E. LEITZ INC., 468 PARK AVENUE SOUTH, NEW YORK 16, NEW YORK

TECHNICAL INFORMATION BULLETIN

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ASTIGMATISM AND CURVATURE OF FIELD .....

A simple lens will not focus an off-axis object point into a sharp point in the image plane. Instead, there will be two image points, one behind the other. In addition, these will not even be well defined points. They are drawn out into two short focal lines orientated vertical to each other. This aberration is called astigmatism.

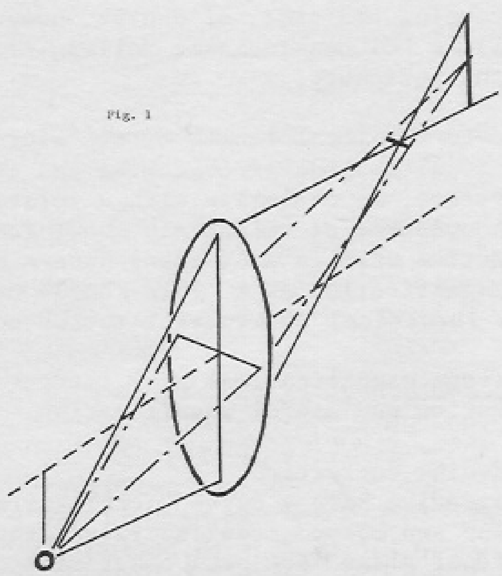


Fig. 1

Geometric optically, we can distinguish two planes, in which rays travel from an off-axis object point to an image point. If we draw a straight line from the off-axis object point to the optic axis, we define a plane. Rays travelling in this plane are called "tangential rays". Rays travelling in a plane vertical to this plane are called "sagittal rays".

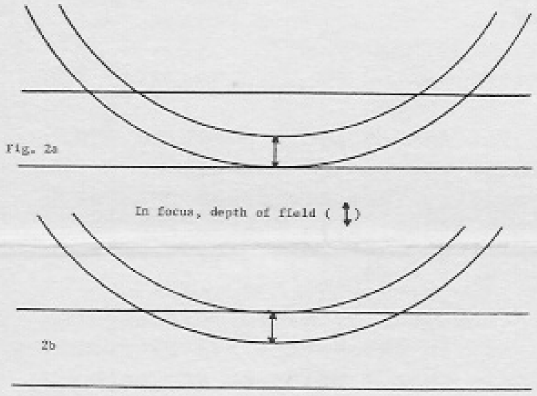
The tangential rays come to an earlier focus than the sagittal rays, which appear at the tangential focus as a focal line. At the focus of the sagittal rays, the tangential rays have passed their focus, and appear as the sagittal focal line, vertical to the tangential focal line, as shown in Fig. 1.-

In addition, the focal distances for both the tangential and the sagittal focal lines become shorter, the more off-axis the object point is.
In other words: off-axis object points are focussed onto two curved image planes. The curved "tangential image plane" has a curvature different from the "sagittal image plane". They coincide on the optic axis; off axis, they have a certain distance from each other, which determines the amount of astigmatism. Normally, the concave side of both curved image planes points towards the objective.

Astigmatism disappears, when the tangential curvature and the sagittal curvature are identical. This can be achieved by selecting suitable radii and lens shapes for the component lenses in an objective. Of course, corrected astigmatism in this case means remaining curvature of field - which is the curvature now common for the tangential and sagittal image plane.

On the other hand, it is possible to give to the sagittal image plane a negative curvature so that its concave side faces away from the objective. If this negative curvature equals that of the positive curvature of the tangential image plane, there will be no curvature of field left - but a prohibitive astigmatism.

It is the simultaneous correction for astigmatism and curvature which represents such difficulties. Correction for astigmatism is more important, since this aberration leads to image unsharpness. Curvature of field does not lead to unsharpness as such, it is only that not the whole field is simultaneously in focus. Visually, this is not too serious, but in photomicrography this is objectionable.
There are several ways to obtain a flatter field:



1) Proper focusing of the microscope. The microscope specimen has a certain thickness. Each combination of objective and eyepiece gives a certain depth of field, indicated as the space between the two arcs in Figs. 2a and 2b. Fig. 2a shows how to bring the largest area of the field of view into focus, which, as can be seen, is increased by the depth of focus. Fig. 2b shows how to focus if highest definition on small detail is desired. The field of view remains the same, of course, however, there will be now considerable falling-off towards the periphery.

2) Image curvature increases approximately inverse to the focal length of the microscope optics. Minimum curvature exists when the focal lengths of objective and eyepiece are the same. For minimum curvature, therefore, an objective with a relatively long focal length should be combined with an eyepiece of relatively short focal length. The restrictions here are that the objective must in many cases have a minimum numerical aperture, and that the eyepiece magnification as a rule should not lead to a total magnification higher than 1000 x the numerical aperture of the objective.

3) Long bellows extensions rather than high microscope magnifications give flatter fields, if this is feasible from the viewpoint of resolution and useful magnification.

4) Periplan eyepieces have a special curvature-reducing correction.
Normal eyepieces, when fully corrected for astigmatism have a curved focal surface the concave side of which faces the eyepiece. The two curved focal surfaces, that of the intermediary image and of the eyepiece focal plane face each other with their convex sides. A smaller field therefore appears in simultaneous focus.
Periplan eyepieces carry a certain amount of astigmatic overcorrection, which leads to considerably improved image flatness.

5) Negative or photo-oculars permit a full anastigmatic correction, together with a largely reduced field curvature. They can not be used visually, since the exit pupil is inside the system.

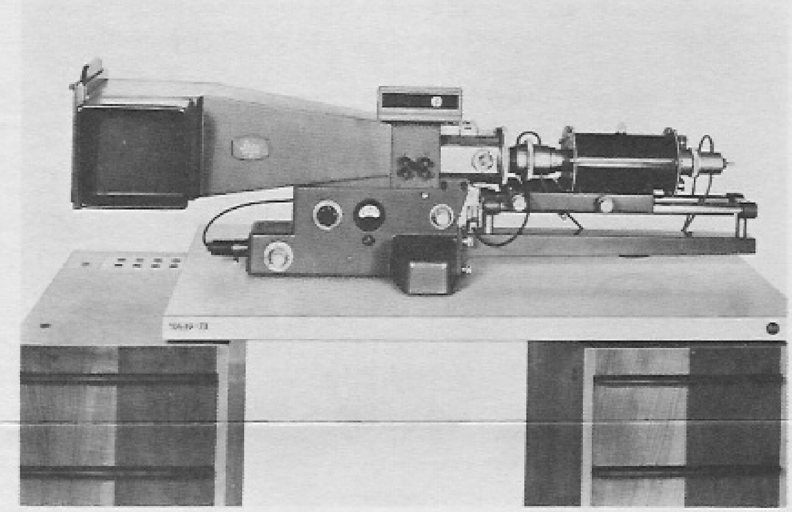
6) In recent years, it has become possible to eliminate both astigmatism and curvature of field at the source in the objective. The introduction of meniscus-shaped lens elements led to the so-called plano-objectives, or plan-systems, which have virtually no curvature of field left with a fully maintained anastigmatic correction.
For full flatness of field, the so-called Petzval-condition has to be fulfilled. This means that the summation of all expressions: "refractive index x focal length" for each refracting surface in the lens train of the objective must be made equal to zero. The meniscus surfaces introduce the necessary balance. Today, even fully apochromatic plano oil immersions with highest apertures are available.

NEW LEITZ WORK TABLES FOR THE LABORATORY.....

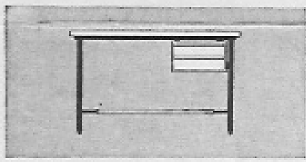
What kind of desk is needed for the support of laboratory instruments?

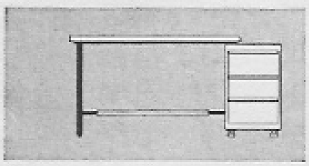
Where do I place the equipment and where the accessories?

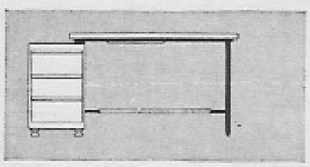
Is it possible to select suitable tables for individual laboratory requirements and yet obtain uniform, pleasing, appearance which stimulates the desire to work?

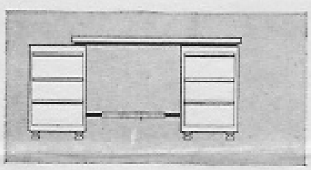


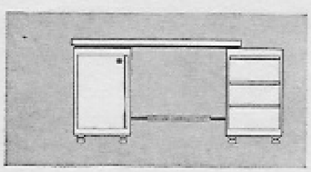
LEITZ Dilatometer Model UBD

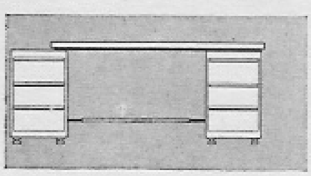


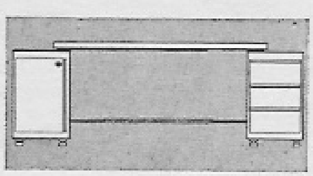












These are some of the questions asked when a new instrument is set up, or a new laboratory is being equipped. Leitz has developed a series of new work tables which offer several advantages and simplify the proper setting-up of a room plus improve the ability to use the instruments placed upon them.
The advantages are the following:

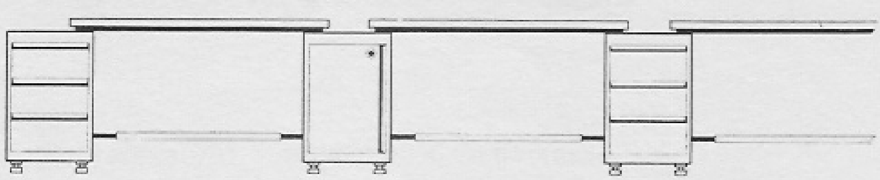
The tables have a high carrying capacity: up to 350 kg, and are perfectly steady. The smooth, clear form represents the modern trend. The table height is based upon long years of experience with the use of laboratory instruments, particularly optical instruments.

The table tops with Formica are burn-proof, scratch-proof, and acid-proof, and can be cleaned very easily. Only selected woods have been used, and the light grey color, with just a shimmer of reflectivity, lends to the room a warm and timeless appearance. The color scheme is in harmony with the lacquer of modern technical instruments.

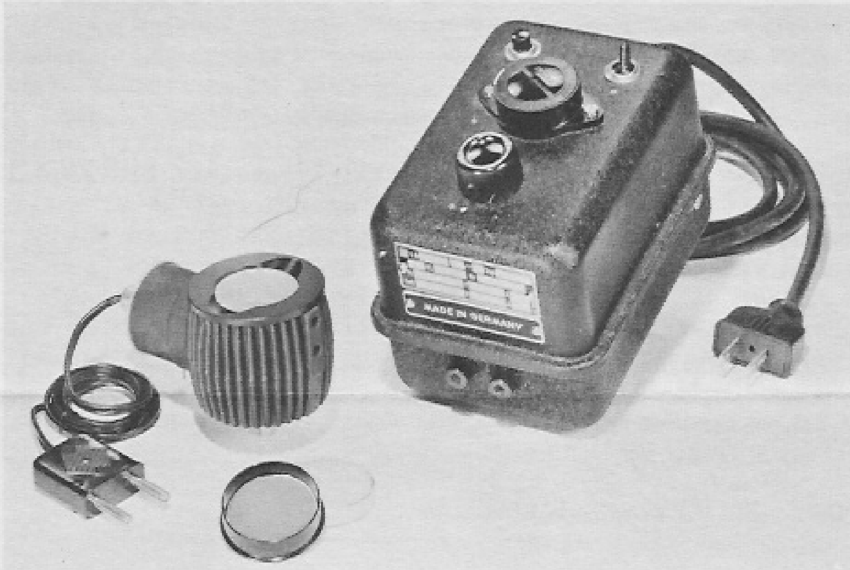
Electrical connections and transformers may be built-in. The transformers are operated conveniently by pulling out the desk draw. If the draw is closed and locked, no one can operate the instrument.

The different tables consist of unitized building blocks. This permits the extension of any existing table to meet additional needs.

A special pamphlet dealing with Leitz laboratory tables is available upon request.



THE NEW MICROSCOPE LAMP 12 V 25 W FOR STUDENT AND LABORATORY MICROSCOPES.....



Modern microscopes are almost invariably used with artificial light sources; the most simple of which is a 15 Watt 110 Volt lamp, mounted on a pin which fits into the microscope base under the condenser. This lamp is satisfactory for most observations through a monocular tube, even under highest magnifications (1250 x).

The popularity of binocular microscopes, however, has increased the demand for a simple, yet more intense light source, that will produce bright images for all magnifications and samples that are thick and heavily stained.

A light bulb for connection to 110 Volt becomes too hot for microscope work if the wattage is higher than 15 - 20 W. However, the higher output is necessary to observe an image at 1250 x or more through the binocular tube. Therefore a low voltage lamp 12 V 25 W has been developed, the intrinsic intensity of which is higher and which does not develop as much heat as a 110 V 25 W bulb. Naturally a low voltage lamp must be equipped with a transformer to reduce the voltage from 110 to 12 Volt. The new lamp therefore is supplied with a regulating transformer which allows the user to increase and decrease the intensity, as desired. It even has a push button to double the intensity output of the lamp, when needed. The lamp itself consists of a cast housing with central positioning pin for SM and Labolux microscopes. It has a built-in metal reflector, one ground glass and one blue glass filter, as well as cord and plug to connect the lamp to the transformer. Further details on this new lamp will be gladly submitted on request.

MACROSCOPIC OBSERVATION BY MEANS OF THE BERTRAND LENS.....

We have recently come across an interesting method for the observation of low power images with the Dialux-Pol Microscope by employing the Bertrand lens.

The lowest magnification of a microscope is usually limited by the power of the lowest objective available and the lowest power eyepiece. The product of the two results in the total magnification (plus the tube factor). The lowest limit of magnification in most microscopes ranges from between 15 - 20 x, the field of view being at most 5 - 7 mm in diameter. The microscopist usually has to resort to the prism magnifiers, stereo microscopes or illuminators for general survey work, if he wants to observe macroscopic objects.

The Polarizing Microscope Dialux-pol has a built-in focusable Bertrand lens, which enables the user to enter into the area of macroscopic observation. In order to take advantage of this, remove the objective, switch in the Bertrand lens and exchange the standard condenser against a low power one. Replace the ring plate of the object stage against a glass plate (Plano-parallel).
The focusing knob of the Bertrand lens and the different position in height of the microscope stage will allow various ratios of magnification to be established; if desired these microscopic images can also be photographed.
The field of view is of course limited by the small opening of the Bertrand lens.

CARBONS FOR MICRO PROJECTORS XI C AND PANPHOT .....

We have often been asked about the burning time of arc lamp carbons as supplied with our micro projectors.

The following table contains the information:

Types of paired carbons	Type of Current	Ampere	Voltage	Burning Rate	mm/h
RKD 8 x 135 mm (Positive carbon) RKD 8 x 110 mm (negative carbon)	D.C.	10	55	74 (positive carbon)	46 (neg. carbon)
RKD 8 x 135 mm RKD 10 x 110 mm	A.C.	15	45	70 (horiz. carbon)	45 (vertical carbon)

THE USE OF MICROTOMES IN TEMPERATURES BELOW 0° C. .....

The oil which is used on the gliding surfaces of microtomes must be removed if the instrument is to be operated at temperatures of -15° or less. We supply a special oil No. 601 which allows their use to -70° C. The price of this oil is $ 2.50 per 100 gr.

VACUUM HEATING STAGE FOR TEMPERATURES UP TO 1750° C. .....

We should like to repeat below the questions most frequently asked by our customers with respect to the use of this new heating stage. These are followed by the answers obtained from the scientific staff at the Leitz company in Wetzlar.

1) What vacuum pump do you recommend for this stage? - Messrs. A. Pfeiffer, Wetzlar manufacture a vacuum pump type VH 25, which can be purchased through Welsh Scientific, Chicago.

2) What is the degree of vacuum necessary for the proper operation of the stage? - The Pfeiffer pump VH 25 is capable of a vacuum of 10^{-6} Torr. The stage vacuum, however, is usually between 10^{-4} and 10^{-5} Torr. because of leakage in the pump lines, as well as the heating stage itself.

3) What heating element is used in a vacuum? - Tantalum

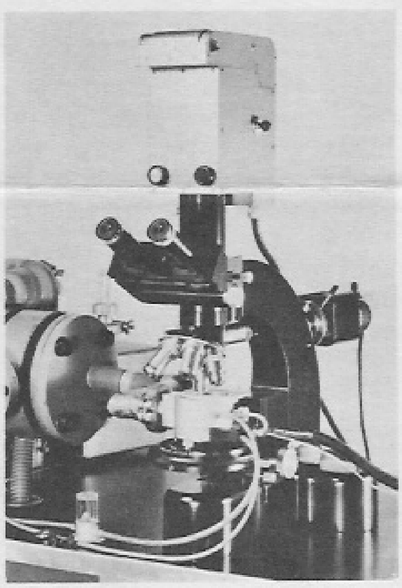
4) What heating element do you recommend for use in protective gas atmosphere up to approximately 1800° C? - Wolframite (Tungsten)

5) Which protective gas do you recommend? - Argon

6) What is the maximum temperature level for the heating element made out of Vachromium? - 900° C.

7) What is the maximum temperature possible, using a heating element made of Rhodium? 1300° C. (This type of heating element has to be procured by the customer himself).

8) Can a platinum heating element be used under vacuum and at the same time be subjected to positive pressure of oxygen? - Platinum becomes brittle under oxygen.



Vacuum Heating Stage

for temperatures

up to 1750° C.