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TECHNICAL INFORMATION BULLETIN

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PHOTOMICROGRAPHY

Color Temperature

Incandescent lamps belong to that group of light sources which have a "continuous spectrum". The light emitted by such sources comprises all wavelengths from red to blue in the visible spectrum. The fact that all wavelengths are represented does not mean, however, that they are all present with equal intensities. The continuous spectrum may contain much more red than blue light, for example. Just how much red and how much blue light is present in the emitted light can be described as the "relative spectral intensity distribution" of the source. This relative spectral intensity distribution is a direct function of the temperature of an incandescent source. At low temperatures, the emission maximum lies in the red spectral region, at high temperatures the emission maximum shifts towards shorter wavelengths. Such a change in the relative spectral emission of the source appears to the human eye as a change in color. The light will appear reddish and warm at low, and whiter, or cooler, at high temperatures, when relatively more blue is emitted. The color impression or quality of the light therefore, is closely related to the temperature of the light source. Color temperature is a numerical expression for a certain relative spectral intensity distribution and is measured in degree Kelvin on the absolute temperature scale. It is not necessarily identical with the actual temperature of the lamp filament, but the temperature to which a so-called black body, an idealized thermal radiator, would have to be heated to emit light of the same relative spectral distribution.

In color photomicrography it is not sufficient to expose the film properly. To record a visual color impression on film one has to adjust the light source to that color temperature for which the color film is balanced. The several layers in a color film have definite relative spectral sensitivities which determine this balance. For each type of emulsion, the manufacturer states the color temperature which the source should have. Only then will the photomicrograph give a color rendition which reproduces the visual impression.

In order to obtain proper color rendition, one therefore has to consider two factors: one is the color temperature for which the emulsion is balanced, the other is the color temperature of the light source. Of these, the first is determined by the choice of film type. The second, the color temperature of the source, can in the case of incandescent light sources very easily be regulated by adjusting the operating ampèrage. In figure No. 1, 2, and 3, the color temperatures of the three incandescent lamps in the Labolux, the Ortholux, and the Panphot are plotted as a function of the ampèrage.

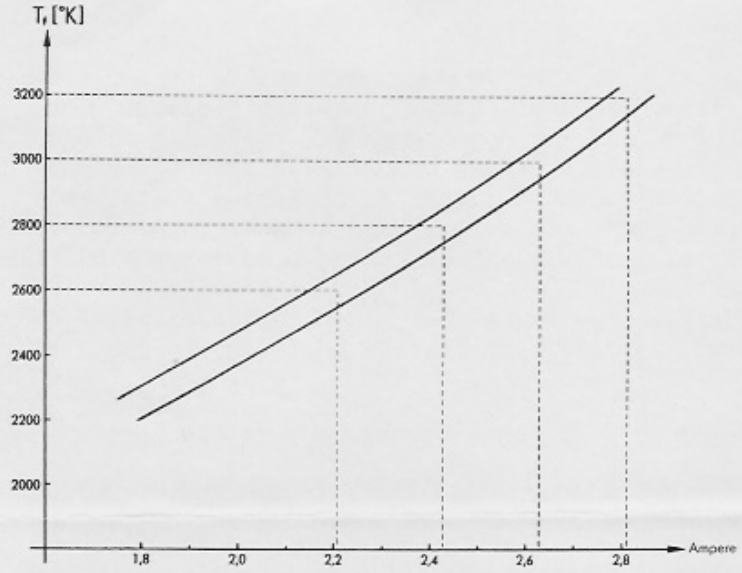


Fig. 1

Labolux

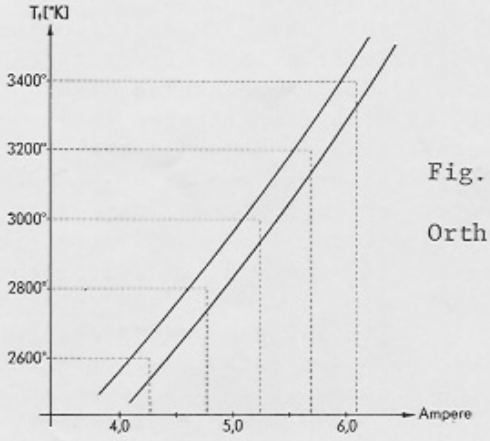


Fig. 2

Ortholux

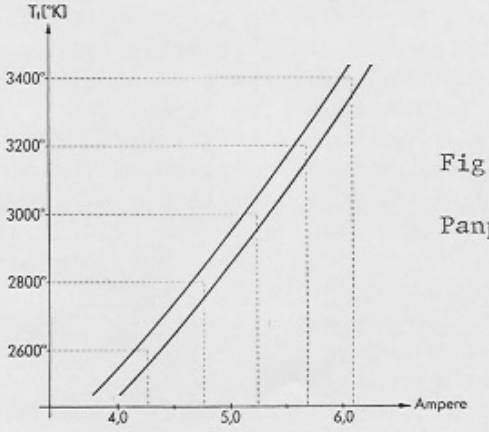


Fig. 3

Panphot

From these graphs can be seen that a range of color temperatures from approximately 2600° K to 3400° K can be covered by regulating the lamp ampèrage. Most tungsten type color emulsions are balanced for color temperatures within this range, as can be seen from table 1.

Table 1

Agfachrome CK20	80 ASA	2900° K
Kodachrome II A	32 ASA	3200° K
Ektachrome B high speed	125 ASA	3200° K
Ektachrome B	32 ASA	3200° K
Anscochrome T/100	100 ASA	3200° K

There are cases, however, where one wants to use film balanced for daylight or where one does not want to operate the incandescent lamp at a high amperage for an extended period of time. An adjustment of color temperature balance between

light source and color emulsion is then possible by means of conversion or light balancing filters. These are available from a number of manufacturers, for instance, the Wratten filters or the Tiffen DM filters.

There are two types of filters: reddish filters which lower the color temperature of the source, and bluish filters which raise the same. The Wratten filters are used to raise or lower the color temperature from a fixed value to a fixed value. Table 2 lists the color temperature differences which are corrected by certain Wratten filters.

Table 2

To lower the color temperature from the fixed value listed in the left column to 3200° K, use the filters listed in the right column.

3300° K		Wratten 81
3400		81A
3500	→ 3200° K	81B
3600		81C
3700		81D

To raise the color temperature to 3200° K:

2490° K		82C plus 82C
2570		82C plus 82B
2650		82C plus 82A
2720	→ 3200° K	82C plus 82
2800		82C
2900		82B
3000		82A
3100		82

The Tiffen Deca Mired filters (DM filters) are independent of the absolute color temperature in their correcting effect. To determine which filter should be used, a short calculation is carried out, for which it is easier not to work directly with color temperature values but with the so-called Mired values. Mired stands for micro reciprocal degree Kelvin.

The Mired values are obtained by dividing 1,000,000 into the color temperature in degrees Kelvin.

$$\frac{1{,}000{,}000}{^{\circ}K} = \text{Mired value}$$

Numerical example: $\frac{1{,}000{,}000}{3200^{\circ}\ K} = 312.5$ Mired

The so-called Deca Mired values are simply a unit ten times larger than the Mired values.

So: 1 Deca Mired = 10 Mired

Numerical example: $\frac{1{,}000{,}000}{3200^{\circ}\ K} = 31.25$ Deca Mired

The Mired values indicate the amount of color temperature correction which the conversion filter effects.

First, one calculates the Deca Mired value of the light source. Then, one calculates the Deca Mired value of the film. The Deca Mired value of the source is then subtracted from the Deca Mired value of the film. This difference represents

the required DM value of the filter. When the sign of the difference is positive, a warming filter of the R series is required. When the sign is negative, a cooling filter of the B series is necessary. There are four R filters: R 1½, R 3, R 6, and R 12, and there are four B filters: B 1½, B 3, B 6, and B 12. DM filters may be combined, so R 3 plus R 6 will have the effect of an R 9. B and R filters, however, cannot be combined.

Numerical example: Color temperature of source: 3800° K

$$\frac{1{,}000{,}000}{3800^{\circ}K} = 26.3 \text{ Deca Mired}$$

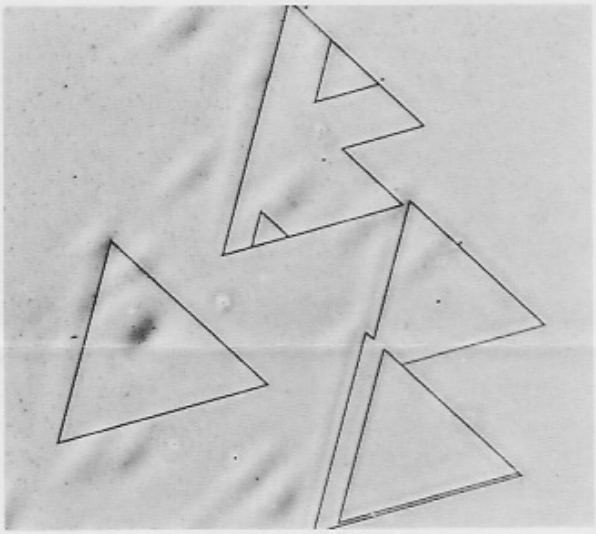
Color temperature of film 3400° K

$$\frac{1{,}000{,}000}{3400^{\circ}K} = 29.4 \text{ Deca Mired}$$

DM value of film minus DM value of source: 29.4 - 26.3 = + 3.1 Deca Mired. The difference is positive, so a filter of the R series is needed and the proper filter is the R 3. The manufacturer recommends the use of the next lower filter combination if no combination will fit exactly to the required value. For example, for -14, use a B 12, for +10 us the R 9.

The use of such conversion filters makes it possible to use emulsions which are only available as daylight types. For these a color temperature between 5400° K and 5800° K is generally assumed. Some daylight type emulsions have a more satisfactory red rendition than others.

PRACTICAL PHOTOMICROGRAPHY



Stacking faults on semiconductor wafer surfaces have extremely low relief. Reflected light phase contrast proves in some cases to be an ideal method of observation due to this method's high sensitivity to detection of minute optic path differences.

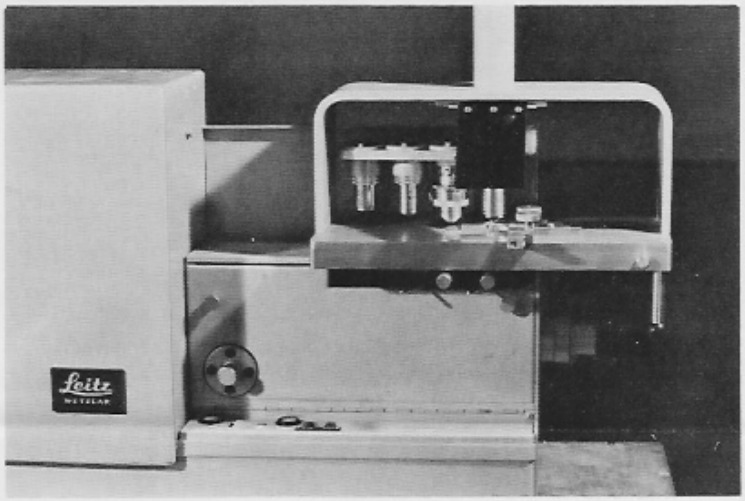
Metallux incident phase contrast objective phaco 50x; Orthomat. Total magnification of print 850x.

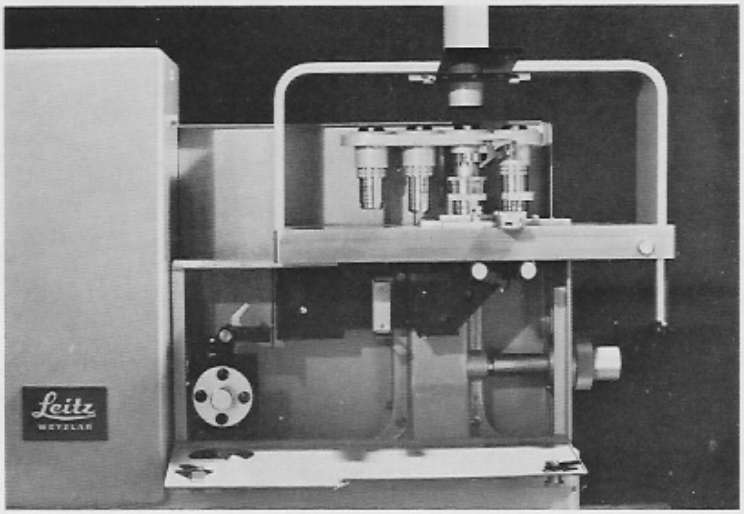
Orthomat at 25 ASA/c, DH 100%, monochromatic green filter 540 mμ, Kodak high contrast copy film developed in Rodinal 1 : 50, 15 minutes at 68° F.

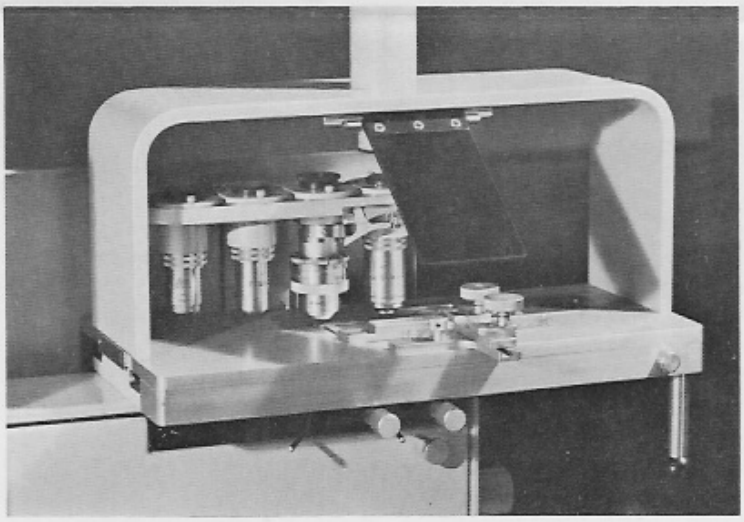
ORTHOMAT

The electrical control unit of the Orthomat is equipped with a selector switch for various voltages: 110, 120, 130 Volts, etc. It is important that the control unit is switched to the right voltage, otherwise the "not yet in operation light" will remain lit. If the light does not extinguish after a minute or so, the switch in the control box ought to be set to the next higher voltage. A special key is available for that purpose - no charge. It makes the switch accessible without need for dismantling the housing of the control unit.

MICROPROJECTION







Microprojection is one of the oldest teaching aids in medical study and diagnosis. Recent developments in high-power Xenon lamps have permitted the design of projectors without troublesome, noisy carbon arc lamps. The well-known Leitz Microprojector XIc has been redesigned and is now equipped with a Xenon 450 Watt lamp which facilitates group demonstrations to an extent never before possible.

The light source is completely maintenance-free, yet more intense than a carbon arc and allows microprojection over the full range of magnifications including the use of oil immersion lenses.

A special dichroic mirror reflects all usable light into the optical system, while heat radiations bypass the specimen stage (see illustrations).

Thus extremely bright images, without bleaching the slides, or destroying living specimens, become possible

The projector may be connected to any normal house current and includes a power pack for settings of 17 or 25 Amp. The change-over is made by remote control. A series of neutral density filters permits variations in light intensity without altering the color balance.

The optical outfit comprises the well-known Leitz plano objectives which produce edge to edge sharpness over a 30% larger field than before. The projector can be used at varying distances, depending upon the desired image size. A large image at short projection distances for group demonstrations is also possible. The operation is simple, silent, and maintenance-free.

For further details write for catalog No. 36-D.2.

THE UNIVERSAL LAMP HOUSING MODEL 250

While until recently we supplied two types of condensers for different burners, we have since standardized on one type only, namely Condenser A (see page 2 of Technical Information Bulletin, Volume III, Number 2). This condenser is 34 mm in diameter.

THE NEW CONDENSER SERIES 600 FOR THE ORTHOLUX

The Ortholux Research Microscope with built-in field diaphragm is supplied with a new series of specially computed condensers as follows:

Condenser #601

Swing-out condenser As. 0.90,
lower element, A : 0.25;
for all achromatic lenses,
also recommended for fluorescence.

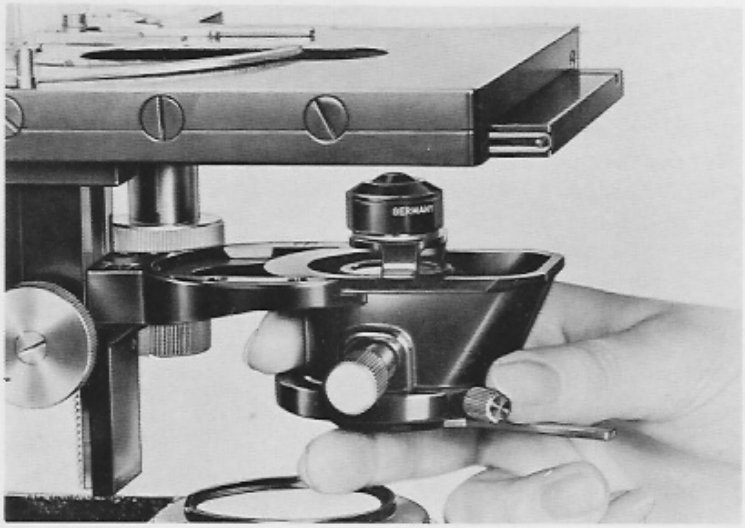
Condenser #602

Achromatic swing-out condenser Achr. 0.90,
excellent spherical and chromatic corrections.
For all well corrected systems, such as fluorite-, apochromatic-, or plano-lenses.
Recommended for Photomicrography.

Condenser #603

Achromatic-aplanatic condenser Apl.Oil 1.25,
highly corrected, as #602,
but with higher numerical aperture.
Especially valuable for use with highly corrected oil-immersions of highest aperture. Also recommended for color photomicrography at high illuminating apertures.

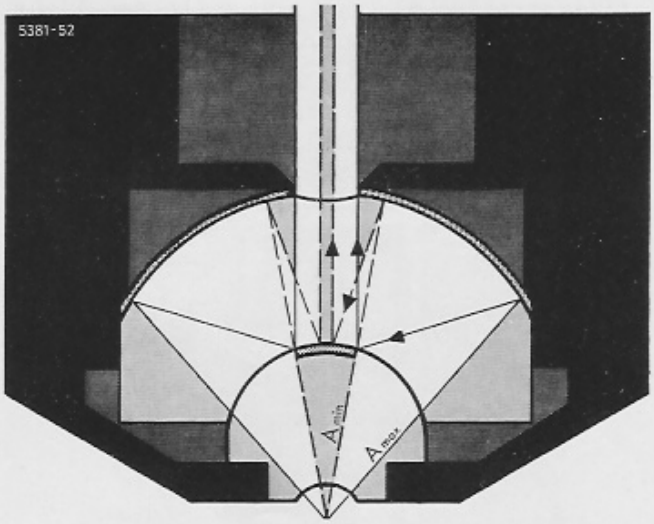
These new condensers are not only more highly corrected, but their improved light transmitting capacity and the more uniform bundle of rays in the field of view is worth mentioning. Since the Ortholux microscope is usually equipped with apochromatic objectives, we include condenser #602 into the basic outfit.



The upper condenser elements are interchangeable, so that only one basic condenser need be furnished. The operation of the new condensers is very similar to the "Berek" type. The aperture diaphragm is on the condenser proper, but the field stop is in the base of the microscope stand operated by a knurl. Condenser #602 fits into the dovetail fork of the substage and has its own centering device.

Older Ortholux Microscopes can be equipped with separate field diaphragm, permitting the use of the old and new condensers.

UV OPTICS



The illustration on page 4 of our Technical Information Bulletin of October 1, 1963, Volume III, Number 2, is incorrect.

The picture opposite should take the place of the one previously shown.

HEATING AND COOLING STAGES

Among the various heating and cooling stages supplied by us is Model 80. Tests have shown that methyl alcohol may be used as a cooling agent without destroying any of the parts of the stage.

THE NEW ACHROMATIC OBJECTIVE 40/0.65

A new high-dry objective has replaced the 45x Achromat. The new lens has an initial magnification of 40x, a numerical aperture of 0.65, and produces a total magnification of 500x, when used in a Leitz binocular microscope with 10x eyepieces. Several outstanding improvements are noticeable; they are the result of knowledge gained from the design and development of the now famous Leitz plano objectives.

Without increasing the price, and with judicious choice of optical glass, as well as improved anti-reflection coatings, a major improvement in an achromatic lens system has been achieved. The image is both more contrasty, as well as sharp from corner to corner without sacrificing any resolution. The achromat 40 is now available from stock and becomes standard equipment on all medical and laboratory microscopes.

POLAROID FILM

When taking photomicrographs of interference patterns, it may happen that two completely different fringe systems appear, whereas only one system appears visually. The reason was a Thallium light source. Thallium has a strong spectral line in the green, but also in the ultra violet. Therefore both spectral lines create separate and distinct fringe systems. The ultra violet line cannot be seen and shows up in the photograph only; while the Polaroid print shows two fringe patterns.

To avoid this phenomenon, we recommend inserting a monochromatic green filter in front of the light source. This will cut out the ultra violet.

EXTERNAL HIGH POWER LIGHT SOURCES FOR USE WITH ARISTOPHOT CAMERA

New holders and reflex housings are now available to permit the clamping of the universal lamp housing model 250 to the uprights of the Aristophot camera.

The arrangement for transmitted light (illustration A), and for reflected light (illustration B) can be seen from the illustrations below. A catalog dealing with the Ortholux light sources is in preparation and will be sent upon request. (Earliest mailing January 1964).

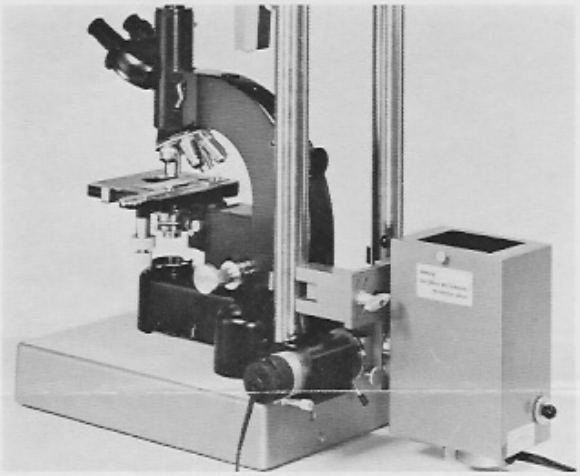


Illustration A

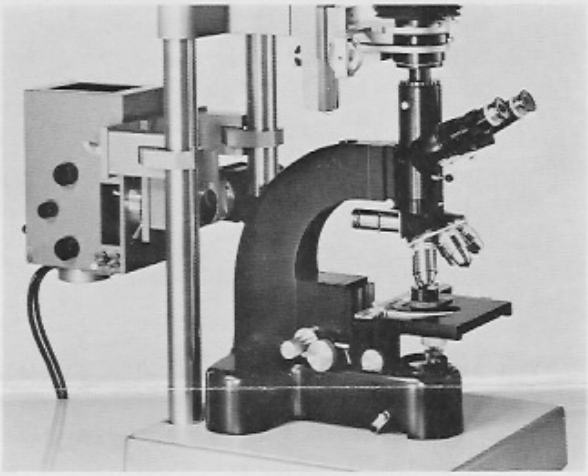


Illustration B

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