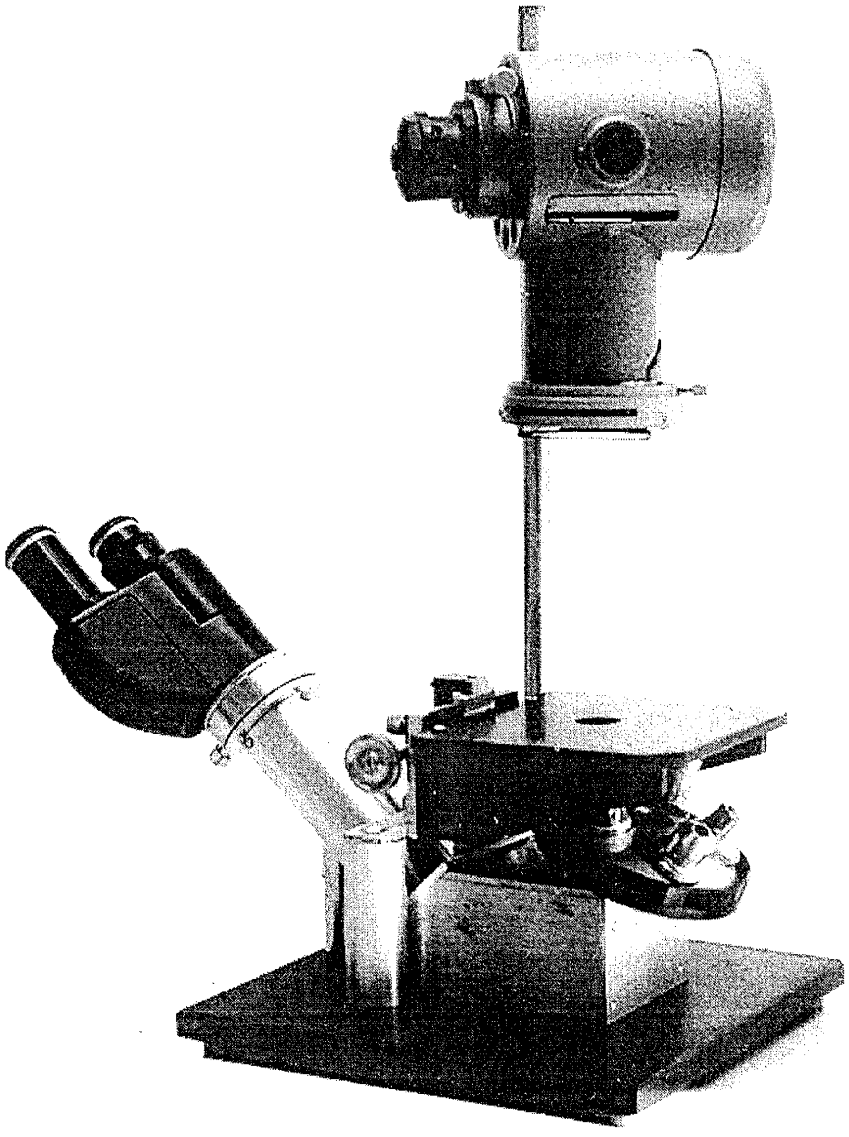
Journal of
THE MICROSCOPICAL SOCIETY OF SOUTHERN CALIFORNIA
Volume 3 Number 2 February 1998

AN INVERTED MICROSCOPE

BERT LORO



Inverted microscopes have been around for nearly 150 years yet are little known to most microscopists. The catalogue of the Billings Collection, for example, with 475 instruments illustrated, shows only 4 inverted microscopes.[5] Nachet was something of a pioneer in this field and offered 3 different models in his catalogues from 1856 to 1910.[1]

Perhaps the best known inverted microscope is the one invented by John McArthur in 1930.[2] The inverted format was undoubtedly key to enabling him to achieve an extremely compact portable design with no need for a coarse focusing mechanism, but with the performance of a full size microscope and having quite exceptional resistance to shock and vibration. It was his

claim that one could use his microscope "...in a train, an aircraft, a rocking boat, on the face of a precipice, or in a mine or pothole." [4]

Inverted microscopes of more conventional design are offered by a number of manufacturers and find their widest application in microbiological labs where they are used to examine sediments and microorganisms in culture bottles, petri dishes etc., or in lying drop preparations.[3]

My first practical experience of inverted microscopes was when I built my own version of a McArthur microscope in 1984. Some years later I acquired a Leitz of early 70's vintage when a local lab was updating its equipment. My first action, of course, was to take it apart "to see what makes it tick." I found the optical system very interesting and soon recognised that I had all the necessary bits and pieces amongst my years of carefully hoarded junk (treasures) to construct a similar instrument. I hope that this account of the optics andconstruction of an inverted microscope will be of interest.

THE MODEL

My guiding model was the Leitz binocular shown in fig.1. The number engraved thereon indicates that it was manufactured about 1973.

The stage is focused by rack and pinion and there is no fine focus. Standard Leitz x4, x6, and x10 objectives are carried on a quadruple nosepiece mounted below the stage on a prism housing. The body tube rises at 30° to the vertical from the end of the housing and has a stout brace which doubles as a carrying handle. The body tube terminates in a conventional binocular head.

Illumination is provided by a lamp clamped to a vertical rod which provides height adjustment. The 40w bulb has a frosted envelope and the lamp condenser is a bullseye type with the upper surface finely ground and etched. It is fitted with a 50mm iris and a filter holder. It can completely fill a NA 0.25 objective with very uniform light at a distance of 4cm.

MSSC Journal
Volume 3 Number 2 February 1998

CONTENTS

MICROSCOPICAL SOCIETY OF SOUTHERN CALIFORNIA

President	George G. Vitt Jr.
Vice President	James D. Solliday
Treasurer	David L. Hirsch
Secretary	Ronald F. Morris
Program	Larry Albright
Workshop	Steve Craig
Education	James D. Clark Jr.

Publication Correspondence To
Editor — Gaylord E. Moss
P.O. Box 9130
Marina del Rey, CA 90295
Tel/FAX (310) 827-3983
e-mail mosss@att.net

Other Correspondence To
President — George G. Vitt, Jr.
2127 Canyon Drive
Los Angeles, CA 90068
Tel/FAX (213) 464-6503
e-mail gvitt@att.net

Dues and Membership Applications To
Treasurer — David L. Hirsch
11815 Indianapolis Street
Los Angeles, CA 90066-2046
Tel (310) 397-8357

Prospective new members, please write to David L. Hirsch for membership application. Dues are $50 yearly for regular members and $40 yearly for corresponding members who are geographically too distant to attend regular meetings. Please make all checks payable in the name of our treasurer David L. Hirsch, **NOT** to MSSC.

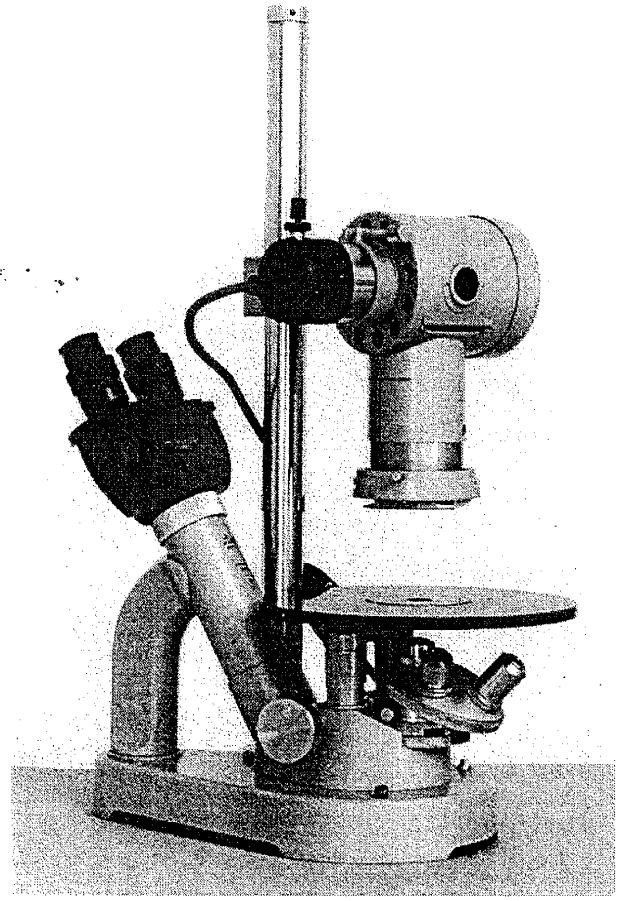


Fig. 1 The Leitz inverted microscope.

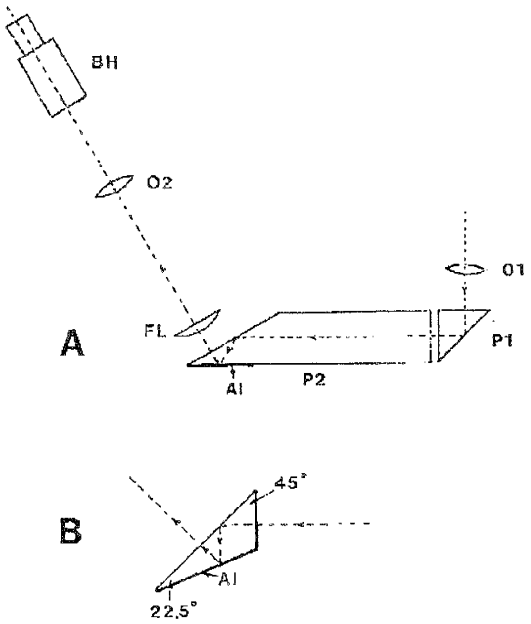


Fig. 2 A. The optical train used by Leitz.
01 Main objective.
P1 90 deg. deflection prism.
FL Field lens.
02 Second stage objective.
BH Binocular head.

Fig. 2B The 45 deg. deflection prism used instead of P2

The optical arrangement is shown in fig.2A. The 45° prism P1 reflects the axial ray from objective O1 horizontally into the long prism P2. When it strikes the 30° end face at 60° incidence it undergoes total internal reflection down to the aluminised lower horizontal face on which it is incident at 30°. After reflection it passes normally through the 30° face and up the inclined body tube.

At the lower end of the body tube is a piano-convex field lens FL which forms an image of the aperture of 01 in the aperture of a low power objective 02. This objective, together with the eyepieces in the binocular head BH, constitute a fixed focus microscope focused on the plane surface of FL. The microscope is in focus when the primary image formed by O1 is coincident with this surface. This surface is at the correct optical distance from O1 to satisfy the 170mm TL objectives. (Note: The primary image is located quite precisely at the surface of FL since an ink spot on this surface is always seen in sharp focus in the field. Surprisingly, I have never had a problem with dirt collecting on this surface and becoming obtrusive.)

The final image in this microscope undergoes two reversals on passing through the two stage optical system, as well as three reflections at the prisms. The binocular head has no effect on image orientation. The net result of all this is that the image corresponds in orientation and motion to the object as seen from above rather than below. This seems perfectly natural and superficially gives the impression of a fully rectified top view of the object but in fact it is equivalent to a reflection of the object in a mirror lying below it. This comes about because of the odd number of reflections involved.

THE COPY

Optically I have kept as close as possible to the Leitz design. The only significant deviation was the substitution of a prism, obtained from an old inclined eyepiece tube, in place of the long prism P2. Like P2 this reflects the image twice, but through a total of 45° (Fig.2B). Hence, the body tube ended up at 45° instead of 30°.

On the mechanical side, fabrication consisted of coupling together a number of existing components and making the rest from available raw materials (Fig.3). The design was very much a series of compromises dictated by availability of materials and my own limited fabrication skills. Throughout, my 6" lathe with milling facilities was absolutely indispensable.

The base is a piece of 1/2" black acrylic plastic to which was bolted the prism housing made from aluminum

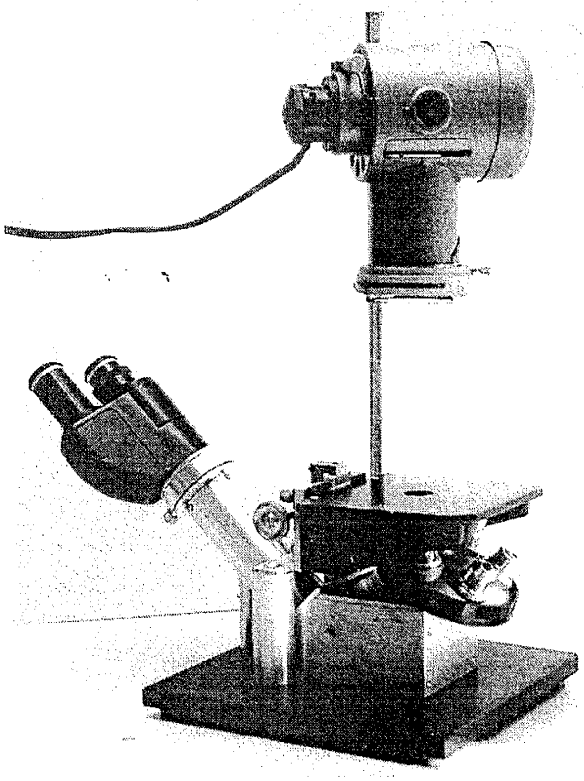


Fig. 3 The copycat inverted microscope

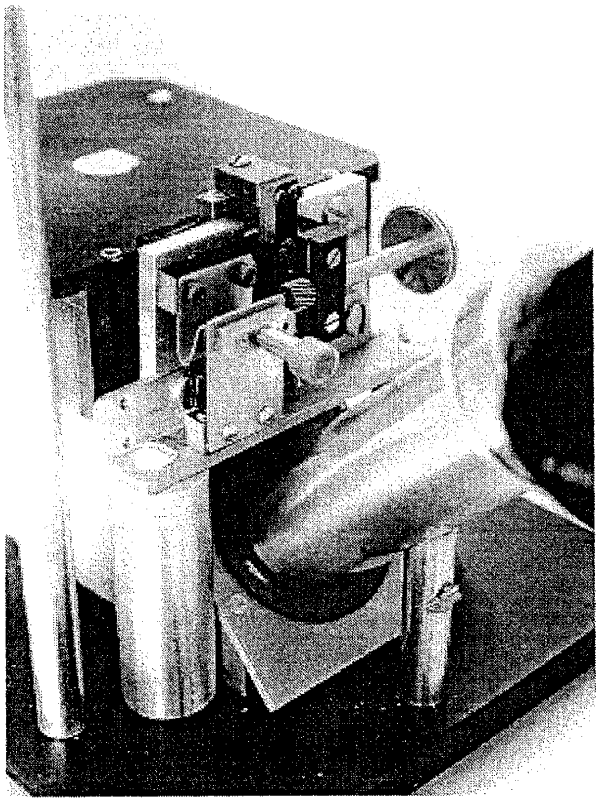


Fig. 4 Close-up of focus controls

plate. The nosepiece is a five port, silky smooth, ball raced beauty by Nikon (a bit of overkill here). Prism P1 came ready mounted for use on a projection eyepiece and required only bolting to the base and the addition of locking screws to fix the alignment. The substitute prism for P2 also came mounted in a die casting which I was able to turn to provide a coupling between the prism housing and the body tube as well as a nest for the field lens FL. The latter was an Edmunds Scientific surplus lens. The second objective 02 is a Wild x2 mounted on a short brass tube attached to the binocular head, which is unmarked but I think was of E. German Zeiss origin. The body tube is a thinly disguised piece of brass kitchen sink tailpipe. It is braced to the base by a length of 1/2" steel rod and is rock steady.

The stage is a plate of 1/4" acrylic plastic bolted firmly to a cemented, three sided box of the same material which makes it highly rigid.

The focusing mechanism is mounted on a bridge, over the prism housing, which consists of a pair of 1" diameter aluminum pillars spanned by a length of 1" hard brass right angle channel. To the latter is bolted a vertical piece of 1/4" steel boiler plate which mounts the dovetail slide. This consists of a milled brass male dovetail, fixed to the stage, sliding in lightly greased ways milled from acrylic. It is driven by a rack and pinion assembly salvaged from an old B&L mechanical stage. Something of an engineering nightmare you might think, but much to my amazement it operates smoothly and focuses a x10 objective with ease.

The lamphouse and condenser is identical to the one on the Leitz. It came from a Leitz Na lamp and required only the replacement of the original lamp holder with a regular household screw base socket to take a 40w frosted household appliance bulb, and the addition of a bracket to mount it on the 1/2" steel support rod.

At a late stage in the project I decided that I would like to be able to use 4mm objectives. This called for an increase in the NA of the illumination and the addition of some kind of fine focus adjustment. The aperture increase was easily taken care of by the addition of a short extension to the lamphouse to mount a molded aspheric condenser lens (Edmunds Scientific). This gave uniform illumination filling about 80% of the aperture of a NA 0.65 4mm objective at a working distance of about 2.5cm. It was quite uncritical for focus and centering. Resolving Pleurosigma angulatum was a piece of cake. (This addition was made since the photo of fig.3)

With even the most rigid microscopes, the focus of a high power objective is quite sensitive to finger pressure on the stage so I decided to turn this effect to advantage in a simple add-on fine focus (Fig.4). A machine screw pushes against a U shaped hard brass

spring attached near the top of the 1/4" steel plate on which the focus slide is mounted.This bends the plate and/or it's mounting thereby tilting the stage down very slightly.The focusing motion achieved amounts to about 60 microns per turn; comparable to or better than the average microscope. I can just imagine the purists' reaction to bending the microscope in order to focus it! But let's not knock something that works. The tilting of the stage for a 10 micron adjustment amounts to no more than about 0.01° and how many stages are squared to better than that?

A final note. It has not escaped my notice that this two stage optical design is ideally suited to the easy addition of phase contrast since the aperture of the main objective is imaged just in front of the second objective; a very convenient site for a phase plate.

REFERENCES

1. Brieux, A Maison Nachet. *Catalogues of Stock from 1854 to 1910,* Facsimile Reprint, Editions Alain Brieux, Paris, 1979

2. McArthur, JN A New Type of Portable Microscope. *J.R.M.S.* Vol.LIV 182-185, 1934

3. McArthur, JN The Lying Drop Versus the Hanging Drop Preparation. *Microscopy*, Vol.35, 277-279, 1985

4. McArthur, JN From Whisper to Vision-The Development of a Micro -Scope over a Half Century. *Microscopy*, Vol.35, 405-419, 1986

5. Purtle, HR *Tech. Ed. The Billings Microscope Collection.* 2nd Edn. Armed Forces Institute of Pathology, Washington D.C., 1974

Indian-Made Scientific Instrument Replicas

R.C. Blankenhorn

Indian-made scientific instrument replicas are becoming increasingly common in the marketplace.They initially appeared in quantity in the antique markets in England (e.g. Portobello Road and the large outdoor flea markets), but have now become relatively common at some swap meets in the U.S. (often being sold by Indian dealers who are importing them directly). Finally, they are beginning to show up in the mass-market mailorder catalogs.They are initially offered as "decorator items" by the importers, but rapidly lose their replica status and become caveat emptor (buyer beware) offerings. As they have become more popular, the Indian manufacturers have come out with more items, of better quality, and are now beginning to mark them with the names of the original English makers. We have seen or heard of the following:

1) WWI-pattern prismatic marching compass 2) Brunton compass 3) Box sextant (sometimes stamped Stanley) 4) Miniature Sextant (sometimes marked Stanley) 5) Small reflecting circle 6) 5-Draw hand-held telescope (sometimes marked Ross) 7) Miniature theodolite

At this time, all of the Indian instrument replicas are made of highly polished brass, with no protective lacquer or oxidized finish (which is a clear give-away) and the quality of their machining is not up the the standards of the originals (but you have to have seen originals to understand the quality of the 19th century English-made instruments) I suspect that their future replicas will become more difficult to identify, so I encourage all collectors to share information on The Forum when a new replica pops up.

Unfortunately, virtually none of the current large-scale makers of scientific instrument replicas are marking them as replicas (e.g. "Made in India" or "1997" date). Thus, they should more properly be called "forgeries' as they will probably defraud a buyer at some time. E-Bay, the large on-line auction site, has had examples of all of the above in the last months, and only the commercial dealers of nautical ware have identified them as replicas in the offering. The other sellers claim no knowledge of what the items are (so the buyers have no recourse when the replica/forgery arrives). I feel very strongly about unmarked replicas as I have seen many beginning collectors burned by them and some have even decided not to collect at all because of their unfortunate experience.

Other opinions and comments are welcome.

R.C.. Blankenhorn, Ph.D./Vince Austin
The Gemmary Rare Books & Antique Scientific Instruments
P.O. Box 2560, Fallbrook, CA 92088
Phone: (760) 728-3321, Ans/Fax: (760) 728-3322
e-mail: rcb@gemmary.com
internet home page:
HREF="http://www.gemmary.com/rcb/">http://www.gemmary.com/rcb/

WORKSHOP of the Microscopical Society of Southern California

by: **George G. Vitt, Jr.**
Date: **Saturday, 7 February 1998**
Location: **Steve Craig's Lab,** 35 persons attended.

General Comments: This was another record-breaking workshop in terms of attendance and the items brought for show and sale. Despite the wet weather of the tail end of the latest "El Nino" storm, members came from as far as San Diego. Several new members and guests were introduced: Richard Selzar of UCSB, is a world-traveler nature lover who is visually oriented; Allen Bishop is a writer/photographer who works on Ferraris, collects Zeiss Contaflexes, and refurbishes microscopes; Bill Buckman (retired from Hughes Aircraft Co.) works on computers and Web pages. Due to the unpredictable weather, the meeting was held in the residence of Steve Craig, our Saturday Workshop Chairman, and Honorary Life Member. Despite the full schedule, the meeting adjourned at 12:15.

Australian PMS: George Vitt reported recent e-mail correspondence with Michael Dingley, Pres. of the Postal Microscopical Society of Australia (<michaeld@amsg.austmus.gov.au>), who had suggested the interchange of our publications. This matter was fully discussed by the attendees and it was agreed that the dissemination of information on the subject of microscopy would be mutually beneficial. Mr. Dingley will be so informed by e-mail and mailing will begin with this month's issue. Ernie Meadows suggested that we also send a copy of our Journal to the U.S. Congressional Library.

Interaction with Crossroads School: George then brought up the possibility of conferring with Mr. Joe Wise of the Crossroads School in regard to his writing to MSSC a letter describing the synergism that has developed between the School and MSSC. In it, he might relate their obtaining an SEM through the efforts of some of our members, and the relationship between the School and UCLA resulting therefrom, with visits of their researchers to use this equipment. This was undoubtedly a factor in the School recently being given a huge grant, and its establishment of a new department. All these events and their ramifications are not yet clear to the writer, but I am sure they will be clarified when we have a chance to confer with Mr. Wise.

Meeting Time Problem: Even though the Workshop is scheduled to begin at 9:00am, some persons have been arriving at the ungodly hour of 7:30am! As has been rumored, their reason for so doing has been to be 'first in line' for any goodies brought for sale. Certainly, this cannot possibly be true, since we all have always maintained, and demonstrated, a high level of sportsmanship and 'fair play, despite our naturally acquisitive instincts. Of most importance, it was pointed out that such early arrivals pose a great inconvenience to Steve Craig's household, particularly as it affects the foreign exchange students living at Steve's. It was agreed by all that such early arrivals are to be thoroughly discouraged, and that **8:30am be the EARLIEST time that anyone arrives.** Thanks to all for cooperating.

Date of Organization: George Vitt brought up the question as to the precise year of establishment of the microscopical society from which MSSC has descended. Two years were in question: 1938 and 1946. Jim Solliday stated unequivocally that, through his examination of early meeting notices and correspondence of early members such as Mr. Smith, that the group was officially formed in 1938. This matter can now be put to rest.

1. **Jim Clark,** our newly elected Education Programs Chairman, presented his plans as to how the various educational groups will be run and be coordinated. In brief, the various activities will be somewhat "self-organized" by individuals who wish to form special interest groups (SIGs) in the various areas of microscopy, with Jim being the coordinator and the 'funnel' through which information on planned activities is disseminated via the MSSC Journal through half page abstracts. It was pointed out by Jim Solliday, that in some hands-on activities, there may be minor expenses for materials, etc., and that this would be borne by the participants of the SIG in question.

2. **Richard Jefts** showed the book *Images of Science*, by Brian Ford, Oxford Univ. Press, NY, 1993; and the magazine *Microscopy Today* featuring an article on Photoshop software. He then showed a booklet which accompanies each box of slides from the PMS (England) in which members make their observations on the slides they have examined. Richard showed his recent entry (reductions of a laser printout) which dealt with the photomicrographs he had made of some of these diatoms, radiolarians and sponge spicules, mainly to see how far he could push resolution, using the blue end of the spectrum on test objects such as the Pleurosigma Angulatum. Richard worked up to 2000X using a 90X Apo OI objective, with condenser oiled to the slide (of course). He passed around 8.5"x11" images of these diatoms, which had been printed by Gaylord Moss on his computer laser printer from scan data of the original B&W (Tech Pan) nega-

tives of Richard's which George Vitt had scanned on a Nikon LS-1000 35mm film scanner, and sent to Gaylord by e-mail. A previously unidentified specimen in these slides, shaped much like a twist-drill, was earmarked as a spicule by Jim Solliday.

3. **Dave Hirsch** showed a form he had designed to record donations to MSSC. Dave then exhibited two cased scrimshaw whale's teeth. He had identified one as a "phoney" by examining its scribed designs under a microscope, and finding that its lines were laser scribed - this being identified by the non-feathered terminations of lines. Dave then showed an early 'black light' unit.

4. **Jim Solliday** showed two marquetry (inlaid wood) coasters, showing vintage microscopes in positive or negative silhouette, being made by Ernie Ives (England), and available for $12/pair. Jim then showed a box of slides of wood sections also prepared by Ernie Ives and available for $26/box of 12. This is a terrific bargain, especially since Ernie has honed his technique (as well as the blade of his sledge microtome!) of wood preparation and sectioning for some years. The superlative nature of his slides reflects his skill. Each slide contains the major sections of the wood sample. Jim then showed a cased Watson "Bactil" microscope which he had obtained at a Quekett Club auction some time ago. This monocular biological type microscope features a wide body tube, brass and chrome, and shows superlative construction, great sturdiness and fineness of adjustments. Watson was the first to introduce, with this model, the ability for the user to make compensations for wear by taking up any "slack" in the microscope movements through simple mechanical adjustments. Jim then gave a short history of Watson.

5. **Stuart Warter** showed a small brass portable microscope. John de Haas identified it as German, probably by Busch, c.1900.

6. **Bill Davies** announced that there will be a symposium of the Am. Inst. of Phys. on 15 March and that he will bring flyers to that effect.

7. **Ernie Meadows** announced that his machine shop (which is superb!) is available for use by MSSC members who may have projects requiring precision machining - in either metal or wood. Ernie said that Stuart Ziff, an expert machinist (among other things), has volunteered to be the major domo and instructor at these sessions. We all applaud Ernie for his marvelous generosity, and Stuart for the contribution of his experience.

8. **Gaylord Moss** described the reported work at the McCrone Institute on the microscopical investigation of fake art. (Note: During the previous week, Gaylord was Co-Chair for holographic materials at the International Symposium of the SPIE (International Society for Optical Engineering) at San Jose, CA. He told of the most pleasant visit with members John & Dianne Field in Santa Clara during this trip.

9. **Leon Stabinsky** announced the sale, from the Nachet collection, of a genuine Van Leeuwenhoeck microscope for a mere $25,000.

10. **Fred Hantsch** told of his field trip to the Permian period layer of minerals in New Mexico where he gathered microscopically-sized samples of quartz. These are prized by micro-mineralogists because they are usually in close to perfect shape, something rarely found in large crystals. Fred then showed a compact and eminently practical seive separation set, of his design and construction, which he uses to segregate (either dry or wet) such micro-minerals according to size. The several nesting seives are made of black plastic 35mm film containers, their bottoms cut out and the metal meshes adhered thereon by heat (melting the plastic) supplied by an electric soldering iron. The seives range from 32 holes/in to 270/in. Fred then described how he cleans these quartz samples by using a wet slurry of feldspar or dolomite (materials softer than quartz), vibrated in a 'converted' foot massage vibrator. Most ingenius! Fred uses very small glass bottles with snap-caps to segregate the various habits of quartz. He is about to leave on another expidition to New Mexico in his new Dodge van.

11. **John de Haas** announced that he has small plastic micromount boxes available.

12. **Dario Solares** showed an excellent portable microtome he had constructed of heavy brass, with each division of the thimble representing 10 microns of plunger movement. The platen is a 3" diameter brass disk and a straight 'cut throat' razor is used for sectioning.

13. **Ron Morris** showed a photo of an excellent microscopical lab layout, especially convenient for the use of an inverted microscope. It is being used by a professor at Oxford Univ. Ron then told of the availability of excellent steel drawered cabinets, from K-Mart and Staples, suitable for storage of microscope. accessories.

14. **Jim Clark** showed a small stereo microscope he had obtained while on a trip to the east coast to attend a Model Engineering show in PA. It was pointed out that this microscope is properly called a *Binocular Loupe*, which can convert to a binocular, and had been made by Leitz. Jim said that another such piece is available for $125. Jim is going to Galapagos Island to observe the solar eclipse on 26 February.

15. **Alan de Haas** described the use of microscope objectives for the inspection of pinholes. He brought

many objectives for sale ($3-12 each), with proceeds to go to the MSSC treasury. Thanks, Alan. He added that mesh suitable for construction of seives is available from the local (LA) big supplier of silk screen printing equipment. The suitable materials available are polymer and stainless steel cloth with up to 600-800 holes/in. (He said "they make great Moire patterns!") The supplier is in the LA Yellow Pages. Alan also brought for sale a high quality German made set of miniature optical bench equipment for optical setups. Included was a precision pinhole with XYZ micrometer adjustment, used in conjunction with a high NA objective as a spatial filter in laser setups where a clean, collimated lased beam is needed. This set was bought at the Workshop for $500 - a bargain, considering that its original price was easily $2,000!

16. **Larry Albright** reminded us that photos for the show at the Palos Verdes Art Museum must be ready for judgement by MSSC membership by the April 1998 meeting - the actual exhibit beginning sometime in June. Larry brought several excellent color enlargements of photomicrographs he had made by polarized light of various grown crystals. Larry's technique was superlative and his 'eye' for composition is A-1. (Not totally objectionable!) The enlargements were done by West Side Processing Lab., and are called "Type R Premium prints", costing $8/each. He added that Custom Color in Glendale also does custom work. Larry then showed a "Beck Star" nickel plated microscope c.1885-6 with its unusual 1-piece base.

17. **George Vitt** described his recent visit to the Digital Imaging department of Samy's Camera Co. on LaBrea Ave. where he investigated their digital color printing capabilities using color laser scanners to expose silver halide photographic color paper made by Fuji. He was shown some very impressive work being done for a local movie studio. They require files in TIFF format, on either ZIP or JAZZ disks. The cost is $15 for 8.6"x11.8" and $30 for 12"x18" prints. The resolutions they handle (dpi) are: 133, 200, 267, 400. Over this gamut, the files range in size from 5.4Mb to 105.5Mb. George then showed a Reichert pocket refractometer (1.3 - 1.75RI) as a comparison to ones of similar design previously shown by Barry Sobel and Steve Craig.

18. **Larry McDavid** said that the Orange County Processing lab can do color prints larger than 16"x20". He then showed a slide storage cabinet c.1900 and his use of "Post-It" semi-adhesive note paper for the keeping of micro-specimens - exactly as Ed Jones does it. He passed around clear plastic encapsulated specimens from Las Cruces, New Mexico: a tarantula and a "false scorpion", sometimes called the "vinegar bug" because of its ability to squirt, in self defense, an accurate stream of acetic acid! Larry then described the role he played in installing an "organically clean" room at NASA. He recommended as being interesting, the book *Compressed Air* by Ingersoll-Rand Corp. Larry also brought a pile of *Microscopy Today* mags as freebies.

19 **Ken Gregory** displayed a Pneumothorax Apparatus c.1935, and a pristine cased B&L surface microscope. c.1918 with 4 objectives, rotating stage, a vertical illuminator beam splitter just above the objective, and four screws- one in each corner of the square base plate for adjusting the height of the microscope above the specimen on which it is placed.

20. **Jerry Adomian** brought a LARGE quantity of lab glassware as 'freebies': test tubes, graduated pipettes, centrifuge tubes, etc., etc. After the meeting, the entire contents of the many boxes were emptied! Thanks a lot Jerry!

We all wish to thank, most sincerely, our **Steve Craig** and his wife **Millie** for the unswerving hospitality they have extended to these Workshops, especially in inclement weather, exacerbated by the unneccessarily early arrival of certain members!

>>>> <<<<

Notes on the January 1998 Meeting of the MSSC

Presentation: We were given an excellent presentation on the Scanning Probe Microscope, its principles, design, capabilities and use. **Michael Serry**, Applications Scientist of Digital Instruments (Santa Barbara, CA) was the speaker. After a description of the principles of the several variants of such microscopes (scanning tunneling microscopes., and different adaptations of the atomic force microscopes), he described the design principles of the latter. Basically, a scanning probe with a very sharp tip (say, a few nano-meters radius) is mounted on the end of a piezo-electrically activated cantilever beam. A PLZT (lead-zirconium titanate piezoelectric material) is an integral part of the other end of the beam and supports the beam rigidly above the specimen to be scanned (the beam points vertically downward). The PLZT is made in four independently excitable quadrants. By electrically exciting diametrically opposing pairs in this quadrant by computer generated voltages, the tip of the beam (and its scanning tip) can be deflected in a horizontal plane in XY. By exciting all four elements, the tip is moved up and down. Although the tip actually swings along the locus of a sphere, its radius is vastly larger than the area scanned by the tip so that, for all intents and purposes, it moves in a flat plane. PLZT hysteresis and temperature effects on the entire apparatus are complications that are now well controlled, as is the isolation of the instrument from vibration and ambient noise transmitted through the air. The use of the 'contact mode', where the tip contacts and 'rides' over the specimen, as well as the 'tapping mode', where the tip is oscillated up and down at the rate of tens or hun-

dreds of KHz, was described. In the 'tapping mode' the tip does not touch the specimen, but vibrates up and down, being vertically positioned by sensing the peak-to-peak amplitude of vibration. If it gets too close to the specimen, the vibrations become damped (the "Q" of the mechanical resonant equivalent circuit is reduced), which gives an indication of the tip's closeness to the specimen. Through negative feedback, the proper distance is maintained. This represents the actual distance to the specimen. As the tip scans across the undulations of the sample's surface, the position of the tip is altered continuously to keep the tip-to-specimen distance constant. It is this control voltage which represents the useful electrical output from the device, being proportional to the elevation of the surface topology. By measuring the phase difference between the waveform representing the actual tip motion and the exciting sine wave, highly sensitive measurement data can also be gathered. Mr. Serry also described many types of uses for such measurements, illustrating his words with excellent slides. Such lectures, though they may seem too technical for 'ordinary microscopists', as some have suggested, should remain a part of our diet, especially when one considers the great enthusiasm for new things and ideas within the makeup of every member of the MSSC! All those in favor?

Elections: After the above presentation, election of officers for FY 1998 took place. It had been intended (and announced) that candidates for office be nominated from the floor and that voting would be by secret ballot. Preparations for this mode of election were made, and Ron Morris, MSSC Secretary, took charge of this portion of the meeting. In the middle of nominations, Barry Sobel made a motion from the floor to the effect that we re-elect the existing slate of officers, and that a simple show of hands ought to be sufficient. The motion was passed and a show of hands indicated 100% unanimity. This was a meaningful, very touching, and most appreciated vote of confidence.

A New VP: Gaylord Moss had previously expressed his desire not to remain as VP, so that he could devote his full attention to the editorship, publication, and distribution of the MSSC Journal. Jim Solliday was nominated from the floor for the position of VP and was voted in unanimously.

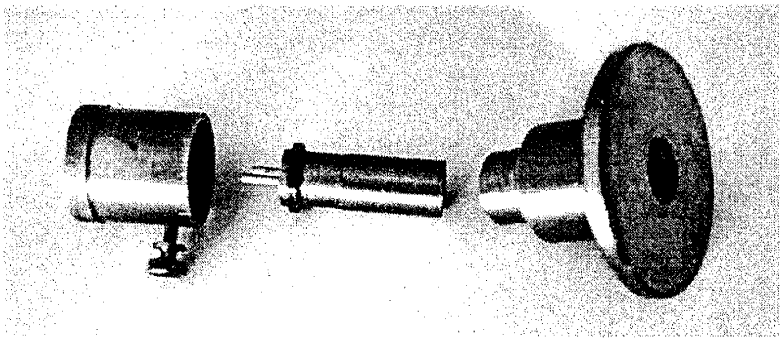
A New Office: A new office was created, that of Lab Workshop Chairman. Jim Clark was nominated for this position and unanimously voted in. This new function in no way affects any aspect of our regular Saturday Workshops, which are run so well by Steve Craig, but will provide an avenue to coordinating the activities of small special interest groups which will be devoted to actual hands-on practice of various micro techniques and procedures. Through this office, the scheduling, public announcements, and activities of the SIGs will be centrally coordinated. The new office will also provide short abstracts of the groups' efforts.

Looks like we have started the New Year with a bang!

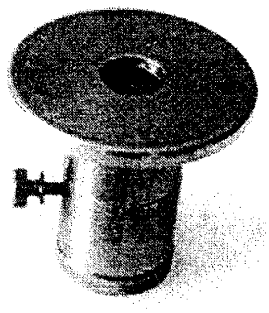
A Microtome Made from an Aircraft Motor

Dario Solares

At the workshop of 4 January 1998, see page 29, Dario Solares showed a microtome that he had made using a burned out aircraft motor as the fine screw thread. Dario machined the body from brass with 36 markings spaced around the bottom of the barrel. One revolution is 360 microns which gives a 10 micron advance for each marking. Pins on the bottom of the motor lock into the base which has a screw lock to hold a given setting. Sections are made with the usual 'cut throat' razor drawn across the top. The incorporation of the motor body as both the thread and sample plunger was very elegantly done.



Exploded view showing base with markings and screw lock, motor body, and top platform.



Assembled microtome

Member Profile

Gaylord E. Moss

On the bridge in Monet's garden at Giverney

My 11th grandfather, John Moss, one of the founders of New Haven Connecticut in 1637, must have had a love of adventure to cross the dangerous Atlantic in the little ships of the time. He lived to age 103 and our family still has a small piece of his land. My mother was of French Huguenot ancestry, her forbears fleeing from the British up the St. Lawrence.

My father, also adventurous, left the farm at age 17 and joined the navy. My parent's marriage came about from their correspondence while my father traveled the world to the Mediterranean, China and Japan in the 1920's.

Throughout their more than fifty happy, romantic years together, my mother's French joy and father's Yankee restraint bound them closely and gave me and my sister a home rich in love and ideas in which to grow. I was born in December, 1934, the year the romantic movie "It Happened One Night" won the academy awards. When I was four, we moved from Connecticut to Salem, a place steeped in history. Everyone thinks of the witch trials, but to me it is more exciting as the seaport where the young United States sent ships to trade with the East Indies. In the early 1800's, one third of the Nation's income passed through the customs house from the ships on Derby and Crowninshield's wharves. I walked to school past the grand sea captain's homes with their "widow's walks" on the roof built to watch far out to sea for the long pennants of homecoming sailing ships. I spent days wandering from room to room of the quiet Peabody museum filled with ship models, sailing paraphernalia and strange smelling artifacts from China, Japan and the South Sea Islands brought back in those Salem ships.

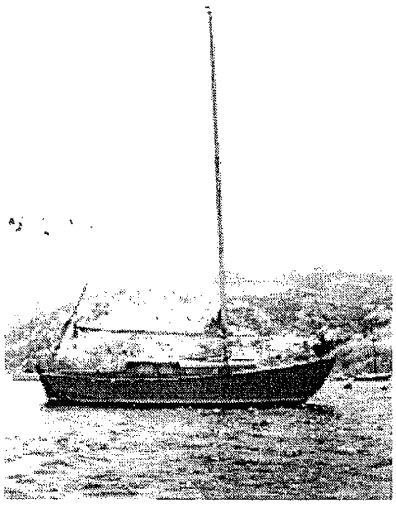
Remnants of the long wharves are still there. The ocean is the same. There is the string of islands-Big and Little Misery with the wrecked steamship hulk on the bottom between on whose ballast bricks one could walk across on at low tide; Baker's, with its lighthouse, Coney, the only one close enough for me to row out to and explore. Then, there are the dark places. The Reef of Norman's Woe, Bowdich Ledge and The Brambles, a frightening reef that we hit one day. I can still see the greenish ugly rocks sliding by beneath the surface as we scraped across, bending our steel centerboard.

Marblehead was an exciting sailing destination going in past the big yachts at the harbor entrance and then swooping about in the crowded inner harbor with the grand yacht clubs with lawns going down to the water and their launches with uniformed crew. One morning I remember seeing a white jacketed steward bringing a tray of breakfast to a couple on the stern of a long black schooner anchored offshore.

One of my strongest memories is of a sunny morning when my father and I were out for a day's sail in our little sloop, the Sea Moss. We encountered the full rigged Danish Ship, Danmark, leaving Salem harbor under sail. The great white ship with gold trim moved slowly at first, with lines of white dressed sailors on the decks and strung out high on the yards singing rhythmic chanteys as they unfurled the sails and hauled on the yards. Gradually the sky filled with towering canvas high overhead as the wake bubbled behind. The ship had to stay in the tortuous channel, wearing ship at each turn, allowing us to cut across and stay with her for a long time. It was the most awesome and beautiful sight.

When I was 10, both my sister and I were struck with a violent intestinal disease that could not be diagnosed, even by the vaunted Lahey clinic in Boston. After some time in the hospital, my intestines perforated and I would have died of peritonitis except for some immediate drastic surgery and many more weeks in the hospital.

Workers were tearing down a building next to my window, and as I lay there, I could look at the workers out in the cold huddling behind a partly demolished wall eating their lunch. I was strapped to all sorts



Kuan Yin off Santa Cruz Island

Daenella at The Isthmus Catalina Island

With Meg in Ryokan in Kanazawa

of life support equipment, in pain, throat parched, unable to move or even drink. It was astounding to see people outside doing normal things and I watched them for hours feeling that I was not a part of the world. I could see a place where the street forked and it seemed so wonderful to think that the men out there could choose to walk down either street, or could even stop and drink a Coke.

Eventually I got well enough to move about the hospital halls in a wheelchair. I had heard that there was a solarium in the hospital and I assumed that it was on the roof. When no one was looking, I wheeled myself onto the freight elevator and pushed the roof button. When it stopped, I rolled out onto the roof to find that there was no solarium. I was alone on a tarry space in melting snow covered with soot. It was like being reborn. The cold air, not tainted with antiseptic and ether, was heavenly. That grimy soot smell and the cold made me feel that I had been reborn. I sat there a long time with tears running down my face. I knew that I could not really keep that feeling of how wonderful it was just to be alive, but felt that I would always at least remember it.

That illness and subsequent weak health all my youth made me miss a couple of years of school but it was compensated by time to read and think. Both my parents were avid readers and had some wonderful books in our home including bound volumes of Harper's Weeklies from the mid 1800's. Salem also had an excellent library where I spent many hours poring over the Compton's and Britannica enyclopedias.

School was not as interesting as my outside reading until plane geometry in high school struck me with the beautiful elegance of Euclid's proofs. Later, calculus gave me a feeling of awe at the products of man's mental ingenuity and at the underlying beauty of mathematics which clearly was a language describing the wondrous organization of the natural world.

In high school I won a science fair with a simulated color television display using a mechanical stroboscope and rotating color wheel and was rewarded with a week's stay at MIT. That week was a an eye-opening experience in which I saw that there were whole groups of people who loved science and were more interested in how things worked than what the Red Sox baseball team was doing.

At Tufts University, the electrical engineering curriculum was the most challenging. I enjoyed combining the rigor of the engineering school with the pleasures of languages, literature and philosophy.

California had been my dream since early childhood when I learned that, in the midst of the bleak New England winters, there was a place that was still sunny and warm. Out of undergraduate school in 1957, I joined the Hughes Aircraft Company on a graduate fellowship program at USC. I was fortunate enough to get into The Exploratory Studies Department of the Hughes Research Laboratories. It was an environment where one could take long shots on far out research. One fellow was working on an early form of artificial intelligence. I was experimenting with ruby and emerald masers when Maiman in the lab next door made the first laser. It was an incredibly exciting time.

Another challenging project was building a laser gravity antenna to look for the gravitational waves that are predicted by Einstein's theories. I was able to measure displacements as small as one femtometer. (1 with 15 zeroes in front of it). This is 100,000 times smaller than a hydrogen atom. This number was unsurpassed for several years, but unfortunately it was far short of the sensitivity needed. Currently MIT and Cal Tech are cooperating on a larger version of this antenna called LIGO which will push the limit further.

The laser work on the gravitational antenna led to holographic experiments for head-up and head-mounted military displays. I had some inventions in

this area that were successful enough that Hughes set up an engineering organization and built a new laboratory to make holographic elements on a large scale. It was a different experience to design and build a new lab with 150 ton vibration isolation blocks and multiple high power laser optical systems in isolation chambers. Then came a combination of invention, development and travel to U.S. and foreign customers. The green glow that one sees on an F-16 cockpit is the holographic optical element in front of the pilot that came out of this development.

When General Motors bought Hughes Aircraft, there was a rush to use Hughes technology in automobiles, and holography was seen as technology that could revolutionize displays and lighting systems. Both GM and Japanese corporations funded some fascinating work and the interaction with people in the automotive industry was a new and most interesting experience.

Although I was paid to work, there was so much more reward just in being able to do such interesting research: to have access to the facilities and tools to experiment and explore ideas and to try to bring ideas to fruition as useful products. The 39 U.S. patents I received and the Hyland invention award given annually for an invention that significantly impacts Hughes were other rewards. Other ancillary benefits were foreign trips to Sweden, England, Israel, France and Japan with superb experiences in each place. I remember waking up in a beautiful room in the Grand Hotel in Stockholm and using the front of the Royal Palace across the harbor as a resolution chart to evaluate holograms to show later that day. As I worked, great white swans flew past my window, and, when I looked out, rows of them were swimming past. It was a fairy tale view and I could not believe that being in this beautiful place was my job.

I co-chaired a week-long optics conference in Cannes staying at the Ritz Carleton. I gave invited papers several times in Paris. Besides such events as these, every day gave me the chance to meet and be stimulated by remarkable people. At the Hughes Research Laboratories, Norbert Wiener and other legends came and lectured to our small group. Richard Feynman was paid to come every Friday to lecture and I will use some of his insights forever.

Aside from sailing, that I will mention later, I had some other hobbies that I enjoyed. I took soaring lessons at El Mirage but never quite soloed. I love to draw and paint and once won first prize in a Hughes art contest for a charcoal drawing. But something that I think has influenced my life was the study of the martial art of Aikido. It is a discipline aimed at training the mind by physical practice.

An example of being out of control occurred in Malibu in 1959, when I was awakened around 2 AM by the sound of the starter motor grinding as someone was trying to steal my beloved Porsche Speedster parked outside. I was so furious that I rushed out, picked up a large rock in each hand and, leaning down to the little slit side curtain, told the occupant to get out of the car. When the guy crawled out under the brandished rocks, he stood up and slowly backed away. Still shaking with rage, I followed him step for step, until he backed over a cliff and toppled to the beach below. Only then did I regain my senses and call the police who came and got him.

Much different was one night, years later, on Melrose Blvd. when I stopped my car to help a screaming woman being chased by a man. He came at me shouting "are you a cop?" Backpedaling and fending him off, thinking at first that he had a knife, I was eventually able to grab his wrist and with a painful Aikido hold force him face down onto the ground. Although I was trying to be careful and not break his wrist, he still fell pretty hard and then twisted his head around and in a very disgusted voice said, "you're a cop." Fortunately, some real cops drove up and I turned him over to them. Aside from some screaming and shouting, this whole episode was very peaceful, almost relaxed, and involved no anger or panic. It proved the saying of my Aikido Sensei Takahashi's that "If you practice to keep a calm mind when someone is running to kick or punch you, then you can be calm anywhere. It paid off that night.

Sailing was a wonderful way to relax and indulge my love of the sea. For a time, I even lived aboard Kuan Yin, my Hong Kong built 30 foot steel and teak Al Mason designed sloop. I will never forget one evening lying on the foredeck as she sailed herself toward the sunset on a flat sea gliding through hundreds of small birds sitting on the water. The boat moved so quietly that the birds just paddled aside, bobbing on the ripples as the boat slid past. A little while later, dolphins swam so close that I could reach out to within a foot of their heads as they turned on their sides to look at me.

Less tranquil was a night storm in Daenella, the mahogany 38 foot square meter boat. In 75 knot winds, under heavily reefed mainsail, a steel chainplate tore in half, instantly bringing down the 58 foot wooden mast. In the towering breaking waves, I thought that the open cockpit would be instantly swamped and that the lead keel would sink her like a stone. Instead she lay diagonally, bow to the waves, and climbed up each onrushing comber to slide into the canyon on the other side. Except for the shrieking wind and the bitter, soaking, cold spray, it was a beautiful night with a brilliant moon. When the mast went down, I put up several flares and waited trying to make sure that the broken pieces of mast did not puncture the hull. After about an hour a distant light proved to be a Coast Guard helicopter which another flare brought down overhead with a huge searchlight like a spaceship. It seemed remarkable that anything could stay aloft in that frenzied wind.

On my vacations, I often traveled. In Athens, three full nights in a row, I walked barefoot up onto the acropolis where no lights or talking was allowed. Feeling the stones smoothed by centuries underfoot and looking down the parapet to the distant music of the Plaka below was an experience of another time. And, in some ways an even more memorable Greek experience was a week spent walking alone in remote villages in Crete.

The absolute, harsh, yet basically kind, morality that I encountered was unlike anything that I had ever experienced.

Once at a stop on a tourist bus in Holland I struck up a conversation with a couple on a classic Dutch leeboard boat.They invited me to accompany them as they were leaving on their vacation in about 15 minutes. On the instant, in suit and tie, I told the bus driver to go on without me and we sailed out through the North Sea Dike and into the wild North Sea and to the canals of Friesland. In the North Sea in heavy weather we passed a modern 40 foot yacht hove to under storm trysail and engine, and, as we sailed on, I gained great respect for the seaworthiness of the classic Dutch leeboard designs and was delighted to see how well their loose footed sailing rig worked.

In Stockholm, Knud Reimers, in my opinion the designer of the most beautiful sailing boats ever built, was kind enough to invite me in for a visit. His Tumlaren and square meter yachts are great works of art and unbelievably, he had on his mantelpiece an exquisite model of "Moose" a 30 square meter yacht that I had marveled at as a boy in Marblehead. Later, at the Royal Danish Yacht Club in Copenhagen, I looked up the records of my own 40 square meter sloop, Daenella, nee Corona, and later visited her boatbuilder.

In the 70's and 80's I was able travel throughout Japan on a series of trips seeing first hand the culture and artifacts I had loved since childhood both from my father's souvinirs and the things in the Peabody museum from the sailing ship trade. In Nagasaki, I found a small ancient tortoise shell shop which was perhaps the one from which my father had sent a box to my mother that she treasured all her life. My companion Meg was born in Japan and her Japanese half-brother arranged for us to see parts of the country that we could not normally have seen. He was even kind enough to accompany us to some of the finest Ryokan where they would not have otherwise admitted a "barbarian."

A trip to China startled me with the immensity of the country and its culture. It was like a visit to another planet.Then Tibet, a place I had always wanted to see, met my wildest dreams of Shangra La. Even with the Chinese there, the very air and light have spiritual qualities. In the countryside people live as they must have a thousand years ago. Flying directly to Lhasa at 12000 ft Meg and I felt tired the first afternoon. Relaxing in a small native restaurant with real Tibetan food the time slipped by.When we came out after nightfall, we found that there was a curfew and no one was allowed on the streets. The day before there had been fighting and monks had been killed. Finally, the restaurant proprietor kindly loaned me her bicycle and the next couple of hours was a fantastic adventure, pedaling along the dark, dirt streets just below the enormous Potola Palace with the full moon rising overhead. As I tried desperately to find the way back to the hotel with Meg sitting uncomfortably on the carrier on the back it was a little distracting to pass AK-47 carrying Chinese soldiers in the shadows on the street corners.

The next day was even more interesting as 17000 ft up on the crest of the pass to Xigaze, the little supercharged diesel Mitsubishi minibus slipped off the narrow snow-covered road with one wheel hanging over an unbelievable steep cliff that went down thousands of feet. Everyone gingerly got out of the teetering bus and many just laid down in the snow with altitude sickness. I took some photographs that were black because I did not think to compensate for the snowy brightness. Eventually an army truck came along and pulled the bus back to the road.

Back in the U.S., in 1988 I collapsed at work and found that my liver was destroyed by hepatitis C. Struggling for several years to survive, it became clear that the only chance was a liver transplant which was done on January 13, 1991 just as the GulfWar began.After some problems, the new liver is working well and I feel very fortunate to have survived again, thanks to amazing medical technology at UCLA and the organ donation by the family of an unknown 14 year old boy to whom I am indebted beyond all measure.

I feel so fortunate to have been able to see so much of the world, to have had so many exciting experiences, to have given and received deep love. So many things, the loveliness of woman, the beauty of nature in the words of the psalm, "passeth all understanding." But all one need do is look around and enjoy.The MSSC is a continuing delight as a place to share things with people who are interested in the real world, and not just artificial entertainments.

Sometimes in literature one finds ideas so beautifully expressed that one wishes to have written them oneself. In *Wind Sand and Stars*, Antoine St. Exupery describes a group of Arab chieftains visiting France who, watching fresh water gushing from a cleft of rocks in the mountains, are awestruck. To them, from the dry desert, lifegiving water was frequently dirty puddles mixed with camel urine.This tumbling, flowing, clear water now before them was an act of God to show them his infinite power. They would not leave until He tired of his profligacy and turned it off.

Many years ago I read a science fiction story , the name of which I have forgotten, but which impressed me very much. It told of a distant future in which mankind had spread to distant stars and lived on sterile planets in tunnels deep underground for protection from deadly radiation. People breathed manufactured air. In their many generations they had forgotten their original home. But there was a beloved song sung by troubadors who wandered from star system to star system. It told of a mythical world where, unbelievably, the air on the surface contained just the right mixture of gases to breathe; and where water flowed naturally on the surface and where the radiation was so benign that one could lie unprotected under the sky and look at the stars. Each stanza of this song had the refrain, "The Cool Green Hills of Earth." To these people such a place was a wonderful myth, an Eden.

It comes to me frequently that there really is such a wonderful magical place -The Cool Green Hills of Earth- and I am fortunate enough to be here.

FRANCIS WENHAM

Courtesy of Larry Albright

One of my virtues and/or vices is an admiration of flawed heroes. One example is Crookes who was fascinated with beautiful gas discharge tubes. He was a pioneer of early photography in his complaints about fogged film almost, but not quite, was the discoverer of x-rays which were fogging his film. Then there was Wheatstone, shy scientist who invented the telegraph (in English history), the concertina, stereoscope and many interesting electrical devices. He did not invent the Wheatstone bridge. Which by way of introduction brings us to Francis Wenham.

Excerpted from tne Presidential Address by L.V. Martin to the Queckett Microscopical Club in 1973

Francis Herbert Wenham was born in Kensington in 1824, the son of an Army surgeon, and as a youngster soon showed an interest in scientific and technical matters. An event that shaped his life was when at the age of 14 he was taken to see the trials on the Thames of a ship, appropriately named the "Archimedes", built to demonstrate the advantages of the screw propeller over the paddles then used. This seems to have decided Wenham to become a marine engineer and specialist in propellers, and when he was 17 he was apprenticed to a company set up in Bristol by the Great Western Railway to build their second Atlantic steamer. He entered the drawing office, no doubt as a premium apprentice since he seems to have been in easy circumstances all his life, and there met many of the leading engineers of the day such as the younger Brunel who designed the ship, and particularly James Nasmyth the inventor of the steam hammer and who was a friend of Wenham for 40 years. The ship being built was the 'Great Britain', the same one which was recently towed as a hulk form the Falkland Islands back to her birthplace in Bristol for restoration.

The portrait (Fig. 1.) is taken from a small card in the possession of the Royal Aeronautical Society by whose kind permission I am able to reproduce it. Wenham's own signature is underneath, written when he was a very old man; I have no idea what the apparatus he holds is, but he seems rather proud of it.

After finishing his time in Bristol, Wenham embarked on a very active and successful career in engineering during which he designed marine engines, ship' propellers, gas and hit air engines, high pressure boilers, a novel road locomotive and many other items. In some cases he manufactured what he designed. Some ships which were fitted with his engines had such a turn of speed that they were used a blockade runners in the American Civil War.

Fig. 1 Francis Wenham late in life

In his early thirties Wenham took time off from his professional engagements and in a river steamer which he himself had designed and built went up the Nile on a photographic tour with Francis Frith taking pictures of pyramids, tombs, temples and everything else of note including the colossal statues at Abu Simbel. This tour made a lasting impression on Wenham who make frequent references to it later in his writings on aeronautics. He learned much about photography from

Frith, and this expedition was the foundation of the latter's fortunes, for the extensive series of photographs which resulted sold well and he eventually built up the largest business in the world publishing travel views. At the end of the trip Wenham sold his boat to the Viceroy of Egypt; I should very much like to see a photograph of it if one exists sine it was of unusual design having four propellers driven by straps, and a boiler pressure of 300 lbs. per square inch which was enormously higher than was usual at the time.

Before turning to microscopy I must mention Wenham's principal spare time activity, and the one for which he is now most famous, namely aeronautics. I cannot now go into any detail of his activities in this direction, but Charles Gibbs-Smith, the historian of the aeroplane (that very word coined by Wenham), has written that Wenham exercised a profound influence on the development of flight, and Wilbur Wright in reply to Wenham's congratulations of the Wright brothers' first success referred to him as one of the ablest and most useful men who ever laboured in the cause of human flight. Wenham's contributions to aeronautics would take a good deal longer to cover than his contributions to microscopy. Wenham tells us that he first looked down a microscope when he was 13 years old, but nothing more is heard of him as a microscopist till he was 26 and had already developed a high degree of skill in working glass and metal. From then until he relinquished the microscope some 30 years later he was the author of very large number of papers on the subject, also of many cognate inventions.

At one time Wenham was noted as an observer as well as an instrument man. He wrote on cyclosis, movement of diatoms and other subjects, but his most notable paper of this sort was 'The Formation and Development of the Vegetable Cell' (1856). His observations seem to controvert the then fairly new doctrines of Schleiden as regards cell division. Dr. Carpenter, who had doubts about current cell theory, was delighted and described the paper as an important rectification of doctrine. Neither he nor Wenham denied what cells could and did multiply by binary division in a growing vegetable but they held that that was not the only way, and Wenham's observations were confirmed by others.

He entered into controversies over the nature of markings on diatoms and podura scales, and devised special means of preparing and examining them. For instance he heated podura scales on a polished knife blade, 'torrefying' he called it, judging the temperature reached by the oxidasation colours on the surface of the metal, as does a toolmaker when he tempers hardened steel. This is a controlled analogy of the once popular device of charring specimens between glass slips and might be worth trying again,. He made replicas in black wax or by electrotyping of the surfaces of diatoms and other transparent objects so that he could examine them by reflected light without any confusion arising from the structure below the surface. Replicas have been used a great deal in electron microscopy for the opposite purpose, to obtain a transparency of an opaque surface, but Wenham's process might still be useful.

He saw the need for a solid mounting medium other than Canada balsam and concocted a mixture of gelatin and green syrup. This was somewhat coloured but was taken up by Deane, Lawrence and others and developed into the glycerol jelly we know today. Wenham's method of preparing a blowfly's tongue by grasping it between finger and thumb, thus inflating it, and then nipping between two glass slips has been revived from time to time; so also has his simple compressor with thin glasses which he designed especially for his Paraboloid.

The Daguerre photographic process came out in 1839 when Wenham was still a boy but he took an interest in it, and after the much faster wet collodion process was introduced in 1850 he began making photomicrographs. Wenham goes into possible illuminants, including electric sparks from a Leyden jar, but decides on sunlight as the best; he shows how to correct the visual to the actinic focus a matter of some importance when plates were sensitive only to blue-and indicates how to make stereoscopic micrographs. He describes how he uses a darkened room as his camera with his microscope on a bench against a shuttered window; sunlight is reflected from an outside mirror though a sleeve in the shutter on to the specimen either direct, though a bullseye lens or through an achromatic condenser. By occasionally rotating the sleeve and adjusting the mirror by strings he manages without a heliostat. Light for manipulation comes though a yellow glass let into the shutter and he has all his chemical baths by him for processing the plates. An easel which can be moved to and fro along the bench carries a card on which the picture is composed and focussed and then the plate is substituted for the card. Wet plates had, of course, to be prepared on the spot for no commercial plates or films could be bought until a dry plate process was achieved a good many years later. The effective inventor of the dry plate was, incidentally, Dr. Richard Maddox a well known microscopist and a friend of Wenham. The frontispiece of the later editions of Beale's 'How to Work with the Microscope' is a photographic reproduction of a number of photomicrographs made by Maddox including several taken with a 1/12-in objective constructed by Wenham.

Since Wenham was actually sitting in his camera while the exposure was proceeding the possibility of shading his plate locally soon occurred to him and he used shaped pieces of paper to adjust the exposure as between dense and transparent parts of the specimen just as a photographer nowadays sometimes shades

the bromide paper when enlarging. More than that, Wenham also used the same method for masking off parts of the picture to allow of a different focus, thus getting sharp images of parts lying at different depths.

With the same arrangements but with a camera in place of the microscope he made, possibly, the first-ever photographic enlargements by projection.The idea was not new since it had been suggested previously by Fox Talbot, (a lifelong friend)but after Wenham had read a paper on 'Enlarged Positives' to the (now Royal) Photographic Society (1853) it was brought out clearly in the subsequent discussion that this was the first time the idea had actually been put into practice.

Apart from designing a friction coarse adjustment he did not concern himself greatly with the microscope stand until he was persuaded to join Ross & Co. as an adviser following the death of Thomas Ross in 1870. He then devised a series of stands as successors of the classic Ross stand contrived by Andrew Ross and improved by his son Thomas. The first of these Wenham stands is illustrated in Fig. 2, stands from the Quarterly Journal of Science (1873); it is a radical departure from its predecessors but was itself soon replaced by another. Wenham wrote a paper in 1875 on the benefits probably illusory-of oblique vision with high powers, and the second microscope was furnished with a stage which could be tilted in relation to the optical axis, possibly as a consequence. It also had a long lever fine adjustment lifting the whole body, which was more sensitive than the previous one which had a much shorter lever acting on the nosepiece only, and was said to be better for precise micrometry since the distance between the objective and the eyepiece remained constant.

In the '70's there was a craze for swinging substages to allow very oblique illumination before it was realized that a wide-angled condenser could provide this much more conveniently. This was particularly so in the United States and the model make then by Zentmayer was much admired. Wenham again redesigned the stand to incorporate Zentmayer's substage and since the older foot would not have allowed the substage to swing so readily he adopted the foot with two turned pillars which was originated by Jackson many years before and used by American opticians. The stand thus became the well-known Ross Zentmayer; several versions of this were produced including a simplified student's instrument.

Finally Wenham produced his magnum opus, the formidable Ross-Wenham Radial. This was brought out in 1882 shortly before he left the firm and was already obsolete by the time it arrived. Nevertheless it was much admired and a number were sold, some with a rather doubtful form of fine adjustment invented by his successor, Dr. Schroeder, who incidentally designed

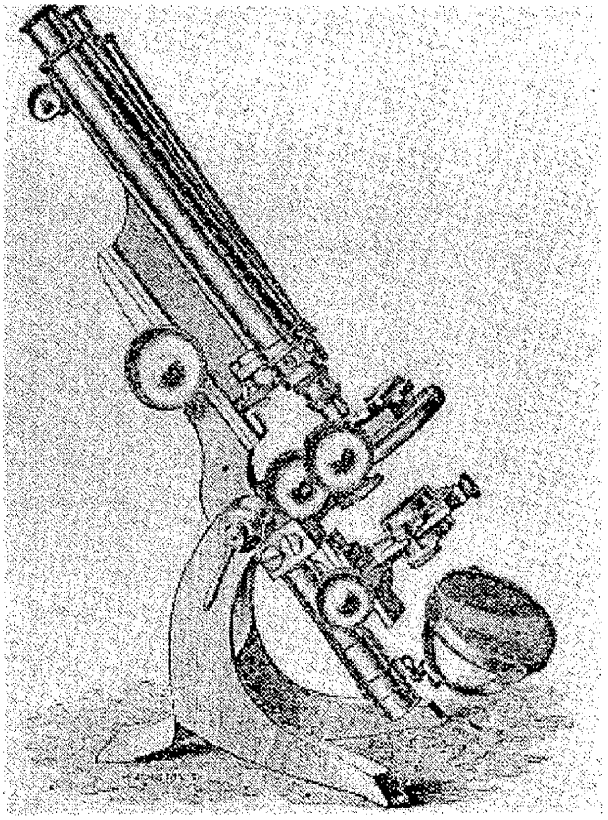


Fig. 2 The first stand designed by Wenham for Ross & Co.

what has been held to be the first anastigmat photographic lens, the Ross Concentric. Whatever the practicability of the enormous Radial it must be one of the most desirable of all collector's pieces in microscopy.

Wheatstone announced his invention of the stereoscope in 1838, but no serious attempt seems to have been made to apply the principle to the microscope-necessarily a binocular-till Riddell in the United States but he improved greatly on this in his following design. The chronology is not clear, but it seems that the first notice of Riddell's binocular did not appear in England till 1853, and then it was his earlier defective instrument that was described. By then Wenham had clearly been working on binoculars for some time, though he never claimed any priority over Riddell, and he published a magnificent paper (1853) concerning the principles on which a stereoscopic binocular should be constructed and making a number of proposals. One of the arrangements he suggested was made for him by Smith and Beck and is illustrated in Beale (1868); in this the tubes are disposed symmetrically unlike the later standard Wenham binocular. Contrary to Riddell's instruments and most other binoculars to this day, this one had a compound refracting prism as the beam splitter-the heart of any binocular microscope-rather than one or more reflecting prisms which do not need to be compound. Fig. 3 illustrates some of Wenham's prisms that were actually made and the one just mentioned is at a; it will be seen that the

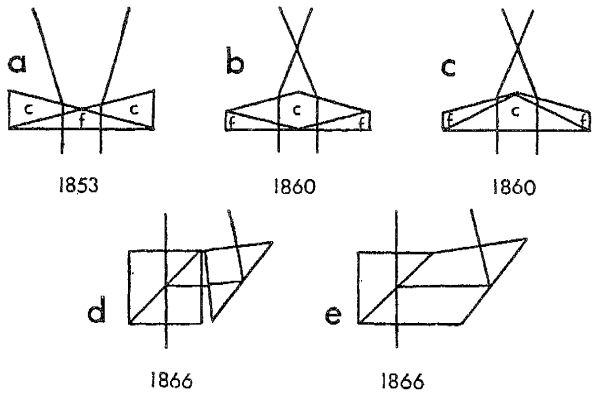


Fig. 3 A selection of different prisms made by Wenham for the binocular microscope

rays coming from the objective are directed to the eyepieces without being crossed over, which gives a pseudoscopic effect in which elevations in the specimen appear as depressions and vice versa. This could be overcome by using erecting eyepieces each of which would reverse the rays reaching it, but Wenham thought this to be a clumsy expedient and suggested that use might familiarize an observer with the true nature of pseudoscopic images.

Thereafter he dropped the subject of binoculars till 1860 when he was persuaded to enter into it again. 'If the pictures in a stereoscope are put in the wrong way round' said he in a paper in that year 'you get a pseudoscopic effect which you correct by reversing the pictures. Let us do the same with the binocular microscope and cross the rays over within the microscope'. And so he did in the prism at b in Fig. 3. This also is a compound crown and flint glass prism; it has to be, otherwise the images would show colour. He said that this prism gave excellent results but it was extremely difficult to make. He himself was about the only man who could have made the four sided element sufficiently truly and he said that it gave him so much trouble that he would not care to make another; although the prism looks fairly large in the diagram it was in fact only as think as a matchstick. He accordingly redesigned it and the prism at c was the result. This worked as well as the other and several microscopes were made which gave satisfaction to their owners-a rather sort-lived satisfaction I fancy, since at the end of 1860 Wenham published his brilliant design for a reflecting prism which held the field for the next fifty years.

Quite soon after stereoscopic binoculars became available the need was felt for a non-stereoscopic instrument which would not interfere with objective aperture but still afford the comfort of using both eyes. Powell and Lealand brought out a prism for the purpose which was interchangeable with the Wenham prism in their microscopes, but this besides shifting the optical axis only provided about one sixth of the light in one eyepiece that it did in the other. Wenham

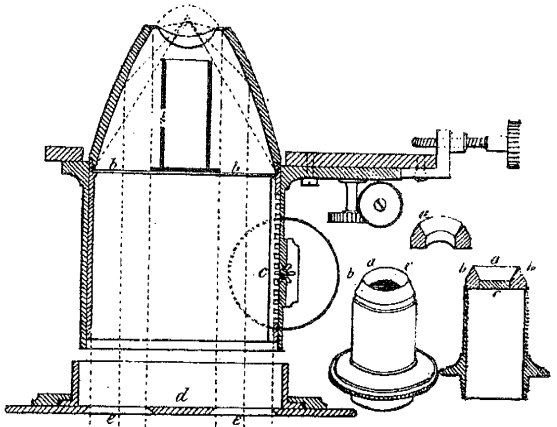


Fig. 5 Wenham's reflecting paraboloid and (inset) Shadbolt's glass illuminator

paid attention to this problem and devised the arrangement shown at d in Fig. 3 Here the rays from the objective are partly reflected and partly transmitted by a very thin layer of air between two adjacent prisms, with those reflected being again reflected by another prism to one side up the auxiliary tube of a standard Wenham binocular. This plan was soon modified as in e to cut out two glass-air surfaces and the reflections arising from them. Rays do not reach the second reflecting surface at a sufficient angle for total reflection, so that surface has to be silvered. This Wenham high-power prism is certainly an improvement over the Powell one but the light is still very unequal as between eyepieces, and this is also the case with the Abbe binocular eyepiece brought out by Zeiss and which copied Wenham's idea of a thin film of air as a beam splitter. At some stage in Ross instruments this air film was replaced by half-silvering or otherwise treating the prisms so that there was equal illumination in each eyepiece, but I cannot say whether this was effected by Wenham or Schroeder, though I suspect it was the later from evidence in another direction.

In all, Wenham designed or suggested no less than 17 binocular arrangements so far as I have been able to trace, including a proposal in his 1853 paper to use a double image prism for a non-stereoscopic binocular. I have it on the authority of Messrs Bausch and Lomb that this is now adopted for certain high-class binoculars, presumably their own.

Wenham first came to notice as a microscopist in 1850 when he produced a paper on darkground illumination. Hitherto this had been unilateral by a lamp or mirror held to one side below the stage or by a substage prism made by Nachet. To secure what was called 'all-round' darkground illumination Wenham devised his silvered reflecting paraboloid which incorporated focusing and centering motions, Fig. 5; one of these was shown on Smith and Beck's stand at the Great Exhibition. Just at this time George Shadbolt, a life-long friend and admirer of Wenham, invented an annular

glass illuminator which also appears in Fig. 5, which is taken from the journal of the Microscopical Society (1852). The two joined forces and the result was the Wenham Paraboloid made of glass and much easier to manufacture than the earlier one. The paraboloid became very popular but fell out of favour when wide angled condensers came into common use since these are more convenient for darkground, using patch stops.

Wenham was very interested in the illumination of opaque objects and devised many schemes for the purpose. He seems to have been the first to use this method, that is to use the objective as its own condenser, and the first to make a vertical illuminator. A principle of illumination he used extensively is shown in Fig. 6. In this the specimen must be in some medium other than air, preferably in balsam. Light is sent into the slide at such an angle that when it reaches the

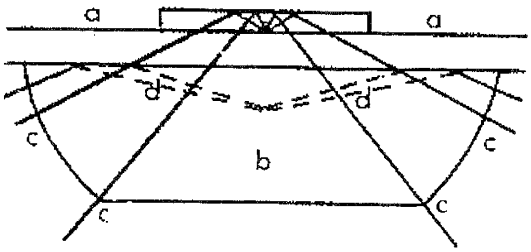


Fig. 6 Plan for reflection from coverglass

upper surface of the cover glass it is totally reflected down on to the specimen. Wenham went about this in several ways and eventually invented a special reflex illuminator that was much used in the United States. It will be apparent that if the object is in air the rays will be totally reflected by the top surface of the slide itself and will never get the the cover glass. Wenham noted that in these circumstances where the specimen was in optical contact with the slide this total reflection was spoiled and if the specimen was not opaque, light passed into it and it became, as it were, self-luminous. He used this principle to examine podura scales and other difficult objects. both these methods of illumination might be of value today.

Till Wenham started making objectives, those with correction counts, and they were much more common than they are now, were constructed with the front element of the combination mounted at the end of a tube which could slide on another tube containing the remaining elements, thus varying its distance from them and compensating for differences in cover glass thickness. The screw adjustment used was inconveniently slow and it was not difficult to put the front lens right through the cover. Wenham arranged for the fronts of his objectives to be fixed and for the rear combinations to move within the objective barrel by the action of a pin in a spiral groove. This construction was adopted by all the makers and is still used today.

He made his first objective, a 1/4-in., in 1850 and followed this with an 18-in. about which he consulted J. J. Lister, who was perhaps second only to Ernst Abbe as an improver of the achromatic microscope. Wenham experimented a great deal with the design of objectives and by 1853 he was making excellent lenses with apertures up to 170° or N.A. 0-99 in today's terminology. Higher than that it was impossible to go until immersion lenses became practicable, as was the case a few years later, although their history goes back at least to Sir David Brewster in 1813.

Wenham was no great mathematician and designed his objectives by tracing rays through diagrams drawn out on a scale of 50:1, a method he learned from J. J. Lister. This worked well enough for him and when he was with Ross and Co. he revised all their high power objectives, giving them a single flint back as well as a single front, leaving only the middle element (or elements) compound. He gave a paper (1872) to the Royal Society on objective design, and Nelson considered some of these Ross objectives to be the best before the advent of apochromatics.

Wenham published a series of articles in the Monthly Microscopical Journal (1869) giving full directions for making objectives and prisms, and some readers did actually make objectives as a result. These articles are well worth consulting since they are full of useful hints on working glass.

So far a success story, but there were grave weaknesses in Wenham's conception of physical optics which were in due course to cost him much of his reputation as a microscopist. The diagrams in Fig. 7 indicate his basic misconception. They both show a cone of rays entering a medium from the air below and contracting in accordance with the laws of refraction, to expand again to the original angle when emerging into the air above.

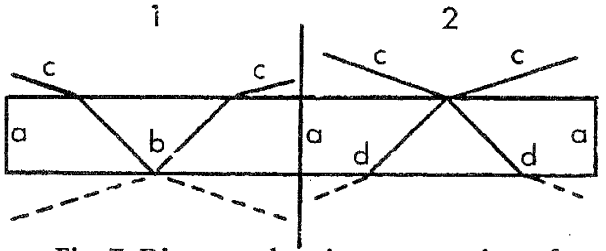


Fig. 7 Diagram showing contraction of illumination cone

Wenham was convinced that the contraction of the cone represented a loss of aperture never to be recovered and that if an object were mounted in the medium, say balsam, at the position b in the first diagram it could not be seen so advantageously as if it were mounted in air, as for instance where the rays cross in the second diagram. Like most others of his time he

continued on page 41

MSSC Meeting Notes for 21 January 1998

David L. Hirsch

The regular meeting of 21 January, 1998 began at 7:45 P.M. 35 members and 4 guests were present.

MAIN SPEAKER. MICHAEL SERRY,Applications Scientist with Digital Instruments gave an excellent talk on Scanning Probe Microscopy (SPM). Details of his speech were covered in the last issue of this Journal. Mr. Serry distributed copies of a well documented brochure describing the SPM process and equipment. Corresponding members may obtain copies of the brochure on Scanning Probe Microscopes by writing to: Digital Instruments, 112 Robin Hill Road, Santa Barbara, CA, 93117. State-of-the-art technologies such as SPM have taken over where light microscopy and even Electron Microscopy have left off. We can only marvel at what the future breakthroughs will be.

AL HERMAN spoke to the membership about his research into methods of preserving computer printouts made in color.

At the regular MSSC meeting on 20 November, 1996, KLAUS KEMP, the accomplished slide preparer from England, demonstrated his technique for making slides featuring meticulous and artistic arrangements of diatoms and butterfly scales. We have learned that Klaus appeared in an English court recently, concerning injuries he suffered in an unprovoked assault by a neighbor. Prior to the trial, several MSSC members sent supportive letters to the court attesting to the character of Mr. Kemp. JIM SOLLIDAY will keep us posted on future events.

Jim reminded us of the forthcoming MSSC photomi-

continued on page 42

Wenham - continued

confounded angle, or rather the chord of the angle, with aperture, which is really a measure of capacity to transmit radiant energy and is higher in proportion to the refractive index of the medium as well as in proportion to the chord of the angle of transmission. A consequence of this thinking was that no object mounted in balsam could ever be seen under a greater angle than about 82°, or as we would put it now, N.A. 0-65, whatever the aperture of the objective since any additional rays emanating from the object could be totally reflected at the cover glass.

Wenham's main antagonist was the American optician Robert Tolles, who with no great literary clarity but with much common sense and practical skill advanced arguments and constructed apparatus and diagrams that eventually showed Wenham's position to be an impossible one.Tolles can probably be regarded as the true progenitor of the of the homogeneous immersion objective for, no doubt benefiting from Wenham's earlier work, he made in 1872 an objective working in liquid balsam with what was termed a 'balsam angle' of 95°, N.A. 1-12. He claimed, rightly that this was the equivalent of more than 180° in air, which claim Wenham ridiculed on the grounds that no objective could possibly see backwards. This unhappy controversy dragged, with Wenham losing nearly all his support, until a new era in microscopy was heralded in 1873 by the publication of the theories of the microscope arrived at simultaneously by Abbe and von Helmholtz, which cut the ground from under Wenham's feet when they were belatedly made known in England.

That was not the end of Wenham, of course, for he had become interested in gas lighting and took out a number of patents which he exploited with a manufacturing company he set up. His patent shadowless burner became almost universal till the advent of the gas mantle and electric lighting. Having substantial private means he retired from business when he was sixty, though not from technical activities for he later took out patents for a mechanical piano and an infinitely variable gear for motor cars. He continued his active interest in aeronautics and indeed bought ten acres on a hill at Woking to carry out gliding experiments. Even as he died at the age of 84 his last paper on aeronautics was passing through the press.

There is, however, a postscript. Long after the aperture controversy had faded away an article by Wenham appeared in the 'English Mechanic' entitled "A Microscopical Reminiscence'. In this he describes an experiment to show that objective apertures measured by the usual methods are fallacious and says that a paper he once laid before the Royal Microscopical Society embodying the experiment was peremptorily rejected the Council at the behest of wire-pullers now gone over to the opposition.'My paper was returned to me' he writes 'without even a request for a demonstration. In consequence of this I tendered my resignation of membership. Directly after this that body of useful workers, the Quekett Microscopical Club, with graceful recognition of my past services for improvements in the microscope and its accessories, at once elected me as a honorary member of their Association'. And, say I, "Good for the Quekett!"

MSSC Meeting Notes for 21 January 1998
continued from page 41

crographic exhibit to be held this May, at a time to be announced. He also gave an excellent presentation of slides prepared more than 100 years ago, featuring the work of Enock, Flatters & Garnett and others. The slides revealed the extreme skills of those early slide preparers and their techniques. Jim showed some Victorian photomicrographic slides revealing the fine structural details of insects from the wasp family, and the skill of the preparer in emphasizing such details. Other slides showed methods for creating 'casts' of cavities in histological specimens.

DEMOCRACY IN ACTION. "If it aint broke, don't fix it", goes that adage of unknown origin. The members of MSSC showed a remarkable vote of confidence by restoring our previous staff of officers, with the exception of our Vice President who asked to step down to focis his activities on the Journal.

The officers for fiscal year 1998 are: GEORGE VITT, President; JIM SOLLIDAY, Vice President; RON MORRIS, Secretary; DAVE HIRSCH, Treasurer; LARRY ALBRIGHT, Program Chairman; STEVE CRAIG, Workshop Chairman; JIM CLARK, Education Program Chairman; GAYLORD MOSS, Editor of the MSSC Journal. In retrospect, the great progress evidenced since our 'make-over' speaks for itself; FOR A BUNCH OF "GOOD OL' BOYS", WE MUST BE DOING SOMETHING RIGHT!!

SHOW AND TELL. How many members identified the substance displayed under the microscope by BARRY SOBEL? Now you know what a calculus (kidney stone) looks like. Many members admired the Sorval model JB-4 precision rotary microtome shown by JOHN DeHASS. A pristine Spencer colorimeter, model 245 was displayed by an unnamed MSSC member. Another item shown by an anonymous member was a Voightlander Braunschweig compound monocular microscope of rugged design. Now hear this! Don't miss the kudos of the multitude; make sure that your name appears along with your showpiece.

MSSC MARKETPLACE. "Sales were brisk," as the saying goes. Your Treasurer was busy making out checks for expenses, in addition to receiving donations from members for items offered at the Sales table. Well made slide boxes went fast, along with assorted optical remnants. Let's give our thanks along with a smile of appreciation to the donors. Attention, Corresponding Members! If you are seeking microscopical items of any kind, write to Editor Gaylord Moss and your needs will be published in the MSSC Journal.

GOLDEN HANDS. About one thousand years ago, little David, age six, disassembled the family mantle clock. My folks were angry of course, and a well deserved punishment awaited me. My grandma, as grandmothers throughout the universe are wont to do, saw things differently as she surveyed the scattered gears and springs. Her comment: "My grandson - such golden hands he has." Perhaps the grandmas of many MSSC members alluded to their children's offspring in the same manner; I hope they did, because I am elated to learn that so many members, Regular and Corresponding alike, possess "Golden Hands." What better evidence is there, than the proliferation of the well conceived, and well constructed microscopically pertinent artifacts, prepared slides and photomicrographs produced by our members?

Whatever the project, it was the makers' "Golden Hands" that brought his or her work to fruition. The project may have negligible intrinsic value compared with that of an original stand by Cuff or Culpeper, but to the MSSC craftspeople, their projects cannot be measured in terms of time and money. I feel that too many lights in the MSSC Brotherhood are being hidden under too many bushels. Those of you among our membership who haven't as yet favored us with samples of your microscopical projects, are urged to do so.

DORIS MILAN. DORIS, the beloved wife of long time member LEO MILAN has just undergone gall bladder surgery and will be in the Kaiser Hospital for probably another week. The Milan's would be happy to hear from MSSC members both Regular and Corresponding. They can be reached at: 3320 Stoner Ave., Los Angeles, CA 90066, or by phone at: (310)391-9654.

FISCAL YEAR CHANGE OVER. Please be advised that the new MSSC fiscal year started 1 January, 1998. To put the Treasurers books on track, for the year 1998 ONLY, dues will be payable on 1 June, 1998. The dues will be for six months, that is, for half of the current annual dues. Regular Members will be assessed $25.00 and Corresponding Members will pay $20.00. 1999 dues will then be payable as of 1 January, 1999 for the entire fiscal and calender year. Say what?

THE LAB REPORT

James D. Clark Jr.

The idea behind the establishment of the MSSC Education Programs chair post is to develop a way to encourage and coordinate learning activities within our organization. To this end, I propose we use this column in the bulletin to list class offerings as they are scheduled or proposed. With the wide range of members' interests, experiences, and skill levels this program has to draw on, I hope we can provide members opportunities to develop their understanding of the science of microscopy.

Since this program will be built around the instructors, they will pick the time, place, cost, and number of participants they can accomodate.
A sampling of ideas I have received so far:

Photomicroscopy	Chemical microscopy
Camera Lucida Techniques	Slide Making
Video Microscopy	Micromineralogy
Microscope Collecting	Restoring Instruments
Field Trips (various venues)	

Program announcements by the instructor will include: a brief abstract, the time, place and required materials. To sign up, members will need to call the instructor and reserve a place. In many classes, enrollment will be limited to allow for indivdual instruction in what may be a very small lab. The hands-on nature of these classes lend themselves to 4-8 students. If a class is over subscribed, it could be repeated at a later date.

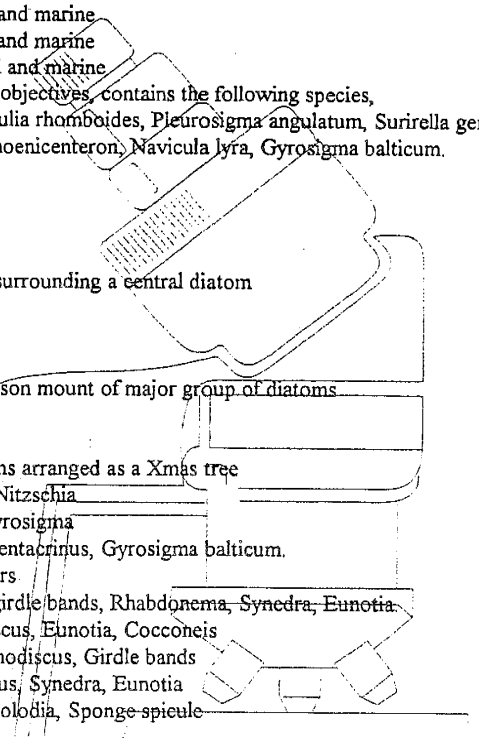
This month, Ron Morris is willing to give a class on "Polaroid Metallurgical Photomicrography". Call Ron for details. In the the future we will be posting the time and place, but do not have that information at this time.

I will be calling on potential instructors, and will particularly welcome your contacting me with your ideas and suggestions.As this program evolves we may able to explore sequences and advanced classes, but for now let us try, through sharing and communication, to make this work and have fun!

Klaus Kemp Slides

Many of our members have written letters to Klaus Kemp and the court supporting him in his present legal travails.As an additional show of support, we list below some of his superb Type and Exhibition mount slides.Also, some of his strew slides and butterfly scale arrangements are listed on the facing page.

K.D. & S. Kemp, Microlife Services, Blautannen, Wickham Way, East Brent, Somerset TA9 4JB, Fax/ Phone 01278 760 411



Type slides each with species list

12 Form , freshwater	£ 7.00
12 Form, marine	£ 7.00
12 Form , freshwater and marine	£ 7.00
30 Form , freshwater, fossil and marine	£ 8.50
50 Form , freshwater, fossil and marine	£11.00
100 Form , freshwater, fossil and marine	£22.00
8 Form test plate, for testing objectives, contains the following species, Amphipleura pellucida, Frustulia rhomboides, Pleurosigma angulatum, Surirella gemma, Nitzshia sigma, Stauroneis phoenicenteron, Navicula lyra, Gyrosigma balticum.	£ 6.00

Exhibition mounts

25 Form star pattern	£ 8.50
50 Form star pattern	£15.00
5 Form circle, four diatoms surrounding a central diatom	£ 4.00
25 Form circle pattern	£ 6.00
50 Form circle pattern	£ 9.00
100 Form circle pattern	£30.00
Centric and Pennate, comparison mount of major group of diatoms	£ 2.20
50 Form rosette pattern	£15.00
100 Form rosette pattern	£30.00
Christmas tree, circa 100 forms arranged as a Xmas tree	£30.00
Bicycle, Arachnoidiscus and Nitzschia	£10.00
American Eagle, Surirella, Gyrosigma	£15.00
American Flag, Triceratium pentacrinus, Gyrosigma balticum.	£40.00
Eifel tower, Synedra and others	£15.00
Choir Boys, Arachnoidiscus girdle bands, Rhabdonema, Synedra, Eunotia	£40.00
Faces, two faces. Arachnoidiscus, Eunotia, Cocconeis	£20.00
Butterfly, Gyrosigma, Stephanodiscus, Girdle bands	£15.00
Penny Farthing, Arachnoidiscus, Synedra, Eunotia	£ 5.00
Microscope, Pinnularia, Rhopolodia, Sponge spicule	£10.00

FEBRUARY MEETING

Wednesday, February 18 at 7 PM
Crossroads School
1714 21st Street
Santa Monica, CA

THE MINERALS OF MARS

Alan Sailor

Alan Sailor will speak on what we know of the minerals of Mars, most of which is from the detailed sectioning, microscopic and other analysis of 12 known Mars meteorites as well as information gatheredfrom the Mars probes.

We will see slides of mineral sections as well as picures from the Viking orbiter and Viking lander as well as the latest Pathfinder and current Mars Observer circling the planet.

Alan works at the Rockwell Science Center and at Cal Tech and has a personal collection of meteorites which is his particular interest.

This promises to be another fascinating presentation, especially for the mineralogists among us, but also for those interested in a detailed look at the various Mars probes.

Editor's Notes

Most months bring a scramble to get sufficient articles to fill our Journal. I appreciate very much those members who have repeatedly contributed the quality articles that make the Journal. Bert Loro is one of these. Although corresponding from far off Victoria, B.C. Bert has contributed three superb articles and a member profile. See, besides this month's cover feature, Memories, Nov 1996 p.44; The Rocking Microtome, Dec 1996 p. 59; and Bert Loro Member Profile, Dec. 1996 p. 72.

I would like to encourage more members, both regular and corresponding, to write up and send in descriptions of your activities or other things pertaining to microscopy. For anyone who does not want to write a long article, please just consider sending in photographs of interesting projects with short descriptions and they can be easily arranged as an article. Hand drawn sketches are fine. Consider that if something is interesting enough for you to spend time on, it is probably worth sharing with the rest of us. Please do.

Gaylord Moss