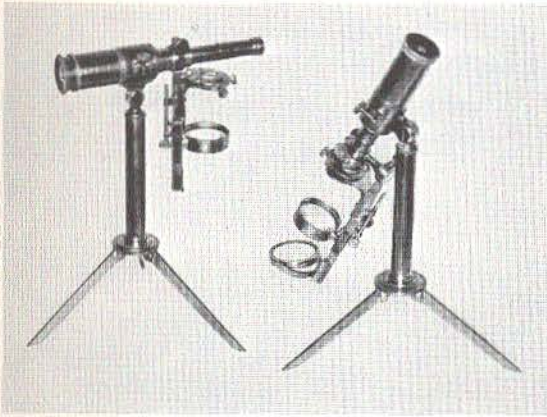

Fig. 58 (left). John Cuthbert, London, England; compound monocular; C. 1827. (AFIP 49072 - 63-6547)

ring and clamp. The double mirror is on a sliding sleeve and is 1-1/2 inches in diameter. The 2-inch oval stage is on a sliding sleeve, has mechanical motion in two directions, and has a Cuff fine adjustment attached.

In order to use this instrument as a dioptric, the reflector tube is replaced with the objective, and the limb is attached to an angle piece bringing the stage and mirror in optic axis. Height is 11 inches.

Accessories are 5 eyepieces; brass object holder; angle piece; Bonanni stage; and stage forceps. It is not signed, but John Cuthbert's card is affixed to the top of its mahogany case. John Mayall considered this to be the most elaborate catadioptric reflecting microscope he had ever seen. ■

Fig. 58 (right). John Cuthbert, London, England; simple and compound monocular; 1827. (AFIP 49071 - 63-6547)

This reflecting instrument (Fig. 58, right) is similar to AFIP 49072 pictured at the left in the same photograph, with the exception that its limb is 5-1/2 rather than 4-1/2 inches long. Height is 12 inches.

Accessories are 3 eyepieces; 3 lieberkühns; 11 ivory sliders; forceps; Bonanni spring stage; condenser for limb; brass object holder; and angle piece. It is signed, "John Cuthbert, London, 1827." ■

The square pillar of this instrument (Fig. 59) is 9-1/4 x 9/16 inch and screws to the top of the box base, 10 x 7-1/2 x 3 inches; it has a back rack. The single mirror, 3-3/16 inches in diameter, is attached to a sleeve with a pinion.

Fig. 59. Giovanni Amici, Modena, Italy; compound monocular; 1827. (AFIP 49070 - 63-6546)

The stage consists of a casing with pinion and plate, and the mechanical portion is a hollow square with milled heads at left and back; two wings with openings for forceps are fixed to the front. The front of the plate is circular, 2-1/4 inches in diameter, and has spring clips; below is a hinged well with revolving diaphragm.

The horizontal body tube is 6-1/2 x 1-1/4 inches and is affixed to the top of the pillar on a pivot pin with a setscrew. The compound eyepiece is 7/8 inch long. There is a prism in the front end of the tube and a short nose below for an objective. On top of the tube is a dovetail slide that carries a double arm with a condenser 9/16 inch in diameter. Height is 16-1/2 inches. ■

The folding, cross-shaped base of this instrument (Fig. 60) supports a square pillar 7 x 1/2 inch with a rack cut in its front. A 3-inch arm with a 1-3/8-inch-diameter ring is affixed to the pillar. The lower portion of the body tube, 3 x 7/8 inch, screws into this ring, while the upper portion carries the 1-1/16 x 1-1/16 x 7/8-inch prism box. Into this box screws, at a right angle, the upper 2-1/2 inches of the tube along with its 3/4-inch-long compound eyepiece. Consequently, the tube is divided with the prism box in the middle; when in use the ocular portion is horizontal.

The stage has a circular front 2 inches in diameter. It is on a casing 1-3/4 inches long and has a pinion and spring clip. On a rod at

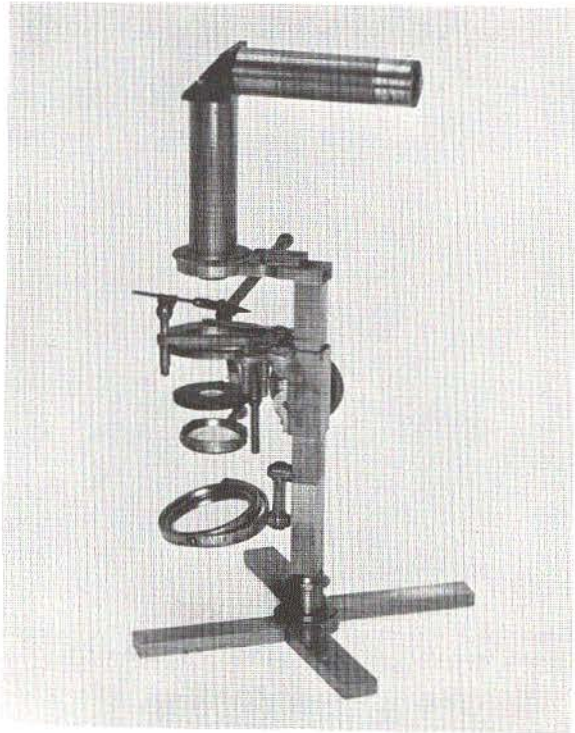

Fig. 60. Giovanni Amici, Modena, Italy; compound monocular; C. 1833. (AFIP 49077 - 60-4713-71)

the back and below the stage is a sliding plano-convex condenser with a diaphragm; the condenser is 1-1/8 inches in diameter. The single mirror is on a pivot arm and is 1-5/8 inches in diameter; there is no fine adjustment. Height is 11-3/4 inches. ■

The circular pillar of this instrument (Fig. 61), 10-1/2 inches high not including the compass joint by which inclination is effected, screws to the top of a mahogany box that forms the base. The 3-1/2-inch-long arm has an additional compass joint for use in a vertical position and carries a square limb, 9-1/2 x 1/2 inch, that is held in place by a milled-head pin and casing at the base of the pillar; a rack is cut at the back.

The mirror is 3-3/16 inches in diameter on the concave side and 2-1/16 on the flat side, and has a rack and pinion movement. There is a heavy glass plate, 3-1/4 x 4-1/4 inches, above the stage plates that has mechanical motion in two directions and is focused by rack and pinion.

The stage fits its casing by a dovetail slide. The fine adjustment screw has a ball-and-socket bearing and a groove in front attaches it to the

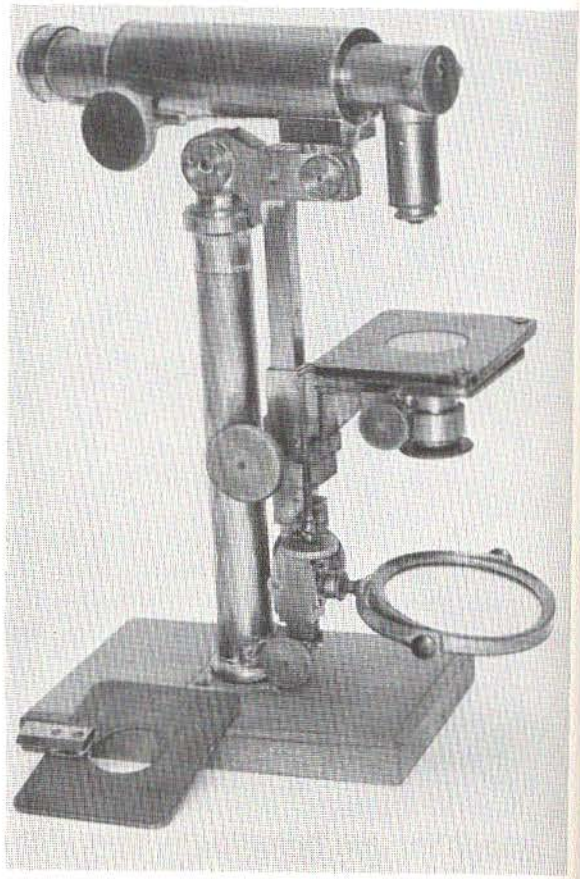

Fig. 61. Charles Chevalier, Paris, France; compound monocular; 1834. (AFIP 19488 - 60-4713-11)

stage. The condenser is situated immediately below the stage, has rack and pinion motion, and a small detachable prism at the top but no lens.

Accessories are 4 eyepieces; objective; plain stage; adapter; bull's-eye condenser; substage condenser with diaphragm; metal and glass trough; mechanical stage; compressorium; condenser with prism; diatom slide; spring clips; watch glass; lieberkühn; and glass discs. All attachments to the body tube are by breech plug sockets. Height is 15-1/2 inches. It is signed on the tube, "Microscope Universal Achromatique, de Charles Chevalier, Ingenieur Optician Brevete, Palais Royal 163, a Paris." ■

A circular brass, leaded base, 3-1/2 inches in diameter and 1/4-inch thick, serves as the support for this instrument (Fig. 62). A square pillar, 5 x 7/16 inch, is fixed in a square collar 1-1/4 inches high, and screws to the base; the pillar has a rack cut at the back.

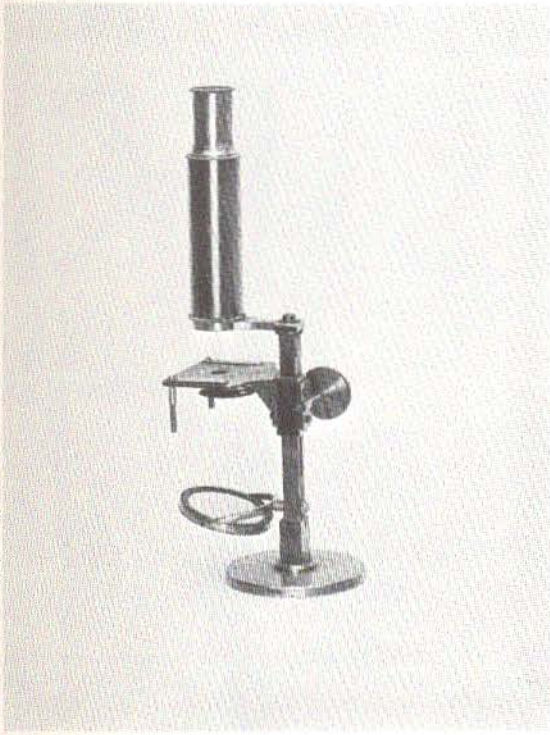

Fig. 62. Charles Chevalier, Paris, France; compound monocular; C. 1835. (AFIP 49079 - 60-4713-226)

The double mirror is fixed to the pillar by a pin and gimbal; the concave side is 2 inches in diameter, and the plane side 1-1/8 inches. The stage casing is 1-1/2 inches long and carries the pinion. The stage plate is 2-15/16 x 2-9/16 inches and is fixed and incurved at the back. Below the stage is the fixed well, 7/16 inch in diameter. At its right there is a rod that carries the revolving diaphragm. The arm is 3 inches long and is fixed to the pillar.

The body tube is 4-1/8 inches long and 1-3/8 inches in diameter, and screws into a ring on the arm; it has no drawtube. The instrument is a small, inexpensive student type. Height is 12-1/2 inches. ■

The leaded, circular base of this Fraunhofer-model instrument (Fig. 63) is 2-3/4 inches in diameter, and has attached to it a tubular pillar, 4-3/8 x 1-3/8 inches, that is cut away in front for the mirror box and the stage. An upper section of the pillar, 2-1/4 x 1-3/16 inches, screws to the main pillar and is sprung for the body tube. The sliding body tube is 5-3/4 inches long, has a cone-shaped nose, and a central screw division.

Fig. 63. Georges Oberhauser, Paris, France; compound monocular; 1835. (AFIP 49076 - 60-4713-9)

The single mirror is 1-1/8 inches in diameter and is on a milled-head pivot. A dovetail fitting above the stage carries a bull's-eye condenser on an adjustable curved arm with slot and clamp screw. The stage is 3 x 1-1/8 inches and has a screw fine adjustment at the lower right side. Height is 9-1/2 inches. It is signed, "Brand Freres, Opticien, Bruxelles," [Brand Brothers, Opticians, Brussels]; they were suppliers. ■

From the compass joint above the flat tripod base arises a circular pillar 7 x 1-3/16 inches with the rack screwed on at the back (Fig. 64). The single mirror is 1-1/2 inches in diameter and is on a pin in a sliding ring. The stage is 2-1/2 x 2-3/4 inches, incurved at the back, and is fixed to a ring collar and carries the pinion; it has apertures for forceps and condenser. Attached to the stage are a spring stage fitting and a disc of diaphragms.

A 3-inch-long arm is fixed to a tube that fits into the top of the pillar. The tube carries a heavy spiral spring, and, at the top, a long screw with milled head. This is the fine adjustment

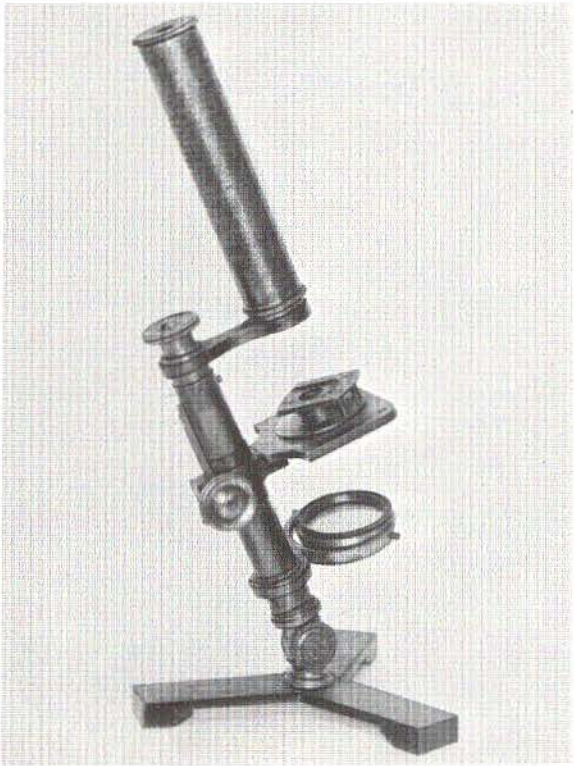

Fig. 64. Maker unknown, London, England; compound monocular; C. 1835. (AFIP 49080 - 60-4713-56)

that moves the entire arm and the body tube; it is the Oberhauser adjustment in reverse.

The body tube is 5-3/4 inches long and 1-1/8 inches in diameter and screws to the arm; there is no drawtube. Height is 14-1/2 inches. It is signed, "Carpenter & Westley, 24 Regent Street, London." This firm was not known to have made microscopes, but Carpenter was a dealer as early as 1825. The construction of some instruments sold by the firm has been attributed to Hugh Powell of London. ■

The pillar is 3-11/16 x 5/16 x 1/8 inch with a 2-inch slotted center, and screws into a plate attached by screws to the circular brass base of this Cary-model instrument (Fig. 65) that is 2-1/4 inches in diameter and 3/4 inch thick. The single mirror on optical axis is 1 inch in diameter and is on a gimbal to which is attached a pin that fits into the base.

The stage plate is fixed to its casing and moves in the slot; it has a screw clamp. Above the plate is a mechanical stage, 1-3/4 x 1-7/8 inches, that moves in two directions by rack and pinion. The fine adjustment is a screw of

Fig. 65. John Braham, Bristol, England; compound monocular; C. 1835. (AFIP 49078 - 60-4713-413)

the Cuff type, and is attached at the right side of the stage casing. The arm is 1-5/8 inches long, is attached to the top of the pillar by a screw, and moves in an arc.

The lower section of the body tube is conical and 1-5/8 inches long, with a field lens in the upper end. The eyepiece is 2-1/8 x 3/4 inch and screws to the cone section; the eye lens is single. The objectives screw into the tube that screws to the arm. The instrument may also be used as a simple microscope. Height is 8 inches. Accessories are stage forceps; live-box; bull's-eye condenser on telescope stand; and a mahogany case. ■

This Pritchard-type instrument (Fig. 66) is much heavier than the Joneses' type constructed by Dollond, and probably had achromatic objectives. It has a circular pillar 5 inches high and 1-1/16 inches in diameter, with a collar and screw clamp at the top, and attached to a flat tripod base. Within the pillar is a drawtube that carries the compass joint.

A short arm carries the heavy stage plate and casing with a pinion and circular limb that is 5-1/2 x 3/4 inch with a milled head at the base. Inside the limb is a pentagonal bar with the rack. The double mirror is 2-3/8 inches in diameter and is on a single arm gimbal pivoted to a sliding collar; there are two screw clamps.

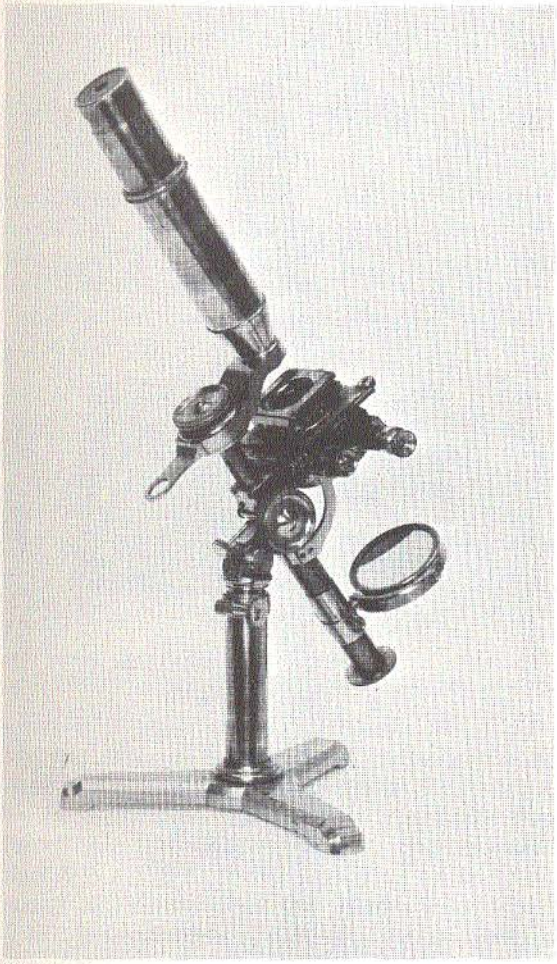

Fig. 66. Dollond, London, England; compound monocular; after 1835. (AFIP 49055 - 60-4713-213)

The heavy stage plate is reinforced underneath with braces to a collar on the limb. A heavy Turrell-type mechanical stage is fixed to the stage plate; the condenser fits by breech plug. One end of the 5-inch arm is flat for use of a simple lens; the other end is heavier and curved slightly upward. The arm is attached to the bar with a milled head and moves in an arc. The body tube screws to the arm and is 4 inches long and 1-5/8 inches in diameter, with a 1-inch cone. The drawtube with ocular is 6-3/4 inches long. Height is 18 inches.

Accessories are an ocular; ocular micrometer; simple objective; 7 ivory sliders; 2 lieberkühns; ivory talc box; brass slider; live-box; ivory disc; hand magnifier; Martin super-stage and discs; lieberkühn stage; fish-plate; forceps; and cone diaphragm. It is signed, "Dollond, London." ■

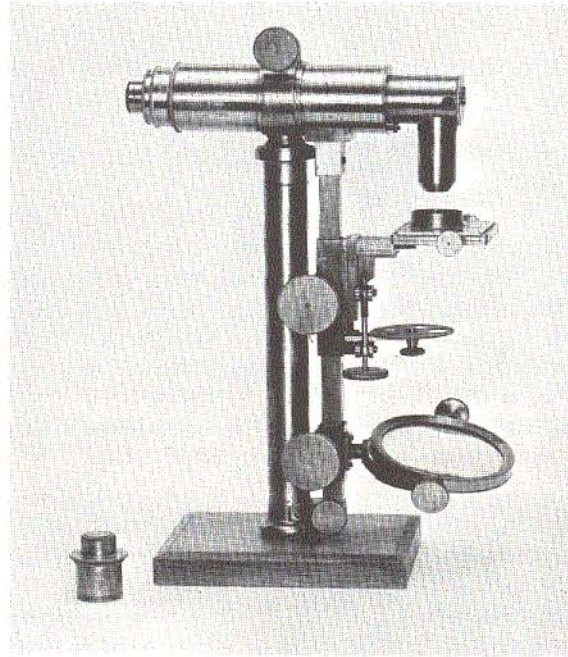

Fig. 67. Charles Chevalier, Paris, France; compound monocular; C. 1836. (AFIP 49081 - 60-4713-221)

The walnut base of this instrument (Fig. 67) is 6-1/2 x 5-1/2 inches, and attached to it is the circular pillar 14 inches high and 1-3/16 inches in diameter, with a wide ring at the top 2-1/8 inches in diameter and with a screw clamp. There is a socket at the base to fasten the limb with a screw pin. The limb is 11 x 1/2 inch, is in a box casing at the top, and is fixed to the body tube; the rack is at the back.

The horizontal body tube is 5-1/2 inches long and 1-7/8 inches in diameter and has a drawtube. The double mirror is on a casing with pinion; the concave side is 3-1/4 inches in diameter and the plane side 2-1/16 inches. The stage casing is 3 inches long and carries a pinion. The fine adjustment is an open-screw type similar to Chevalier's universal model pictured in Fig. 61 (AFIP 19488). There is also a revolving disc of diaphragms on a swing-out arm.

The stage plate fits to the casing by a dove-tail slide and carries the mechanical stage that is 2-1/2 x 3-1/4 inches; it moves in two directions by rack and pinion on a single screw with double milled heads. Height is 15 inches. It is signed on the tube and the mechanical stage, "Microscope Achromatique, de Charles Chevalier, Ingenieur Opticien Brevete, Palais Royal 163, a Paris." ■

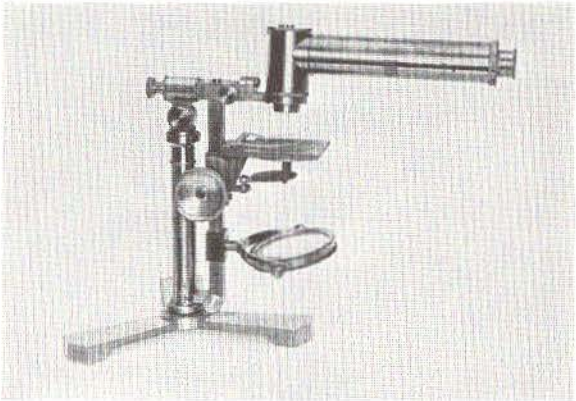

Fig. 68. Charles Chevalier, Paris, France; compound monocular; C. 1839. (AFIP 49083 - 60-4713-214)

A 7-inch circular pillar surmounted by a compass joint screws into the tripod base of this instrument (Fig. 68). Just above the joint is a cylinder, 1-1/16 x 7/8 inch, with a square, central 1/4-inch opening into which the rectangular arm fits secured by a milled-head screw; the arm is 1-5/6 inches long. The ring portion of the arm fits into a conical opening at the front; it is fastened by a milled-head pin. The ring section is movable on a screw pivot, and has a short vertical tube on which slides the short-nosed prism box for horizontal use. By removing the prism box the body tube slides on the vertical tube and becomes a vertical microscope.

The 7/16-inch-square limb is fixed to the arm and is held by a milled-head pin in a slot at the base of the pillar; the rack is at the back of the limb. The double mirror is on a sliding casing and is 2-1/2 inches in diameter on the concave side and 1-1/2 inches on the plane side. The stage plate is 2-3/8 inches square and is fixed to a casing that carries the pinion, spring clips, and two openings for forceps.

The central portion of the revolving stage is 2-1/4 inches in diameter. An inner 1/8-inch ring has two rods with springs beneath. The innermost ring has a 3/8-inch opening and may be removed to enlarge the stage opening to 1-5/6 inches. Below the stage and attached to the casing is a revolving disc of diaphragms that may be swung out of optic axis.

The body tube is 5-3/4 x 1-1/4 inches and slides on the prism box or the short vertical tube; the prism box is 2 x 1-1/4 inches. The ocular is compound and has a breechlock fitting; the objective screws in. It is the smaller model of Chevalier's universal microscope. ■

Fig. 69. Bertrand, Paris, France; compound monocular; C. 1839. (AFIP 49084 - 60-4713-296)

This miniature microscope (Fig. 69) is known as a mineral or furnace type. A mahogany box, 3-1/2 x 1-1/2 x 2 inches, has a conical dovetail slide cut into its top into which the instrument fits. The brass base is 1 x 1/32 inch and screws to a tube stand, 1-3/4 x 7/8 inch. There is a square cut in the front that houses a single mirror 5/8-inch in diameter on a milled-head pivot. The stand is cut away 3/4 inch from the bottom for the fixed circular stage. At the top of the stand there is a screw-in cylinder, 5/8 x 9/16 inch, into which the body tube slides. There is an outer casing that slides downward to become a slide holder. The body tube is 1-5/8 inches long; the objective and ocular screw in. Height is 4-1/2 inches. ■

AFIP 255. Georges Oberhauser, Paris, France; compound monocular; 1839. *Not illustrated.*

This Fraunhofer-model instrument is a duplicate in construction and detail of that by the same maker in Fig. 63 (AFIP 49076). It is signed, "G. Oberhauser, Place Dauphine 19, Paris." ■

AFIP 49085. Bertrand, Paris, France; compound monocular; C. 1839. *Not illustrated.*

This instrument is a duplicate of that by the same maker in Fig. 69 (AFIP 49084). Accessories are an objective, ocular, and forceps. ■

AFIP 49088. Bertrand, Paris, France; compound monocular; C. 1839. *Not illustrated.*

This instrument is similar in size and construction to that by the same maker in Fig. 69 (AFIP 49084). One difference is that this model has no outer casing for the slide holder. Accessories are 2 brass discs; objective; ocular; and a glass slider. Its box container is stamped, "Hilla, Optician, No. 2 Cranbourne St., Leicester Sup," indicating that Hilla was a supplier for Bertrand's microscopes in Leicester, England. ■

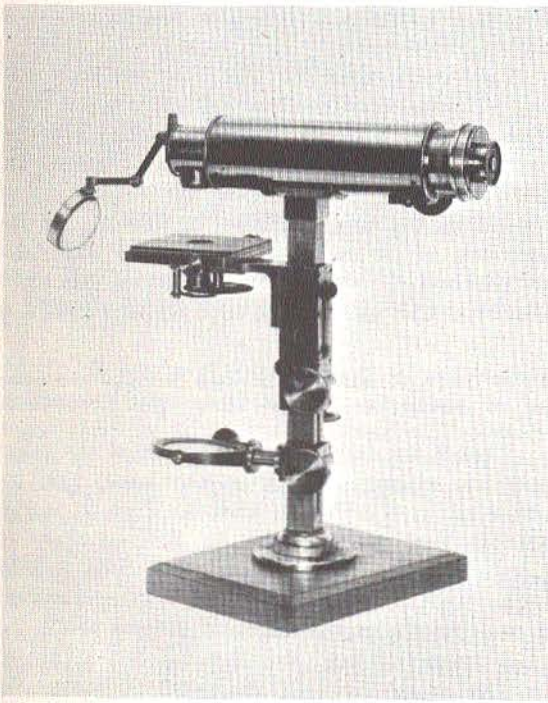

Fig. 70. Froment, Paris, France; compound monocular; 1839. (AFIP 49082 - 60-4713-223)

Attached to the walnut base, 5 x 6-1/2 inches, the rectangular pillar of this instrument (Fig. 70) is 9 x 5/8 x 3/4 inch, and has a rack at the back. The single mirror is 2 inches in diameter and is on a casing with pinion. The stage casing, 3-3/4 inches long, has a pinion and carries a Chevalier-type fine adjustment on the right side that is entirely encased.

The stage plate is 2-7/8 x 3-1/8 inches and is fixed to the casing. Above the stage are two plates, the upper of black glass, that move in two directions by a single rack and pinion with double milled heads. Below the stage is a dark chamber, a revolving disc of diaphragms, and a swing-out small condenser.

The horizontal body tube is 5-3/4 inches long and 1-7/8 inches in diameter and is fixed to the pillar. The nose is 1-1/8 x 1-1/4 inches and carries the prism box. A bull's-eye condenser, 1-3/4 inches in diameter on a jointed arm, is in a dovetail slide at the front of the tube. The drawtube has a rack and pinion movement. Height is 13 inches.

It is signed on the tube, "Froment a Paris." Only two of these instruments are known to have been made by Froment, a prominent optician, who probably introduced this microscope as competition to Charles Chevalier. The workmanship is superior to that of Chevalier, but its high cost most likely precluded its success. ■

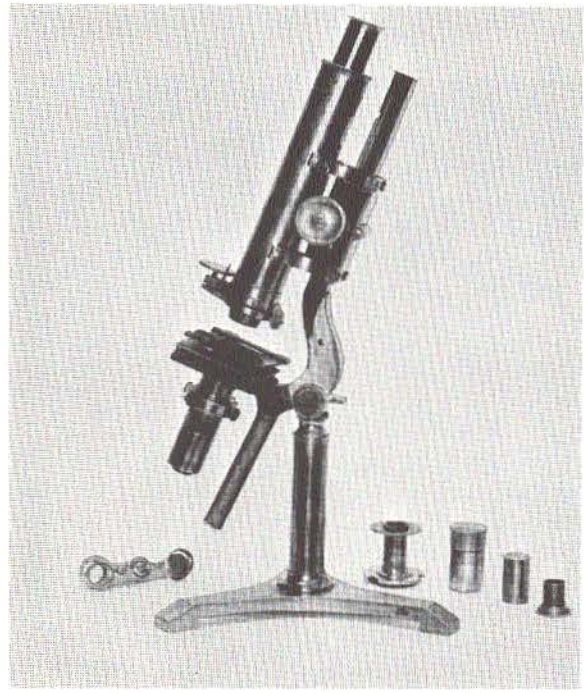

Fig. 71. Andrew Ross & Co., London, England; compound monocular; 1839. (AFIP 49095 - 60-4713-238)

The circular pillar of this instrument (Fig. 71) is 6 inches high and 1-1/16 inches in diameter, attached to a solid tripod base, and capped by a compass joint and screw clamp. It has a 11-inch-long Lister* triangular limb with a 4-inch tubular tailpiece that supports the cradle

*Joseph J. Lister, early 19th century English microscopist, whose work, both experimentally and mathematically, exerted a powerful influence on the early history of the optics of the microscope.

carrying the body, with a rack and pinion for coarse adjustment. The fine adjustment is a short lever-type nosepiece in front of the body tube.

The stage plate is fixed to the limb, above which is the mechanical part with rectangular motion furnished by the two racks and pinions. Both pinions are fixed in a frame below the right side of the stage and are parallel. The lower portion of the stage plate has a breech-lock fitting for the condenser that is attached.

The body tube is 8-1/4 inches long and 1-9/16 inches in diameter; there is no drawtube. Height is 18 inches. Accessories include an eyepiece; polarizer; analyzer (body prism); and a Brooke double nosepiece. It is signed on the foot, "Andrew Ross & Co., Opticians, 33 Regent St., Piccadilly." ■

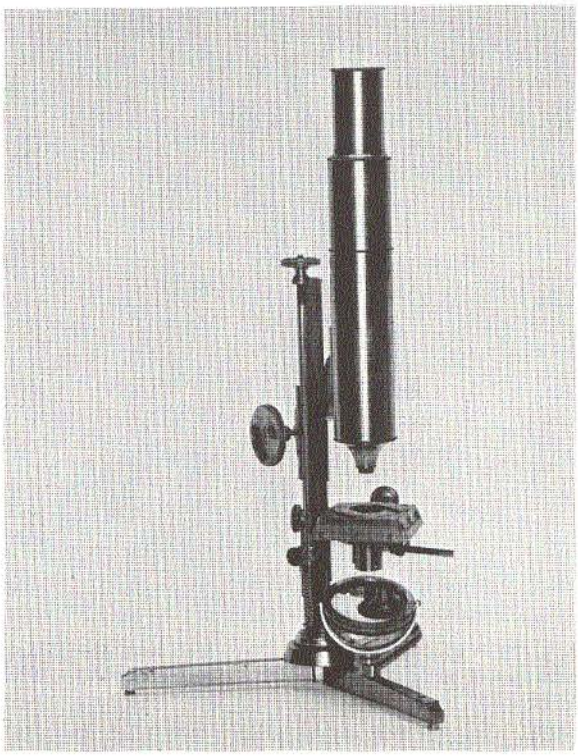

Fig. 72. Simon Plössl, Vienna, Austria; compound monocular; before 1840. (AFIP 49074 - 60-4713-230)

A folding tripod base supports the triangular pillar of this instrument (Fig. 72), that is 9-3/4 inches high and rests on 1/2-inch-diameter double circular bases; a rack is cut at the back. The single mirror is fixed to the front foot on two jointed arms, is 2 inches in diameter, and has a black plaster back.

The stage plate is 2-1/2 inches square and fixed diagonally to the casing. The upper section is mechanical and moves in two directions by milled-head screws. On a lever beneath the stage is a cylinder for condenser or diaphragm. The pinion is a single milled head, 1-3/4 inches in diameter, in a casing 2-1/2 inches long with a 1-1/4-inch angular arm attached to the tube by a plate and four screws. The fine adjustment is a milled-head steel rod 10 inches long from the top of the pillar. It passes through a socket with a screw clamp on the stage casing to a plate at the base of the pillar and terminates with a milled head and heavy steel spiral spring. The fine adjustment screw at the top is 1-1/4 inches in diameter.

The body tube is 7-1/2 inches long and 1-5/8 inches in diameter and has a screw division 5 inches above its lower end. The eye section is 2-3/8 x 1-5/16 inches, screws in, and is sprung. Height is 17 inches. It is signed on the tube, "Plössl in Wein." The instrument is an example of Plössl's large-type microscope; he continued the use of this style steel rod fine adjustment until the late 1860's. ■

AFIP 71801. Maker unknown; simple and compound monocular; before 1840. *Not illustrated.*

Except for the circular section of the pillar and the compass joint at the base, this instrument is similar to that in Fig. 52 (AFIP 49059) and attributable to William Cary of London. The pillar is 4-1/2 x 5/16 x 3/16 inch, with the lower 1-1/16 inches circular; a rack is cut at the back; it screws to the top of a rosewood box, 6-3/8 x 4-3/8 x 2 inches.

The stage is 1-11/16 x 1-3/16 inches, is incurved at the back, and is fixed to a casing that carries the pinion. It has two openings for condenser and forceps. The 1-3/4-inch-long arm is fixed to the pillar with a screw.

The body tube is 4-3/4 inches long and 1 inch in diameter, is cone shaped, and screws to the arm. It has a field lens and a screw-in compound eye lens. The single mirror is 1-3/16 inches in diameter and is secured to the pillar by a pin. (Donated by Mrs. Charles E. Riordan) ■

This instrument (Fig. 73) has a Fraunhofer drum-type body that may be screwed to a circular leaded base or to the top of its box container. The single mirror is 1-1/4 inches in diameter and is on a milled-head pivot.

The stage is 2-5/8 x 1-1/4 inches and is

Fig. 73. Georges Oberhauser, Paris, France; compound monocular; before 1840. (AFIP 49073 - 60-4713-227)

fixed. It has a revolving disc of diaphragms below the stage opening at the back of the body; there is no fine adjustment. Above the stage at the right is a screw pivot with two arms carrying a bull's-eye condenser 1-5/16 inches in diameter.

The heavy ring section above the stage has a breechlock into which fits a flanged tube, 1-1/2 x 1-1/8 inches, into which the body tube slides; this is the only coarse adjustment. At the back of the ring is a screw fitting for a tubular piece 7 x 7/8 inch. This screws to the box or leaded base, and when in use forms the horizontal microscope. The body tube is 4-1/2 inches long and 1 inch in diameter; the ocular slides into the tube. ■

The solid tripod base of this instrument (Fig. 74) supports a fixed circular pillar 5-3/4 x 7/8 inch. The single mirror is on a sliding collar, and is 2-1/8 inches in diameter and has a plaster flat back for white cloud illumination by sunlight.

The stage is fixed at the top of the pillar, is 2-1/2 x 1-7/8 inches, and has openings for forceps. There are spring clips above the stage and circular spring clips on the rods below the stage. The pillar contains a triangular bar with rack and pinion.

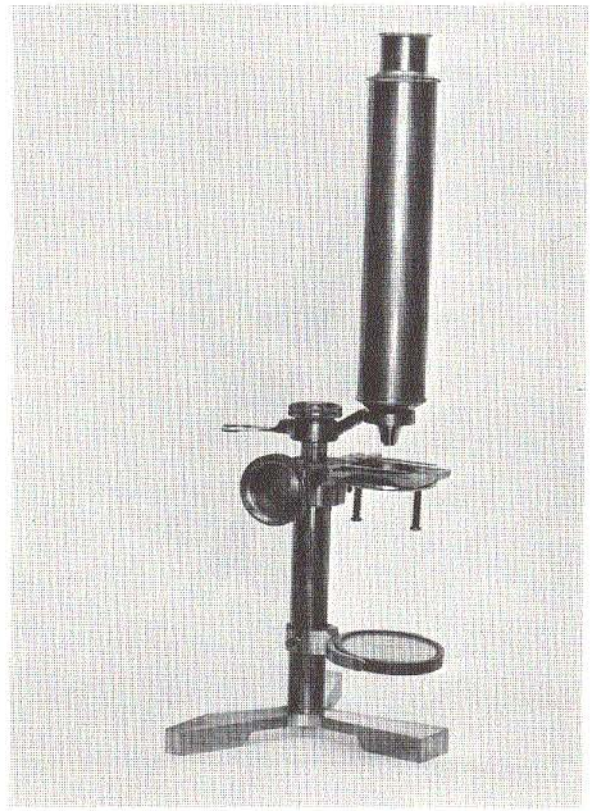

Fig. 74. Andrew Pritchard, London, England; simple and compound monocular; C. 1840. (AFIP 49092 - 60-4713-136)

The arm is 4-1/2 inches long, is attached to the bar by a milled-head screw, and moves in an arc. One end of the arm is flat with a spring opening for a simple lens, while the other end is at an upward angle, and to which the body tube screws. The body tube is 7 inches long and 1-1/2 inches in diameter. The eyepiece has a compound lens and screws in; it has an open cap protector. Height is 16 inches.

The only accessories are 3 button-type objectives. It is signed, on the foot, "A. Pritchard, 162 Fleet Street, London, A295." ■

A 4-inch brass pillar with compass joint at the top is attached to a solid tripod base of japanned iron of this student model instrument (Fig. 75). A short support carries a tubular limb 5-1/2 inches long. The double mirror is 1-3/4 inches in diameter for the concave and 1-3/16 for the plane; it is on a gimbal and attached to the limb by a pin with a milled head.

At the top of the limb is a box casing with a fixed stage, 2-1/2 x 2 inches, and with a 1/2-inch central opening, a pinion, spring clips,

Fig. 75. Charles Chevalier, Paris, France; compound monocular; C. 1840. (AFIP 49090 - 60-4713-211)

and openings for condenser and forceps. A revolving disc of diaphragms is attached to the stage, with the encased screw fine adjustment at the lower right. Within the limb is a 5/16-inch square bar with a rack at the back. To this is attached the 3-inch-long arm with ring into which the tube screws. The body tube is 6-3/4 inches long and 1-1/4 inches in diameter; there is no drawtube. A compound ocular and a stage condenser are attached. Height is 15-1/4 inches. ■

AFIP 72896. Charles Chevalier, Paris, France; compound monocular; C. 1840. *Not illustrated.*

This instrument is identical to the microscope by the same maker in Fig. 75 (AFIP 49090), with the exception that the mirror is on a sliding collar, and there is a cylinder well with a revolving disc of diaphragms. ■

The folding, telescopic, tripod base of this catadioptric instrument (Fig. 76) screws to a 7-1/2-inch-high cone-shaped pillar with compass

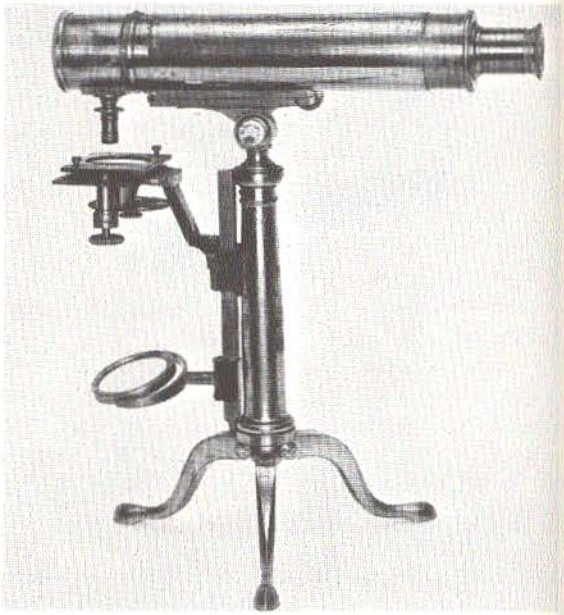

Fig. 76. Maker unknown; compound monocular; C. 1840. (AFIP 49086 - 60-4713-222)

joint at the top; the 1/4-inch-square limb is fixed to the pillar, with a rack at the front. The single mirror on a sliding case is 1-9/16 inches in diameter.

The stage plate is fixed to an angle arm and is 2-1/4 x 2 x 9/16 inch. It has an upper plate 1-1/2 x 2-1/4 inches on screw rods, with a central opening with a screw thread. The fine adjustment (Chevalier's encased screw) is at the left side. Below it is a cone and a revolving disc of diaphragms on a rod.

The rectangular arm is 3 inches long; it is split and hinged at the front end. The lower half is fixed to the joint and the upper half to the body tube, and is held in place by a milled-head pin. The body tube is 7-3/4 x 1-5/8 inches and has a drawtube with a field lens; the prism box slides in. The objective screws to a fitting below the front end. By removing the prism box and using an adapter the microscope may be used in a vertical position. Height is 12 inches. ■

The Y-shaped tripod foot of this instrument (Fig. 77) is 10 inches long and 8 inches wide at the front; the heel is hinged at 2 inches. The circular pillar is 4 inches high and 1-1/2 inches in diameter; it has a compass joint with a clamp at the top. In this joint is a short, heavy arm, that carries the 8-inch circular limb, with an inner triangular bar.

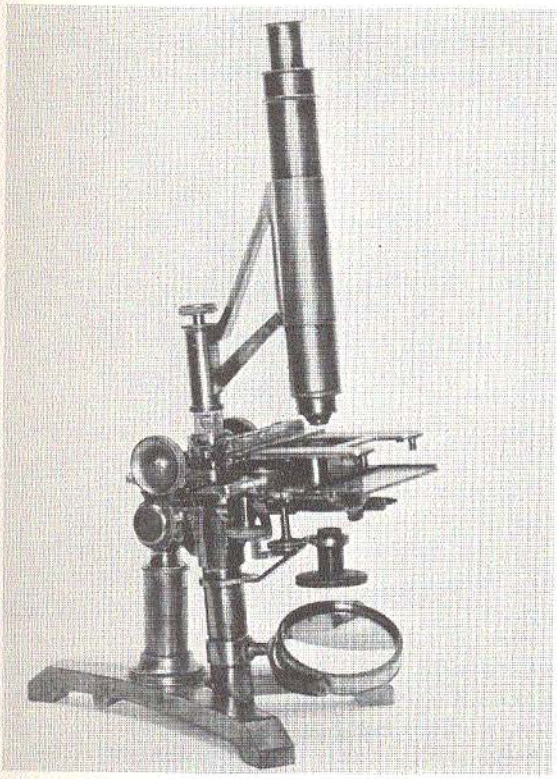

Fig. 77. Andrew Ross & Co., London, England; simple and compound monocular; C. 1840. (AFIP 49091 - 60-4713-203)

The stage plate is 5-1/4 x 4-3/4 inches, with a mechanical stage above that has rectangular motions controlled by two racks and pinions. Both pinions are fixed in a frame below the stage and are not parallel. A revolving disc of diaphragms fits beneath the stage with a short cylindrical tube. There is a double mirror, 2-3/4 inches in diameter, at the lower end of the limb on a sliding sleeve, and immediately above is another sleeve with an angle arm for a screw-in condenser, polarizer or dark well.

The micrometer fine adjustment is located above the compass joint, and has a lever action on the coarse adjustment; the rack and pinion coarse adjustment is above on the triangular bar. There is a ring at the top of the triangular bar, and immediately above the ring the bar becomes circular and carries a 2-inch-long collar secured by a milled-head screw. A 5-inch brass tube is fixed to this collar by two arms that extend upward.

The body tube is 9 inches long and 1-3/8 inches in diameter and slides in the brass tube. The lower end of the body tube has a screw-in nosepiece with an inner tube that slides freely and is pressed down by a spring; this was intended for a nosepiece fine adjustment.

For use as a simple microscope, the entire arm may be removed and another substituted. In working position it is 20 inches high. No reference to it has been found in the literature, and it probably represents Ross' change from the Jackson model and precedes his "long lever bar" fine adjustment of 1843. It is signed on the foot, "Andw. Ross & Co., Opticians, 33 Regent St., Piccadilly." ■

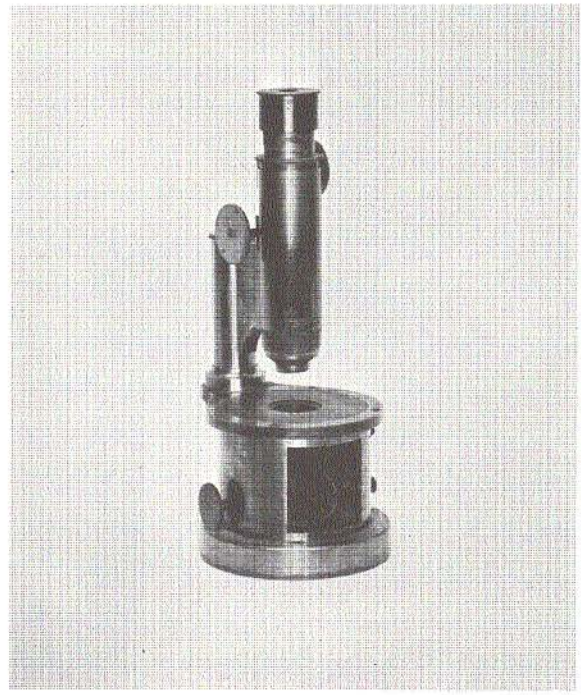

Fig. 78. Georges Oberhauser, Paris, France; compound monocular; after 1840. (AFIP 71796 - 60-4713-229)

The leaded base of this pancratic instrument (Fig. 78) is 4-3/16 x 3/4 inch and the cylinder body is 2-7/16 x 3-1/8 inches; the front is cut away for 1-3/4 inches. The double mirror is 1-3/4 inches in diameter and is on a milled-head pivot. There is a revolving disc of diaphragms below the stage plate with an opening at the left side. The stage plate is 3-7/8 inches in diameter, has a projection at the back, and is fixed to the pillar.

Originally a circular pillar, 3-3/4 x 1 inch, was fixed to the body by three screws. This was altered by drilling the top of the pillar and inserting a long iron bolt with a base nut, allowing the pillar to move in an arc. The 1-1/4 x

7/16-inch arm is fixed to the pillar and has a plate attached by screws to a tube, 3-3/4 x 1-1/8 inches, and is sprung at the top.

The center of the stage plate is metal with a 1/8-inch recessed aperture of 1-5/16 inches; there are openings for two spring clips, condenser and forceps. The body tube is 4 inches long and 1-1/4 inches in diameter and carries a rack at the back. Above this is another plate with a single milled-head pinion on the left side for the drawtube that carries a rack; the drawtube has an opening for a compound ocular, and has a screw-on cap. The nosepiece screws in and has a breechlock fitting into which fits a flanged objective.

This microscope was introduced by Oberhauser in the 1830's and was a modification of the Fraunhofer instruments; it is the earliest Oberhauser microscope in the Collection that bears a serial number. It is signed on the arm, "Georges Oberhauser, Brevete, Place Dauphine 19, Paris," and, "Microscope, Achromatique, a Grossissements, Variables, No. 1158." ■

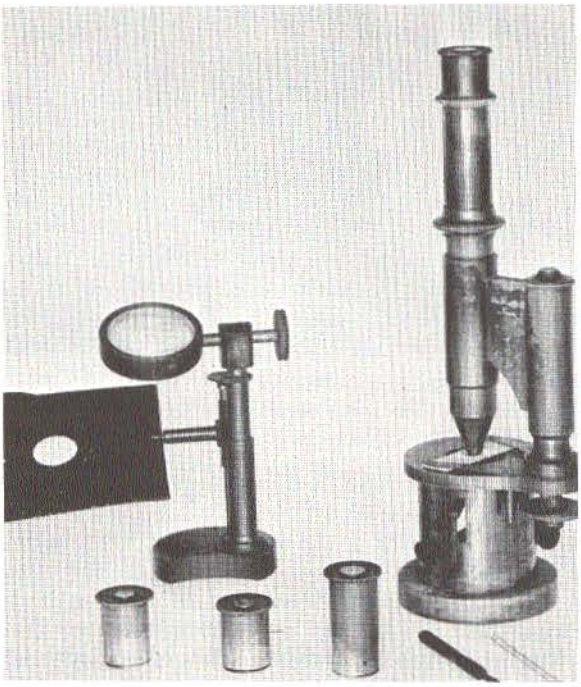

Fig. 79. Georges Oberhauser, Paris, France; compound monocular; after 1840. (AFIP 49089 - 60-4713-12)

This instrument (Fig. 79) has a leaded circular base 3-1/4 x 1/2 inch, and a cylinder body 2-1/4 inches high and 2-5/16 inches in diameter with an opening in front 1-5/16 x 1-3/4 inches. It carries a single mirror, 1 inch in diameter, and a lever diaphragm cylinder. The stage plate rotates on the body, is 2-7/8 inches in diameter, and has a projection at the back; the central section is metal with a recessed aperture.

The circular pillar is 4 x 1-5/16 inches, is fixed to the stage plate projection, and carries a fine adjustment with the screw head at the base. An arm, 2-3/4 x 1 inch, and curved to 1-3/4 inches, is attached to the pillar and fixed to a sprung tube, 2-3/4 x 1-1/8 inches, into which the body tube slides. The body tube is 8-1/4 x 1-5/16 inches and has a screw ring division in the central section. On a separate 5-1/2-inch-high stand is an adjustable compound condenser and a thin stage with a revolving diaphragm 3-1/2 inches in diameter.

This model was designated by Oberhauser as, "Microscope a Tambour a Dissection" [drum microscope for dissecting]. The design was copied by Nachet, Lerebours, Soleil and Chevalier with modifications chiefly in the mechanism of the substage. Height is 11-3/4 inches. Accessories are 3 metal diaphragms and 3 compound oculars. It is signed on the arm, "Georges Oberhauser, Place Dauphine 19, Paris, No. 1391." ■

AFIP 49075. Maker unknown; compound monocular; C. 1841. *Not illustrated.*

This instrument is a duplicate of that in Fig. 78 (AFIP 71796) with the following exceptions: The pillar is fixed to the stage plate by three screws; both pinions are on the right side; the objective screws to the body tube; and there is a stage condenser on an arm with milled-head screw. Height is 11-1/2 inches. Accessories are an objective and a compound ocular with screw cap. An instrument similar to this model was introduced by Georges Oberhauser of Paris in the 1830's, and was a modification of the Fraunhofer model. Early models had a rotating stage, fine adjustment on the pillar, and a sliding body tube; a rack and pinion was added later to the body tube. About 1840 a rack and pinion was added to the drawtube to make it pancratic. ■

AFIP 49087. Bertrand, Paris, France; compound monocular; C. 1841. *Not illustrated.*

This microscope is similar to that in Fig. 69 (AFIP 49084) by the same maker, except that it was made at a later date. ■

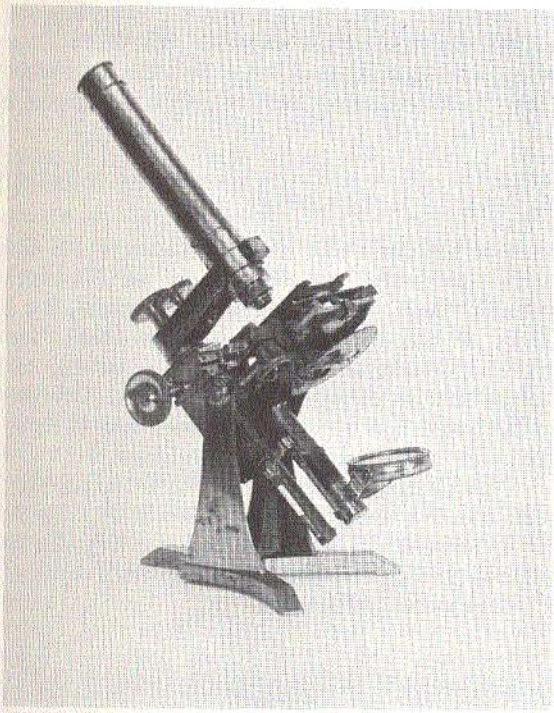

Fig. 80. Andrew Ross & Co., London, England; simple and compound monocular; after 1841. (AFIP 49096 - 60-4713-210)

The two 5-inch-high uprights of this instrument (Fig. 80) are strengthened by internal buttresses mounted on a strong tripod 5-1/4 x 7 inches. There is an axis between the uprights upon which the upper portion of the instrument turns to either a horizontal or vertical position. This movable part is fixed to the axis near its center of gravity, and consists of the stage, triangular bar and its socket, the arm that carries the microscope tube, and the tailpiece and mirror.

The stage has rectangular movements on racked cylinders and is moved by pinions with milled heads below the stage. These are identical to those on the instrument made by Ross in Fig. 77 (AFIP 49091).

The arm supporting the tube carries the long lever fine adjustment operated by a milled head on top of the arm and connected with the sliding nosepiece. The triangular bar is operated by rack and pinion.

The tube is 7-3/4 x 1-1/4 inches, has a screw-in sliding nosepiece, but no drawtube. The tubular tailpiece is fixed to the stage. The double mirror on a 2-inch sleeve is 1-3/4 inches in diameter and slides on the tailpiece. On the same sleeve is another short sleeve with an arm for dark wells. The arm to which the tube is fixed is attached by a long milled-head screw to the triangular bar. This entire arm may be replaced by another arm if a simple microscope is desired. Height is 15-3/4 inches. It is signed on the tube, "Andw. Ross, Optician, London, No. 65." ■

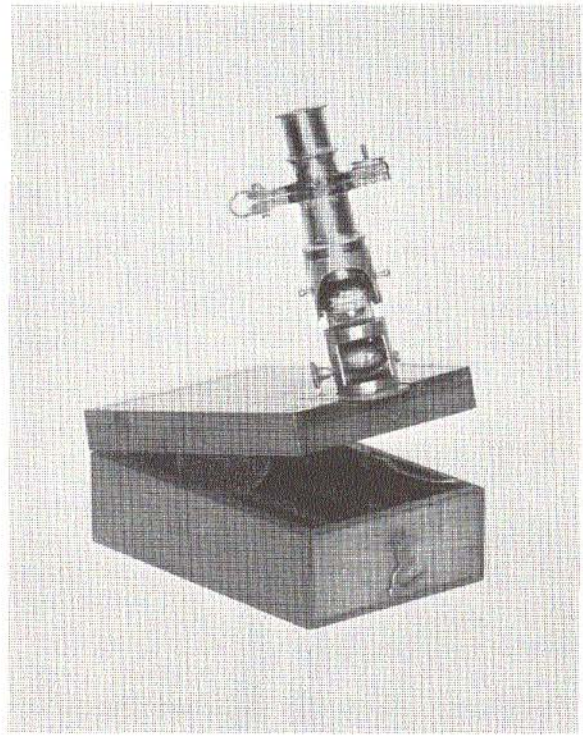

Fig. 81. Bertrand, Paris, France; compound monocular; after 1841. (AFIP 49093 - 60-4713-218)

The mahogany box container for this instrument (Fig. 81) is 2-1/2 x 3-7/8 x 1-5/8 inches with a brass dovetail mounted at the front of the lid. The 7/8-inch-diameter base screws to the tubular stand, 3/4 x 11/16 inch, and has a fixed stage plate.

The single mirror is 7/16 inch in diameter. At the back of the stand is a heavy brass plate to which is attached the upper section of the stand that has a sliding outer case for slides. A cylinder section, 3/4 x 9/16 inch is screwed to the upper end. At the top of the cylinder is a 2-inch horizontal steel spring clamp, the lower side of which is fixed to an inner tube. This spring clamp has a milled-head screw and forms the fine adjustment. The body tube is 2-1/8 x 1/2 inch and slides into the inner tube. Accessories are 3 button-type objectives and a compound ocular. ■

AFIP 49113. Noel P. Lerebours, Paris, France; compound monocular; C. 1846. *Not illustrated.*

The tubular body of this instrument is 4-1/8 x 1-5/16 inches and screws to a hollow, circular brass base 1-7/8 x 3/8 inch. The upper portion of the body is 1 inch in diameter and is sprung. There is an oval cutout, 1 x 1-1/8 inches, at the bottom.

The 15/16-inch-diameter mirror is on a milled-head pivot. The circular stage is 1-3/16 inches in diameter, has a central aperture, and is fixed; the body is cut away above the stage. There is no fine adjustment.

The sliding body tube is 2-3/8 inches long and 1 inch in diameter. The 1-3/4-inch-long compound eyepiece screws into the body tube. Height is 8 inches. The only accessory is an achromatic objective. It is similar to the instrument by the same maker in Fig. 82 (AFIP 49114). ■

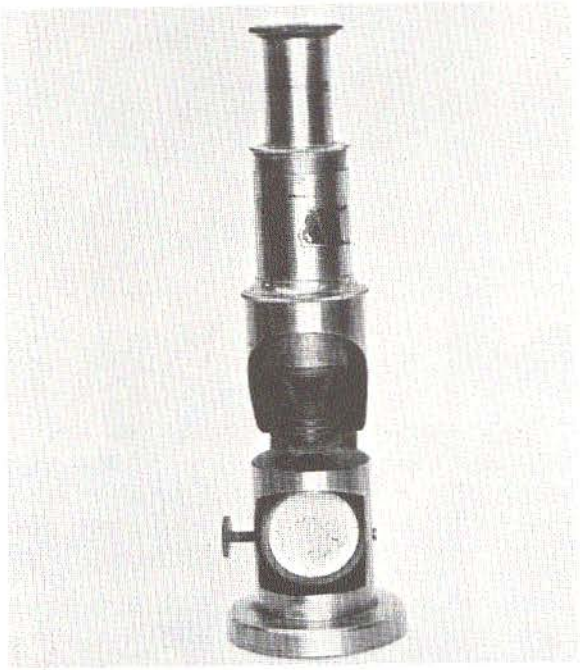

Fig. 82. Noel P. Lerebours, Paris, France; compound monocular; 1846 to 1850. (AFIP 49114 - 60-4713-284)

This miniature drum microscope (Fig. 82) has a 2-1/4-inch-diameter base fixed to the tubular body that is 5-1/2 x 1-1/2 inches. The upper 1-1/2 inches of the body is 1-3/16 inches in diameter and is not sprung. There is a 1-1/16-inch-diameter mirror. The 1-3/8-inch-diameter circular stage is fixed.

The body tube is 2-5/8 x 1-1/8 inches and slides for coarse adjustment. The 2-inch-long compound eyepiece screws into the body tube; there is no fine adjustment. Height is 8 inches. ■

AFIP 181. Maker unknown; compound monocular; C. 1846. *Not illustrated.*

The tubular body of this instrument is 3-1/4 x 1-1/4 inches and screws to the 1-3/4-inch circular base. There is an oval cutout, 1 x 1 inch, in the lower portion of the body. The 15/16-inch-diameter mirror is inserted in the cutout and is on a milled-head pivot. The circular stage has a central aperture and is fixed; the body is cut away above the stage.

The sliding body tube is 2-3/8 inches long, and the 1-1/2-inch ocular screws in. Height is 6 inches. The instrument is very similar to that in Fig. 82 (AFIP 49114) made by Noel P. Lerebours of Paris. ■

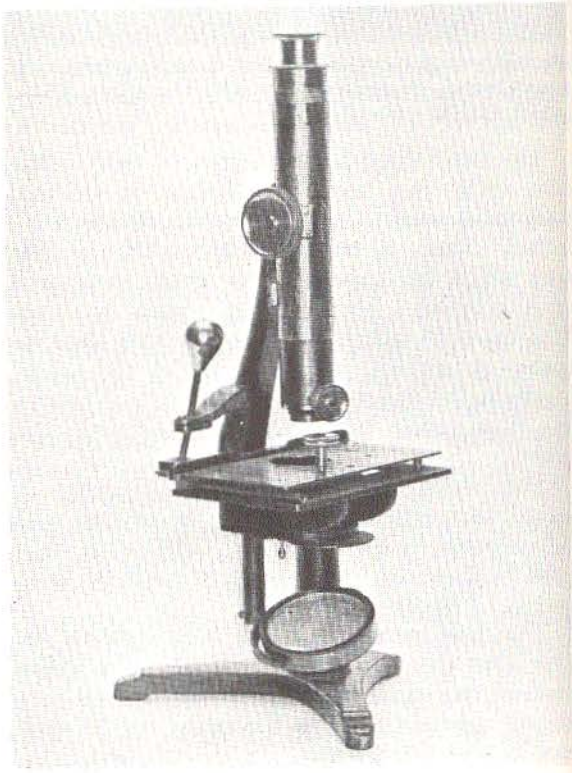

Fig. 83. Powell & Lealand, London, England; compound monocular; before 1848. (AFIP 49098 - 60-4713-137)

The solid tripod base of this instrument (Fig. 83) with a spread of 7-1/2 x 6 inches has a 5-inch-high screw-in pillar with a flange, 5 x

1-1/8 inches tapering to 1 inch at the top from 1-1/8 inch at the base. The 8-inch-long Lister limb has a horseshoe cast at the base that is 2 x 4 x 7/8 inch. The tubular section at the left rotates in the flange and is held by a screw. There is a 2-1/4-inch arm at the right for the ball-and-socket lever to the stage. To the lower section of the horseshoe is attached a plate with an opening and a breechlock setting and into which fits the revolving disc of diaphragms.

The screw-in brass tubular tailpiece is 2-3/8 x 1/2 inch, and there is a fitting on a pivot for the dark well. The double mirror on a gimbal and pin is 2-1/4 inches in diameter. The brass stage plate is 5-1/2 x 3-5/8 inches with a 1-3/8-inch opening, is fixed to the upper section of the horseshoe, and carries above it the brass lever motion mechanical stage. There are three threaded holes in the stage, one with a milled-head screw, and a sliding bar at the back.

The limb is attached by four screws to the brass tube that is 5-3/8 x 1-1/4 inches and sprung at the top and bottom. The lower end has a slot in front, 1 x 1/4 inch, in which moves part of the fine adjustment; the tube carries a single milled-head pinion.

The brass body tube is 8-3/4 inches long, has a sliding nosepiece, and the rack is attached to the inner side of the tube. Height is 15-1/4 inches. It is signed on the tube, "Powell & Lealand, London"; it was designed by C. Varley of London. ■

The modified claw-footed base of this instrument (Fig. 84) is green japanned iron. The curved pillar is 5 inches high, has a compass joint at the lower end, and screws to the base. At the top it is fixed to a tube, 2-5/8 x 1-1/8 inches, and carries a single milled-head pinion. The single mirror is 1-1/16 inches in diameter and fixed to the pillar by a pin.

Below the 2-1/4 x 1-3/4-inch stage plate is a revolving disc of diaphragms; above is a lever mechanical stage. Fixed to the front of the tube is a bull's-eye condenser 1-1/2 inches in diameter on a jointed arm. The body tube carries the rack, and is 6 inches long with the drawtube closed. Height is 10-1/4 inches.

It is most likely of French make, the mechanical stage dating it after 1843. The claw-footed-type base was used generally after the horseshoe base was introduced by the Frenchman, Georges Oberhauser. ■

Fig. 84. Maker unknown; compound monocular; C. 1848. (AFIP 49097 - 63-6549)

AFIP 254. Maker unknown; compound monocular; before 1850. *Not illustrated.*

The 4-1/4 x 5/8-inch circular leaded base of this instrument is similar to the base of the microscope made by Oberhauser in Fig. 79 (AFIP 49089), as are a number of its other characteristics. The lever movement of the cylinder diaphragm is similar to models made by Nachet of Paris.

There is a 2 x 2-1/4-inch cutout in front of the 3-1/4 x 3-inch-long tubular body that houses the 1-inch double mirror on a pivot with two milled heads. The stage plate is 4 inches in diameter, has a projection in back, and is fixed to the body; it carries a mechanical stage. Below the stage is a lever to operate the cylinder diaphragm.

The pillar is 3-3/4 x 15/16 inch and is fixed to the stage plate projection. It carries the fine adjustment with base screw, and the arm with a 1-3/4-inch ring to which screws a 2-inch-long heavy tube into which the body tube slides. The body tube is 7-1/4 inches long, has a screw division at 4-3/4 inches, and a 1-inch conical nose; the objective screws in and the ocular slides in. Height is 13-1/4 inches. Although not signed, the workmanship points to Nachet, Sr., of Paris as the maker. ■

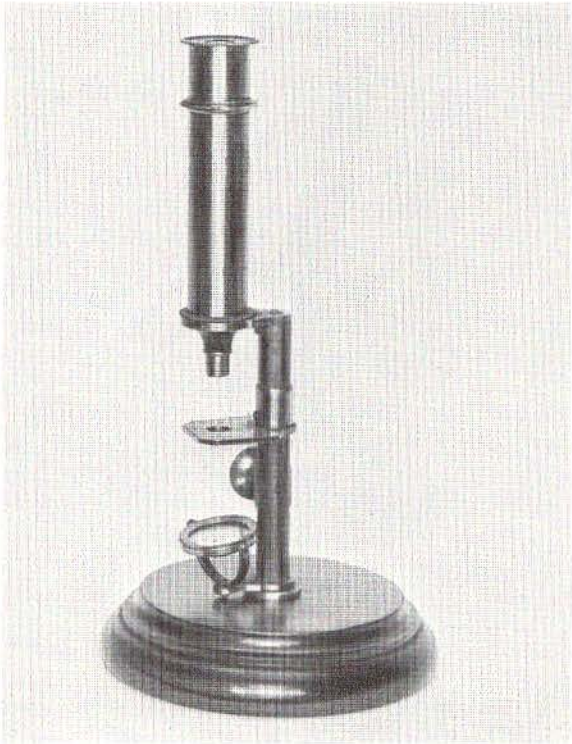

Fig. 85. Simon Plössl, Vienna, Austria; compound monocular; before 1850. (AFIP 49100 - 60-4713-148)

There is a screw-on brass socket on the 4-1/4 x 1/2-inch circular pillar of this instrument (Fig. 85) originally probably screwed to a brass base, although it is now on a 5-inch-diameter walnut base.

The 7/8-inch-diameter single mirror is on a gimbal and 1-1/2-inch arm. The stage is 1-5/8 x 1-1/4 inches and is on a collar with a fixed pinion. The rack is inside the pillar that has a recessed opening 3/8 inch in diameter. The arm is 1-1/2 inches long, has a ring end, and is attached to the top of the pillar by a screw; it moves in an arc.

The body tube is 4 x 7/8 inch, has a cone nose 5/8-inch long, and screws to the arm. The upper section of the body tube has a field lens and a single eye lens. This is the smallest of the three models made by Plössl before 1850; this type was also made with a drawtube. Height is 10 inches. ■

The 2-1/2-inch-high pillar of this instrument (Fig. 86) is in the form of a monkey seated on a rectangular block with his left leg crossed. It is attached to the circular, hollow metal base with screws.

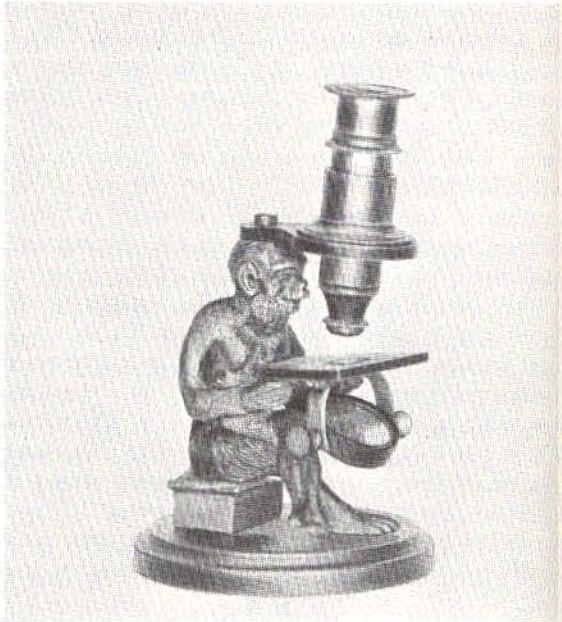

Fig. 86. M. Moreau, Paris, France; compound monocular; C. 1850. (AFIP 49099 - 60-4713-268)

The extended forearms of the monkey support the stage that is 1-1/4 x 1-1/16 inches with a 5/16-inch aperture. The 5/8-inch-diameter single mirror with double milled-head pivots is on two curved supports below the stage. The arm is 1-5/8 inches long, has a tubular ring 5/8-inch in diameter, and is attached to the head of the monkey by a screw.

The body tube is 1-5/8 inches long, has a 5/16-inch cone nose, and slides into the tube ring. There is a field lens and the single eyepiece screws in. Height is 4-1/2 inches, and it is signed on the base, "Moreau." It is referred to as the "monkey" microscope. ■

This instrument (Fig. 87) has a circular leaded base 3-3/4 inches in diameter. The 5-7/8-inch-high pillar, 7/16-inch square, is held by a screw in a 1-inch-high box casing that screws to the base; the rack is at the back. The single mirror is 2 inches in diameter, is attached to the pillar by a pin, and held by a screw.

The stage casing is 1 inch in diameter and, with a single milled-head pinion, carries the 2-5/8 x 3-7/8-inch stage. The stage has a 1/2-inch central aperture. Below the stage is a fixed cone and a revolving disc of diaphragms on a rod. The arm is 2-3/4 inches long, has a ring, and is attached to the pillar by a screw; it moves in an arc to the right.

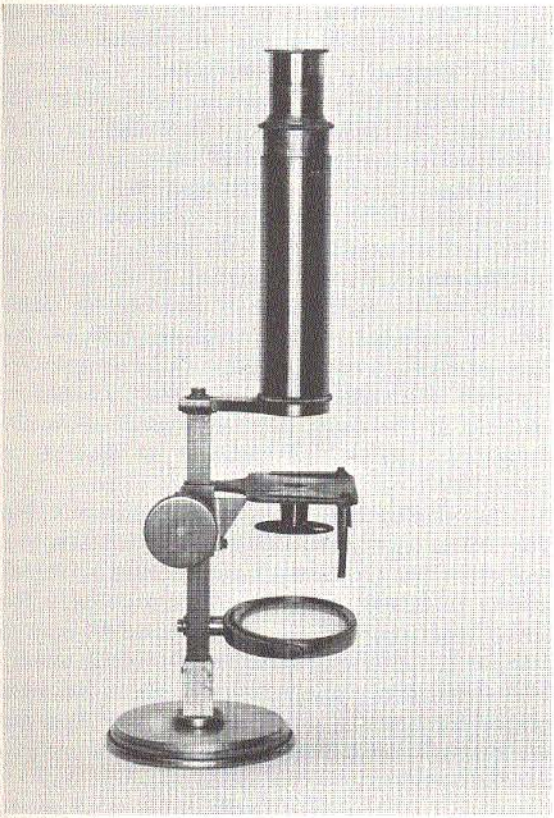

Fig. 87. Charles Chevalier, Paris, France; compound monocular; C. 1850. (AFIP 49102 - 60-4713-248)

The body tube has a drawtube, is 4-5/8 x 15/16 inch long, and screws to the arm. The objective screws to the arm and the ocular slides in. Height is 13 inches. This type microscope was first introduced by Chevalier in 1838 and was continued until after 1865. As none of his instruments had serial numbers affixed, and the lower-priced models were not signed, the date of 1850 is approximate. ■

The body is 1-1/2 x 1-3/8 inches long and screws to the 1-3/4-inch-diameter circular leaded base of this instrument (Fig. 88). The body has a cutout in front, 1 x 1-1/8 inches, that houses the 7/8-inch single mirror on a milled-head pivot. The circular stage is fixed to the body, is 1-5/16 inches in diameter, has a 3/8-inch opening, and a projection at the back.

The circular pillar is 1-7/16 inches high and 3/8 inch in diameter, and screws to the stage projection; there is no fine adjustment. The arm is attached to the pillar by a screw, has a tubular ring at the front, is 1-1/16 x 1 inch, and is sprung; the arm and stage are blackened.

Fig. 88. Maker unknown; compound monocular; C. 1850. (AFIP 49101 - 60-4713-350)

Attached to the front of the arm tube is a ball-and-socket arm with a 7/8-inch Selligue lens condenser. The body tube is 2-5/16 inches long. The eyepiece is 1-3/16 x 7/8 inch, has a compound lens, and screws to the body. Accessories are 3 objectives and a forceps. This miniature instrument is constructed along the lines of Georges Oberhauser's large model. ■

This instrument's (Fig. 89) circular leaded base is 1-7/8 x 3/8 inch and supports two thin pillars, 11/16-inch high, to which is attached the tubular body 4-1/2 x 1-5/16 inches. The upper 1-1/8 inches of the body is 1 inch in diameter and is sprung; it may be inclined to a horizontal position. At the front there is a 1-inch oval cutout.

The single mirror is 7/8 inch in diameter, and is on a milled-head pivot that fits into a slot in the right pillar when in vertical position. At 1-5/8 inches the body is cut away at the sides, and in this opening the 2 x 1-1/4-inch stage is fixed. There is no fine adjustment. The sliding body tube is 2-7/16 x 15/16 inch, and the compound ocular is 1-1/4 x 13/16 inch and screws in. ■

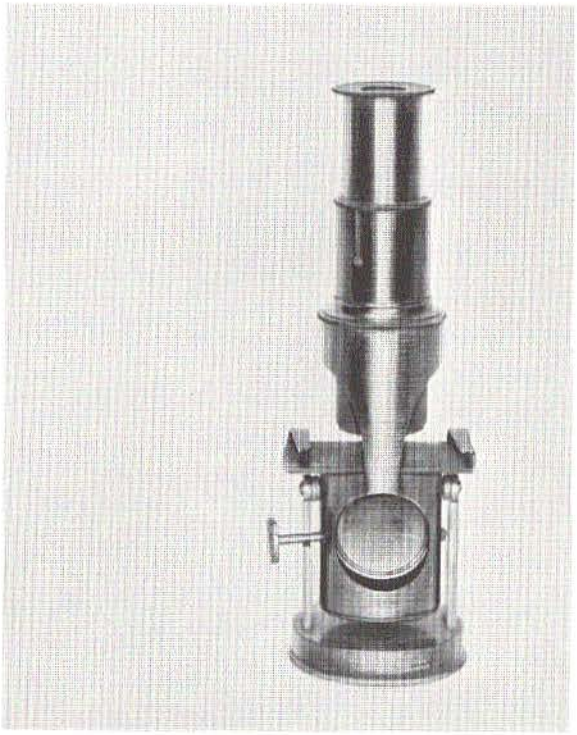

Fig. 89. Maker unknown; compound monocular; C. 1850. (AFIP 49104 - 60-4713-349)

This instrument (Fig. 90) has a circular leaded base 2-3/4 inches in diameter, and a tubular body 6-1/2 inches long. The lower 4-1/4 inches of the body is 1-1/2 inches in diameter, and the upper 2-1/4 inches is 1-1/8 inches; the upper section is sprung. A 1-1/4-inch cutout at the front of the tube houses a single mirror 1-1/16 inches in diameter on a pivot, milled head at the left.

The stage plate is 2-3/4 x 1-1/4 inches, is fixed to the tube at 2-1/16 inches with a cutout section above it. A second plate has the fine adjustment on the right. There is a revolving disc of diaphragms below the stage with an opening at the back. On a dovetail above the stage is a bull's-eye condenser 1-1/2 inches in diameter.

The sliding body tube is in three sections. The lower section is 3-1/4 x 1-1/16 inches, and screws to the central section that is 1-11/16 x 1-1/4 inches and has a heavy collar. The upper section screws to the central section and is 1-1/4 x 1 inch. Height is 11 inches. The instrument is constructed along the lines of the Fraunhofer model, but differs from any such models in the Collection. ■

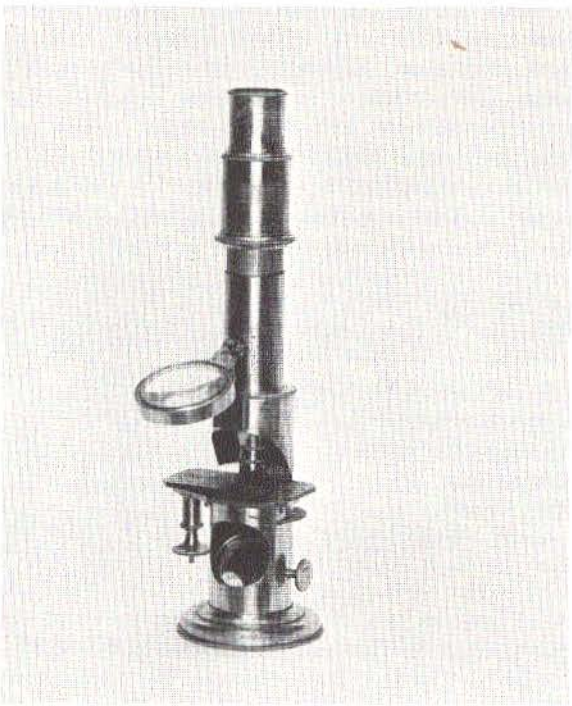

Fig. 90. Maker unknown; compound monocular; C. 1850. (AFIP 164 - 60-4713-130)

Fig. 91. Nachet & Son, Paris, France; compound monocular; C. 1850. (AFIP 49103 - 60-4713-158)

The circular leaded base of this instrument (Fig. 91) is 4-1/8 x 5/8 inch. A semicircular

casting makes up the 3-1/4-inch square pillar and stage plate; the casting represented an innovation. A tubular limb, 5 x 7/16 inch, with a milled-head setscrew arises from the projection at the back of the pillar. On this limb on a sliding case is an arm with a ring opening for a condenser or diaphragm. At the top on a sliding case is another arm, 2-7/8 inches long, that carries the 1-5/8-inch single mirror on a gimbal.

The stage is 3-5/16 inches in diameter and has a 7/8-inch central aperture. The prism box with tubular objective and screw fine adjustment fits into a dovetail slide on the base. A four-sided prism is the most important element of this microscope.

The body tube is 7 x 1-1/8 inches and angles to the front of the prism box. The upper 2-1/4 inches comprise the compound eyepiece with setscrew, and there is a slot with a screw adjustment for the micrometer slide; below it is a screw and projection ring for the goniometer. Height is 9 inches.

Accessories are 2 button-type objectives and an ocular. It is signed on the base, "Nachet et Fils, 17 Rue St. Severin, Paris." This instrument was used in the laboratory of the Medical Museum by Dr. J. J. Woodward, famed photomicroscopist, from 1865 to 1884.

Dr. J. Lawrence Smith of the University of Louisiana invented this type of microscope in 1850. It was devised to improve and simplify the Chevalier inverted attachment to the universal microscope (1834), that was difficult to work with. From Dr. Smith's drawings and specifications Nachet constructed the first instrument of this type which was exhibited in September 1850. Another instrument with slight modifications was used in the laboratory of Wurtz and Verdier, Paris. Nachet exhibited the "Nachet Chemical Microscope" in 1851 at the London Exposition, and he continued to produce this type microscope with modifications for more than 25 years, but at no time was Dr. Smith mentioned as the inventor. ■

This microscope (Fig. 92) has a solid tripod foot and a screw-in tubular pillar, 5-1/4 inches high and 15/16 inch in diameter, with a heavy ring collar; there is an inner sliding tube with compass joint. A short arm with ring casing and screw clamp supports the 7 x 7/8-inch tubular limb to which is attached the fixed stage casing with a single milled-head pinion.

The single mirror is 1-3/4 inches in diameter and is on a sliding collar. The stage is 2-7/8 x 2-3/4 inches and is incurved at the back; it has spring clips, a 1-1/8-inch recessed aperture, and a breechlock socket for the condenser. The limb is within a triangular bar and carries the rack at the back. The 4-inch-long arm is fastened to the bar by a milled-head screw; one end of the arm is for a simple lens.

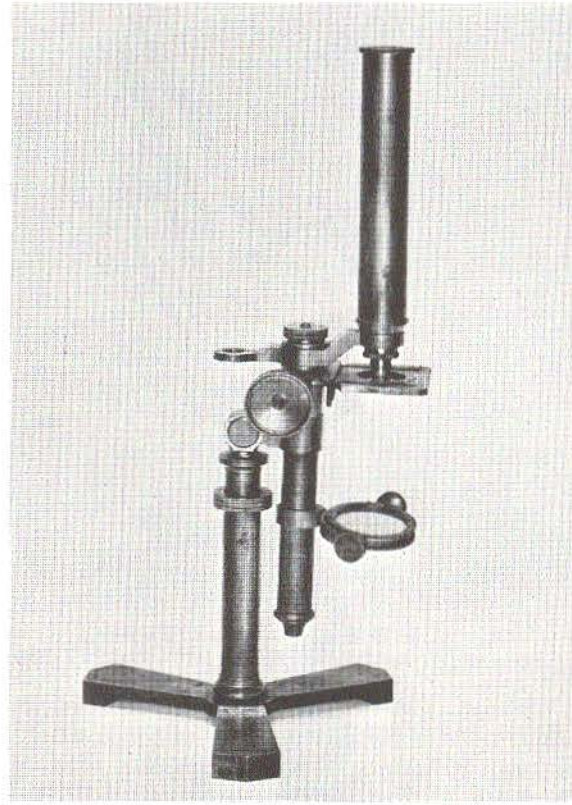

Fig. 92. C. A. & H. Spencer, Canastota, New York; simple and compound monocular; 1850. (AFIP 49105 - 60-4713-22)

The body tube is 7 x 1-3/16 inches and screws into the opposite end of the arm that extends upward. There is a breechlock socket for the objective; it has no fine adjustment. Height is 18-1/4 inches. The microscope is one of the first made in the United States. It is signed on the tube, "C.A. & H. Spencer, Canastota, N. Y." Between 1850 and 1854, C.A. and H. Spencer were producing both the small and large trunnion Pritchard-type* microscopes, and at least two types of cheaper student models. About 1854 the firm name was changed to Spencer and Eaton, and later to C.A. Spencer and Sons. ■

*Andrew Pritchard, London, England, see Fig. 74 (AFIP 49092).

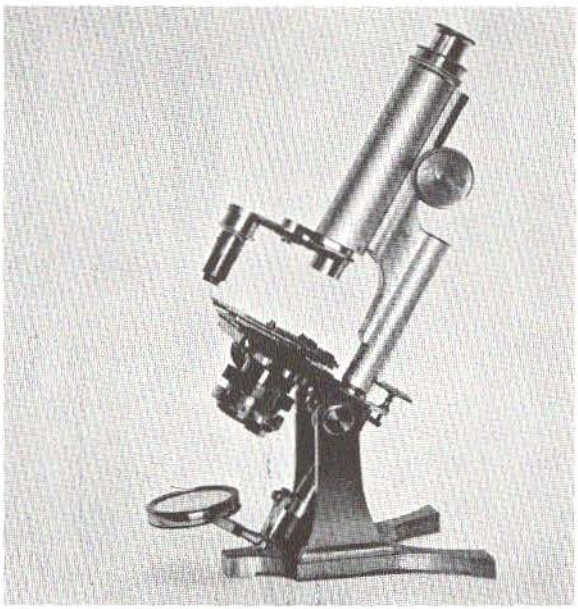

Fig. 93. Smith & Beck, London, England; compound monocular; 1850. (AFIP 201 - 60-4713-338)

The reversed claw-footed base of this instrument (Fig. 93) has a spread of 6-1/4 x 5-3/4 inches, with two 4-1/4-inch uprights attached by screws. The stage plate is 5-1/4 x 2-3/8 inches, is incurved at the back and has flanges hinged to the uprights by screws. A tubular tailpiece, 3-3/4 x 11/16 inch, carries the 2-inch double mirror on a sliding case and arm.

A tubular limb with a cap and angular arm, 4-3/4 x 13/16 inch, is fixed to the back of the stage plate with a double milled-head precision pinion. Within the limb is another tube and a rod and spiral spring, with a milled head on a lever below the stage plate that forms the fine adjustment.

A mechanical stage with a revolving top plate and slide holder bar is fixed to the stage plate. Originally, it probably had a cylinder diaphragm, but now has an achromatic condenser in a sprung casing with a setscrew on a square arm attached to the left side of the stage plate.

The body tube is 5-3/4 x 1-7/16 inches and carries the rack and has attached a Brooke nosepiece; it has a drawtube. Height is 15 inches.

It is signed, "Smith & Beck, 6 Coleman St., London, 2251." The type of fine adjustment described above was not used on any other model. This student model was made until 1876, but is not listed in the catalogues of 1880. Before 1896, Smith and Beck introduced the "pathological model" that had the same fine adjustment, a single pillar, and a tripod base. ■

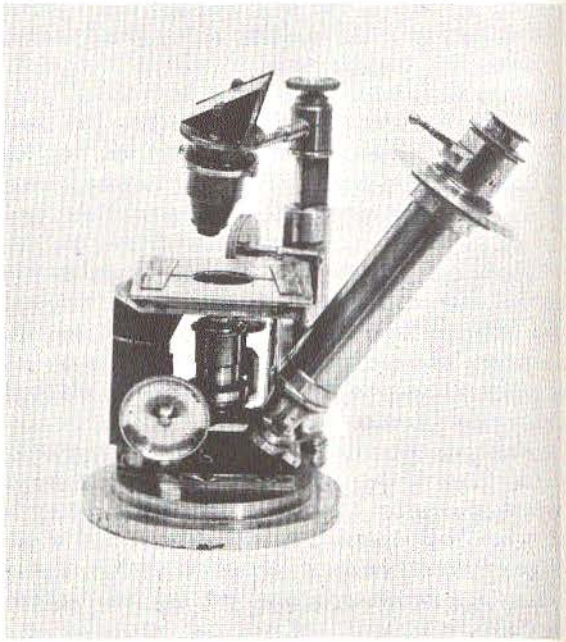

Fig. 94. J. & W. Grunow, New Haven, Connecticut; compound monocular; 1855. (AFIP 71790 - 66-1836-5)

On the circular base of this instrument (Fig. 94) is another base that rotates, and which has a dovetail into which slides the prism box with a fitting for an objective and the fine adjustment. The body tube screws to the prism box and carries the goniometer, slide-in micrometer, and the ocular.

The triangular pillar, 3-1/4 inches high, has a rack in front and is located at the back of the revolving base. A casing with pinion and a 3 x 3-inch stage plate are on the pillar. On the stage plate is a lever mechanical stage, 3-3/8 inches square, with a 1-1/4-inch circular opening; the lever is below the stage, and there are two sliding bars in dovetail grooves.

A 5 x 1-inch tubular pillar with pinion is fixed to the projection at the back of the base; a triangular bar with rack is within the pillar. The top of the bar is circular, 7/16 inch in diameter, and has a milled-head screw. On this bar may be fitted an arm for the prism condenser, the oblique illuminator, or the polarizer for the inverted microscope. By removing the inverted tube and prism box a double mirror may be inserted. When the arm with the extra body tube is placed on the bar the instrument may be used as an ordinary vertical microscope. The arm to which the body is attached is 5 inches long; the tube is 6 x 1-1/8 inches, has breechlock fitting for adapters and screw-in objectives.

Accessories are an objective; prism condenser; bull's-eye lens; 2 oculars; goniometer; mirror; and oblique illuminator. It is signed on the base, "J & W Grunow, New Haven, Conn., No. 56; invented by Prof. J. Lawrence Smith." Made in 1855 it differs from the inverted chemical microscope type made by the Grunows for their trade. ■

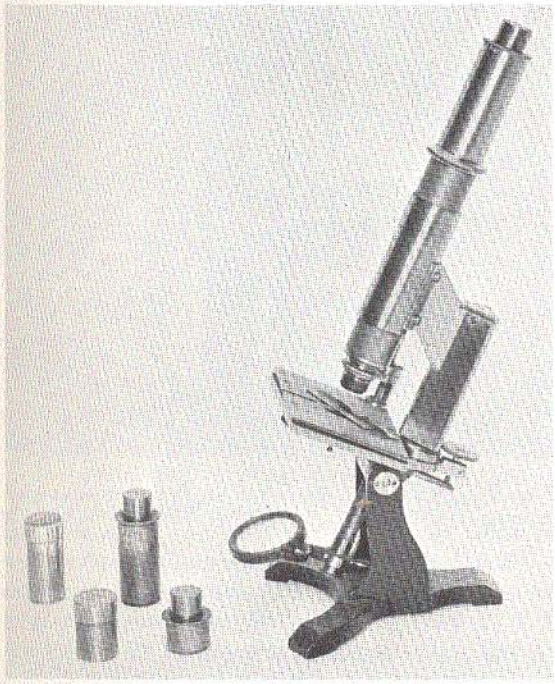

Fig. 95. J. & W. Grunow, New Haven, Conn.; compound monocular; before 1859. (AFIP 69930 - 60-4713-82)

The Y-shaped cast iron base of this instrument (Fig. 95) has two uprights 3-1/2 inches high. The 3-1/2-inch-high triangular pillar, the 4 x 2-3/4-inch stage plate, and the brass trunnion bar are all in one casting. A tubular tailpiece, 2-1/2 x 3/8 inch, is fixed to the trunnion bar and carries a sliding collar and arm for the double mirror, that is 1-1/2 inches in diameter for the concave and 1 inch for the plane.

Below the stage plate is a breechlock for a revolving disc of diaphragms. At the right of the stage plate and fixed to it is a curved arm for the lever mechanical stage, that has two bar holders with dovetail slides.

The triangular pillar has an outer casing with a short angular arm fixed to a 3 x 1-3/16-inch tube, sprung at the top and bottom, into which the body tube slides. The fine adjustment is at the back of the stage plate and works on the outer casing of the triangular pillar. The body tube is 7-1/2 inches long and 1-1/16 in diameter, and has a heavy ring 4-3/4 inches from the bottom. The ocular slides in, and the objectives have breechlock fittings. Height is 13-3/4 inches.

Accessories are 3 oculars and an objective. It is signed, "J & W Grunow, New Haven, No. 179." Before 1856 the Grunows were making two types of student microscopes. The high-priced model had a Lister limb with rack and pinion, and the low-priced model was similar to this model, except that it had a tubular pillar and no mechanical stage. ■

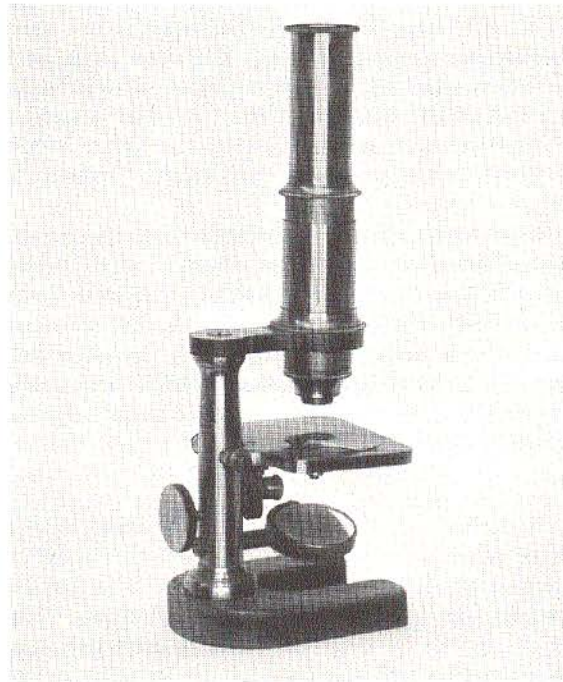

Fig. 96. F.W. Schiek, Berlin, Germany; compound monocular; before 1860. (AFIP 49118 - 60-4713-117)

The horseshoe-shaped base of this instrument (Fig. 96) is made of japanned iron and is 3-1/4 x 2-1/4 inches, and attached to it is a brass pillar 3-15/16 x 11/16 x 5/8 inch. A double mirror, 1-1/4 inches in diameter, is attached to the pillar by a pin and screw.

The 2-7/8 x 3-inch stage is also attached to the pillar by a U-shaped projection and pivot screws. It has a 9/16-inch central aperture, and a revolving disc of diaphragms. There is a projection at the inner back of the stage with a milled-head screw pin through the pillar that serves as a fine adjustment.

The 2-3/4-inch-long arm is attached to the pillar by a screw. There is a 1-1/2-inch ring at the front with a fixed tube 2 x 1-3/16 inches. The body tube is 6 inches long with a cone nose at the lower 3-1/2 inches. The upper section of the tube is 2-1/2 x 1 inch and slides into the fixed tube for coarse adjustment. Height is 9-1/2 inches. After Oberhauser introduced the horseshoe-shaped base in 1848, this model came into use to insure space for oblique illumination. ■

AFIP 53392. Maker unknown; compound monocular; C. 1860. *Not illustrated.*

This is similar to the instrument in Fig. 50 (AFIP 49068). Principal differences are that the tube with ring top is 3-1/8 inches long, and the body tube 6 x 1-5/8 inches. The rack is screwed to the outside of the tube and a single milled-head pinion is fixed to the tube; holes for glass tubes are above the stage. Height is 10-3/4 inches.

Accessories are an objective; objective with lieberkühn attached to the stage; ivory slider; and a brass-mounted hand glass. It is signed on the body tube, "J.H. Steward, 406 Strand, London"; it was sold, not made, by Steward, who established a business in 1856 and made mathematical instruments and sold microscopes. (Donated by Dr. M. Abrahams) ■

Attached to the 3-1/2 x 7/16-inch leaded base of this instrument (Fig. 97) is a cylindrical body 2-1/2 x 2-9/16 inches, that has an opening in front 1-1/2 x 1-3/8 inches. The single mirror is 1-1/8 inches in diameter, and there is a revolving disc of diaphragms. The stage is attached to a fixed plate and is 2-1/2 x 3-1/2 inches. There is a fan-shaped projection at the back, and a 9/16-inch central aperture. The projection has an indicator and a graduated scale marked, "Presbyte - Moyenne - Myope," [Far-Normal-Near].

The 2-1/8 x 3/4-inch pillar arises from the fixed circular plate. On the pillar below the plate is a two-armed adjustment for the indicator. Attached to the top of the pillar is a 3-inch-long arm to which is fixed a 3 x 13/16-inch tube, sprung below and slotted at the back. In front of the tube is a dovetail for the stage condenser. On the arm, at the back, is another tubular pillar, 3 x 5/8 inch, that carries the screw adjustment; this is attached to an arm that is screwed to the body tube.

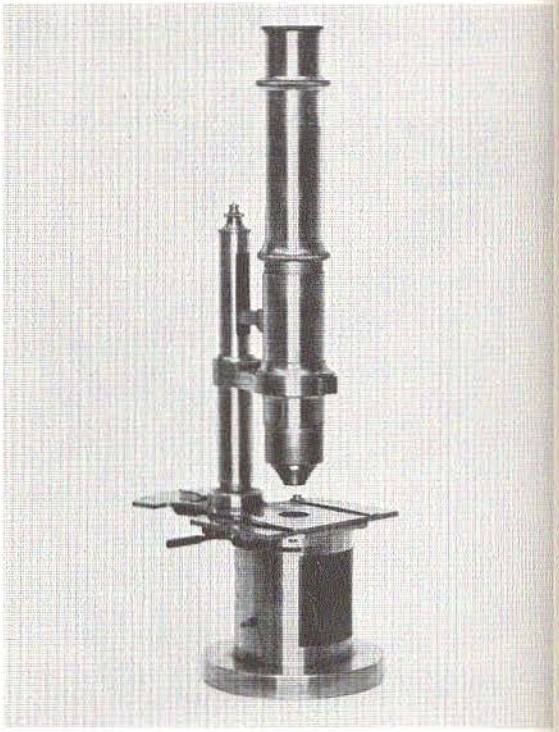

Fig. 97. Nachet & Son, Paris, France; compound monocular; C. 1860. (AFIP 49106 - 60-4713-110)

The body tube with cone nose is in two sections, the lower 4-3/8 inches and the upper 4-7/16 x 1-1/8 inches; the upper section screws to the lower section. Height is 12-3/4 inches. It is signed on the arm, "Nachet et Fils, Rue Serpente 16, Paris." ■

AFIP 163. Maker unknown; compound monocular; C. 1860. *Not illustrated.*

This instrument is similar to that in Fig. 50 (AFIP 49068). Accessories are 4 objectives; objective with lieberkühn; mounted hand glass; live-box; and brass talc box. It is signed, "Semmons, New York"; it was sold by that company. ■

This instrument (Fig. 98) has a circular leaded and conical base 3-1/4 inches in diameter, to which is attached the tubular pillar, 4-3/4 x 11/16 inch, with a rack at the back and a heavy collar. A dovetail piece, 6-1/2 x 7/8 x 1/8 inch is fixed on a 2-3/8-inch-long casing with a double milled-head pinion. A vertical stage, 1-1/2 x 2 inches, with a disc of diaphragms on a rod is on sliding fittings. The single 1-1/8-inch-diameter mirror is on a gimbal and rod.

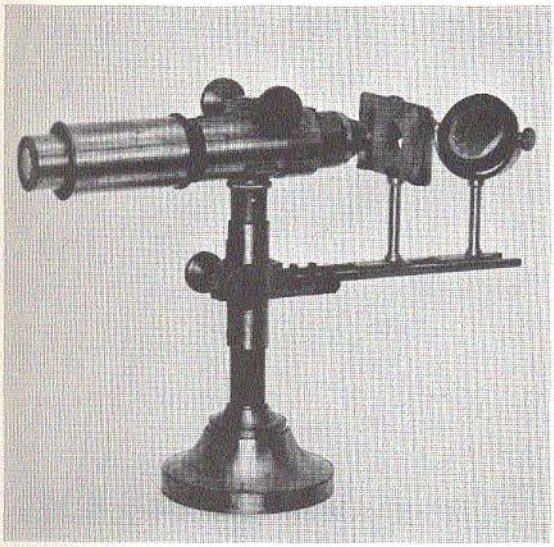

Fig. 98. Nachet & Son, Paris, France; compound monocular; C. 1860. (AFIP 49107 - 60-4713-243)

At the top of the pillar is a fixed horizontal ring, 2-3/8 x 1-1/4 inches, with a double milled-head pinion at the top. The body tube is 3-1/4 x 3/4 inch, has a cone nose, and carries a rack. The 3-1/4-inch ocular screws to the body, and there is an eye lens and field lens. Height is 8 inches. It is signed on the base, "Nachet et Fils, Rue Serpente 16, a Paris." ■

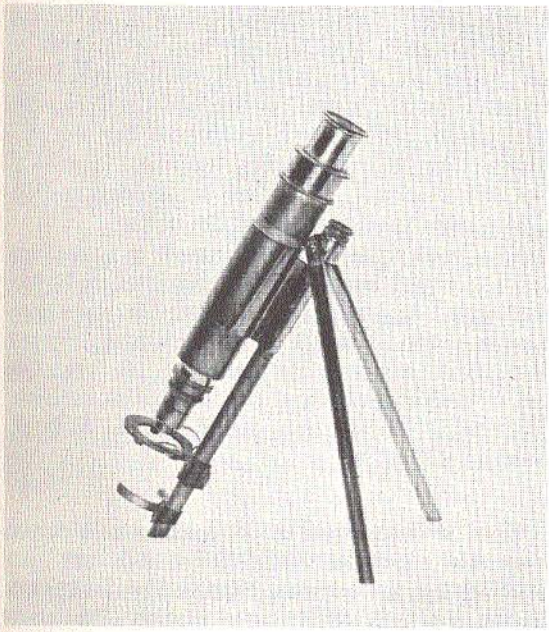

Fig. 99. Charles Baker, London, England; compound monocular; C. 1860. (AFIP 49243 - 60-4713-324)

An 8-1/2-inch-long tubular limb and angular arm are attached to the body tube of this portable instrument (Fig. 99), the lower end of which carries a 2-inch circular stage on a sliding body. The stage has a 1-3/16-inch central aperture, the stage casing has a screw opening, and the lower side of the stage has a fixed lug with screw openings. These permit the insertion of three steel rods when the instrument is to be placed in a vertical position.

Below the stage is a sliding tube with gimbal and a 1-inch-diameter single mirror. The upper end of the limb has a milled-head screw fine adjustment, and immediately below are hinged two 8-inch-long tubular legs, which when combined with the limb, form a firm tripod support. The legs are made to store accessories. The body tube is 7 inches long and has a drawtube. It is signed, "Baker, London." ■

AFIP 45263. Maker unknown; compound monocular; after 1860. *Not illustrated.*

Attached to the horseshoe base of this instrument is a brass tubular pillar 2-5/8 x 7/8 inch with a ring top. The 3-1/4 x 2-3/4-inch stage is incurved at the back and is fixed to the pillar ring; it has a revolving disc of diaphragms. The upper end of the pillar is triangular, 2-1/8 inches high, and has an outer casing with milled-head fine adjustment at the top. The 2-3/4-inch arm is fixed to the pillar and has a ring end in front that holds the 2-1/2 x 1-1/4-inch screw-in tube.

The body tube is 5-1/2 inches long, has a cone nose, and drawtube with sliding motion. The single mirror is on a gimbal with a ball-and-socket arm attached to a pivot below the stage. Height is 10 inches. It is very similar to a small model made by E. Hartnack of Paris. (Donated by Dr. D.O. Cullen) ■

The japanned iron, claw-footed base of this instrument (Fig. 100) has two 3-3/4-inch uprights attached and is similar to others made by Andrew Ross of London. The stage is 2-3/4 x 2-1/2 inches and is cast with two flanges and a 1-inch-high collar; it is attached to the uprights by pivot screws. A tubular limb, 4-1/4 x 3-1/4 inches, that carries the slide casing for the 1-1/2-inch single mirror, is attached to the stage collar. The stage has a sliding bar, a 3/4-inch central aperture, and openings for the condenser and forceps. Beneath the stage is a revolving disc of diaphragms.

Fig. 100. Maker unknown; compound monocular; after 1860. (AFIP 158 - 60-4713-122)

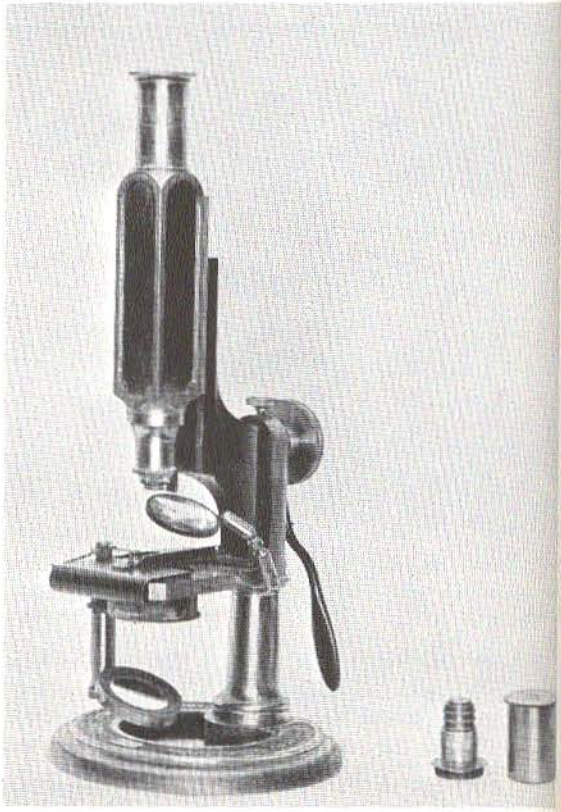

Fig. 101. Smith, Beck, & Beck, London, England; compound monocular; C. 1862. (AFIP 49112 - 60-4713-114)

There is a double milled-head pinion on the collar, and a triangular bar with rack at the back within the limb. The arm is 3 inches long and is attached to the bar with a screw. The body tube is 7 x 1-1/8 inches, has a screw-in cone nose 3/4 inch long, and screws to the arm.

Originally the base and uprights were japanned green, but were later repainted aluminum. The mirror case, diaphragm and objectives are black in color; all other parts are nickel plated. Height is 14-3/4 inches. It is signed, "J. H. Steward, 406 Strand, London, No. 312"; it was sold, not made, by Steward. ■

The center of the 5-3/8-inch circular base of this instrument (Fig. 101) has been partially cut away. The 2-3/4-inch tubular pillar has a ring, and the upper 3 x 1-1/8-inch section is also cut away in the front and back. The stage is 3-7/8 x 2-3/4 inches, is fixed to the angular arm, and carries the slide holder and spring.

On a tubular fitting beneath the stage is a single mirror, 1-1/16 inches in diameter, on a gimbal and pivot, and a cylinder with a swing-out diaphragm with stop. The stage condenser is attached by ball-and-socket joint to the left of the stage. The angular arm is attached to the pillar by a milled-head pinion that forms the axis for the lateral inclination and the coarse adjustment. The front section of the arm is 4 inches long and dovetailed with lock screws at top and bottom. The fine adjustment milled-head pinion is at the top of the pillar.

The body tube with chain rack is square and 4-1/4 x 1-1/8 inches; the upper section is tubular and 1-1/4 x 7/8 inch, and the lower section is conical and 1-1/8 inches long. Height is 12-3/4 inches. Accessories are objective and a compound ocular. It is signed on the base, "Universal Microscope, Smith, Beck, & Beck, London, 4309." ■

This instrument (Fig. 102) has a solid tripod base and a single pillar, 2-7/8 x 1 inch, surmounted by a compass joint. The Lister arm carries a single milled-head pinion. The stage plate has a 1-inch central opening, is fixed to the arm, has dovetails for a mechanical stage, and is 2-7/8 x 2-9/16 inches.

Fig. 102. Joseph Zentmayer, Philadelphia, Pennsylvania; compound monocular; C. 1862. (AFIP 49108 - 60-4713-76)

Beneath the stage is a fixed cylinder with a revolving disc of diaphragms. The tailpiece is 3 inches long, flat, beveled, and on a screw pivot. It carries a sliding case with a double mirror on a gimbal, and is 1-5/8 inches in diameter on the concave side, and 1-3/8 inches on the plane side. The body tube is 7-7/8 x 1-1/4 inches with a short cone nose, and carries the rack; the fine adjustment is a short lever in front of the tube.

It is signed on the foot, "Jos. Zentmayer, Philadelphia." This model was introduced in 1862 for use by U.S. Army hospitals, and was made until 1876, when a circular stage and swing substage were included in its construction. ■

AFIP 292. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1862. *Not illustrated.*

This instrument is a duplicate of that in Fig. 102 (AFIP 49108) by the same maker with the following exceptions: The stage plate is cut away in front to a depth of 1-3/4 inches and 2 inches wide; it has dovetail sides. The second stage, added along with a mirror in 1942, has two plates cut away in the same manner. The lower plate slides into a dovetail; the upper plate is attached at the back to two pillars, 1-1/4 inches high, and carries a slide holder with spring clips. Height is 15 inches, and it is signed, "Jos. Zentmayer, Philada." It is known as the "United States Army Hospital Model," as is that in Fig. 102. ■

Fig. 103. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1862. (AFIP 49119 - 60-4713-86)

This instrument (Fig. 103) is mounted on a tripod base. The body and stage swing on two brass pillars, 4-3/4 x 7/8 x 3/4 inch, that rest upon a revolving plate, 3-1/4 inches in diameter, with a graduated edge by which the angular aperture of the objective glasses may be ascertained.

The body is 9-1/8 x 1-1/4 inches and is moved with a double milled-head pinion and rack for the coarse adjustment; there is a fine micrometer screw for the fine adjustment.

The mechanical stage is 4 x 4-3/8 inches, has a screw adjustment with a milled-head pinion for the horizontal motion, and a delicate chain and pinion with milled-head screw for the vertical motion. At the center of the upper side of the stage is a circular plate with graduated edge for measuring aperture

angles. The stage is 3/16 inch thick and affords unusual facility for greater obliquity of illumination when difficult tests are to be resolved.

Under the stage is a small tube with rack and pinion attached; the accessory illuminating apparatus is carried in this tube. The double mirror is 2-1/8 inches in diameter, and its arm slides inside the tubular bar that is jointed with screw pivot to provide the required motion for oblique illumination. There is a graduated drawtube that slides into the body tube. Height is 19-1/4 inches. It is known as the "Grand American Model," and is signed, "Jos. Zentmayer, Maker, Philadelphia, No. 36." The first microscope made by Zentmayer in 1854 closely resembles this instrument. ■

AFIP 38. J. & W. Grunow, New York, N.Y.; compound monocular; C. 1865. *Not illustrated.*

This instrument has an iron base cast with the 4-inch pillars. A gimbal with a 2-inch double mirror is attached to the 4-inch swinging tailpiece. The adjustable stage is 3 x 4 inches with a 15/16-inch-diameter central aperture.

The 7-inch-long body tube with a rack at the back is screwed to the Lister limb; attached to the tube is a screw fine adjustment. Height is 15 inches. It is signed, "J. & W. Grunow, New York, 458." ■

Fig. 104. Hawkins & Wale, New York, N.Y.; compound monocular; before 1867. (AFIP 357 - 60-4713-79)

The coarse adjustment of the spiral slide of this instrument (Fig. 104) is original with George Wale, and was used on a student model exhibited at the International Exposition in Philadelphia in 1876. In 1879 Wale devised an improved method of inclining the microscope that was later adopted by Swift & Son, London.

The reversed claw foot has a spread of 5-1/4 x 7 inches, and two black japanned iron fixed uprights 3-3/8 inches high. A curved arm on an axis with a screw clamp is fixed to a tube, 4 x 1-9/16 inches; they are of blackened brass, and the tube has a spiral opening of 5/16 inch. The flat tailpiece on a pivot to the axis has a double mirror, 1-3/4 inches in diameter, on a slide with handles, and the blackened cylinder substage, on a slide with lever motion, has a diaphragm.

The stage plate, 3-1/8 x 2 inches, is hinged to a plate on axis. It has a screw spring clamp for the glass stage plate with a slide bar. The fine adjustment micrometer screw on the limb acts on the stage. The body tube is 7-1/4 x 1-7/16 inches and has a screw at the lower side. It moves in a spiral opening and provides a rapid and steady movement. Height is 14-1/4 inches. It is signed, "Hawkins and Wale, New York." George Wale was a microscope maker in New York and Paterson, New Jersey, from the 1860's until the early 1880's. Hawkins is otherwise unknown and his name does not appear on other instruments made by Wale. ■

AFIP 49122. R. & J. Beck, London, England; compound monocular; C. 1867. *Not illustrated.*

This instrument is similar to that in Fig. 93 (AFIP 201) by Smith & Beck with the following differences: It has a reversed claw foot spread of 5-1/2 x 6-1/2 inches, and the stage plate is 4-1/2 x 3-3/8 inches. The tubular tailpiece is 3-3/4 inches, has a 1-5/8-inch double mirror on a slide casing, and a straight arm. The glass stage plate is 4 x 2-1/2 inches, has a spring holder and slide bar, and an aperture for the stage condenser.

The tubular limb is 4-5/8 x 13/16 inch, and has attached an angular arm with pinion and double milled-head screws. The body tube is 8-1/2 x 1-7/16 inches with a 7/8-inch nose; it has a drawtube and carries the rack. It is signed on the body, "R. & J. Beck, 31 Cornhill, London, 5001." This microscope is another of those used by Dr. J. J. Woodward, famed Medical Museum photomicroscopist, in connection with his photomicrographic research. ■

AFIP 49117. R. & J. Beck, London, England; compound monocular; C. 1867. *Not illustrated.*

This microscope is very similar to that in Fig. 93 (AFIP 201). The mirror of this model is on a sliding case with pivot arm, the stage plate is 4-1/2 x 3-1/2 inches, and below it is a cylinder with a revolving diaphragm. It is signed, "R. & J. Beck, 31 Cornhill, London, 5007." ■

Fig. 105. Smith & Beck, London, England; compound monocular; C. 1867. (AFIP 49111 - 60-4713-140)

The 11 x 4-1/2 x 1/4-inch walnut base of this instrument (Fig. 105) supports two brass uprights. The stage plate is 2-1/16 x 3-1/2 inches with flanges, and is connected to the uprights by a trunnion with two milled-head screws; it has a cylinder for a diaphragm.

The tubular tailpiece, 2-1/4 x 1/2 inch, carries the single 1-11/16-inch mirror on a pin. The tubular limb with angular arm is 4-1/2 x 13/16 inch and is attached to the stage plate; The arm is fixed to a tube 4 x 1-7/16 inches. The limb, arm, tube, and cylinder are all blackened brass.

The fine adjustment is a milled head at the top of the limb. The body tube is 8-3/4 inches long, slides, has a short nose, and no drawtube. The 1-1/4-inch stage condenser is on a ball-and-socket arm attached to a trunnion on the left side. Height is 15-1/2 inches.

Accessories are 2 objectives; 4 oculars; and a cylinder diaphragm. It is signed on an upright, "Smith & Beck, London, 5018." Called the "Educational Model," it was first exhibited in 1855; the serial number suggests a date of about 1867. It was listed in catalogues from 1856 to 1865. ■

AFIP 71807. Smith & Beck, London, England; compound monocular; C. 1867. *Not illustrated.*

This instrument is a duplicate of that in Fig. 105 (AFIP 49111) by the same maker. Accessories are 4 glass sliders and stage forceps. It is signed, "Smith & Beck, London, 5019." ■

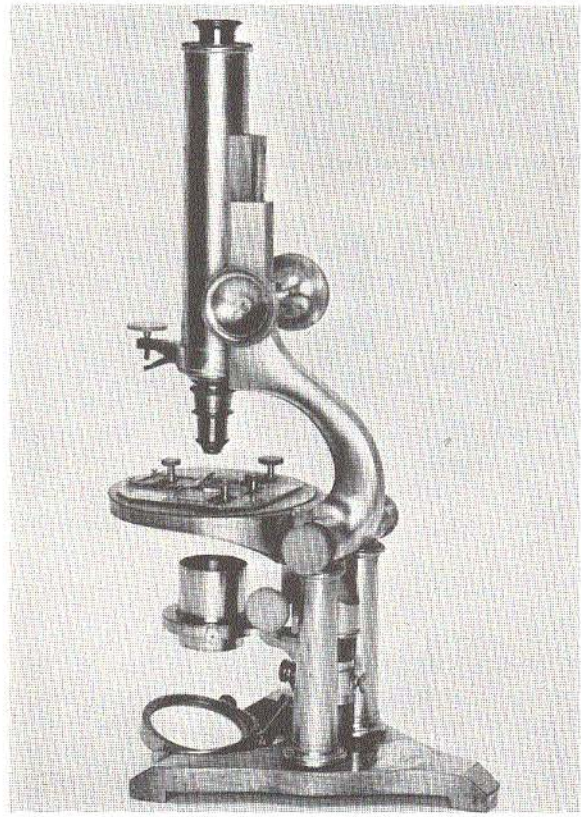

Fig. 106. Boston Optical Works (Tolles), Boston, Mass.; compound monocular; after 1867. (AFIP 17745 - 60-4713-6)

This instrument (Fig. 106) has a claw-footed base with a spread of 6-3/4 x 7-3/4 inches, and two conical pillars 5-3/4 inches high. A steel trunnion supports the Lister limb (Jackson model) with a double milled-head pinion. The tubular tailpiece is 2-3/4 x 11/16 inch, carries a double mirror on a gimbal, and two jointed arms and a sliding case with setscrew.

A heavy stage ring, 4-7/8 inches in diameter, is fixed to the limb. Above it is a thin revolving plate that carries a thin mechanical stage that has two motions. There are two milled heads on top of the stage and an adjustable slide bar. Below is the substage tube with rack and pinion and centering screws.

The body tube is 8 x 1-1/2 inches, has a graduated drawtube, spring nose, and a short lever fine adjustment. It is 18 inches high and weighs 14 pounds.

It is signed, "Boston, Optical Works, Tolles." Robert B. Tolles (1822-83), the name included in the signature on the tube, was an apprentice of Charles A. Spencer, microscope maker of Canastota, N.Y. In 1858 Tolles established a small business in that city, for the purpose of making lenses. In 1867 he became manager of the newly organized Boston Optical Works, where stands and lenses were made, and his objectives earned a high degree of acceptance in the microscope field. ■

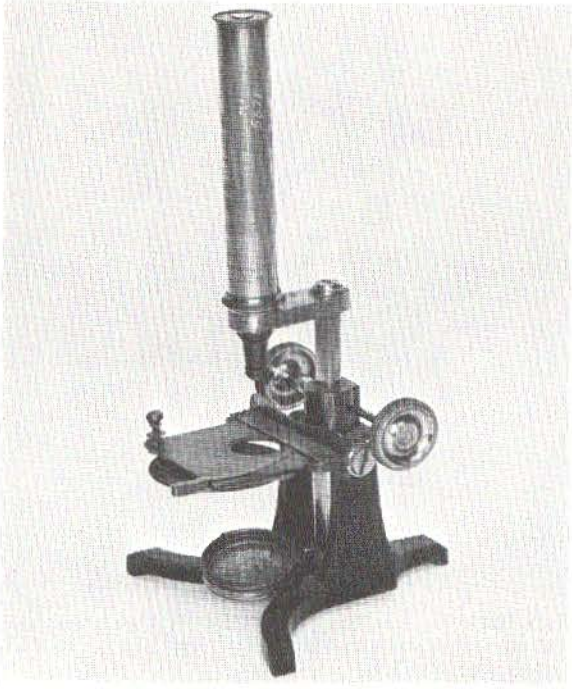

Fig. 107. James W. Queen, Philadelphia, Pa.; compound monocular; before 1868. (AFIP 19459 - 60-4713-67)

The claw-footed base of this instrument (Fig. 107) has a spread of 5-7/8 x 5-3/4 inches. The two uprights are 3-1/4 inches high and are of cast iron, japanned black. The brass stage is 2-7/8 x 4 inches, is incurved at the back, and cast with a 7/8-inch collar and flanges; it is attached to the uprights by screws. There is a recessed aperture in the stage, 1-1/16 inches in diameter, a slide bar, and openings for a stage condenser and forceps. Beneath the stage is a revolving disc of diaphragms.

The tubular tailpiece is 3 x 3/4 inch, and is fixed to the stage plate with screws. It carries a single mirror 1-1/2 inches in diameter on a gimbal and pin. The collar carries a double milled-head pinion and triangular bar with rack at the back. The arm is 2-1/2 x 7/8 x 5/16 inch, and is attached to the bar by a screw; there is no fine adjustment.

The body tube is 6 inches long and 1 inch in diameter and screws to the arm; there is no drawtube. It is 11 inches high. It is signed, "Jas. W. Queen, Phila." This model was introduced about 1865, and its base and uprights are modifications of those made by Andrew Ross of London in the 1840's. This is probably one of the earliest models; it was improved and better constructed around 1870 following the reorganization of the firm of James W. Queen and Co. ■

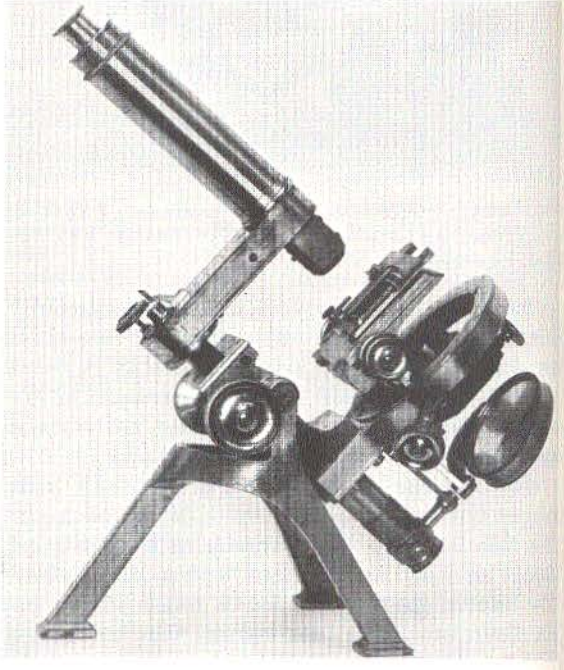

Fig. 108. Powell & Lealand, London, England; compound monocular; 1868. (AFIP 49124 - 60-4713-128)

The upright tripod of this instrument (Fig. 108) is 5 inches high and has a spread of 9 x 7-1/4 inches. The trunnion with limb is 7-7/16

inches long and the upper section, 4 x 2-3/16 inches, carries a double milled-head pinion. The central section is a massive graduated ring, 5-1/4 x 7/16 inch, with a 2-1/4-inch projection at the back. The lower section is the tubular tailpiece that is fixed to the ring projection by a plate and screws. The 2-7/8-inch double mirror is on a half gimbal and two jointed arms, and is carried on a sliding case with set-screw.

Within the large ring is a thin ring with rack that rotates by a horizontal pinion (the 1861 model had a vertical pinion). The substage is on a dovetail slide with rack and pinion on the left side; it is fixed to the back of the outer ring and is not moved by rotation of the inner ring, as was the case with the 1861 model substage. The stage plate is 3-3/4 x 3-3/8 inches and is 1-1/4 inches above the ring, and carries a Turrell mechanical stage. The bar is 1-9/16 inches and is planed at the sides to 1-1/4 inches; the single rack is at the back.

The arm is 6 x 1-1/4 x 7/8 inch and is attached to the bar by a screw. It carries the long lever fine adjustment with a milled head on top at the back. The 1-1/4-inch nosepiece is fixed to the front of the arm, and has a side opening for a prism. The body tube is 6-1/8 x 1-5/8 inches, screws to the arm, and has a drawtube. Height is 17-1/2 inches.

Accessories are 9 objectives; 8 oculars; paired ocular; 2 lieberkühns; 3 selenites; 2 dark wells and holder; 4 illuminators; binocular tube; erecting tube; 2 micrometers; Nachet prism; revolving disc of diaphragms; stage forceps; adapter; spot lens; oblique illuminator; camera lucida; oil condenser; polarizer; high and low prisms; and achromatic condenser. It is known as Model No. 1, and is signed, "Powell & Lealand, 170 Euston Road, London, 1868. ■

The brass base of this instrument (Fig. 109) has rounded ends and is 2-3/4 x 3-7/16 inches; at one end is a conical pillar 4-7/8 inches high. The 1-1/4-inch double mirror on a gimbal and two jointed arms is attached to the base in optic axis.

The stage is 2-3/4 x 3-1/8 inches, has a circular cutout at the back, and is attached to the pillar by pivot screws; it has a 5/8-inch central aperture. Beneath the stage is a dovetail slide diaphragm holder, and there is a vertical rod at the back with a spiral spring. A milled-head screw through the pillar to the rod forms the fine adjustment.

Fig. 109. F.W. Schiek, Berlin, Germany; compound monocular; C. 1869. (AFIP 49121 - 60-4713-111)

The arm is 2-7/8 inches long and fixed to the pillar. It has a ring front into which screws a sprung tube, 2-1/2 x 1-1/8 inches. The body tube with short nose is 5 inches long; it has a drawtube and slides into the arm tube. Height is 11-1/4 inches. Accessories are 2 oculars. It is signed on the arm, "Schiek in Berlin, No. 1143." Some of the instruments by this maker are signed, "Schieck," "Shieck," others, "Schiek." ■

AFIP 162. J. & W. Grunow, New York, N.Y.; compound monocular; C. 1869. *Not illustrated.*

This portable instrument is somewhat similar to the model by Charles Baker in Fig. 99 (AFIP 49243) particularly with regard to its support. Two 7-inch-high hinged, square and pointed legs are attached to a plate that is screwed to the tube; a rectangular limb and angular arm are also attached to the sprung tube.

The stage plate is 2-1/2 x 1-7/8 inches and is fixed to the limb. Above it is a thin plate screwed to the left side and below it at the right is a milled-head screw fine adjustment; this moves the upper plate on an arc.

The single 1-3/8-inch-diameter mirror is attached by a swinging arm and gimbal to the limb. The 7-1/2-inch-long body tube slides. It is 10 inches high when closed, and signed, "J. & W. Grunow, New York, 556." ■

AFIP 58961-31. E. B. Meyrowitz, New York, N.Y.; compound monocular; C. 1870. *Not illustrated.*

This corneal instrument is all brass except for the cast iron base that is 20 inches long, from the rear of which arises the chin rest, and from the front the 7-inch-high brass pillar. Height is 18 inches. It is signed, "E. B. Meyrowitz, New York - Paris, 107." (Donated by the American Ophthalmological Association) ■

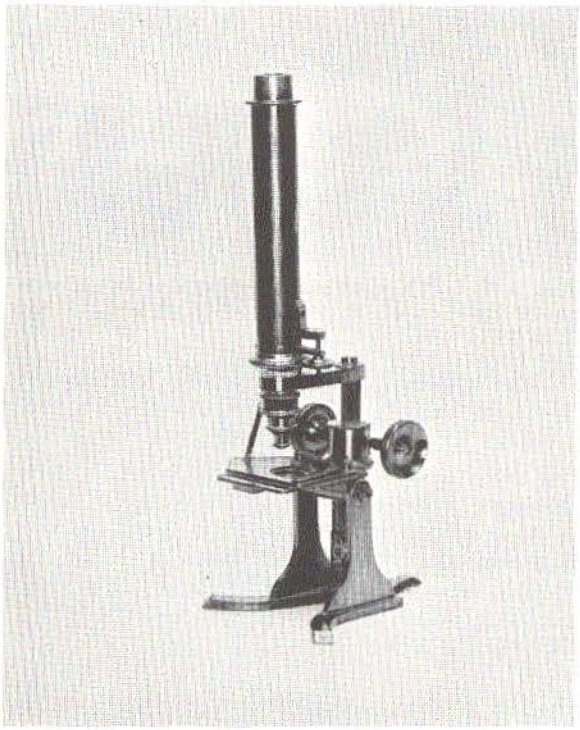

Fig. 110. I. Roxley, Brighton, England; compound monocular; C. 1870. (AFIP 517554 - 60-4713-235)

The base of this instrument (Fig. 110) has a spread of 4 inches, and supports two 3-1/4-inch-high pillars. A 4-1/4-inch swinging tailpiece has an inclosed rack with two screw adjustments; a 3-inch arm is screwed to the top of the rack. The 4-1/2 x 2-1/2-inch stage is cut away in back and inserted into the upper inch of the tailpiece. The stage plate is secured to the stage by a 2-3/4-inch spring pin.

The body tube is 7 inches long and is inserted into the arm, and has a screw fine adjustment at the lower end. Height is 14 inches. Accessories are two objectives and a prism. It is signed, "I. Roxley, 128 S. James St., Brighton." (Donated by Dr. J. R. Schumaker) ■

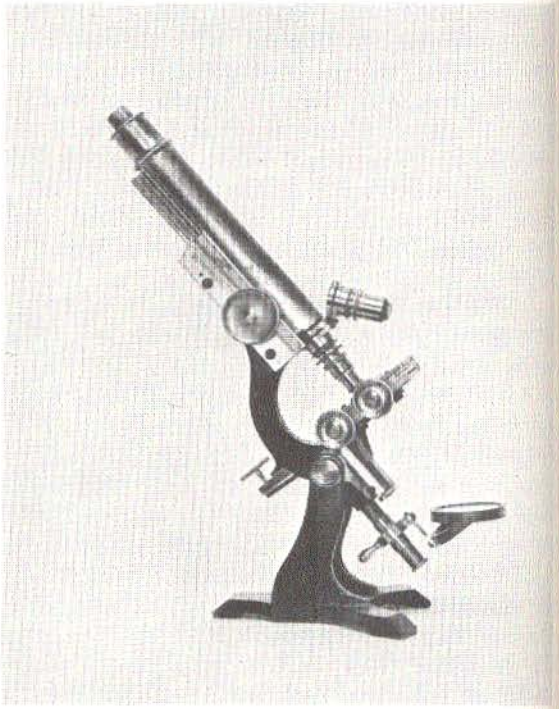

Fig. 111. J. & W. Grunow, New Haven, Conn.; compound monocular; C. 1870. (AFIP 517745 - 60-4713-380)

The black base of this instrument (Fig. 111) has a spread of 6 inches and supports the brass upper portion with an overall height of 17 inches. The two pillars are 5 inches high, and the 2-1/2-inch-long tailpiece attached to the trunnion has a short arm on a pivot with gimbal and double mirror.

The stage is 3 x 4 inches with a 1-inch central aperture and two side adjustments. The stage and the 8-inch-long body tube with rack at the back are screwed to the 7-inch curved limb; there is a fine adjustment attached to the lower section of the limb. A double nosepiece with Bausch & Lomb objectives is attached to the body tube. It is signed, "J. & W. Grunow, New Haven, Conn., No. 195." (Donated by Lt. Colonel David W. Dick) ■

This table model all-brass microscope (Fig. 112) has a rack and pinion vertical movement that extends upward from the center of the base, which is 3-1/2 inches in diameter and 1-1/4 inches high. The tapered arm is 4-3/4 inches long and screwed to the triangle upright. Inserted at the opposite end of the arm is a circular opening through which is fitted a body tube 12 inches long. ■

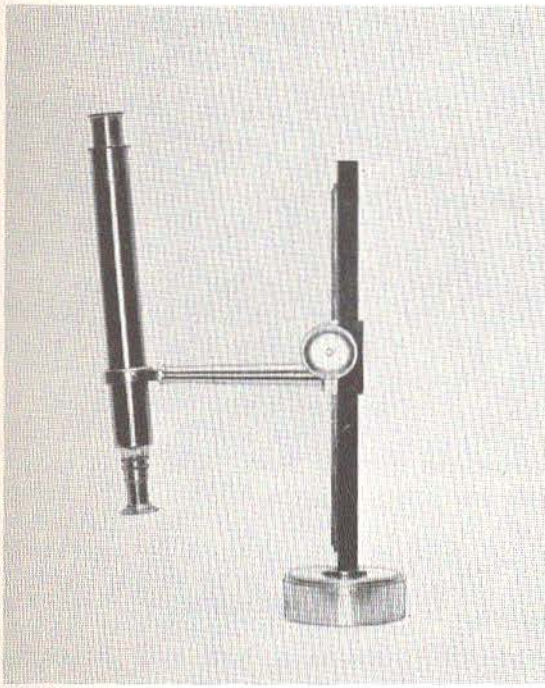

Fig. 112. Powell & Lealand, London, England; compound monocular; before 1870. (AFIP 49405 - 60-4713-301)

Fig. 113. Maker unknown; compound monocular; before 1870. (AFIP 55840 - 60-4713-115)

The claw-footed base of this instrument (Fig. 113) has a spread of 6 x 6 inches, and attached to it are two 4-1/4-inch uprights of cast iron, japanned black. The 1-inch collar and trunnion of the stage plate are cast in brass and fixed to the uprights with screws; the collar carries a double milled-head pinion.

The tubular tailpiece is 3-1/4 x 4 inches, is fixed to the lower side of the collar, and carries a 1-3/4-inch double mirror on a gimbal and a heavy brass ring arm; it slides on the tailpiece. The stage is 3-1/2 x 2-7/8 inches with a 1-3/16-inch aperture, and has a heavy U-shaped plate slide holder on pins. Beneath the stage is a revolving disc of diaphragms, 2-3/4 inches in diameter, that moves from the left. The collar carries a triangular bar with rack at the back.

The arm is 4 x 7/16 inch with 1-3/8 inches at the front; the back 7/8 inch is fixed to the bar with a screw. The body tube is 7 x 1-1/4 inches and screws to the arm; there is a short screw-in cone nose. There is no fine adjustment. Height is 15-1/2 inches. ■

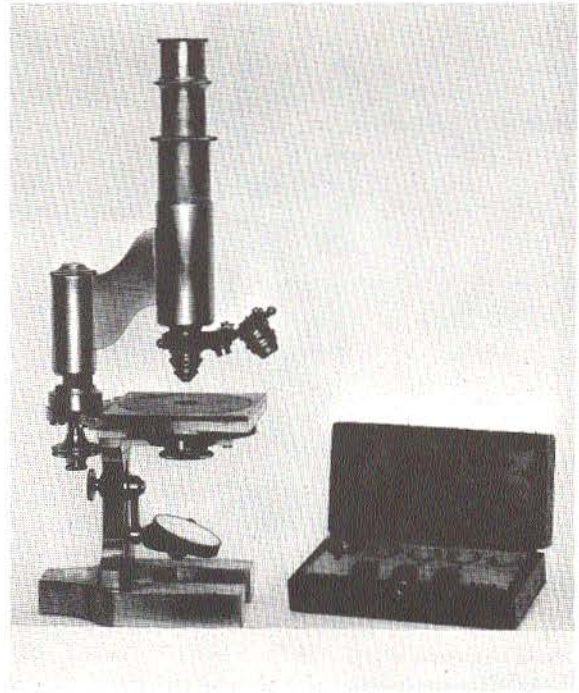

Fig. 114. E. Hartnack & Co., Paris, France; compound monocular; before 1870. (AFIP 80375 - 60-4713-250)

The horseshoe base of this instrument (Fig. 114) has a rectangular pillar 3-1/2 x 2-1/2 x 7/16 inch, cut away at the sides with a central

slot; a 3-1/8-inch circular plate with a projection at the back is fixed to the pillar. Beneath the plate is a dovetail slide and tube for a condenser. The 1-5/8-inch double mirror is on a gimbal and arm with milled-head setscrew and moves in the slot.

The stage is 3-1/8 x 3-1/4 inches and is attached to the heavy plate of the same size with a projection at the back. A 3-inch-high triangular limb rises from the projection and has a tubular outer casing with an angular arm fixed to a split tube 2-3/4 x 1-1/4 inches. The milled-head fine adjustment is at the lower end of the bar.

The body tube is 4 inches long, has a short nose, a double nosepiece, a drawtube, and slides into the split tube. It is 11 inches high when closed.

Accessories are an objective, 3 diaphragms, and an ocular. It is signed on the arm, "E. Hartnack et Cie, Place Dauphine 21, Paris." ■

Fig. 115. F.W. Schiek, Berlin, Germany; compound monocular; C. 1870. (AFIP 49125 - 60-4713-329)

The horseshoe base of this modified Hartnack-type microscope (Fig. 115) supports two tubular pillars 3-1/2 inches high. The trunnion, tailpiece and stage plate are in one casting and attached to the pillars by screws. The tailpiece is 2-3/8 x 1-1/8 x 1/4 inch, has a central slot, and carries a 1-3/4-inch double mirror on a gimbal and jointed arm with a milled-head setscrew.

The circular stage plate is 3 inches in diameter, and beneath it is a dovetail that carries at the right a sliding holder for condenser or diaphragm. The stage is 5-1/8 x 3-1/2 x 1/4 inch, has a 1-inch aperture, and is attached to the plate with 3 screws. The 4-3/4-inch triangular limb rises from the stage, and has a tubular outer casing with a broad arm attached to a 2-3/4 x 1-3/16-inch tube, with a single milled-head pinion in front.

The body tube has a short cone nose and is 8 inches long; the lower section, 3-5/8 x 1 inch, carries the rack in front. The upper section with two heavy rings is 4-3/8 x 1-3/16 inches; there is no drawtube. The fine adjustment is at the top of the limb and moves the outer casing and the body. Height is 16 inches, and it is signed, "F.W. Shieck, Berlin, No. 1551." ■

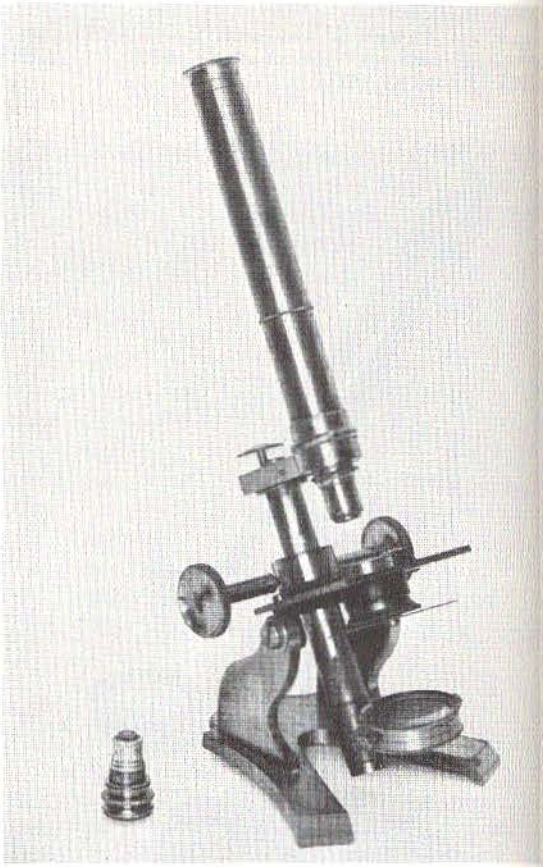

Fig. 116. James W. Queen & Co., Philadelphia, Pa.; compound monocular; before 1871. (AFIP 55556 - 60-4713-81)

The two curved brass uprights, 3 inches high, and the claw-footed base of this instrument (Fig. 116) have been cast in one piece. The stage is 3 x 3-1/2 inches, is incurved at the back, and has a collar 3/4-inch long with flanges cast in one piece; it is attached to the uprights with screws.

The stage has a recessed aperture, 1-5/16 inches in diameter, and a slide bar and openings for the stage condenser and forceps. Beneath the stage is a tube for a condenser or cylinder disc of diaphragms. The tubular tailpiece is 3-3/16 x 3/4 inch, is attached to the stage, and carries a 1-1/2-inch double mirror on a gimbal and a slide casing. The collar carries a double milled-head pinion and a tubular bar with a rack at the back.

The arm is 3 inches long and attached to the bar with a screw. The body tube has a short spring tube nose, is 7 x 1 inches, and is attached to a ring at the front; there is a screw division at 2-1/2 inches from the lower end. The fine adjustment is a long lever with milled-head screw on top and at the back of the arm. When closed it is 12 inches high, and similar in many respects to that in Fig. 107 (AFIP 19459) by the same maker. ■

AFIP 49123. Powell & Lealand, London, England; compound monocular; before 1871. *Not illustrated.*

This instrument is similar to that in Fig. 108 (AFIP 49124) by the same maker, and is the No. 1 model. Differences are that this microscope has a 4-1/4 x 1/4-inch graduated silver ring, the rotating stage is mounted in the same plane as the ring, and the inner ring pinion is on a vertical angle. Also, the body tube is 4-1/2 x 1-5/8 inches, and has a drawtube. It is signed, "Powell & Lealand, 170 Euston Road, London." ■

The circular, leaded brass base of this instrument (Fig. 117) is 2-1/2 inches in diameter, and supports a 4-1/2-inch-high tubular pillar with a ball-and-socket foot. The 1-inch single mirror is on a gimbal and is screwed to the pillar.

The stage is 1-7/8 x 2-9/16 inches, has a central 7/16-inch aperture, and a fixed casing. A 2-inch-long arm is fixed to the pillar with a 1-5/8 x 1-1/8-inch fixed tube in front with a double milled-head pinion.

The body tube is 4-1/2 inches long, has a short cone nose, and a rack at the back. There is a field lens, and a single eye lens that screws in; there is no fine adjustment. It is 8 inches high when closed.

Fig. 117. Maker unknown; compound monocular; C. 1871. (AFIP 138 - 60-4713-199)

This type instrument appeared on the market in the late 1860's unsigned. Hartnack of Paris is known to have made microscopes "for trade" and unsigned; Nachet also made a small microscope mounted on a round foot similar to this model. ■

AFIP 49109. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1871. *Not illustrated.*

This instrument is a duplicate of that in Fig. 103 (AFIP 49119) by the same maker. It has an achromatic condenser with two revolving discs. It is signed on the foot, "J. Zentmayer, Maker, Philadelphia, No. 436," and is his "Grand American Model." ■

AFIP 189. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1872. *Not illustrated.*

This instrument, the "Grand American Model," is a duplicate of that in Fig. 103 (AFIP 49119) by the same maker, with the exception that the condenser tube of this model has a fixed collar with a single revolving disc of diaphragms. It is signed, "Jos. Zentmayer, Maker, Philadelphia, No. 449." ■

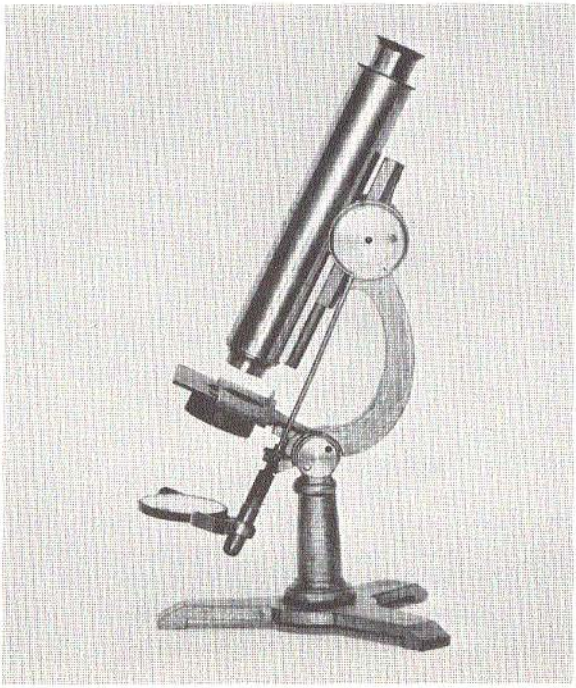

Fig. 118. James W. Queen & Co., Philadelphia, Pa.; compound monocular; C. 1872. (AFIP 49128 - 60-4713-447)

This instrument (Fig. 118) has a tripod base supporting a 4-inch-high conical pillar with a compass joint and Lister limb, all of cast iron with japanned bronze finish; all other parts are brass. The limb carries a double milled-head pinion. On the left side is a 5-1/2-inch rod with a spring fitting to the pinion rod that forms the fine adjustment. The tubular tailpiece is on a pivot and is 2-3/4 x 3/8 inch, and carries a sliding case with a 1-7/8-inch single mirror on a gimbal.

The stage is blackened, is 3-1/8 x 2-3/4 inches, incurved at the back, and fixed to the limb. It has a sliding super stage and a 1-inch central aperture. Beneath the stage is a tube for condenser or cylinder diaphragm. The body tube, 7-1/4 x 1-5/16 inches, has a short cone nose and carries the rack; there is no drawtube. When closed it is 14 inches high, and is signed, "No. 130, James W. Queen & Co., Philadelphia and New York." This model was introduced about 1872 and discontinued before 1875. ■

Dr. J. J. Woodward, photomicroscopist at the Army Medical Museum, used this instrument (Fig. 119) for determination of the angular aperture of objectives. This is the first model devised and used by Woodward, although the

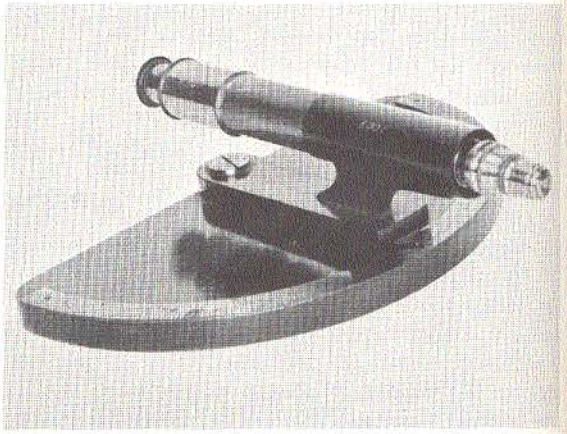

Fig. 119. Maker unknown; apertometer for microscope objectives; before 1872. (AFIP 49218 - 60-4713-84)

actual maker is unknown. In the early 1870's apertures of objectives were determined after their construction and not made on a predetermined basis.

The instrument has a half-circle mahogany base 12-3/4 inches long with a brass graduated scale on the outer edge indicating degrees. A horizontal revolving block with indicator carries a metal 4 x 1-7/16-inch angular arm attached to a horizontal tube. The body tube is 8 inches long and has a short cone nose. ■

AFIP 518714. E. Hartnack, Potsdam, Germany; compound monocular; C. 1872. *Not illustrated.*

This instrument is similar to that in Fig. 114 (AFIP 80375) by the same maker with these differences: The stage is 4 inches in diameter; underneath is a circular mounting carrying the Abbe condenser that may be centered, and an iris diaphragm; the latter slides into a groove and may be turned on its axis. The condenser may be moved toward the stage or away by means of a rack and pinion. It is signed, "E. Hartnack, Potsdam."

E. Hartnack of Potsdam, Germany, succeeded his uncle, Georges Oberhauser, in business in Paris. He moved back to Potsdam in 1870 where he re-established his business. ■

A 3-7/8 x 1-inch tubular pillar is attached to the solid tripod base of this instrument (Fig. 120) with a compass joint at the top. There is a Lister limb with a double milled-head pinion, to which is attached a circular stage plate 3-1/4 inches in diameter. Beneath the stage plate is a recessed opening for the breechlock cylinder

Fig. 120. James W. Queen & Co., Philadelphia, Pa.; compound monocular; C. 1874. (AFIP 49110 - 60-4713-101)

condenser. The revolving brass stage has a black glass top, the same size as the stage plate, and a slide bar held by a spring clip at the back. The tubular tailpiece is 3-1/8 x 1/2 inch, is on a pivot with a sliding case, and holds a double mirror on a gimbal.

The body tube is 8-1/2 x 1-7/16 inches, has a 1/2-inch cone nose, and carries the rack; there is a drawtube and a short bar for fine adjustment. Height is 15 inches. It is signed, "James W. Queen & Co., Philadelphia and New York, 218." ■

This instrument (Fig. 121), 10 inches high, and an identical instrument 10-1/2 inches high, have been in the Collection for many years but have not been identified. Supposition is that they were made for use in connection with the Army Medical Museum's extensive exhibit at the International Exposition in Philadelphia in 1876.

The instrument pictured has a thin, wide horseshoe base with openings for four screws. To the base is attached a short Lister limb with a single milled-head pinion. The body tube is 7 x 1-1/2 inches, and has a 1-1/2-inch-long cone nose. The rack at the back is limited by pins to a motion of 3/8 inch. An ocular is attached to the nose by screws.

Fig. 121. Maker unknown; compound monocular; before 1875. (AFIP 68 - 60-4713-255)

The second instrument also has an ocular attached by screws, a short cone nose, and carries a Zeiss AA objective. ■

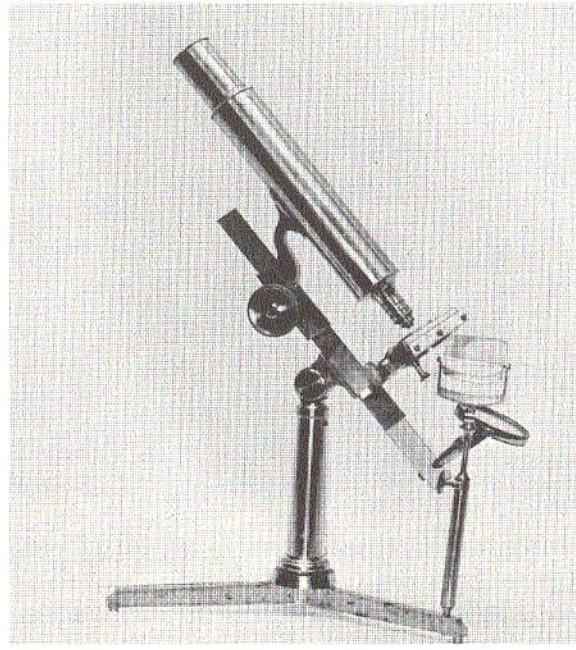

Fig. 122. Simon Plössl, Vienna, Austria; compound monocular; before 1875. (AFIP 506440 - 60-4713-303)

The tripod base of this instrument (Fig. 122) has a spread of 10 inches and supports a 5-1/2-inch-high tapered, circular pillar with compass joint at the top. A short arm is fixed to the compass joint and screwed to the 10-3/4-inch triangular limb. A single 2-1/4-inch mirror on a gimbal and the 2-1/2 x 2-1/4-inch stage are also screwed to the limb. A 2-inch arm is attached to a sliding bar on the limb and screwed to the 9-1/2-inch-long body tube. A 2-1/2-inch prism on a 4-inch cylindrical rod is inserted into the base. Height is 18 inches.

Accessories include 2 oculars, forceps, ivory talc box, hand lens, and a 13-inch-high stand for bull's-eye condenser. It is signed, "Plössl in Wein." The instrument is believed to have been used by Drs. Rudolph L. Virchow, eminent German pathologist, and Robert Koch, famous German bacteriologist, and to have been made between 1850 and 1875. (Donated by Dr. L. Albert Thunig) ■

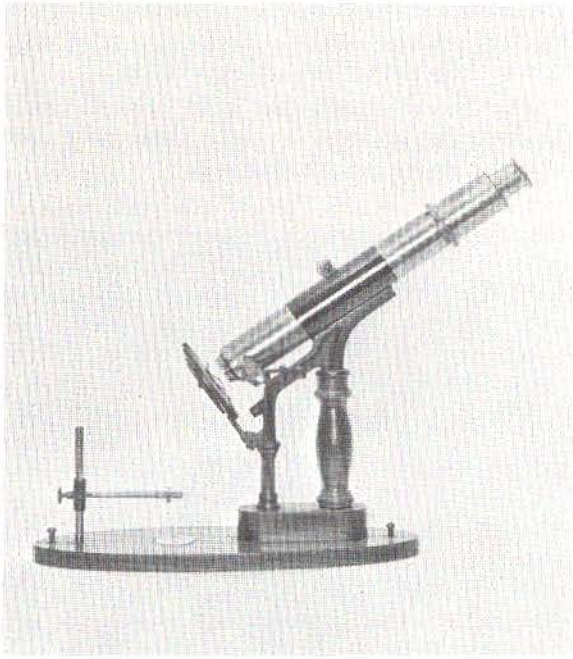

Fig. 123. James W. Queen & Co., Philadelphia, Pa.; compound monocular; before 1875. (AFIP 49115 - 60-4713-371)

The oval walnut base of this instrument (Fig. 123) is 12 x 4 inches, and supports two turned walnut pillars, one 4-1/4, and the other 2 inches high, to which is affixed a blackened cast iron limb at a 45° angle. The limb carries a fixed, blackened split tube, 3-1/4 x 1-7/16 inches, with a milled-head screw clamp.

The 3-inch circular brass stage is fixed to the limb by a plate, and has a circular cutout at the front and a 7/8-inch central opening; beneath the stage is a revolving disc of diaphragms. At the front of the base is a 3-3/4-inch vertical rod carrying, on a sliding case with a setscrew, a 4-inch horizontal rod with a slide case for the gimbal of the 1-3/4-inch single mirror. The body tube is 14 inches long, has a short cone nose, and a drawtube. A 1-inch condensing lens with universal joint is fixed to the left side of the limb.

It is signed on the base, "J.W. Queen & Co., Philadelphia and New York." This type microscope was devised by Dr. Oliver Wendell Holmes about 1873. Before 1875 Queen changed the design to incorporate a large square stage, added a fine adjustment, and made a lamp or mirror optional. ■

AFIP 49116. James W. Queen & Co., Philadelphia, Pa.; compound monocular; before 1875. *Not illustrated.*

This microscope is a duplicate of that in Fig. 123 (AFIP 49115) by the same maker. ■

Fig. 124. J. Grunow, New York, N.Y.; compound monocular; C. 1875. (AFIP 252 - 60-4713-74)

The blackened iron horseshoe base has a spread of 5 x 3-3/8 inches and supports the

single 2-1/2-inch-high, curved, brass pillar of this instrument (Fig. 124). The trunnion casting is attached to the support by a rivet and to the stage plate by three screws.

Beneath the trunnion is a milled-head fine adjustment, and screwed to it on a gimbal and arm is a double mirror. The stage is 4 x 3 inches and has cutaway corners at the back. There is a brass revolving disc of diaphragms on the front top surface of the stage.

A tubular limb, 2-1/2 x 7/8 inch, with a heavy collar rises from the trunnion through the stage. An arm, 3 x 1-1/4 x 7/16 inch, with rounded ends, and attached to the limb with two screws, has a screw-in tube, 2-7/8 x 1-1/16 inches, in front. The body tube is 7-1/4 inches long; the lower section is 4 inches long and slides into the screw-in tube. The upper section is 3-1/4 inches long and has a heavy milled ring.

It is 12 inches high when closed. An Abbe* condenser and iris diaphragm have been added. It is signed, "J. Grunow, New York, No. 707." ■

Fig. 125. Maker unknown; compound monocular; C. 1875. (AFIP 175 - 60-4713-131)

*Ernst Abbe (1840-1905), prominent German mathematician and optician associated with Carl Zeiss in Jena, was responsible for a number of optical innovations.

The circular, green bronze base is 3-3/8 x 5/8 inch, and supports the 6-inch-high tubular pillar of this instrument (Fig. 125) with a ball-and-socket foot. The lower section of the pillar, 3 x 5/8 inch, has a 1-3/16-inch single mirror on a gimbal and pin, and a fixed stage.

The stage is 2-3/4 x 2-3/8 inches and has a 3/8-inch central aperture. Beneath the stage is a revolving disc of diaphragms that may be moved from the right side or from the front. Above the stage is a sliding casing on a pillar with a U-shaped slide holder.

The arm is 2-1/2 inches long and is attached to the pillar with a screw; it has a ring front, 1-5/8 inches in diameter, and a fixed tube, 2 x 2-1/4 inches, with a single milled-head pinion at the back. On the tube is a ring that carries a two-jointed arm with a 1-1/4-inch condenser.

The body tube is 6-1/4 inches long, has a short cone nose, and the lower 4-1/4 inches carries the rack at the back. The upper section, with milled-edge ring, is 2 inches long. It is 11 inches high when closed, and probably of French origin. It is similar to that in Fig. 117 (AFIP 138) but is of a larger size. ■

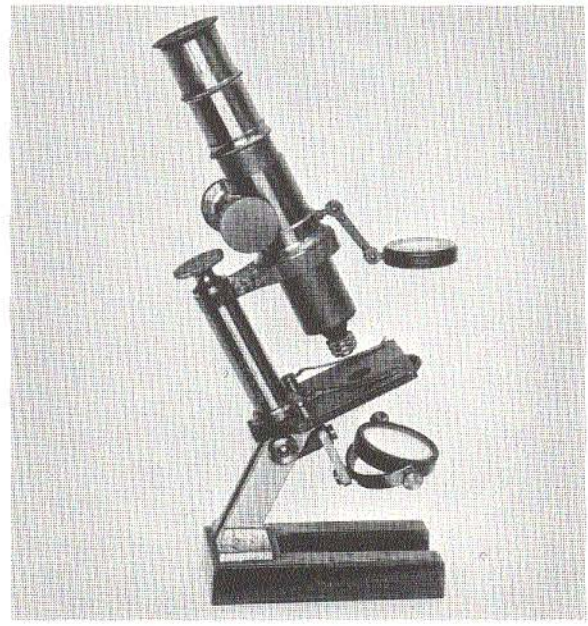

Fig. 126. Maker unknown; compound monocular; C. 1875. (AFIP 184 - 60-4713-198)

The square horseshoe base of blackened iron is 2-1/2 x 3/4 inch, and supports the two brass uprights of this instrument (Fig. 126) at an angle. The stage and trunnion are cast in one piece and attached to the uprights by screws.

Attached to the front of the trunnion by a pivot screw is an arm with gimbal and a 5/16-inch single mirror.

The stage is 3 x 2-1/4 inches and has a 7/16-inch central aperture. Beneath the stage is a revolving disc of diaphragms that moves from the front. The tubular limb is 2-1/4 x 5/8 inch and attached to the stage by screws.

The arm is 2-3/4 inches long and attached to the limb by a milled-head screw with a 1-1/2-inch ring in front and a fixed tube, 1-5/8 x 1 inch, with a double milled-head pinion at the back. On the tube is a ring with a ball-and-socket arm and a 1-3/16-inch condenser.

The body tube is 5-5/8 inches long. The lower 3-1/2 inches carries the rack at the back, and the upper 2-1/8 inches has two milled-edge rings and is sprung. It is 10 inches high when closed. ■

Fig. 127. E. Gautschey, Lausanne, Switzerland; compound monocular; C. 1875. (AFIP 173 - 60-4713-189)

The modified claw-footed base is 4-1/2 x 4 inches and supports the tubular pillar of this instrument (Fig. 127), which is 2-3/4 x 3/4 inch, by means of a cradle joint. An arm with a slot carrying a gimbal and a 1-3/16-inch double mirror is on a pivot at the front of the pillar.

The 3-3/4 x 3-inch stage is attached to the pillar, and has a central aperture, 9/16 inch in diameter. Beneath the stage is a tube for a cylinder condenser or diaphragm. The pillar carries a triangular bar 2-1/2 inches long with a tubular outer casing; a 2-3/8-inch arm is fixed to the bar. In front there is a 1-13/16-inch ring to which is attached the 1-7/8 x 1-5/16-inch tube. There is also a milled-head fine adjustment at the top of the bar.

The body tube is 3-3/4 inches long, has a short cone nose, drawtube, and sliding adjustment. It is 10 inches high when closed, and is signed on the tube, "E. Gautschey, Optician, Lausanne." Gautschey is not mentioned in the literature as a maker of microscopes, and probably was a dealer. ■

Fig. 128. Nachet & Son, Paris, France; compound monocular; C. 1875. (AFIP 49129 - 60-4713-247)

The modified claw-footed base with a spread of 5 x 4 inches supports the two 2-3/8-inch uprights of this instrument (Fig. 128), along with the trunnion. In front of the trunnion is an arm on a pivot with gimbal and a single 1-5/16-inch mirror.

The stage is 3-1/4 x 2-3/4 inches, is incurved at the back, and attached to the trunnion;

it has a central 1-inch aperture. Beneath the stage is a plate and a milled-edge revolving disc with a threaded opening; beneath the plate is a revolving disc of diaphragms.

The limb is 3 inches long and is attached to the stage, and has a milled-head fine adjustment at the top. The 3-1/4 x 1-3/16-inch tubular outer casing of the body tube is connected to the limb by a 2 x 3/4-inch arm.

The body tube is 6-1/2 inches long and the lower 4-1/4 inches slide into the tubular casing. The upper portion has a milled-edge ring and a graduated drawtube. ■

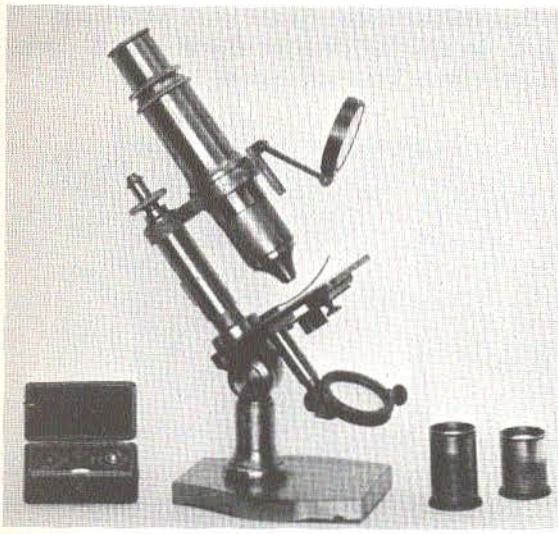

Fig. 129. Nachet, Paris, France; compound monocular; C. 1875. (AFIP 33241 - 60-4713-249)

The solid brass base, with typical Nachet curves, is 4 x 3-1/4 inches and supports the tubular pillar of this instrument (Fig. 129). A compass joint caps the pillar, which is 1-3/4 x 1-3/16 inches. The flanges are cast with a plate that is screwed to the stage. There is a screw-in 1-1/4-inch-long tube, into which another tube slides carrying the single 1-1/8-inch mirror on a gimbal.

The stage, with a collar at the back, is 3-3/8 x 3-1/8 inches, is incurved at the back, and has a central 9/16-inch aperture. Beneath the stage is a dovetail slide with two diaphragm tubes. The tubular limb is attached to the collar and is 2-1/4 inches long, and has an outer casing. The arm is 2-7/8 inches long and is fixed to the limb. It has a ring in front 1-1/2 inches in diameter, a screw-in tube, 2-7/8 x 1-3/16 inches, and is sprung. In front of the ring there is a dovetail slide with a 1-7/16-inch condenser on an arm. There is a milled-head fine adjustment at the top of the limb.

The body tube is 4-1/8 inches long, has a short cone nose, milled-edge rings, and a drawtube. When closed it is 10 inches high. Accessories are 2 objectives and 2 oculars. It is signed on the arm, "Nachet, Optician, Rue Serpente 16, Paris." This model was introduced by Nachet in the 1860's and was still on the market in 1878. (Donated by Major J. W. Smith) ■

AFIP 8306. Nachet & Son, Paris, France; compound monocular; C. 1875. *Not illustrated.*

This instrument is similar in many respects to that in Fig. 129 (AFIP 33241) by the same maker. Major differences are that the base of this microscope is 4-1/2 x 3-1/8 inches, and the pillar is 2-1/2 inches high. The stage is 3-3/4 x 3-1/8 inches and the spring clips are in dovetail slots. The body tube is 4-1/4 x 3-1/16 inches. It is 10 inches high, and signed on the base, "Nachet et Fils, 17 Rue St. Severin, Paris." ■

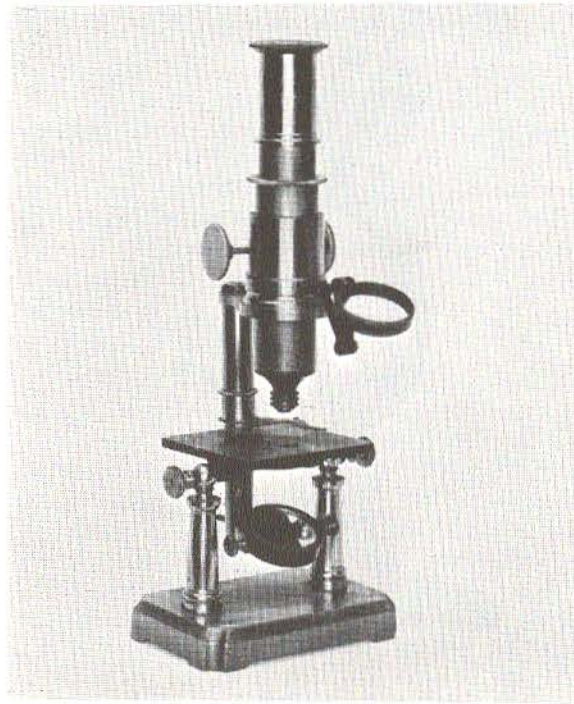

Fig. 130. Maker unknown; compound monocular; after 1875. (AFIP 183 - 60-4713-188)

The bronzed iron base is 4 x 2-3/4 inches and supports the two tubular pillars of this instrument (Fig. 130) that are 2 inches high. The 2-5/8-inch-square stage plate with collar and

flanges in one casting is attached to the pillars. A 4-1/2-inch-long tubular limb is attached to the stage collar; the lower 1-3/4 inches carries a gimbal with a 1-1/8-inch double mirror. Above the stage on a slide casing to the limb is a U-shaped slide holder.

A 2-7/8-inch arm is fixed to the top of the limb. At the front is a 1-9/16-inch ring to which is fixed a 1-1/2 x 15/16-inch tube; at the back is a double milled-head pinion. There is a 1-1/4-inch stage condenser on a ring on the tube with a universal arm.

The body tube is 3-1/2 inches long, has a short cone nose, a rack at the back, and a draw-tube with a field lens; the single eye lens screws in. The instrument is 10 inches high when closed. This type instrument, probably of French make, was made with an oblong or oval base, was moderately priced, and distributed by many dealers. ■

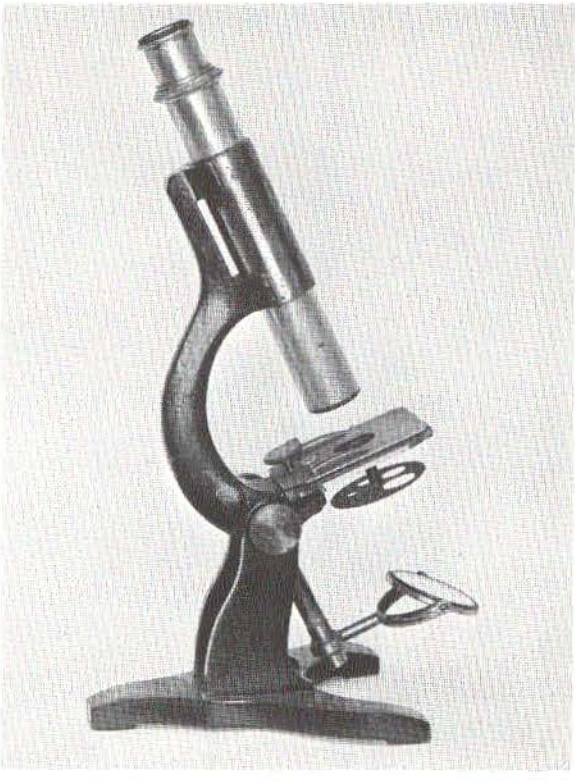

Fig. 131. Robert B. Tolles, Boston, Massachusetts; compound monocular; after 1875. (AFIP 49120 - 60-4713-200)

The claw-footed base has a spread of 5-1/2 x 6-1/2 inches and supports the two 4-inch-high uprights of this instrument (Fig. 131) which are in one casting of black japanned iron. A Lister limb, also black japanned iron, is attached to a trunnion. There is a fixed tubular tailpiece 3 x 7/16 inch on a slide casing with arm and gimbal for the 1-3/4-inch single mirror.

The stage plate is fixed to the limb, is 3-1/8 x 3-1/4 inches, and incurved at the back. Beneath the stage at the right is a rod with a revolving disc of diaphragms. Attached to the front of the stage plate is a nickel-plated stage, 3-1/2 x 2-1/2 inches, with a central 3/4-inch aperture, and a milled-head fine adjustment at the back. A brass tube, 3-3/8 x 1-3/8 inches, is screwed to the upper limb.

The nickel-plated body tube is 8-1/2 inches long, and has a screw ring nose; the upper 1-1/4 inches has a diameter of 1-11/16 inches. It is 15 inches high when closed, and is signed on the tube, "Tolles, Boston, 295." ■

Fig. 132. C. B. Kleine, New York, N.Y.; compound monocular; before 1876. (AFIP 155 - 60-4713-89)

The claw-footed base with a spread of 5 x 4-3/4 inches supports the two 2-1/2-inch uprights of this instrument (Fig. 132). The stage plate, 4-3/4 x 2-1/2 inches, is incurved at the back, with flanges cast in one piece, and is attached to the pillars by a screw pin. A beveled, flat tailpiece on a pivot has a dovetail slide casing with a 1-1/2-inch double mirror on a gimbal. At the front of the stage plate

is an inset revolving disc of diaphragms. At the back, beneath the stage, is a plate connected to the fine adjustment and an attached tube for the cylinder condenser.

The glass stage is 4 x 2-3/4 inches and has a central 1-inch aperture. A brass slide holder is held in place by a milled-head spring clip. Rising from the stage plate is a 3-1/4 x 15/16-inch tubular limb with a ring projection and a milled-head fine adjustment screw. The limb with an angular arm has a double milled-head pinion.

The body tube is 6-1/4 x 1-1/4 inches, has a short cone nose, a drawtube, and a Jackson fitting with a chain rack. It is 12 inches high when closed, and is signed, "C.B. Kleine, New York"; Kleine is unknown as a maker and probably was a dealer. ■

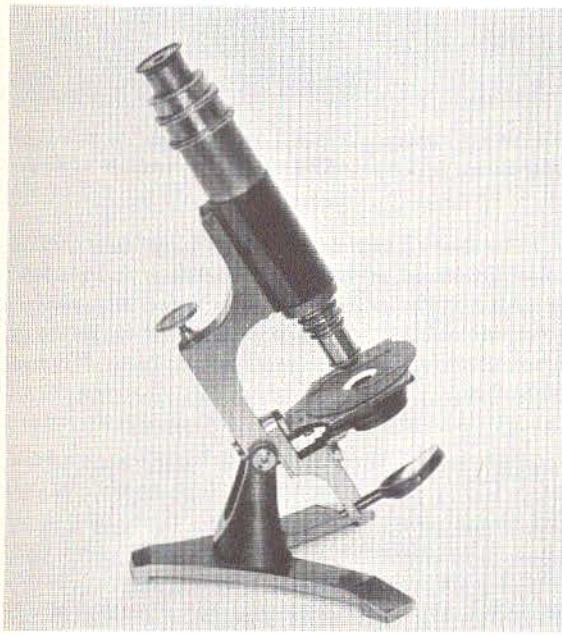

Fig. 133. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1876. (AFIP 49131 - 60-4713-300)

This instrument (Fig. 133) has a claw-footed base with a spread of 6 x 6 inches supporting a cone-shaped pillar 2-3/4 inches high, cut away front and back, and both in one casting of blackened brass. The square limb is 3 inches long with a 2-3/4-inch angle arm in front. It carries a grooved fitting attached to a blackened brass tube 3 x 1-7/16 inches long. The lower end of the limb is screwed to the pillar and carries a swinging tailpiece with dovetail slide and condenser tube.

On a pin and sliding bar below the limb is a double mirror on a gimbal. The stage plate is attached to the limb, is 3 x 3 inches, incurved at the back, and has a 2-3/4-inch thin, circular revolving stage above it. It also has a central aperture 7/8 inch in diameter.

The sliding body tube is 4-3/4 inches long, has a short cone nose, and a drawtube. The micrometer fine adjustment is a concealed lever at the top of the limb. When closed it is 12 inches high. It is signed, "J. Zentmayer, Phila., Patd. Aug. 15, 76." This American Histological Model was introduced about 1876 and was among the earliest of this type manufactured. ■

AFIP 175242. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1876. *Not illustrated.*

This microscope is a duplicate (American Histological Model) of that by the same maker in Fig. 133 (AFIP 49131). (Donated by Mr. Minor Worthington Tuttle) ■

AFIP 191. Maker unknown; compound monocular; C. 1876. *Not illustrated.*

This instrument is very similar to that in Fig. 99 (AFIP 49243) made by Charles Baker. Principal differences are that this model has a 2-1/4 x 1-7/8-inch stage, the casing is fixed to the limb, and there is a tube for a condenser; the single mirror is on a slide casing. It is signed, "Braham, Bath," but reference to such a maker or dealer has not been found in the literature. ■

The claw-footed base is black japanned iron with a spread of 5-3/4 x 5-1/2 inches, and supports the two brass 2-3/4-inch-high tubular pillars of this instrument (Fig. 134). A Lister limb, 6-1/2 inches long, screws on the trunnion; the lower 2 inches of the limb form the tailpiece. The 1-9/16-inch double mirror is on a ball-and-socket gimbal.

The stage is fixed to the limb, is 2-1/2 x 3-1/4 inches, has a 1/2-inch central aperture, and a slide bar on a pin; beneath the stage is a revolving disc of diaphragms. The upper end of the limb is attached to a sprung tube, 3-1/4 x 1-3/16 inches.

The body tube is 7-1/2 inches long and fits into the outer tube; there is a screw fine adjustment at the lower end, no drawtube, and an ocular with slit for micrometer slide. The

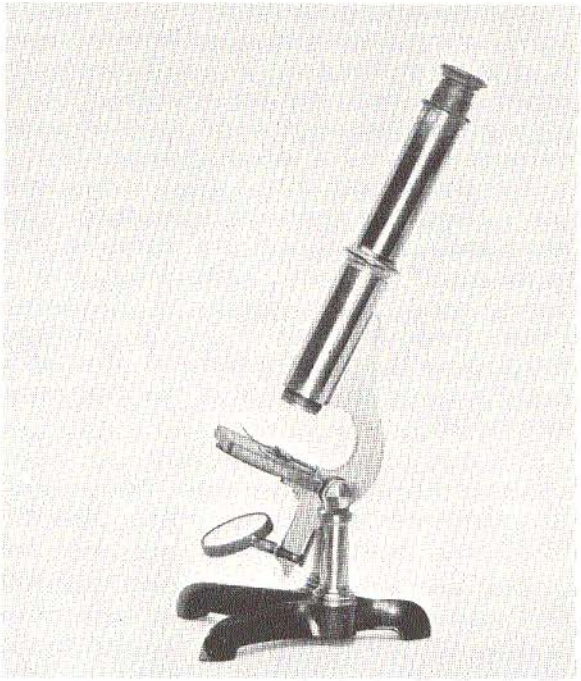

Fig. 134. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1876. (AFIP 49133 - 60-4713-429)

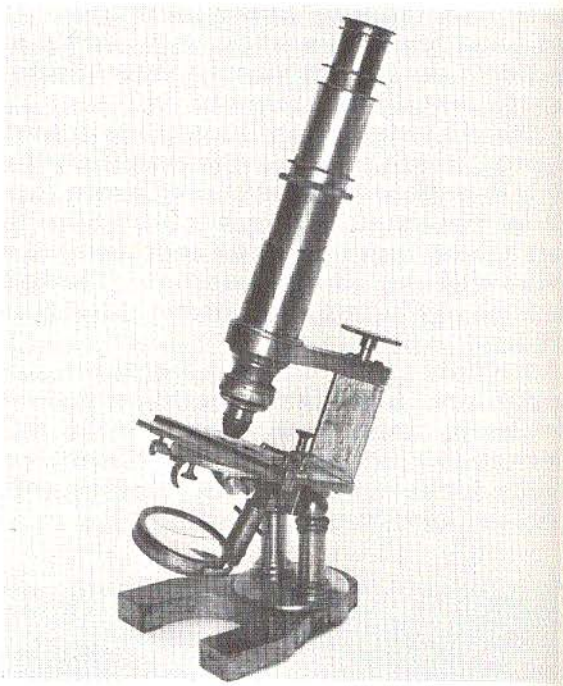

Fig. 135. George Wale, New York, N.Y.; compound monocular; after 1876. (AFIP 19646 - 60-4713-72)

stage, diaphragm disc, mirror case, and ocular are of dark red rubber.

It is signed on the stage, "Bausch & Lomb Optical Co." This is one of the earliest models made by this firm; the construction is unique, and it was discontinued before 1878. The screw tube focusing was later replaced by a sliding tube or rack and pinion. (Donated by Bausch & Lomb Optical Company) ■

The modified horseshoe base, 4-5/8 x 4 inches, supports a revolving plate to which are attached the two tubular 2-1/2-inch-high pillars of this instrument (Fig. 135). The 4-1/2 x 2-1/4-inch stage plate and trunnion are in one casting and are attached to the pillars.

The slotted, pivoted tubular tailpiece, 1-3/8 x 1/2 inch, has a sliding case with a pivoted gimbal and a 1-3/4-inch double mirror. Beneath the recessed opening at the front of the stage plate is a calotte diaphragm. The glass stage is 2-3/4 x 3-3/4 inches and is held by a spring bar.

Rising from the back of the stage plate is a 2-1/2-inch-long triangular limb. The 4-1/2-inch-long arm has a long lever fine adjustment. A tube, 2 x 1-3/8 inches, with a spring pin at the back, is fixed in a ring in front of the stage.

The body tube is 7 inches long, has a short cone nose, an adapter, a drawtube, and a spiral groove for the screw motion coarse adjustment, first introduced by Wale. It is 13 inches high when closed, and is signed on the base, "George Wale." ■

The modified claw-footed base has a spread of 5-1/2 x 6-1/2 inches and supports the two 3-1/4-inch-high uprights of this instrument (Fig. 136), that are of black japanned cast iron. The Lister limb and trunnion are in one casting of black japanned iron and are screwed to the uprights.

The tubular tailpiece is 2-1/4 x 1/2 inch, and is fixed to the limb; it has a slide casing and a short arm with a double mirror on a gimbal. The mirror is 1-1/2 inches in diameter on the concave surface and 1-1/4 inches on the plane surface.

The thin, circular brass stage is 3-7/8 inches in diameter, and is fixed to the limb. Beneath the stage is a revolving disc of diaphragms. The upper section of the limb has a double milled-head pinion, and a 3-7/8-inch rod that forms the fine adjustment.

The body tube is 8-3/4 x 1-3/16 inches, has a rack at the back, and a short cone nose; there

Fig. 136. C.A. Spencer & Sons, Geneva, N.Y.; compound monocular; C. 1878. (AFIP 738 - 60-4713-432)

Fig. 137. James W. Queen & Co., Philadelphia, Pa.; compound monocular; before 1878. (AFIP 136 - 60-4713-92)

is no drawtube. When closed it is 14-1/2 inches high, and is signed on the tube, "C.A. Spencer & Sons, for Geneva Optical Co., No. 46." It is known as the "Student Model." ■

AFIP 134. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1878. *Not illustrated.*

This all-brass (American Histological Model) instrument is constructed along the same lines as that in Fig. 133 (AFIP 49131) by the same maker, but is a later model. Differences are: The cone-shaped pillar is 3-1/2 inches high; the 3-inch-high square limb has a 3-1/4-inch angle arm in front; the stage is 3-1/4 x 3 inches; and the body tube is 5-1/4 x 1-1/4 inches and carries the rack at the back. When closed it is 11-1/2 inches high, and is signed, "J. Zentmayer, Phila., Patd., Aug. 15, 76." ■

The claw-footed base has a spread of 5 x 5-1/4 inches and supports the two brass curved uprights of this instrument (Fig. 137), that are cast in one piece and 3 inches high. The stage plate is screwed to the uprights, is 3-1/8 x 3-5/8 inches, incurved at the back, and has a 3/4-inch-high collar and flanges cast in one piece; above the stage plate is a two-motion mechanical stage. There is a recessed 1-inch central opening in the stage plate.

Beneath and in front of the stage plate is a sliding plate on grooved rods and a tube with a revolving disc of diaphragms. The tubular tail-piece is attached to the stage plate and is 3-3/16 x 3/4 inch; it carries a 1-1/2-inch double mirror and sliding case on a gimbal. The collar carries a double milled-head pinion and a tubular bar with rack at the back; the 3-inch-long arm is screwed to the bar.

The body tube has a short spring tube nose, is 4-5/8 x 1 inch, and is attached to a ring in front of the arm. There is a screw division in the tube 2-1/2 inches from the lower end. The fine adjustment is a long lever with a milled head on top and to the back of the arm. When closed it is 10 inches high. It is signed, "James W. Queen & Co., Philadelphia–New York." It is similar to those by the same maker in Fig. 107 (AFIP 19459), and Fig. 116 (AFIP 55556), but is of a later date. ■

Screwed to the 5-1/2 x 4-1/8-inch horseshoe base of this instrument (Fig. 138) is a black enameled, slotted rectangular pillar 4 inches high. The stage plate, trunnion, triangular bar,

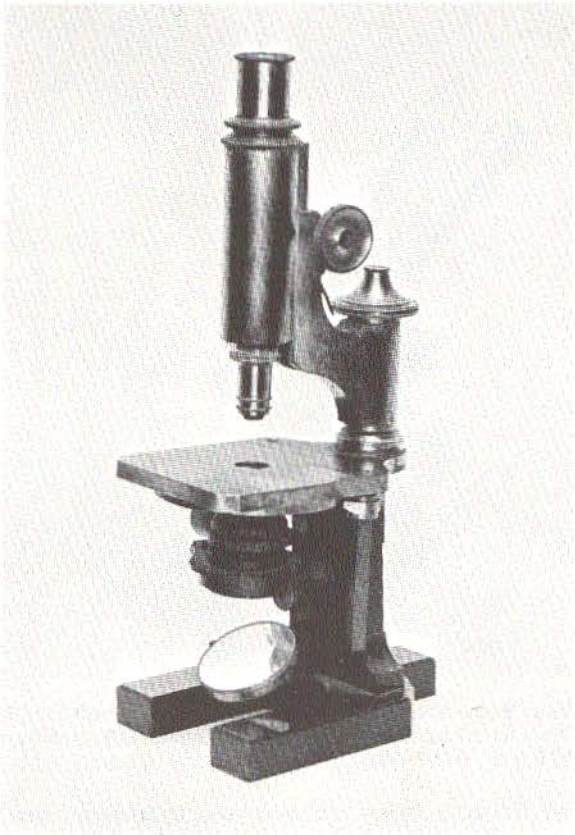

Fig. 138. Carl Zeiss, Jena, Germany; compound monocular; C. 1878. (AFIP 49134 - 60-4713-336)

and grooved, triangular tailpiece are cast in one piece and screwed to the pillar.

The tailpiece carries a sliding substage and a pin gimbal with a 1-15/16-inch double mirror. The stage has a 5/8-inch central aperture, is 5-1/2 x 3-3/4 inches, and incurved at the back. A 2-1/4-inch tubular limb with an angular arm is on the triangular bar with micrometer screw at the top. The front of the arm is 3-1/8 inches long and has a double milled-head pinion.

The body tube is 4 x 1-3/8 inches long, has a rack at the back, a graduated drawtube, and a short cone nose. It is 13-1/2 inches high when closed, signed on the arm, "Carl Zeiss, Jena, No. 4187," and is called the Stand No. I Model. "Stand" is the English translation of the German word, "stativ," that referred to the type of stand that supported the optical portion of the particular microscope; Stativ IV, Stativ IIa, and Stativ IIb are some of the designations accompanying descriptions of German instruments in the Collection. ■

Fig. 139. R. & J. Beck, London, England; compound monocular; C. 1878. (AFIP 69407 - 60-4713-194)

This instrument (Fig. 139) has a solid tripod base and a 3-inch-high tubular pillar capped with a compass joint. On a 2-inch rectangular tailpiece on a pivot is an arm and gimbal with a 1-5/8-inch-diameter double mirror.

The 3-inch circular stage plate has a projection at the back and a recessed opening with a plate and tube for the diaphragm. Beneath the stage is a tube for the cylinder condenser. The glass stage is 4 x 2-7/8 inches and is screwed by a milled-head spring. There is a slide bar and openings for the stage condenser and forceps.

The triangular limb is attached to the stage plate, is 3-3/4 inches long, and has an outer casing with a Jackson-type angular arm with a double milled-head pinion. The fine adjustment micrometer screws at the top of the limb.

The body tube is 4-3/4 x 1-1/8 inches, has a short cone nose, rack at the back, and a drawtube. Accessories are a Wales objective, 2 oculars, and a Stanhope lens in a tube. It is signed on the foot, "R. & J. Beck, London and Philadelphia, 9011." This model was introduced about 1875 and continued until 1892, and is known as the "Economic" model. (Donated by Dr. Frederic J. Ressiquie) ■

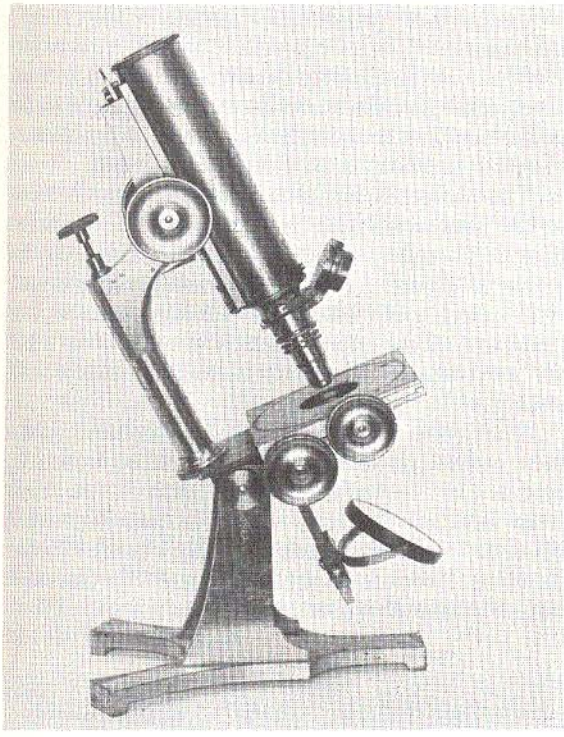

Fig. 140. Benjamin Pike, New York, N.Y.; compound monocular; C. 1878. (AFIP 19647 - 60-4713-190)

The reversed claw-footed base has a spread of 7 x 5-1/4 inches and supports the two uprights of this instrument (Fig. 140) that are 4-1/2 inches high. The stage plate and trunnion are cast in one piece and screwed to the uprights. On a pivot is a square tailpiece, 3-1/4 x 1/4 inch, with sliding case and two setscrews. There is a gimbal with a 2-1/8-inch double mirror.

Beneath the stage is a tube for the condenser. Above the stage is a double milled-head mechanical stage, 3-9/16 inches square, with a central 1-5/16-inch aperture. Rising from the back of the plate is a 4-1/2-inch-high tubular limb with angular arm. A Jackson fitting, 3-1/4 inches long, is in front of the plate, with a double milled-head pinion, and a long lever fine adjustment with a micrometer screw at the top of the limb.

The body tube is 6 x 1-1/2 inches, has a short cone nose, and a graduated drawtube. When closed it is 13-1/2 inches high. It is signed on the foot, "Pike, Maker, 518 Broadway, New York, No. 1177," and on the stage, "J. Iseli, N.Y., No. 18 South 5th Ave., 1878." Benjamin Pike was a New York dealer in 1851, and Benjamin Pike, Jr., in 1859; they imported English and French microscopes. Benjamin Pike Sons & Co. were dealers in 1881-82. While this instrument is signed, "Pike, Maker," no record has been found listing him as such; Iseli was probably a dealer. ■

Fig. 141. Maker unknown; compound monocular; before 1879. (AFIP 54427 - 60-4713-195)

The 6-1/4 x 5-3/8 x 1/2-inch mahogany base supports the black japanned iron claw foot, 5-1/2 x 4-3/4 inches, of this instrument (Fig. 141). The foot supports two brass curved uprights, each 3-1/4 inches high. The stage plate and two collars and flanges are cast in one piece, and screwed to the uprights.

The tubular tailpiece is 3-1/2 x 9/16 inch, and is screwed to the lower collar. There is a sliding case with a short arm and gimbal and a 1-1/2-inch single mirror. The stage plate is curved at the back, is 3-5/8 x 2-3/4 inches, and has a central 7/8-inch threaded opening, and openings for forceps. Beneath the stage plate is a revolving disc of diaphragms.

The brass stage is 5-1/8 x 2-1/16 inches, incurved at the sides, has a slide bar with two spring clips, and a beveled central aperture. The upper collar is 1-1/8 inches long, has a double milled-head pinion, and a triangular bar with a rack at the back. The arm is 3 inches long and is screwed to the bar. The body tube is 7 x 1-1/8 inches, is screwed to a ring in front of the arm, has a short lever fine adjustment at the lower right side, and a cone nose. It is 12-1/2 inches high when closed.

Accessories are a Crouch objective; ocular; forceps; live-box; glass tube; bull's-eye condenser on stand; and dissecting needle handle.

James W. Queen & Co., Philadelphia, made a similar instrument from 1868 to 1878; it was also listed by Tiemann & Co., New York, from 1879 to 1889; Lentz & Sons, Philadelphia, 1883; John Reynders, New York, 1889; and Fieck Bros., Pittsburgh, 1890; the names of all of these appear on duplicates of this model. ■

AFIP 155694. Maker unknown; compound monocular; before 1879. *Not illustrated.*

This instrument is a duplicate of that in Fig. 141 (AFIP 54427) with the following exceptions: The foot is brass, there is no extra stage, only a slide bar, and there is no disc of diaphragms.

While this microscope is signed, "J. H. Steward, 50 Cornhill, London," there is no record that Steward was the actual maker. He undoubtedly was a supplier and carried several makes of microscopes, and on the made-for-trade models he did use his name. It is probable Engelbert and Hensold of Wetzlar, Germany, were the actual makers in the 1870's. The case for the objective of the instrument is signed, "Engelbert & Hensold, No. 8; Sole Agent, J. H. Steward, 406 Strand, London," substantiating the presumption that Steward was the supplier for the German makers. ■

Fig. 142. Henry Crouch, London, England; compound monocular; before 1879. (AFIP 49130 - 60-4713-201)

The black japanned English base of this instrument (Fig. 142) is 6 x 5-1/4 x 4-3/8 inches. A 6-1/2-inch Lister limb is on a trunnion, and the lower end has a swinging tubular tailpiece, 2-1/4 x 9/16 inch, and a 1-1/2-inch single mirror on a pivot arm and gimbal.

The stage is 2-7/8 x 2-5/8 inches, is fixed to the limb, and has a central 1-1/4-inch aperture, and openings for forceps. Beneath the stage is a tube for the condenser or diaphragm, and a cylinder with a revolving disc of diaphragms. The upper front of the limb is 3-3/4 inches long, and has a double milled-head pinion.

The body tube is 6 x 1-5/8 inches, has a rack at the back, a 1-inch nosepiece, drawtube, and a short screw fine adjustment at the lower front of the tube. It is 12 inches high when closed, and is signed on the base, "Henry Crouch, London; Agents, James W. Queen & Co., Philadelphia, No. 1764." ■

Fig. 143. F. Miller and Bro., New York, N.Y.; compound monocular; before 1879. (AFIP 197 - 60-4713-191)

The claw-footed base has a spread of 6-3/4 x 5 inches and is made of black japanned iron. It supports the two uprights of this instrument

(Fig. 143), that are 3-1/2 inches high. An iron trunnion with plate is screwed to the uprights.

The black stage plate is 3-3/4 x 3 inches, is screwed to the trunnion plate, and has a central 1-3/16-inch threaded aperture. The nickel stage is 2-7/8 x 3 inches and is screwed to the plate at the side. The milled-head fine adjustment beneath the stage at the right moves an object at an angle. The tubular limb is 4-1/2 x 3/4 inch, is screwed to the stage plate, and has an angular arm attached to a 4 x 1-7/16-inch tube. The body tube is 8-1/2 inches long, has a milled-edge ring 1-1/2 inches from the top, and a short cone nose; there is no draw-tube. When closed it is 14 inches high.

It is signed, "F. Miller & Bro., New York." F. Miller worked under Robert B. Tolles in Boston, and in 1868 established his own business in New York. He made excellent lenses, some of which were tested and used by Dr. J. J. Woodward at the Museum and are now a part of this Collection. ■

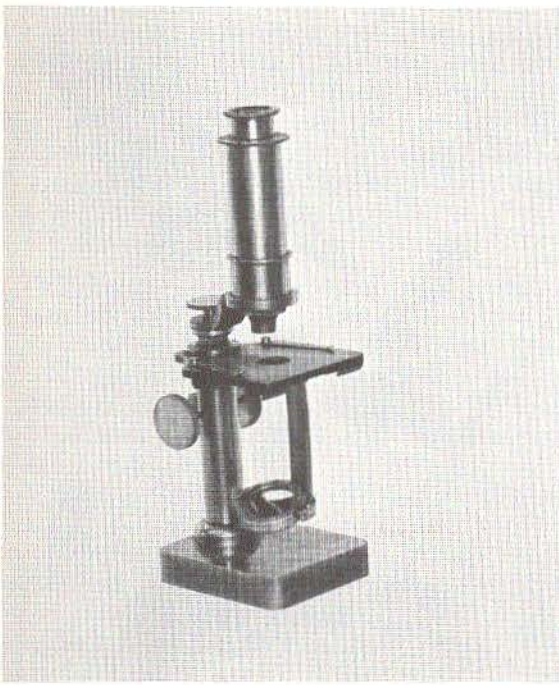

Fig. 144. Carl Zeiss, Jena, Germany; compound monocular; C. 1879. (AFIP 165 - 60-4713-174)

The solid brass base of this instrument (Fig. 144) has rounded corners and is 3-7/16 x 2-15/16 x 3/4 inch. The tubular pillar is 4 x 7/8 inch high, is screwed to the base, and has a double milled-head pinion and a square inner bar with rack at the back.

The stage is 3-9/16 x 2-15/16 inches, is incurved at the back, screwed to the pillar, and has a 11/16-inch central opening. Beneath the stage are four dovetail fittings, probably for arm rests. At the left there is a 3-1/2 x 1/2 x 3/16-inch arm with a gimbal on a pin and a 1-1/8-inch single mirror. The up-curved arm is 2-7/8 inches long and attached to the bar by a milled-head screw. The front end of the arm has an attached tube 7/8-inch long and 1-1/8 inches in diameter.

The body tube is 3-1/2 inches long, has a cone nose, and slides into an arm tube; the top is sprung, and there is no fine adjustment. When closed it is 11 inches high, and is signed on the base, "1517, C. Zeiss, Jena," and is known as the "Stand No. 179" model. ■

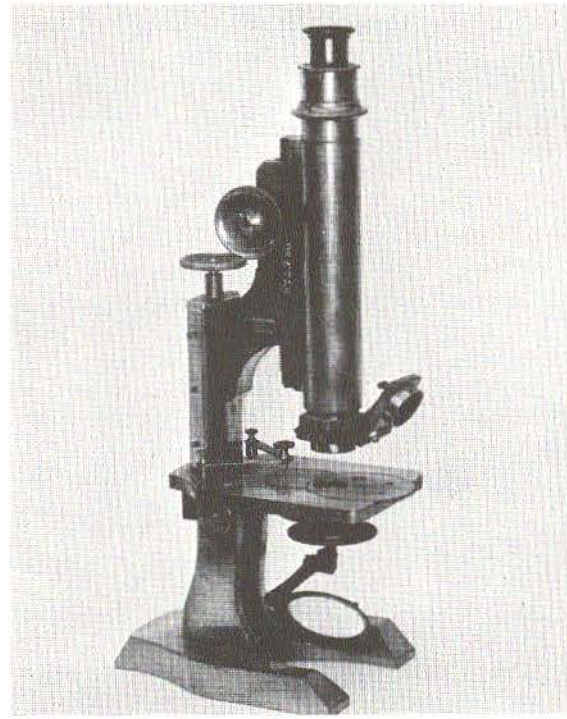

Fig. 145. J. Grunow, New York, N.Y.; compound monocular; C. 1879. (AFIP 253 - 60-4713-176)

The modified horseshoe base is 5-1/2 x 4 inches and supports the two uprights of this instrument (Fig. 145), that are 3-1/2 inches high. The inner bar of the limb and trunnion are cast in one piece and screwed to the uprights. The stage plate is 4-1/2 x 3 x 5/16 inch and screwed to the trunnion. Beneath the stage plate at the left is a two-jointed arm with gimbal, a 1-5/8-inch double mirror, and an oval plate with a breechlock fitting for a condenser.

A revolving disc of diaphragms is set in the stage plate at the front. At the back is a milled-head spring to hold a glass stage. The bar is enclosed by a flat hexagonal casing, 3-1/2 inches long, with a 3-3/4-inch angle arm at the front with a double milled-head pinion. The fine adjustment micrometer screw is at the top of the limb.

The body tube is 5-1/2 x 1-1/8 inches, has a rack at the back, a short cone nose, an angular form double nosepiece, and a graduated drawtube. It is 13 inches high when closed, and is signed on the arm, "J. Grunow, New York, 933." Prior to 1884 this model was changed to incorporate a tubular casing on the limb and substage. It is the smallest model of the three made by Grunow, and bears the highest serial number of any of the Grunow microscopes in the Collection. ■

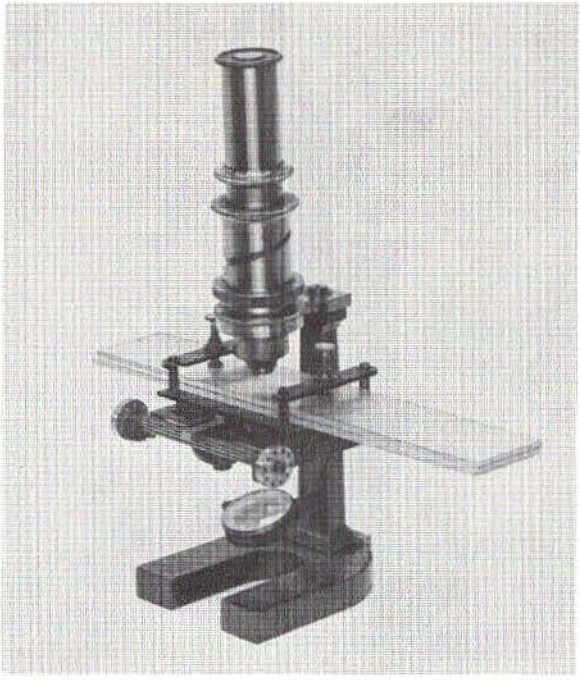

Fig. 146. Schmidt & Haensch, Berlin, Germany; compound monocular; C. 1879. (AFIP 49126 - 60-4713-256)

The horseshoe base, 4 x 3 inches, and the rectangular pillar, 4-5/8 x 7/16 inch, of this instrument (Fig. 146) are in one casting and of black japanned iron. At the lower end of the pillar is a screw pivot and a gimbal with a 1-inch single mirror.

The stage plate is 3-1/2 x 3 inches and is attached to the pillar; the center is cut to 3 x 1-1/2 inches. Beneath the stage plate at the right is a lever for lateral motion of the mechanical stage; forward and backward motion are by rack and pinion. The pinion heads are perforated and may be locked on lateral motion at either side by pins.

The mechanical stage has four uprights and two movable bars with milled-head screws. Two glass plates, 9-1/4 x 1-5/8 x 1/8 inch, fit between the bars; the lower plate is marked by five 1-inch squares; the plates form the compressorium.

The 2-1/2-inch-long arm is screwed to the pillar, has a 1-1/2-inch ring in front, and a double milled-head ring, with a spiral grooved tube, 1-3/4 x 1-3/16 inches; the lower ring forms the screw adjustment.

The body tube is 5-3/4 inches long, has a short cone nose, a screw pin in back that has a spiral motion, and a milled-head ring central section. This model was designed for determining trichinae infection of meat, and is not adaptable for use as an ordinary microscope. ■

Fig. 147. Walter H. Bulloch, Chicago, Ill.; compound monocular; 1879 (AFIP 49135 - 60-4713-100)

This instrument (Fig. 147) has a heavy, modified, reversed claw-footed base of brass, to which is screwed a tubular pillar 2-1/2 x 15/16 inch. At the top of the pillar are two flange uprights 1-1/2 inches high; an angular

limb screws to the uprights. At the back of the lower end of the limb is an angular swinging tailpiece and a grooved slide arm and gimbal for support of the mirror. At the front of the lower end is another angular tailpiece that is graduated and swings independently; it is grooved for a substage; there is a fixed angular plate to which the stage plate screws.

The stage is 3-7/8 inches in diameter, has a milled edge, and revolves. The upper surface is black glass and 3-1/2 inches in diameter, with a 1-3/4-inch central aperture. The upper end of the limb is 4 inches long, and has a Jackson fitting with a double milled-head pinion; there is a micrometer screw fine adjustment on the limb.

The body tube is 5-1/8 x 1-7/16 inches, has a short cone nose, a rack at the back, a sprung top and a drawtube. When closed it is 13 inches high. It is not signed, but is unmistakably a Bulloch instrument. Bulloch established his own business about 1867, and specialized in microscope stands but is not credited with making lenses. In 1873 he introduced a substage sector with rack and pinion, and in 1877 a two-ring, swinging tailpiece and substage, a modification of Zentmayer's single ring patent of 1876; it was patented in 1879. Bulloch used either straight or angular shanks for tailpieces. This was known as the "Biological Model." ■

The modified horseshoe base, with a spread of 6 x 5-3/4 inches, supports the two tubular pillars, each 3 x 3/4 inch, of this instrument (Fig. 148); a heavy rectangular trunnion is screwed to the pillars. There is a 2-inch-long flat tailpiece on a screw pivot with gimbal and 2-inch double mirror.

The stage plate is 4-1/2 x 3-1/4 inches, is incurved to 2 inches at the back, and screwed to the trunnion. The stage is 3-1/4 x 2-1/2 inches and is in a dovetail fitting 1/4 inch above the plate; it has a revolving disc of diaphragms and two clips on the plate fitting. Beneath the plate is a 1-11/16-inch screw-in tube for a cylinder condenser.

The tubular limb is 4-1/4 x 13/16 inch and is fixed to the back of the stage plate. At the top are two 1-3/4-inch-long parallel arms on screw pivots to the limb. Attached to the front of the stage plate is a split tube, 2-1/2 x 1-11/16 inches, with a projecting bar at the back. There is a micrometer screw for fine adjustment at the top of the limb.

Fig. 148. W. & H. Seibert, Wetzlar, Germany; compound monocular; after 1879. (AFIP 20368 - 60-4713-180)

The body tube is 4 inches long, has a slide adjustment and a milled-edge ring drawtube 3 inches long; it has a short cone nose. The upper section of the body tube is reduced to 1-1/8 inches in diameter and may be drawn for about 1/2 inch. It is 12 inches high when closed, and is signed, "Seibert." The firm of Seibert and Kraft was succeeded by W. & H. Seibert before 1903. ■

The 4-3/8 x 7/8-inch tubular pillar of this instrument (Fig. 149) has a compass joint at its top, and is screwed to the tripod foot by a recessed clamp. The angular limb has a circular plate at the base and a graduated swinging tailpiece with a tube for a condenser, a short tubular arm for a pin gimbal, and a 1-5/8-inch double mirror.

The stage plate is fixed to the circular plate on a limb, is 3-1/4 inches in diameter, and has a central aperture 1-3/16 inches in diameter. The fine adjustment is a milled head on the limb. The upper section of the limb is 4 inches long, and has a double milled-head pinion and Jackson fitting.

The body tube is 7 x 1-3/8 inches, has a rack at the back, and a 1-inch screw-in cylinder nose, a double nosepiece, and a drawtube. It

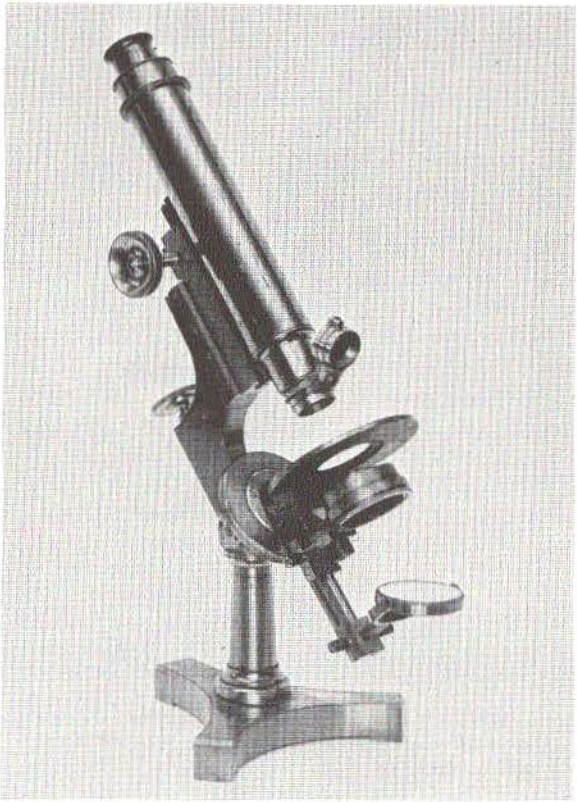

Fig. 149. Acme Optical Works, Philadelphia, Pa.; compound monocular; C. 1880. (AFIP 135 - 60-4713-281)

is 13-1/2 inches high, and is signed on the foot, "Made by Acme Optical Works, Jas. W. Queen & Co., Philadelphia, Agents, 475"; it is the Acme No. 3 model. The Queen Company was the agent for the Acme Optical Works until Acme acquired Sidle and Poalk in 1882. In 1892 a binocular Acme No. 3 model became available. ■

AFIP 613449. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1880. *Not illustrated.*

The horseshoe base of this instrument is 6 x 4-3/8 inches, and supports the 2-1/2-inch-high cylindrical pillar that is capped by an inclination joint. The 2-3/4-inch limb has a fine adjustment at the top. The 3 x 3-3/4-inch stage plate is incurved at the back, and fixed to it is the vulcanite stage with a 3/4-inch central aperture and a substage condenser. The gimbal for the 2-inch double mirror is inserted into the swinging tailpiece.

The 4-1/2-inch-long body tube has a drawtube, a double nosepiece, and a rack and pinion coarse adjustment. When closed it is 12-1/2 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., New York City, 36331." (Donated by Dr. Fred Stewart) ■

AFIP 49139. Acme Optical Works, Philadelphia, Pa.; compound monocular; C. 1880. *Not illustrated.*

This instrument is a duplicate of that in Fig. 149 (AFIP 135) by the same maker. It is signed, "Jas. W. Queen & Co., Philadelphia"; that company was an agent for the Acme Works; it is the Acme No. 3 model. ■

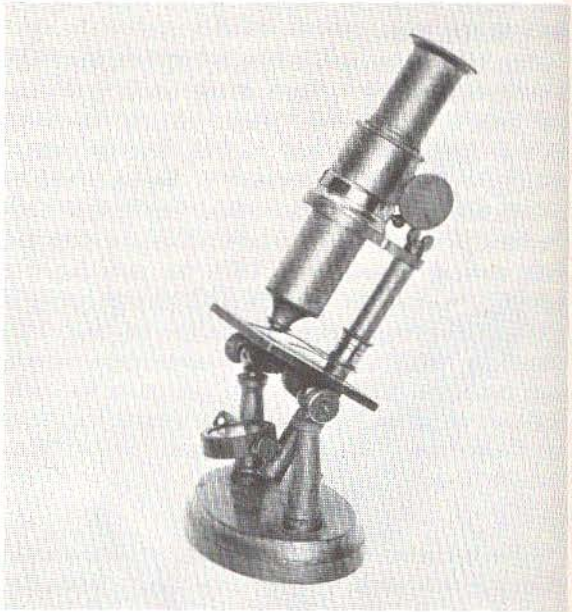

Fig. 150. Maker unknown; compound monocular; C. 1880. (AFIP 613452 - 60-4713-305)

This all-brass microscope is 9-1/2 inches high (Fig. 150) with a 4 x 2-3/4-inch oval base, to which are screwed two uprights, each 2-3/8 inches high. The stage plate is 2-3/8 inches square and attached to the uprights, and below it is a disc of diaphragms. Inserted in the rear of the stage plate is a 4-3/4-inch-long circular rod, 3/8 inch in diameter, the lower 2 inches of which extend below the stage plate where the 1-inch double mirror on a gimbal is inserted; at the top of the rod is an arm for the body tube. There is a trunnion mount on the oval base and rack and pinion focusing. The body tube is 3-1/4 inches long, has a short cone nose, and a drawtube. Height is 9-1/4 inches, and is probably of French manufacture. (Donated by Dr. J. R. Schumaker) ■

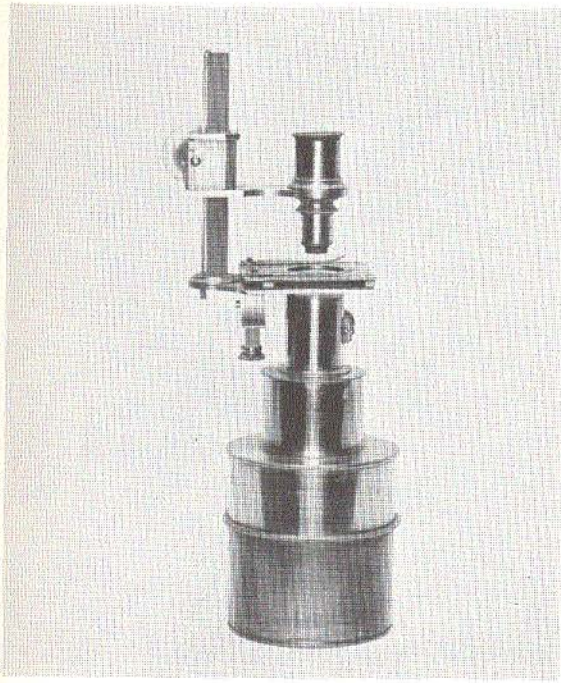

Fig. 151. William Ladd, London, England; compound monocular; C. 1880. (AFIP 49434 - 60-4713-398)

This all-brass instrument (Fig. 151) is 14 inches high, and has a cylindrical base 3-3/4 inches in diameter and 4-1/4 inches high; inserted in the lower portion of the base is a glass, 3-1/4 inches in diameter. Extending from the upper portion of the cylindrical base is another cylinder 1-3/4 inches high and 2 inches in diameter, and screwed into this is a third cylinder, 1-7/8 inches high and 1-1/4 inches in diameter.

Attached to the top cylinder is a stage plate 2-3/8 x 3 inches, to which is screwed a movable stage plate with a 1-3/16-inch aperture. Attached to the rear of the stage plate is a 5-inch-long triangular rod that has a vertical steel chain adjustment for a lens holder. It is signed, "W. Ladd, 11 & 12 Beak St., Regent St., W." ■

The claw-footed base of this instrument (Fig. 152) has a spread of 5-3/8 x 4-1/2 inches, and supports two uprights, each 2-7/8 inches high, made of iron with a bronze finish. A brass curved limb, stage plate, and trunnion are in one casting and screwed to the uprights. A slotted tailpiece, 2-1/2 x 3/4 x 3/16 inch, on a pivot to the trunnion, has a slide with pivot gimbal and a 1-1/2-inch double mirror.

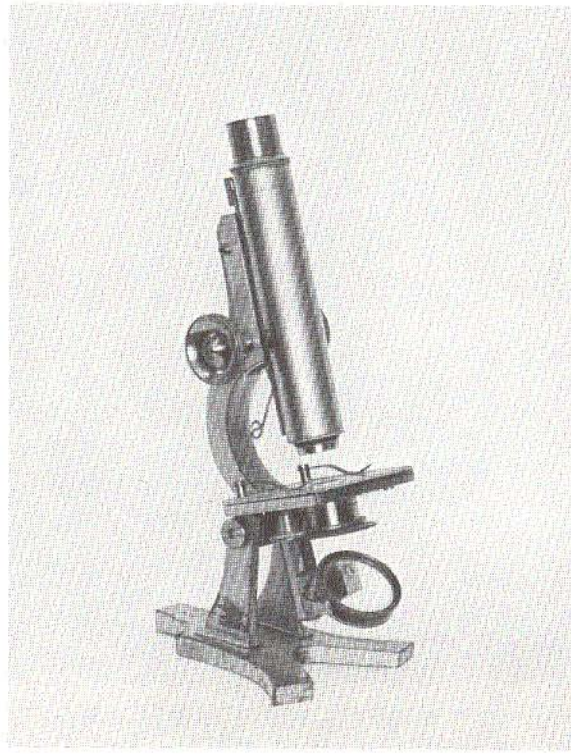

Fig. 152. T.H. McAllister, New York, N.Y.; compound monocular; before 1880. (AFIP 70440 - 60-4713-186)

The stage plate is 3-1/4 x 3 inches and is incurved at the back. Beneath the stage is a screw-in tube for cylinder condenser, and a cylinder diaphragm. At the right side of the stage is a micrometer screw fine adjustment that raises one side of the stage. The thin brass stage, screwed to the left side of the plate, has a 5/8-inch central opening.

The upper front of the limb is 3-1/4 inches long, and has a double milled-head pinion. The body tube is 7-1/4 x 1-3/16 inches, has a grooved fitting at the back with a chronometer chain rack, a drawtube, and a short cone nose. The instrument is 12 inches high when closed.

It is signed, "T.H. McAllister, New York." McAllister and Brother were dealers in Philadelphia in the 1860's. Before 1867 T. H. McAllister moved to New York where he listed three models in 1879 with chain quick movement. This instrument, and that in Fig. 132 (AFIP 155), are the only two microscopes in the Collection that have the chain movement. The stage and fine adjustment of this model were considered unsatisfactory because only one side moved, placing the object at an angle. It is known as the "Student Model." ■

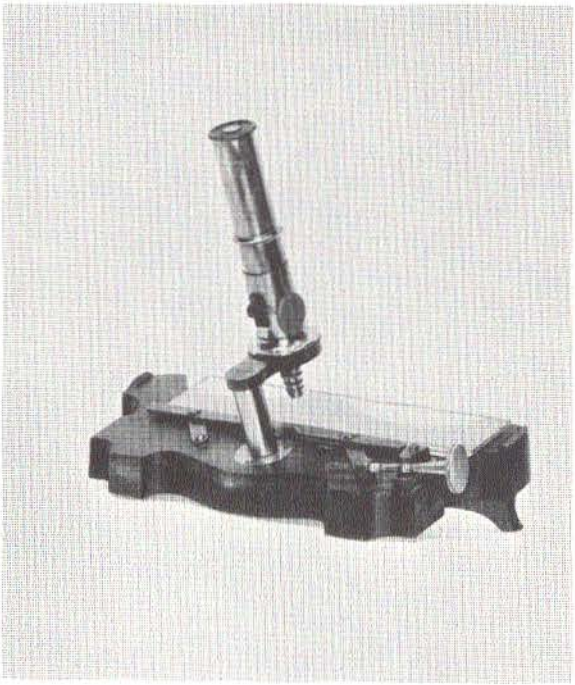

Fig. 153. Maker unknown; compound monocular; before 1880. (AFIP 49127 - 60-4713-428)

Attached to the front of the hardwood base of this instrument (Fig. 153), 12 x 4-1/8 x 1-1/8 inches, are two legs, each 1-1/4 inches high, that serve to create an inclined stage; a 1-inch inset graduated scale is at the right. A tubular pillar, 1-3/4 x 11/16 inch, is screwed into a square case.

On top of the stage is a bar, 8 x 3/8 x 1/16 inch, that is attached to the supports. Actuated by a milled-head screw, the bar may be moved to or away from the stage aperture. There is a two-glass plate compressorium, 1-5/8 x 1/8 x 9-1/4 inches, on the stage. Beneath the stage in front is a 1-1/8-inch single mirror on a double milled-head gimbal and pin.

The 3-inch-long arm is screwed to the pillar. A front ring, 1-13/16 inches in diameter, has a fixed ring brass tube 2-1/8 inches long, the upper section of which carries a single milled pinion. The body tube is 6 inches long, has a rack at the back, a milled-edge ring in the center section, and a short cone nose; there is no drawtube. It was designed for examining meat for trichinae. ■

The claw-footed base of this all-brass instrument (Fig. 154) has a spread of 7 x 6-1/2 inches, and supports a tubular pillar, 3-3/8 x 1-1/8 inches, that is surmounted by a compass

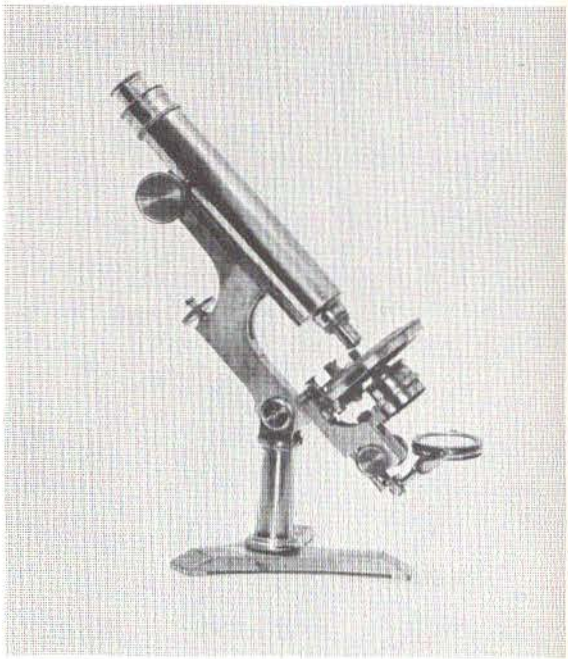

Fig. 154. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; before 1880. (AFIP 49132 - 60-4713-342)

joint. A 4-1/2 inch-long vertical limb with a wide angular arm, 4-3/4 inches at the front, has a double milled-head pinion and a lever fine adjustment micrometer on the limb. A swinging tailpiece carries the substage with rack and pinion motion. On a tube is a sliding arm and gimbal with a double mirror.

A 4-inch circular stage is fixed to the limb. The glass stage plate is 3 inches in diameter, has a 1-inch aperture, a slide bar with milled-head spring, and openings for forceps. The body tube is 8 x 1-1/2 inches, has a short cone nose, and a drawtube. Height is 16 inches.

It is signed, "J. Zentmayer, Philadelphia, Patented, 1876, 2032." It is known as the "United States Army Hospital Model," and when first introduced in 1862, had a square stage, curved limb, and a short lever adjustment at the front of the tube. ■

A mahogany case, 4-1/2 x 3 x 1-1/2 inches, originally served as the base of this instrument (Fig. 155). Two 3-1/8-inch-high uprights screw to the lid of the case, and there is a Lister limb on a compass joint with a single milled-head pinion. A plate is fixed to the lower end of the limb, and attached to it on a pivot is a short arm and gimbal with a 15/16-inch-diameter single mirror.

Fig. 155. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1880. (AFIP 54281 - 60-4713-304)

The stage is 2-7/16 x 1-3/8 inches and is fixed to the plate, and has a 1/2-inch central aperture. Beneath the stage on a screw pivot is a swinging arm for a 3/8-inch plano-convex condenser. The body tube is 2-15/16 inches long, has a rack at the back, drawtube, and a screw-in compound lens.

It is signed on an upright, "Jos. Zentmayer, Philada." The instrument has no serial number, which may indicate that few of this type were made; Zentmayer's precision workmanship is readily apparent. ■

AFIP 69927. Maker unknown; compound monocular; C. 1880. *Not illustrated.*

This instrument is similar to that in Fig. 130 (AFIP 183); not signed, it is probably of French manufacture. (Donated by Dr. Charles Hopkins) ■

The horseshoe base, 3-3/4 x 3 inches, and a 1-1/2-inch-high pillar with flanges of this instrument (Fig. 156), are all cast in one piece of rough, black finished iron. A 3-3/4-inch-long curved limb of the same finish is attached to the pillar by a pin, and carries a double milled-head pinion of brass. On a pivot short arm at the base of the limb is a gimbal with a 1-1/4-inch double mirror.

Fig. 156. Maker unknown; compound monocular; C. 1880. (AFIP 166 - 60-4713-263)

The stage consists of two plates, 2-1/8 x 2-3/4 inches, held by screws; between them is a revolving disc of diaphragms with front motion. The stage has a 5/16-inch central aperture, and is screwed to the limb.

The brass body tube is 5-1/2 inches long; the lower section, 3 x 1-1/8 inches, carries a rack at the back and a short cone nose; the upper section, 1 inch in diameter, has a screw division. Height is 9-1/4 inches. ■

AFIP 49140. Carl Zeiss, Jena, Germany; compound monocular; 1881. *Not illustrated.*

This instrument is a duplicate of that in Fig. 138 (AFIP 49134) by the same maker. It is signed, "Carl Zeiss, Jena, No. 4721." ■

AFIP 71789. John Field, Birmingham, England; compound monocular; 1881. *Not illustrated.*

This instrument was made originally with a circular base, 3-7/16 inches in diameter and 1/4 inch thick, with openings for 3 spring legs. The 2-1/2-inch-high pillar has a rack and pinion coarse adjustment. The stage is 2-5/16 x 1-3/4 inches, and has a 3/8-inch central aperture. Attached to the rear of the stage is a 1-3/4-inch swinging arm for the gimbal and 1-3/8-inch mirror.

The body tube is 4-3/4 inches long and has a drawtube. The entire instrument is nickel-plated and is 8-1/2 inches high when closed. It is signed, "Griffith Club Microscope." Introduced in 1881, this model was designed by E.H. Griffith, F.R.M.S., Fairport, N.Y., and its construction is attributed to John Field of Birmingham, England. ■

Fig. 157. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; after 1881. (AFIP 229 - 60-4713-192)

The horseshoe base, 5-1/2 x 3-3/4 inches, and the cut cone pillar, 3 inches high, of this instrument (Fig. 157) are cast in one piece of black japanned iron; a brass Zentmayer limb and arm on a trunnion are screwed to the pillar. The swinging tailpiece has an arm, gimbal, and a double mirror.

The stage is fixed to the swinging tailpiece that is screwed to the limb and is 2-1/2 x 2-7/8 inches; it has a 1/2-inch central aperture. Beneath the stage on a rod at the left is a revolving disc of diaphragms. The limb carries the fine adjustment screw and a double milled-head pinion.

The body tube is 5-1/8 x 1-1/2 inches, has a rack at the back, a short cone nose, a double nosepiece, and a drawtube. When closed it is 12 inches high. It is signed, "J. Zentmayer." The original American model has a claw foot and a pillar similar to that of the Histological Model (Fig. 133–AFIP 49131), a revolving diaphragm inset on top of the stage, and a sliding body tube; later models were made with rack and pinion optional. This is the only model made with a horseshoe base and is known as the "American Student Model." ■

Fig. 158. Jean Gabriel Chevallier, Paris, France; compound monocular; 1882. (AFIP 49094 60-4713-134)

The rectangular base, 6-1/4 x 3-1/4 x 11/16 inch, and the solid 3-inch-high pillar with heavy flanges of this instrument (Fig. 158) are cast in a single piece of iron with a dull black finish. The square limb is 7 x 3/4 inch, is on a trunnion axis, and is screwed to the pillar; the lower 1-1/2 inches of the limb are tubular.

On a double pivot short arm there is a gimbal with a 1-3/4-inch double mirror. At the top of the limb is an angular arm and a double milled-edge ring tube, 2-1/2 x 1-3/8 inches. A micrometer screw fine adjustment at the top of the limb adjusts the stage.

The stage is 3 x 3-1/4 inches, is on a sliding plate, and moves on the limb; it has a central 1/2-inch aperture opening for the stage condenser. Beneath the stage is a tube and a revolving disc of diaphragms.

The body tube is 3-7/8 inches long, has a milled-ring at the top with sliding adjustment, a milled-ring drawtube, and a short cone nose. It is 12-1/2 inches high and signed on the tube, "Maison, L. Ingr. Chevallier, Optn., Place du Pont, Neuf 15, Paris." Chevallier, 1778-1848, was well known for his optical inventions, and for many years following his death, his firm continued producing optical instruments under his name. ■

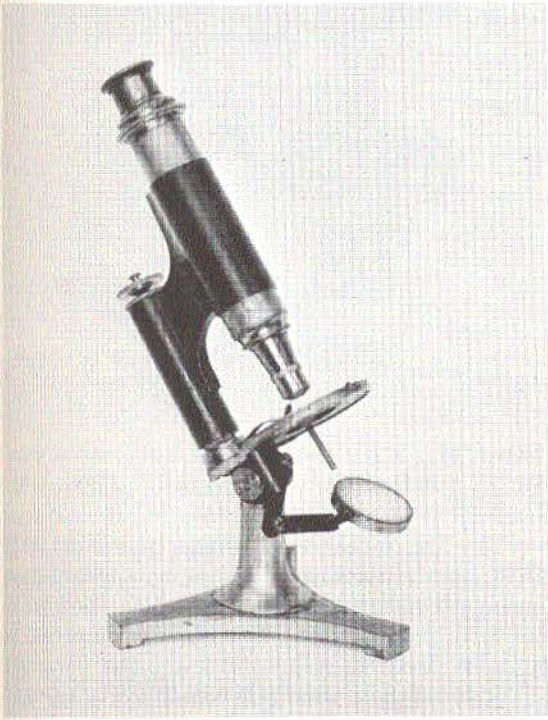

Fig. 159. R. & J. Beck, London, England; compound monocular; before 1882. (AFIP 517746 - 60-4713-271)

This instrument (Fig. 159) of brass and black coated metal has a flat tripod base with a spread of 5 inches. The 2-inch-high pillar has a compass joint at the top to which is screwed a double-jointed arm for the gimbal and 1-1/2-inch single mirror. The 2-1/2-inch circular stage with rear projection has a 1-inch central aperture. The 3-1/2-inch limb has a screw fine adjustment at the top.

The body tube is 4-3/8 inches long, has a short cone nose, a drawtube, and slides into a casing attached to the arm; height is 11 inches. It is signed, "R. & J. Beck, London & Philadelphia, 11860; W. H. Walmsley & Co., Philadelphia, Sole American Agents." (Donated by Miss Carolyn Fix) ■

AFIP 53392A. E. Hartnack, Paris, France; compound monocular; 1882. *Not illustrated.*

The tubular pillar of this microscope is 5-1/4 x 15/16 inch, has a rack at the back, and screws to a section of the sliding base case. The circular stage is 3-7/16 inches in diameter, has an arm with a double milled-head pinion, and a 1-3/16-inch central aperture.

A triangular vertical limb, 12 x 5/8 inch, fits into the pillar and has a graduated rack at the back. There is a 3-inch arm with a double milled-head pinion for an objective, and above that another arm with a double milled-head pinion into which fits a 6-inch horizontal tube. This tube contains a prism box, a compound eye lens, and a camera lucida; the latter has a screw-on cover. The only accessories are two objectives. This is a modified model by Hartnack of the larger and more complicated instrument devised and used by Wilhelm His, renowned German embryologist. (Donated by Dr. M. Abrahams) ■

Fig. 160. Maker unknown; compound monocular; 1883. (AFIP 613453 - 60-4713-244)

The flat tripod base of this instrument (Fig. 160) has a spread of 5 inches, and supports the 2-1/2-inch-high pillar that is capped by a compass joint. A double-jointed arm for the gimbal and 1-7/8-inch mirror is screwed to the front of

the compass joint. The 4-5/8-inch limb has a fine adjustment at the top. The 2-3/4 x 4-inch stage is incurved at the back, has a 3/4-inch central aperture, and a substage ring for a condenser.

The body tube is 4-1/2 inches long, has a drawtube, and a rack and pinion coarse adjustment; height is 14-1/4 inches. It is signed, "Dr. McIntosh, Patent, March 13, 1883, Chicago, Ill." It is not known whether Dr. McIntosh made the instrument, or if it was made for him. However, a Lyman D. McIntosh of Chicago did receive a patent in 1883, apparently for an improvement on the tilting joint of a microscope. (Donated by Dr. J. R. Schumaker) ■

AFIP 53392B. Carl Zeiss, Jena, Germany; compound monocular; C. 1883. *Not illustrated.*

The horseshoe base without a heel is 3-1/2 x 3 inches, and supports the tubular pillar of this instrument, that is 2-3/4 inches high and 7/8 inch in diameter. The 2-3/4 x 3-1/2-inch stage, incurved at the back, is screwed to the pillar.

Beneath the stage at the left is an angular two-joint arm, the lower section of which is slotted for pivot gimbal and 1-3/8-inch double mirror. At the right of the stage is a dovetail slide and tube for cylinder diaphragm. Rising from the stage is a tubular limb, 3 x 1-1/8 inches, with an inner triangular bar and 3-inch-long arm. At the top of the limb is a micrometer screw, and in front is a sprung screw-in tube, 2-7/16 x 1-1/8 inches.

The sliding body tube is 6 inches long, has two milled-edge rings at the top, and a short cone nose; there is no drawtube. Height is 11-1/4 inches. This model was introduced before 1879 and discontinued before 1898; from 1879 to 1885 it was referred to as "Stativ VIIA," and in 1889 it was "Stativ VII." It is signed, "Carl Zeiss, Jena, 5749." (Donated by Dr. M. Abrahams) ■

AFIP 49148. Carl Zeiss, Jena, Germany; compound monocular; C. 1884. *Not illustrated.*

This instrument is a duplicate of that in Fig. 181 (AFIP 49195) by the same maker. It is signed, "Carl Zeiss, Jena, 17998." The instrument was used at the Army Medical Museum from 1893 to 1902 by Major Walter Reed, the conqueror of yellow fever, and later by Major James Carroll, Curator of the Museum from 1902 to 1907, during his noted bacteriological studies. ■

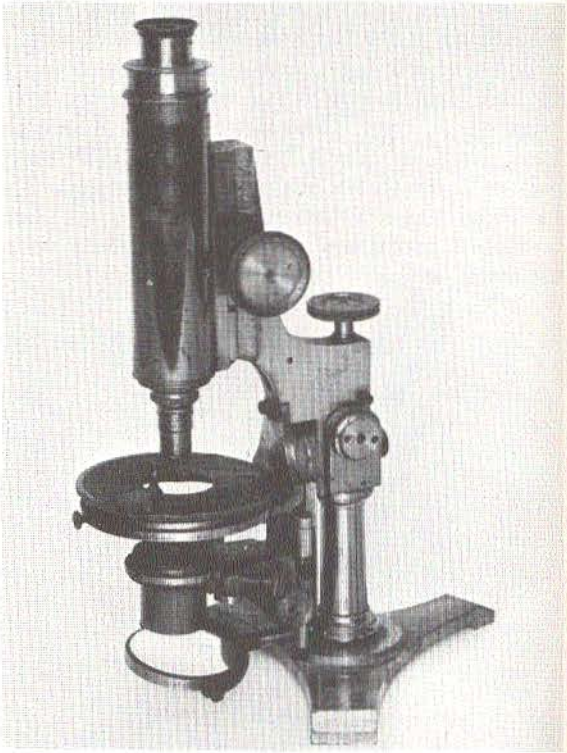

Fig. 161. W.H. Bulloch, Chicago, Ill.; compound monocular; C. 1884. (AFIP 19827 - 60-4713-68)

The claw-footed base of this instrument (Fig. 161) has a spread of 6-1/2 x 6-1/4 inches, and supports a revolving plate with tubular pillar and flanges 5 x 15/16 inch. There is an angular limb in a cradle joint, the lower end of which has a straight shank swinging tailpiece, and a short arm with gimbal and double mirror; a second arm has a rack and pinion that centers the substage tube.

The 3-1/2-inch-diameter stage is screwed to an angular plate on a limb. The 3-3/4-inch revolving stage plate has a black glass center and at the left a milled-head spring for a slide holder. The front of the arm is 4 inches long, has a Jackson fitting, and a double milled-head pinion.

The body tube is 6 x 1-1/2 inches, has a rack at the back, and a short cone nose. The drawtube has fittings for erector, field lens, and a screw-in single eye lens; there is a fine adjustment screw on the limb. Height is 16 inches. It is signed, "W. H. Bulloch, Chicago, Patented 1879, 308." This "Professional Model" was introduced in 1879 and varies very little from the large Congress and the small Biological models. (Donated by Mrs. W. E. Watson) ■

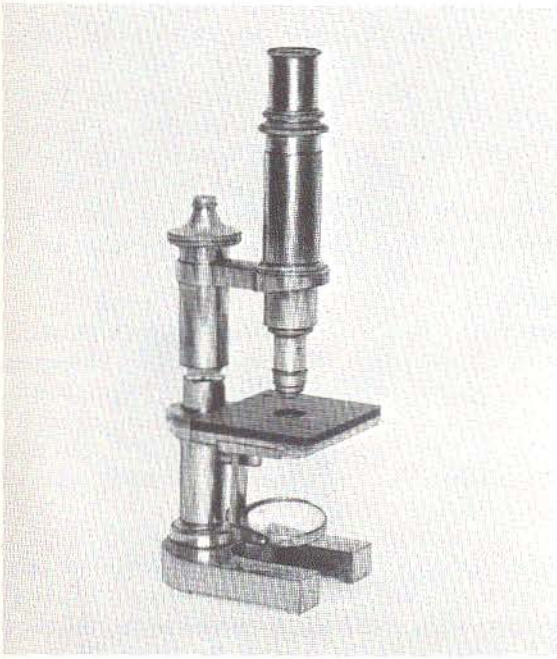

Fig. 162. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1885. (AFIP 180 - 60-4713-60)

The horseshoe base is 3-7/8 x 3-1/8 inches, has no heel, and supports the 2-1/2 x 15/16-inch tubular pillar of this instrument (Fig. 162). The 1-1/2-inch double mirror is on a pivot arm with gimbal, and the 4 x 3-1/8-inch stage plate is incurved at the back and screwed to the pillar.

Beneath the stage plate is a dovetail slide and tube for a small condenser. The stage is black and fixed to the plate, is 3-1/8 x 2-5/8 inches, and has a 5/8-inch central aperture. Rising from the stage plate is a collar and triangular bar with tubular outer casing 3-1/2 x 15/16 inch; it has a 3-1/4-inch-long fixed arm and a micrometer screw; a split tube, 2-3/8 x 1-3/16 inches, is attached to the front ring.

The body tube is 5-7/16 inches long and has no nosepiece; the drawtube is nickel-plated. It is all brass, 11 inches high, and signed, "E. Leitz, Wetzlar, No. 15060"; it is the "Stand 111B" model. ■

Fig. 163. E.H. & F.H. Tighe, Detroit, Mich.; compound monocular; C. 1885. (AFIP 174-60-4713-202)

The horseshoe base is 5 x 3-1/4 inches and supports the 3 x 3/4-inch tubular pillar of this instrument (Fig. 163). There is a cradle joint with a horizontal U-curved tubular limb, a 1-inch vertical, circular plate, and a 1-inch-long slotted extension at the lower end; a 2-3/4-inch swinging tailpiece supports a tubular arm and a pin gimbal for the double mirror.

The 3-1/4-inch circular stage with apertures for spring clips is screwed to a slotted extension. Beneath the stage is a sprung tube, 1-1/2 inches in diameter, for a condenser or cylinder diaphragm. At the upper end of the limb is a fixed tube, 1-3/4 x 3/4 inch, that has a micrometer screw at the base for the fine adjustment; a rectangular fitting with a double milled-head pinion is attached to the front of the tube.

The body tube is 4-3/4 x 1-1/4 inches, has a diagonal rack at the back, a graduated drawtube, and a short cone nose with a nickel-plated angular double nosepiece. It is 11 inches high when closed, and is signed, "E.H. & F.H. Tighe, Detroit, Mich." The construction of the instrument is unique, with nothing to indicate its origin except the Tighe name. The rack and pinion is of a type introduced about 1880 by Swift & Son, London. ■

The iron horseshoe base is 4 x 3-1/2 inches and supports the brass tubular pillar, 6 x 3/4 inch, of this instrument (Fig. 164). On the lower section of the pillar is a pivot short arm and gimbal with a 1-1/8-inch single mirror. The iron stage plate is 3 x 2-3/4 inches, is incurved at the back, and is screwed to the pillar. The stage is a thin, blackened brass plate, 2-3/4 x 1-1/4 inches, and is screwed to the plate at the

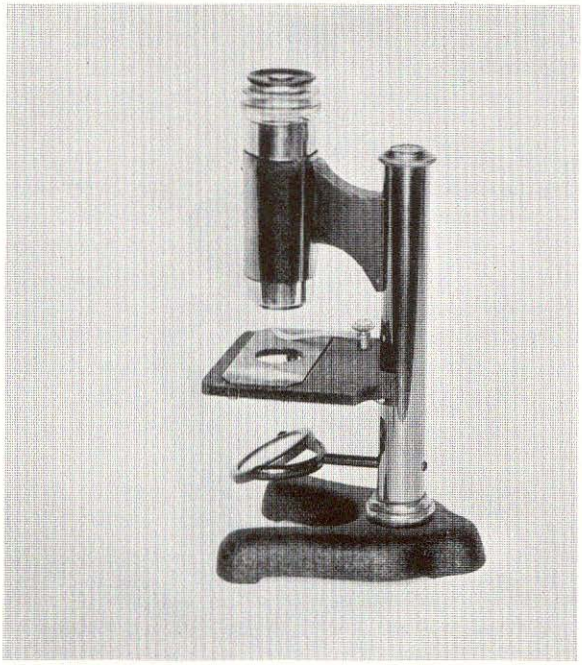

Fig. 164. Ernst Gundlach, Manhattan Optical Co., Rochester, N.Y.; compound monocular; C. 1885; (AFIP 187 - 60-4713-264)

left. There is a milled-head screw beneath the plate at the right that serves as the fine adjustment; it moves the stage on an angle.

An iron angular arm attached to a brass split tube, 2 x 1-3/16 inches long, is at the upper section of the pillar. The body tube is 3-3/4 inches long, has a slide adjustment, a nickel-plated drawtube, and a short cone nose; height is 7 inches.

It is signed at the top of the pillar, "Gundlach, Manhattan Opt. Co., Rochester, N.Y." There is also a slogan, "It's All In The Lens," and the model identification, "Simplex No. 2."

Gundlach was in business in Berlin from 1866 to 1870. In 1873 he sold out to Seibert & Kraft and moved to Hackensack, N.J. In 1876 when Bausch & Lomb established a microscope department, Gundlach was named superintendent. He remained there until 1878 and the next year opened his own business in Rochester, N.Y. In 1882 he introduced a college microscope known as, "Physician No. I," and a new calotte diaphragm. ■

AFIP 69136. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1886. ***Not illustrated.***

The horseshoe base supports the two iron uprights of this instrument that are held together at the top by a milled-head screw. In separate castings, the 4-inch-high uprights are curved at the upper ends with V-shaped flanges.

A curved tubular limb with a rectangular arm of iron, cast in one piece, has side grooves for flanges, and forms an inclination action. The lower end of the limb has an extension and carries the 3-inch-long swinging tailpiece, with arm and sliding pin gimbal for the single mirror.

The 3-1/2-inch circular stage is screwed to the limb extension and has a 1-inch central aperture. Beneath the stage on a pivot arm is a revolving disc of diaphragms. The lever, roller-motion fine adjustment micrometer is on the limb. The front of the iron arm is 2-1/2 inches long, and has attached a rectangular brass fitting 3 inches long, to which is attached a 4-9/16 x 1-1/8-inch tube.

The body tube is 5-1/2 inches long, has two milled-edge rings at the top, a screw-in short cone nose, and a sliding adjustment. It is 11 inches high, and signed on the stage, "Bausch & Lomb Optical Co.," and on the arm, "Patented Jan. 21, 79"; the latter was the fine adjustment patent. This model was introduced in 1885 and discontinued before 1889. It was constructed with concentric arm motion, which was first used by George Wale in 1879, by Andrew Ross in 1882, and by Swift & Son in 1881. It was also made with either a sliding tube or rack and pinion, and had 1-inch and 1/4-inch special objectives. (Donated by Wake Forest College) ■

The claw-footed base is 6 x 6 inches, and supports two 3-inch tubular pillars of this instrument (Fig. 165) that are cast in one piece of black japanned iron; a curved tubular limb and angular arm, also cast in one piece of the same material, are screwed to the pillars. At the lower end of the limb is a flat, 1-inch grooved extension, with a 3-inch-long swinging tailpiece, and a sliding arm and pin gimbal with double mirror. There is a micrometer screw fine adjustment on the limb.

The fluted iron stage is 5-1/4 x 3-1/2 inches, is screwed to the extension, and has a central aperture; beneath the stage is a tube for cylinder diaphragm. A 2-1/4-inch brass fitting is attached to the front of the arm with a double milled-head pinion.

The body tube is 6-1/2 x 1-1/4 inches and has a short screw-in cone nose and a drawtube with milled-edge ring. When closed it is 12 inches high, and is known as a "Trichinae Model." It is signed, "Bureau of Animal In-

Fig. 165. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; after 1885. (AFIP 19474 - 60-4713-159)

dustry, 374, Pat. Oct. 3, 1876; Pat. Oct. 13, 1885." The instrument was made for the U.S. Department of Agriculture. ■

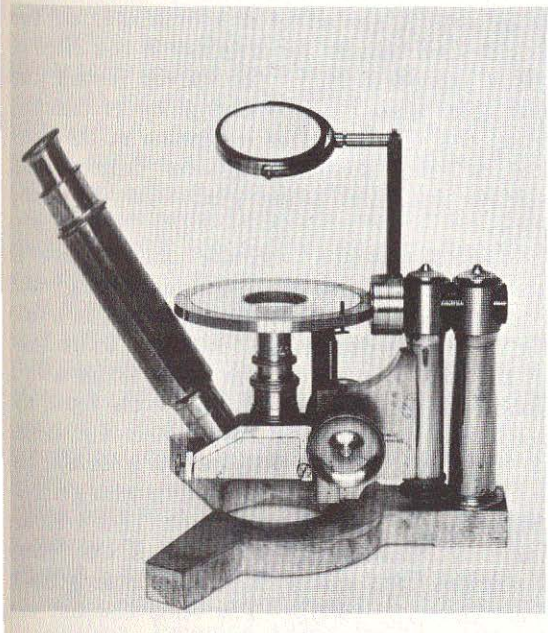

Fig. 166. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1886. (AFIP 19475 - 60-4713-24)

The heavy tripod base of this instrument (Fig. 166) has a spread of 7 x 7-1/2 inches, and supports a 5 x 15/16-inch tubular pillar with an aperture at the top. The tubular limb is 4-3/4 inches high and has an angular arm. A tubular extension for lateral inclination and inversion fits into the lower back of the pillar; a short extension at the front of the pillar has a circular plate, 1-1/4 x 1/4 inch, a 4-inch swinging, grooved tailpiece that carries a sliding substage, and a sliding arm and pin gimbal with double mirror.

The stage is a heavy 4-inch brass ring with a 3-5/16-inch heavy glass center, and is screwed to the limb plate; it has a 1-1/4-inch central aperture. The front of the arm has a 2-1/4-inch fitting with a double milled-head pinion and a grooved rack on a plate with an angular double nosepiece; a prism box fits onto the nosepiece when inverted.

The body tube is 5-7/8 x 1-1/4 inches, has a cylinder nose 1-1/8 inches long, and a drawtube. It is all brass and in vertical position is 14-1/2 inches high. It is signed, "Bausch & Lomb Optical Co." This instrument was designated the "Universal Model," and incorporates the same principles as the higher priced model introduced in 1886, but is of different construction; it was discontinued before 1896. ■

AFIP 53086. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1886. *Not illustrated.*

The horseshoe base with projection is 4-3/4 x 2-3/4 inches, and supports the 3 x 7/8-inch tubular pillar of this instrument. Extending up from the pillar is a 4-1/4-inch-high tubular pillar section with angle arm attached by means of a cradle joint. The limb has a circular plate at the base, a 3-inch-long swinging tailpiece with sliding arm, and pin gimbal for the double mirror.

The stage is 2-1/2 x 3-3/8 inches, is screwed to the limb plate, and has a 3/4-inch central aperture; a flat iris diaphragm is fixed beneath the stage. The front of the arm is fixed to a 3 x 1-3/8-inch tube that carries the fine adjustment. There is a micrometer screw at the top of the limb.

The body tube is 5-1/2 inches long, has a milled-edge ring, slide motion, cone nose, and a drawtube with milled-edge ring. It is 12 inches high, and signed, "Bausch & Lomb Optical Co., Pat. Oct. 3, 1876; Pat. Oct. 13, 1885."

This model was introduced in 1886 and constructed along the simple lines used in Europe but with a number of improvements. The faculty of the Harvard Medical School contributed many valuable suggestions, and the model name, "Harvard B," was adopted in recognition of their help. ■

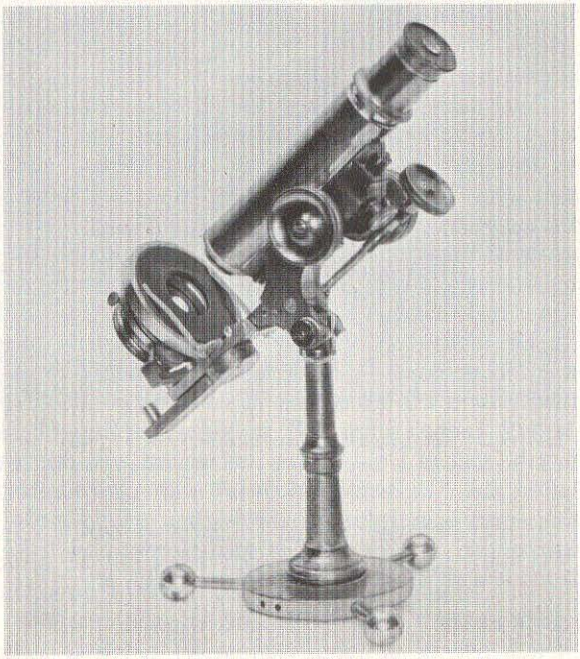

Fig. 167. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1886. (AFIP 192 - 60-4713-339)

The circular base of this instrument (Fig. 167) is 3-5/16 inches in diameter and 1/4 inch thick. Three screw-in ball-end supports, 1-1/2-inches long, form a flat tripod, that supports the 5-1/4-inch-high pillar with screw division and cradle joint; there is a Jackson-type limb and arm with a double milled-head pinion. The fine adjustment is an endless screw micrometer.

The graduated, swinging tailpiece has a 1-3/8-inch-diameter double mirror in a dovetail slide. The 2-5/8-inch circular stage with a black glass top is fixed to the limb, and has a 1-inch aperture.

The swing-out substage has an Abbe condenser and filter holder. The body tube is 5 x 1/4 inches, has a rack, graduated drawtube, and cone nose. The circular base may also be used as a turntable. The instrument is all brass with nickel trim and is 10-3/4 inches high. It is signed, "E.H. Griffith, Pat. Dec. 14, 1866, Rochester, N.Y., 1069." ■

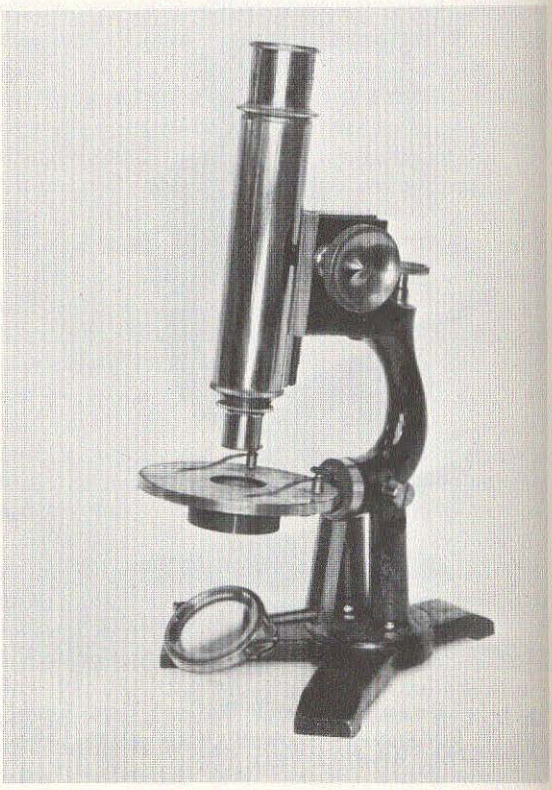

Fig. 168. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; before 1887. (AFIP 159 - 60-4713-193)

This instrument (Fig. 168) has a claw-footed base with a spread of 6 x 6 inches, and two 3-inch-high tubular pillars cast in one piece of black japanned iron. The curved tubular limb and arm, also cast in one piece of japanned iron, has a 1-inch flat extension at the lower end, a 3-inch swinging, grooved tailpiece with sliding arm, and a pin gimbal for the double mirror.

The 3-1/2-inch circular brass stage is screwed to the limb extension, and has a 1-inch central aperture. Beneath the stage is a tube for a cylinder diaphragm. Attached to the front of the arm is a 2-1/4-inch brass fitting with a double milled-head pinion, and on the top of the limb is a micrometer screw fine adjustment.

The body tube is 6-1/2 x 1-1/4 inches, has a short cone nose, and a drawtube with a milled-edge ring. When closed it is 11-3/4 inches high. It is signed, "A.S. Aloe & Co., 'Diagnostician,' St. Louis, Mo., Pat. Oct. 3, 1876; Pat. Oct. 13, 1885." The Aloe company was an agent for Bausch & Lomb instruments, and "Diagnostician" was the trade name for this model. ■

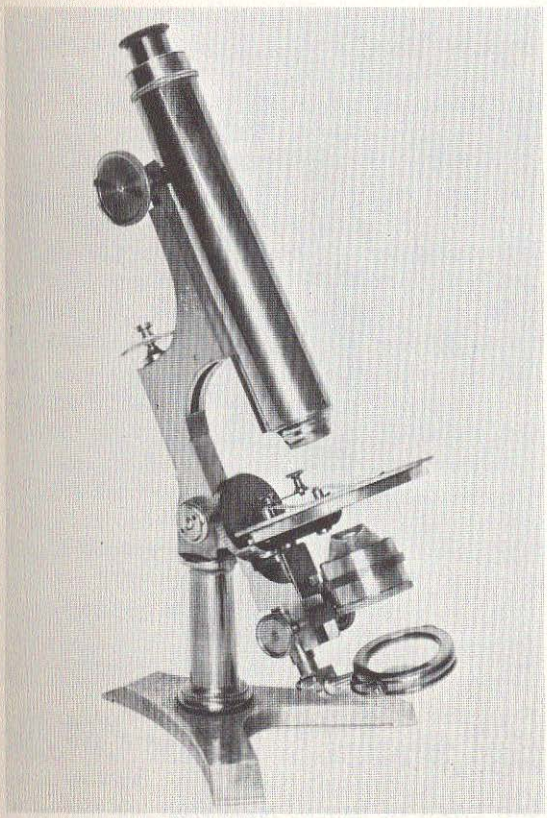

Fig. 169. Joseph Zentmayer, Philadelphia, Pa.; compound monocular; C. 1887. (AFIP 157 - 60-4713-25)

The claw-footed base has a spread of 6-1/2 x 6 inches and supports the 4-3/4 x 1-inch tubular pillar of this instrument (Fig. 169), that is capped by a compass joint. The vertical limb is 4-1/2 inches long, has a 4-3/4-inch angular arm at the front, a double milled-head pinion, and a lever fine adjustment micrometer. A pointed swinging tailpiece carries the substage with rack and pinion motion; there is a sliding arm and gimbal with a double mirror.

In front of the tailpiece is a graduated, circular vertical plate, 1-7/8 x 1/4 inch, with an angle plate at the base. A 4-3/8-inch circular, concentric revolving stage is screwed to the plate. The stage plate has a 1-3/16-inch central aperture, and a milled-head spring for slide holder.

The body tube is 8-3/4 x 1-1/2 inches, has a rack at the back, a short cone nose, and a drawtube. It is all brass, and when closed is 15 inches high. It is signed, "J. Zentmayer, Philadelphia, Patented 1876, 2892." The instrument is among the last constructed by Zentmayer; its swinging tailpiece was patented in 1876. Compared with another Zentmayer instrument in Fig. 154 (AFIP 49132), some variation in size and construction may be noted; it is another version of the "United States Army Hospital Model." ■

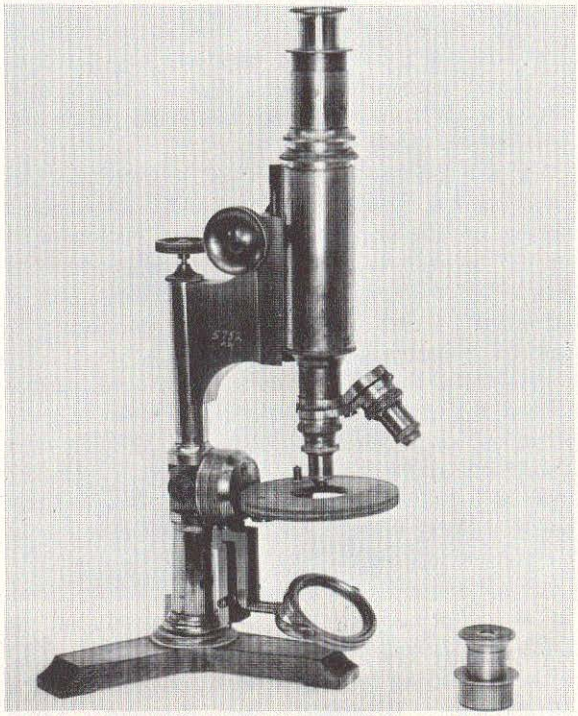

Fig. 170. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1887. (AFIP 492 - 60-4713-135)

The heavy tripod base has a spread of 6-1/4 inches, and supports the 2-3/4-inch-high tubular pillar of this instrument (Fig. 170) that is capped by a cradle joint. A 4-1/2-inch-long tubular limb with angular arm has an extension in front of the lower end, and two grooved swinging tailpieces; one has a sliding arm and gimbal for the double mirror, and the other a sliding arm for an adjustable substage.

The 3-1/2-inch circular stage has a milled edge and concentric revolving motion, and a 1-1/4-inch central aperture. The arm has a 3-1/4-inch front with a double milled-head pinion; there is a screw fine adjustment at the top of the limb.

The body tube is 4 inches long, has a cylinder nose with an angular double nosepiece; 1-inch-long broad gauge with adapter for society screw; and two drawtubes. It is all brass, and when closed is 14 inches high. The only accessory is an ocular. It is signed, "Bausch

& Lomb Optical Co." This model was introduced late in 1885; it was called "Stand J" in 1892, and was discontinued about 1902. ■

AFIP 725. R. & J. Beck, London, England; compound monocular; C. 1889. *Not illustrated.*

The triangular base of this instrument is 6 x 4-1/2 x 1 inch, and supports the 4-1/2 x 2-3/4 x 1-inch pillar with a slot at the top and set at a 40° forward angle; base and pillar are cast in one piece of iron.

A 6-1/2-inch-long limb is screwed to the pillar, has a wide angular arm and a micrometer screw at the top, and a double milled-head pinion in front. The blackened brass stage is 3 x 2-7/8 inches, incurved at the back, and is attached to the limb by a screw-on plate; it has a 7/8-inch central aperture.

Beneath the stage is a plate with screw thread for condenser and an oval disc of diaphragms; on a screw plate is a tailpiece with short arm and gimbal for the mirror. The body tube is 5-1/4 x 1-1/8 inches, has a rack at the back, a short cone nose, and a drawtube. It is 10-3/4 inches high.

It is signed, "Beck, London, 15453," and is a low-priced student model introduced in 1885 and listed until 1903; it was made with either a sliding tube or a rack and pinion quick adjustment. (Donated by Spencer Lens Company) ■

The 4 x 7/8-inch tubular pillar of this instrument (Fig. 171) incloses a triangular bar, and is attached to the 3 x 3/4 x 3/4-inch base. The 3 x 1-3/4-inch stage has a 5/8-inch central aperture, and is attached to the pillar by a screw-on plate that has a pivot arm with gimbal and a single 3/4-inch mirror; inset beneath the stage is a revolving disc of diaphragms.

The arm is 2-3/4 inches long, has a 1-9/16-inch ring front, and a fixed split tube 2-1/8 x 1-1/4 inches; the screw fine adjustment is at the top of the pillar. The body tube is 4-7/8 inches long, has a sliding adjustment, and a milled-edge ring at the top; there is no drawtube. It is all brass and 8-1/2 inches high.

It is signed on the foot, "C. Verick, Rue de la Parchemineru 2, Paris, 1740." Verick, an apprentice of Hartnack, established his own business before 1877, and was succeeded by Maurice Stiassnie before 1902. This model was devised with the assistance of Dr. Malassez of Paris and introduced in 1883; it was made with two types of bases, horseshoe, or folding V-shaped base. ■

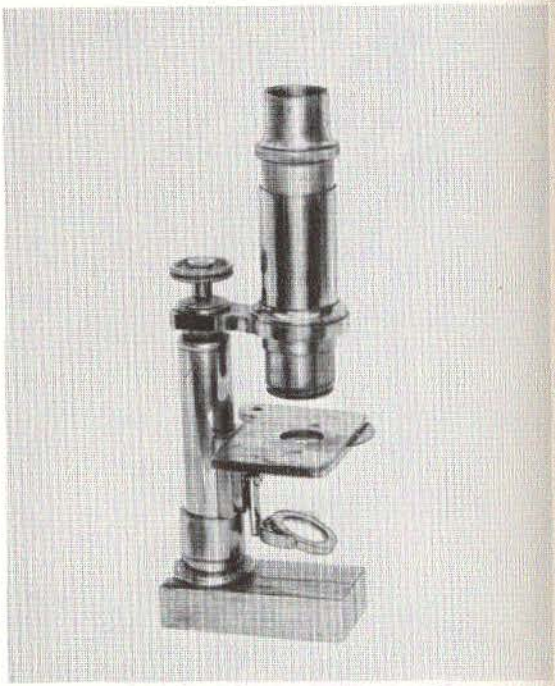

Fig. 171. C. Verick, Paris, France; compound monocular; C. 1890. (AFIP 190 - 60-4713-261)

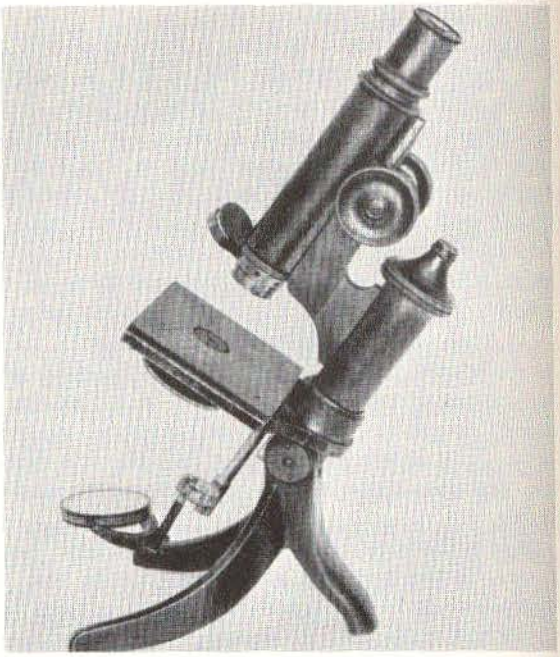

Fig. 172. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1890. (AFIP 17944 - 60-4713-266)

This instrument (Fig. 172) has a blackened English tripod base 4 inches high, and supports a 3 x 1-1/16-inch limb by means of a cradle joint. There is a fixed 3-inch arm in front with a double milled-head pinion; the fine adjustment is at the top of the limb. The stage plate is attached between the base and limb, and is incurved at the back.

The stage is 3 x 3-3/8 inches and is screwed to the plate; it has a 3/4-inch central aperture. Beneath the stage is a tube for a cylinder diaphragm, a 2-1/2-inch-long fixed tailpiece with slide casing on a pivot arm, and a gimbal with a 1-9/16-inch double mirror.

The body tube is 5-1/4 x 1-3/16 inches, has a rack at the back, and a graduated drawtube. Of brass and black-coated metal, and 11 inches high when closed, it is the "Stand II" model. This type instrument was introduced about 1890 and was still on the market in 1903 when a screw substage was incorporated. ■

AFIP 49138. James W. Queen & Co., Philadelphia, Pa., compound monocular; C. 1890. *Not illustrated.*

The black japanned iron tripod foot, 6 x 6 inches, of this instrument supports the 3-1/4 x 1-3/16-inch brass tubular pillar that is capped by a heavy cradle joint; a curved, black japanned iron limb with a circular plate and a projection at the base is screwed to the joint.

A grooved, swinging tailpiece, 3-1/2 inches long, with a sliding short arm and gimbal with a double mirror is attached to the plate. The 3-1/2-inch circular stage is screwed to the limb projection, and beneath it is a revolving disc of diaphragms on a swing-out arm; the stage has a 1-inch central opening.

The front section of the limb is 3 inches long, has a micrometer screw at the base, and is fixed to a 4-inch-long brass section that has a double milled-head pinion. The body tube is 6x1-3/8 inches, has a rack at the back, a short cylinder nose, and a drawtube. It is 12 inches high when closed.

The only accessory is an ocular. It is signed, "Queen & Co., Philada, 2026." This model, Acme No. 4, was introduced by John W. Sidle & Co. of Lancaster, Pa., in 1881. The serial number indicates the microscope was made in the early 1890's, at which time Queen & Co. were the owners of the Sidle Co. ■

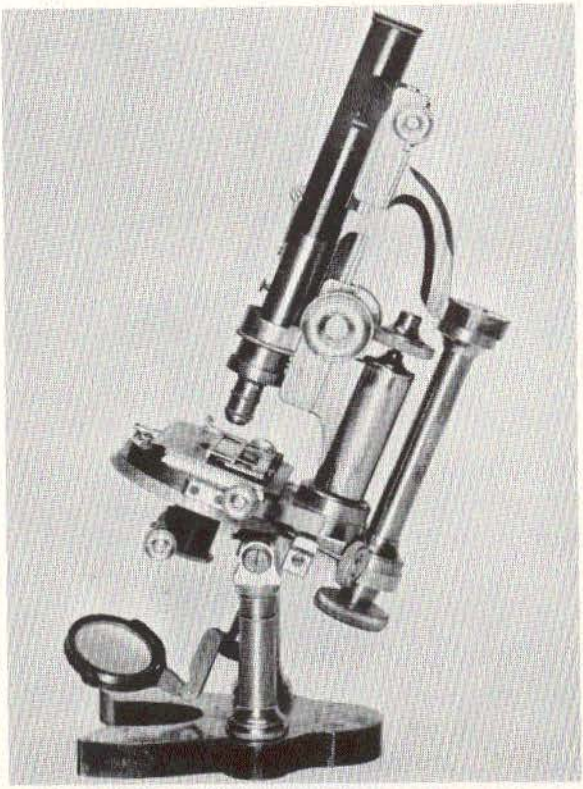

Fig. 173. Nachet & Son, Paris, France; compound monocular; C. 1890. (AFIP 200035 - 60-4713-13)

The modified horseshoe base of this instrument (Fig. 173) is 6 x 4-1/4 inches, and supports the two 3-1/4-inch-high cylindrical pillars. The 7-inch-high limb with curved arm is suspended on an axis between the pillars, and the arm is screwed to the upper section of the body tube; another 3-inch limb is screwed to the rear of the stage plate, and has a screw fine adjustment at the top.

The circular stage is 4 inches in diameter, and attached to it is an adjustable 2-3/4 x 3-5/8-inch mechanical stage; a millimeter scale encircles the lower section of the stage plate. There is a swing-out substage condenser, tie bar for rotating the polarizer and analyzer as a unit, and a rack and pinion coarse adjustment for the compensator.

The body tube is 6-3/4 inches long, has a sliding quartz compensator, a condensing lens, and rack and pinion coarse adjustment. When closed it is 15-1/2 inches high, and is signed, "Nachet, 17 Rue St. Severin, Paris." This petrologic microscope was first introduced during the early 1880's. (Donated by Mr. J.B. Reeside, Jr.) ■

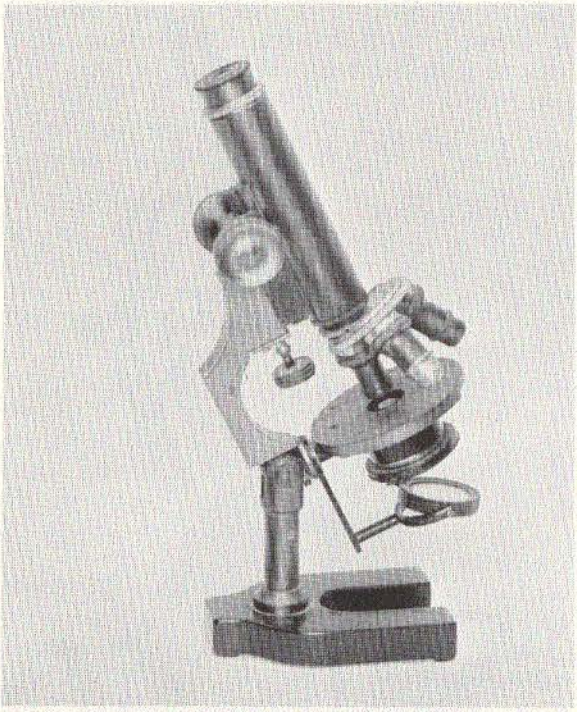

Fig. 174. Maker unknown; compound monocular; C. 1890. (AFIP 517748-60-4713-318)

The horseshoe base of this instrument (Fig. 174) supports the 3-1/4-inch-high pillar capped by a compass joint. A 1-1/2-inch double mirror with gimbal is attached to the swinging tailpiece. The stage is 3-1/4 inches in diameter with substage condenser and iris diaphragm. The 4-inch angular limb has the fine adjustment attached to its underside.

The body tube is 4-3/4 inches long, has a rack and pinion coarse adjustment, a graduated drawtube, and triple nosepiece. (Donated by Dr. Ralph D. Lilly) ■

This instrument (Fig. 175) has a claw-footed base, 4 x 5-1/2 inches, that supports the two 3-inch-high pillars. The 3-inch curved limb and the 2 x 1-1/2-inch arm are cast in one piece. The screw fine adjustment is at the top of the limb. A grooved swinging tailpiece is screwed to the front of the limb, and the 1-7/8-inch double mirror with gimbal and 3/4-inch arm slide in the groove. The 3-3/8-inch-diameter stage attached to the limb has a substage with a revolving disc of diaphragms.

The body tube is 4-1/2 inches long, has a drawtube, rack and pinion coarse adjustment, and double nosepiece. Height is 11-1/2 inches. (Donated by Colonel Paul C. LeGolvan) ■

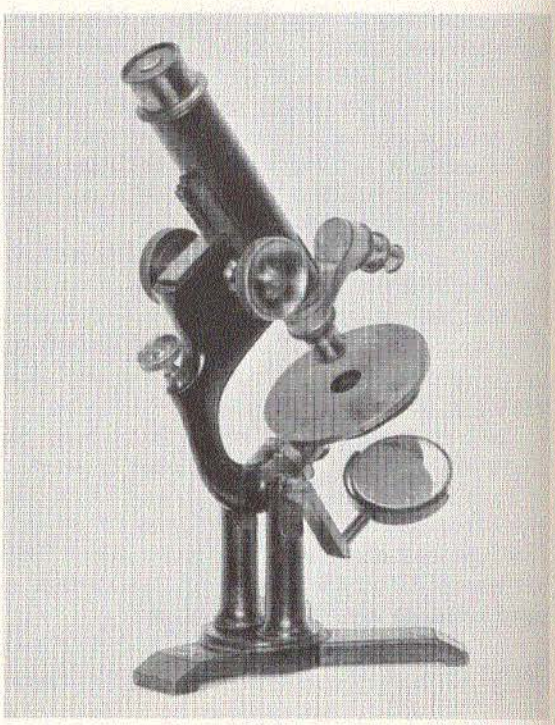

Fig. 175. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1890. (AFIP 517747 - 60-4713-132)

The horseshoe base, 6 x 3-3/4 inches, and the 3-1/2-inch-high rectangular pillar of this instrument (Fig. 176) are cast in one piece of green japanned iron; the pillar has a 5/8-inch central slot for a bar.

The stage plate is 5-1/2 x 3-3/4 inches, is incurved at the back, with a 3-1/4-inch bar beneath; it is in one casting and screwed to the pillar. A slotted, 3-1/4 x 3/8 x 3/16-inch pivot tailpiece has a sliding pin gimbal with a double mirror.

The stage is thin, 3-7/8 inches square, screwed to the stage plate, and has a 3/4-inch central aperture. Beneath the stage is a 1-1/8-inch-diameter pivot tube for cylinder diaphragm. The tubular limb is 3-1/4 x 1-1/8 inches, is screwed to the stage plate, and has an angular arm attached to the body tube.

The body tube is 3-1/2 x 1-3/8 inches, has a spring cone nose, and a drawtube that moves in a slotted groove; there is no coarse adjustment. The unique fine adjustment is a long lever from the spring nose that extends through the arm and an aperture in the limb. It has a motion of 3/8 inch and is acted upon by a micrometer screw at the top of the limb. When

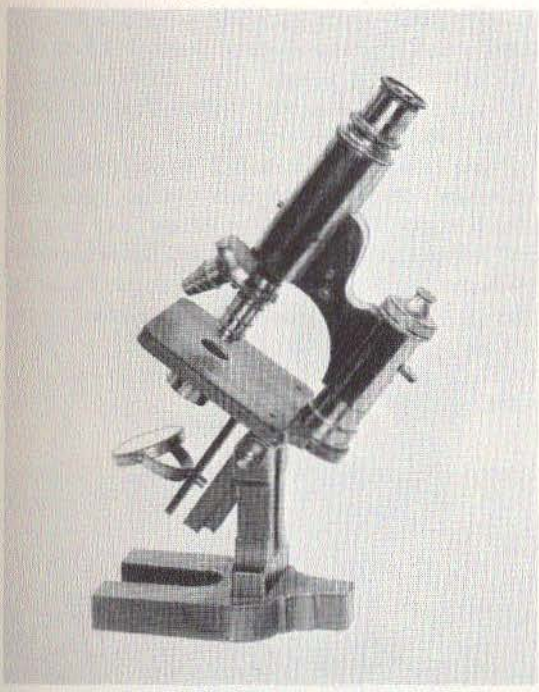

Fig. 176. Maker unknown; compound monocular; after 1890. (AFIP 69928 - 60-4713-259)

closed it is 13 inches high. The numbers on the objectives are German and are indicative of the instrument's probable origin. ■

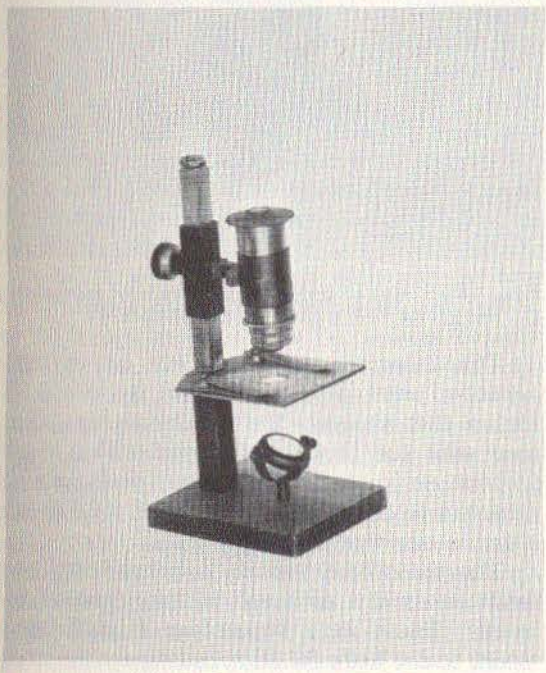

Fig. 177. Maker unknown; compound monocular; after 1890. (AFIP 176 - 60-4713-277)

This instrument (Fig. 177) has a blackened brass base, 2-3/8 x 2 inches, a blackened pillar, 1-5/8 x 3/8 inch, and a square brass limb, 2-3/4 x 1/4 inch. A gimbal with a 1/2-inch single mirror is on a short arm to the base in optical axis. A 2 x 1-3/4-inch thin, white metal stage is fixed to the limb; it has a 5/16-inch central aperture.

The 3/4-inch-long arm is attached to a sliding case by a thumbscrew, and is fixed to a 5/8 x 11/16-inch tube. The sliding brass body tube is 1-5/16 inches long, and has a screw-in single eye lens. It is 5 inches high. The only accessory is a 2-button objective. ■

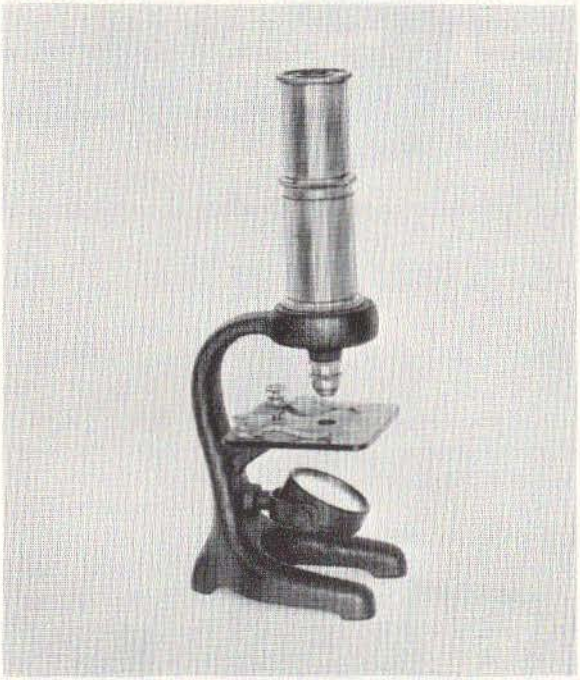

Fig. 178. Maker unknown; compound monocular; after 1890. (AFIP 172 - 60-4713-280)

The 2-3/4 x 2-1/8-inch horseshoe base of this instrument (Fig. 178) supports a 4-inch-high pillar with a curved arm and ring, a plate for a stage, and an aperture for the mirror; all cast in one piece of rough, black iron.

The black stage is 2 x 2-1/16 inches, is screwed to the stage plate, and has a 1/4-inch central aperture; a 1-1/16-inch single mirror is on a pin gimbal.

A brass split tube, 1-1/2 x 15/16 inch, is attached to the arm ring. The brass body tube is 3-5/16 inches long, has a short cone nose, and a milled-edge ring; there is no drawtube. It is 7 inches high. ■

AFIP 558432. J. Zentmayer, Philadelphia, Pa.; compound monocular; C. 1890. *Not illustrated.*

This instrument is a duplicate of that in Fig. 103 (AFIP 49119) by the same maker. It is signed, "J. Zentmayer, Maker, Philadelphia; Sold by W. Wales, New York, No. 532." A box of accessories includes objectives, oculars, a prism, parabolic illuminator, and a substage condenser. (Donated by Dr. Victor C. Lazares) ■

AFIP 49142. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1891. *Not illustrated.*

This is a duplicate of the instrument by the same maker in Fig. 170 (AFIP 492), with the following exceptions: The tripod foot is black japanned iron, and there is a circular glass stage, cylinder diaphragm, and a straight, double nosepiece. It is signed, "Bausch & Lomb Optical Co." ■

Fig. 179. Voigt & Hochgesang, Göttingen, Germany; compound monocular; C. 1891. (AFIP 200034 - 66-1836-9)

The horseshoe base of this instrument (Fig. 179) supports the 2-1/8 x 3 x 1/2-inch-high pillar capped by a compass joint. A swinging, slotted tailpiece, screwed to the flat iron extension attached at the top of the compass joint, carries the gimbal and 2-inch double mirror. The stage plate is 5-1/2 x 2-1/2 inches with a rack and pinion substage and 3-1/2-inch graduated revolving stage. The triangular limb is 3-3/4 inches long with screw fine adjustment at the top.

The body tube is 4-1/2 inches long, has a drawtube rack and pinion coarse adjustment, clamp nosepiece, Nicol polarizer, cap analyzer, and a Bertrand lens. The drawtube is controlled by a rack and pinion adjustment on the front of the body tube. Height is 14 inches. Accessories are 3 oculars, and a small box of objectives and lenses. (Donated by Mr. J.B. Reeside, Jr.) ■

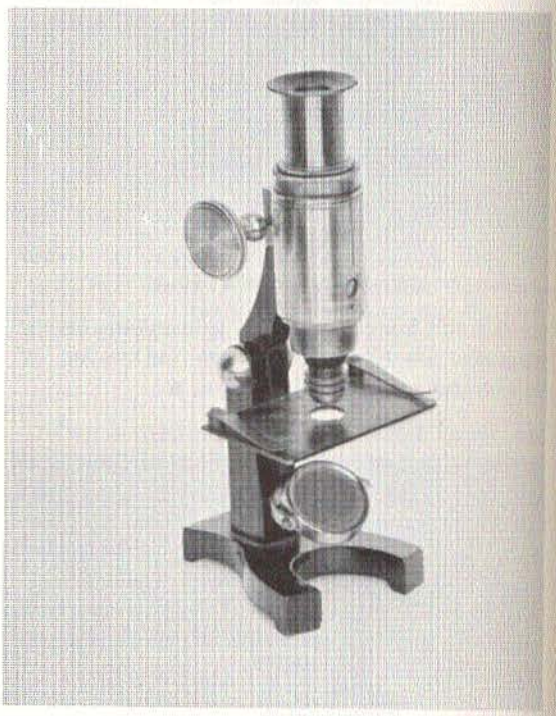

Fig. 180. Maker unknown; compound monocular; C. 1891. (AFIP 695080 - 60-4713-376)

This instrument (Fig. 180) has a black japanned iron horseshoe base 2-1/4 x 3-1/4 inches that supports the 2-1/2-inch-high pillar, cast with the base, and topped with a simple inclination joint; a 1-inch mirror on a gimbal is attached to the pillar. The 1-1/2 x 2-1/2-inch stage is screwed to the pillar.

The brass body tube is 2 inches long, has a drawtube, and a rack and pinion coarse adjustment. There is a superstage magnifier on a mount to the body for illuminating opaque specimens. Height is 7 inches. (Donated by Mrs. Ralph O. Anderson) ■

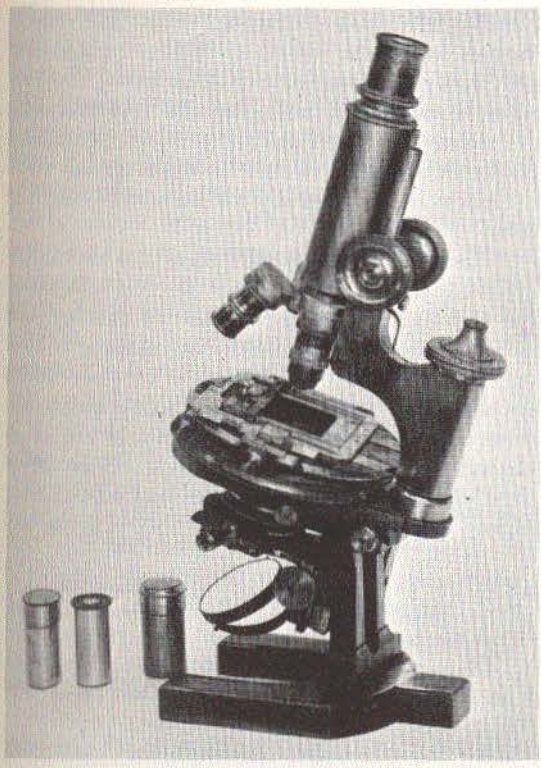

Fig. 181. Carl Zeiss, Jena, Germany; compound monocular; 1891. (AFIP 49195 - 60-4713-178)

A slotted, rectangular pillar, 3-3/4 inches high, is screwed to the horseshoe base of this instrument (Fig. 181), which is 6 x 4-1/8 inches. The stage plate, trunnion, and triangular bar are all cast in one piece of black japanned iron and screwed to the pillar with a lever lock. Attached to the plate are a 3-1/8-inch-long triangular tailpiece with rack, a pinion casing with a central swinging substage condenser and iris diaphragm, and a pin gimbal with a 1-15/16-inch double mirror.

A 2-7/8-inch tubular limb with angular arm and graduated screw micrometer at the top is on the triangular bar. The 4-1/4-inch detachable, circular, revolving stage is made of vulcanite; it has centering screws, and a 1-1/2-inch recessed central aperture for diaphragm. The front of the arm is 3-1/8 inches long, and has a double milled-head pinion.

The body tube is 4 x 1-3/8 inches, has a rack at the back, a short cone nose, and a graduated drawtube. It is 12-3/4 inches high when closed, and is signed on the tube, "Carl Zeiss, Jena, No. 17094." This model, "Stand IA," was introduced between 1883 and 1885. It is the same size as Zeiss' "Stand I," but has a circular stage and improved substage. ■

Fig. 182. Carl Zeiss, Jena, Germany; compound monocular; 1891. (AFIP 49141 - 60-4713-177)

A slotted, rectangular pillar, 3-1/4 inches high, is screwed to the black japanned horseshoe base of this instrument (Fig. 182), which is 5-3/8 x 3-5/8 inches; a 5 x 3-1/4-inch stage plate is incurved at the back, and screwed to the pillar; the trunnion and triangular bar are cast in one piece.

The triangular tailpiece is screwed to the stage plate, has a complete rack and pinion, substage, and a pin gimbal with a 1-15/16-inch double mirror. The stage is heavy, 3-1/2 inches square, and screwed to the plate. It has a 1-1/4-inch recessed aperture for diaphragm; the diaphragm is cemented in, and has a 1/2-inch aperture.

The tubular limb on the triangular bar is 2-1/4 inches long, and has a micrometer screw at the top. The arm is 4-3/8 inches long, and has a 1-13/16-inch-diameter ring front; screwed to the arm is a ring collar with a 2 x 1-1/4-inch split tube.

The sliding body tube is 5-1/2 inches long, has a graduated drawtube, and a flat nose with society screw. It is all brass with the exception of the base, and is 11 inches high. It is signed, "C. Zeiss, Jena, 17821." This model was introduced in 1883 as "Stand VA"; in 1892 it became "Stand VI"; it was discontinued before 1898. ■

AFIP 49431. Maker unknown; compound monocular; before 1892. *Not illustrated.*

This all-brass projection microscope is 12-5/8 inches high and is 4 inches in diameter at the bottom and 2-1/2 inches at the top, where the 4-1/2 x 3-1/8-inch stage plate with cutout back is fixed. A sliding stage, 4 x 2-5/8 inches, has a 3/8-inch central aperture.

Attached at the rear of the stage plate is the 3-7/8-inch-long limb that is screwed to the 2-1/4-inch body tube, with rack and pinion adjustment. The eye lens is in a sliding draw-tube. ■

AFIP 488362. J. Duboscq, Paris, France; compound monocular; before 1892. *Not illustrated.*

This solar instrument has a 9-inch-square plate for a base, to which are attached two 7-inch brass rods that hold the 11 x 5-inch mirror. One of the brass rods controls the movement of the mirror.

The lower 4-inch section of the brass body tube is 4 inches in diameter, the middle 2-inch section is 1-1/2 inches in diameter, and the upper 2-1/2 inches, 1 inch in diameter. A stage plate, 3 x 2-1/2 inches, is attached to the upper portion of the body tube; there is a rack and pinion adjustment. Height is 24 inches, and it is signed, "J. Duboscq, Paris." ■

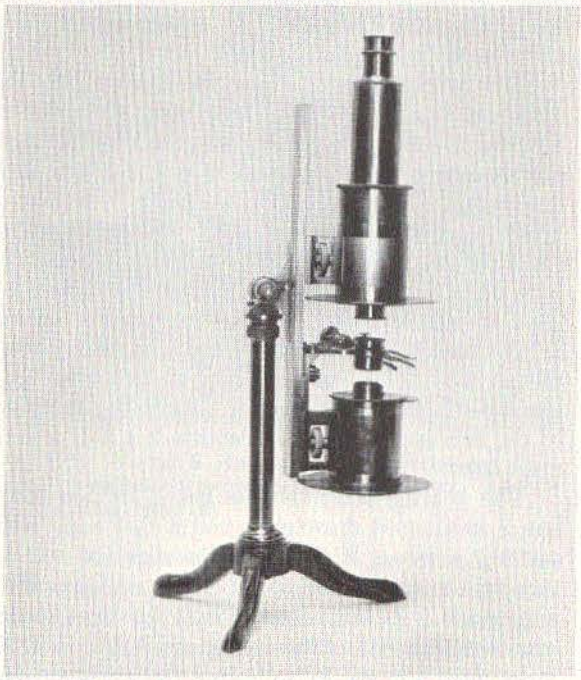

Fig. 183. J. Duboscq, Paris, France; compound monocular; C. 1892. (AFIP 49432 - 60-4713-310)

This all-brass instrument (Fig. 183) is 16-1/2 inches high, and rests on a black tripod base that has a spread of 9-1/4 inches. The body tube is 8-1/2 inches long and inserted into a drum-like cylinder, 2-7/8 x 2-1/2 inches, that contains a lens 2 inches in diameter; a similar cylinder is located in the center of the body tube.

The vertical adjustment is a 13-5/8-inch-long grooved track attached to the rear of each of the two cylinders; at the base of each cylinder is a circular plate 5 inches in diameter. A lens may be inserted into the top of the lower cylinder and into the base of the upper cylinder. An object holder on a jointed movable arm is attached to the adjustment track; at the top of this attachment is a movable lens holder. It is signed, "J. Duboscq of Paris, No. 176." ■

AFIP 49189. Carl Zeiss, Jena, Germany; compound monocular; 1892. *Not illustrated.*

This instrument is a duplicate of that in Fig. 181 (AFIP 49195) by the same maker with the exception that this model has a mechanical stage and a single nosepiece. It is signed, "Carl Zeiss, Jena, 20233." ■

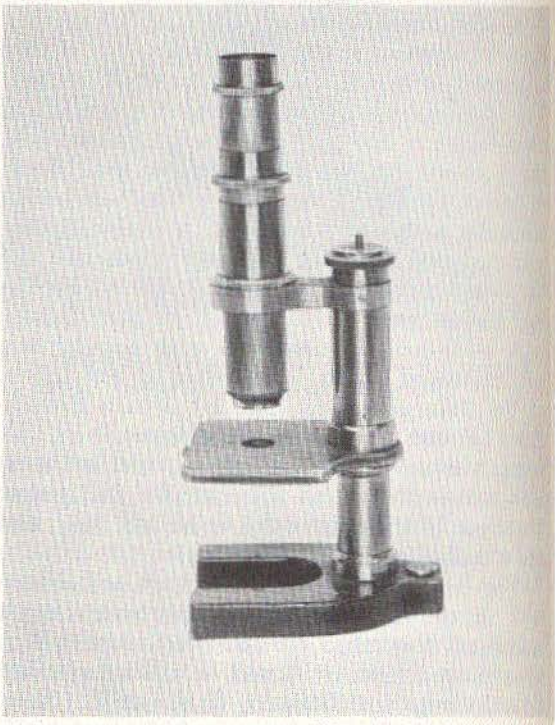

Fig. 184. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1892. (AFIP 291 - 60-4713-144)

The black japanned iron horseshoe base, 4-5/8 x 3-1/2 inches, supports the 2-1/4 x 1-inch tubular pillar of this instrument (Fig. 184). The brass stage is 3-7/16 x 3-7/8 inches, is incurved at the back, and attached to the pillar; it has a 9/16-inch central aperture, and a revolving disc of diaphragms.

The tubular limb with triangular inner bar is 2-1/4 x 1-1/8 inches; the fine adjustment micrometer is at the top. The heavy horizontal arm is 3-1/4 inches long, has a 1-9/16-inch ring front, and a fixed split tube, 1-1/2 x 1-3/16 inches. The sliding body tube is 5-1/2 inches long, has a drawtube, and a short cone nose. It is all brass except the base, and is 9-1/2 inches high.

This model, the "Continental A" with solid pillar, was first listed in 1892 along with the "AA" with inclining pillar; they replaced the "Biological" model of 1889. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y. and New York City, 13453." (Donated by Captain Austin Lowrey) ■

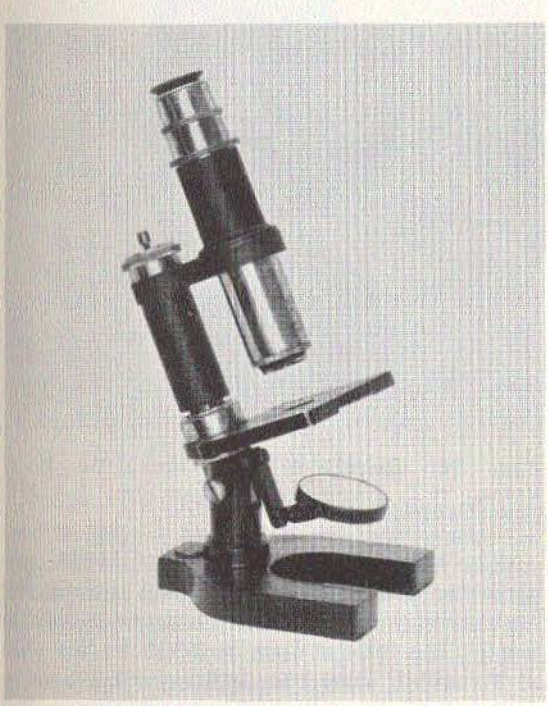

Fig. 185. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1892. (AFIP 198 - 60-4713-150)

The iron horseshoe base, 4-5/8 x 3-1/4 inches, supports the 2 x 1-inch tubular pillar of this instrument (Fig. 185). The blackened brass stage is 3-11/16 x 3-5/8 inches, is incurved at the back, and attached to the limb; it has a 9/16-inch central aperture and a revolving disc of diaphragms. The 1-1/2-inch-long pivot tailpiece has a pin gimbal and a 1-5/8-inch single mirror.

The blackened brass tubular limb is 2-1/2 x 1-1/16 inches, has a triangular inner bar, a micrometer screw at the top, and a cradle joint to the pillar. The iron horizontal arm is 3-1/4 inches long, has a 1-9/16-inch-in-diameter ring front, and a fixed, blackened split tube 1-1/2 x 1-3/16 inches long. The sliding body tube is 5-1/2 inches long, has a short cone nose and a drawtube. The iron and blackened parts all have a rough finish. It is 9-1/2 inches high, and signed on the stage, "Bausch & Lomb Optical Co., Rochester, N.Y. & New York City, 12924." This model, "Continental AA," was introduced in 1892 and discontinued before 1900. ■

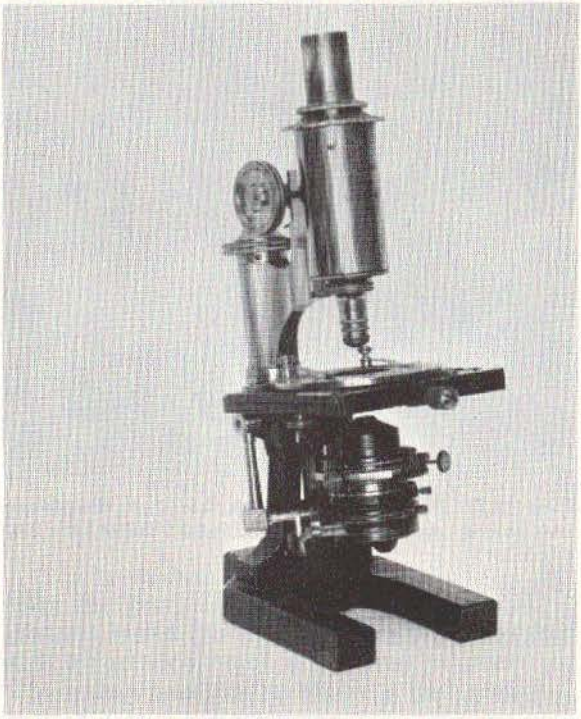

Fig. 186. Carl Zeiss, Jena, Germany; compound monocular; C. 1892. (AFIP 49413 - 60-4713-151)

This instrument (Fig. 186) has a horseshoe base, 6 x 4-1/4 inches, and a rectangular slotted pillar 3-3/4 inches high, that is screwed to the base. The trunnion, stage plate, and triangular bar are cast in one piece and screwed to the pillar with a lever clamp.

The stage plate is 5-3/4 x 4 inches, and incurved at the back; the 2-3/4-inch-long triangular tailpiece is screwed to the plate; it has a complete substage with rack and pinion. The mechanical photographic stage is fixed to the stage plate; the tubular limb and angular arm are also fixed to the stage plate. At the top of the limb is a graduated micrometer screw. The arm is 3 inches long at the front and has a double milled-head pinion.

The body tube is 5-1/8 x 1-5/8 inches, has a rack at the back, a graduated drawtube, and a screw-in nosepiece. It is 11-3/4 inches high and all brass except for the pillar and base. It is signed, "Carl Zeiss, Jena, No. 21997." This type of base and pillar were introduced between 1885 and 1889, and redesigned and improved about 1898. ■

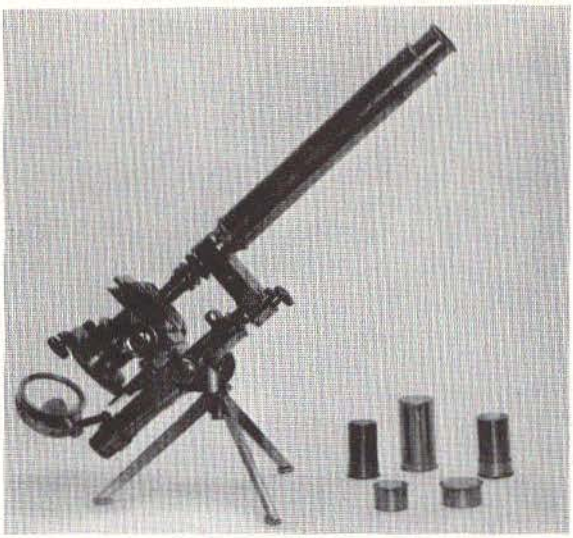

Fig. 187. Powell & Lealand, London, England; compound monocular; 1893. (AFIP 19451 - 60-4713-245)

This microscope (Fig. 187) has a 4-inch-high folding tripod and a curved arm at the top, to which is screwed a tubular limb, 6-1/8 x 7/8 inch, and a single milled-head pinion. Inside the limb is a triangular bar with a rack at the back.

The stage plate is 3 x 2-3/4 inches, and is fixed to the limb. Above the stage plate is a Turrell mechanical stage, and below it, on a dovetail slide, is the achromatic condenser with rack and pinion lateral screw motions. The double mirror is on two arms and is 1-7/8 inches in diameter; there is a half-gimbal fixed to the sliding case.

The arm is 3-1/4 x 1-1/8 x 11/16 inch and is attached by a setscrew to a triangular bar. The arm carries the long lever fine adjustment with a milled head on top; Powell & Lealand adopted this type fine adjustment in 1843 and used it on all their instruments.

The body tube is 7 x 1-1/4 inches, is sprung at the top and screws to the spring nosepiece fitting at the lower end; the compound ocular slides in. Overall length of the tube, nosepiece, and ocular is 10-1/2 inches. Accessories include objectives and oculars. It is signed, "Powell & Lealand, 170 Euston Road, London, 1893." ■

Fig. 188. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1893. (AFIP 49136 - 60-4713-153)

The horseshoe base, 5 x 3-5/8 inches, supports the 2-3/8 x 1-inch tubular pillar of this instrument (Fig. 188), that is capped by a cradle joint. The tubular limb is 2-3/4 x 1 inch, has a triangular inner bar, and is screwed to the pillar; there is a fine adjustment screw at the top of the limb.

The stage is 4-3/8 x 3-5/8 inches, incurved at the back, and is fixed to the limb; it has a 3/4-inch aperture. Beneath the stage is a slide plate with tube for cylinder diaphragm. The 1-3/4-inch-long pivot tailpiece has a pin arm and gimbal with a double mirror.

The 3-1/2-inch-long horizontal arm has a 1-11/16-inch-diameter ring front with a fixed split tube, 2-1/4 x 1-5/16 inches. The sliding body tube is 6-1/4 inches long, has a drawtube, and a short cone nose with society screw. The instrument is all brass, and 10-1/2 inches high when closed.

It is signed, "Bausch & Lomb Optical Co." The instrument appears to be a composite of the Bausch & Lomb "Continental AA" and the "B" models of 1892-1893. It has the stage and arm of the "AA" model, while the size and parts are identical to those of the "B" model. ■

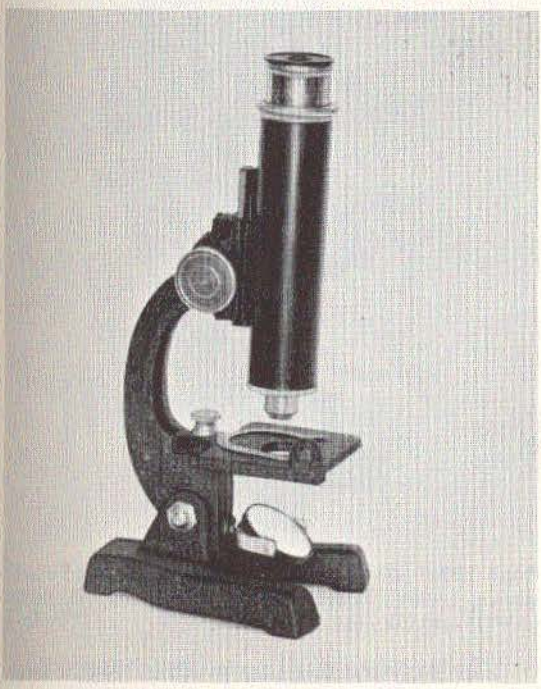

Fig. 189. Maker unknown; compound monocular; C. 1893. (AFIP 178 - 60-4713-152)

The 3-3/4 x 3-inch horseshoe base and two uprights, each 1 inch high, of this instrument (Fig. 189) are cast in one piece of rough, finished iron; a curved limb and an arm, of like material, are screwed to the uprights. At the lower end of the limb is a nickel pin gimbal with a 1-1/16-inch-diameter single mirror.

The stage is of rough, finished iron, is 1-3/4 x 2-1/4 inches, and is attached to the limb by means of a thumbscrew. It has a U-shaped nickel spring clip, a 5/8-inch central aperture, and an aperture for stage condenser on a flange.

The front of the arm is 1-1/2 inches long, and has a single nickel milled-head pinion. The blackened brass body tube is 4-5/8 inches long, has a nickel screw-in nosepiece and a nickel graduated drawtube. It is 8 inches high. ■

AFIP 49191. Carl Zeiss, Jena, Germany; compound monocular; 1893. *Not illustrated.*

This instrument is a duplicate of that in Fig. 181 (AFIP 49195) by the same maker. It is signed, "Carl Zeiss, Jena, No. 22613." ■

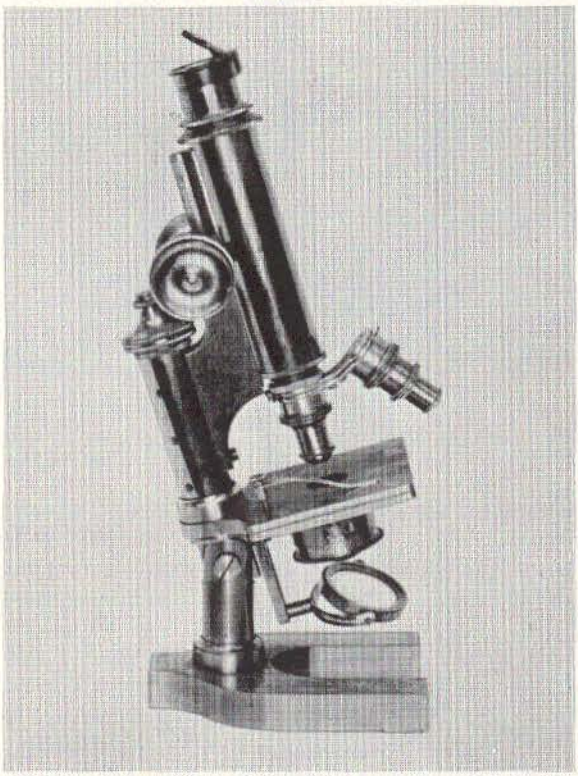

Fig. 190. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1894. (AFIP 16738 - 60-4713-146)

The horseshoe base, 5 x 3-5/8 inches, supports the 2-1/2-inch-high tubular pillar with a cradle joint at the top of this all-brass instrument (Fig. 190). The tubular limb is 3-1/4 x 1 inch, has a triangular bar, and a fine adjustment at the top; the angular arm is screwed to the limb.

The stage is 4-1/2 x 3-5/8 inches, and has a 3/4-inch central aperture. Beneath the stage is a dovetail slide with dome diaphragm, a 2-inch grooved, swinging tailpiece with slide arm and gimbal for the 1-9/16-inch-diameter double mirror.

The front of the arm is 3-1/4 inches long and has a double milled-head pinion. The body

tube is 6 x 1-1/4 inches, has a rack at back, and graduated drawtube. When closed it is 12 inches high. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y. & New York City, 14412," and is the "Continental BB3" model. The Continental B and BB models were introduced after 1889 but before 1892, and continued until about 1915; the numeral after the letters B or BB was used to indicate certain accessories supplied with the instrument. ■

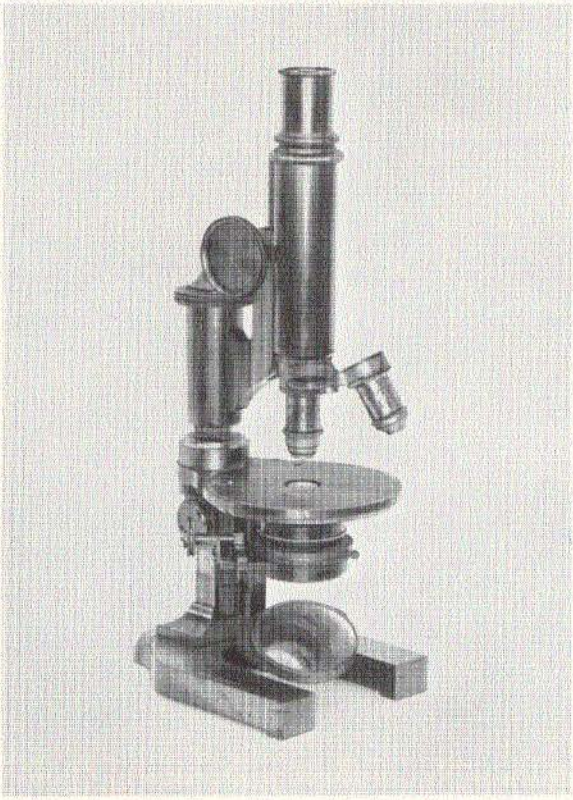

Fig. 191. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1894. (AFIP 49143 - 60-4713-139)

This all-brass instrument (Fig. 191) has a 5-1/4 x 4-inch horseshoe base supporting the 3-inch-high rectangular pillar capped by a slot joint. The 3-1/2-inch tubular limb has a triangular bar and angular arm, and a screw fine adjustment at the top.

The 3-3/4-inch circular stage has a 5/8-inch central aperture. Fixed to the lower end of the limb is a 2-5/16-inch-long rectangular tailpiece with rack and pinion substage with Abbe condenser, swing-out centering iris diaphragm, and screw pivot gimbal with a 1-5/16-inch double mirror.

The front of the arm is 3 inches long and has a double milled-head pinion. The body tube is 5-1/2 inches long and has a graduated drawtube. When closed it is 11-3/4 inches high.

It is signed, "E. Leitz, Wetzlar, Germany, No. 23616." This model, "Stand IA," was introduced prior to 1894 and was still listed in the catalogue in 1911; it is slightly smaller than the "Stand I" model by the same maker. ■

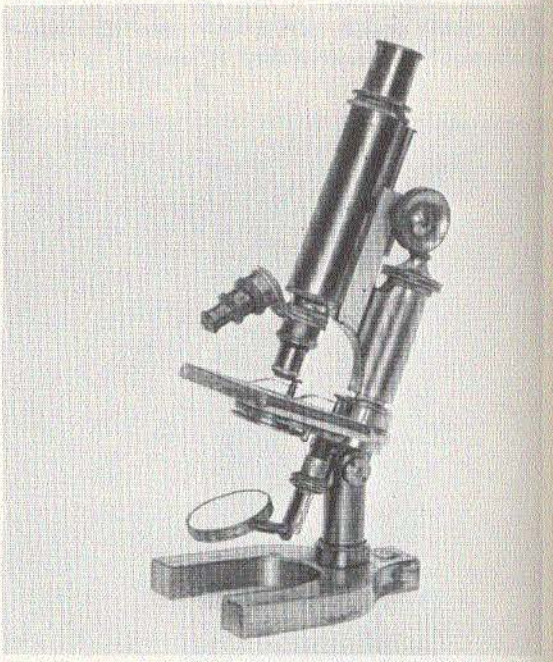

Fig. 192. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1895. (AFIP 49190 - 60-4713-183)

The 3 x 1-inch tubular pillar of this all-brass instrument (Fig. 192) is screwed to the 5-3/4 x 4-1/4-inch horseshoe base. The tubular limb is 3-1/2 x 1-1/16 inches, has a triangular bar and angular arm, and is screwed to the pillar. The 2-1/2-inch-long slotted tailpiece is on a screw pivot and has a sliding arm and gimbal with a 1-15/16-inch double mirror.

The stage plate is 4-3/4 x 3-7/8 inches, is incurved at the back, and fixed to the limb. The vulcanite stage is 3 x 3-3/4 inches, and has a 15/16-inch central aperture. Beneath the stage is a swing-out condenser on an adjustable screw.

The front of the arm is 3-1/4-inches long and has a double milled-head pinion. The body tube is 5-3/8 inches long, has a rack at the back, and a graduated drawtube; the fine adjustment micrometer is at the top of the limb.

It is 11-3/4 inches high when closed, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y. & New York City, 17053." ■

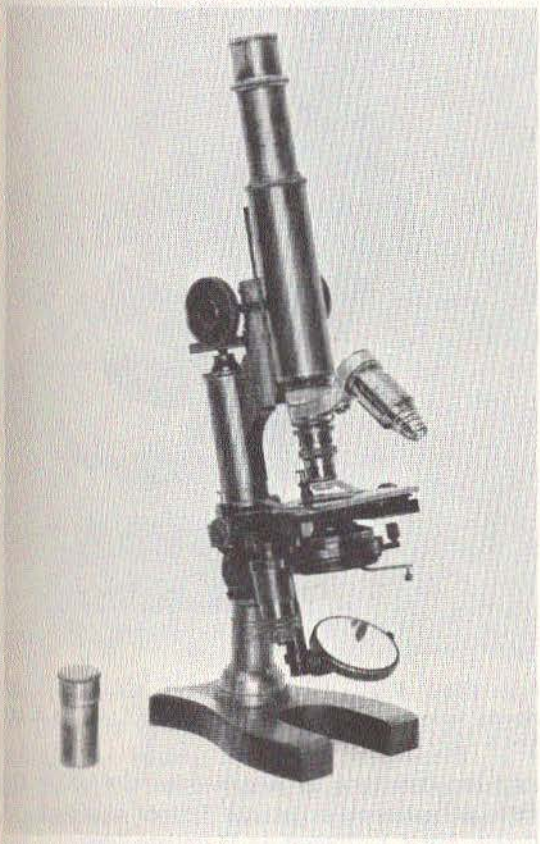

Fig. 193. Nachet & Son, Paris, France; compound monocular; 1895. (AFIP 50222 - 60-4713-125)

The Nachet horseshoe base is 5-1/4 x 3-3/8 inches, and supports the 2-1/2-inch-high tubular pillar with flanges of this all-brass instrument (Fig. 193). The tubular limb, triangular bar, and the angular arm are screwed to the pillar; there is a graduated micrometer screw at the top of the limb.

The front of the arm is 2-3/4 inches long and has a double milled-head pinion. The 4-1/4 x 3-1/4-inch stage plate is incurved at at the back, and fixed to the limb. The movable stage is fixed to the stage plate, and has a 1-1/8-inch central aperture.

The hinged tubular tailpiece on the lower limb is 2-3/4 inches long, has a sliding casing, and a pivot arm and gimbal with a 1-11/16-inch double mirror. The swing-out substage with Abbe condenser and movable iris diaphragm is attached by an adjustable screw at the right.

The body tube is 5-1/2 inches long, has a diagonal rack at the back, and a graduated drawtube. It is 12 inches high, and is the "Stand 4" model. It is signed, "Nachet et Fils, 17 Rue St. Severin, Paris." ■

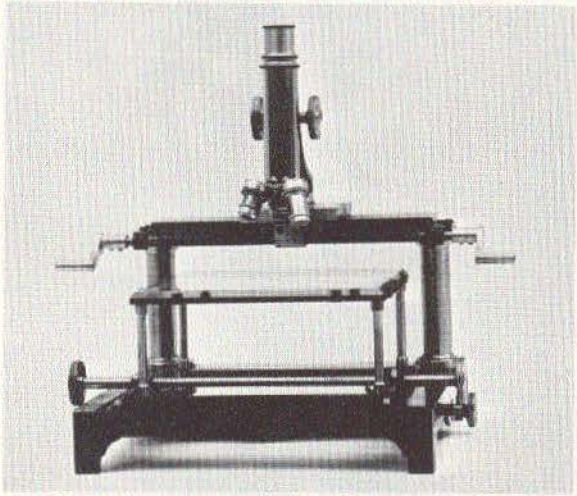

Fig. 194. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1896. (AFIP 49146 - 60-4713-405)

The hollow, cast iron base of this instrument (Fig. 194) is 10-1/4 x 10-3/4 x 2 inches, with sides cut away to form the legs. The upper portion of the instrument sets on a heavy beam supported by two tubular brass pillars, each 4 x 1 inch high. Movements are effected on a lateral track and a screw with handles; motion of the stage is by rack and pinion.

The glass plate stage is on a frame supported by four columns. The tracks permit motion of microscope and the stage. The rectangular mirror is 6-1/2 x 2 inches and has a milled head under the stage.

The body tube is 5-1/4 inches long, has a rack and pinion adjustment, and a graduated drawtube; the body tube may be removed from the stand and a simple lens substituted. It is signed, "E. Leitz, Wetzlar." This instrument was devised by Dr. E. Nebelthau of Marburg, Germany, C. 1896, for use in examining very large sections of tissue or culture plates. ■

The horseshoe base of this all-brass instrument (Fig. 195) is 6-1/2 x 4-1/8 inches, and supports the tubular pillar, 5-1/4 x 1-1/4 inches, that is cut away at the top to 7/8 inch at front and back. The 5-1/2-inch tubular limb with triangular bar and angular arm is attached to

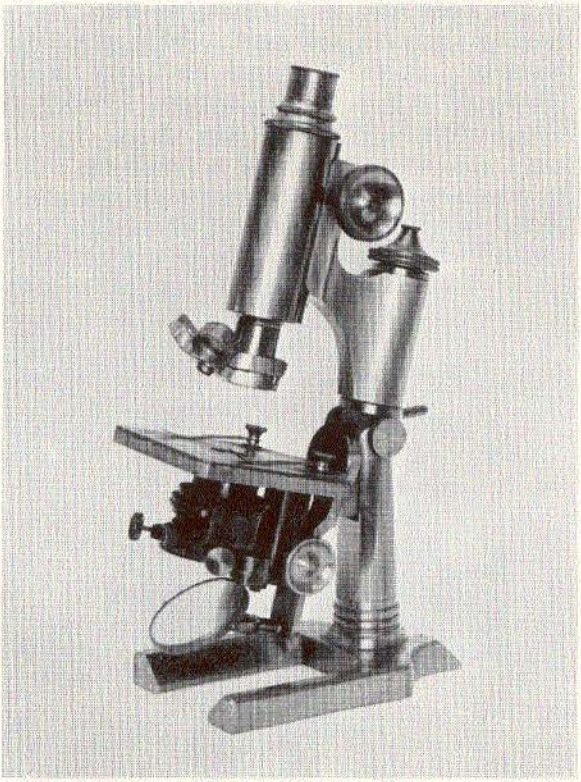

Fig. 195. L. Schrauer, New York, N.Y.; compound monocular; C. 1896. (AFIP 49137 - 60-4713-124)

Fig. 196. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1896. (AFIP 49144 - 60-4713-123)

the pillar by milled-head screws and a lever clamp.

A grooved 3-1/4-inch-long swinging tailpiece has a sliding short arm and gimbal with a 2-1/8-inch double mirror. The heavy stage plate is 4-3/16 x 3-7/8 inches, is incurved at the back, and attached to the limb. The 3-7/8-inch-square stage is screwed to the plate, and has a 13/16-inch central aperture.

Fixed to the plate is a rack and pinion substage with Abbe condenser, iris diaphragm, and centering screws. The front of the arm is 2-7/8 inches long, and has a double milled-head pinion. The body tube is 5-1/4 inches long, has a rack at the back, graduated drawtube, and a 7/8-inch-long cylinder nose; there is a graduated micrometer fine adjustment at the top of the limb. It is 13 inches high when closed, and is signed, "L. Schrauer, Maker, New York." ■

The horseshoe base is 5 x 3-1/2 inches and supports the 2-1/2-inch-high tubular pillar of this all-brass instrument (Fig. 196) that is capped by a cradle joint. The tubular limb is 2-1/2 x 1-1/8 inches, has a triangular bar and angular arm that is screwed to the pillar; the fine adjustment is at the top of the limb. A screw pivot tailpiece is 2 inches long and has a pivot gimbal with a 1-15/16-inch double mirror.

The stage plate is fixed to the limb and is 4-1/2 x 3-3/8 inches, and is incurved at the back; it has a 3/4-inch central aperture. The stage is 3 x 3-3/8 inches and screwed to the plate; beneath the stage is a substage on an adjustable screw.

The front of the arm is 3 inches long, and has a double milled-head pinion. The body tube is 5-1/4 inches long, has a back rack, and a drawtube. It is 11 inches high when closed.

It is signed, "E. Leitz, Wetzlar, No. 28846." This model, "Stand II," was introduced about 1890, and made with an improved substage before 1894; it was still on the market in 1909. ■

This instrument (Fig. 197) has a tripod foot with a spread of 6 x 5 inches, and two tubular pillars each 3 inches high, all cast in one piece of black japanned iron. The tubular limb, rectangular arm, and trunnion are also cast in one piece and screwed to the pillars.

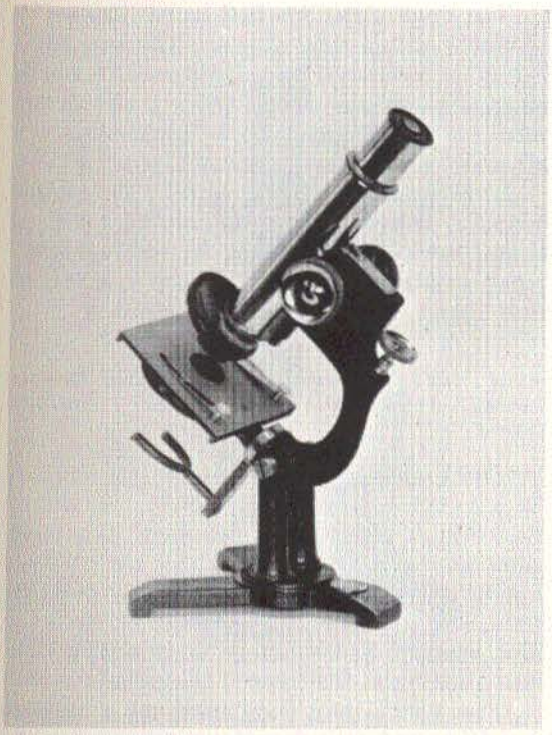

Fig. 197. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1896. (AFIP 195 - 60-4713-171)

The front of the arm is brass with a double milled-head pinion; the fine adjustment is at the top of the limb. There is a grooved, swinging tailpiece, and a sliding arm and gimbal for the 1-15/16-inch double mirror.

The stage is of polished brass and 3-1/2 inches, and is screwed to a plate extension of the limb; it has a 15/16-inch central opening. Beneath the stage is a tube for a cylinder diaphragm. The body tube is 6-1/2 inches long, has a back rack, and an ungraduated drawtube. The instrument is the "Stand F" model, and is 12 inches high. It is engraved, "Pat. Oct. 3, 1876; Pat. Oct. 13, 1885." ■

The stage of this instrument (Fig. 198) is 3-1/2 x 2-3/8 inches. A 1-inch arm and 9/16-inch short tube for a screw-in handle are on the upper surface. The body tube is 5-3/4 inches long, has a drawtube with screw motion for adjustment, and a society screw for the objective.

This model, the "Demonstration O," was introduced in 1896 and continued until 1902 with minor changes; after 1908 an entirely new model was made bearing the identical designation, "O." ■

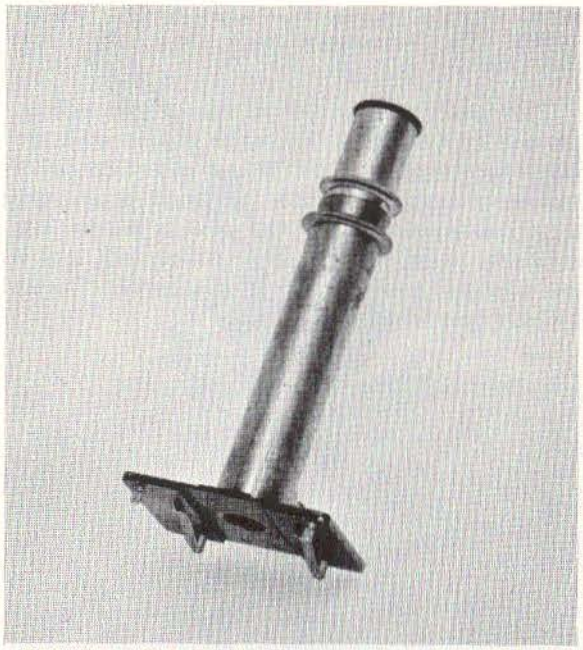

Fig. 198. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1896. (AFIP 169 - 60-4713-312)

AFIP 518514. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1897. *Not illustrated.*

This black and brass-trimmed instrument has a horseshoe base, 6 x 4-1/8 inches, that supports the 2-1/2-inch-high pillar capped by a cradle joint. The 3-inch-long limb has a micrometer fine adjustment at the top. The stage is 3-7/8 x 5 inches, incurved at the back, has a 1-1/4-inch central aperture, and a substage condenser and diaphragm. The gimbal for the 2-inch double mirror is on a 2-inch swinging tailpiece.

The 4-inch-long body tube has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. When closed it is 11-1/2 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 42444." (Donated by Mr. Richard L. Freeman) ■

AFIP 49414. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; before 1898. *Not illustrated.*

This instrument is a duplicate of those in Fig. 190 (AFIP 16738) and Fig. 192 (AFIP 49190), both made by Bausch & Lomb. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y. and Chicago, No. 24141," and is the "Stand BB8" model. ■

AFIP 17785. James W. Queen & Co., Philadelphia, Pa.; compound monocular; 1898. *Not illustrated.*

This instrument is a duplicate of that in Fig. 199 (AFIP 49147) by the same maker with the following exceptions: The base and pillar of this instrument are black japanned brass, the swing tailpiece carries the double mirror, the substage is on a screw and swings out, and it has a triple nosepiece. It is signed, "Queen & Co., Philadelphia, 4186." ■

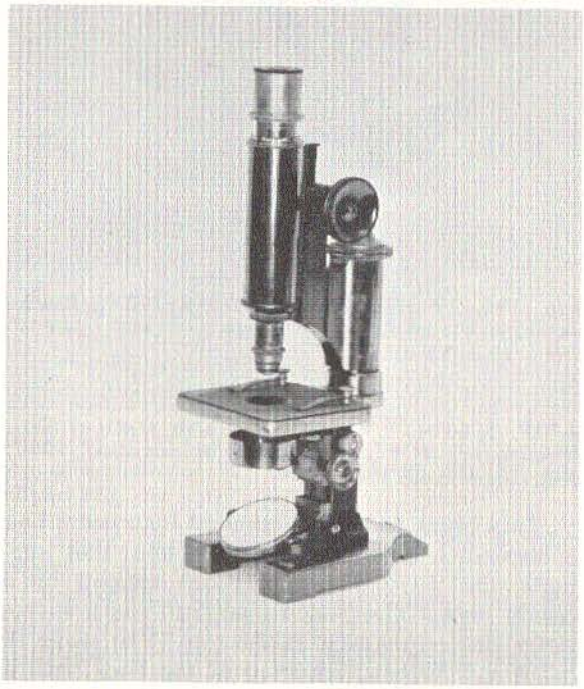

Fig. 199. James W. Queen & Co., Philadelphia, Pa.; compound monocular; 1898. (AFIP 49147 - 60-4713-149)

A horseshoe base, 5-3/8 x 3-3/4 inches, supports the 2-1/2-inch-high rectangular pillar of this instrument (Fig. 199). A tubular limb, triangular bar, and angular arm are attached to the stage plate; there is a graduated micrometer screw for fine adjustment at the top of the limb. The tailpiece is 4 x 15/16 x 1/4 inch and is attached to the limb.

There is a rack and double milled-head pinion, tube for condenser, and a dovetail slide with pivot gimbal for the 1-7/8-inch double mirror. A heavy stage plate of white metal, 4-5/8 x 3-1/2 inches, incurved at the back, is fixed to the limb. There is a thin, hard rubber stage, 3-3/16 x 3-1/2 inches, fixed to the plate; the stage has a 9/16-inch central aperture.

The front of the arm is 3 inches long and has a double milled-head pinion. The body tube is 5-1/2 inches long, has a diagonal rack at the back, a short cone nose, and a graduated drawtube. When closed it is 11 inches high; it is all brass except for the black iron pillar.

It is signed, "Queen & Co., Philadelphia, 4126." Queen & Co. introduced two Continental models such as this in 1893, which were later improved and other models added, and first listed in the catalogues in 1898. ■

AFIP 16739. Ernst Leitz, Wetzlar, Germany; compound monocular; before 1899. *Not illustrated.*

The V-shaped folding base of this instrument is 3 x 3-3/4 inches, and screwed to it is the 6-inch-high pillar with a Seibert* fine adjustment at the top; the gimbal for the 1-3/8-inch single mirror is screwed to the front of the pillar. The 2-7/8 x 2-5/8-inch stage has a 1/2-inch aperture and substage condenser; it slides into a fitting at the front of the pillar.

The 4-inch-long body tube has a graduated drawtube and a rack and pinion with a single milled head. When closed it is 8 inches high. A label is lettered, "E. Leitz, Wetzlar; New York, 411 W. 59th St." ■

AFIP 49149. Carl Zeiss, Jena, Germany; compound monocular; 1899. *Not illustrated.*

This instrument is a duplicate of that in Fig. 181 (AFIP 49195) by the same maker; the only difference is that the instrument in Fig. 181 has a revolving rather than a mechanical stage. It is signed, "Carl Zeiss, Jena, No. 31061." ■

The iron English base of this instrument (Fig. 200) is 3 inches high with a spread of 4-1/2 x 4 inches. The stage is 3-3/4 x 2-1/2 inches, is incurved at the back, has a rounded front with flanges, and is screwed to the base; it has a 5/8-inch aperture.

Beneath the stage is a revolving disc of diaphragms, and a gimbal with a 1-1/4-inch double mirror on a 1-1/4-inch-long arm. A tubular curved limb is screwed to the stage.

It has a ring front with a 2 x 1-1/8-inch fixed tube with a double milled-head pinion, and a

*W. & H. Seibert of Wetzlar, Germany, were opticians and makers of microscopes and objectives.

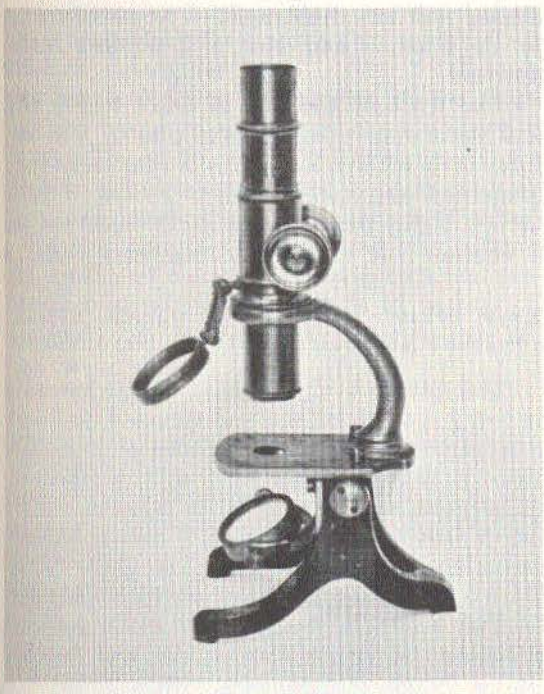

Fig. 200. Maker unknown; compound monocular; before 1900. (AFIP 188 - 60-4713-121)

ring with a ball-and-socket arm with a 1-7/16-inch stage condenser. The body tube is 6 inches long, and has a back rack; the upper section is split, and has a society screw. When closed it is 10-1/2 inches high; it is all brass except for the base. There are no identifying marks and no reference to it has been found in the literature. ■

The 4-inch-high brass tripod base of this instrument (Fig. 201) has a spread of 6 x 5-1/4 inches with a supporting bar; the triangular bar and plate are cast in one piece and screwed to the base. The stage plate is 3-3/8 inches square and is screwed to the limb plate. There is a fixed tubular tailpiece, 2-1/4 x 7/8 inch, and a sliding case with arm, gimbal, and a 1-3/4-inch double mirror. The swinging substage has a rack and pinion, Abbe condenser, and iris diaphragm. There is a Turrell mechanical stage.

The outer casing of the limb is triangular with an angular arm; the fine adjustment is at the top of the limb. The front of the arm is 3-1/2 inches long, and has a double milled-head pinion. The body tube is 5-3/4 inches long, has a diagonal rack at the back, and a drawtube with ring graduations. When closed it is 12 inches high. It is signed, "Henry Crouch, London, 10141." Crouch adopted the Continental form of fine adjustment after 1889, but continued to use the 1882 style of base construction. ■

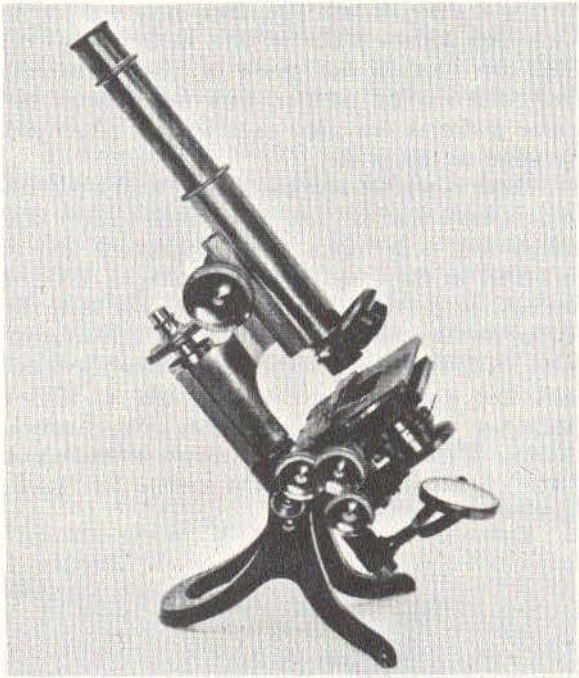

Fig. 201. Henry Crouch, London, England; compound monocular; before 1900. (AFIP 17784 - 60-4713-142)

Fig. 202. Schutz Co., Kassel, Germany; compound monocular; before 1900. (AFIP 200 - 60-4713-147)

The 5 x 3-1/8-inch horseshoe base and 1-1/4-inch-high square pillar of this instrument (Fig. 202) are cast in one piece of black japanned iron; the curved tubular limb and arm of the same material are also cast in one piece and screwed to the pillar.

There is a pivot arm and gimbal with a 1-7/16-inch single mirror. The 2-3/4-inch-square iron stage has a 3/8-inch central aperture and is screwed to the limb. A brass tube, 2 x 1-1/4 inches, is screwed to the front of the arm; the upper section is a micrometer fine adjustment. The 6-1/2-inch-long sliding body tube is brass and has a society screw. Height is 10-3/4 inches. It is signed, "Schutz, AG., Cassel, 40161, D.R.G.M." [The German abbreviation "AG." in the signature is the symbol for "joint-stock company".] ■

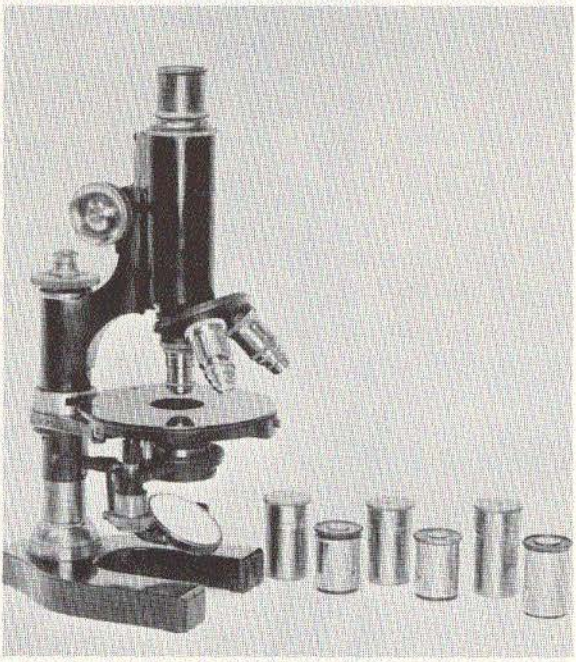

Fig. 203. Nachet & Son, Paris, France; compound monocular; C. 1900. (AFIP 17778 - 60-4713-126)

The hollow, cast iron horseshoe base is 6 x 4 inches, and supports the 3 x 1-inch tubular brass pillar of this instrument (Fig. 203). A tubular limb, triangular bar, and angular arm are attached to the pillar by a pin; a 4-inch circular stage plate is fixed to the limb; the fine adjustment is at the top of the limb.

There is a three-arm tailpiece on a pivot with gimbal and a 1-3/16-inch double mirror, and a screw, swinging substage with Abbe condenser and iris diaphragm. The circular stage is detachable and has a 1-1/8-inch central aperture.

The front of the arm is 3-3/4 inches long and has a double milled-head pinion. The body tube is 5 inches long, has a rear rack, and a graduated drawtube. When closed it is 12 inches high. Accessories are 3 objectives and 3 oculars. It is signed, "Nachet á Paris." ■

AFIP 49249. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1900. *Not illustrated.*

The folding V-shaped base of this instrument is 5-1/2 x 4-5/8 inches and supports the 3-inch-high pillar capped by an inclination joint. The limb is 3-1/4 inches long with a screw fine adjustment at the top. The stage is 3-1/2 x 3-3/4 inches, has a 7/8-inch central aperture, and a substage condenser. The gimbal for the 2-inch double mirror is on a stationary tailpiece.

The 4-inch-long body tube has a graduated drawtube, a double nosepiece, and rack and pinion coarse adjustment. When closed it is 10 inches high, and is signed, "E. Leitz, Wetzlar, No. 56120." ■

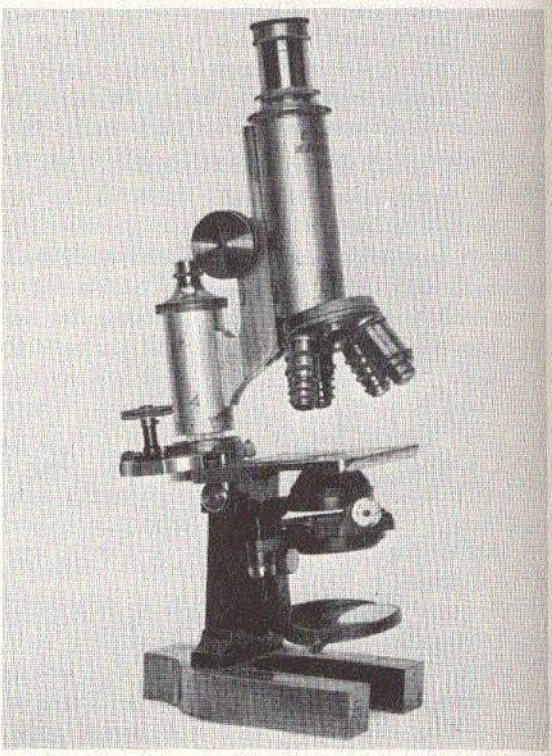

Fig. 204. C. Reichert, Vienna, Austria; compound monocular; C. 1900. (AFIP 175812 - 60-4713-127)

The horseshoe base of this instrument (Fig. 204) is 5 x 3-1/2 inches, and supports the 3-1/4-inch-high rectangular pillar. The 3-1/2-inch-long limb is screwed to the rear of the stage plate and has a micrometer fine adjustment at the top. The stage is 3 x 3-3/8 inches, has a 3/4-inch central aperture, and a complete substage. The double mirror is 2 inches in diameter.

The body tube is 4 inches long, has a drawtube, quintuplet nosepiece, and a rack and pinion coarse adjustment. Height is 13 inches. It is signed, "C. Reichert, W. Bennogasse 26, Wien." ■

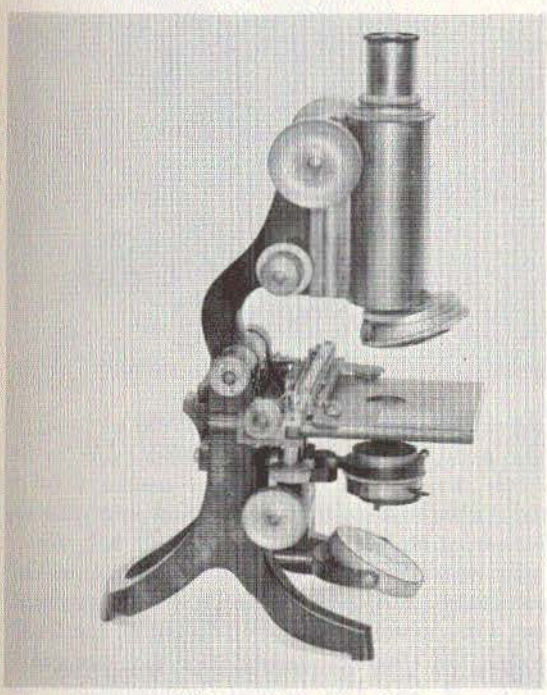

Fig. 205. J. Swift & Son, London, England; compound monocular; after 1900. (AFIP 16733 - 60-4713-327)

The bent claw base of this instrument (Fig. 205) is black japanned metal and is 5-3/4 inches high. The black curved limb and arm are screwed on the trunnion. The stage is 4-1/4 x 3-3/4 inches, is screwed to the limb, has grooved sides for the mechanical stage, a 7/8-inch central aperture, opening for clips, and a millimeter ruled square at the right.

Beneath the stage is a plate with rack and pinion substage with condenser and iris diaphragm. The swinging tailpiece behind the substage plate has an arm and gimbal with a 1-7/8-inch double mirror. The front of the arm is 3-3/8 inches long, and has a double milled-head pinion. The fine adjustment with two milled heads is the side type. The body tube is 5-1/4 inches long, has a rack at the back, and a graduated drawtube. When closed it is 11-3/4 inches high.

It is signed, "J. Swift & Son, London, 'Army.'" This model was designed by Sir A.E. Wright of the Army Medical School, Netley, England, and introduced before 1898. It was subsequently adopted by the Royal Army Medical Department as standard equipment. It was made with a fine adjustment at the top of the limb and with a stationary or swing-out substage until 1910. ■

AFIP 15223. J. Swift & Son, London, England; compound monocular; after 1900. ***Not illustrated.***

This instrument is a duplicate of that in Fig. 205 (AFIP 16733) by the same maker. It is signed, "J. Swift & Son, London"; the serial number is 16197. ■

AFIP 17782. J. Swift & Son, London, England; compound monocular; after 1900. ***Not illustrated.***

This instrument is a duplicate of that in Fig. 205 (AFIP 16733) by the same maker. It is signed, "J. Swift & Son, London, 'Army'." ■

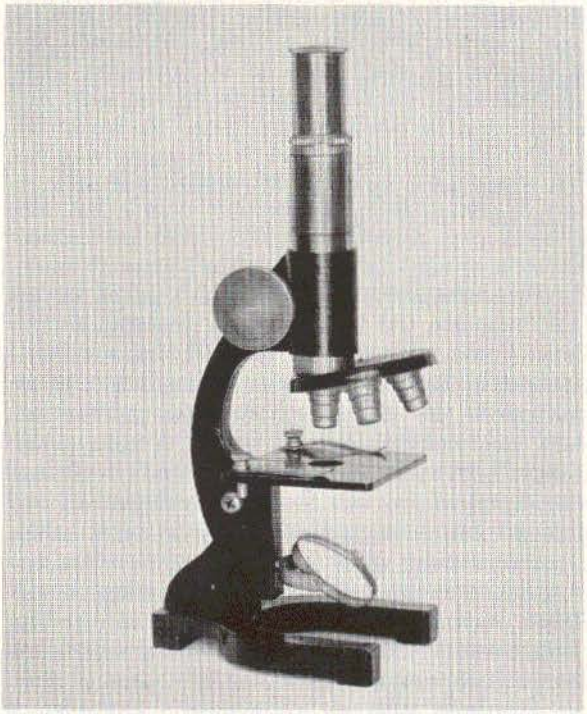

Fig. 206. Maker unknown; compound monocular; after 1900. (AFIP 199 - 60-4713-145)

The horseshoe base of this instrument (Fig. 206) is 3-3/4 x 2-3/4 inches, and supports the thin pillar that is 1 inch high. The stage has two flanges in two casts, is riveted to the limb, and attached to the pillar for inclining. There is a pin gimbal with a 15/16-inch single mirror.

The curved limb has a double milled-head pinion and a tube, 1-1/2 x 1 inch. The stage is 2-1/4 inches square, and has a 7/16-inch central aperture. The body tube is 4-1/2 inches long, has a short rack, and a drawtube. The tube and trim are nickel plated while the rest of the microscope is black japanned iron; it is 9 inches high. ■

AFIP 179. Maker unknown; compound monocular; after 1900. *Not illustrated.*

The black japanned iron, horseshoe base is 2-1/2 x 1-7/8 inches, and supports the tubular pillar of this instrument that is 2 x 1/2 inch. The stage is iron, 2-1/8 x 1-7/8 inches, incurved at the back, and fixed to the pillar; it has a 5/16-inch central aperture. The single mirror is 1-1/8 inches in diameter.

The tubular limb is 1-5/8 x 1/2 inch, has an inner tubular bar, and a fine adjustment at the top. The horizontal arm is 2 inches long, has a 15/16-inch-diameter ring front, and a fixed, split tube, 1-1/8 x 1 inch. The body tube is 3-3/4 inches long, has a slide adjustment, and a milled-edge ring; there is no drawtube. The instrument is all brass except for the base and stage, and is 7-1/2 inches high. It is signed, "A.F. Stoeger, New York." Stoeger was not the maker but a supplier; the instrument appears to be of French origin. ■

The horseshoe base is 6-1/4 x 4-1/2 inches and supports the two massive, rectangular pillars of this instrument (Fig. 207) that are 3-3/4 inches high. The circular stage plate is attached to the pillars by trunnion and screws, and has a lever lock; it has a complete substage with rack and pinion. The 1-9/16-inch double mirror is on a short arm and gimbal, and the revolving mechanical stage is detachable.

The tubular limb has a triangular bar and angular arm, and is fixed to the stage plate; there is a large micrometer screw at the top. The front of the arm is 3-3/4 inches long and has a double milled-head pinion.

The body tube is 5-3/4 inches long, has a rack at the back, and a graduated drawtube. When closed it is 13-1/2 inches high. The base

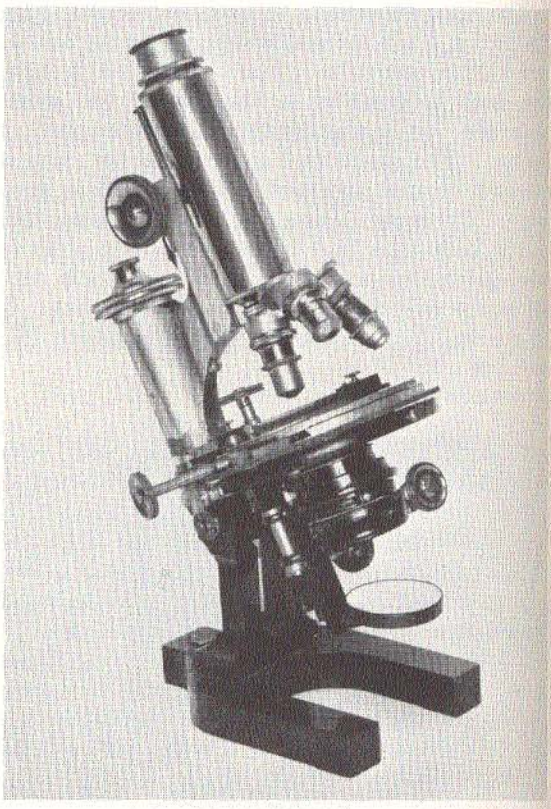

Fig. 207. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; after 1900. (AFIP 49409 - 60-4713-36)

and pillars are black japanned iron and the remainder brass.

It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 48990." This type instrument was introduced in 1898 and listed as the "DDS" model. In 1900 the designation was changed to "DD"; it was the largest and most complete Continental model made by Bausch & Lomb at the time. ■

The bent-claw-type base of this instrument (Fig. 208) is 4 inches high and has a spread of 6-1/2 x 5-1/4 inches. The limb, triangular bar and angular arm are screwed to a trunnion; there is a graduated fine adjustment at the top of the limb.

The stage plate is octagonal, incurved at the back, and fixed to the limb. Beneath the stage is a rack and pinion substage that swings out, and an iris diaphragm that swings independently. On a pivot tailpiece is a sliding gimbal with a 1-9/16-inch double mirror. The 4-1/2-inch circular stage revolves, and has a 1-inch central aperture.

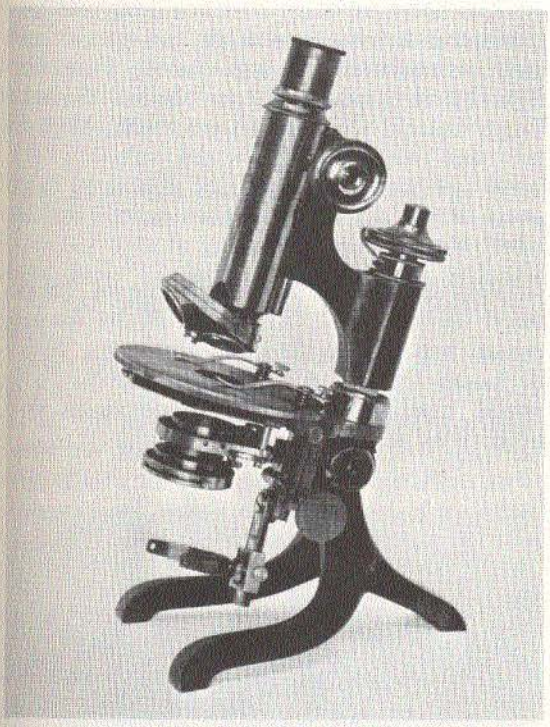

Fig. 208. Maurice Stiassnie, Paris, France; compound monocular; after 1900. (AFIP 17779 - 60-4713-116)

The front of the arm is 3-1/8 inches long and has a double milled-head pinion. The body tube is 5-1/2 inches long, has a back rack, and a graduated drawtube. It is 12 inches high when closed, and is all brass with the exception of the base and arm. It is signed on the tube, "M. Stiassnie, 204 Bould Raspail, Paris." ■

The tubular tripod base of this instrument (Fig. 209) is 4 inches high, has flanges at the top, and a spread of 6 x 5 inches; the stage with flanges is 4-1/2 x 3-3/4 inches and is screwed to the base. Beneath the stage is a fixed tube with condenser and iris diaphragm, a tubular tailpiece, 3-3/8 x 3/4 inch, and a sliding case with arm and gimbal with a 1-5/8-inch double mirror. The stage has a 13/16-inch central aperture.

The tubular limb, triangular bar and angular arm are all fixed to the stage; there is a fine adjustment at the top of the limb. The front of the arm is 2-3/4 inches long and has a double milled-head pinion. The body tube is 4 inches long, has a rack at the back, and a graduated drawtube. When closed it is 10-1/2 inches high; it is all brass except for the base that is black japanned iron.

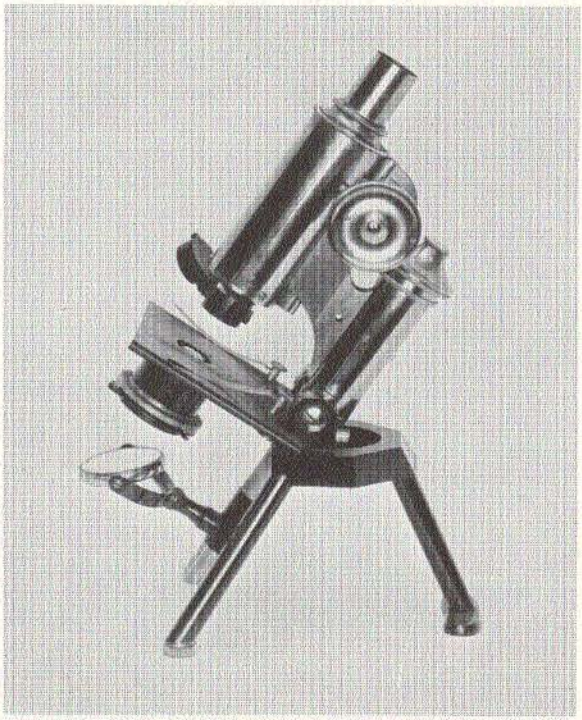

Fig. 209. J. Swift & Son, London, England, compound monocular; 1901. (AFIP 17783 - 60-4713-161)

It is signed on the base, "J. Swift & Son, London, 14973ED." This model was introduced in 1901 and made especially for use on the ship "Discovery," of Scott's Antarctic Expedition in 1901. ■

The claw-footed base, 6-1/4 x 6 inches, and the 4-1/4-inch-high single, flat pillar of this instrument (Fig. 210) are cast in one piece of green bronze; the brass curved limb is screwed to the pillar. There is a pivot arm and gimbal with 1-3/8-inch single mirror.

The stage is 2-15/16 x 3-1/16 inches, is incurved at the back, and is attached to the limb by a flange and screw; it has a sliding pin holder and a 15/16-inch central aperture. Beneath the stage is a revolving disc of diaphragms.

The upper section of the arm is fixed to a tube, 3-1/8 x 1-3/8 inches; there is a double milled-head pinion. The body tube with rack, not diagonal, is 7-1/2 inches long; there is a screw division in its upper two inches. The fine adjustment is a fixed ring at the division with a horizontal micrometer screw at the front of the tube that moves the long spring nose. It is 12 inches high.

It is signed on the base, "Trade Mark: The

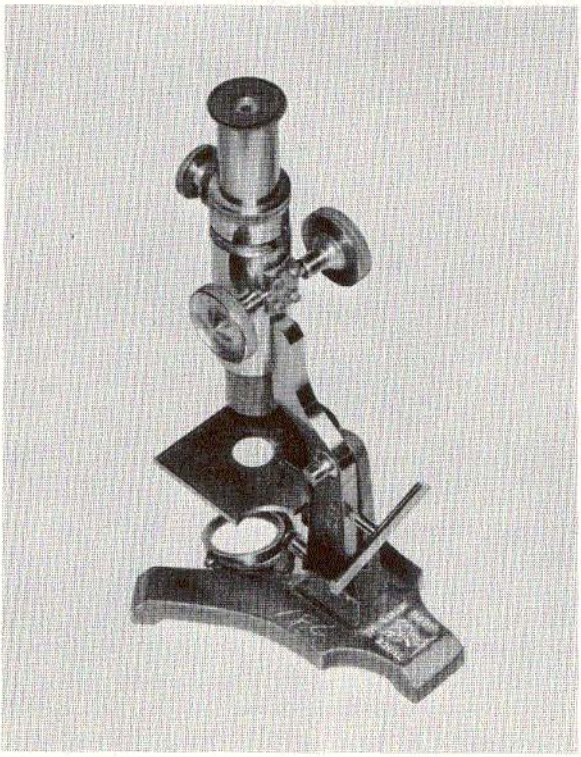

Fig. 210. Maker unknown; compound monocular; before 1902. (AFIP 186 - 63-6531)

Liver," and a symbol with a water bird and fish. The vertical short lever fine adjustment on the 5-inch-long spring nose was obsolete by 1898. The fine adjustment is horizontal and on top of the tube; mention of this type of adjustment has not been found in the literature. ■

AFIP 49446. M. Stiassnie, Paris, France; compound monocular; C. 1902. *Not illustrated.*

This instrument is a duplicate of that pictured in Fig. 208 (AFIP 17779) by the same maker, and bearing the identical signature, "M. Stiassnie, 204 Bould Raspail, Paris." ■

AFIP 49246. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1902. *Not illustrated.*

The folding base of this instrument is 5-3/4 x 4-1/4 inches and supports the 3-inch-high pillar capped by an inclination joint. The limb is 3-1/4 inches long with a screw fine adjustment at the top. The stage is 3-3/8 x 3-7/8 inches, has a 1-1/4-inch central aperture, and a substage condenser and diaphragm. The gimbal for the 2-inch double mirror is on a swinging tailpiece.

The body tube is 4 inches long and has a graduated drawtube, a triple nosepiece, and a rack and pinion coarse adjustment. When closed it is 11 inches high. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 47189." ■

AFIP 16734. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1902. *Not illustrated.*

This instrument is a duplicate of that pictured in Fig. 207 (AFIP 49409) by the same maker, and has an identical signature, "Bausch & Lomb Optical Co., Rochester, N.Y."; the serial number is 50102. Accessories are 3 objectives. ■

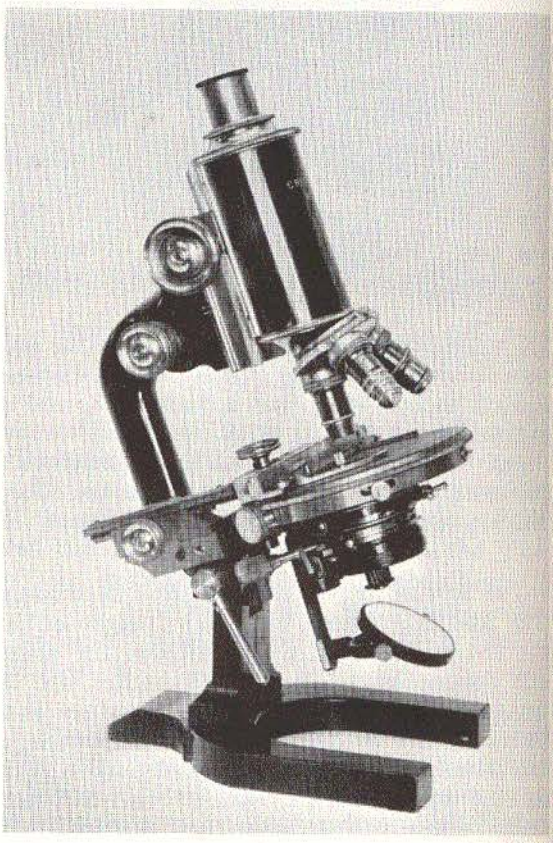

Fig. 211. C. Reichert, Vienna, Austria; compound monocular; 1902. (AFIP 49194 - 60-4713-106)

The horseshoe base is 7-1/4 x 4-7/8 inches and supports the 3-1/2-inch-high rectangular pillar of this instrument (Fig. 211); the curved limb and arm with double milled-head pinion is attached to the pillar by screw and lever lock. The 4-3/4-inch circular, concentric stage has

centering screws, and there is a complete substage on rack and pinion with a centering iris diaphragm. There is a 3-3/4-inch-long slotted tailpiece with slide arm and gimbal with a 15/16-inch double mirror.

The side fine adjustment is on the arm; the front of the arm is 3-1/4 inches long. The body tube is 5 inches long, has a rack at the back and a 1-1/4-inch graduated drawtube. When closed it is 13 inches high; it has a black finish with brass trim, and is the "Stand AI" model.

It is signed on the base, "C. Reichert, Wien; No. 29517." Reichert established his business in 1876, and in 1930 introduced a small portable microscope that he supplied to the Japanese Army. The latter instruments were marked as if Japanese made, but it is not known if Reichert established a factory in Japan. ■

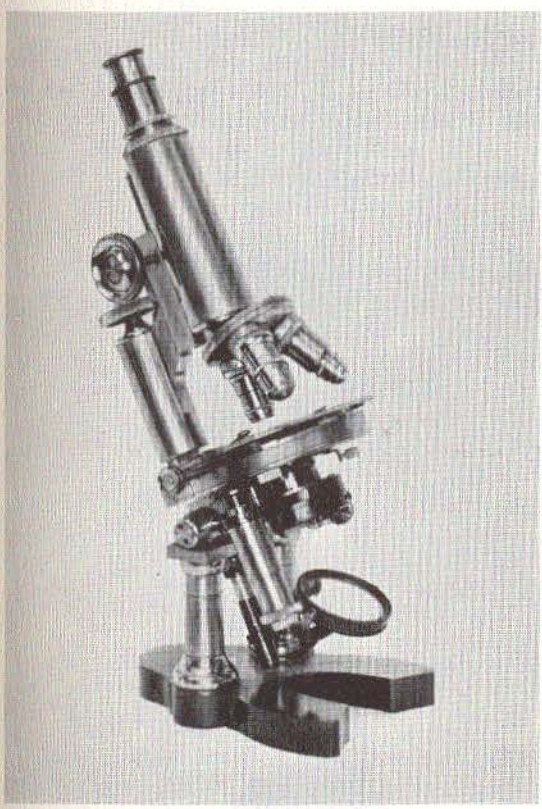

Fig. 212. A. Nachet, Paris, France; compound monocular; 1902. (AFIP 49196 - 60-4713-143)

The Nachet horseshoe base is 6 x 4-1/4 inches and supports the two 3 x 3/4-inch-high tubular pillars of this all-brass instrument (Fig. 212); the stage plate and trunnion are screwed to the pillars. There is a hinged tubular tailpiece with slide case, angular arm, and gimbal with a 1-7/8-inch double mirror.

The 3-5/8-inch concentric, circular stage has a fixed mechanical stage and two spring clips. Beneath the stage is a screwed-on swinging substage with iris diaphragm that swings by rack and pinion. The tubular limb and angular arm are fixed to the stage, and the whole revolves. The front of the arm is 2-1/2 inches long and has a double milled-head pinion; the fine adjustment is at the top of the limb.

The body tube is 5-7/8 inches long and 1-1/2 inches in diameter, has a rack at the back, and a graduated drawtube. When closed it is 12 inches high.

It is signed, "A. Nachet, 17 Rue St. Severin, Paris." Nachet originally made his large model microscopes with an odd-shaped horseshoe base, two pillars, and a trunnion. From 1895 to 1900 he used a regular horseshoe base and a single large pillar; this 1902 model indicates that he reverted to his original type of construction. ■

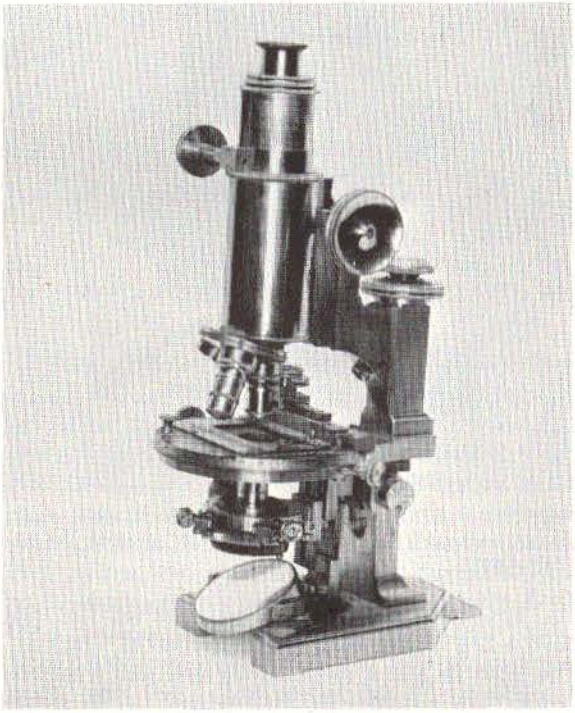

Fig. 213. R. & J. Beck, London, England; compound monocular; 1903. (AFIP 49197 - 60-4713-326)

The continental horseshoe base is 7 x 4-5/8 inches and supports the 3-inch-high rectangular pillar of this all-brass instrument (Fig. 213) and the square limb and angular arm with a

double milled-head pinion. There is a large micrometer at the top of the limb. The 5-inch circular, concentric stage plate has a rack and pinion revolving motion and a fixed mechanical stage. The substage is attached to a fixed plate with rack and pinion; the iris diaphragm swings out. The flat tailpiece is on a pivot. There is a sliding case and gimbal with a 2-1/2-inch double mirror.

The body tube is 5-1/2 inches long and 2-1/16 inches in diameter, has a rack at the back, a rack and pinion drawtube, and extra drawtube. It is 14-1/2 inches high when closed, and is signed, "R. & J. Beck, London, 25392." This model was introduced before 1903 with either a continental or English base. ■

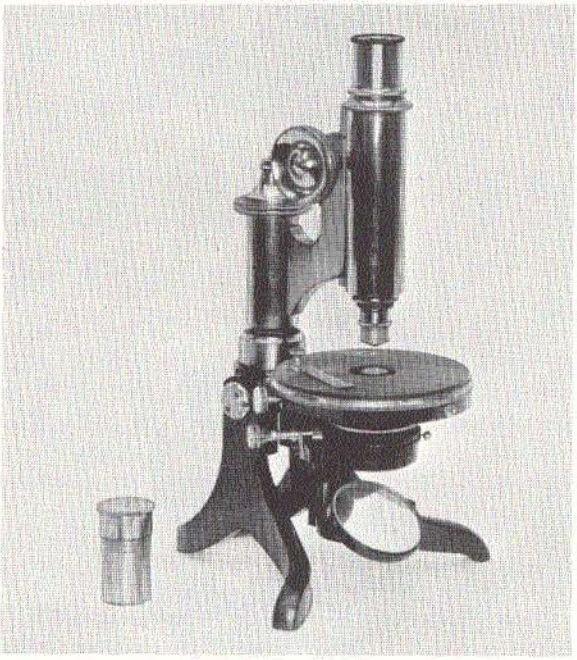

Fig. 214. Ernst Leitz, Wetzlar, Germany; compound monocular; 1903. (AFIP 49198 - 60-4713-167)

This instrument (Fig. 214) has an English base 4-1/4 inches high with a spread of 6 inches. The limb is 2-3/4 inches long and has a micrometer fine adjustment at the top. The stage plate is 3-3/4 inches in diameter with a projection at the back; the 3-3/4-inch circular, revolving stage has openings for spring clips.

A slotted stationary tailpiece beneath the stage has a rack and pinion adjustment for the substage condenser. The 2-inch double mirror on a gimbal and short arm slides into the lower section of the tailpiece.

The 3-3/4-inch-long body tube has a rack and pinion coarse adjustment and a graduated drawtube. Height is 12 inches. It is signed, "E. Leitz, Wetzlar, No. 76028." This "Stand IA" model was introduced in 1894 and by 1898 was obtainable with either a horseshoe or English base. ■

AFIP 49245. Spencer Lens Co., Buffalo, N.Y., compound monocular; 1904. *Not illustrated.*

This instrument fits into an aluminum case, the cover of which serves as the base. The 2-1/2-inch-high pillar is capped by an inclination joint and slips into a groove on the base and is locked by a clamp. The 3-3/4-inch-long limb has a screw fine adjustment at the top. The folding stage is 3-3/4 x 3-3/8 inches, has a 1-1/8-inch central aperture and a substage condenser. The arm and gimbal for the 2-inch double mirror is screwed to a projection beneath the stage.

The 4-1/2-inch-long body tube has a graduated drawtube, a double nosepiece, and rack and pinion coarse adjustment. When closed it is 9-1/2 inches high. It is signed, "Spencer Lens Co., Buffalo, N.Y." ■

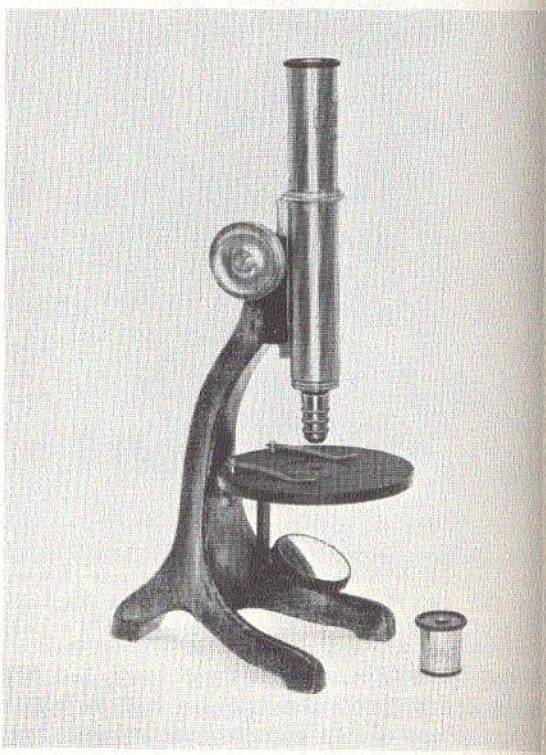

Fig. 215. Carl Zeiss, Jena, Germany; compound monocular; C. 1904. (AFIP 49415 - 60-4713-141)

The 5-1/4 x 4-inch bent claw-footed base and the curved limb of this instrument (Fig. 215) are cast in one piece of iron. The 4-inch circular stage is screwed to the plate, and has a 1-3/8-inch recessed aperture.

The front of the arm is 2-1/4 inches long and has a brass fitting and a milled-head pinion. The body tube is 6-1/2 inches long and 1 inch in diameter, has a back rack and a milled-edge ring; there is no drawtube. When closed it is 12 inches high.

It is signed, "Carl Zeiss, Jena, No. 42902." This model, "Stand IX," was devised by Professor Johne of Dresden and was introduced before 1889 as the "Trichina Microscope"; it was discontinued before 1927. ■

Fig. 216. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1904. (AFIP 49411 - 60-4713-386)

The horseshoe base of this instrument (Fig. 216) has a spread of 2-1/2 x 6 inches and is cast with the 2-inch-high pillar capped with lever controlled compass joint. The curved limb is 5-3/4 inches long and has a continuous safety fine adjustment; the 3-1/2 x 3-9/16-inch stage is attached to the limb. A short arm with gimbal and 2-inch single mirror are attached to the stationary tailpiece. The substage is fixed to the stage plate.

The brass body tube is 3-3/4 inches has a drawtube, and a double nosepiece back rack carries the coarse adjustment. closed it is 11 inches high. It is signed Leitz, Wetzlar, No. 82979." This model introduced about 1904; in 1905 it was liste "Stand IIK," and before 1909 as "Stand F

Fig. 217. Spencer Lens Co., Buffalo, N compound monocular; 1904. (AFIP 49199 - 4713-80)

This microscope (Fig. 217) has a horses base, 4-1/2 x 5-1/2 inches, a 2-5/8-inch t lar pillar, square fixed stage, screw subst and a 2-inch double mirror. It has a 3-inch b continental limb, arm, a fine adjustment, a rack and pinion coarse adjustment; it is b with portions finished in black. The body is 4 inches long, has a graduated drawtube, triple nosepiece. It is signed, "Spencer L Co., Buffalo, N.Y., 3765." This model, "4 was introduced about 1900 and was an impr ment over the "Continental No. I" of 189 was again improved in 1920 and designated "30" model. ■

The 5-1/2 x 3-3/8-inch horseshoe bas this instrument (Fig. 218) is iron, as are 6-inch-long curved limb and arm cast in piece and screwed to the base; it is not clinable. It has a brass rack and pinion co

Fig. 218. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1904. (AFIP 19476 - 60-4713-99)

adjustment, and the 1-3/4-inch double mirror is in a socket. The 5-inch-long body tube and the drawtube are brass, while the parts are brown japanned iron.

The original stage was rectangular, of polished iron, and screwed to the limb. The substitute stage now attached to the instrument has a special mechanical movement, is all brass, and has a 5-inch circular glass top for twenty mounts; it is operated by a knob on top of the glass plate. A rod attached to the stage supports a brass plate on which rests a glass plate extending to the body tube.

It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 43980." This type base was introduced about 1904 but before 1908 was redesigned but still listed as "Stand A." ■

The square horseshoe base is 6-1/2 x 4-1/4 inches, and supports the 3-inch-high rectangular pillar of this instrument (Fig. 219). The 4-3/4-inch circular stage plate is on a trunnion and is screwed to the pillar and has a lever lock. There is a detachable, circular, revolving mechanical stage. The tubular limb and angular arm has a double milled-head pinion; the fine adjustment screw is at the top of the limb.

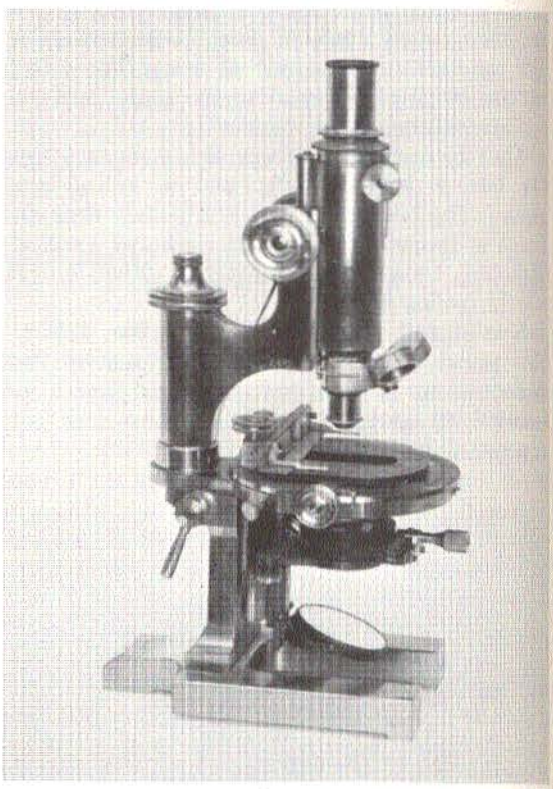

Fig. 219. Andrew Ross, Ltd., London, England; compound monocular; 1904. (AFIP 49412 - 60-4713-162)

The substage is on a fixed bar with rack and pinion, the Abbe condenser swings down, and the iris diaphragm has a rack and pinion eccentric motion. There is a gimbal on a bar with sliding motion and a 1-7/8-inch double mirror. The front of the arm is 3-1/4 inches long.

The body tube is 7-1/2 inches long and 1-3/8 inches in diameter, has a rack at the back, rack and pinion drawtube, and an additional graduated drawtube. It is all brass, 15-1/2 inches high, and signed, "Ross, London, 6569." The Ross microscope was introduced in 1878, and this model, "Standard No. I," before 1902. ■

The 6-1/2-inch-high tripod base of this instrument (Fig. 220) has a spread of 9 inches, with each leg set on a 1-inch-diameter brass foot. The upper section is cut away to form two supports connected by a lever-controlled compass joint and has two milled-head, graduated fine adjustments. The stage plate is 5 inches in diameter with a 3-7/8-inch-square mechanical stage and complete substage. The 3-inch double mirror is on a gimbal attached to a swinging tailpiece.

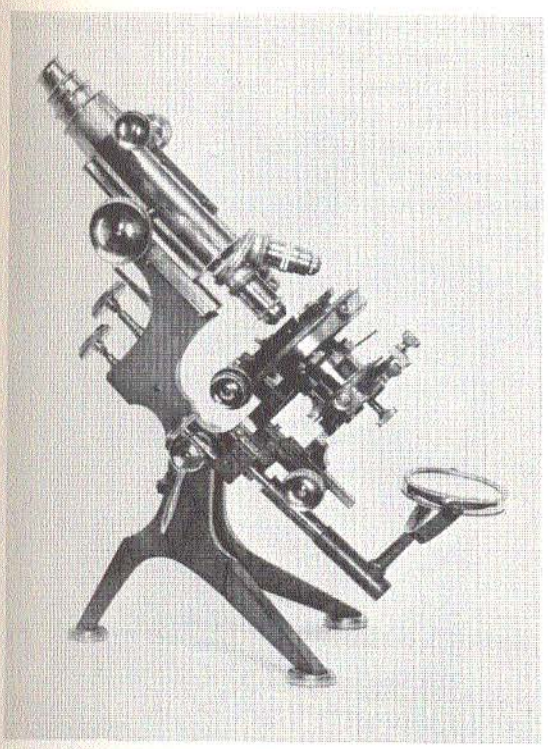

Fig. 220. W. Watson & Sons, London, England; compound monocular; 1904. (AFIP 49410 - 60-4713-383)

The 5-inch-long body tube has a rack at the back for coarse adjustment and a triple nosepiece. There are two drawtubes, the inner graduated, and the outer with rack and pinion adjustment. When closed it is 16 inches high.

It is signed, "W. Watson & Sons, 313 High Holborn, London, 7915." The fine adjustment is signed, "Males Watson." This "Grand Model" was devised by Dr. H. van Heurck of Amsterdam, Holland, and introduced in 1895; many improvements were made between then and 1904. ■

This instrument (Fig. 221) is inclosed in a wooden-framed glass box 11-1/2 inches square, and has a continental stand with a limb in a horizontal position and a large circular stage. The stage may be revolved and is 8-1/2 inches in diameter. The body tube is 7-1/2 inches long.

This same principle was used on a simple microscope in Italy before 1686, and Winter & Harris had a similar instrument in 1830. It was also used in France in the 1860's and in Germany about 1880. The instrument is signed, "No. 6766, 'The Museum,' patent; W. Watson & Sons, 313 High Holborn, London, W.C." ■

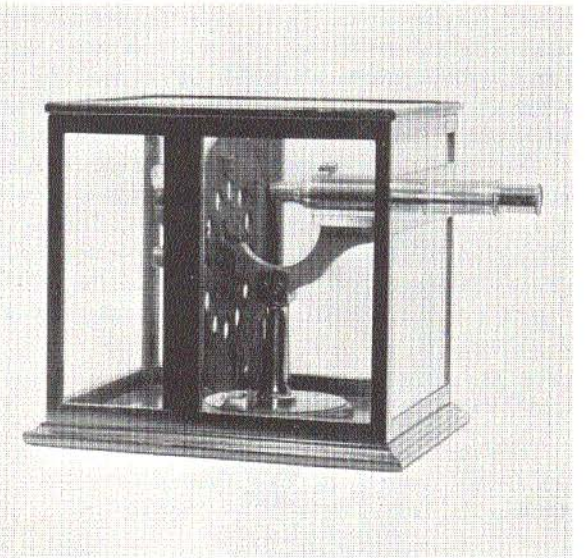

Fig. 221. W. Watson & Sons, London, England; compound monocular; 1904. (AFIP 49438 - 60-4713-392)

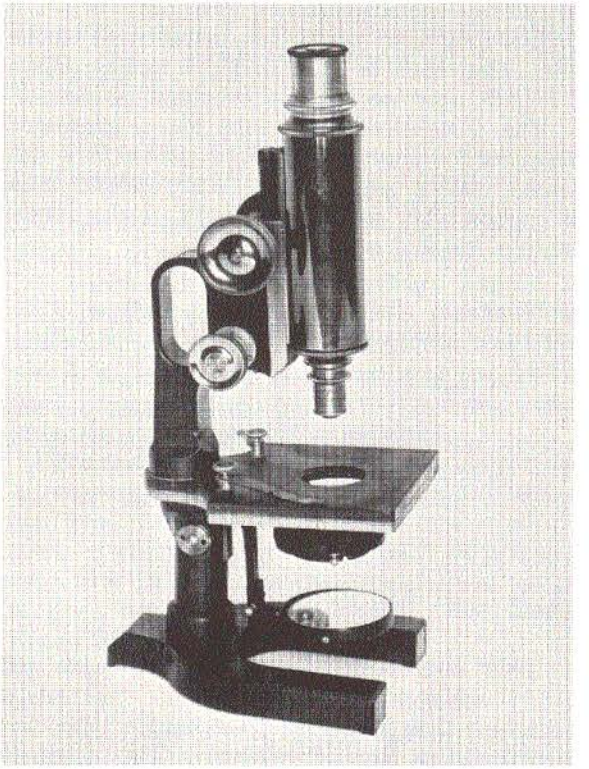

Fig. 222. Spencer Lens Co., Buffalo, N.Y.; compound monocular; 1904. (AFIP 49417 - 60-4713-88)

This instrument (Fig. 222) has a 4-1/4 x 5-inch horseshoe base, 2-1/2-inch-high tubular

pillar, handle arm, 3-7/8 x 5-1/4 stationary stage with vulcanite top, and a screw substage with double mirror attached by gimbal to a swinging arm. It has a rack and pinion coarse adjustment and a side arm fine adjustment.

The limb is 4-1/4 inches long, and the 4-1/4-inch-long body tube has a black, graduated drawtube. It is signed, "Spencer Lens Co., Buffalo, N.Y., 3734." This model, "26B," was introduced before 1904 and is a modification of the "20" type of 1902; it was discontinued about 1919. ■

AFIP 42. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1905. *Not illustrated.*

This instrument is a duplicate of that in Fig. 216 (AFIP 49411) by the same maker. It is signed, "E. Leitz, Wetzlar, No. 83214." ■

AFIP 71806. Ernst Leitz, Wetzlar, Germany; compound monocular; 1906. *Not illustrated.*

This instrument has a folding V-shaped base that supports the 3-inch-high pillar capped by an inclination joint. The limb is 3-1/2 inches long with screw fine adjustment at the top. The stage is 3-1/2 x 3-3/4 inches, has a 7/8-inch aperture, and a substage condenser.

The 4-inch-long body tube has a graduated drawtube, a triple nosepiece, and a rack and pinion coarse adjustment. When closed it is 10 inches high, and is signed, "E. Leitz, Wetzlar, No. 88185." ■

AFIP 49420. Spencer Lens Co., Buffalo, N.Y.; compound monocular; C. 1906. *Not illustrated.*

This instrument is a duplicate of that in Fig. 222 (AFIP 49417) by the same maker, but has a triple nosepiece and dissimilar identification. It is signed, "Spencer Lens Co., Buffalo, N.Y., 9082"; it is known as the "26H" model. ■

AFIP 49422. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1907. *Not illustrated.*

This instrument has a horseshoe base and 3-1/4-inch-high rectangular pillar. The 4-1/8-inch-long limb and arm, of the handle type, has a lever-type fine adjustment. The stage is 6-1/4 x 4-7/8 inches, and has a vulcanite top. The substage is complete and has a rack and pinion motion. The 2-inch mirror is on a fork attached to the bar of the substage. The body tube is 4-1/2 inches long and has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. It is 12-1/4 inches high when closed, and is the "CAH8" model. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 66994." The "Stand CA" model was first listed in 1904. In 1907 it was redesigned and listed in 1908 as "Stand CAH"; it was discontinued before 1914. ■

Fig. 223. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1907. (AFIP 337707 - 66-1836-13)

The folding V-shaped base of this instrument (Fig. 223) is 5-1/2 x 4-3/4 inches, and supports the 3-inch-high pillar capped by an inclination joint. The handle-type limb is 5-1/4 inches long and has a side fine adjustment. The 3-1/2-inch-square stage has a 1-1/4-inch central aperture, and a substage condenser and diaphragm. The gimbal for the 2-inch-diameter double mirror is on a swinging tailpiece.

The 4-1/2-inch-long body tube has a graduated drawtube, a triple nosepiece, and rack and pinion coarse adjustment. When closed it is 10-1/2 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 59325." ■

The base, pillar, and tube of this instrument (Fig. 224) are of the same construction as the Stand IA microscope in Fig. 181 (AFIP 49195) by the same maker. The stage is 9-7/8 inches

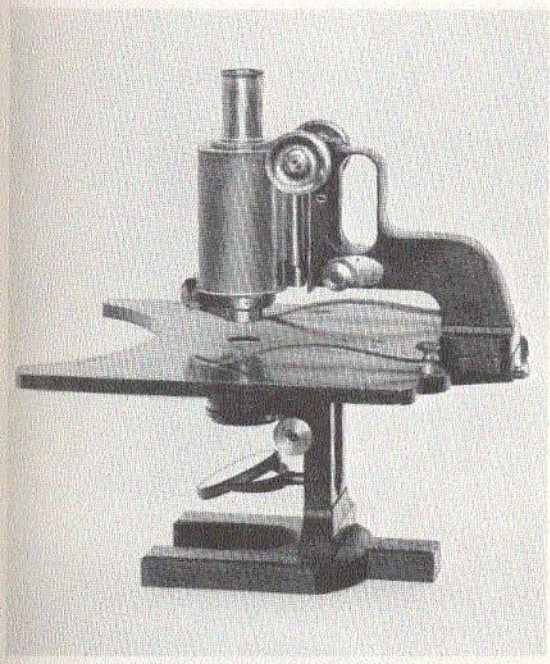

Fig. 224. Carl Zeiss, Jena, Germany; compound monocular; C. 1907. (AFIP 49439 - 60-4713-185)

square, is incurved at the front, and fixed to the joint; it requires an abnormal projection for the handle arm; the substage has rack and pinion movement.

There is a rack and pinion coarse adjustment and a Berger side fine adjustment. The body tube is 3-1/2 inches long and 1-3/4 inches in diameter, making it especially suitable for photomicrography; there is a drawtube and a triple nosepiece. It is signed, "Carl Zeiss, Jena, No. 44362." This model, "Stand ID," was introduced before 1902 and was designated the "brain section microscope." ■

This instrument (Fig. 225) has a horseshoe base, 2-3/4-inch-high round pillar with compass joint, a handle-type limb and arm, and a 1-7/8-inch swinging double mirror. The stage is 4-1/4 x 6-1/4 inches and has a vulcanite top; the substage is a screw-in type. It has an iris diaphragm, and screw fine adjustment.

The body tube is 3-3/4 inches long with a graduated drawtube, and a rack and pinion coarse adjustment. The instrument is all brass with a black finish. Height is 11-1/2 inches. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., A.M.M., 78646." This model, "Stand BBH8," has an improved BB stand and was introduced in 1907 and discontinued in 1918. ■

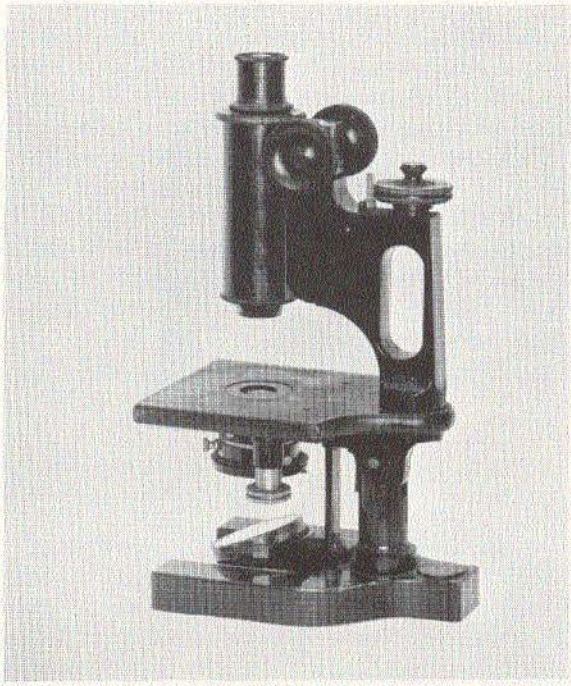

Fig. 225. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1907. (AFIP 49421 - 60-4713-163)

AFIP 49244. Carl Zeiss, Jena, Germany; compound monocular; C. 1907. *Not illustrated.*

The horseshoe base of this instrument is 4-1/2 x 2-3/4 inches, and supports the two 2-1/2-inch-high rectangular pillars capped by an inclination joint. The limb is 2 inches long with a screw fine adjustment at the top. The 4-1/8 x 3-1/8-inch stage is incurved at the back, has a 1/2-inch central aperture, and a substage condenser and diaphragm.

The body tube is 4 inches long, has a triple nosepiece, a drawtube with an adjustment at the front, and a rack and pinion coarse adjustment at the back. When closed it is 9 inches high. It is known as the "Stand VIA" model; it does not fold. It is signed, "Carl Zeiss, Jena, No. 43501." ■

This instrument (Fig. 226) has a 4 x 5-inch horseshoe base, 3-inch-high rectangular pillar with joint, a revolving stage, and a complete substage. The 4-3/4-inch limb and arm are of the handle type with a double milled-head pinion; there is a Berger side fine adjustment.

The body tube is 3-1/4-inches long and 2-1/4-inches in diameter, and has a rack at the

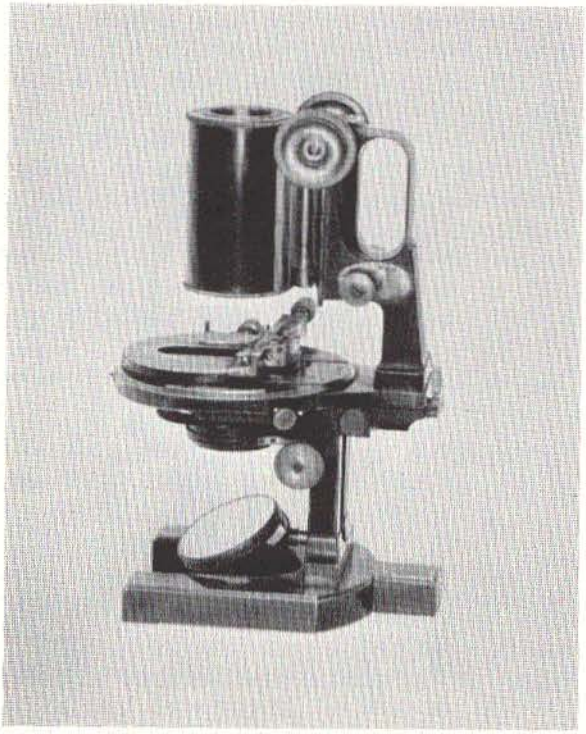

Fig. 226. Carl Zeiss, Jena, Germany; compound monocular; C. 1908. (AFIP 17776 - 60-4713-107)

back; both ends are fitted with removable plates; the lower plate has a society screw. The upper plate has a graduated drawtube into which the narrow eyepiece tube and light collar may be screwed. There is a 2-inch-diameter double mirror.

It is signed, "Carl Zeiss, Jena, No. 48785." This model, "Stand IC," was introduced before 1902 and discontinued after 1923; it was intended principally for photomicrography. ■

The large base of this instrument (Fig. 227) is constructed along continental lines, horseshoe in shape, and with a single 3-3/4-inch-high rectangular pillar capped with a compass joint and lever clamp. The 5-1/2-inch-long limb is also rectangular and straight to the point where it curves to form the arm; there is a double milled-head pinion and a Leitz side fine adjustment.

There are revolving and mechanical stages, a substage, and the mirror is 2-1/8 inches in diameter. The body tube is 3-3/4 inches long with a rack at the back, screw collars at each end, and a triple nosepiece; the drawtube is graduated. The instrument, the "Stand I" model, is finished in black with brass trim. It is signed,

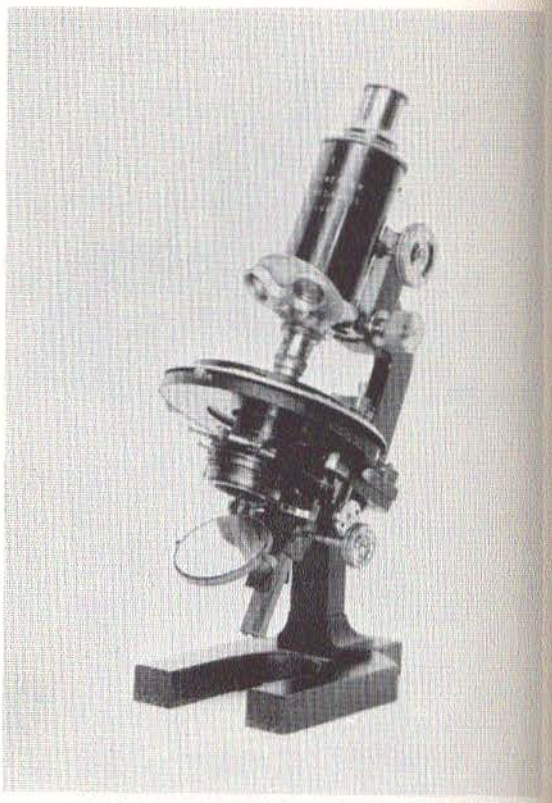

Fig. 227. Voigtländer, Braunschweig, Germany; compound monocular; C. 1908. (AFIP 49419 - 60-4713-387)

"Voigtlaender, Braunschweig, No. 897." The size of the body tube makes this microscope especially suitable for photomicrography. ■

The curved horseshoe base, 6-1/2 x 5 inches, supports the 3-inch-high rectangular pillar of this instrument (Fig. 228); both are cast in one piece. The curved limb and the arm are attached to the pillar by a joint and lever clamp.

The circular revolving stage is 4-1/2 inches in diameter and has centering screws; there is a complete substage on rack and pinion. The 2-inch double mirror is attached by a pin to the substage bar. The front of the arm is 3 inches long, and has a double milled-head pinion coarse adjustment; there is a side fine adjustment on the arm.

The body tube is 4 inches long and 1-3/4 inches in diameter; it has a rack at the back, a graduated drawtube, and triple nosepiece. It is black with brass trim, 13-1/2 inches high when closed, and signed, "F. Koristka, Milano, No. 16213." ■

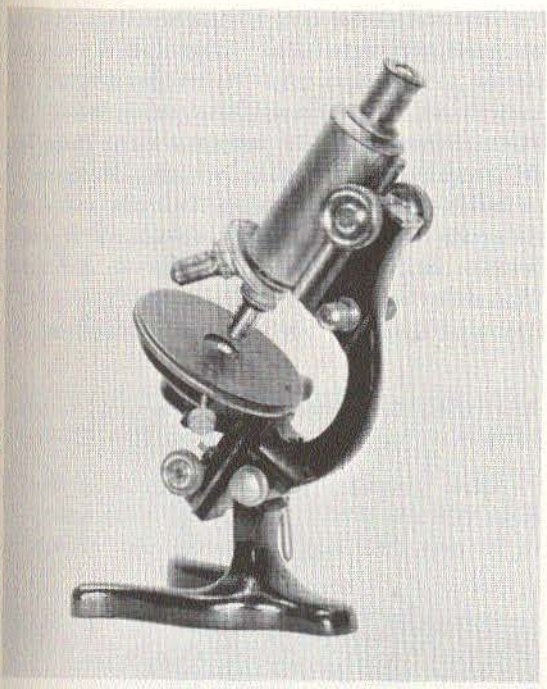

Fig. 228. F. Koristka, Milan, Italy; compound monocular; C. 1908. (AFIP 67 - 60-4713-317)

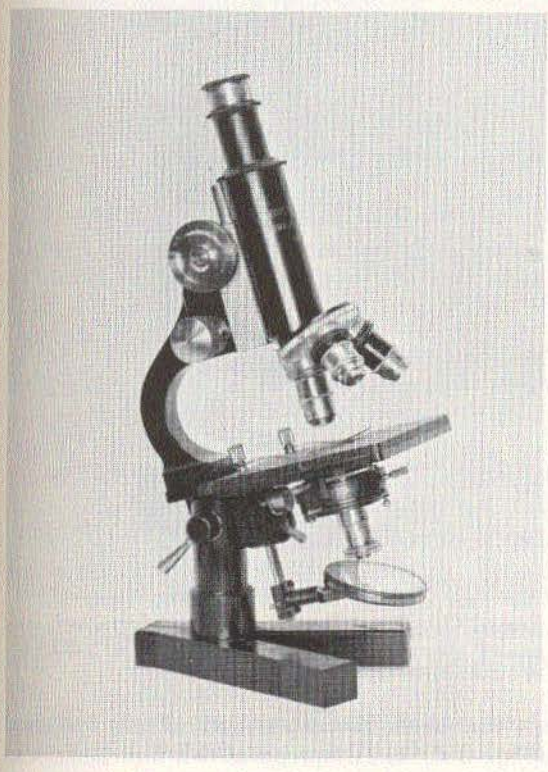

Fig. 229. Voigtlander, Braunschweig, Germany; compound monocular; C. 1908. (AFIP 49247 - 60-4713-391)

The folding, V-shaped base of this brass-trimmed instrument (Fig. 229) has a spread of 4-1/2 x 5-3/4 inches, and supports the 3-inch-high tubular pillar with a side lever control. The 4-inch-square stage is on an axis and folds; there is a complete substage on a screw fitting, and a double mirror on a slide bar.

The 5-1/2-inch-long curved limb has a double milled-head pinion and a side fine adjustment. The body tube is 4 inches long with a rack and pinion coarse adjustment, a graduated drawtube, and triple nosepiece. It is 10-1/2 inches high, and signed, "Voigtlaender, Braunschweig, 1125." ■

AFIP 49248. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1908. *Not illustrated.*

In construction and size this instrument is similar to several other microscopes by the same maker in the Collection. The limb of this model is rectangular. The side fine adjustment is a new form with milled heads at the side of the arm; previous models had varied fine adjustment mechanisms. It is known as the "Stand D" model, has a triple nosepiece, and is signed, "E. Leitz, Wetzlar, 105539." ■

Fig. 230. Bausch & Lomb Optical Co., Rochester, N. Y.; compound monocular; 1908. (AFIP 49145 - 60-4713-32)

The base of this instrument (Fig. 230) consists of a blackened metal stage 3-1/4 x 3-7/8 inches. Underneath the stage at the front are small posts to hold the instrument level when in a vertical position.

The tube into which the body tube slides is attached to the handle by which the instrument may be held; the body tube slides and when adjusted may be secured by a setscrew above the handle; the tube is fixed at 6-1/4 inches. It has a black and brass finish and is 9 inches high.

This model was introduced in 1908 and called the "Demonstration O"; it was a redesign of the 1896-1903 model in Fig. 198 (AFIP 169); it was discontinued before 1929. It is signed, "Bausch & Lomb Optical Co., Rochester, N. Y., 28." ■

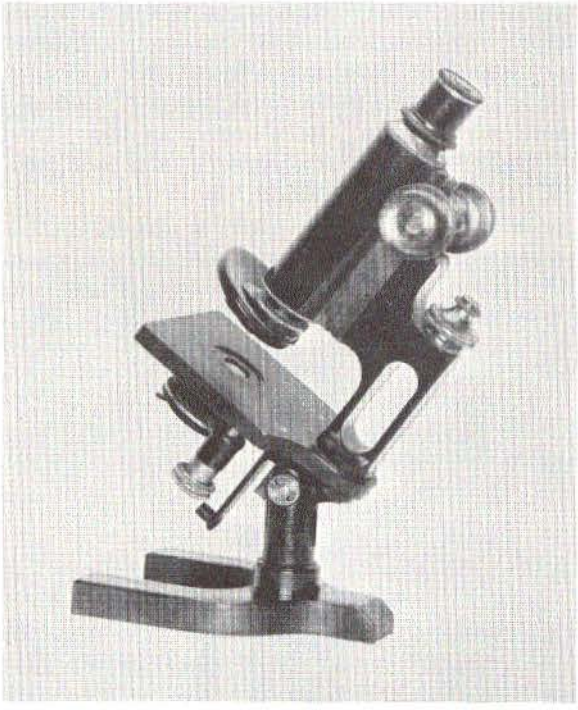

Fig. 231. Spencer Lens Co., Buffalo, N. Y., compound monocular; 1908. (AFIP 49416 - 60-4713-321)

This instrument (Fig. 231) has a horseshoe base and a 2-1/2-inch tubular pillar capped by a joint. The stage is 3-3/4 x 5-1/4 inches; there is a screw-in substage. The mirror is on a swinging bar, the 3-1/4-inch limb and arm are of the handle type, and the screw fine adjustment is at the top of the limb.

The body tube is 4-1/2 inches long, and has a graduated drawtube. There is a rack and pinion adjustment and triple nosepiece. The instrument is of black finish with brass trim; when closed it is 11 inches high. This "No. 66" model was introduced before 1906 and had a 4-7/16-inch stage; before 1910 the stage was reduced in size to 3-3/4 inches; it was continued until shortly after 1914. It is signed, "Spencer Lens Co., Buffalo, N. Y., 11442." (Donated by Major Frederick F. Russell) ■

AFIP 16735. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1909. *Not illustrated.*

This instrument is a duplicate of that in Fig. 216 (AFIP 49411) by the same maker. It is signed, "E. Leitz, Wetzlar, No. 123428." ■

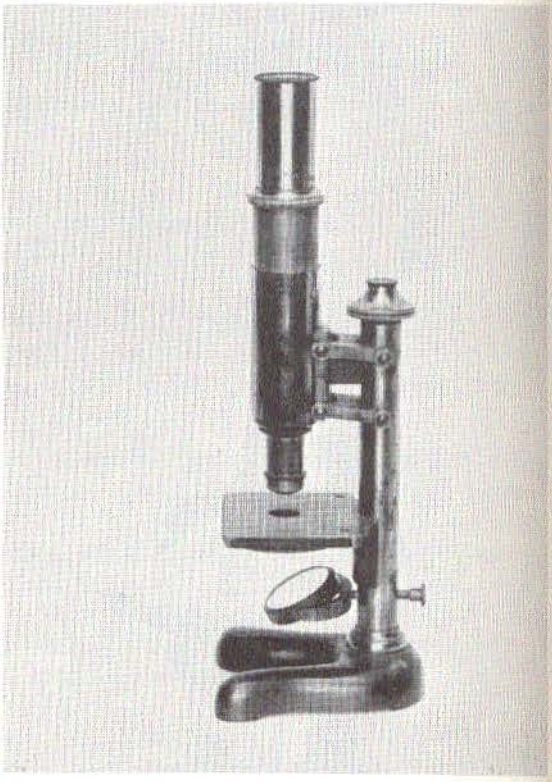

Fig. 232. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1909. (AFIP 613455 - 60-4713-314)

The black horseshoe base of this instrument (Fig. 232) has a spread of 3-1/2 inches. Arising from the rear of the base is a cylindrical 6-inch-high brass pillar with a fine adjustment at the top. The 2-3/4-inch body cylinder is

attached to the pillar by two screw clamps and holds the 6-inch body tube; there is a top control fine adjustment.

A 2-5/8 x 3-inch stage with a 1/2-inch central aperture is screwed to the pillar; beneath the stage is a revolving disc of diaphragms. A 1-1/2-inch rod is inserted through the pillar to which is attached a single 1-1/2-inch mirror on a gimbal. Height is 11 inches. It is signed, "E. Leitz, Wetzlar, No. 34571." (Donated by Dr. J.R. Schumaker) ■

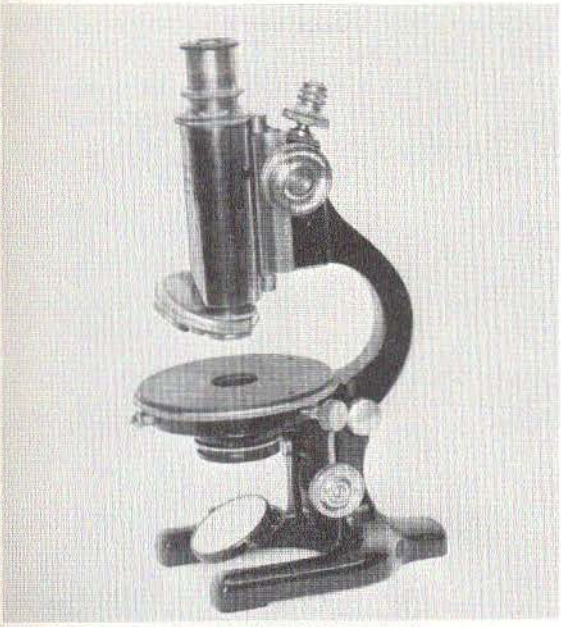

Fig. 233. F. Koristka, Milan, Italy; compound monocular; C. 1909. (AFIP 17377 - 60-4713-105)

The horseshoe base, 5-3/4 x 4 inches, and the 2-inch-high pillar of this instrument (Fig. 233) are cast in one piece; the curved limb and arm are attached to the pillar by screws. The 4-inch circular, revolving stage has centering screws; the substage has a condenser, iris diaphragm, and rack and pinion. The 1-3/4-inch double mirror is on a swinging arm.

The front of the arm is 3 inches long and has a double milled-head pinion coarse adjustment. A fine adjustment is at the top of the limb. The body tube is 4 inches long, has a rack and pinion for coarse adjustment, triple nosepiece, and a drawtube. It is all brass with stand, arm and limb finished in black, and 11 inches high when closed. It is signed, "F. Koristka, Milano, No. 16785." ■

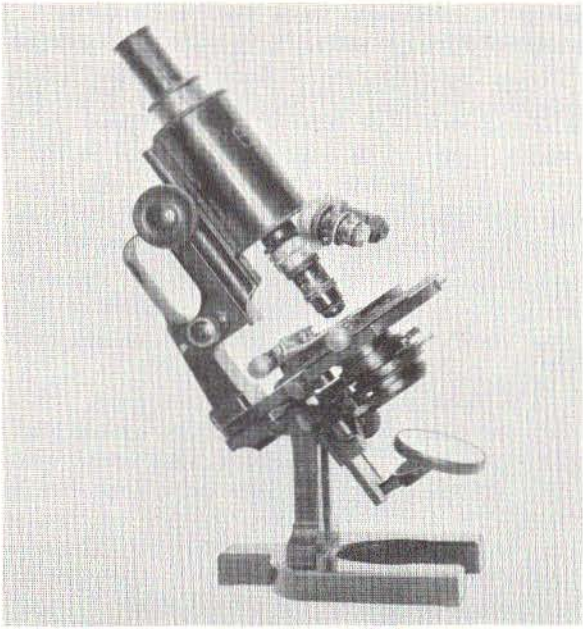

Fig. 234. Carl Zeiss, Jena, Germany; compound monocular; C. 1909. (AFIP 39 - 60-4713-385)

This instrument (Fig. 234) has a horseshoe base, two 3-inch-high rectangular pillars, 5-1/2-inch-long handle limb and arm, 4-1/2-inch circular stage plate, and a complete substage with rack and pinion; a 2-1/8-inch double mirror is attached to the tailpiece.

The body tube is 3-1/2 inches long, has a graduated drawtube, a rack and pinion coarse adjustment, and a triple nosepiece. This type of handle limb and arm was introduced before 1902 and was continued in use on the Stand I, II, and III models for many years. The instrument is 13-1/2 inches high. It is signed, "Carl Zeiss, Jena, No. 50331," and is the "Stand IB" model. ■

AFIP 613454. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1909. *Not illustrated.*

This instrument is a duplicate of that in Fig. 232 (AFIP 613455) by the same maker. It is signed, "E. Leitz, Wetzlar, No. 34571." (Donated by Dr. J.R. Schumaker) ■

AFIP 613456. Ernst Leitz, Wetzlar, Germany; compound monocular; 1909. *Not illustrated.*

This instrument is a duplicate of that in Fig. 232 (AFIP 613455) by the same maker. It is signed, "E. Leitz, Wetzlar, No. 34613." (Donated by Dr. J.R. Schumaker) ■

AFIP 51. Spencer Lens Co., Buffalo, N. Y.; compound monocular; 1910. *Not illustrated.*

This instrument has a horseshoe base, and a 2-1/2-inch-high tubular pillar capped by a cradle joint. The 3-inch stage plate is fixed to the 4-1/2-inch-long limb of the handle type; the fine adjustment is on the side of the limb.

There is a complete screw-on substage with swinging bar for the mirror, and the circular, revolving mechanical stage is similar to that used on the "No. 16" microscope by the same maker.

The body tube is 4-1/2 inches long, has a rack and pinion coarse adjustment, and a graduated drawtube. It is black with brass trim. This model, "No. 22," was introduced before 1906. The early models were black and brass; later models, all black. It is signed, "Spencer Lens Co., Buffalo, N.Y., 12486." (Donated by Brig. General George R. Callender) ■

AFIP 517759. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1910. *Not illustrated.*

The 3-3/4 x 3-1/2-inch horseshoe base and pillar of this instrument are cast in one piece. The gimbal for the 1-1/4-inch mirror is attached to the pillar. The 4-inch-long curved limb is screwed to the body tube, has a rack and pinion coarse adjustment, and a side fine adjustment. The 2-3/4 x 3-inch stage has a 1 x 1-3/8-inch oval cutout. The body tube is 7 inches long. When closed it is 11 inches high, and is signed, "Ernst Leitz, Wetzlar, 294898." (Donated by Lt. Colonel Walter F. Maybaum) ■

AFIP 16736. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1910. *Not illustrated.*

This instrument is a duplicate of several other "Stand D" model microscopes in the Collection by the same maker. It is signed, "E. Leitz, Wetzlar, 133515." ■

AFIP 17780. Voigtländer, Braunschweig, Germany; compound monocular; C. 1910. *Not illustrated.*

This instrument is a duplicate of that in Fig. 229 (AFIP 49247) by the same maker, with the exception that this model is all black. It is signed, "Voigtländer, Braunschweig, 1471, U.S.N. No. 44." ■

AFIP 699203. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1910. *Not illustrated.*

The folding V-shaped base of this instrument is 5-1/2 x 5-1/2 inches with a spread of 3-1/2 inches, and supports the 2-inch-high pillar with a trunnion and cradle joint. The 3-5/16-inch-square stage is screwed to the stationary tailpiece. It has a 3/4-inch central aperture and a substage condenser and diaphragm.

The limb is 2-1/2 inches long and has a fine adjustment at the top. The body tube is 3-3/4 inches long, has a graduated drawtube, double nosepiece, and a rack and pinion coarse adjustment. When closed it is 10 inches high. Accessories are three oculars. It is signed, "E. Leitz, Wetzlar, 109126." (Donated by Dr. Jae L. Littrell) ■

Fig. 235. Bausch & Lomb Optical Co., Rochester, N. Y.; compound monocular; C. 1910. (AFIP 49448 - 60-4713-35)

The modified, rounded form horseshoe base and the pillar of this instrument (Fig. 235) are cast in one piece; the pillar is capped with an inclination joint. The 5-inch-long limb is curved with rounded edges and has a screw fine adjustment at the top. The 4-inch-square stage has a central aperture and screw-in substage with a double iris diaphragm. The 2-inch mirror is

on a swinging arm. The body tube is 4 inches long, has a back rack, a graduated drawtube, and triple nosepiece. It is 12 inches high when closed, and has a black finish with brass trim.

The only accessory is a mechanical stage. It is signed, "Bausch & Lomb Optical Co., Rochester, N. Y., 87143." This model, "Stand FFS," was introduced before 1911 and discontinued prior to 1926. ■

Fig. 236. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1910. (AFIP 49193 - 60-4713-164)

The 3-inch iron tubular pillar is screwed to the horseshoe base of this instrument (Fig. 236). The stage is 3-3/8 inches square; beneath the stage is a fixed tube with substage condenser and diaphragm; the 2-inch double mirror is on a swinging tailpiece.

There is a 3-1/2-inch tubular limb and angular arm with a double milled-head pinion; the fine adjustment is at the top of the limb. The body tube is 4 x 1-3/16 inches, has a rack and pinion coarse adjustment, and a drawtube. The base and the pillar are black and all other parts brass; it is 11 inches high when closed.

Accessories are two objectives. It is signed, "E. Leitz, Wetzlar, 139129." This model was introduced before 1894; before 1911 the base was modified; it was discontinued about 1914. ■

Fig. 237. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1910. (AFIP 337708 - 60-4713-311)

The 6-1/2 x 4-inch horseshoe base of this instrument (Fig. 237) and the pillar are cast in one piece. The gimbal with 1-7/8-inch double mirror is attached to the 2-inch swinging tailpiece. The 4-inch-square stage has a 1-3/8-inch central aperture and a complete substage. The 6-inch curved limb has a side fine adjustment.

The 4-inch-long body tube has a graduated drawtube, rack and pinion coarse adjustment, and a triple nosepiece. When closed it is 11-1/2 inches high. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., No. 111172." The only accessory is a Spencer mechanical stage. ■

The horseshoe base of this instrument (Fig. 238) is 5-1/2 x 4-1/2 inches, and screwed to it is a 2-3/4-inch-high cylindrical pillar. The

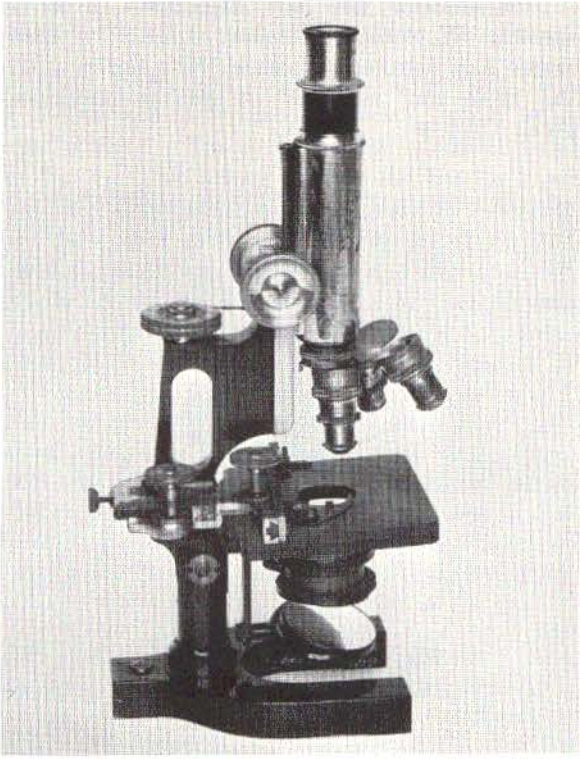

Fig. 238. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1910. (AFIP 613457 - 60-4713-87)

handle-type limb is 3 inches long with a micrometer screw fine adjustment at the top. The stage is 4-1/2 x 5-1/2 inches, incurved at the back, has a 1-1/4-inch central aperture, a mechanical stage, substage condenser, and a diaphragm. The gimbal for the 2-inch double mirror is screwed to the swinging tailpiece.

The 4-1/4-inch-long body tube has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. When closed it is 12-1/2 inches high and is finished in black with brass components. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 61018." (Donated by Dr. J.R. Schumaker) ■

The 6 x 4-1/8-inch horseshoe base and 2-inch-high pillar of this instrument (Fig. 239) are cast in one piece; the curved limb with fine adjustment at the top is connected by a compass joint to the pillar, and has a 2-1/2-inch arm attached to its upper section. The stage is 4-1/8 x 4-5/16 inches, has a 1/2-inch central aperture, and a fixed tube with Abbe condenser and iris diaphragm. The gimbal for the 1-7/8-inch mirror is attached to a 2-inch swinging tailpiece.

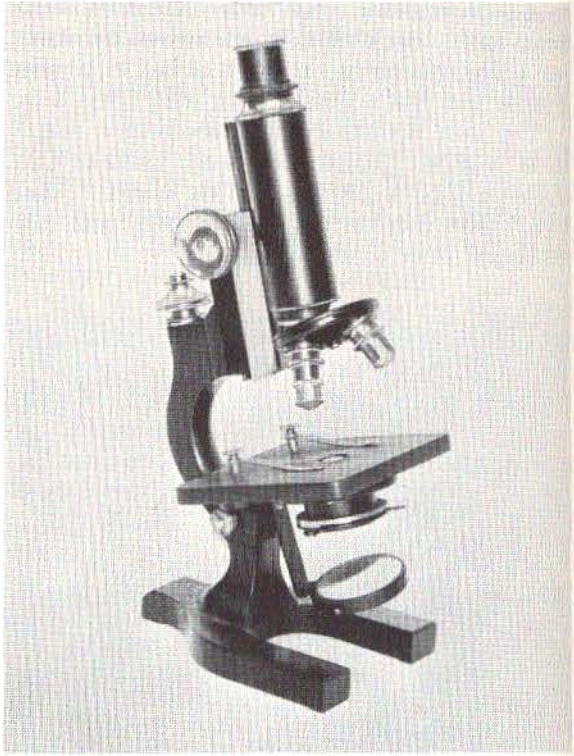

Fig. 239. Spencer Lens Co., Buffalo, N.Y.; compound monocular; 1911. (AFIP 49192 - 60-4713-2)

The body tube is 4-1/2 inches long, has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. When closed it is 12-1/4 inches high. It is signed, "Spencer Lens Co., Buffalo, N.Y., 14170, A.M.M." This model, "No. 65H," was introduced in 1911 and was still listed in the catalogue in 1920. ■

This model, No. 60H (Fig. 240), when it was introduced, represented a radical change in construction from the 1904 model. This instrument has a folding tripod base with a spread of 4-1/4 x 6-1/4 inches. The curved limb is 5 inches long and has a side fine adjustment with a millimeter scale on the right side. The 4-1/4 x 3-1/2-inch stage has a 1-1/4-inch aperture and a substage condenser. The gimbal for the 2-inch double mirror is screwed to a swinging tailpiece.

The 4-inch-long body tube has a graduated drawtube, a rack and pinion coarse adjustment, and a triple nosepiece. Height is 11-1/2 inches. It is signed, "Spencer Lens Co., Buffalo, N.Y., 25704, A.M.M." ■

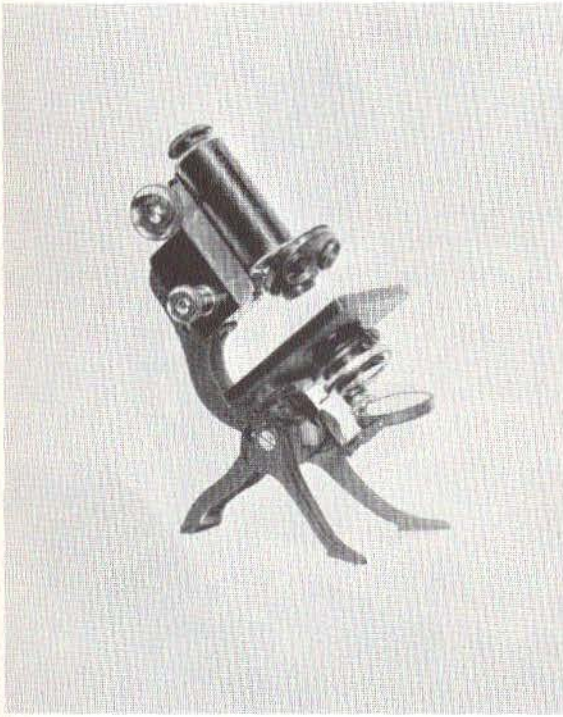

Fig. 240. Spencer Lens Co., Buffalo, N.Y.; compound monocular; C. 1912. (AFIP 954 - 60-4713-362)

AFIP 49447. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1912. *Not illustrated.*

This instrument is very similar to several other instruments by the same maker in the Collection. Differences are that this model has an all-black finish, the limb is rectangular and straight to the arm, and it has no ring handle. It is known as the "Stand BHP" model, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 88413." (Donated by Bausch & Lomb Optical Company) ■

AFIP 49444. F. Koristka, Milan, Italy; compound monocular; C. 1912. *Not illustrated.*

This instrument is a duplicate of that in Fig. 233 (AFIP 17377) by the same maker; this model was made about 1912. It is signed, "F. Koristka, Milano, 21104." ■

AFIP 16732. F. Koristka, Milan, Italy; compound monocular; C. 1912. *Not illustrated.*

This instrument is a duplicate of that in Fig. 233 (AFIP 17377) by the same maker. It is signed, "F. Koristka, Milano, 21110." ■

AFIP 17781. F. Koristka, Milan, Italy; compound monocular; C. 1912. *Not illustrated.*

This instrument is a duplicate of that in Fig. 233 (AFIP 17377) by the same maker. It is signed, "F. Koristka, Milano, 21147." ■

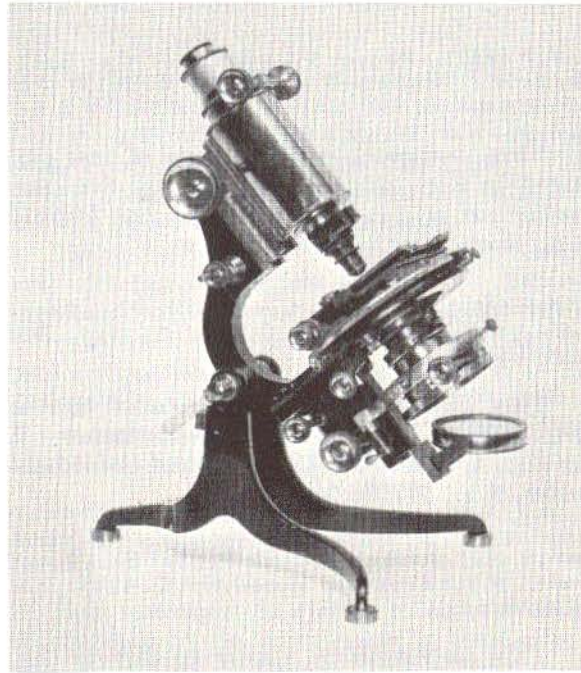

Fig. 241. Harry K. Harring, Washington, D. C.; compound monocular; 1913. (AFIP 41695 - 60-4713-328)

The base of this instrument (Fig. 241) has a spread of 11-1/4 x 8-3/4 inches. The 6-inch curved limb is attached to the base by a lever lock cradle joint, and has a side fine adjustment.

There is a 5-1/4-inch-diameter concentric, revolving stage with a mechanical stage; the substage has a rack and pinion motion. The 2-3/16-inch double mirror is on a slide attached to a swinging bar.

The body tube is 4-3/4 inches long and 2-1/8 inches in diameter; it has a back rack, a rack and pinion drawtube, with an additional drawtube. The nose has an adaptor for a sliding objective. It is 12-1/2 inches high and has a black finish with brass trim.

Harry K. Harring, an instrument maker at the U. S. Bureau of Standards, designed and made this microscope over a period of seven years for his own personal use; the lenses, oculars, and the condensers are factory made. It is signed, "H. K. Harring." (Donated by Mrs. Harry K. Harring) ■

AFIP 517754. Spencer Lens Co., Buffalo, N.Y.; compound monocular; C. 1914. *Not illustrated.*

This instrument is a duplicate of that in Fig. 240 (AFIP 954) by the same maker. It has an accessory mechanical stage and an ocular. It is signed, "Spencer, Buffalo, USA, 67189." ■

AFIP 68621. Bausch & Lomb Optical Co., Rochester N.Y.; compound monocular; C. 1915. *Not illustrated.*

This instrument is a duplicate of that pictured in Fig. 225 (AFIP 49421) by the same maker. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 117072." ■

AFIP 68622. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1915. *Not illustrated.*

This instrument is a duplicate of that in Fig. 225 (AFIP 49421) by the same maker. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 117076." ■

AFIP 482. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1915. *Not illustrated.*

This instrument is similar to that in Fig. 225 (AFIP 49421) by the same maker. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 117081." ■

AFIP 483. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1915. *Not illustrated.*

This instrument is similar to that in Fig. 225 (AFIP 49421) by the same maker, but is all black. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 117083." ■

The horseshoe base of this instrument (Fig. 242) is 7 x 4-1/2 inches and supports the 3-1/4-inch-high cylindrical pillar capped by an inclination joint. The 6-1/2-inch-long limb is of the handle type and has a side fine adjustment. The 4-1/2-inch-diameter circular stage has a mechanical stage, a 1-1/4-inch central aperture, and a rack and pinion substage.

The 4-1/2-inch-long body tube is 2-3/16 inches in diameter, has a quadruple nosepiece, and a rack and pinion coarse adjustment. When closed it is 12-1/2 inches high, and is the "Stand IC" model. It is signed, "Carl Zeiss, Jena, Germany, N. 85023." ■

Fig. 242. Carl Zeiss, Jena, Germany; compound monocular; C. 1916. (AFIP 44 - 66-1545-2)

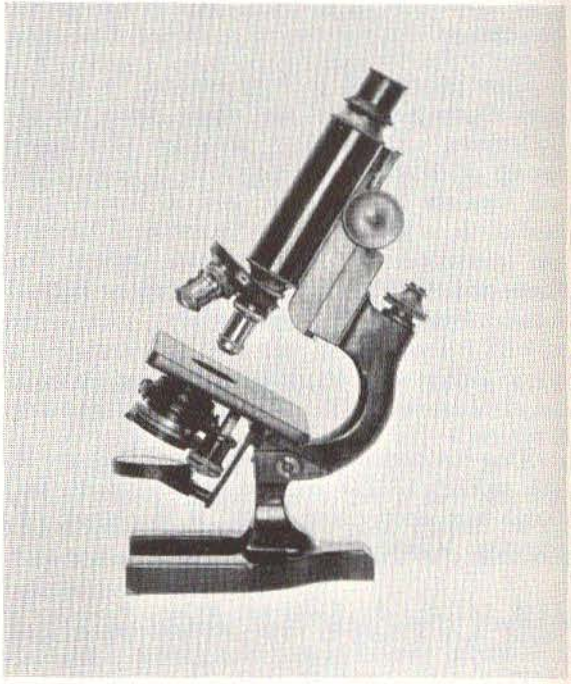

Fig. 243. Spencer Lens Co., Buffalo, N.Y.; compound monocular; C. 1916. (AFIP 517750 - 60-4713-442)

The 6 x 4-1/4-inch horseshoe base of this instrument (Fig. 243) and the pillar are cast in one piece; screwed to the pillar is the swinging tailpiece that holds the gimbal and 2-inch double mirror. The 4-5/16 x 4-3/16-inch stage has a 1-1/4-inch central aperture and a complete substage condenser.

The 4-inch curved limb has a screw fine adjustment at the top. The 4-1/2-inch-long body tube has a graduated drawtube, a rack and pinion coarse adjustment, and a triple nosepiece. When closed it is 11 inches high, and is signed, "Spencer Lens Co., Buffalo, N.Y., 26641." (Donated by Dr. Russel P. Sherwin) ■

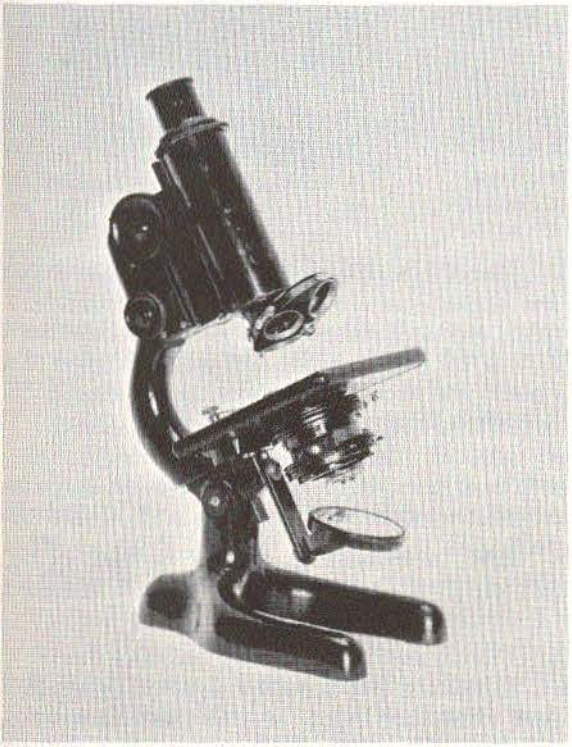

Fig. 244. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1917. (AFIP 52 - 60-4713-377)

This all-black instrument (Fig. 244) has a 6-1/4 x 4-inch rounded horseshoe base cast in one piece with the pillar. The gimbal with 1-7/8-inch double mirror is attached to a 2-inch-long swinging tailpiece. The 4-inch-square stage has a 1-3/8-inch central aperture, and a complete substage. The 6-inch curved limb has a side fine adjustment.

The 4-inch body tube has a graduated drawtube, rack and pinion coarse adjustment, and a quadruple nosepiece. When closed it is 11 inches high. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 126775, Med. Dept. U.S. Army." This model, "Stand FFS," was introduced in 1914 and was still listed in catalogues in 1929. ■

AFIP 485. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1917. *Not illustrated.*

The horseshoe base of this instrument is 6-1/2 x 4 inches. The stage is 4 inches square, has a 1-3/8-inch central aperture, a swing-out Abbe condenser, and an iris diaphragm. The 2-inch double mirror and gimbal are attached to the 2-inch-long swinging tailpiece.

The 5-3/4-inch curved limb has a 3-inch arm with brass side fine adjustment. The 4-inch-long body tube has a graduated drawtube, a brass rack and pinion coarse adjustment, and a triple nosepiece. When closed it is 11 inches high, and is the "Stand FFS" model. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 126837." ■

AFIP 19448. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1917. *Not illustrated.*

This instrument is similar to several other microscopes by the same maker in the Collection that are not illustrated. The only variation is that this instrument is entirely black japanned. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 125200, Med. Dept. U.S. Army." ■

AFIP 19449. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1917. *Not illustrated.*

This all-black instrument is also similar to several other instruments by the same maker in the Collection that are not illustrated. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 126373, Med. Dept. U.S. Army." ■

AFIP 16740. Spencer Lens Co., Buffalo, N.Y.; compound monocular; 1918. *Not illustrated.*

This instrument is a duplicate of that in Fig. 240 (AFIP 954) by the same maker. It is signed, "Spencer, Buffalo, USA, 46281." ■

The 6 x 4-1/4-inch horseshoe base of this instrument (Fig. 245) and the 2-inch-high pillar are cast in one piece. A 2-inch swinging tailpiece holds the 1-7/8-inch mirror and gimbal screwed to the pillar. A 4-1/8 x 4-3/8-inch

Fig. 245. Spencer Lens Co., Buffalo, N.Y.; compound monocular; C. 1918. (AFIP 740 - 66-1545-1)

stage has a 1-1/4-inch central aperture and substage condenser. The 5-1/2-inch-long curved limb has a side fine adjustment.

The 3-inch-long body tube has a graduated drawtube, rack and pinion coarse adjustment, and a triple nosepiece. When closed it is 11 inches high, and is the "No. 25H" model. It is signed, "Spencer, Buffalo, USA, 49962." ■

AFIP 78091. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1918. *Not illustrated.*

This instrument is a duplicate of several other microscopes in the Collection by the same maker. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 128549." ■

The modified horseshoe base of this instrument (Fig. 246) is 5-1/4 x 7-1/2 inches, and is cast with the 2-inch-high pillar that has a trunnion and cradle joint with lever control. The 6-3/4-inch-long limb has a double milled-head micrometer fine adjustment.

The 2-1/2-inch concentric stage plate is fixed to the limb, and the substage, on rack and pinion, and the 2-inch double mirror are attached to the stationary tailpiece. The square stage has a projection at the front for the forward adjustment, and there is a micrometer side adjustment.

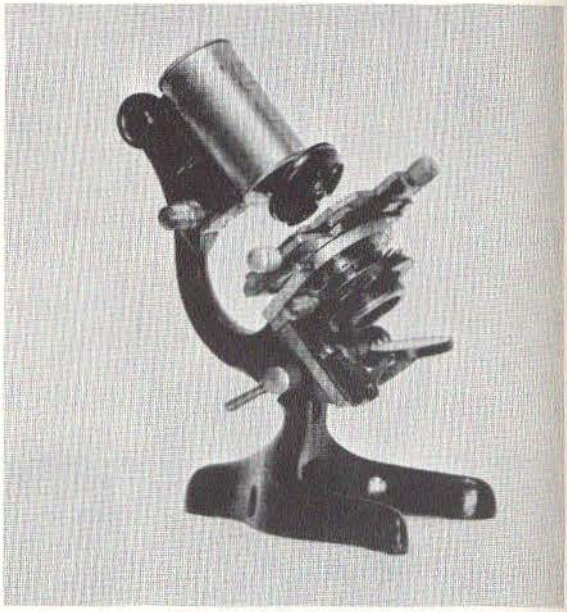

Fig. 246. F. Koristka, Milan, Italy; compound monocular; before 1920. (AFIP 49443 - 60-4713-354)

The 3-3/4-inch-long body tube has a rack and pinion coarse adjustment, a graduated drawtube, and a triple nosepiece. It is the "Model A," is 14 inches high, and was designed principally for photomicrography. It is signed, "F. Koristka, Milano, No. 33229." ■

AFIP 49445. F. Koristka, Milan, Italy; compound monocular; before 1920. *Not illustrated.*

This instrument is similar to that in Fig. 228 (AFIP 67) by the same maker. It is signed, "F. Koristka, Milano, No. 33198." ■

The 5-3/4 x 4-3/4-inch rounded-type, modified horseshoe base of this instrument (Fig. 247) and the pillar are cast in one piece; the 6-1/4-inch-long limb is curved and attached to the pillar by a lever clamp. The 4-3/8-inch revolving, circular stage is covered with vulcanite and has two centering screws; the swing-out substage is on a rack and pinion and has an Abbe condenser, two iris diaphragms, and a mirror on a dovetail slide.

The body tube is 4 x 1-1/4 inches, has a graduated drawtube, rack and pinion coarse adjustment, and triple nosepiece. There is a double milled-head pinion and a side fine adjustment on the arm. Parts of the instrument are brass and others black. Height is 11-3/4 inches, and it is a "Model B."

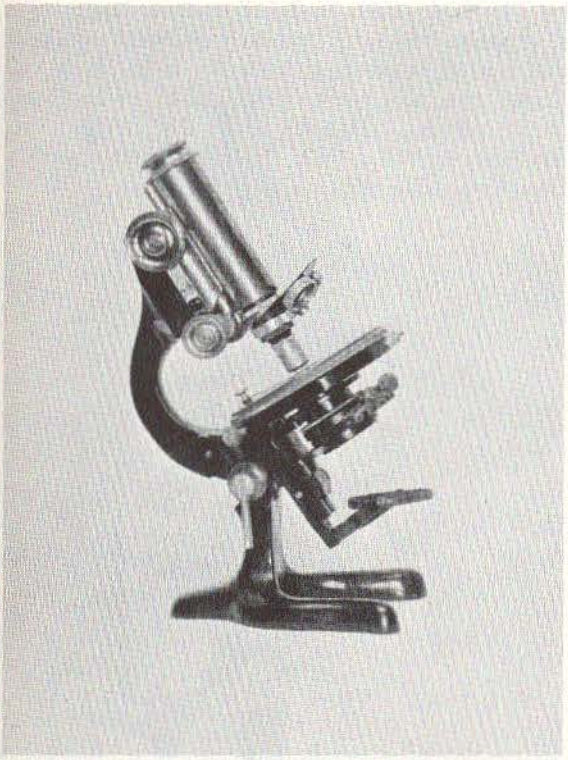

Fig. 247. Otto Himmler, Berlin, Germany; compound monocular; C. 1920. (AFIP 8307 - 60-4713-364)

Himmler was making microscopes in 1883 and using Seibert's fine adjustment; in 1890 he changed the type of fine adjustment and also the base. The stand of this model is similar to the Leitz "C" model of 1909. It is signed, "O Himmler, Berlin, 18457, B." ■

The horseshoe base of this instrument (Fig. 248) is 5-1/4 x 6-1/2 inches and is cast in one piece with the pillar; a cradle joint with lever control is at the top of the pillar. The limb and arm are cast in one piece, and a double milled-head micrometer fine adjustment is attached to the arm; the 4-1/4-inch stage plate is screwed to the limb. A substage condenser is attached beneath the stage plate. The 2-1/8-inch double mirror with gimbal on an arm is screwed to the tailpiece.

The 4-1/2-inch-diameter stage has a 1-1/8-inch central aperture. The 3-3/4-inch-long body tube has a graduated drawtube, rack and pinion coarse adjustment, and triple nosepiece. Height is 12-1/2 inches. It is signed, "Voigtlaender, Braunschweig, No. 51468." (Donated by Dr. Eugene G. Lipow) ■

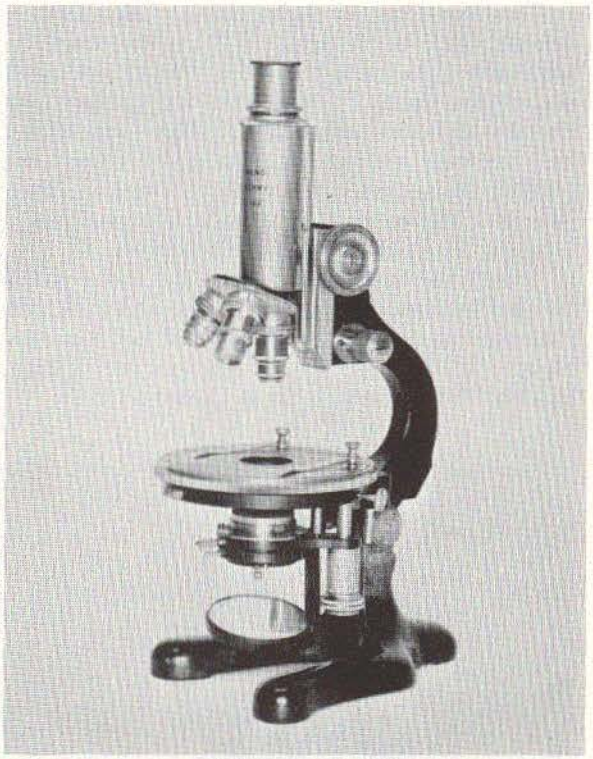

Fig. 248. Voigtländer, Braunschweig, Germany; compound monocular; C. 1920. (AFIP 517760 - 60-4713-45)

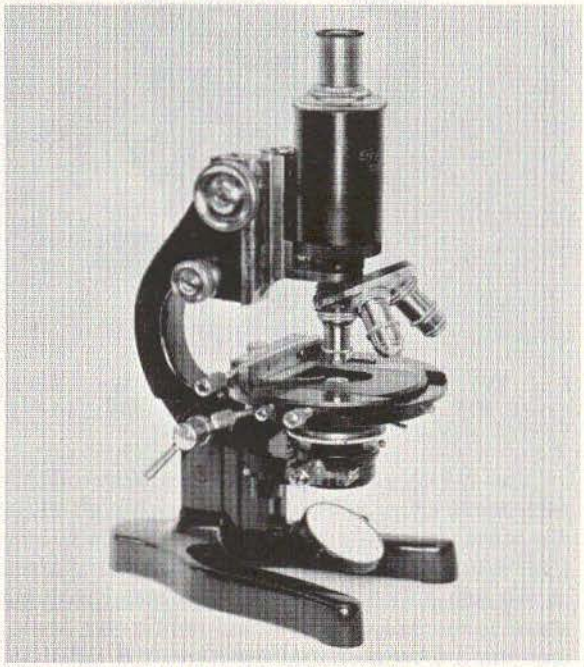

Fig. 249. Ernst Leitz, Wetzlar, Germany; compound monocular; 1920. (AFIP 910429 - 60-4713-169)

The modified horseshoe base of this instrument (Fig. 249) is 8 x 5-1/2 inches and supports the pillar capped by a lever controlled inclination joint. The 6-inch-long curved limb has a side fine adjustment. The stage plate is 4 inches in diameter, has a 4-3/4-inch revolving stage and a mechanical stage. There is a rack and pinion for the complete substage. It has a 2-inch-diameter double mirror.

The 3-1/2-inch-long body tube has a graduated drawtube, triple nosepiece, and rack and pinion adjustment. When closed it is 13 inches high. It is signed, "Ernst Leitz, Wetzlar, 265084." (Donated by Ernst Leitz) ■

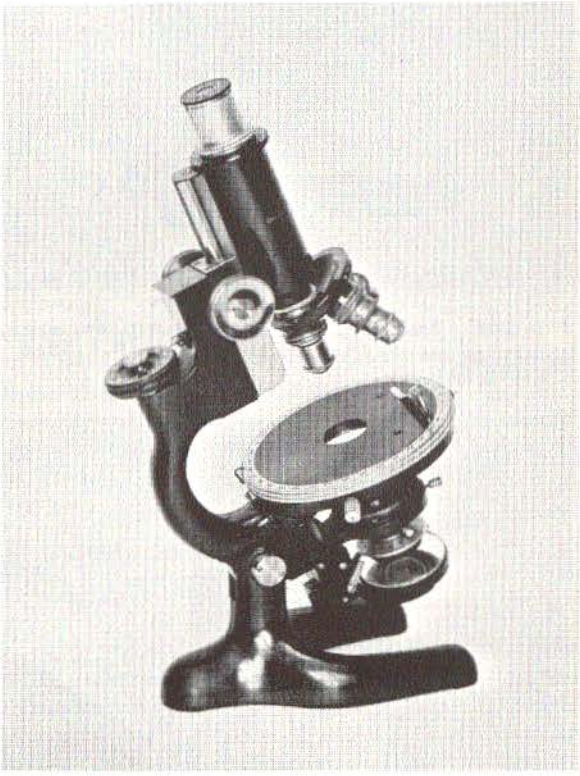

Fig. 250. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1920. (AFIP 517753 - 60-4713-48)

The 6-1/2 x 4-inch horseshoe base of this instrument (Fig. 250) and the 2-inch-high pillar are cast in one piece. The 5-7/8-inch-long limb has a micrometer screw fine adjustment at the top. The 4-5/8-inch-diameter revolving stage is encircled by a nickel centimeter scale, and has a 1-inch central aperture; the substage condenser has a rack and pinion control. A stationary tailpiece holds the gimbal for the 1-7/8-inch double mirror.

The body tube is 3-1/2 inches long, has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. It is black with brass trim, and when closed is 11 inches high. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 205679." (Donated by Bausch & Lomb Optical Company) ■

Fig. 251. Nachet, Paris, France; compound monocular; before 1920. (AFIP 17943 - 60-4713-382)

This instrument (Fig. 251) has a folding base with two rectangular sides, a hinged incurved side, and a lower hinged and divided plate that revolves; when opened the sides form a tripod, which supports the 1-3/4-inch-high tubular pillar capped by a joint.

The stage is 3-1/4 x 4 inches, is of the folding type, and has a fixed mechanical stage. There is a complete substage with screw motion, and a mirror on swinging arms; there is a continental limb with fine adjustment at the top. The body tube is 4-1/2 inches long with rack and pinion coarse adjustment and a drawtube. The instrument is the "Model 4," and is signed, "Nachet, 17 Rue St. Severin, Paris." ■

The three folding legs of this instrument (Fig. 252) form a tripod when opened, and support the 5-1/2-inch-long curved limb and arm of white metal, with a double milled-head pinion

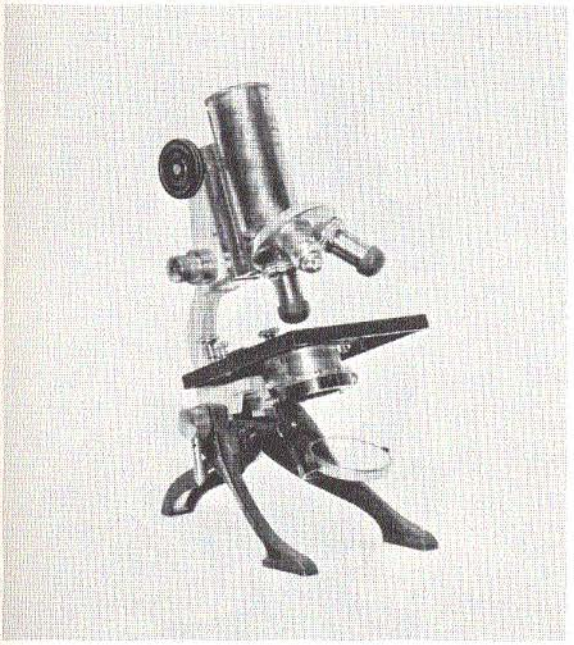

Fig. 252. F. Koristka, Milan, Italy; compound monocular; 1921. (AFIP 17371 - 60-4713-361)

and a side arm fine adjustment. The stage is 3-7/8 inches square and is fixed to the limb; there is a fixed substage, and the condenser swings downward.

There are two iris diaphragms and a 1-3/4-inch-diameter double mirror that swings on two arms. The 3-1/2-inch-long body tube has a rack and pinion coarse adjustment, and a draw-tube. The instrument is known as the "Model G," and is finished in black with white metal parts and brass trim. It is 10 inches high when closed. Accessories are 3 objectives; 2 oculars; triple nosepiece; and separate stage. It is signed, "F. Koristka, Milano, 33285." ■

The 3-3/4-inch-long body tube of this instrument (Fig. 253) is attached to a 6-inch-high vertical pillar stand with a rectangular base plate that may be fastened to a table by a screw clamp. The sleeve that holds the sliding tube is attached to the vertical pillar and may be clamped by a screw device.

Coarse adjustment is made by means of the sliding body tube, and the fine adjustment is by a screw attached to the stage. The single mirror is on a pin gimbal. The 3-inch upper section of the body tube is detachable. When closed it is 9 inches high, and is signed, "E. Leitz, Wetzlar, 218852." It is known as the "TPM" model. ■

Fig. 253. Ernst Leitz, Wetzlar, Germany; compound monocular; 1923. (AFIP 203 - 63-6532)

Fig. 254. Maker unknown; compound monocular; 1925. (AFIP 30240 - 60-4713-434)

This instrument (Fig. 254) has a double screw ring and sleeve. There is a thin plate

to which is fixed a 1-1/4-inch circular stage with spring clip; the single mirror is on a pin gimbal. It is supported by three 4-inch-high steel legs that screw to the ring; the body tube has an ocular and three objectives. It folds into a metal tubular case and is inscribed, "Junior; Made in Germany." ■

AFIP 517752. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1922. *Not illustrated.*

The horseshoe base, pillar, and limb of this instrument are cast in one piece. Screwed to the pillar is a 2-inch-long swinging tailpiece for the gimbal and 1-7/8-inch-diameter double mirror. The 4-inch-square stage has a 3/8-inch central aperture and a substage iris diaphragm.

The 5-1/2-inch-long body tube has a rack and pinion coarse adjustment and a double nosepiece. Height is 12 inches. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 159415." (Donated by Bausch & Lomb Optical Company) ■

AFIP 65847. Ernst Leitz, Wetzlar, Germany; compound monocular; C. 1926. *Not illustrated.*

The rounded-type, 7 x 4-3/4-inch, modified horseshoe base of this instrument and the 2-1/2-inch-high pillar are cast in one piece. The curved 5-3/4-inch limb is screwed to the pillar and has a screw fine adjustment. The stage is 4-1/2 inches square and covered with vulcanite; the substage has a rack and pinion motion; the double mirror is on a pin.

The body tube is 4 inches long, has a graduated drawtube, triple nosepiece, and rack and pinion coarse adjustment. It is 12 inches high. This "L" model superseded the "F" model before 1920 and was continued until after 1926. It is signed, "Ernst Leitz, Wetzlar, 291872." ■

The 5-1/2 x 4-3/8-inch modified horseshoe base of this instrument (Fig. 255) supports the 2-1/2-inch high pillar that is capped by a lever controlled inclination joint. The 6-inch-long curved limb has a side fine adjustment. The 3-3/4 x 2-3/4-inch stage plate has a 1-3/8-inch central aperture, a rack and pinion controlled mechanical stage and substage. The gimbal for the 2-inch double mirror is on a stationary tailpiece.

The body tube is 3-1/2 inches long, has a graduated drawtube, quadruple nosepiece, and rack and pinion coarse adjustment. It is 12 inches high when closed. Very similar to the Leitz "Stand A" microscope, it is signed, "Kremp, AG., Wetzlar, No. 7803, Made in Germany." (Donated by R.Y. Ferner Company) ■

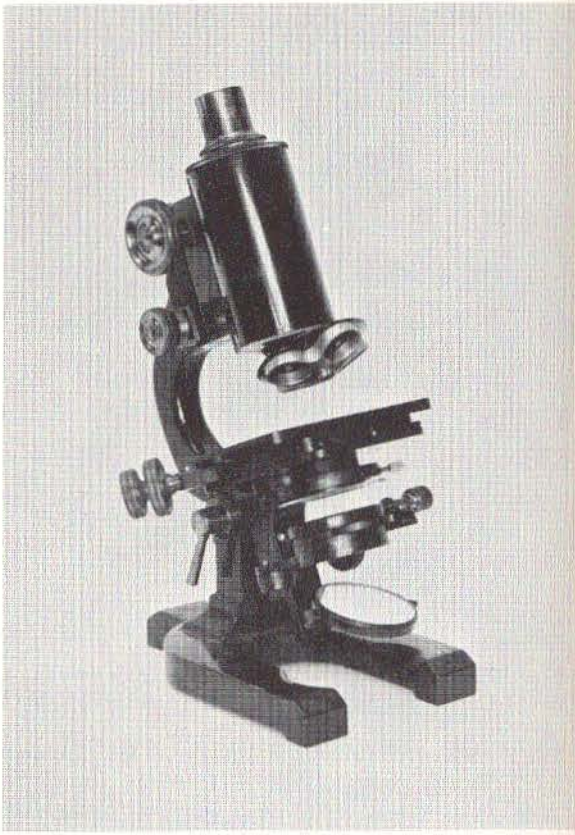

Fig. 255. Kremp Co., Wetzlar, Germany; compound monocular; before 1928. (AFIP 29095 - 60-4713-109)

AFIP 909197. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; C. 1931. *Not illustrated.*

The 6-1/2 x 4-inch horseshoe base of this instrument and the 2-inch-high pillar are cast in one piece. The curved limb is 6 inches long and has a side fine adjustment. The 4-1/2-inch-square stage has a 3/4-inch central aperture, a substage condenser, and diaphragm with rack and pinion control. The double mirror is 1-7/8 inches in diameter.

The body tube is 3-1/2 inches long, has a triple nosepiece, and rack and pinion coarse adjustment. It is black with nickel trim and 12 inches high when closed. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 232995." (Donated by Colonel Thurmond D. Boaz, Jr.) ■

AFIP 671. Wollensak, Rochester, N.Y.; compound monocular; before 1933. *Not illustrated.*

The 3-1/2 x 2-1/2-inch horseshoe base of this instrument and the 1-1/4-inch-high pillar are cast in one piece. It has a 2-1/8-inch-long curved limb at the top of which is a fixed tube and a single milled-head pinion. Beneath the stage is a 1-1/8-inch-diameter single mirror on a pin; the stage has a 1 x 3/4-inch cutout.

The body tube is 4-1/2 inches long and 3/4 inch in diameter; it has a back rack but no drawtube. It is 7-1/2 inches high, and is finished in black except for nickel trim. It is signed, "350 Power, Wollensak – Rochester, USA." ■

AFIP 337714. Tiyoda, Tokyo, Japan; compound monocular; C. 1940. *Not illustrated.*

This black microscope with nickel trim has a folding V-shaped base 4-1/2 x 6 inches, and supports a 2-1/2-inch-high pillar with an inclination joint. The 6-inch-long curved limb has a side fine adjustment. The folding stage is 3-3/4 x 3-3/8 inches, has a 7/8-inch aperture, and a complete substage. The gimbal for the 1-5/8-inch double mirror is on a stationary tailpiece.

The body tube is 3-1/2 inches long, has a graduated drawtube, rack and pinion coarse adjustment, and triple nosepiece. When closed it is 10-1/2 inches high. It is signed, "Tiyoda, Tokyo, MKQ, Pat. 214050, No. 5977." ■

This is a bullet comparison microscope (Fig. 256), the base of which measures 11 x 7-1/2 inches. It consists of two microscope tubes and a comparison eyepiece, built as a single unit for comparing objects held on two completely adjustable stages. In this form it is used for either visual examination or, with a suitably equipped camera, for permanently recording the microscopic image.

There is an iris diaphragm at the end of each microscope tube for use in increasing depth of focus or balancing the illumination when the two objects under examination do not reflect light equally. The tubes are built as a unit with the comparison eyepiece that is fitted with a prism assembly bringing the extreme horizontal limits of the two images well within

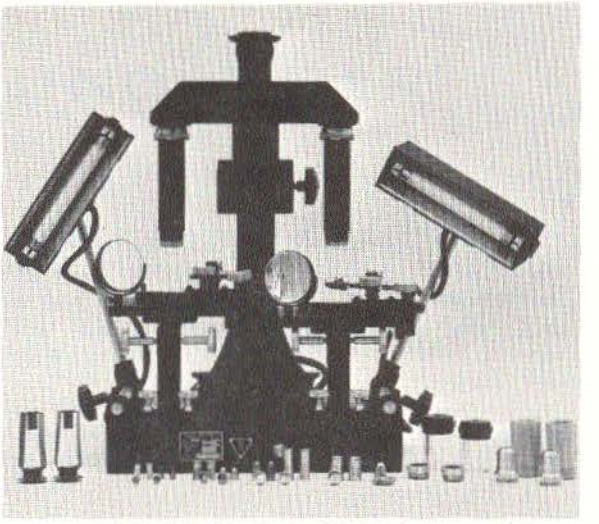

Fig. 256. Bausch & Lomb Optical Co., Rochester, N.Y.; compound monocular; 1957. (AFIP 518779 - 66-5478-5)

the eyepiece field. Visually the images are right side up and in their proper position; on the camera ground glass they are inverted and reversed. The eyepiece is threaded for focusing on the dividing line between the two fields.

Two independent stages hold the two objects to be compared. These stages are separately adjustable vertically by rack and pinion, and are fitted with ungraduated mechanical stages that permit horizontal movement from front to back and side to side.

Holders permit mounting and manipulating the bullets, shells, or other small objects that may be mounted in a horizontal position. These holders consist of rectangular metal stage plates that carry the ball-and-socket chucks permitting rotation of the objects both about a fixed center and on an axis. These rimmed chuck holders and the adjustments on the stages permit movement of the specimens in every direction. Each specimen is illuminated by a 4-watt fluorescent lamp in a universally adjustable reflector.

Accessories include 2 base plates with supports for bullet chucks; 8 bullet chucks for various caliber bullets; 2 shell chucks; 2 microscope mirrors with extension supports; and 6 objectives. It is signed, "Bausch & Lomb Optical Company, Rochester, N.Y., Serial No. PD 606." ■

Fig. 257. J. & W. Grunow, New Haven, Conn.; compound binocular; 1853. (AFIP 49227 - 60-4713-78)

The horseshoe base of this instrument (Fig. 257) with a Riddell body, is 7-1/2 x 4-3/8 inches, and supports the two 4-1/8-inch-high pillars that hold the 4 x 6-inch stage with central aperture. A 4-1/8-inch-long pillar arises from the rear of the base to which is attached a 3-inch-long cylindrical limb that contains a triangular bar with rack and pinion coarse adjustment, and an arm with a lever.

The 6-1/2-inch-long body tube fits into a 2 x 3 x 1-1/2-inch box, at the base of which is a short cone nose for the ocular; at the front and rear of the box are screw fine adjustments. A pinion attached to the two 4-7/8 x 1-inch bars outside the body tubes activates their horizontal movement.

When closed it is 16 inches high, and is signed, "Invented by Prof. J. L. Riddell, University of Louisiana; Made by Grunow Broths., New Haven, Conn." (Donated by Mrs. J. L. Riddell) ■

AFIP 34251. Joseph Zentmayer, Philadelphia, Pa.; compound binocular; 1860-61. *Not illustrated.*

This instrument is a duplicate, except for the binocular tube, of the Zentmayer microscope in Fig. 103 (AFIP 49119); it is also a duplicate of two other instruments in the Collection by the same maker that are not illustrated. It is signed, "Made by Jos. Zentmayer, Philadelphia, No. 5." ■

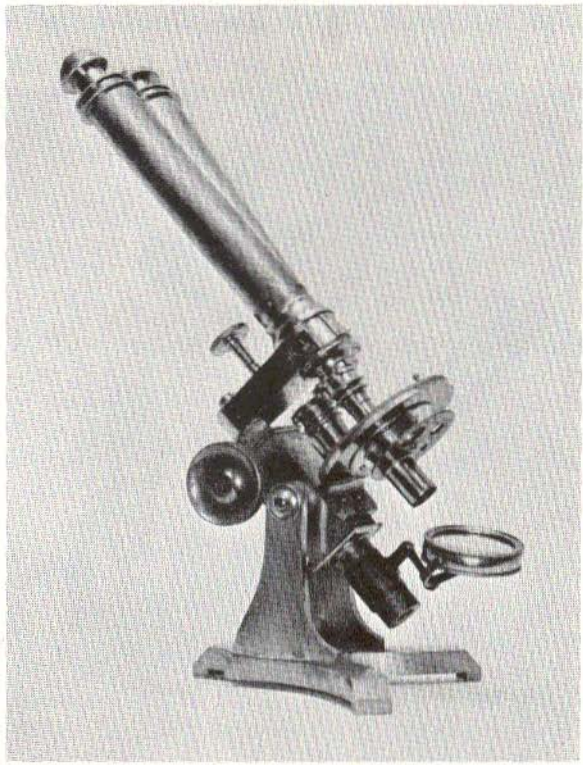

Fig. 258. Charles Collins, London, England; compound binocular; after 1865. (AFIP 49235 - 60-4713-330)

The 5-1/2 x 6-1/4-inch claw-footed base of this instrument (Fig. 258) supports the two 4-inch-high pillars with trunnion and rectangular limb. The tubular tailpiece supports the arm and gimbal for the 2-1/2-inch double mirror. The limb has a triangular bar with rack and pinion; at the top of the bar is a 4-inch Ross-type arm with long lever screw adjustment.

There is a circular revolving stage with a spring slide holder; beneath the stage is a tube for a disc of diaphragms and polarizer tube. The double body tube screws to the arm that carries the prism box and the screw nose for the double nosepiece. The drawtubes have a sliding bar adjustment. It is all brass and 18 inches high.

The rectangular prism box, a principal feature of this model, was devised by Dr. G. Harley of London. In addition to the Wenham prism there is also a Nicol prism with a space between. This instrument is one of the earliest models made by Collins; in 1871 he adopted the rack and pinion to the drawtubes, and a large mechanical stage. Original models were on a Ross-type stand; before 1879 a Jackson-type stand was made available. It is signed, "Chas. Collins, Optician, 77 Gr. Titchfield Str., London." ■

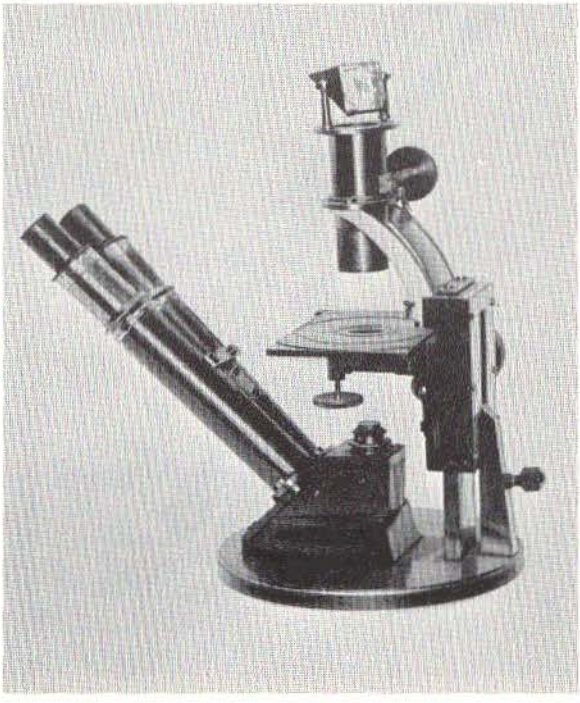

Fig. 259. J. & W. Grunow, New Haven, Conn.; compound binocular; 1867. (AFIP 49228 - 60-4713-404)

The circular base of this inverted-type instrument (Fig. 259) is 6-9/16 x 1/2 inch, and the rectangular pillar is 6 x 7/16 x 3/8 inch and has a double vertical rack and a block pillar at the back. The 4 x 2 x 1-inch limb with a single milled-head vertical pinion moves on the pillar. At the top of the limb is a double curved arm with oval plate and tube with single milled-head pinion carrying a rack tube with oval plate and two small pillars supporting a cased prism.

The stage plate is 3 x 2-1/2 inches, is fixed to the limb, and has a 7/8-inch central aperture. Beneath the stage plate at the right there is a fine adjustment micrometer screw. The prism box is 2 x 3-1/2 inches, and has two prisms fixed to the base.

The tubes are 6-3/8 x 1-1/8 inches and screw to the prism box at an angle; the drawtubes have an adjustable bar; the right drawtube is graduated. When closed it is 9-1/2 inches high. It is signed, "J. & W. Grunow, New York." The instrument is said to be the first and only attempt up until then to produce the inverted microscope in binocular form, and was made expressly for Major General George H. Thomas of the United States Army in 1867. (Donated by Maj. General George H. Thomas) ■

The triangular base of this instrument (Fig. 260) is 7-5/8 x 5-1/4 x 1/2 inch, and supports a pillar, 3-5/8 x 4 inches, that is incurved at the top to 1-1/8 inches; it is hinged to the base at the back by two screws in the post. In the center of the base is a raised perforated bar for inclining the body tube.

The 3-1/4-inch circular stage plate is hinged to the pillar. There is a 6-inch-long tubular limb at the lower end of which a stud fits into perforations in the central bar; on the upper end is a triangular bar with rack and a double milled-head pinion. The 3-3/4-inch-long arm is fixed to the upper limb; there is a micrometer long lever fine adjustment at the back. In front of the arm are the binocular tubes and the prism box. At the lower end of the limb is a 1-3/4-inch-diameter mirror and gimbal on a sliding case with arm.

There is a concentric glass top stage on the stage plate with a movable brass upper stage with slide-holding grooves. The body tubes are 8 x 1-1/4 inches; the drawtubes have a milled-head rack and pinion. Height is 14 inches. It has an accessory bull's-eye condenser on a stand. It is signed, "R. & J. Beck, London,

Fig. 260. R. & J. Beck, London, England; compound binocular; C. 1868. (AFIP 47637 - 60-4713-133)

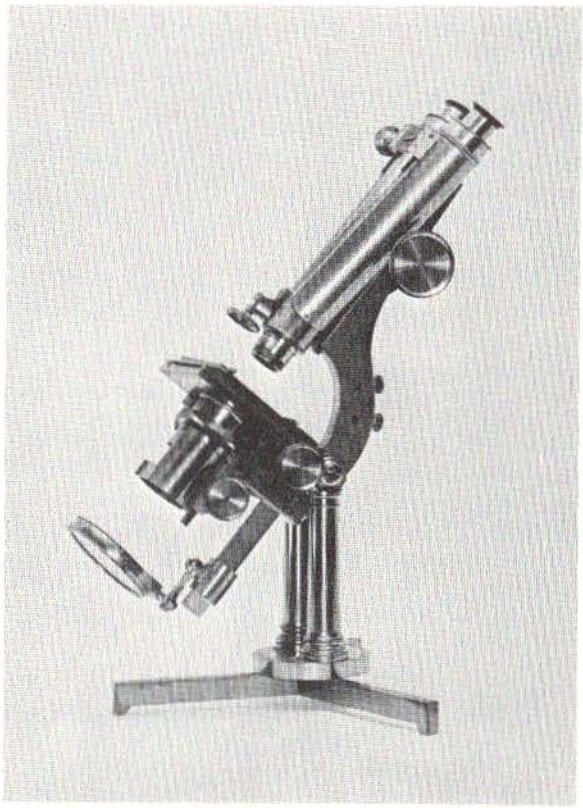

Fig. 261. R. & J. Beck, London, England; compound binocular; C. 1868. (AFIP 49232 - 60-4713-302)

5191." This model was introduced in 1864, and was also made in monocular form. (Donated by Mr. R. D. Murray) ■

This instrument (Fig. 261) has a folding tripod base, and a 3-1/2-inch revolving plate from which arise two 5-inch cylindrical pillars. There is a Jackson-type 9-inch-long curved limb with a double milled-head pinion on a trunnion attached to the pillars.

The rectangular 3-1/4 x 4-inch stage plate, fixed to the limb, has a rack and pinion mechanical stage; beneath the stage is a substage. There is a rack and pinion and sliding case with a 2-3/4-inch-diameter double mirror on a triangular bar.

The binocular body tubes have rack and pinion drawtubes and at the base a sliding prism box; there is a short lever fine adjustment in front. Height is 19 inches, and it is signed, "R. & J. Beck, 31 Cornhill, London, 5222." The stand for this model was either a solid or folding tripod in 1851. Before 1870 a rectangular or circular stage with rack and pinion, or White's lever mechanical stage, was optional; the Wenham binocular tubes date from between 1860 and 1864. ■

This instrument (Fig. 262) has a reversed claw-footed base with two 4-1/2-inch-high pillars; an 8-inch Lister limb is screwed to the pillars. The lower end of the limb is tubular and has a sliding case with arm and gimbal and a double mirror.

The 3-3/4-inch circular stage has a black glass stage plate with concentric motion, a movable object holder, and a revolving disc of diaphragms. There is a rack and pinion coarse adjustment, and the fine adjustment is a short lever screw in front of the tubes. The binocular tubes are 8-1/2 inches high and have a transverse bar for adjustment of the drawtubes. When closed it is 14 inches high. It is signed, "H. Crouch, 54 London Wall, London, 422." When introduced in 1868 it was advertised as "the best low priced instrument on the market." ■

Fig. 262. Henry Crouch, London, England; compound binocular; C. 1869. (AFIP 49233 - 60-4713-323)

AFIP 65. Henry Crouch, London, England; compound binocular; C. 1869. *Not illustrated.*

This instrument is a duplicate of that in Fig. 262 (AFIP 49233) by the same maker. It is signed, "H. Crouch, 54 London Wall, London, 425." ■

AFIP 49237. Charles Collins, London, England; compound binocular; C. 1870. *Not illustrated.*

This instrument is a duplicate of that in Fig. 258 (AFIP 49235) by the same maker. It is signed, "Chas. Collins, Optician, 77 Gr. Titchfield Str., London." ■

AFIP 66. Charles Collins, London, England; compound binocular; C. 1870. *Not illustrated.*

This instrument is a duplicate of that in Fig. 258 (AFIP 49235) by the same maker. It is signed, "Chas. Collins, 77 Gr. Titchfield Str., London." ■

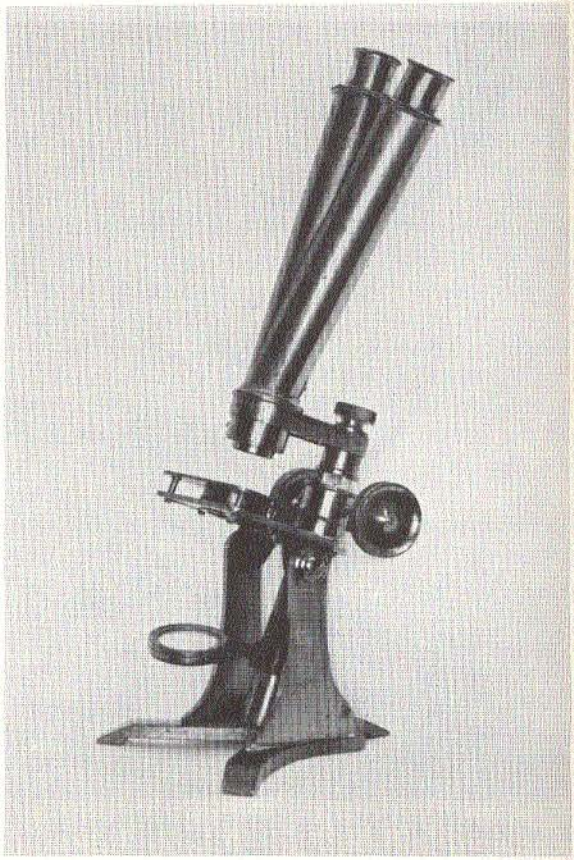

Fig. 263. Maker unknown; compound binocular; after 1870. (AFIP 167 - 60-4713-120)

A claw-footed base supports the two 4-inch-high uprights of this instrument (Fig. 263). Its 7-inch-long tubular limb has an inner triangular bar with rack and double milled-head pinion and a trunnion joint; there is a 1-1/4-inch double mirror on a sliding case.

The 4 x 3-inch stage plate is fixed to the limb, and the arm has a long lever fine adjustment. The condenser tube has been reversed and an extra stage on studs has been added. The 7-1/2-inch-long body tubes screw to the 3-1/2-inch arm and have a dovetailed Y-shaped bar to move the drawtubes. It is 15 inches high and is signed, "Stereoscopic Co., Optical Department, 110 Regent St., W"; there is no record to indicate that this company made microscopes. The instrument has a Ross-type base, and is similar to a model by Charles Collins that sold for about fifty dollars. The altered stage also bears a similarity to those in illustrations of a model by Collins. No reference to the Y-shaped bar to move the drawtubes has been found in the literature. ■

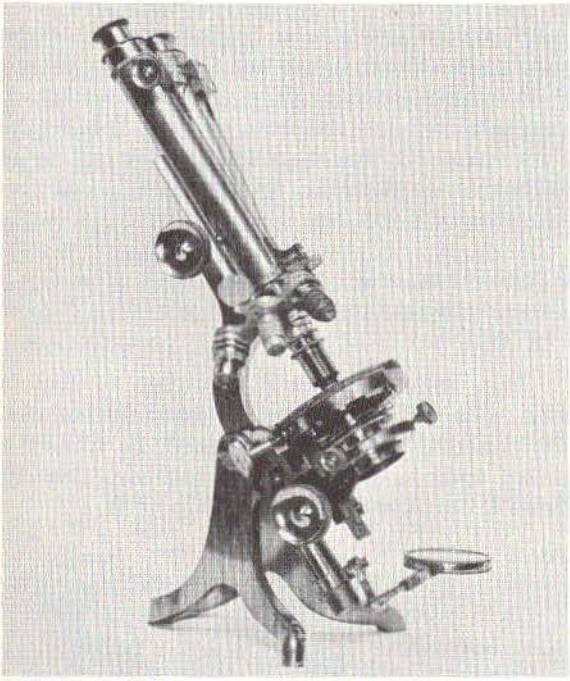

Fig. 264. Henry Crouch, London, England; compound binocular; C. 1870. (AFIP 517761 - 60-4713-357)

This instrument (Fig. 264) has an English base with a spread of 6 x 5-1/4 inches. It has a pivot arm and gimbal with a double mirror 2-1/4 inches in diameter. The curved limb is 8-1/2 inches long and has a rack and pinion coarse adjustment. The stage is circular and 4 inches in diameter and has a central aperture 1-1/2 inches in diameter; there is a substage condenser.

The binocular body tubes are 9 inches long, with drawtube rack at the front. Between the body tube and the objective is a double nosepiece. When closed it is 18 inches high. Accessories are 2 oculars. It is signed, "Henry Crouch, London; Agents, James W. Queen & Co., Philadelphia, 1656." (Donated by St. Mary's Hospital, Decatur, Illinois) ■

AFIP 61. R. & J. Beck, London, England; compound binocular; C. 1871. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker with the exception that this model is black with brass trim. Accessories are 2 objectives; 4 oculars; stage forceps; and a double nosepiece. It is signed, "R. & J. Beck, London, 6659." ■

AFIP 49230. R. & J. Beck, London, England; compound binocular; C. 1872. *Not illustrated.*

This instrument is a duplicate of that in Fig. 261 (AFIP 49232) by the same maker, except that this model has a solid tripod base and the stage is concentric and rotating. Accessories include objectives; oculars; camera lucida; analyzer; polarizer; and erecting tube. It is signed, "R. & J. Beck, 31 Cornhill, London, 6807." ■

AFIP 62. R. & J. Beck, London, England; compound binocular; C. 1872. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker. Accessories include 2 objectives; 4 oculars; stage forceps; bull's-eye on stand; and a double nosepiece. It is signed, "R. & J. Beck, London; J.W. Queen & Co., Agents, Philadelphia & New York." ■

AFIP 63. R. & J. Beck, London, England; compound binocular; C. 1873. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker, with the exception that this model is black with brass trim. It is signed, "R. & J. Beck, London, 7051; J.W. Queen, Agents, Philadelphia & New York." ■

AFIP 49234. R. & J. Beck, London, England; compound binocular; C. 1878. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker. It is signed, "R. & J. Beck, London & Philadelphia, 8505." ■

AFIP 202. R. & J. Beck, London, England; compound binocular; C. 1878. *Not illustrated.*

This instrument is a duplicate of that in Fig. 261 (AFIP 49232) by the same maker. It is signed, "R. & J. Beck, London & Philadelphia, 8524." ■

AFIP 168. R. & J. Beck, London, England; compound binocular; C. 1878. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker, with the exception that this model has a solid base, no depression, no central bar, and the upper stage has been replaced with a heavy

concentric mechanical stage. Accessories are 2 oculars and a mechanical stage. It is signed, "R. & J. Beck, 8508, London & Philadelphia." ■

AFIP 64. R. & J. Beck, London, England; compound binocular; C. 1878. *Not illustrated.*

This instrument is a duplicate of that in Fig. 260 (AFIP 47637) by the same maker, with the exception that this model has a solid base, no depression, and no central bar. It is signed, "R. & J. Beck, 8509, London & Philadelphia." ■

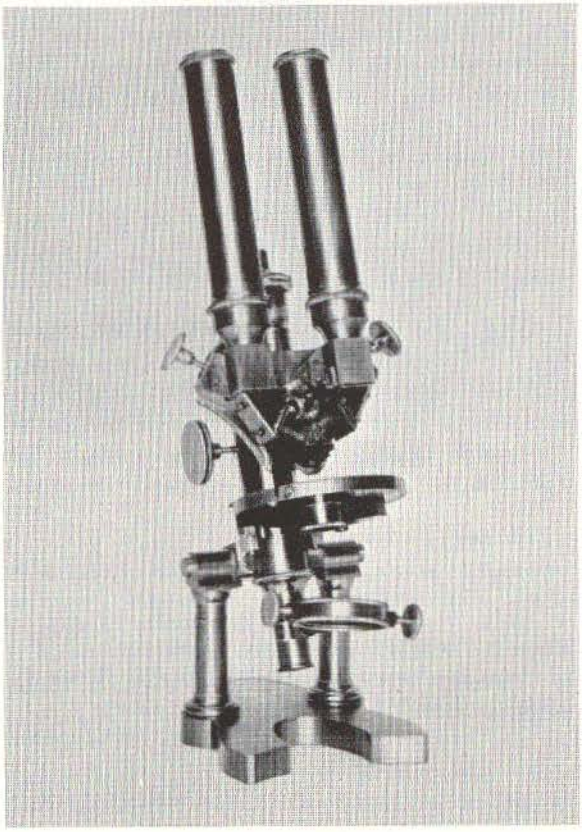

Fig. 265. Nachet & Son, Paris, France; compound binocular; before 1879. (AFIP 49238 - 60-4713-23)

The 6 x 4-1/2-inch modified horseshoe base of this instrument (Fig. 265) supports the two tubular 2-3/4-inch-high pillars to which is screwed the 3-inch-long tubular limb. It has a small tubular tailpiece with fixed arm, pin gimbal, and 1-5/8-inch double mirror. The limb has a double milled-head pinion and an inner triangular bar with rack; a short arm carries the fine adjustment.

The 3-5/8-inch-diameter circular stage has a slide holder and a tube beneath for a cylinder diaphragm. Prism boxes are attached to the arm with milled heads to a ball-and-socket to separate the prisms; two vertical 6-1/2-inch-long tubes fit the prism boxes. Height is 14 inches. It is signed, "Nachet et Fils, 17 Rue St. Severin, Paris." ■

AFIP 49239. John W. Sidle & Co., Lancaster, Pa.; compound binocular; C. 1880. *Not illustrated.*

This instrument is a duplicate of that in Fig. 149 (AFIP 135) by the same maker with the exception that this model is binocular rather than monocular. It is signed, "John W. Sidle & Co., Lancaster, Pa., Acme." ■

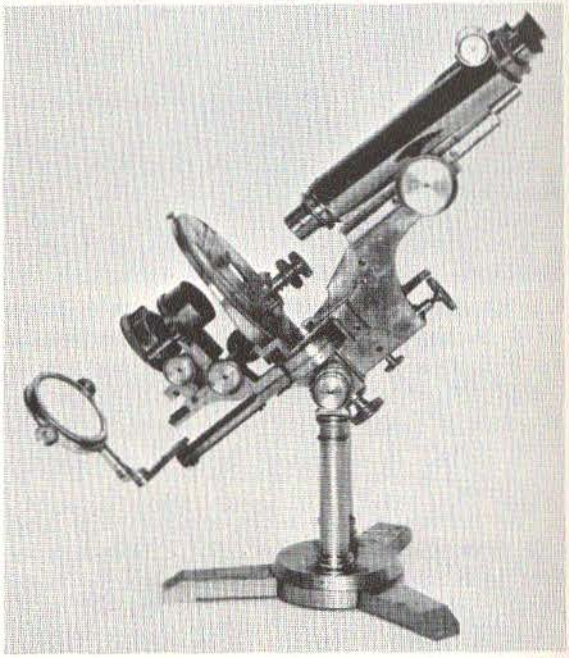

Fig. 266. Walter H. Bulloch, Chicago, Ill.; compound binocular; 1881. (AFIP 71791 - 60-4713-91)

This instrument (Fig. 266) has a tripod base with a 4-inch circular, revolving plate to which the two 5-1/4-inch-high tubular pillars are attached. A limb and angle arm are attached to the pillars by trunnion joint with two milled-head screws; there are two circular plates on swinging bars for the substage and mirror. The substage is on a rack and pinion and carries a Gillet diaphragm and a 2-5/8-inch-diameter double mirror with rack and pinion.

The 5-inch circular stage plate is fixed to the limb, and the arm carries a micrometer fine adjustment at the top with a double milled-head pinion. The 8-inch-long body tubes have a rack at the back and a prism box; the drawtubes have rack and pinion. Height is 18-3/4 inches.

There is a box of accessories including objectives; oculars; prisms; revolving diaphragm; stage forceps; and a monocular body tube. It is signed, "W. H. Bulloch, Chicago, Patd. 1879, 158." This model was introduced before 1876 and improved in 1877 and 1879. ■

AFIP 49236. Walter H. Bulloch, Chicago, Ill.; compound binocular; 1885. *Not illustrated.*

This instrument is a duplicate of that in Fig. 266 (AFIP 71791) by the same maker. It is signed, "W. H. Bulloch, Chicago, Patd. 1879, 381." ■

AFIP 170. R. & J. Beck, London, England; compound binocular; C. 1888. *Not illustrated.*

This instrument is similar to that in Fig. 139 (AFIP 69407) by the same maker. Differences are that this model is binocular rather than monocular, the glass stage plate has been replaced with one of hard rubber, there is no tube beneath the stage, the binocular tubes have a prism box, and the drawtubes have a sliding bar. It has a double nosepiece. It is signed, "R. & J. Beck, London, 14805." ■

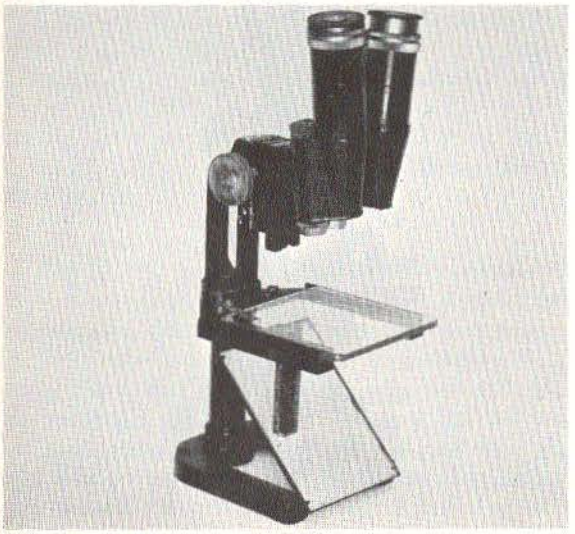

Fig. 267. Ernst Leitz, Wetzlar, Germany; compound binocular; C. 1895. (AFIP 956 - 60-4713-77)

The horseshoe base of this biobjective instrument (Fig. 267) is 4-3/4 x 4-1/4 inches. The 3-1/4-inch-high pillar has a fitting at the front for the 4-3/4 x 3-1/2-inch mirror. The 5-1/2 x 4-3/8-inch stage plate, incurved at the back, has a 4-inch-square glass plate that slides into grooves. It has a handle-type limb 4 inches long.

The binocular tubes are adjustable and have a rack and pinion coarse adjustment. When closed it is 13 inches high, and is signed, "E. Leitz, Wetzlar, Germany, 3071." This type microscope was invented about 1895 by Greenough, an American living in Paris. ■

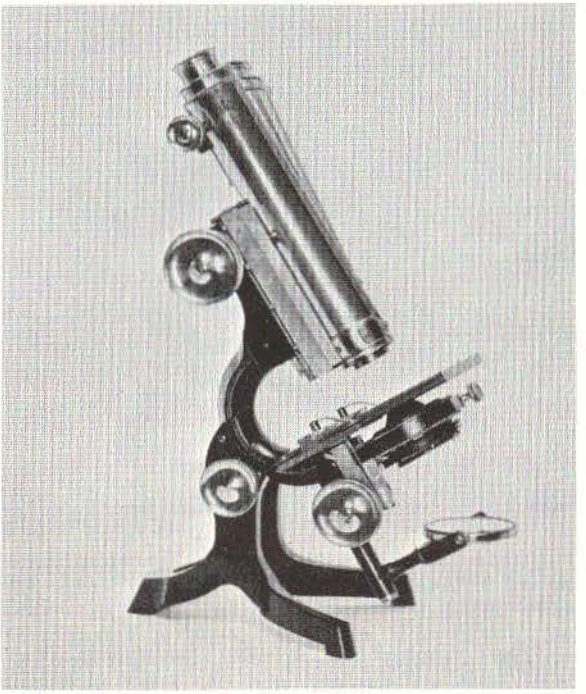

Fig. 268. James Swift & Son, London, England; compound binocular; after 1895. (AFIP 49240 - 60-4713-384)

This instrument (Fig. 268) has the typical Swift combination upright and tripod base 5-3/4 x 6 inches with flanges. A curved limb with grooves moves in the flanges and is held in position by a large milled-head screw; the upper part of the limb forms an arm that has a double milled-head pinion.

The stage is fixed to the limb and is 3-3/4 inches square and has a scale and slide holder; the complete substage is on a bar with rack and pinion. The mirror bar is tubular with a swinging motion and has a sliding case and arm and

a gimbal with a 2-inch double mirror. The fine adjustment is a screw on the left side of the arm.

The 8-inch-long body tubes have rack and pinion coarse adjustment, a prism box in the lower section, and a cone nose. The draw-tubes have rack and pinion at the back. When closed it is 13 inches high, and is signed, "J. Swift & Son, London, 14024 HY." ■

Fig. 269. Ernst Leitz, Wetzlar, Germany; compound binocular; C. 1899. (AFIP 49241 - 60-4713-182)

The tripod base of this instrument (Fig. 269) is 6 x 6 inches, and the 7-1/2-inch-long curved limb and the 4 x 4-1/2-inch stage plate are all cast in one piece. The 3-7/8-inch-square, vulcanite stage has a 3/4-inch aperture; there is a substage disc of diaphragms. The gimbal for the 2-inch-diameter double mirror is on a 2-inch arm screwed to the limb.

The 6-3/4-inch-long Greenough stereoscopic tubes have a rack and pinion coarse adjustment. When closed it is 12 inches high, and is signed, "E. Leitz, Wetzlar." ■

This corneal instrument (Fig. 270) has a 14-7/8 x 15-3/4-inch base with arm and chin rest. It has a sliding 9-inch-square plate in the base with a tripod foot and 7-inch-high pil-

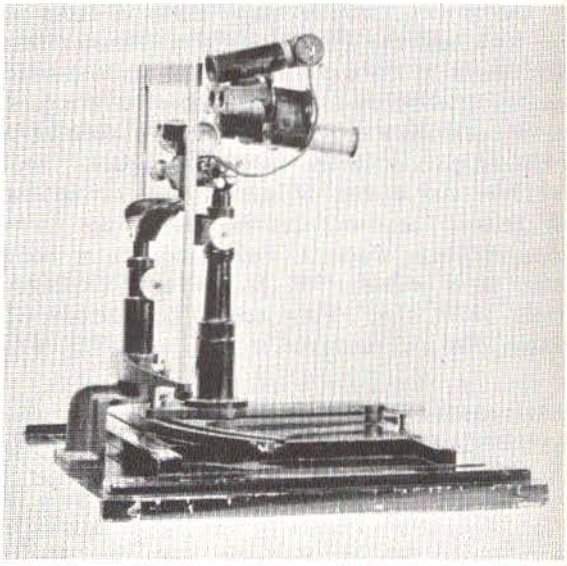

Fig. 270. Carl Zeiss, Jena, Germany; compound binocular; C. 1903. (AFIP 50 - 60-4713-425)

lar with rack and pinion for forward and backward motion. There is a tubular inner bar in the pillar with rack and pinion that carries the binocular tubes, prism box, and the electric lighting system. This system evolved into the slit-lamp microscope. It is signed, "Zeiss, Jena, No. 41687." ■

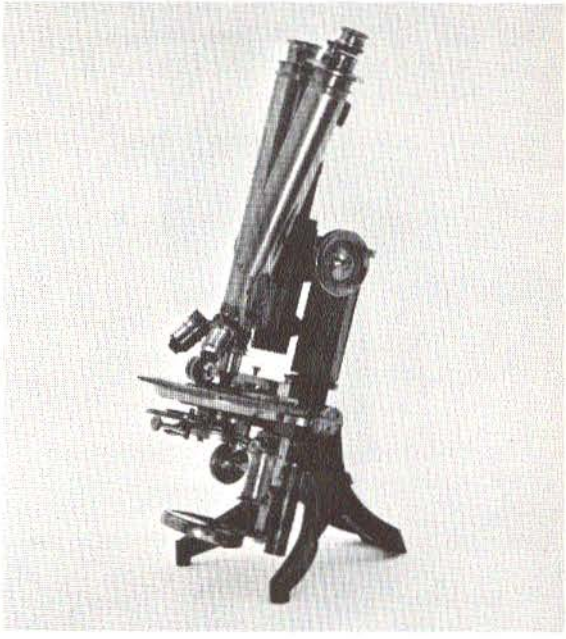

Fig. 271. J. Swift & Son, London, England; compound binocular; C. 1910. (AFIP 518520 - 66-1545-3)

This instrument (Fig. 271) has a bent, claw-footed base with a spread of 5 inches in front and 6-3/4 inches from front to back. The base rises for 5-3/4 inches to form two pillars connected by a trunnion. The stage plate is 4-3/4 inches in diameter, has a complete substage, and a 5-1/2-inch-diameter revolving stage to which is attached a mechanical stage. A 1-1/2-inch-long arm for the gimbal and 2-3/8-inch double mirror is screwed to the casing that slides on the 3-inch-long tubular tailpiece.

The hexagonal limb is 3-3/4-inches long, and has a micrometer screw fine adjustment at the top. The binocular body tubes are 8-3/4 inches long, with rack and pinion coarse adjustment, and a triple nosepiece; the drawtubes also have rack and pinion coarse adjustment. When closed it is 17 inches high, and is signed, "J. Swift & Son, 81 Tottenham Court Rd., London." It is similar to the Petrological microscope pictured and described in Swift's 1910 catalogue. (Donated by Dr. Gustavus H. Klinck) ■

AFIP 35. Ernst Leitz, Wetzlar, Germany; compound binocular; C. 1919. *Not illustrated.*

The horseshoe base of this instrument is 6-1/2 x 4-1/2 inches and supports a 3-inch-high pillar with a double joint and clamping lever. The curved limb is 6-1/4 inches long and has a side fine adjustment. The 4-3/4-inch circular stage has a rotary motion. There is a rack and pinion coarse adjustment and a sliding screw fine adjustment.

The tubes are of the box type with prisms and parallel eyepiece tubes; they are interchangeable to monocular; the quadruple nosepiece is separate and removable. The 1-7/8-inch double mirror has a universal joint and a dovetail slide. It is signed, "Ernst Leitz, Wetzlar, 25, No. 198321." ■

The 6-1/2 x 4-1/4-inch horseshoe base of this instrument (Fig. 272) supports a 3-inch-high rectangular pillar that has a lever-controlled inclination joint. The limb is 6 inches long and curved, and the stage is vulcanite covered; the substage is complete with rack and pinion.

The usual iris diaphragm adjusts laterally and swings out; the mirror is adjustable and in two planes. The body tube has a prism system and two adjustable, parallel ocular tubes, rack and pinion coarse adjustment, and triple nosepiece. It is signed, "Pat. Jan. 5, 1915, Bausch & Lomb Optical Co., Rochester, N.Y., USA, 148002." ■

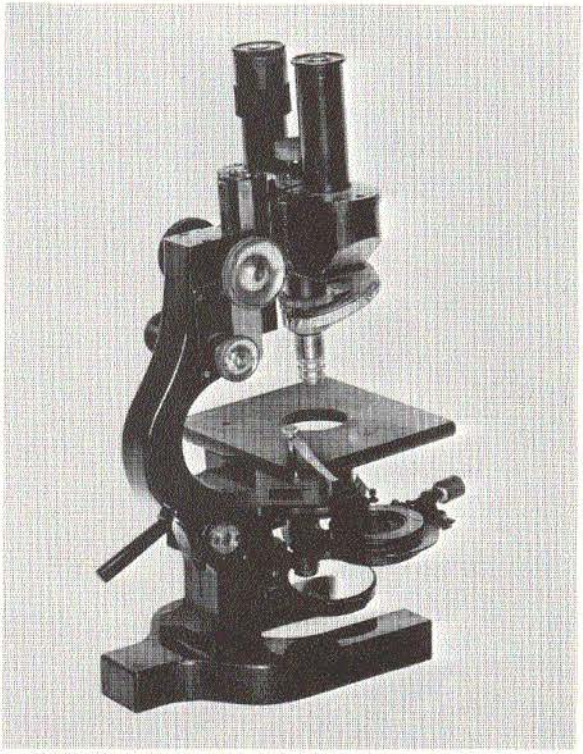

Fig. 272. Bausch & Lomb Optical Co.; Rochester, N.Y.; compound binocular; C. 1919. (AFIP 41 - 60-4713-34)

AFIP 49442. F. Koristka, Milan, Italy; compound binocular; before 1920. *Not illustrated.*

This instrument is a duplicate of that in Fig. 228 (AFIP 67) by the same maker, except that this model is binocular rather than monocular, and the body tube is a prism box with adjustable, parallel eyepiece tubes. It is signed, "N32477, F. Koristka, Milano." ■

The 6-1/4 x 4-inch horseshoe base of this instrument (Fig. 273) and the 2-inch-high pillar are cast in one piece. The curved limb is 6 inches long with a side fine adjustment. The circular, revolving stage is 6 inches in diameter, has a vernier scale at the outer edge, and a 1-1/4-inch aperture. A 7/8-inch slot for a mechanical stage extends for 4 inches across the front of the stage. A complete substage is on a rack and pinion. The double mirror is 2 inches in diameter.

The binocular body tubes are set into a prism box and have adjustable parallel oculars; there

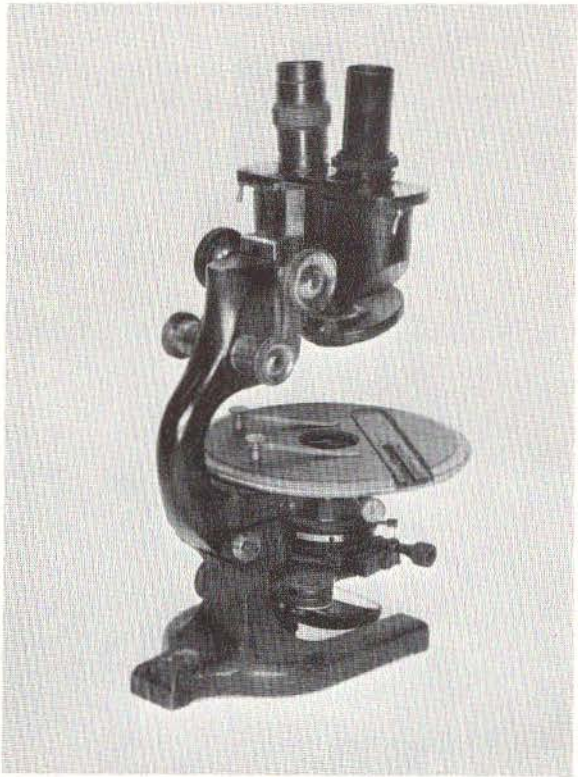

Fig. 273. Spencer Lens Co., Buffalo, N.Y.; compound binocular; C. 1920. (AFIP 654 - 60-4713-75)

is a triple nosepiece. When closed it is 12 inches high, and is signed, "Spencer, Buffalo, USA, 58114." ■

AFIP 699170. Spencer Lens Co., Buffalo, N.Y.; compound binocular; C. 1920. *Not illustrated.*

The horseshoe base of this instrument is 6 x 4-1/8 inches, and is cast in one piece with the 2-inch-high pillar. The curved limb is 5-5/8 inches long and has a side fine adjustment. The 4-5/8-inch-diameter revolving, circular stage has a mechanical stage and a complete substage with rack and pinion adjustment.

The body tube consists of a prism box, 2-5/8 x 3-1/2 inches, with adjustable parallel tubes for the oculars, a triple nosepiece, and rack and pinion coarse adjustment. When closed it is 12 inches high, and signed, "Spencer, Buffalo, USA, 58126." ■

AFIP 49242. Bausch & Lomb Optical Co., Rochester, N.Y.; compound binocular; 1922. *Not illustrated.*

The 6-1/2 x 4-1/2-inch horseshoe base of this instrument supports the 3-inch-high rectangular pillar with inclination joint. The 6-inch-long curved limb has a side fine adjustment. The revolving stage is 5 inches in diameter, has a mechanical stage and substage with rack and pinion motion. The gimbal for the 2-inch-double mirror is attached to the stationary tailpiece.

The body tube is a prism system with two parallel, adjustable oculars, a triple nosepiece, and a rack and pinion coarse adjustment. It is black with brass trim and 12 inches high when closed. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 160526." ■

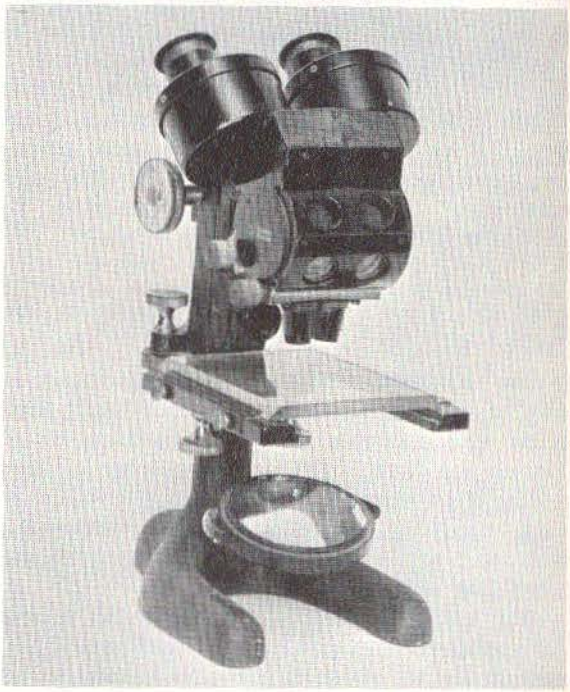

Fig. 274. Bausch & Lomb Optical Co., Rochester, N.Y.; compound binocular; C. 1925. (AFIP 517762 - 60-4713-359)

The horseshoe base of this biobjective instrument (Fig. 274) is 6 x 4 inches and is cast in one piece with the 2-inch-high pillar. The 3-1/2-inch-long limb is attached to the rear of the stage plate and has rack and pinion coarse adjustment. The stage plate is 6-1/4 x 4 inches, is incurved at the back, and has a 3-1/4 x 4-inch beveled glass stage. The paired objectives are mounted in a drum. Attached to the pillar is a gimbal for the 2-3/8-inch-diameter double mirror.

The binocular body tubes are 5-1/4 inches long and on a 3-1/2-inch curved arm. It is 10-1/2 inches high, and signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 233849." ■

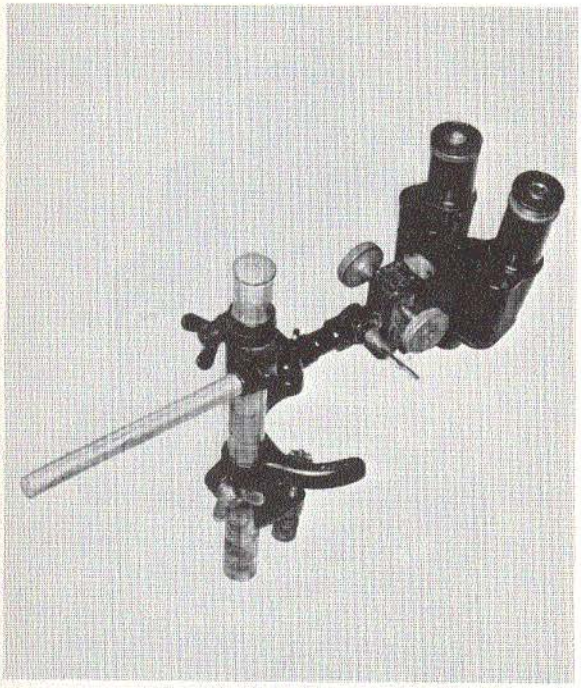

Fig. 275. Ernst Leitz, Wetzlar, Germany; compound binocular; 1925. (AFIP 71805 - 63-6534)

This biobjective instrument (Fig. 275) consists of a 12-inch-high vertical cylindrical rod with an adjustable table clamp. At the top of the rod a horizontal rod 6-1/4 inches long is attached with adjustable wing nuts, which in turn is connected to a 2-inch-long swivel joint that fits into the arm; there is a rack and pinion adjustment on the arm. The binocular body tubes are 4-1/4 inches long. It is signed, "E. Leitz, Wetzlar, Germany, 2624." ■

AFIP 910510. Spencer Lens Co., Buffalo, N.Y.; compound binocular; C. 1930. *Not illustrated.*

This instrument is similar to that in Fig. 278 (AFIP 910501) by the same maker. It has an Abbe N.A. 1.40 wide-angle condenser, iris diaphragm, and an oblique iris diaphragm. The vertical illuminator is on a quick change mount. It is signed, "Spencer, Buffalo, USA, 126383." (Donated by American Optical Company) ■

This instrument (Fig. 276) has a V-shaped base, 7-1/2 x 5-1/8 inches, that supports the 3-1/2 x 2-1/2 x 1/2-inch pillar. The 8-1/2-inch-long limb is curved to fit into the inclination joint, and has a side fine adjustment. The 4-1/2 x 4-3/4-inch stage has an adjustable micrometer stage, a 2 x 7/8-inch aperture, and

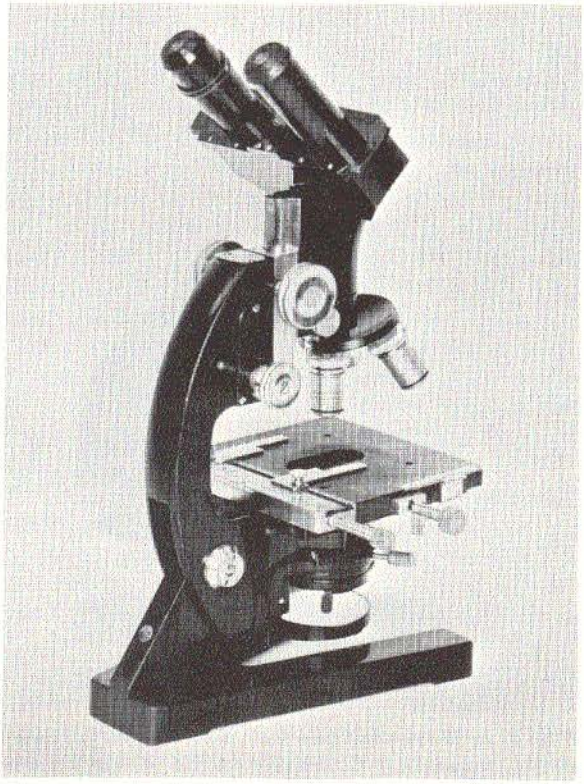

Fig. 276. Bausch & Lomb Optical Co., Rochester, N.Y.; compound binocular; C. 1930. (AFIP 517751 - 60-4713-46)

an adjustable forward and backward motion; a graduated scale is screwed to the right side of the stage. The substage condenser is on a rack and pinion. The double mirror is 2-1/8 inches in diameter.

The body tube is 3-1/2 inches long and has a rack and pinion coarse adjustment. The binocular ocular attachment fits into a slot in the body tube. When closed it is 13 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., USA, 230895." ■

AFIP 518716. Carl Zeiss, Jena, Germany; compound binocular; C. 1930. *Not illustrated.*

This corneal slit-lamp microscope has a 9-1/4-inch circular base. Arising from the base on a swivel joint is an 8-1/2-inch-long arm that supports the 12-inch-high pillar for the binoculars. A 6-inch-high pillar on the opposite end of the arm carries the chin rest and slit-lamp housing. There is a separate rheostat. It is signed, "Carl Zeiss, Jena, Germany, No. 35626"; the rheostat is marked, "No. 93811 B." (Donated by the American Ophthalmological Association) ■

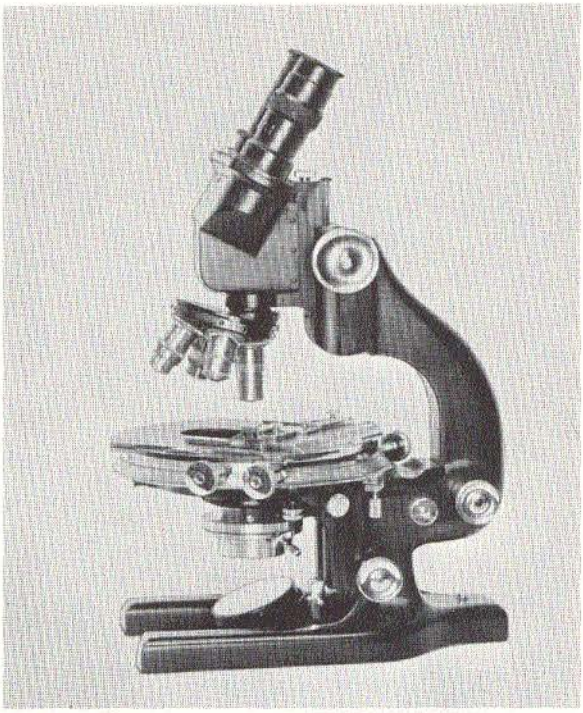

Fig. 277. Spencer Lens Co., Buffalo, N.Y.; compound binocular; C. 1930. (AFIP 910143 - 60-4713-448)

The 8-1/2 x 4-3/4-inch horseshoe base of this instrument (Fig. 277) and the 2-inch-high pillar are cast in one piece. The 8-inch-long curved limb has a screw fine adjustment at the lower end. The circular stage is 6-1/4 inches in diameter and circled by a centimeter scale, as is the adjustable mechanical stage; there is a complete substage on rack and pinion. The double mirror is 2 inches in diameter.

The adjustable binocular body tubes fit into a prism box. There is a quadruple nosepiece, rack and pinion coarse adjustment, and accessory monocular body tube. It is the "No. 5" model and is 12-1/2 inches high when closed. It is signed, "Spencer, Buffalo, USA, 252613." The American Optical Co. purchased the Spencer Lens Co. in 1935 and the Spencer name was changed to American Optical Co. in 1945. Microscopes made thereafter were signed, "Spencer" or "AO - Spencer." (Donated by American Optical Company) ■

This instrument (Fig. 278) is of unique construction in that the parts supporting the body are placed at the side away from the operator permitting easy access to the stage.

Salient features are the variable inclination

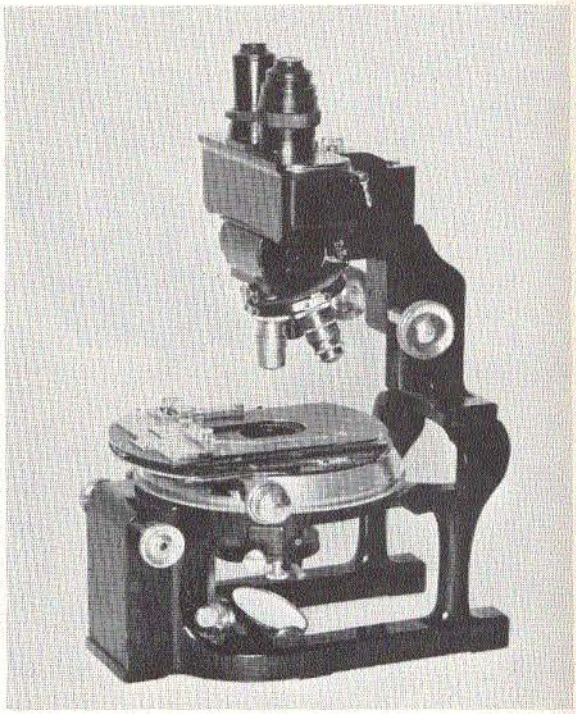

Fig. 278. Spencer Lens Co., Buffalo, N.Y.; compound binocular; 1932. (AFIP 910501 - 66-571-2)

of the binocular body and its ease of manipulation, the combination of single and double tube in one and the convenient shift from one to another, and the converging of the eyepiece tubes at the proper angle. Other features are the low fine adjustment, the convenient location of the concentric buttons on both sides of the stage near the fine adjustment button, the large plain stage for large objects, both movements of which are actuated by mechanical means, and the convenient location of the coarse adjustment. It is signed, "Spencer, Buffalo, 126380." (Donated by American Optical Company) ■

The 8 x 4-1/2-inch horseshoe base of this instrument (Fig. 279) and the 1-1/2-inch-high pillars are cast in one piece. The 7-1/2-inch curved limb has a side fine adjustment at the lower end. The stage is 5 x 5-1/4 inches, has a millimeter scale on each side, and a complete substage on rack and pinion. The gimbal for the 1-7/8-inch double mirror is on a stationary tailpiece.

The body tube is a prism system with two adjustable ocular tubes, a quadruple nosepiece, and rack and pinion coarse adjustment.

Fig. 279. Spencer Lens Co., Buffalo, N.Y.; compound binocular; 1932. (AFIP 634 - 60-4713-42)

When closed it is 13 inches high. There is an accessory monocular tube and mechanical stage. It is signed, "Spencer, Buffalo, USA, 126639." ■

AFIP 698949. Bausch & Lomb Optical Co., Rochester, N.Y.; compound binocular; C. 1935. *Not illustrated.*

The 7-1/2 x 4-1/2-inch horseshoe base of this stereoscopic instrument and the 2-inch-high pillar are cast in one piece. The 5-inch-long curved limb has a rack and pinion coarse adjustment. The 7 x 5-1/2-inch stage plate, incurved at the back, has a 4-inch square glass plate that slides into grooves. When closed it is 11 inches high, and is signed, "Bausch & Lomb Optical Co., USA, US Pat. 2,093,605." ■

AFIP 518946. Bausch & Lomb Optical Co., Rochester, N.Y.; compound binocular; 1937. *Not illustrated.*

This DDE research and photomicrographic microscope incorporates the suggestion of Dr. Lester W. Sharp of Cornell University and his associate, Dr. L.F. Randolph, of the U. S. Department of Agriculture and Cornell University, of placing the arm at the front of the instrument, so as to give free access to the object, stage, objectives, substage and mirror for greater convenience and comfort to the user. The rack and pinion adjustment is placed in a position away from the operator and carries both the binocular body and the fine adjustment. The fine adjustment mechanism carries only the nosepiece and objectives. The binocular body tube is inclined. To convert to monocular vision an operating head located at the front of the binocular is turned 90° and all light is directed into the right eyepiece.

The 6-inch-diameter circular, revolving stage carries mechanical movements in two directions. It is centerable by the usual centering screws and has a clamp to arrest the centering adjustment. A special slide with cross lines in a circle is included to aid in centering the stage. The mechanical movements have forward and backward adjustments by rack and pinion, and transverse adjustment by multiple screw. There are scales for all movements including a graduated circumference for degrees of rotation. The transverse adjustment may be removed to provide a large flat stage. A clamp arrests the backward and forward adjustment; another clamp arrests the rotation of the stage.

The complete substage has geared rack and pinion adjustment, and a supplementary condenser on a swing arm. The graduated iris diaphragm is rotatable and decenterable and may be swung out of optical axis to attach a polarizer. Accessories are a monocular body tube and 6 oculars. It is signed, "Bausch & Lomb Opt. Co., U.S.A., Pat. 1,860,430; 1,862,031; One Int. = 0.0025; WM39." ■

This instrument (Fig. 280) is a "No. 8 MLS Phase" model with an inclined binocular body. The converging eyetubes are adjustable for interpupillary distance and differences in eye refraction. The binocular body may be replaced with a monocular body for photomicrography.

The phase turret condenser unit includes three components, a standard Abbe N.A. 1.25 condenser, a rotating plate or turret with four removable annular diaphragms for phase contrast and one clear aperture for ordinary bright field microscopy, and an iris diaphragm mount.

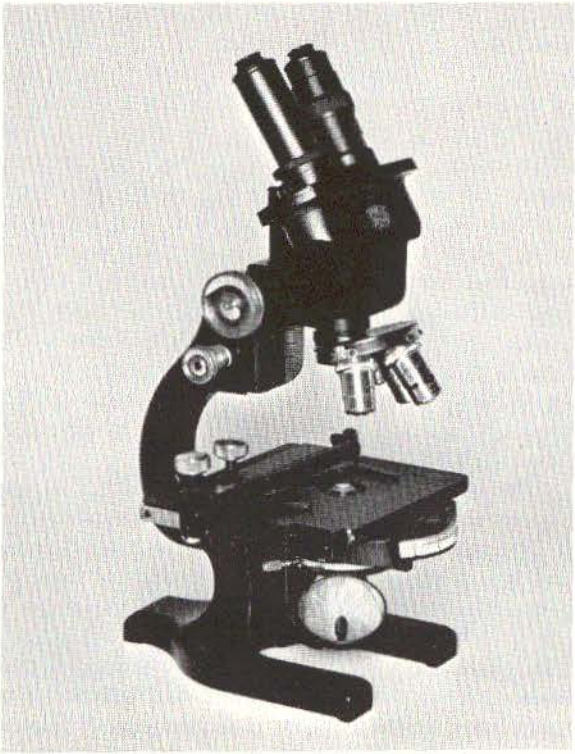

Fig. 280. American Optical Co., Buffalo, N.Y.; compound binocular; 1948. (AFIP 518551 - 66-571-1)

The complete condenser is centerable and each annular diaphragm is individually centerable to permit perfect concentricity with the diffraction rings in the objectives.

The square stage has a built-on mechanical stage. The stage controls are above the level of the stage and close to the fine adjustment and quadruple nosepiece. It is signed, "Spencer, Buffalo, 159588." (Donated by American Optical Company) ■

AFIP 699187. Officine Galileo, Milan, Italy; compound binocular; 1955. *Not illustrated.*

The 8-1/2 x 5-inch base of this instrument and the 2-1/2-inch-high pillars are cast in one piece. The 8-inch-long curved limb fits into the inclination joint on the pillars and has a micrometer side fine adjustment. The stage is 5-1/4 x 4-3/4 inches, has an attached mechanical stage, a 1-inch central aperture, and a rack and pinion substage condenser. The gimbal for the 2-inch double mirror is on a stationary tailpiece.

The body tube is 3-3/4 inches long, has a binocular attachment, a rack and pinion coarse adjustment, and a quadruple nosepiece. When closed it is 15 inches high. It is signed, "Officine Galileo, Opplem, N.Y., No. 125643." The agent for Officine Galileo was the Opplem Co., Inc. of New York City, and later of East Rutherford, N.J. ■

Fig. 281. American Optical Co., Buffalo, N.Y.; compound trinocular; 1961. (AFIP 518521 - 66-571-4)

This instrument (Fig. 281) comprises various parts that may be assembled as needed into various types of microscopes. It may be used with the arm and controls toward or away from the operator. The model number, X4TG - HAW, is indicative of the parts comprising the instrument, i.e., X - swing-in auxiliary condenser; 4 - built-in illuminator; T - trinocular body; G - graduated stage; H - 5, 10, 43, and 97x objectives; A - 5x oculars; and W - wide field oculars. Accompanying the instrument is a Model 350 voltage selector. The serial number is 465390, and it is signed, "AO - Spencer." (Donated by American Optical Company) ■

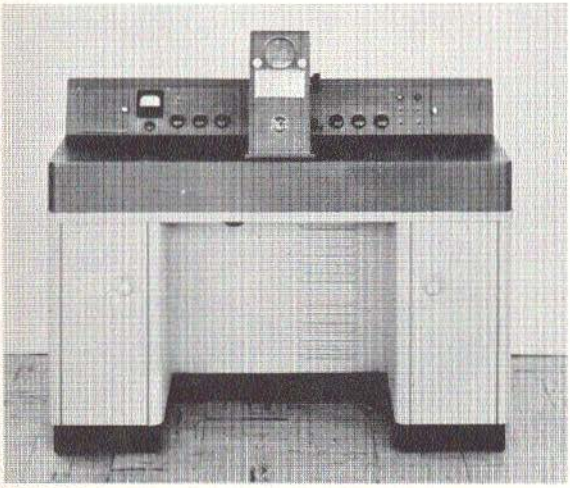

Fig. 282. Radio Corporation of America, Camden, New Jersey; electron microscope; 1943. (AFIP 518766-63-6558)

This instrument (Fig. 282) is designed for rapid analysis and has 100x more resolution than the light microscope. It is limited to two fixed magnifications with a minimum number of controls.

The console combines a work table, desk and microscope all in one unit. The resolving power is 100 angstroms (100 x light microscope); depth of focus 5μ; useful magnification to 50,000 diameters; built-in facilities for making micrographs and stereomicrographs; is completely self-contained; and has the advantage that several observers may view the image at the same time. It is called the "EMC," and is 30 inches high, 48 wide, and 29 deep. ■

In 1937 the German firm of Siemens initiated the production of electron microscopes with an electron source for 70 KV electrons, and between 1937 and 1945 the voltage was increased steadily up to 220 KV. Other important improvements were made during this time but the external design of the instruments remained essentially the same.

Shortly after the cessation of World War II hostilities in 1945, two of the Siemens electron microscopes were brought to the United States,

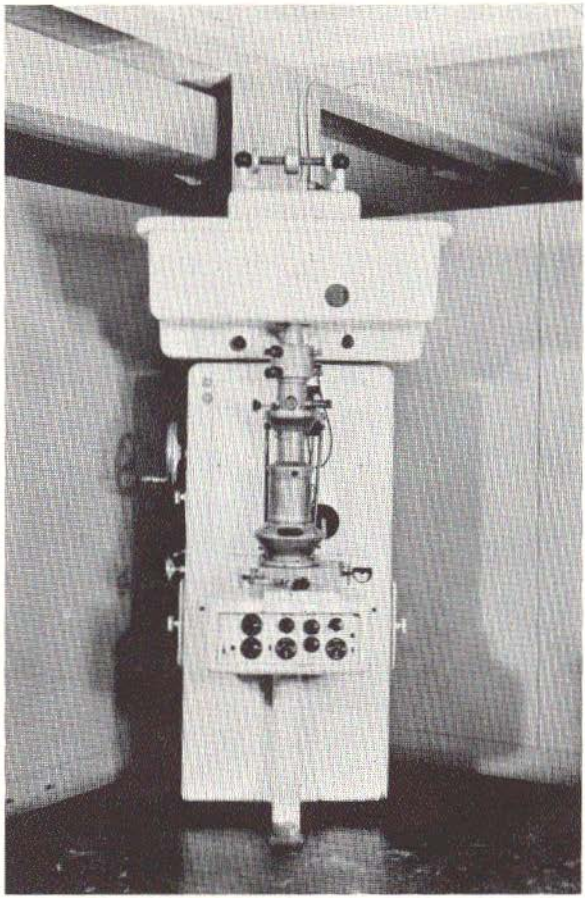

Fig. 283. Siemens Electric Co., Berlin, Germany; electron microscope; 1944. (AFIP 613496 - 58-5084-5)

but neither unit was complete. Subsequently, the U.S. Army Signal Corps Engineering Laboratories acquired the two instruments in 1948 and undertook to assemble a complete instrument from the combined components of the two units; one was the 80 KV type, the other 100 KV. The 100 KV model was chosen for rebuilding and is pictured in Fig. 283. The instrument has magnetic lenses, and was originally built by B. v. Borries and E. Ruska in 1944 at the Laboratory for Electron Optics of the Siemens Co. It was added to the Collection in 1955 through transfer from the Signal Corps. ■

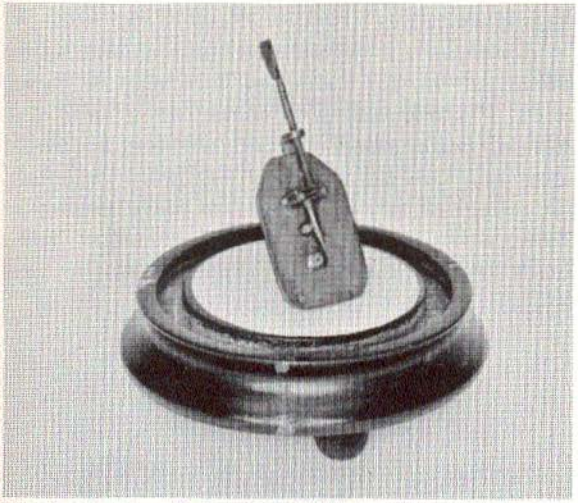

Fig. 284. John Mayall, Jr., London, England; reproduction of an original simple microscope made about 1673 by Antoni van Leeuwenhoek of Leyden, Holland; reproduced C. 1887. (AFIP 49150 - 60-4713-41)

This all-brass instrument (Fig. 284) consists of two plates, 1-3/16 x 3/4 inch, riveted together, between which is a 1/16-inch biconvex lens. At the bottom of the plate there is an L-shaped brace with a 1-3/4-inch screw extending from the top of the L to a block in the center of the plate. Inserted through the block is a 1/2-inch-long pointed screw where the object to be examined may be fixed.

In the illustration (Fig. 284) the instrument is pictured on a display stand. The original by van Leeuwenhoek is in the Museum of the University of Utrecht, Holland; van Leeuwenhoek did his pioneering work in microbiology with the aid of small simple microscopes such as this. (Donated by Mr. John Mayall, Jr.) ■

AFIP 332898. Bausch & Lomb Optical Co., Rochester, N.Y.; reproduction of an original simple microscope made about 1673 by Antoni van Leeuwenhoek of Leyden, Holland; reproduced in 1933. *Not illustrated.*

This instrument is similar to that in Fig. 284 (AFIP 49150) made by John Mayall, Jr. of London. (Donated by Mr. Thomas C. Stewart) ■

AFIP 613567. Instituut Voor Geschiedenis, Leyden, Holland; reproduction of an original simple microscope made about 1673 by Antoni van Leeuwenhoek of Leyden, Holland; reproduced C. 1956. *Not illustrated.*

This instrument is a duplicate of that in Fig. 284 (AFIP 49150). It is signed, "Copie, Leiden." ■

Fig. 285. Depovilly, Paris, France; simple; C. 1686. (AFIP 49151 - 60-4713-355)

This instrument (Fig. 285) has two engraved plates 2-3/4 inches long hinged at one end and joined to a turned ivory handle. Between the plates is a rotating brass wheel that projects beyond the edges of the plates and contains eight objects. Focusing is accomplished by altering the distance between the plates by means of a milled-edge wheel that also projects beyond the plates' edges.

The high-power lens is mounted in a circular setting in the upper portion of the front plate. There is a 1/4-inch aperture in the back plate opposite the lens that is covered with a movable shield with a 1/16-inch aperture. It is 5-1/2 inches long, and is signed, "Depovilly a Paris." ■

Fig. 286. John Mayall, Jr., London, England; reproduction of an original simple microscope made in Italy in 1686; reproduced in 1885. (AFIP 49152 - 60-4713-63)

The 4-1/2-inch-diameter base and 5-inch-high pillar of this instrument (Fig. 286) are turned from a single piece of dark wood. The objects are fixed on the edge of a 3-1/2-inch-diameter wooden vertical disc that rotates under the lens suspended above the disc; portions of the objects are thereby brought into the optic axis.

A peg with screw action extends through the pillar near the base, and a spring that carries the lens holder is attached at the top. By means of a cord that winds on the peg, the lens holder is lowered or raised by the spring to proper focus. (Donated by Mr. John Mayall, Jr.) ■

AFIP 49153. John Mayall, Jr., London, England; reproduction of an original simple microscope made about 1696 by Stephen Gray of London; reproduced in 1885. *Not illustrated.*

This simple water microscope consists of an object holder, 3-1/2 x 1-1/4 inches, pivoted on a lens carrier, 4-1/2 x 1/4 inches. A thumbscrew functions through the plate to allow the object carrier to be focused under the water lens; a slot permits the carrier to pass the screw, under which a disc acts as a washer.

The lens carrier is sprung from the object holder to follow the movement of the screw. There is a concavity at the lens carrier of 1/8 inch diameter with a 1/32-inch hole through the 1/8-inch plate. On the opposite side is a corresponding concavity of 1/16 inch diameter. Drops of water may be placed in these concavities to form a biconvex lens of unequal curvature.

There is a 1/10-inch cylindrical hole in the plate and in this a shallow lens may be formed with a small amount of water, or a fluid containing organisms, until both surfaces are deeply convex. This permits visibility of the organisms by means of rays of light that have undergone total reflection within the water before being refracted to the eye. (Donated by Mr. John Mayall, Jr.) ■

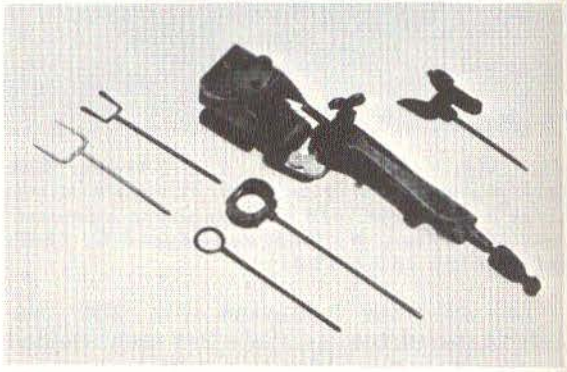

Fig. 287. Johan J. van Musschenbroek, Leyden, Holland; simple; before 1702. (AFIP 49154 - 66-5478-3)

This instrument (Fig. 287) has a solid brass stem 3 inches long. A brass plate is attached to the stem by a double hinge, at the top of which the stem projects through a square brass form. A brass screw with a large ring nut passes through the back of the frame and presses against the back of the stem. Attached to the stem is a strong steel spring that acts against the plate and holds the stem against the screw; a similar screw passes through the right side of the frame. Rotation of the two screws produces a smooth and fine adjustment.

The objective is carried by a block attached by a double hinge to the front of the plate. Objects are supported by a single spike that fits into a hollow rod which passes through a longitudinal hole through the axis of the stem. The objectives are mounted between thin brass plates, one of which has a depression deep

enough to accept the lens; both plates are drilled with a small hole opposite the center of the lens. The plates are riveted and soldered together and fit into a dovetail in the back of the block.

A small box of blackened sheet brass slides on a wooden block that carries the lenses in grooves. The bottom of the box is open so that the stem carrying the object may pass up inside the box. Opposite the lens is a large hole in the back of the box, and pivoted near the top is a shaped brass diaphragm with holes of varying size. These apparently represented the earliest provision for controlling the amount of incident light of which there is a record. ■

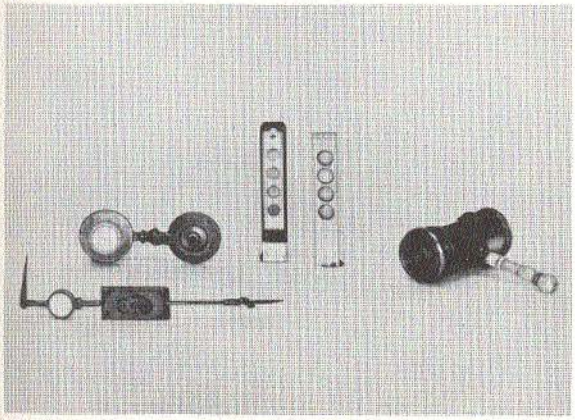

Fig. 288. E. Culpeper, London, England; simple; C. 1720. (AFIP 49155 - 60-4713-66)

This instrument (Fig. 288) has a brass body with a turned ivory handle, 2-1/2 inches long and 1 inch in diameter, and resembling the third form of the Wilson screw-barrel microscope. Culpeper substituted a brass plate for the leather pad to carry a forceps at one end and an ivory disc at the other. One side is blackened, and there is a steel spring at each side to hold the object. The outer tube is 1-3/4 inches long and has a lens; the inner tube is 1-1/2 inches long and contains a condenser.

Accessories are 2 lenses; plate with forceps and ivory disc; lens carrier for opaque objects; brass frame for slides; and 2 ivory sliders. It is signed, "Culpeper Fecit." ■

This instrument (Fig. 289) is very similar to the first Wilson screw-barrel microscope. The barrel is brass and has a brass spiral spring. The original screw socket has been replaced with a larger one soldered onto the base plate; a wing nut attaches it to the scroll.

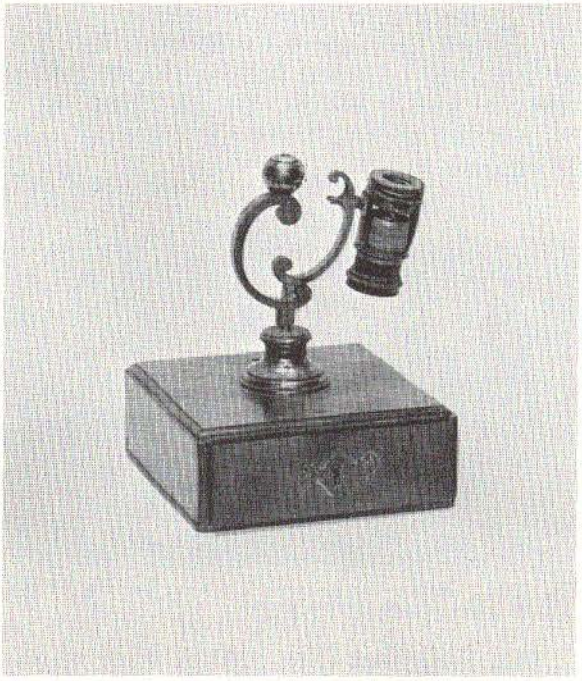

Fig. 289. George Sterrop, London, England; simple; C. 1730. (AFIP 49160 - 60-4713-397)

This portion of the microscope appears to be older than its other parts.

While the instrument is not signed, the scroll, in two parts, and the mirror, lens carrier for opaque objects, and the lenses bear strong resemblance to Sterrop's work. Accessories are 3 lenses, 5 ivory sliders, and lens carrier for opaque objects. ■

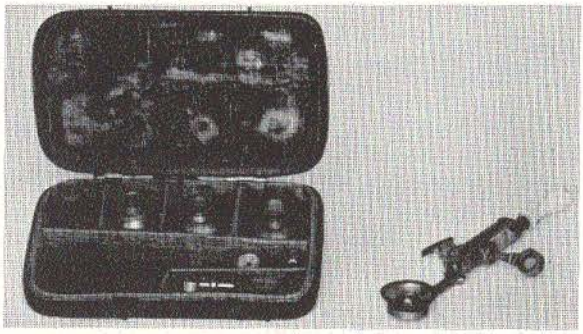

Fig. 290. George Adams, London, England; simple; 1738. (AFIP 49157 - 60-4713-39)

This instrument (Fig. 290) consists of a flat brass plate, 1-3/4 x 5/6 inch, attached to a handle that supports the lens holder, through which passes a screw that is connected to the back plate; a spring keeps the plates apart. A nut adjusts the lens to the focus of the objects.

The chief feature of the instrument is a silver, concave speculum in the center of which is the lens. The speculum is known as the lieberkühn and was in general use until 1850. It is 5-1/2 inches overall. There are three accessory lieberkühns. ■

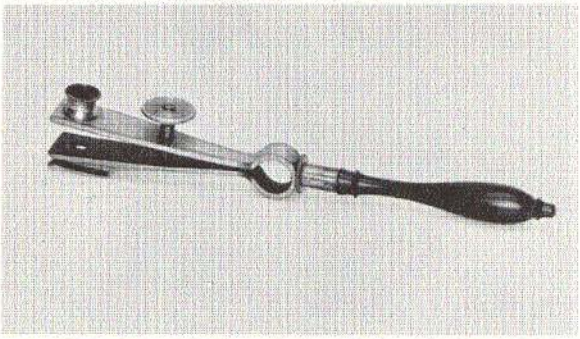

Fig. 291. Maker unknown; simple; before 1738. (AFIP 49156 - 60-4713-332)

This instrument (Fig. 291) is made of one piece of flat brass curved and bent in the center to form two plates each 2-1/2 inches long. The lower plate has a 1/8-inch aperture and slide holder that is screwed to it. The upper plate has a milled-head screw for focusing and a 3/8-inch lens holder. ■

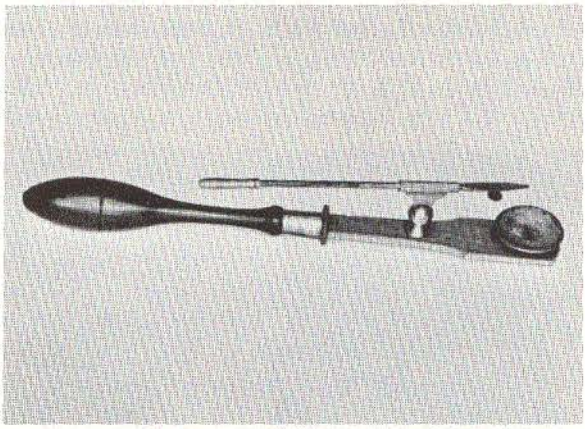

Fig. 292. Maker unknown; simple; after 1738. (AFIP 49159 - 60-4713-40)

This instrument (Fig. 292) has a 3-inch wood and brass handle attached to a flat brass plate that is 2-3/8 inches long and 9/16-inch wide. At the end of the plate is a screw-in, low-power lens with 3/4-inch lieberkühn. In the center of the plate is a stud with a hinged socket for the 3-3/8-inch-long forceps. It is most likely of English make. ■

AFIP 161. Maker unknown; simple; after 1738. *Not illustrated.*

This instrument is similar to that in Fig. 292 (AFIP 49159), although somewhat smaller. ■

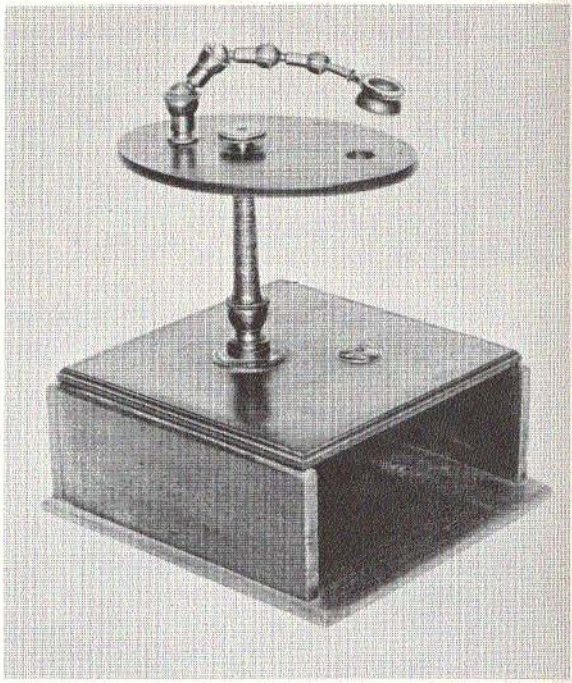

Fig. 293. Pierre Lyonet, Paris, France; simple; C. 1745. (AFIP 49162 - 60-4713-38)

A wooden box base serves as the support for the 4-inch-high turned brass pillar of this instrument (Fig. 293); an oval mahogany stage, 5-1/2 x 4 inches, is clamped to the top of the 3-3/4-inch-high pillar. There is a 1/2-inch circular aperture near the end of the stage and over the mirror into which fits a glass plate.

Clamped to the stage behind the pillar is an arm with four ball-and-socket joints that carries the lens and a lieberkühn. Accessories are 3 lenses and a lieberkühn. ■

The excellent workmanship of this 2-3/4 x 1-inch instrument (Fig. 294) is readily apparent. It is fitted with an ivory handle and has a steel spiral spring. The usual Wilson carrier for opaque objects is replaced by a holder for a lieberkühn, the body of which is brass and slightly bent at a right angle immediately above a double compass joint to which is attached a forceps. Accessories are 5 objectives; lieberkühn and lens; 4 ivory sliders; brass box with talc; and brass rings. ■

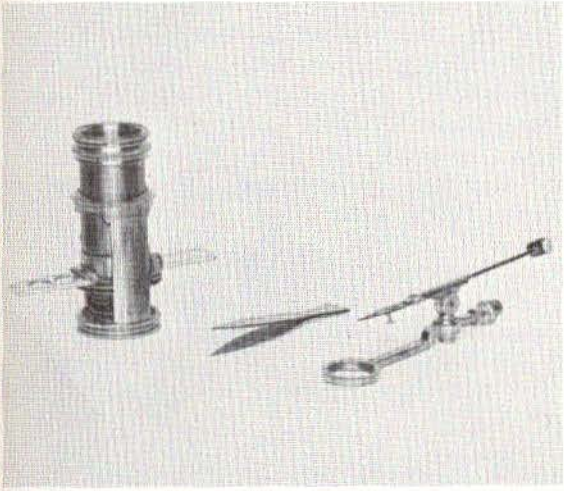

Fig. 294. George Adams, London, England; simple; 1746. (AFIP 49161 - 60-4713-378)

AFIP 49026. John Cuff, London, England; simple; C. 1750. *Not illustrated.*

This is an aquatic microscope with the rectangular pillar, 5-1/4 inches high, fitted to the rear of a brass oval plate attached to an oval lignum vitae base, 4 x 3 x 2 inches. The gimbal for the 1-3/4-inch-diameter mirror is attached to the lower section of the pillar; the circular stage is attached to the top of the pillar. A flat rod slides into fittings on the back of the pillar. The movable lens holder and the fine adjustment are screwed to the top of the rod. Height is 9 inches and it is signed, "J. Cuff, London, Inv. & Fec." ■

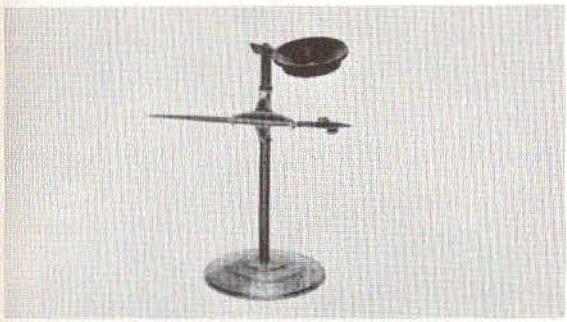

Fig. 295. Maker unknown; simple; C. 1760. (AFIP 49174 - 60-4713-400)

This instrument (Fig. 295) has a circular brass base 1-3/8 inches in diameter that supports the 3-inch-high, slender pillar at the top of which is a low-power lens mounted in a brass cell. There is a sliding socket on the pillar that carries the forceps rod. ■

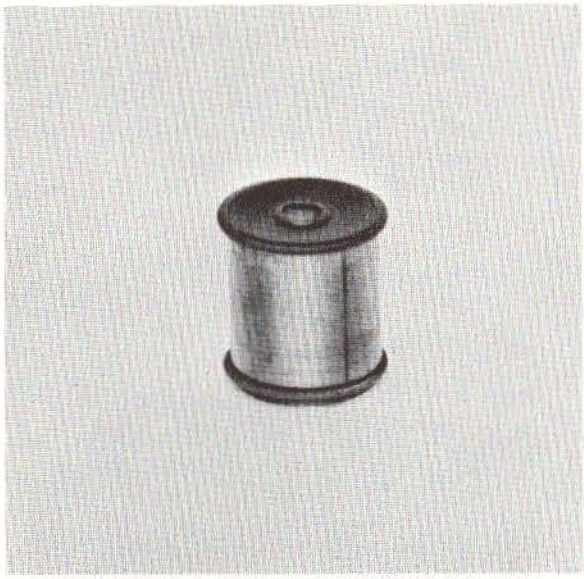

Fig. 296. Maker unknown; simple; C. 1775. (AFIP 49167 - 60-4713-313)

The brass tube of this instrument (Fig. 296) is 7/8 inch long and 3/4 inch in diameter. It has a low-power lens in a brass cell at one end, and at the other a brass animalcule cage with a screw-in top. ■

AFIP 49164. Maker unknown; simple; C. 1775. *Not illustrated.*

This instrument, similar to that pictured in Fig. 298 (AFIP 49172), has a T-shaped brass plate that is 1-3/4 inches long and 1/2 inch wide; the inside is cut away to 1-5/16 x 1/4 inch and the forceps holder slides into this area. The lens consists of two plano-convex glasses in cells that screw into a ring; the plano surfaces face each other. The 1-1/8-inch-long handle and the lens arm are hinged to the plate and both fold upon it. It is 3 inches long when open. This type microscope was still on the market in 1893. ■

This instrument (Fig. 297) is a modification of the Ellis aquatic microscope with a box base, 6-1/2 x 4-1/2 inches, and a socket into which screws the 4-1/2-inch-high circular pillar. Near the base of the pillar is a square section with an aperture into which the pin is inserted that carries the single mirror.

The stage fits into a socket at the top of the pillar, the center of which has been drilled to receive a rod with slide fitting to carry the lens arm. There is a socket at the side of the stage

Fig. 297. Henry Shuttleworth, London, England; simple; C. 1787. (AFIP 49163 - 60-4713-37)

to hold the forceps. Accessories are 2 objectives; 3 ivory sliders; ivory talc box; and stage forceps. ■

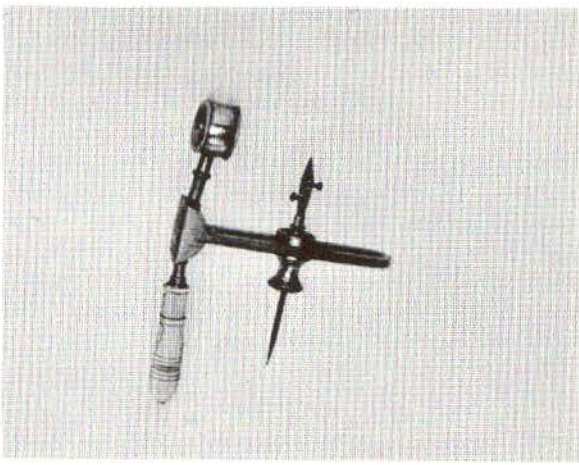

Fig. 298. W. & S. Jones, London, England; simple; 1789. (AFIP 49172 - 60-4713-96)

This instrument (Fig. 298) is practically identical to another microscope in the Collection whose maker is unknown, except that this model is larger. The plate is 2-3/8 inches long, and the lens arm and ivory handle fold upon the plate. It is 4 inches long when open. ■

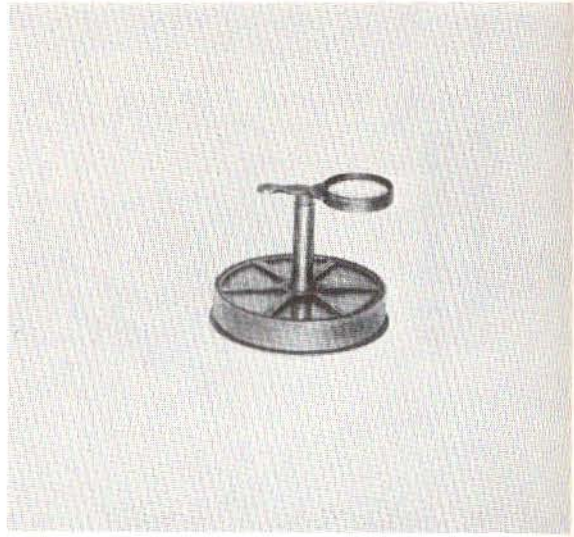

Fig. 299. Maker unknown; simple; after 1790. (AFIP 49170 - 60-4713-95)

The base of this instrument (Fig. 299) is a circular white metal box 2-3/8 inches in diameter divided into six compartments. From its center arises a 1-1/4-inch-high circular, hollow pillar at the top of which is a 7/8-inch-long arm that holds the biconvex lens; the arm is fitted to a rod that slides in the pillar. The instrument was designed for the study of seeds segregated in the compartments of the base. ■

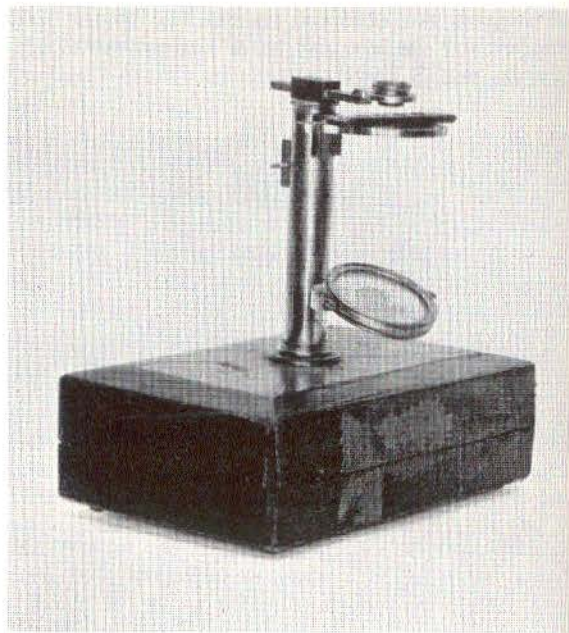

Fig. 300. W. & S. Jones, London, England; simple; C. 1795. (AFIP 49166 - 60-4713-331)

This instrument (Fig. 300) is an improved model of the aquatic microscope made by John Cuff of London in 1755. The circular pillar screws into the leather-covered lid of a box that serves as the base; at the base of the pillar is a section for the mirror. There is a rack on the pillar that operates on an inner tube, on the end of which is a sliding rod with a spring box for the arm of the lens carrier. The circular stage has a glass plate and fitting for forceps.

Accessories are 4 objectives; extra square stage; and a brass slider. It is signed, "W. & S. Jones, 30 Holborn, London." ■

Fig. 301. W. & S. Jones, London, England; simple; C. 1798. (AFIP 49173 - 60-4713-399)

The oval ebony base of this instrument (Fig. 301) is 2-3/8 x 1-5/8 inches and supports the 1/8-inch-square pillar that slides into a square brass case near its edge. Attached to the pillar by means of a sliding box is the 1-1/4-inch circular stage that has an arm behind it; the stage has openings for a glass plate or discs and a stage forceps. Below the stage is a thin brass plate with spring fastenings for sliders.

On the pillar below the stage is a brass fitting with an arm carrying a milled-head screw, comprising an inverted Hevelius focusing adjustment. At the top of the pillar the ring and arm are fixed with a screw opening for the lenses. Attached to the ring by screw pivots are three lenses that may be used singly or in combination. The 1-inch-diameter plane and concave mirror is fitted to the base. Height is 4 inches. It is signed, "W. & S. Jones, Holborn, London." ■

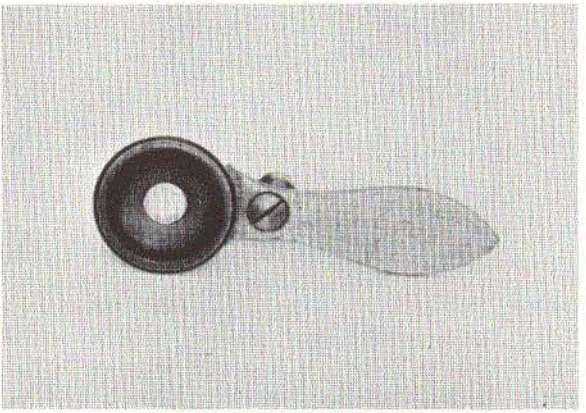

Fig. 302. Maker unknown; simple; after 1800. (AFIP 49175 - 60-4713-368)

This instrument (Fig. 302) consists of a 2-1/2-inch-long, flat, curved brass plate with a heavy ring at the upper end; two biconvex lenses screw into the ring. Focusing is achieved by a screw motion. Below the plate is a screw-fixed pillar, the lower end of which screws into a circular brass stage.

There have been a number of designations given this type instrument: "Cloth microscope, thread counter, and linen tester or prover with handle." Its principal use was in counting the number of threads in the warp and woof of cloth. Such instruments were in use as far back as the early 1700's. ■

AFIP 49177. Maker unknown; simple; after 1800. *Not illustrated.*

This instrument consists of a conical brass tube 1-1/4 inches long, one end of which has attached a low-power biconvex lens in a screw cap. There are two 1-inch-diameter glass plates between which objects may be placed and held in position by a screw cap. A long wooden handle screws to the body. ■

The construction of this instrument (Fig. 303) is very similar to the microscope made by George Adams in Fig. 290 (AFIP 49157), except that on this model the focusing screw is

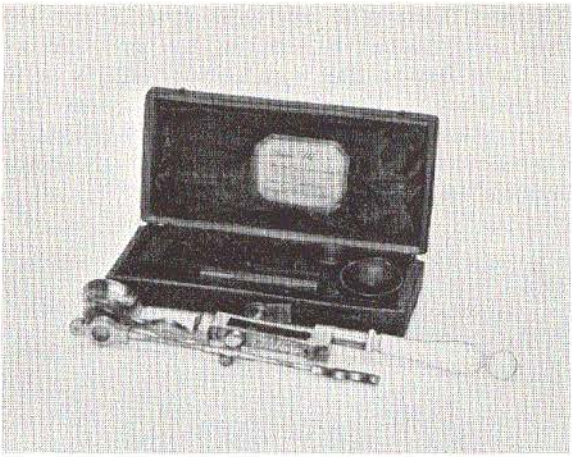

Fig. 303. T. Harris & Son, London, England; simple; after 1820. (AFIP 49178 - 60-4713-337)

hinged to the back plate. The ivory handle is 2-1/2 inches long, and overall length of the instrument is 7-3/8 inches. It is signed, "T. Harris & Son, London." ■

Fig. 304. Dollond, London, England; simple; after 1820. (AFIP 49184 - 60-4713-19)

The 2-3/4-inch-high circular pillar of this instrument (Fig. 304) is screwed to the 2-1/8 x 1-3/4-inch brass base, and has attached a collar with a gimbal supporting a single mirror. Above this is another collar with a hinged joint that carries the condenser. Fixed to the top of the pillar is an arm that carries the mechanical stage; there is a single diaphragm beneath the stage.

A recessed disc at the top of the pillar is operated by a milled screw, and above this is a dovetail socket into which the lenses slide; the lenses and the Wollaston doublet are mounted in brass slides. It is signed, "Dollond, London, Wollaston's Doublet 40," and is very similar to the Englishman William H. Wollaston's original instrument. ■

AFIP 71804. Charles Stanhope, Chevening, England; simple; after 1829. *Not illustrated.*

This all-brass instrument consists of a hollow tube 1-7/8 inches high and 7/8 inch in diameter with slits on two sides. A lens screws into one end, and a slide-in cap with a 5/16-inch-square crystal into the other. ■

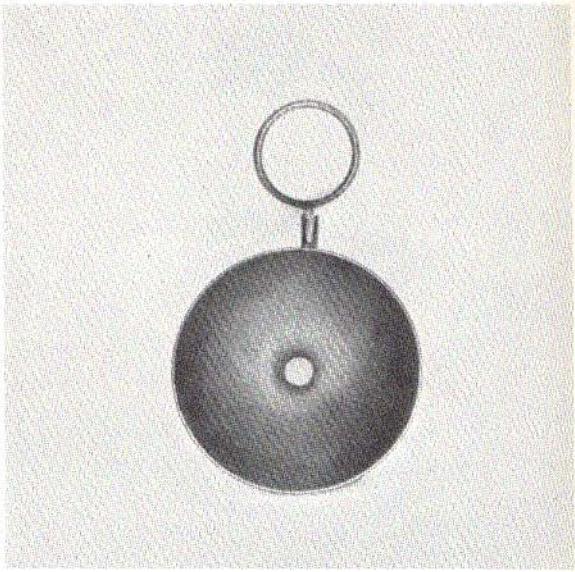

Fig. 305. Charles Stanhope, Chevening, England; simple; after 1829. (AFIP 49179 - 60-4713-309)

This instrument (Fig. 305) is a modification of the cylinder loupe used by jewelers. It has a double convex lens with surfaces of unequal curvature separated from each other by a considerable thickness of glass. The distance between the two surfaces may be so adjusted that when the near convex lens is turned toward the eye, with the minute objects in place on the other surface, they will be in focus. This type lens was modified by French instrument makers who placed photographs of objects on a plane surface. It has attached a 5/8-inch-long handle with a 1/2-inch-diameter ring. ■

AFIP 49180. Charles Stanhope, Chevening, England; simple; after 1829. *Not illustrated.*

The lens of this instrument, 3/4 x 3/8 inches, is inserted into the 2-1/2-inch-long metal handle. ■

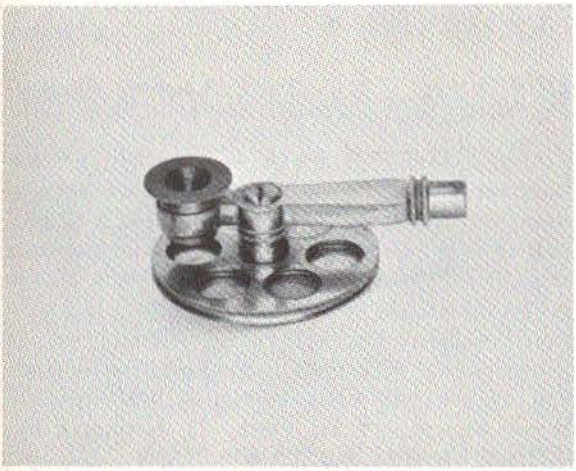

Fig. 306. Maker unknown, simple; C. 1830. (AFIP 49181 - 60-4713-308)

This brass instrument (Fig. 306) consists of a 1-7/8-inch-diameter revolving disc of diaphragms, in the center of which is a 1/4-inch-long tube into which screws a 2-1/2-inch-long arm. The eye lens fits into one end of the arm, and the other has a screw opening for a handle. ■

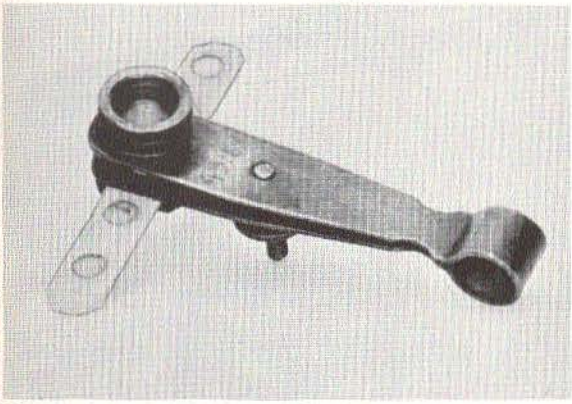

Fig. 307. Maker unknown; simple; C. 1830. (AFIP 49182 - 60-4713-307)

This instrument (Fig. 307) is similar to that in Fig. 291 (AFIP 49156), except that this model is slightly larger and has three low-power lenses that screw together and fit into the 1/2-inch aperture at the end of the top plate; it was made without a handle. ■

AFIP 49183. Maker unknown, simple; C. 1830. *Not illustrated.*

This instrument has a 1-1/2-inch-long and 3/4-inch-diameter brass body similar to that of the Wilson screw-barrel microscope. The lower end is closed by a brass plate with a small square aperture. The 1-1/4-inch-long screw barrel has a single biconvex lens at the lower end. It is similar to the linen prover microscope in Fig. 302 (AFIP 49175). ■

Fig. 308. Maker unknown; simple; C. 1830. (AFIP 137 - 60-4713-335)

This instrument (Fig. 308) has a 2-inch-diameter circular, brass ring base to which is attached a 1-inch-high pillar at the back with a screw for focusing. The ring is sawed at the front to make a spring, and fitted into it is a circular brass plate with a cross-shaped opening. A heavy brass ring is screwed to the arm attached to the pillar, and the lens tube screws into the brass ring. The tube contains lenses at top and bottom, with a diaphragm between; focused by a screw motion, the tube pivots on the pillar. The instrument strongly resembles the linen tester type. ■

This instrument (Fig. 309) consists of a brass tube, 1 x 5/8 inch long, the lower end of which has a screw cap. At the opposite end is a lens cell with a single plano-convex glass set in a screw cap. Behind the cell is a collar into which screws the 1-1/4-inch-long brass handle, and behind the collar are two slots for

Fig. 309. Jamin, Paris, France; simple; after 1835. (AFIP 49169 - 60-4713-372)

slides with screw adjustment. The tube has an inclosed prism in the lower end and a 1/4 x 5/16-inch aperture. It is signed, "Jamin, Opten, Brevete, Paris." ■

Fig. 310. Charles Chevalier, Paris, France; simple; C. 1850. (AFIP 49403 - 60-4713-358)

The brass cylindrical pillar of this instrument (Fig. 301) is 4-3/8 inches high, with an inner rectangular bar with a rack at the back; the pinion that controls the drawtube is screwed to the pillar. The 2-inch-diameter circular stage that is screwed to the upper portion of the pillar, has a 1/2-inch central aperture and a revolving disc of diaphragms.

At the upper end of the rectangular bar in the pillar is a 2-3/4-inch revolving, horizontal rod for the eye lens. The arm for the gimbal and 2-inch double mirror is inserted into the lower portion of the pillar, which in turn screws into the center of a 7-1/2 x 5 x 2-1/8-inch box that serves as the base. When closed it is 7-1/2 inches high. ■

AFIP 49185. F.L. West, London, England; simple; C. 1850. *Not illustrated.*

The 5-inch-high brass pillar screws to the 2-inch-diameter, solid brass circular base of this instrument. The lens holder is a sliding ball collar with a setscrew and 1-inch-long arm with a spike at right angles. Below this is a sliding double ball socket for the 4-1/2-inch-long forceps. One end of the forceps rod has a brass cup with openings plugged with cork. Focusing of the instrument is by screw motion. It is signed, "F.L. West, 31 Cockspur St., Charing Cross, London." ■

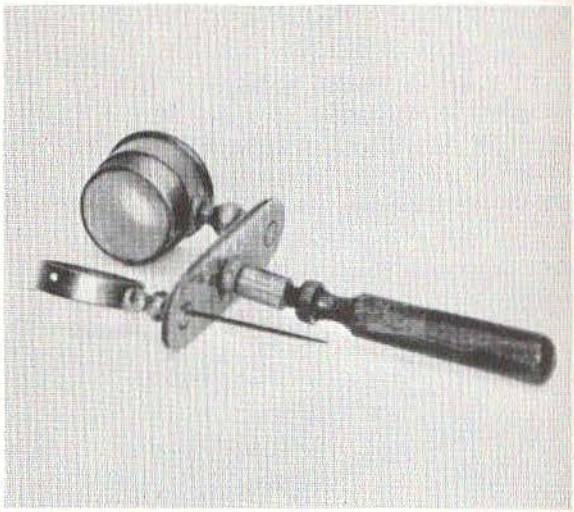

Fig. 311. Maker unknown; simple; C. 1850. (AFIP 49186 - 60-4713-370)

This instrument (Fig. 311) has a base plate 1-5/8 x 1/2 inch with round ends, at one end of which is a turned rod with ring to which the lens tube is permanently attached. At the other end of the plate is a stud with a hole into which is inserted a detachable ring with a plane glass that serves as the stage. The tube has a single lens, and the focusing is achieved by means of a small screw. A 1-3/4-inch-long wooden handle screws into the base plate. Height is 3-1/2 inches. ■

AFIP 49165. Maker unknown; simple; C. 1850. *Not illustrated.*

This instrument is best known as a bell glass microscope. The glass bell is 2 inches high and attached to a brass collar into which screws the 1-3/8-inch-long lens barrel; there is a plano-convex lens at each end of the barrel. ■

Fig. 312. Maker unknown; simple; after 1850. (AFIP 49187 - 60-4713-401)

The 1-3/4-inch-long wooden handle of this instrument (Fig. 312) is attached to a heavy brass ring; a projecting collar is at the front of the ring, and at the back a double steel spring clip for sliders. The brass lens cell has a collar that screws into the base ring and provides focusing. The rear portion of the cell is constructed like a lieberkühn, but it is not silvered. The front, which extends beyond the lens, is concave and blackened; the lens is plano-convex glass. Height is 3-3/4 inches. ■

Fig. 313. Maker unknown; simple; after 1850. (AFIP 49171 - 60-4713-367)

This instrument (Fig. 313) has a 3-inch-high blackened brass tripod base, to which are attached two 2-inch-diameter plano-convex lenses in blackened brass rings; both lenses are low power and the focus is fixed. ■

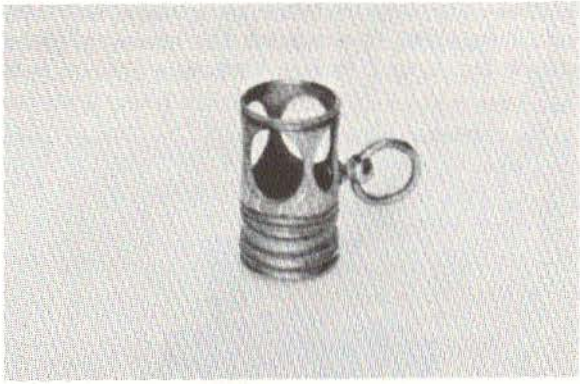

Fig. 314. Maker unknown; simple; after 1850. (AFIP 49176 - 60-4713-388)

This instrument (Fig. 314) consists of a nickel-plated tube, 7/8 inch long and 5/16 inch in diameter, in one end of which there is a single biconvex glass. The opposite end of the tube is open and has four oval holes cut cut at the sides. A ring on one side permits attaching it to a watch chain. ■

Fig. 315. Maker unknown; simple; before 1867. (AFIP 133 - 60-4713-278)

This instrument (Fig. 315) consists of a guttapercha tube and pedestal base. The lower front of the tube is cut away to inclose a single mirror that is operated by a button. Near the top of the tube is a diaphragm. The upper portion of the tube slides in and has slots for slides. The lens is fitted in a screw barrel by which focusing is actuated; the brass eyepiece slides in. It is 7 inches high. ■

Fig. 316. James H. Logan, Allegheny, Pa.; simple; 1869. (AFIP 49188 - 60-4713-325)

This wooden instrument (Fig. 316) is constructed of walnut with a circular base supporting a four-section, 5-1/2-inch-high pillar, the parts of which are glued together; the plane glass mirror is attached to a rotating button arm on the pillar. An arm is attached at the top of the pillar and carries the lens. The center of the pillar is cut away on two sides to house a screw that actuates the coarse adjustment. The 4-1/2 x 1-1/2-inch stage has a circular aperture and two steel clips. Height is 8-1/2 inches. (Donated by Bausch & Lomb Optical Company) ■

AFIP 49188A. James H. Logan, Allegheny, Pa.; simple; 1869. *Not illustrated.*

This instrument is a duplicate of that in Fig. 316 (AFIP 49188) by the same maker. ■

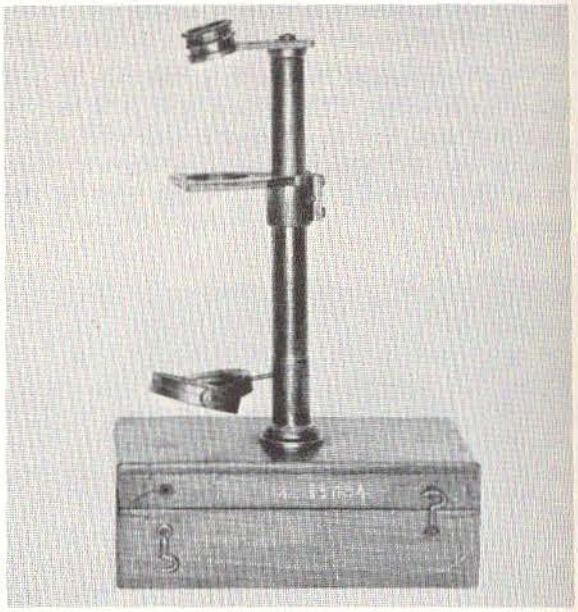

Fig. 317. James W. Queen & Co., Philadelphia, Pa.; simple; C. 1870. (AFIP 19484 - 60-4713-316)

The 5-1/4-inch-high brass tube pillar of this instrument (Fig. 317) screws into the box lid base. A 5-1/2 x 3 x 2-inch stage is attached to the upper portion of the pillar, and the lower portion carries a concave mirror; within the tube is a cylindrical rod with rack, the upper portion of which carries a fixed arm for the lenses; a pinion controls the rack. When closed it is 7 inches high. ■

AFIP 55557. James W. Queen & Co., Philadelphia, Pa.; simple; before 1875. *Not illustrated.*

This instrument consists of a brass cylindrical tube, 1-1/4 inches long, the ring top of which screws in; a glass is fitted to the lower end. Immediately above the glass is a small opening on both sides of the tube for slides. A brass, 1-1/4-inch-long drawtube fits into the ring cap at the top, has a biconvex lens at both ends, and slides into a collar that screws into the top of the body tube. ■

AFIP 205867. Maker unknown; simple; C. 1900. *Not illustrated.*

This is an all-brass, 1-inch-diameter and 2-inch-long instrument, with 3/4-inch slots on each side for slides. At one end is a screw-in lens and at the other a slide-in cap with a 5/16-inch square crystal. (Donated by Mr. Minor Worthington Tuttle) ■

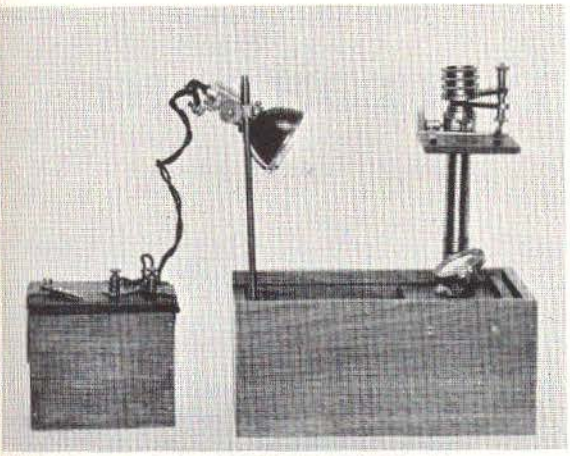

Fig. 318. Maker unknown; simple; C. 1900. (AFIP 160 - 60-4713-366)

The 4-inch-high brass pillar of this instrument (Fig. 318) is mounted on a 2-1/4 x 3-1/2-inch hinged shelf contained in a box 4 x 6-1/4 x 3 inches; the 2-inch-square stage is attached to the upper portion of the pillar. Inclosed within the pillar is a rack and pinion controlled inner tube, attached to the top of which is a 1-1/2-inch-long arm for the triple eyepiece. At the opposite end of the box is a 5-1/2-inch-high rod for a small electric lamp; there is a separate battery box. This is an early example of a simple portable microscope with a built-in electric lamp light source. ■

DISSECTING MICROSCOPES

Fig. 319. Andrew W. Ross & Co., London, England; simple dissecting; C. 1831. (AFIP 49401 - 60-4713-363)

This all-brass instrument (Fig. 319) has a tripod base that supports the 4-1/2-inch-high tubular pillar; a triangular bar within the pillar has a rack and pinion vertical adjustment. Attached to the top of the triangular bar is a 3-5/8-inch-long arm with rack and pinion terminating in a 5/8-inch aperture for the ocular.

The stage is 2-9/16 x 4 inches with a 1-1/2-inch central aperture. A gimbal for the 1-3/4-inch mirror is inserted into the base. When closed it is 7 inches high, and is signed, "Andrew Ross & Co., 33 Regent St., Piccadilly." ■

This all-brass instrument (Fig. 320) has a tripod base supporting a 3-inch-high tubular pillar that has a square inner bar with rack and pinion horizontal adjustment. A 2-3/4-inch-long arm with rack and pinion terminates in a 5/8-inch aperture for the ocular. The gimbal for the 1-3/4-inch-diameter mirror is inserted into the base.

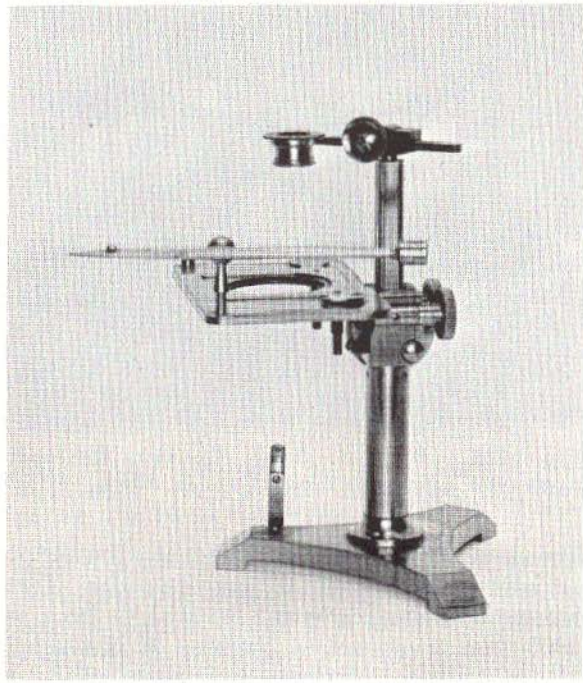

Fig. 320. Andrew W. Ross & Co., London, England; simple dissecting; C. 1832. (AFIP 49400 - 60-4713-322)

The stage is 4-3/4 x 2-7/8 inches, has a 1-1/2-inch central aperture, and an opening for the 5-3/8-inch-long stage forceps. When closed it is 5-5/8 inches high, and is signed, "Ross, London, 2038." ■

The four 3-inch-high brass pillars of this microscope (Fig. 321) are attached to a 7-inch-square wooden base; also attached is a 1-1/2-inch single mirror on a swivel. On top of the 6-1/2-inch-diameter stationary, brass, circular stage plate is a revolving stage 4-1/8 inches in diameter; there is a 1-3/8-inch-diameter aperture in the center of the stage.

A magnifying lens is attached to the swivel arm that is fixed to one of the corner pillars.

Fig. 321. R. & J. Beck, London, England; compound binocular dissecting; C. 1865. (AFIP 49402 - 63-6552)

The swivel binocular attachment is attached to an adjustable rack on the opposite pillar. This binocular arrangement was devised by Beck in 1860 from a concept by Nachet. It is signed, "R. & J. Beck, 31 Cornhill, London, 4843." ■

Fig. 322. Maker unknown; simple dissecting; C. 1870. (AFIP 182 - 60-4713-360)

This all-brass instrument (Fig. 322) is 5-3/8 inches in diameter, 3-5/8 inches high, and has a 4-1/8-inch-diameter stage with a black glass insert. A round double mirror inclosed in brass is attached to a 3-1/4-inch-high tubular brass pillar that contains the vertical adjustment and serves as one of the three legs. Attached at the top of the pillar is a 3-inch-long arm that holds the ocular. ■

Fig. 323. Maker unknown; compound dissecting; before 1870. (AFIP 49404 - 60-4713-306)

The 6-inch-diameter round metal stage of this instrument (Fig. 323) also serves as the base; inserted into the stage is a glass plate. Extending from the rear of the stage is an 8-1/2-inch-high curved pillar with rack and pinion adjustment. The 8-1/8-inch-long body tube is attached to the rack. Height is 12 inches. ■

AFIP 517955. Bausch & Lomb Optical Co., Rochester, N.Y., simple dissecting; 1874. *Not illustrated.*

This instrument consists of a small wooden case 3 x 1-1/2 x 3/4 inch. One of the ends of the case is attached to the lid, which when reversed forms a stand for the three lenses and

stage. These are supported by a steel rod, the lower end of which is hinged to the lid so that it may be turned downward to lie in a groove; a button fastens the rod in both positions. The glass stage and magnifier are adjustable and the former may be fixed by a setscrew. An adjustable mirror is fitted into the case, and two dissecting needles fit into grooves in the lid.

This dissecting microscope was made for botanical and entomological work. The glass plate in the stage forms a cell for holding water so that aquatic animals may be examined. It is signed on the case, "64. J. J. Bausch, Pat. June 9, 74," and on the lens holder, "Bausch & Lomb Optical Co., Rochester, N.Y., USA." ■

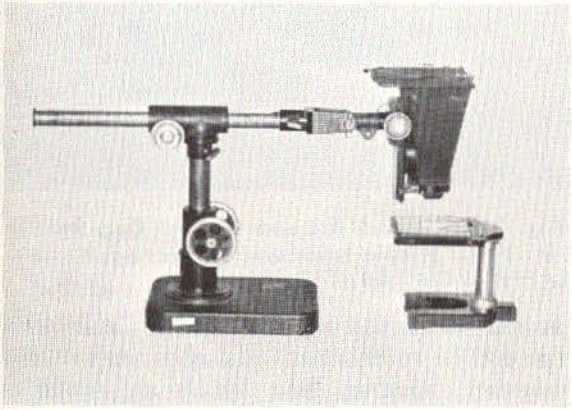

Fig. 324. Carl Zeiss, Jena, Germany; simple photographical dissecting; C. 1879. (AFIP 49406 - 66-2829)

The base of this instrument (Fig. 324) is 5-1/4 x 3-1/2 inches and supports the 3-3/8-inch-high pillar; screwed to the pillar is the 5-1/4 x 3-7/8-inch stage plate. As accessories, the instrument has two stereoscopic cameras with time and instantaneous shutters, and a camera stand. It is known as the Braus-Drüner model and is one of the first cameras made for stereoscopic photomicrography. It is signed, "Carl Zeiss, Jena, No. 187." ■

The 3-1/2 x 4-inch base of black japanned iron with rounded ornamental corners of this instrument (Fig. 325) supports the 3-1/4-inch-high tubular pillar of brass, which in turn holds the 3-3/8 x 3-5/16-inch stage. A 1-9/16-inch-diameter mirror is attached to the base. At the top of the pillar the vertical adjustment section

Fig. 325. Bausch & Lomb Optical Co., Rochester, N.Y.; simple dissecting; C. 1880. (AFIP 156 - 60-4713-393)

slides in and attached to it is a 2-inch arm that holds the lens. When closed it is 4 inches high, and is signed, "Bausch & Lomb Optical Co., Pat. Aug. 3, 1880." ■

AFIP 177. Chevallier, Paris, France; simple dissecting; C. 1880. *Not illustrated.*

This instrument is made of brass and cast iron. The top plate is attached to the base by means of two cast iron supports and two round brass pillars, each 3-7/8 inches high. One of the pillars contains within it a rack and pinion vertical adjustment with a 7/8 x 1/2-inch grooved top. The stage is 4-5/8 inches in diameter and has a removable glass insert. A 5-1/2-inch-long adjustable brass lens holder fits into an aperture in one corner of the stage. The substage mirror is 2 inches in diameter. It is signed, "L. Ingt. Chevallier, Optician du Roi, a Paris." ■

The 4-1/8 x 5-3/8-inch horseshoe base of this instrument (Fig. 326) supports the 3-3/4-inch-high pillar to which is attached the 3-1/2 x 4-1/4-inch glass stage plate. Contained within the pillar is a triangular bar, to the top of which

Fig. 326. Bausch & Lomb Optical Co., Rochester, N.Y.; simple dissecting; 1900. (AFIP 337715 - 60-4713-27)

is attached a jointed arm for the double lens. It has a 2-inch-diameter double mirror. When closed it is 6 inches high, and is signed, "Bausch & Lomb Optical Co., New York, Rochester, N.Y., Chicago, 33721." ■

AFIP 17775. Bausch & Lomb Optical Co., Rochester, N.Y.; simple binocular dissecting; C. 1900. *Not illustrated.*

This instrument is similar to that in Fig. 327 (AFIP 17774) by the same maker. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 51127." ■

AFIP 17773. Bausch & Lomb Optical Co., Rochester, N.Y.; simple binocular dissecting; C. 1900. *Not illustrated.*

This instrument is a duplicate of that pictured in Fig. 327 (AFIP 17774) by the same maker, except that this model has a single lens holder and the double mirror is 2 inches in diameter. It is signed, "Bausch & Lomb Optical Co., Rochester, N.Y." ■

The horseshoe base of this instrument (Fig. 327) is 5-1/4 x 4 inches, and supports the 4-inch-high tubular pillar; a triangular bar with rack at the back slides within the pillar by pinion controls. A 2-1/2-inch-long swinging arm

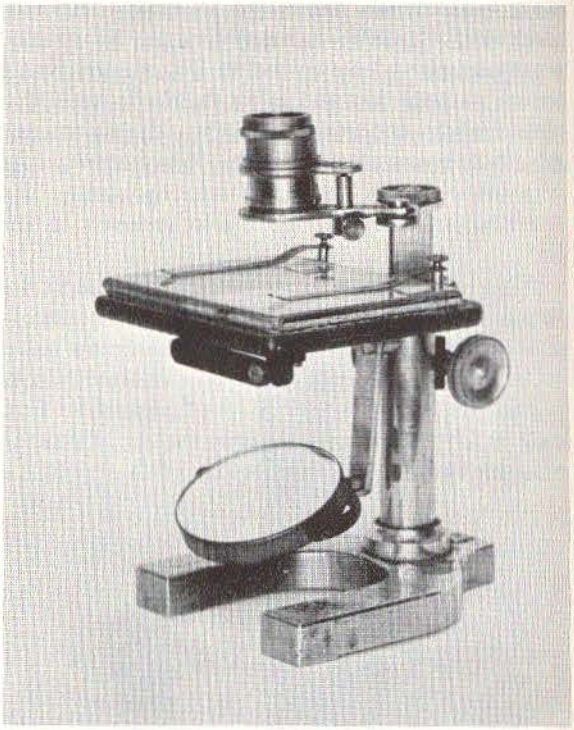

Fig. 327. Bausch & Lomb Optical Co., Rochester, N.Y.; simple binocular dissecting; C. 1903. (AFIP 17774 - 60-4713-390)

is attached to the top of the bar and screwed to its end is another arm that ends in a 1-inch-diameter aperture into which an ocular is screwed. In the center of the arm a rod is inserted that is attached to another arm with a 1-inch aperture for a second ocular.

The stage plate is 4-1/4 x 4-1/2 inches and attached to it is a glass stage of the same size. A gimbal for the 2-5/8-inch-diameter double mirror is on a 2-3/4-inch-long swinging tailpiece screwed to the pillar. When closed it is 6-7/8 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y., 52753." ■

AFIP 196. Bausch & Lomb Optical Co., Rochester, N.Y.; simple dissecting; C. 1905. *Not illustrated.*

This instrument has a 4-inch-square iron base supporting the 3-3/4-inch-high tubular pillar that contains the rack and pinion adjustment. A 3-1/2-inch-diameter circular stage is attached to the top of the pillar, along with a 1-inch arm lens holder. When closed it is 4-1/4 inches high, and is signed, "Bausch & Lomb Optical Co., Rochester, N.Y." ■

Fig. 328. Bausch & Lomb Optical Co., Rochester, N.Y.; simple dissecting; C. 1906. (AFIP 185 - 60-4713-396)

The 5-1/2 x 4-inch black horseshoe base supports the 3-inch-high tubular pillar of this instrument (Fig. 328) that contains the rack and pinion adjustment. At the top of the triangular bar that slides into the pillar, there is attached a 2-inch arm into which is screwed another arm, 2-3/4 inches long, that terminates in a 1-inch aperture for the ocular.

The stage is 3-7/8 x 3 inches, and has a sliding vulcanite stage insert with a 1-inch central aperture. When closed it is 4-3/4 inches high, and is signed, "Bausch & Lomb, 77937." ■