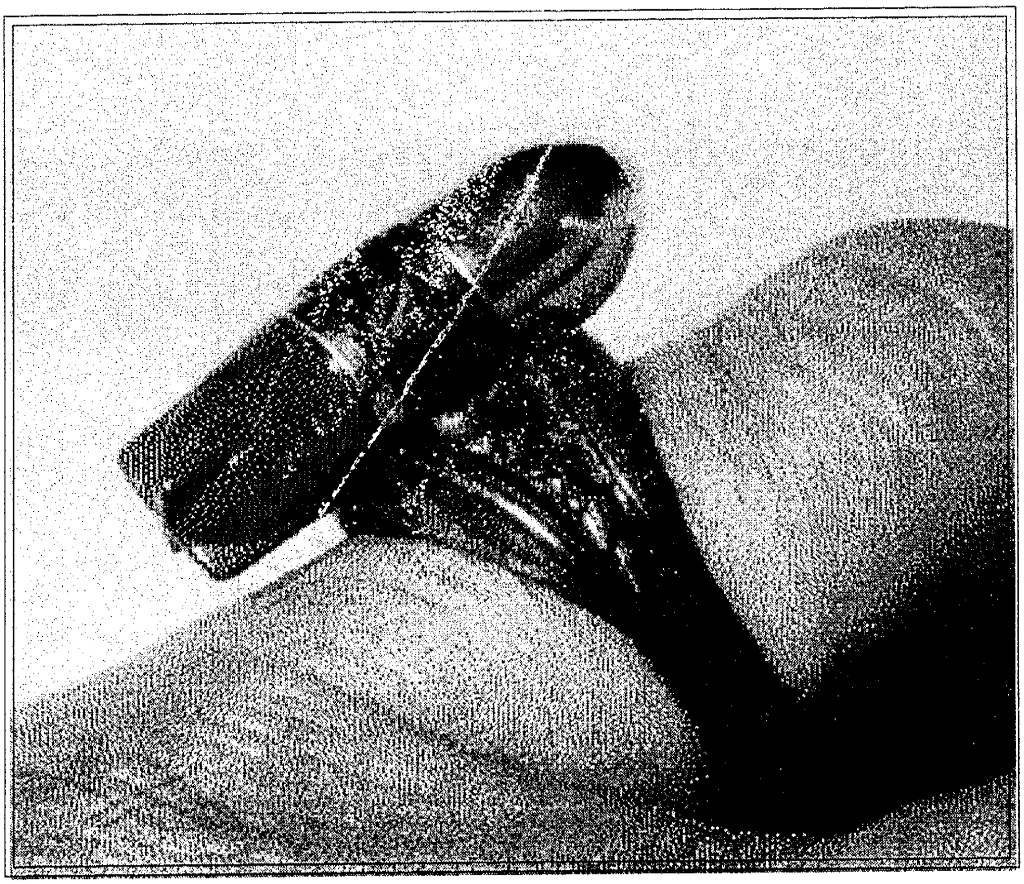
Journal of
THE MICROSCOPICAL SOCIETY OF SOUTHERN CALIFORNIA
Volume 5 Number 12 December 2000

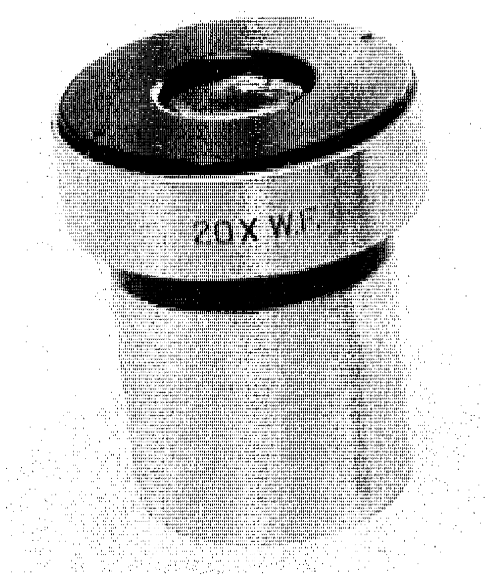
MAKING A SPINTHARISCOPE

Larry Albright



When I was about 11, I had a Lone Ranger Bomb Ring, which I treasured far above my other goodies. The tail came off the bomb and a little lens let you peer into it at night and see the sparkling of Alpha particles against Zinc Sulfide. I did not know all of that then, only that it was "magic," and who would have guessed that a real bomb ring was soon to be dropped' on Japan.

After recently acquiring a couple of microscope slides marked "Radio Active" featuring Xenotrime And Zippite, on Victorian mounts, I tried making my own slides with some success, copying the raised surface plan of the microscope slides. These were fairly successful, but had to be viewed under a stereo microscope or magnifier. I then decided that to build one into a device self contained like the Bomb Ring using quality com-



ponents would be a good project. I made about a dozen using microscope oculars with some very successful ones in the batch. Some were made with Uranium oxide which was used in ceramics to give an orange and yellow color. With Uranium, the alpha "hits" were a little far between, but the anticipation was fun. Many "hits" looks great, but one can tire of the high activity rate as well. Finding the right amount is fun as it is a little hard to predict the result until it is assembled. I am going to show you the technique I felt was the most successful.

The microscope or telescope eyepiece is a perfect beginning for building a high quality spinthariscope. I prefer a 20X wide field eyepiece.The magnification is perfect and the eyepieces are usually not as desirable or valuable as the 10x. Ideally this eyepiece shold have a platform for a reticle which would be in focus perfectly. Some of the reticle platforms are a threaded part that can be adjusted.This is a big plus..

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Volume 5 Number 12 Dec. 2000
CONTENTS

MICROSCOPICAL SOCIETY OF SOUTHERN CALIFORNIA

Making a Spinthariscope
Larry Albright 225

Three Reicherts
George G. Vitt, Jr. 230

MSSC Workshop of 2 Dec 2000.
George G. Vitt, Jr. 231

A Film Canister Photo Studio
Gaylord E. Moss 241

2000 Topic Index MSSC Journal 240

2000 Author Index MSSC Journal 242

In the Mind's Eye
Chris Thomas - Postal Microscopical Society 243

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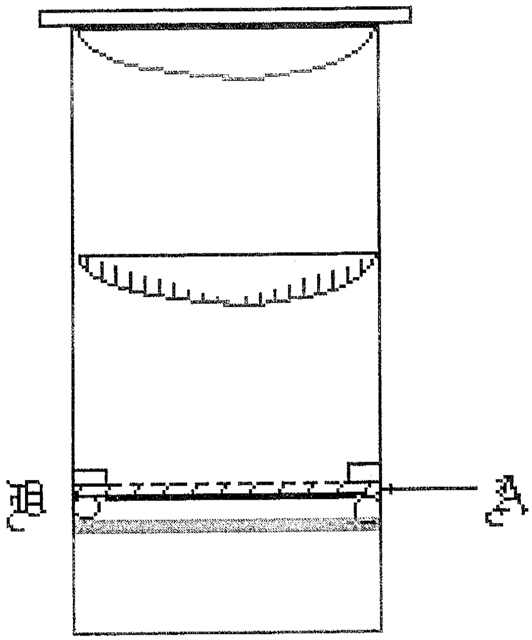
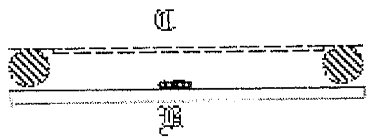




What I have done is to first build a sub assembly as follows:

I ended up using cover slip or a penny for a substrate. Almost anyting else I tried cost more than a penny. Especially round cover slips. Fortunately pennies and cover slips are very close to 18 millimeters in diameter.A perfect size to fit into an eyepiece. (Perhaps the first reticles were 18mm.)

The assembly looks like this.

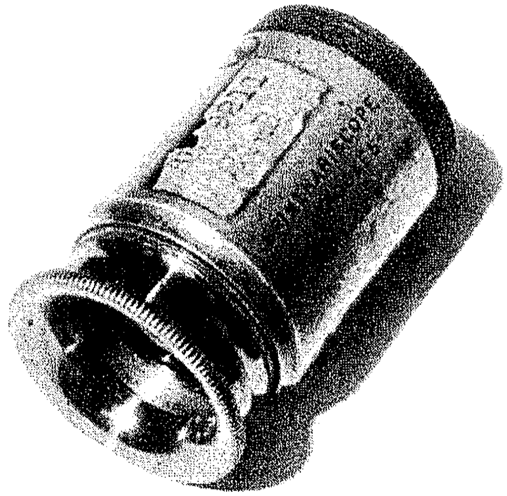
There is a penny which will house the radioactive source.This also will act as a barrier for the Apha particles. I measured these devices and the leakage in or out is extremely low.Alpha particles do not penetrate much at all. Putting the phosphor on the wrong side of a #1 Cover slip hardly works at all. It must be in a direct path with no obstacles. On top of the penny is a neoprene O ring about 3mm in thickness which is a spacer between the source and the phosphor.This is what makes the spinthariscope more interesting as the display is non repeating and equal over the surface of the zinc sulfide screen. Alpha particles have some distance to travel.Luminous paint is a mixture of the two and not as interesting under magnification. If the assembly is to be mounted in an adjustable reticle carrier it is helpful in this instance to make the assembly from two cover slips because it is better to focus with light coming through. It is very rewarding to have the phosphor screen in sharp focus.A penny can then be added on the outside to block the light and keep the energy inside.

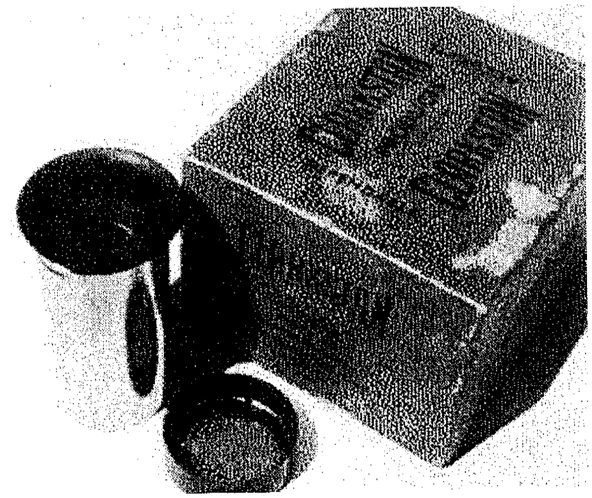
The final part is made of a 18mm #2 Round cover glass with a circle of Zinc Sulfide adhered to one side.This layer must be as close to one layer of phosphor as possible. If this is achieved, the particles of phosphor that are struck will be seen to light up on the opposite side. Too thick a coating and there will only be dull flashes not the sharp bright sparkles!

What are we going to use as an Alpha source for our project?

It is a long time since WWII, but some surplus items from that era are wonderful sources for radium paint. This is the best and most consistant source.The paint was put on electrical meters, compasses & circuit breakers with a white tip on the toggle. Coleman lamp mantles are prospects, and old or new smoke alarms are another. Old wrist watches had enough luminous material for many spinthariscopes. Perhaps a jewelry store of long standing might have some. I have seen also Catalina pottery that was good. A pin head sized bit of radium paint is more than enough for a spinthariscope. One meter dial would be an ample supply for twenty. There were some that were used in an early radio navigation system that had a "Tune For Max" meter that read backwards with the pointer on the right.These are a treasure trove of the material and still show up occasionally. When a large source is found one should be very careful in harvesting material. It should not be allowed to enter the air as dust that one can breathe. I usually use water to cover the area and carefully scrape a tiny bit into the water. This can be evaporated on the penny or something porous that could be attached with glue to the center of the penny. It should not be covered with glue or laquer as the energy is diminished. Radium has a half life of over 2000 years. So an older surplus item will seem quite new compared to that! What I usually do is use a thin layer of UV curing cement and place the powder or carrier on that.The cement will hold quite well once it is zapped with a black light lamp or sunlight. Usually 15 minutes. Silicone rubber is good. It gets a skin quickly so imbedding phosphors must be done quickly.

Zinc Sulfide by itself is not terribly efficient but good enough to make history. Crookes was the discoveror and user of Zinc Sulfide to convert radiation of different types into light from x-rays to particles, to cathode rays from evacuated chambers.





The 1950's Clarkstan

The spinthariscope was invented in 1903 by William Crookes. The above, an example of the first commercially-available version of the spinthariscope, came from Robert Millikan's Laboratory at CalTech and dates from the 1920s or earlier. After dark-adapting the eyes, the viewer observes a screen of zinc sulfide where tiny flashes of light appear, something Crookes described as a "turbulent luminous sea." Each flash of light is produced by an alpha particle emitted from a tiny sample of radium on the tip of a pointer positioned just above the screen. The spinthariscope can be considered the first radiation counter, i.e., it is capable of recording individual events.

Such a miraculous instrument required a suitably wondrous name and Crookes obliged: "I propose to call this little instrument the Spinthariscope from the Greek word scintillation." To Lawrence Badash (1964), it was only natural that the eloquent Sir William chose the name from Homer's Hymn to the god Apollo.

Crookes' spinthariscope made its first public appearance at a special soiree of the British Royal Society, May 15, 1903. The creme de la creme of the social and scientific elite were there to rub shoulders and take in the spectacular exhibits on display, e.g. recent developments in wireless telegraphy, poisonous sea-snakes, and archeological expeditions in Crete. But it was the spinthariscope, the piece de résistance, that lit up that star-studded evening (Keller 1983).

"Alpha Counter" was a spinthariscope for the "immediate, positive detection of radioactive ores." After dark-adapting their eyes for 5 to 10 minutes, the user would hold the end of the spinthariscope containing the scintillation screen against the sample (e.g., uranium ore), and count the number of scintillations. Depending on the density, and several other factors, a count rate of 50 scintillations per minute might indicate a sample containing 20% uranium. The red lens was used to prevent or suppress the glow that occurred when the screen was exposed to light (other than red).

"Another noteworthy prank involved a special type of eyepiece called a spinthariscope (from the German word for "spark"). It was a pseudo-eyepiece with a sealed end which contained a small screen coated with zinc sulfide. A small, radioactive sample was placed near the screen. Radioactive particles emitted from the deposit struck the zinc sulfide screen, creating an image that very much resembled a globular star cluster. Leo slipped this device in the finder of a 69" telescope at a Chicago exhibit and, after several public sessions, "Word got around that M13 was better in the finder than the main telescope!"

O.K lets start!

We will begin with the cell and after it is finished, it can be viewed in many ways.

1. Start with the penny (These are available in banks in rolls of 100 for a dollar) or another cover slip.

Cement an 18mm O ring to the penny or the second cover slip. You can use epoxy, U.V., cure or Super glue.

2. Place the lumious paint in the center of the penny. This could be ° this size . I have cut single numbers from a luminous watch dial and just cemented the

complete cut out piece to the penny. First put a tiny dot of cement in the center and make it thin. Then, place the luminous powder or piece on top of the cement. It should be adhered but not covered. Be careful not to breathe any dust, if there is any.

3. Now the cover glass is to be coated on one side. We want a circle of phosphor about 15mm in diameter. I use a test tube bottle with a screw cap. I put phosphor in the bottle and the mouth of the bottle is 15mm. Any bottle with a 15mm or so mouth will do. I put a thin smear of cement on the glass and then place the cover slip over the mouth of the bottle and center it as well as possible. Then carefully invert the bottle letting the powder fall onto the coverslip covering it. I usually wait about 10 seconds and tip the bottle down again. Gently rap the bottle to knock off all the loose powder on the coverslip. You should have a thin yellow area on the coverslip that you can barely see some light through. Allow the cement to cure or dry.

4. Place the cover slip onto the O. ring with the phosphor on the inside towards the luminous paint or material. The coverslip should be cemented to the O ring forming a cell with the luminous paint facing the phosphor circle. If the phosphor is on the outside, it will not do.

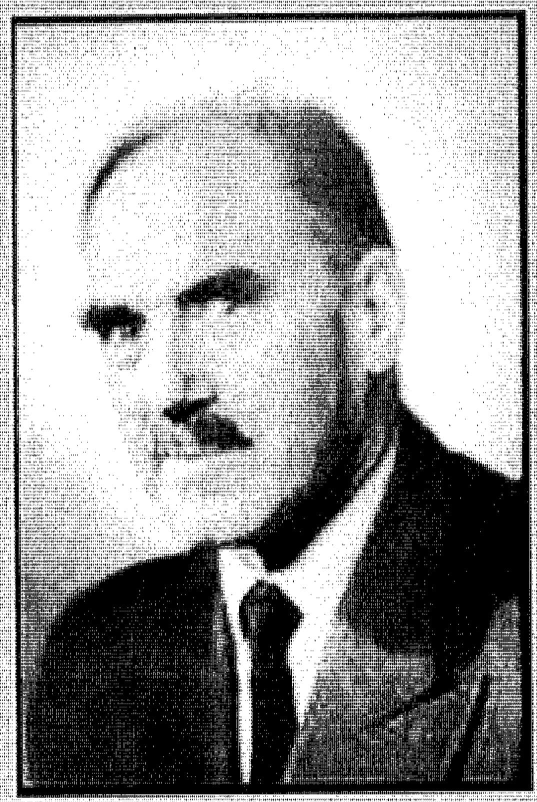
Now you have a tidy little unit ready to be put on a microscope slide, mounted onto a reticle platform inside an eypiece, or installed in any magnifier that is available. In the light, focus the magnifier on the phosphor screen. It is hard to focus by the light of the phosphor. You can leave the finished assembly penny down until night and after about 15 minutes of darkness you can begin to see the sparkles. This is a good time to make little corrections in the amount of Alpha emitting materials to use. I like a medium amout of activity, like gently falling rain.. Once your eyes have dark adapted you will be seeing small flashes that are 1 photon of light each. Our eyes are amazing things. The top cover glass does not have to be cemented until you are satisfied with the result.

I have some materials in moderate quantities. I can supply a few grams of a phosphor which is ZnS(AG) Copper activated. This is P-31 4737 A short persistence and sensitive phosphor much better than previously available. It is made by U.S. Radium Company. I will prepare a kit for members with 4-cover slips 2-O rings and 1/2 gram of phosphor. I do not want to provide the luminous material as it could be complicated. I have a small geiger counter I would make available to evaluate materials. (As you know that device is really a hoax as there is no such thing as a geiger.) I have some other Zinc Sulfide forms. One is whitish blue but not as sensitive. One is a long persistance. Just in case anyone wants to experiment, I will ask $5 for the kit. This is not a money making scheme at all. It is more of a filter for people who take things they never use. I have done that too.

Three Reicherts

George G. Vitt Jr.

Carl Reichert married into the Leitz family in 1874 and began manufacturing in Vienna two years later. This, and the fact that he had some of the Leitz technicians working for him, explains why his instruments are so similar in design to those of Leitz.The firm was known for high quality instruments well into the 20th century when it was eventually bought out by American Optical in 1962 and, subsequently, by the group owning Leica. Several MSSC members have the Reichert Zetopan, which is without doubt one of the last of the precision, well made research microscopes.



Dr.Otto Reichert 1888-1972

Carl Reichert 1851-1922

Karl Reichert 1883-1953

WORKSHOP of the Microscopical Society of Southern California

Date: Saturday, 2 December 2000
Location: Ken Gregory's residence
George G. Vitt, Jr.

1. Jim Solliday made several announcements:
a) The January and February 2001 Workshops will be held at Izzy Lieberman's residence; the March and April Workshops will be held at Ken Gregory's residence.
b) The January meeting will feature Martin Scott who will present "History of Resolution" and also "Bentley's Snow-flake research in the Buffalo Museum."
c) The MSSC Christmas party will be at Dario Solares' residence on 17 December 2-8pm.
There followed a discussion on the reduction of expenses of refreshments served at meetings, which could save some $500/year; the forming of a Program Committee of three members; means of expanding MSSC membership through ads in the UCLA 'Daily Bruin' and at community colleges.

2. Stuart Warter described several mics (see photos): 1. Ken Gregory's Watson Edinburgh polarization microscope with tripod foot (see photo) c.1934; 2. Swift Pol. microscope (see photo); 3. Edinburgh model with horseshoe foot c.1894 (see photo); 4. Polarizing microscope c.1900, with sharp corners in the horseshoe foot; 5. Swift Pol. petrographic microscope c.1900 with the 'Crouch type' foot (a tripod foot with a "U" in rear). Since there is no condenser, the resulting small NA precludes the observation of conoscopic interference figures in mineral specimens; 6. Swift microscope with Travis stage, swingout condenser and Crouch foot.

3. Jim Solliday showed his Wild M-11 monocular microscope c.1958-60 (see photo) with inclined rotatable eyepiece and cylinder bell-jar shaped cover which makes a hermetic closure against the circular foot of the instrument. It features a 4-objective ball bearing turret, a floating mechanical stage, swingout Abbe 1.3NA condenser with filter holder, 2-sided mirror, and a fine focus adjustment that acts on the stage. Tiyoda had made a copy of the M11. There was a discussion of the Wild M-5 (MOTIC) design which had been copied in China. Jim said that, in Herman Adler's opinion, Wild made the very best quality mics. Jim's M-11 fully attests to this opinion.

4. John De Haas showed a 1909 Koristka microscope (see photo) of excellent construction. He also showed a B&L microtome (see photo).

5. Alan de Haas showed: 1. A French Nachet monocular Continental microscope, #78489, c.1921 (see photo) with 4-objective turret, wrinkle finish foot; 2. A very unusual Leitz student microscope with a swing-out type of divisible objective of excellent optical quality, having powers of 8.5x, 22x and 42x. It has a single knob coarse focus adjustment and the outer brass tube that surrounds the body tube has exceptionally thick walls and appears to have been made of a free machining brass (bronze?); 3. A rare Zeiss clinical comparison spectroscope used to analyze fluids by comparison of the unknown to a known sample, contained in two glass SS tubes. The length of the micrometer chamber is calibrated. The unit can be mounted horizontally. The spectra are obtained via a 3-prism 'direct vision' Amici prism in the same manner as in the 5-prism Browning spectrometer of the early 1900s (see photo).

Note: In the case of a prism-spectroscope the rays are deflected in passing through the system so that, in order to view the spectrum, the eye is to be pointed not directly towards the luminous source, but in some oblique direction - which is sometimes inconvenient. Accordingly, various prism systems have been proposed which are designed so that rays corresponding to some definite standard color are finally bent back into their original direction, with the result that there is dispersion without deviation, which is an effect precisely opposite to that which is obtained with an achromatic prism. In these so-called 'direct vision prisms', the spectrum of an illuminated slit will be seen in the same direction as the slit itself.

Alan then showed: 4. An Ultra-Fluor Zeiss objective (very expensive!) #100108, used only with a certain 10:1 eyepiece of quartz and calcite and one tube length for UV observation only, using a 0.35mm quartz cover glass.

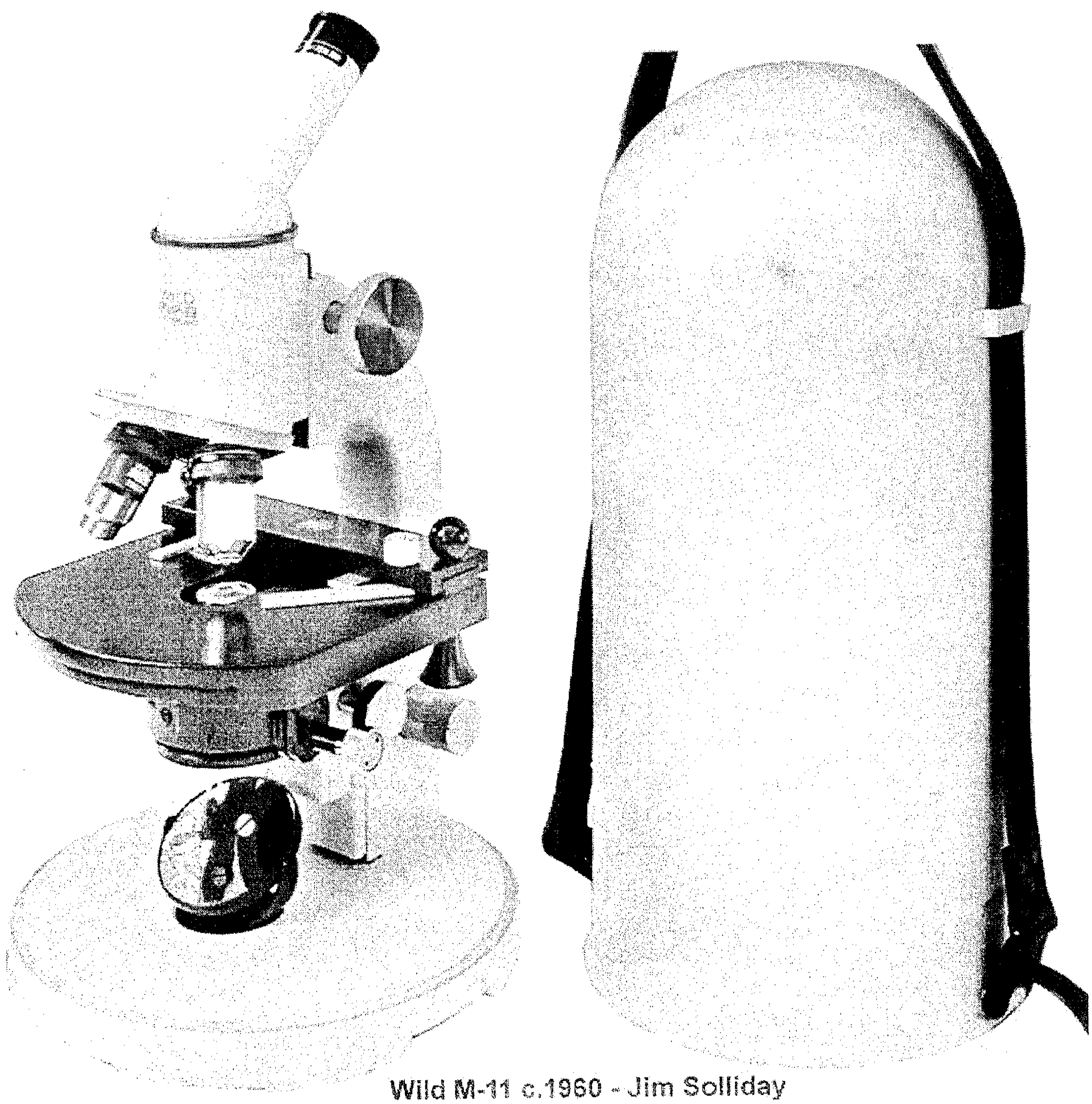
6. Gaylord Moss told us of Chinese manufacture in clean rooms of solid state lasers. He cited a 250mw pulsed diode laser at 1060 nm, where the output is converted by a YAG up converter to 532 nm. Gaylord particularly noted that all YAG crystals, being used by US laser equipment manufacturers, are being made in China.

7. Allen Bishop described a Fuji developed CCD imaging unit for use in 35mm cameras. He then described: 1. A large dissecting stand #1887, by Zeiss, for which he had constructed arm rests of mahogany (see photo); 2. A Zeiss Jena goniometer with graduated disk and a

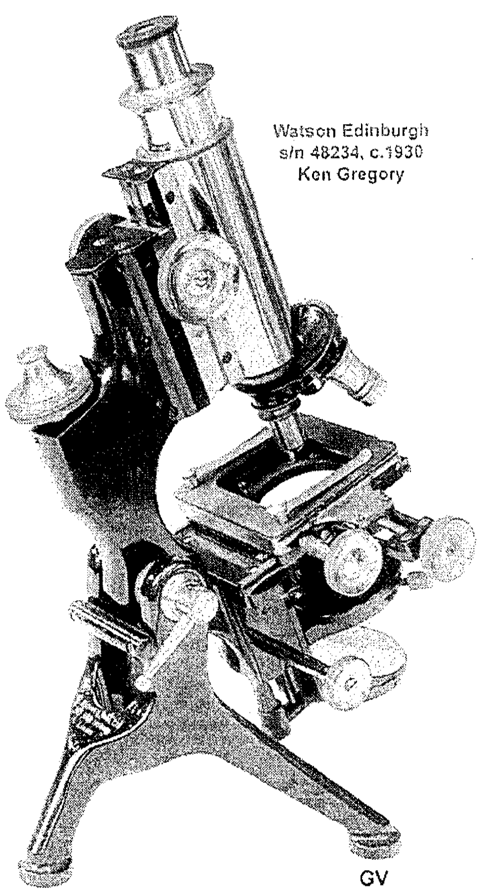
micrometer eyepiece where, amazingly, the eye lens is by Olympus! The unit is used to examine and measure the angles in mineral crystals and comes with 8 retardation plates of different values. The photo shows this unit beside a similar unit of Ken Gregory.

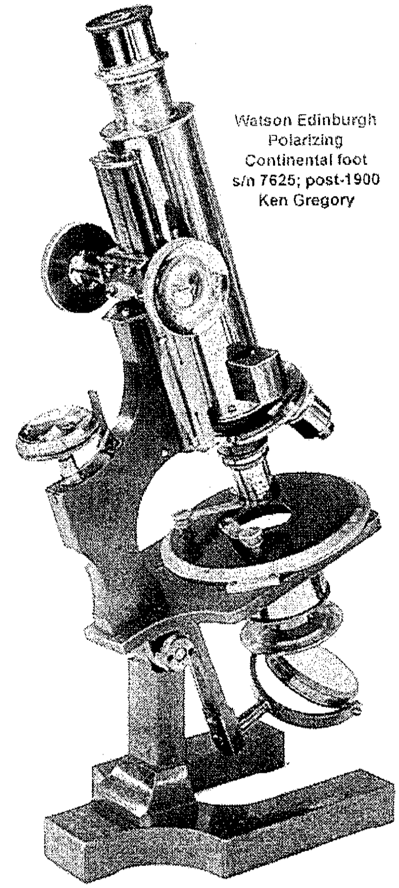
8. Gary Legel described his experience with John De Haas' brine shrimps brought home from our exhibition meeting. They seem to be photophobic and half of them had succumbed at a storage temperature of 40 deg.F., but the remainder produced some 10,000 new hatchlings! He described seeing some grossly overpriced mics. in a shop in Solvang. Gary then exhibited a small microscope 'replica', sold by Edmund Scientific Co., which is a composite of features found in c.1900 microscopes

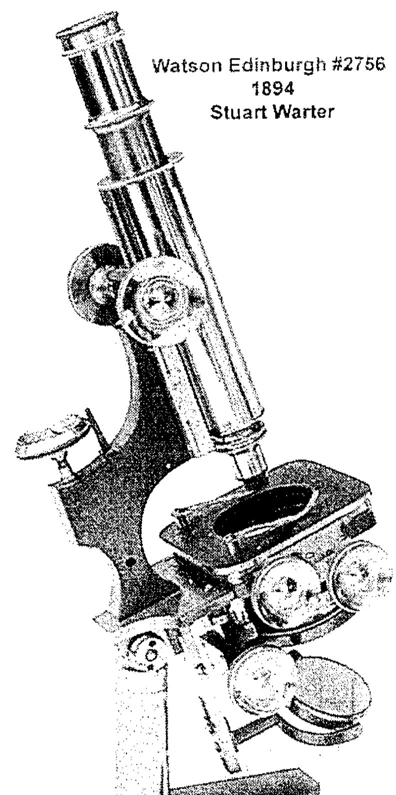
9. Jack Levy showed his newly designed and constructed "photo tent" (see photo) which he will use to photograph butterflies in their natural environment. The mesh tent it 4.5-ft. in diameter and is supported in the field by three monopod legs. The steel hoop can be collapsed to smaller diameter in the same manner as a band saw blade is collapsed for storage.

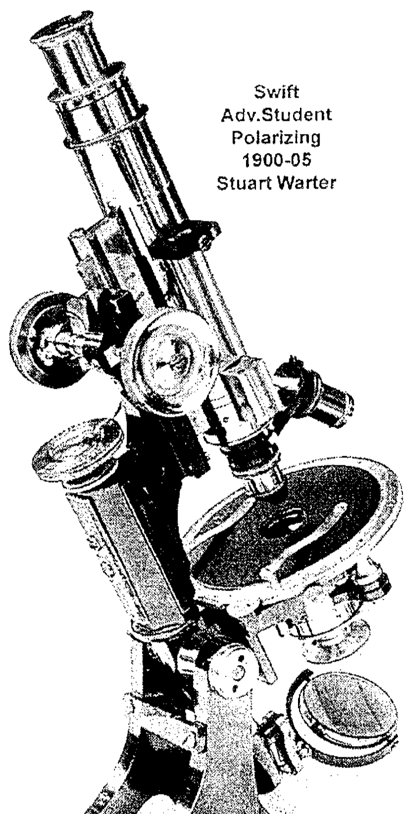


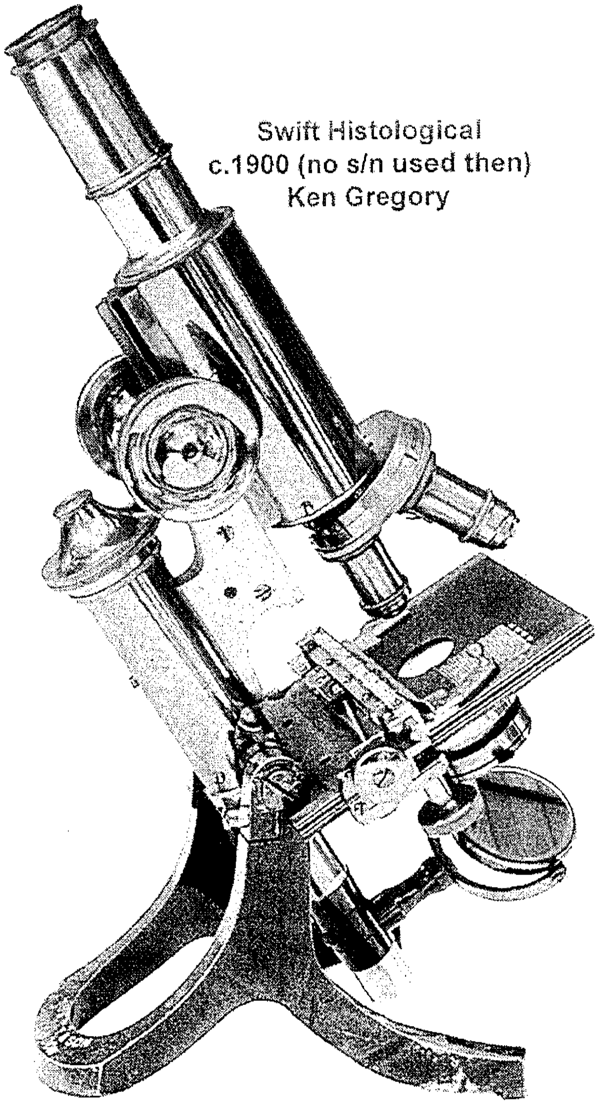
Wild M-11 c.1960 - Jim Solliday

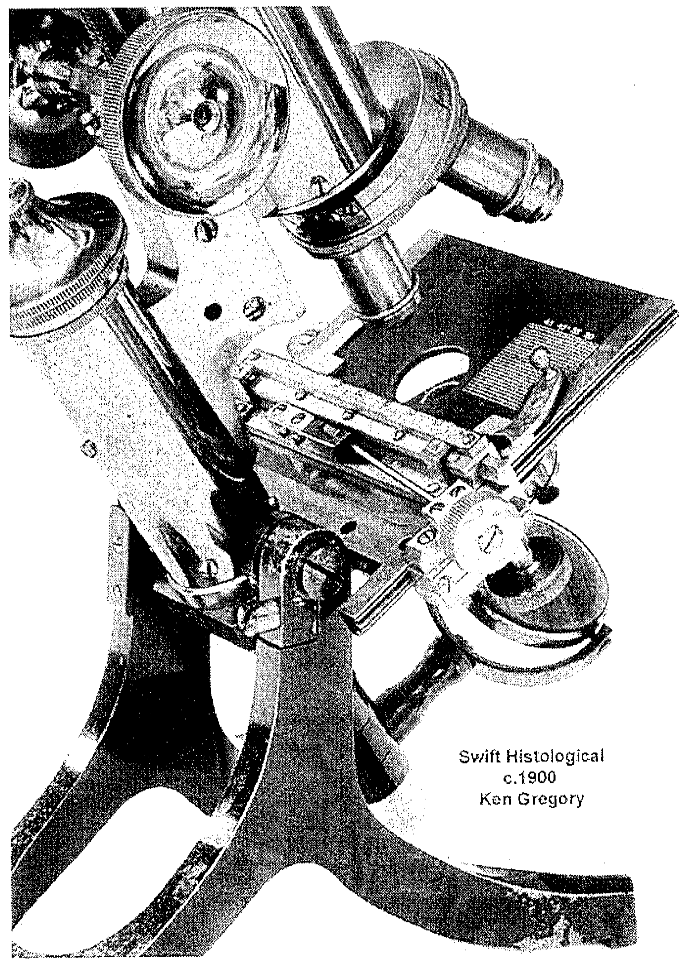

Watson Edinburgh
s/n 48234, c.1930
Ken Gregory
GV

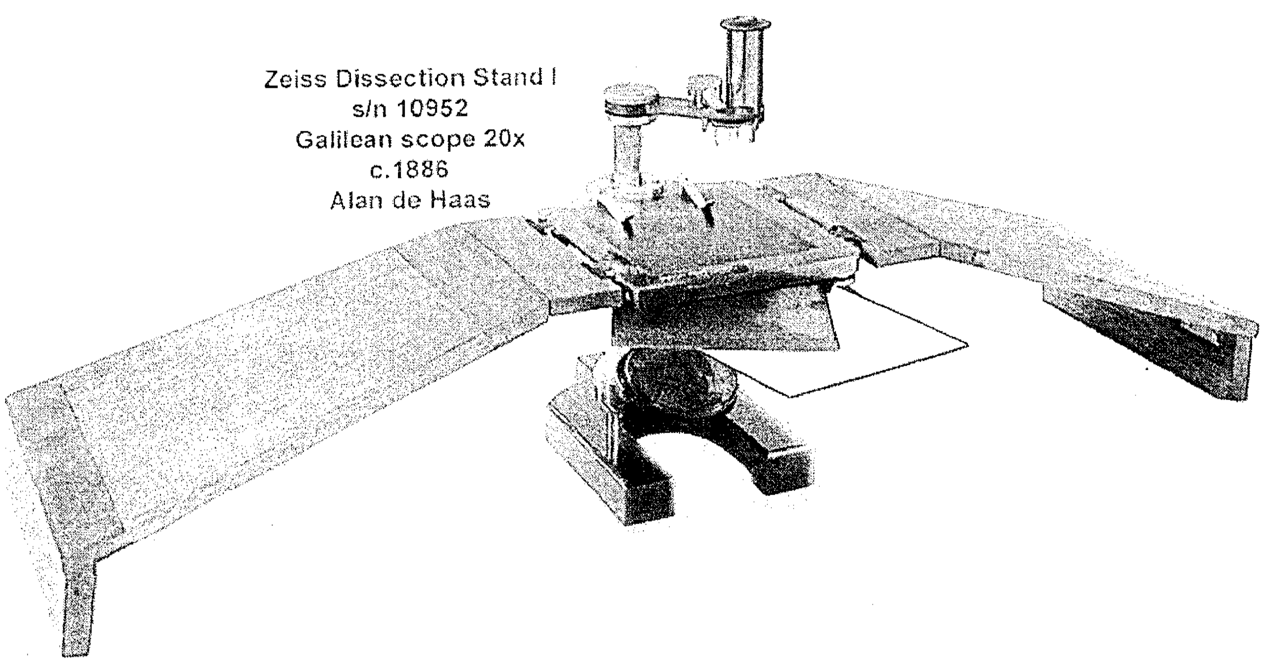

Watson Edinburgh
Polarizing
Continental foot
s/n 7625; post-1900
Ken Gregory


Watson Edinburgh #2756
1894
Stuart Warter
GV

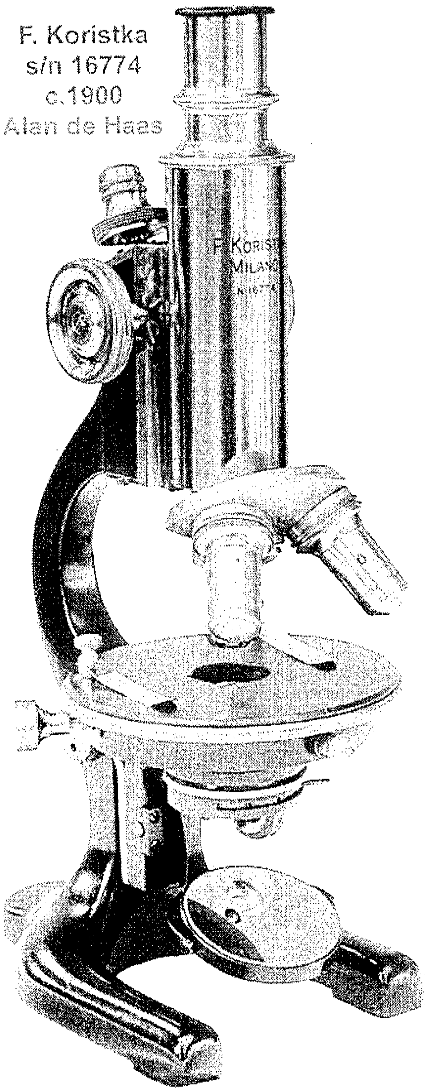

Swift
Adv.Student
Polarizing
1900-05
Stuart Warter


Swift Histological
c.1900 (no s/n used then)
Ken Gregory

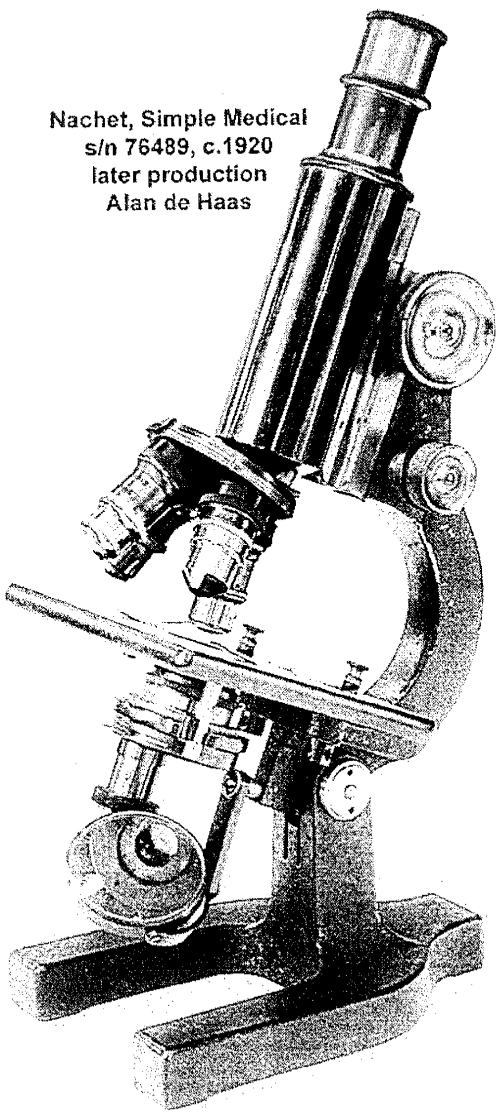

Swift Histological
c.1900
Ken Gregory

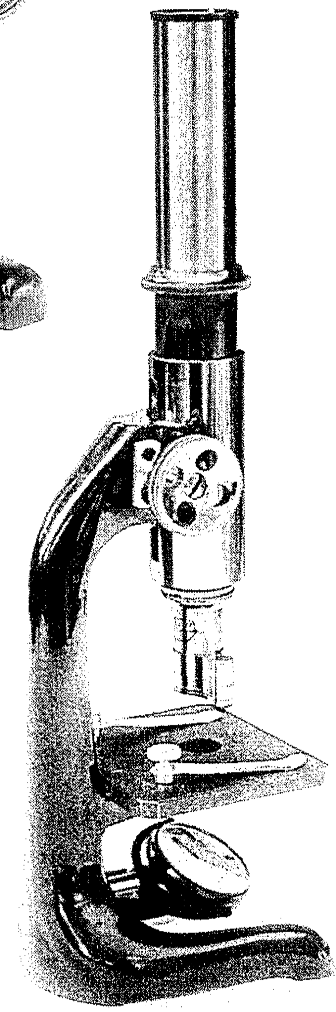

Zeiss Dissection Stand I
s/n 10952
Galilean scope 20x
c.1886
Alan de Haas

F. Koristka
s/n 16774
c.1900
Alan de Haas

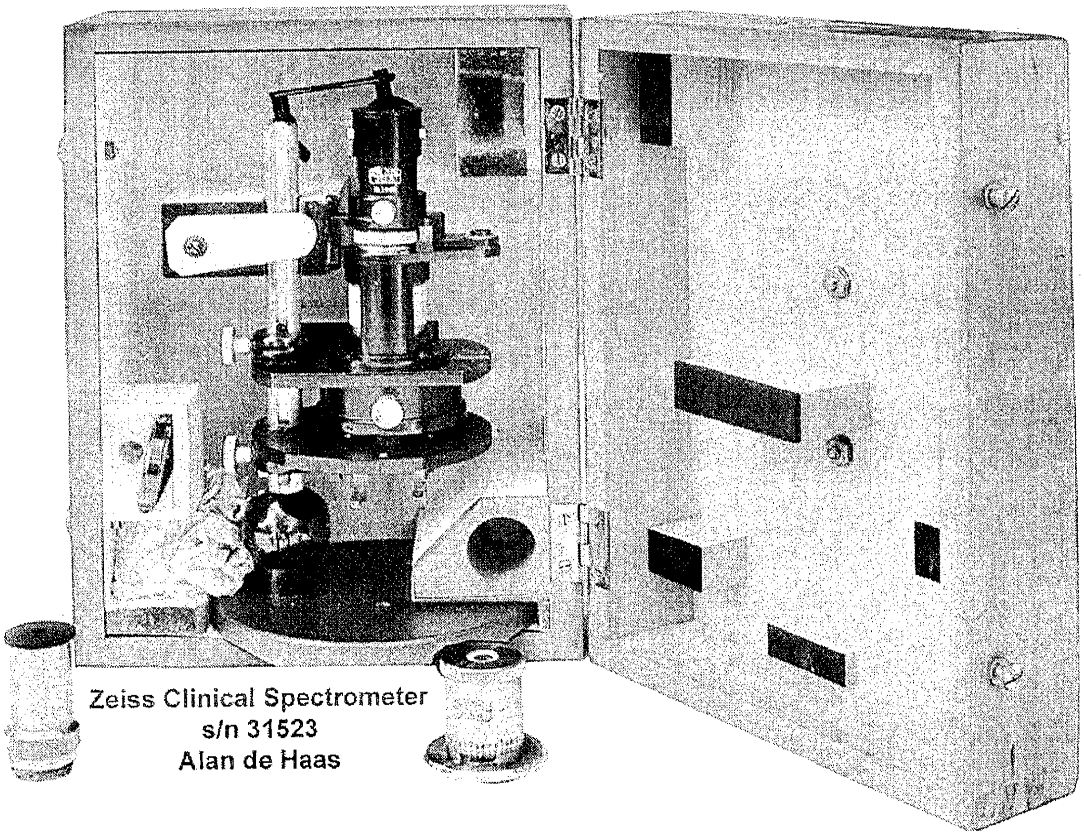


Nachet, Simple Medical
s/n 76489, c.1920
later production
Alan de Haas

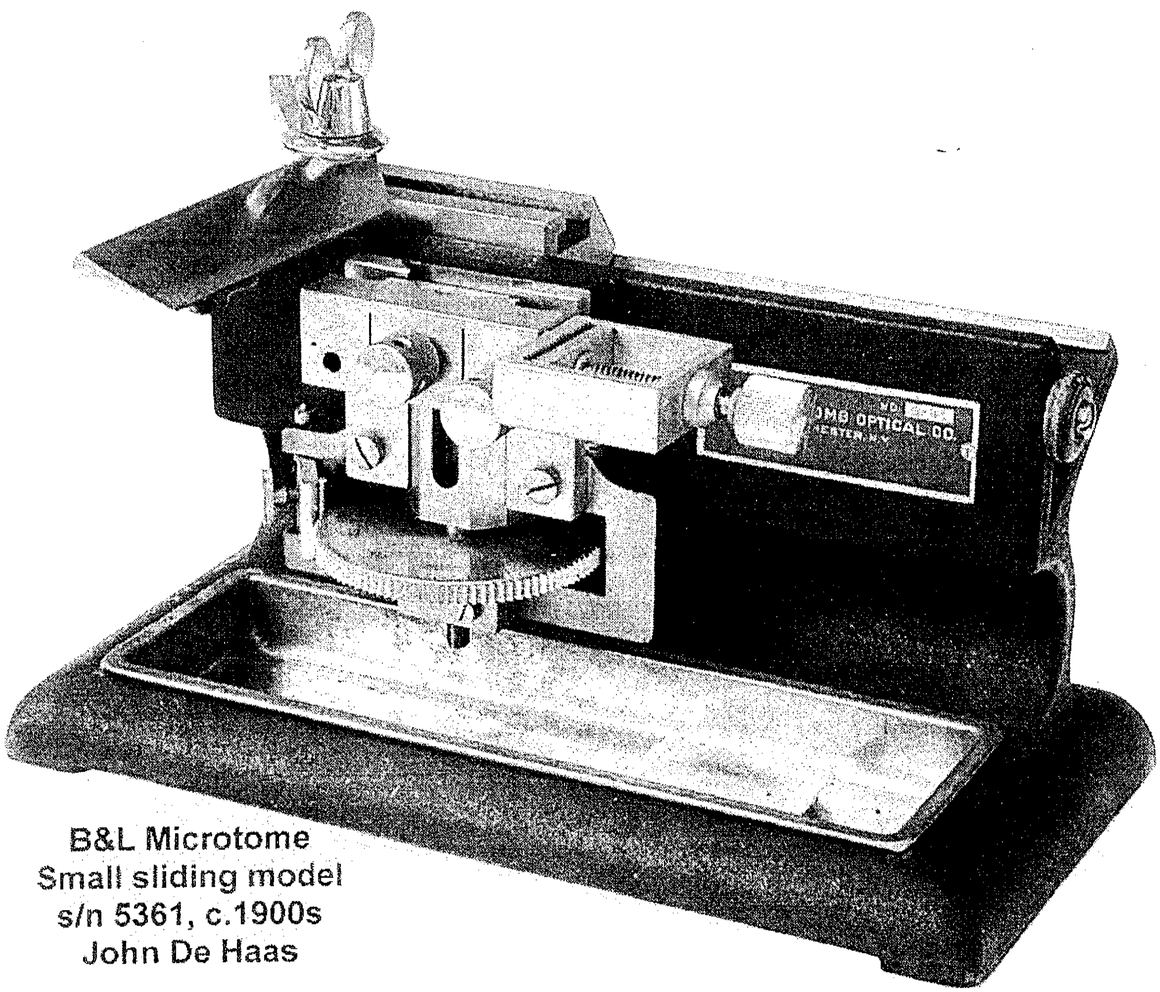




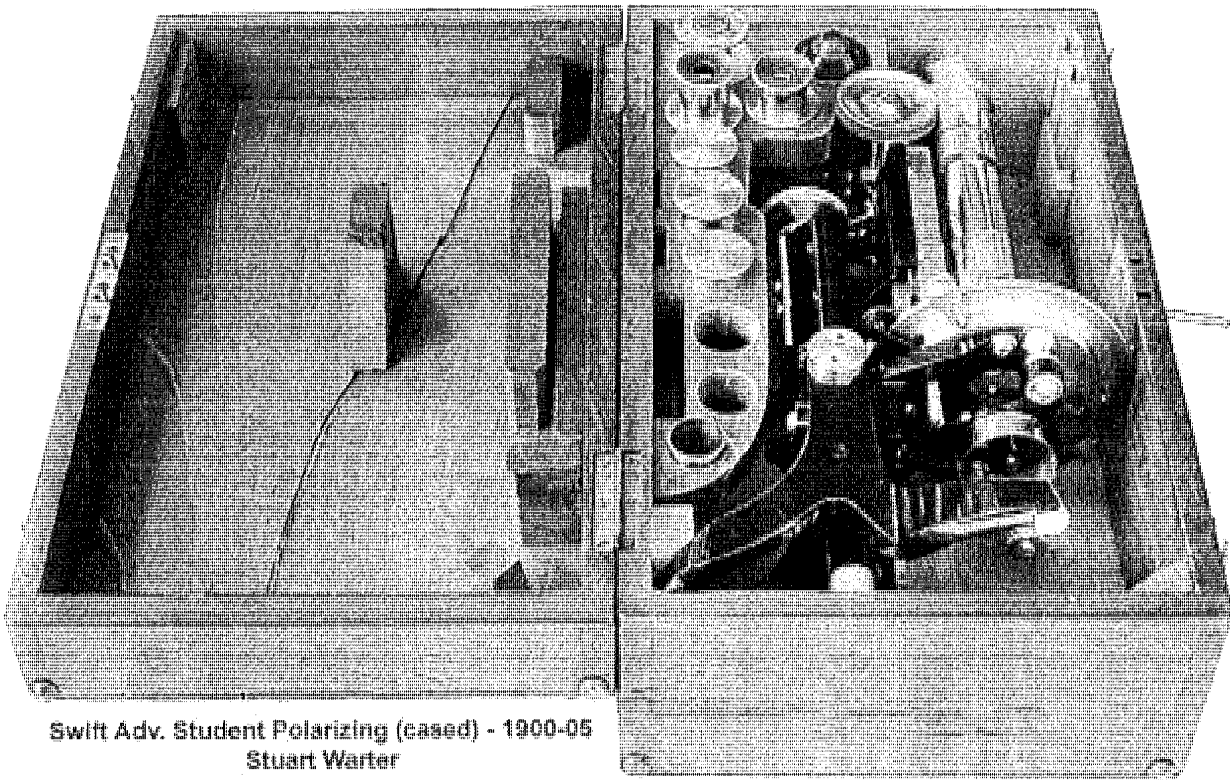
Leitz Stand 0
s/n 275427, c.1920
Fine optics, divisible
Alan de Haas



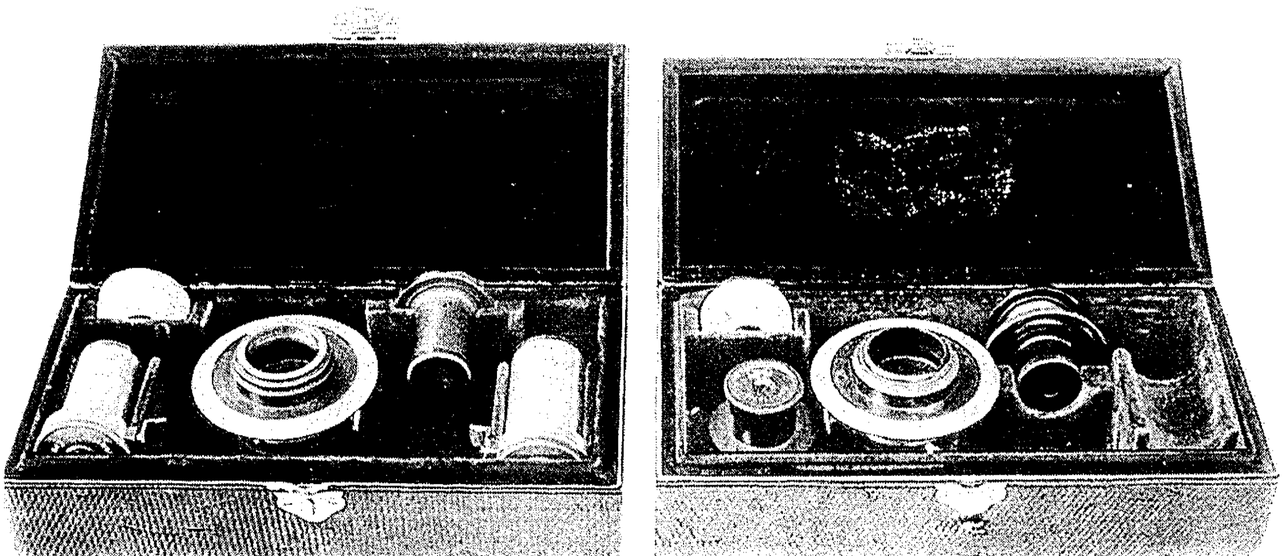
Zeiss Clinical Spectrometer
s/n 31523
Alan de Haas



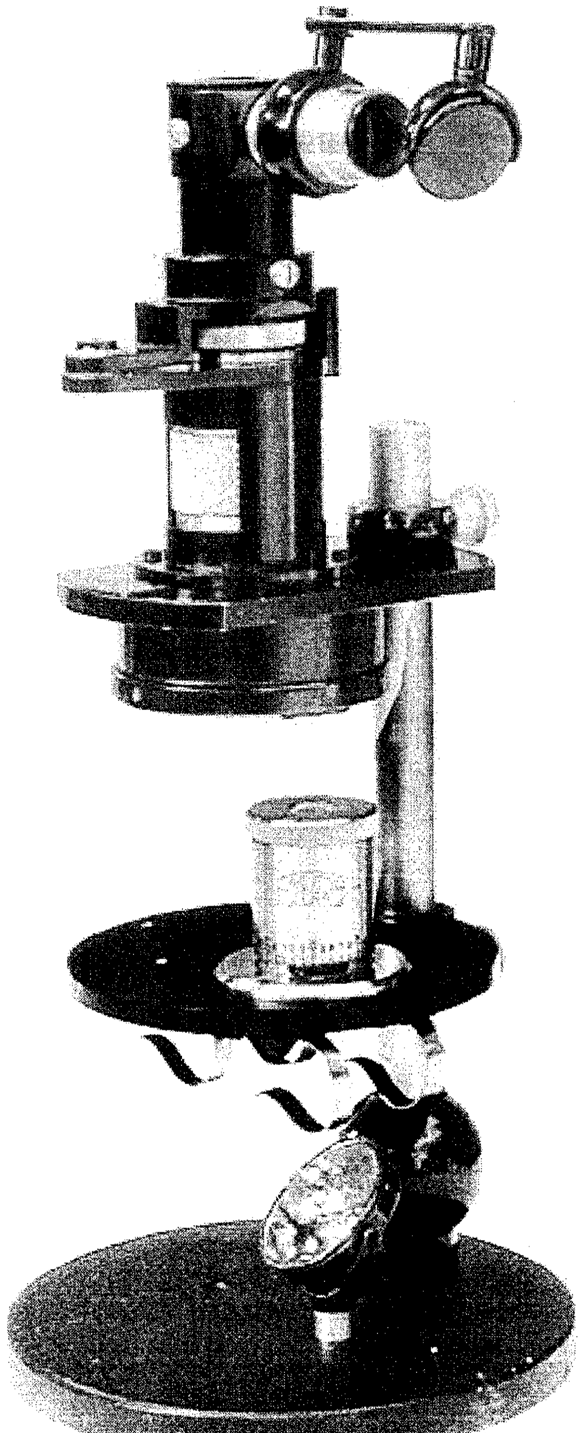
B&L Microtome
Small sliding model
s/n 5361, c.1900s
John De Haas



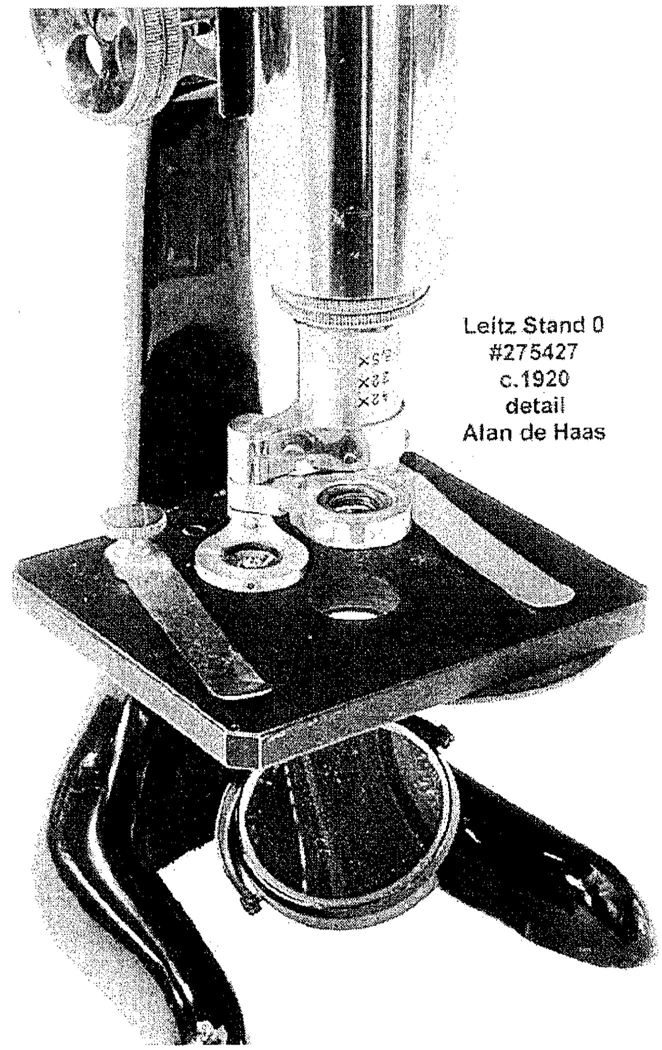
Swift Adv. Student Polarizing (cased) - 1900-05
Stuart Warter



Zeiss Polarization Outfits - early 1900s - Ken Gregory, Allen Bishop



Zeiss Clinical Spectrometer
s/n 31523
Alan de Haas

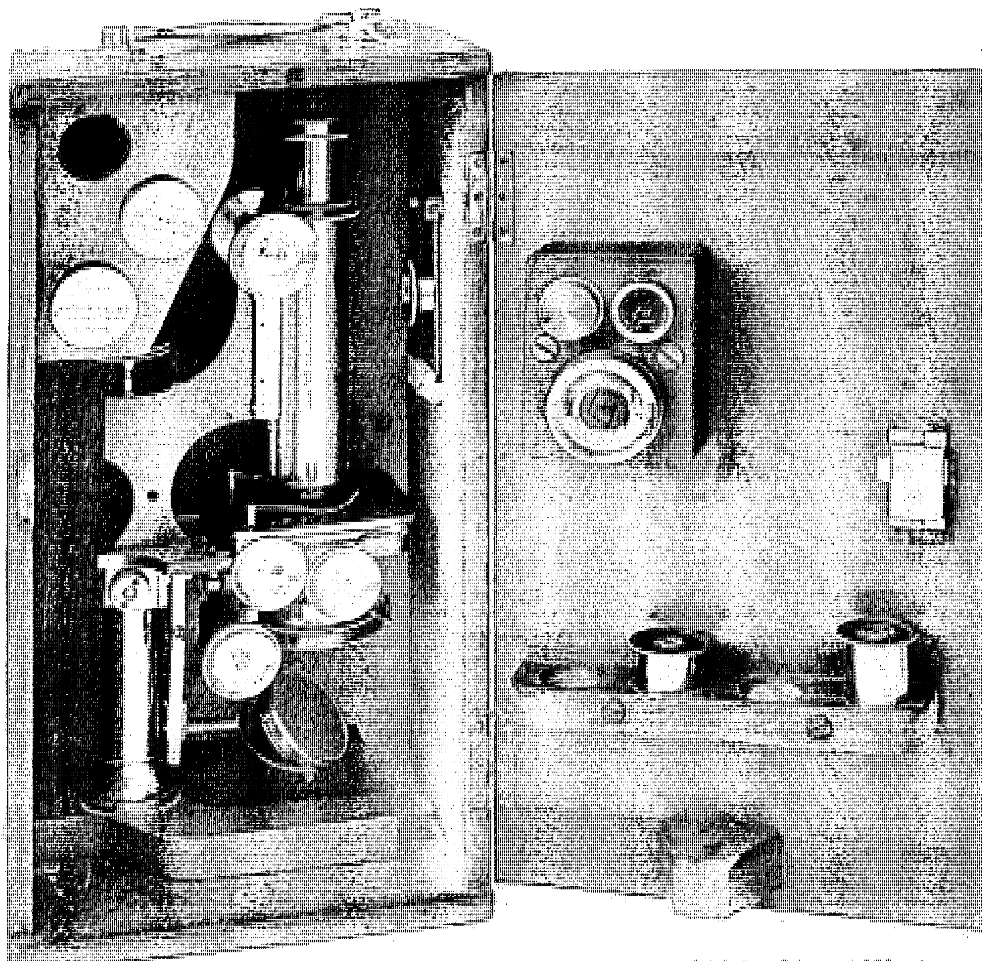


Leitz Stand 0
#275427
c.1920
detail
Alan de Haas

In December, 2000, on the television program "Who Wants to be a Millionaire", Regis Philbin asked the following question at the $2000.-level."On what part of a microscope could the specimen be placed-(Aj) ocular,(B)stage:(c)mirror;(d)J foot.The contestant was unsure, but didn't want to use a lifeline so early in the game. He chose an incorrect answer(c)mirror as his final answer and had to leave with only $1000.This shows that a little bit of knowledge about microscopy could be worth at least $990,000.Attending meetings of the Microscopical Society of Southern California is a smart move!

Submitted by Jack Levy

Jack Levy with his portable insect photographing net enclosure


Watson Edinburgh s/n 2756 (cased) - 1894 - Stuart Warter

TOPIC INDEX
MSSC JOURNAL 2000

A Discovered,A Discovery and A Darwinian Diatom.Jefts, RM June p.105.
An Improved Smoke Cell Design for the Video Display of Brownian Motion. Davies,B.August p.148
Diatomaceous Earth: Fossil Frustules and Filtration. .Jefts, RM Jan. p.1.
e-bay Seminar by Chris Brunt. Sept. p.203.
Ernie Ives Coleoptera Beetle Digital Photograph.Albright,L. Feb. p.41.
Film Canister Photo Studio. Moss, GE. Dec. p.241.
Fuess Company, Bishop,A.April p.74
Fuess Petro Stand, Bishop,A.April p.63.
Index, 2000 Author. Dec. p.242.
Index, 2000Topic. Dec. p.240.
In the Mind's Eye.Thomas, C. Dec. p.43.
James D. Solliday. Sept. p.182
Joseph Zentmayer's Pocket Microscope. LaRue,BJ.August p.143
Keyence Digital Video Microscope System. Gansoddin,L. July p.142
Making a Spinthariscope.Albright,L. Dec. p.225.
Map & directions to workshop at home of Ken Gregory.August p.162
Membership List Additions and Corrections. Feb. p.35.
Microscopy in America - Part I. Directory Listings of Microscopical Societies.Warter, SL. Mar. p.59.
Microscopy in America Part II,Warter,S.April p.79.
Microscopy in America Part IV. Listing of Microscopists from the Microscopist's Annual,Warter, S. June p.106
Microscopy in America. Part III. The Microscopist's Annual of 1879,Warter, S. May p.91.
Microtomes Medium Size, deHaas,J.April p. 76.
MSSC Journal Mailing List for 2000. Jan. p.17.
MSSC Workshop of 2 Dec 2000. Vitt,GG Jr. Dec. p.231.
MSSC Workshop of 4 November 2000. Vitt,GG Jr. Nov. p.220.
MSSC Workshop of 6 May 2000. Vitt,GG Jr. May p.98.
Nikon 950 Digital Camera and the Microscope. Vitt,GG Jr. Jan. p.16.
Oct. 28 Special Workshop on Portable Microscopes. Vitt,GG Jr. Nov. p.205
Picture of the first post World War II Zeiss binocular microscope, the W stand. Layfield,H. Sept. p.181.
Priestly on the Bicentennial of the Invention of the Microscope.Warter,S Jan. p.9.
Program for Meeting of August, 2000. Make Your Own Micromount Slides (material kits and instructions provided by Ed Jones; bring a stereo microscope.).August p.162
Program for Meeting of July 19, 2000.
Program for Meeting of November, 2000.The Yearly Member Exhibition Meeting. Sept. p.204.
Program for Meeting of October, 2000.The Microscope and the Computer. Solliday,JD. Oct.p.182.
Program for the Meeting of April 19, 2000. Brownian Motion, Mechanisms Old and New for Viewing. Davies,W. Jan. p.20.
Program for Wednesday, May 17, 2000.Annual Spring Pond Life Meeting. Feb. p.42.
Radial Arm Microscope,A Short History of . Solliday,JD. March p.43.
Reicherts,Three. Vitt,GG Jr. Dec. p.230.
Report of the MSSC, Meeting of August, 2000. Vitt,GG Jr. Sept. p.163.
Report of the MSSC, Meeting of July, 2000. Hirsch,DL.August p.161
Report of the MSSC, Meeting of October, 2000. Hirsch,DL. Sept. p.203.
Societe Genevoise, Bishop,A. May p.84.
Some Thoughts on Trick Illumination. Hartley, May p.100.
Spencer Prototype. Bishop,A. October p.183
Stan Baird's Camera to Tripod Adapter. Vitt,GG Jr. June p. 124.
The Microprojector. Hirsch,DL. Sept. p.76.
The Polaroid DMC Digital Microscope Camera. Kleinman,GM. July p.130
Two More Travelling Microscopes. Wilkinson, B Feb. p.38.
Unusual Zeiss Microscope Objectives - Nicholas Grossman – Zeiss Historica. March p.49.
V. Gunson Thorpe, F.R.M.S, Surgeon in the Royal Navy A Microscopist with the World at His Feet. Solliday, JD. Feb.

p.21.
Voyage of Discovery,The Challenger Expedition. Field,J. July p.123
Workshop of Saturday, 1 April 2000, Vitt,GG Jr.April p. 82.
Workshop of the MSSC, August 5, 2000 featuring Seibert Microscopes. Vitt,GG Jr. Sept. p.163.
Workshop of the MSSC, August 5, 2000. Vitt,GG Jr.. August p.155
Workshop of the MSSC, 11 March, 2000. Vitt,GG Jr. Mar. p.52.
Workshop of the MSSC, 5 February, 2000. Vitt,GG Jr. Feb. p.36.
Workshop of the MSSC, January, 2000. Vitt,GG Jr. Jan. p.14.
Workshop of the MSSC, July, 2000. Vitt,GG Jr. July p.134
Workshop of the MSSC, June 3, 2000. Vitt,GG Jr. June p. 120.
Workshop of the MSSC, October 6, 2000. Vitt,GG Jr. Oct. p.194

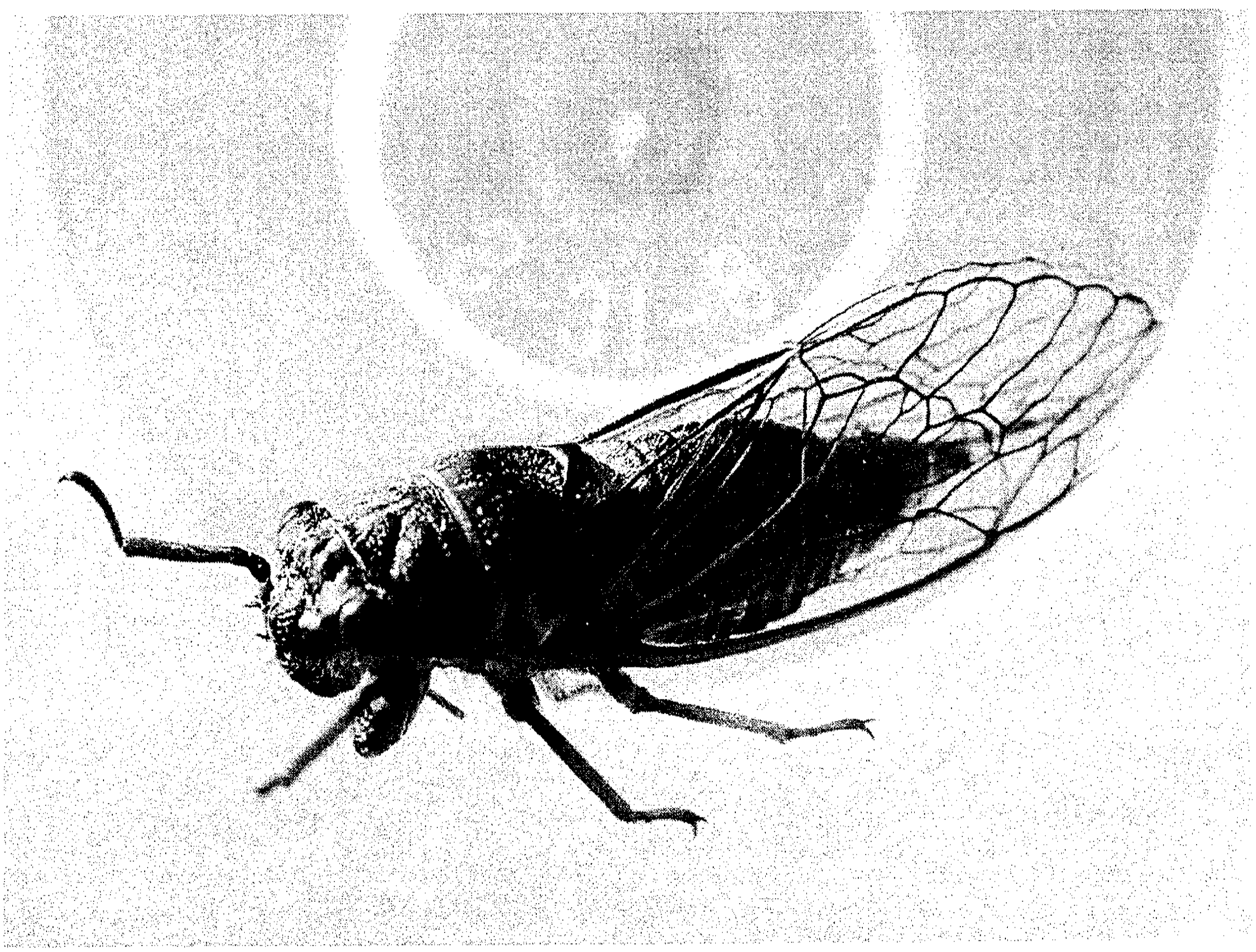
A Film Canister Photo Studio

Gaylord Moss

I never cease to be awed and delighted by the elegant design and construction of insects. After having caught the specimen below in Julian California, I desired to take a photograph before releasing it to go about its insect business. Having put it temporarily in a Fuji 35mm film canister, I realized that this made the perfect film studio to make the photographs, both capturing the insect and providing good lighting and lens access.

The lens on the Nikon 990 digital camera, which I had with me, was a perfect fit into the mouth of the canister. I had only to remove the top from the canister, put the lens against the opening and snap the shutter. Since the camera autofocuses down to 0.8 inches and the sunlight coming through the plastic was nicely diffused, the whole process was as simple as that. See the resulting photo below.

Any of the Nikon 900 series digital cameras with their remarkable close focusing capability would work as well.



AUTHOR INDEX
MSSC JOURNAL 2000

Albright,L Making a Spinthariscope.. Dec. p.225.
Albright,L. Ernie Ives Coleoptera Beetle Digital Photograph.. Feb. p.41.
Bishop,A .Fuess Petro Stand,. April p.63.
Bishop,A Spencer Prototype.. October p.183
Bishop,A. Fuess Company,. April p.74
Bishop,A.Societe Genevoise, May p.84.
Brunt,C. e-bay Seminar by Chris Brunt. Sept. p.203.
Davies,B. An Improved Smoke Cell Design for the Video Display of Brownian Motion.. August p.148
deHaas,J. Microtomes Medium Size. April p. 76.
Gansoddin,L. Keyence Digital Video Microscope System. July p.142
Grossman,N Unusual Zeiss Microscope Objectives — Zeiss Historica. March p.49.
Hartley Some Thoughts on Trick Illumination., May p.100.
Hirsch,DL Report of the MSSC, Meeting of October, 2000. Sept. p.203.
Hirsch,DL The Microprojector.. Sept. p.76.
Hirsch,DL. Report of the MSSC, Meeting of July, 2000. August p.161
Index, 2000 Author. Dec. p.242.
Index, 2000 Topic. Dec. p.240.
Jefts, RM. A Discovered, A Discovery and A Darwinian Diatom. June p.105.
Jefts, RM. Diatomaceous Earth: Fossil Frustules and Filtration. . Jan. p.1.
Kleinman,GM. The Polaroid DMC Digital Microscope Camera. July p.130
LaRue,BJ. Joseph Zentmayer's Pocket Microscope. August p.143
Layfield,H Picture of the first post World War II Zeiss binocular microscope, the W stand.. Sept. p.181.
Map & directions to workshop at home of Ken Gregory. August p.162
Membership List Additions and Corrections. Feb. p.35.
Microscopy in America Part IV. Listing of Microscopists from the Microscopist's Annual, June p.106
MSSC Journal Mailing List for 2000. Jan. p.17.
Moss, GE. Film Canister Photo Studio. Dec. p.241.
Program for Meeting of August, 2000. Make Your Own Micromount Slides (material kits and instructions provided by Ed Jones; bring a stereo microscope.). August p.162
Program for Meeting of July 19, 2000.
Program for Meeting of November, 2000. The Yearly Member Exhibition Meeting. Sept. p.204.
Program for Meeting of October, 2000. The Microscope and the Computer. James D. Solliday. Sept. p.182
Program for the Meeting of April 19, 2000. Brownian Motion, Mechanisms Old and New for Viewing. Davies,W. Jan. p.20.
Program for Wednesday, May 17, 2000. Annual Spring Pond Life Meeting. Feb. p.42.
Solliday,JD. Radial Arm Microscope, A Short History of . March p.43.
Solliday,JD.V. Gunson Thorpe, F.R.M.S, Surgeon in the Royal Navy A Microscopist with the World at His Feet. Feb. p.21.
Thomas, C.In the Mind's Eye. Dec. p.43.
Vitt,GG Jr MSSC Workshop of 4 November 2000.. Nov. p.220.
Vitt,GG Jr MSSC Workshop of 6 May 2000.. May p.98.
Vitt,GG Jr Oct. 28 Special Workshop on Portable Microscopes.. Nov. p.205
Vitt,GG Jr Report of the MSSC, Meeting of August, 2000.. Sept. p.163.
Vitt,GG Jr. Three Reicherts. Dec. p.230.
Vitt,GG Jr. MSSC Workshop of 2 Dec 2000. Dec. p.231.
Vitt,GG Jr. Nikon 950 Digital Camera and the Microscope. Jan. p.16.
Vitt,GG Jr. Stan Baird's Camera to Tripod Adapter. June p. 124.
Voyage of Discovery, The Challenger Expedition. Field,J. July p.123
Warter, SL. Microscopy in America - Part I. Directory Listings of Microscopical Societies. Mar. p.59.
Warter, SL. Microscopy in America. Part III. The Microscopist's Annual of 1879, May p.91.
Warter,SL Microscopy in America Part II,. April p.79.

Warter,SL Priestly on the Bicentennial of the Invention of the Microscope. Jan. p.9.
Wilkinson, B Two More Travelling Microscopes. Feb. p.38.
Workshop of Saturday, 1 April 2000, Vitt,GG Jr. April p. 82.
Workshop of the MSSC, August 5, 2000 featuring Seibert Microscopes. Vitt,GG Jr. Sept. p.163.
Workshop of the MSSC, August 5, 2000. Vitt,GG Jr.. August p.155
Workshop of the MSSC, 11 March, 2000. Vitt,GG Jr. Mar. p.52.
Workshop of the MSSC, 5 February, 2000. Vitt,GG Jr. Feb. p.36.
Workshop of the MSSC, January, 2000. Vitt,GG Jr. Jan. p.14.
Workshop of the MSSC, July, 2000. Vitt,GG Jr. July p.134
Workshop of the MSSC, June 3, 2000. Vitt,GG Jr. June p. 120.
Workshop of the MSSC, October 6, 2000. Vitt,GG Jr. Oct. p.194

IN THE MIND'S EYE

Or how I learnt to love a diatom

Chris Thomas

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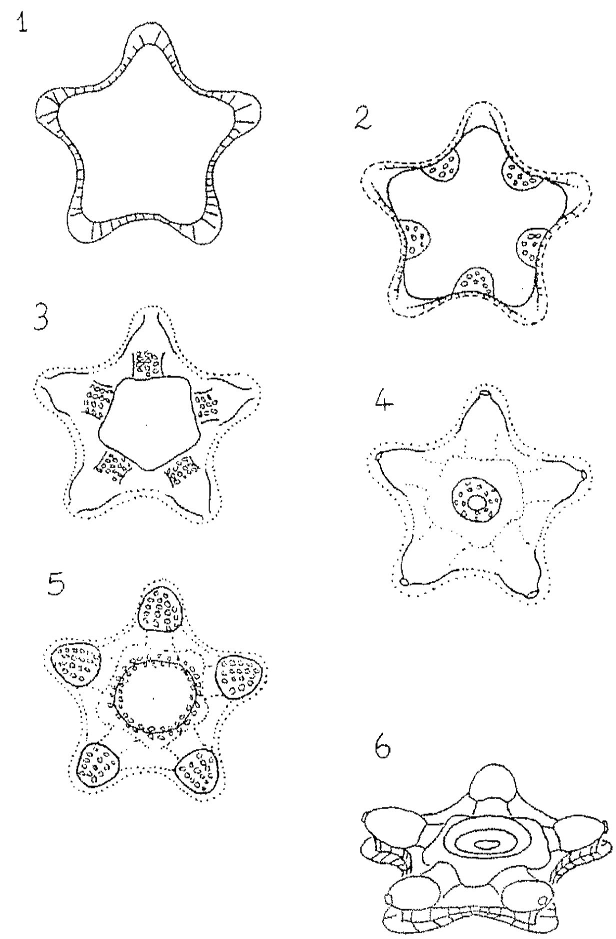
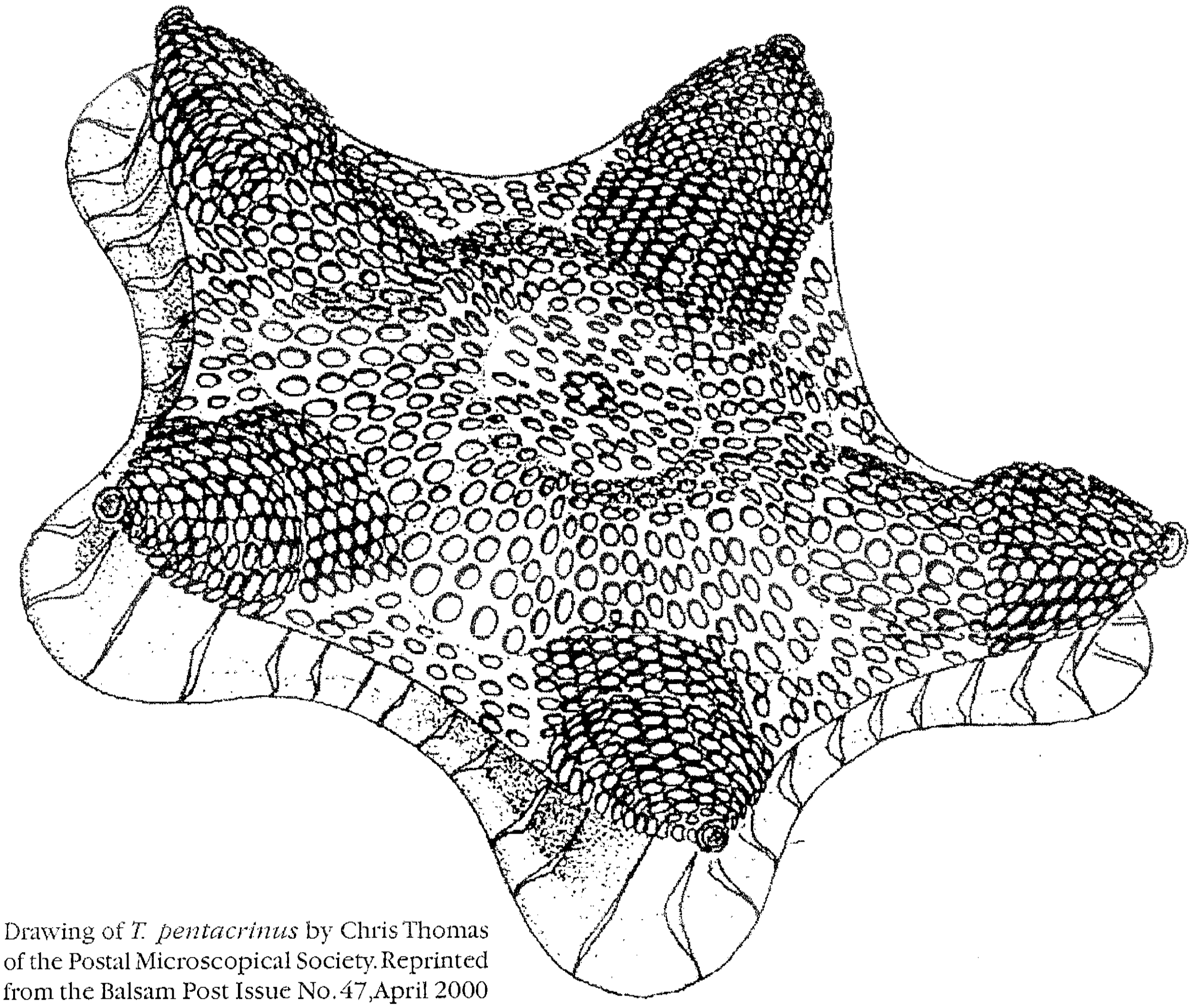
Most of us amateur microscopists have our favorite subjects and those that do not excite us as much. To be honest, diatom slides generally fall into the second category for me. It is not quite 'once you have seen one, you have seen them all' but though they may challenge the optics of many microscopes when carefully prepared, I find them prettier alive. However, occasonally you do come across the exceptional sample or slide which grabs your interest. A slide of *Triceratum pentacrinus* specimens by K.D. Kemp in PMS box 96/22 is a case in point.



I was fascinated by the slide not only for the unusual shape of the diatoms but also by the patterning. Normally, a photograph could capture the beauty of the slide, however, the specimens were very sculptured and the appearance varied greatly with focussing due to the short depth of field for a 40X objective. Secondly, though the surface patterning could be visualised as the usual semi-regular array of raised discs (punctae, I believe), I could not quite form a clear impression of the three dimensional structure of the frustule without going to some extra effort. In such situations, I reach for a pencil and paper and try to draw the subject. This time, it was not going to be quite that simple because of course I had made this trivial decision on the night before I needed to send the box on to the next member of the circuit!

OK, what to do next? Well, a rough impression of the sample appeared in my mind when I focussed up and down but no doubt this would dissipate as soon as the slide left my hands. So, some photography was required after all. I photographed a choice specimen with a 40X objective starting with the focal plane at the bottom of the diatom. The focus was then adjusted to slightly higher up the diatom and the sample photographed again. I repeated this until I reached the uppermost focal plane of the sample, seven pictures in all. I then chose the best focal plane for the diatom for visual impact and photographed it twice, once with the light entering on the right half of the lower con-



Drawing of *T. pentacrinus* by Chris Thomas of the Postal Microscopical Society. Reprinted from the Balsam Post Issue No. 47, April 2000 with the kind permission of the PMS.

denser aperture and once with light only entering the left half of the lower condenser aperture.This had two purposes; the one sided illumination would throw some of the surface features in relief and the two pictures could be combined to make a stereoscopic image that might be of use.

With the prints returned from the photographer, I concentrated on identifying which elements were in focus in each of the pictures and drew out a rough plan.

Figure 1. shows the plans for the five most imortant planes in the progression from the bottom of the slide to the upper focus.The stereoscopic pictures appeared to confirm the relative placement of features in photos three to five. Now came the tricky part. I did not really know how much I moved the focus each time before taking a picture. I guestimated that it was not much more than the height of a single surface puncta.

The base of the diatom was redrawn but as if viewed off to one side.The features in focus on the next picture were then drawn over the first image but slightly above it.The process was repeated for all the photos and plans drawn until I had a rough 3D presentation as shown in picture 6 of Figure 1. Entering the surface detail and a bit of shading gave the image shown above which was on the cover of this Balsom Post.

At the end of the process, I was pleasantly surprised. I had seriously underestimated the complexity of the 3D shape of *T. pentacrinus* and the representation finally obtained was unexpected. I learned to imagine and appreciate the beauty and complexity of a particular diatom frustule that went beyond the two dimensionality of the focal plane and photographic image. Am I satisfied? No, not really. I hope to do the sample even more justice in watercolours.