The DIAPLAN—a new LEITZ microscope

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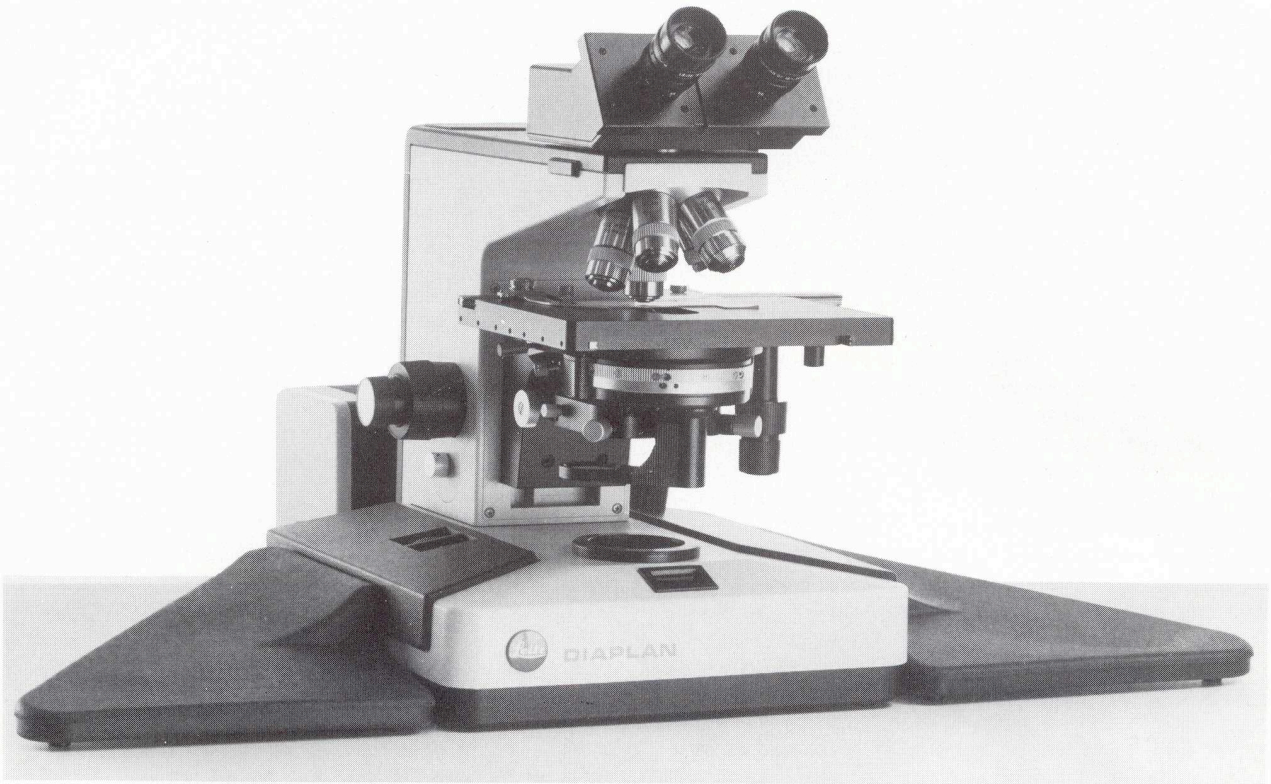

Fig. 1: LEITZ DIAPLAN diagnostic and research microscope with Lamp housing 103; field of view 20 with new PLAN objective series.

At ACHEMA 1985 in Frankfurt the DIAPLAN®, newly developed by LEITZ, was shown the public for the first time (Fig. 1). It replaces the existing DIALUX 22/22EB and to some extent (depending on the type of use) also the ORTHOLUX 2. The DIAPLAN belongs to the long-established, yet still important traditional sector of optical microscopy. Within this general microscopy the DIAPLAN has been conceived according to practical criteria as an instrument for scientific microscopy and therefore for that broadly-based and important field of application of visual diagnosis and photomicrography of microstructures. Its performance spectrum therefore places it between the microscopes of the routine laboratory and the large research microscopes. It is thus a microscope of clearly more sophisticated design, essential to accommodating the very broad practical spectrum of its users. Its range of accessories accordingly allows the microscopist to expand his instrument to tackle his individual problems until it becomes a microscope suitable also for the solution of research tasks.

Optimum reliability, operating convenience, and ergonomy can in general be taken for granted in a microscope newly conceived by LEITZ. The new DIAPLAN microscope is the result, expected by the user, of the traditional LEITZ symbiosis of mechanical precision, modern electronics, and optical quality, derived from the technological expertise of the microscope manufacturer, who has provided yardsticks in this field worldwide for more than 130 years. The DIAPLAN is used preferably in scientific, biological, and medical laboratories as well as those of other natural sciences, and in addition by scientists in government and private institutions, hospitals, and clinics.

Characteristics of the LEITZ DIAPLAN

Although the DIAPLAN microscope represents a completely new development, it was obviously possible to utilise a broad basis of experience of earlier well-tried and pioneering microscope conceptions by LEITZ and to build on this basis. As a result, the DIAPLAN features a number of significant practical optical and technical optimisations, incorporated in this stand for the special benefit of the user.

An example of this is the extension facility of the DIAPLAN which converts it from a microscope for normal field of view (SFZ 20) (Fig. 1) into one for largefield (SFZ 28) observation (Fig. 2). It is therefore left entirely to the user to decide whether the advantage of a large field of view with complete flattening of the image justifies the increased financial layout involved in the production of such large fields of view. The decision will largely be influenced on the one hand by the individual working habits of the microscopist, and, on the other, obviously by the question of the practical possibilities of the microscope. Will it be used mainly for exacting varied routine tasks, or more for the investigation or solution of partial problems within the framework of a scientific research programme?

Even at first glance the microscope stand appears solid and compact and reveals its high degree of stability: an obvious advantage in photomicrography. Nevertheless, or precisely because of it, the DIAPLAN impresses with the harmony and balance of its proportions. In response to the demands of the users for a practical, ergonomically optimised microscope its design is almost ideal.

The detailed dimensions of the DIAPLAN necessary for this design were calculated on the basis of comprehensive studies in the LEITZ Design Department and in consultation with competent practitioners worldwide, an important consideration always occupying a prominent place in the evolution of new instruments. The result of these efforts and studies was a microscope stand that allows its user to work in a completely relaxed posture. The microscopist's hands and the forearms rest quite naturally on the broad foot of the stand or on handrests functionally supplementing it and adjustable to the individual habits and needs of the user (Figs. 1, 2). Like the coverplates of the microscope foot they are made of a material felt to be pleasant to the skin and attached to the microscope so that they cannot be lost, yet are detachable. Needless to say, the control elements of the DIAPLAN microscope are ergonomically arranged.

Product description—technical details

1) Coarse and fine adjustment

The microscopic image is focused with the vertical adjustment of the object stage. The coarse and fine adjustments are coaxial. A maintenance-free recirculating ball bearing drive permits the use of the fine drive across the entire 25 mm vertical adjustment range of the object stage. With the aid of an adjustable vertical stop for the coarse adjustment the upward movement of the object stage can be fixed whenever required. If it is fixed in the focal plane, this can be reproduced, provided conventional microscope slides are used, after the stage is lowered for the purpose of changing the specimen, with the coarse adjustment at any time, quickly and without danger to objective and specimen. This obviously saves considerable time.

2) Revolving nosepiece

Two different types of revolving nosepiece are available to the user. One of them has no tube lens, the other has one of factor 0.8 ×. Their horizontal dovetail guides permit rapid exchange of the objective carriers, without the need for lowering the object stage.

3) Stage

The standard object stage of the DIAPLAN is a permanently attached mechanical stage with 90° rotation facility. Its adjustment range of 52 × 76 mm allows the complete scanning of smear preparations from edge to edge of the slide. Low-level coaxial controls and a stage guide running on ball bearings ensure absolutely even, precise, and easy stage movement. The specimen is held on the stage plate absolutely securely, yet without risk of damage. The rotating facility of the mechanical stage will always be useful when, for instance, in cinemicrography, with video recordings, but also in photomicrography, certain structures have to be vertically or more favourably positioned, or when graticules are to be aligned with certain object structures. In addition, a rotating mechanical stage allows optimum azimuthual alignment of the object to the splitting-up direction when the interference contrast method is used.

4) Current supply

LEITZ have always on principle declined to offer the customer products which suffered from compromises that were unacceptable in practice, no matter how insignificant they appeared. A typical example of such a compromise is the incorporation of the transformer for 100W low-voltage light sources in the foot of the stand as a routine feature by some manufacturers. It creates problems owing to physical laws such as the heating of the base of the microscope, it is found unpleasant by the microscopist during prolonged observation and, even more important, it produces a focusing change owing to material expansion, which, although visually not noticeable, is unacceptable in photomicrography particularly when long exposure times are required. An originally critically focused microscope specimen becomes spontaneously unsharp during observation or exposure, and therefore unsuitable for the evaluation of the photographic record. Naturally, LEITZ, too, are aware of the great benefit to the customer of a current supply for a 100W light source that is integrated in the microscope. But the user must never be expected to make any concessions such as tolerating the heating of the microscope foot with all its consequences, or trying to solve the question of temperature by limiting the lamp voltage to 11V—a solution offered by another manufacturer of microscopes—which reduces the 100W power to only 85W. Such half measures have never been the practice at LEITZ. It is all the more welcome to find that the development work consistently carried out by LEITZ to produce a current supply for the 100W light sources built into the microscope, which creates no problems even for

a critical user, has been worthwhile. Because in the LEITZ DIAPLAN such a current supply, meeting all practical demands in the form of progressive built-in electronics, through which the 12V 100W tungsten halogen lamp can be continuously regulated, has been realised.

A precision digital voltmeter built into the foot of the DIAPLAN serves for the reproducible setting of the colour temperature and at the same time indicates the operational readiness of the instrument.

5) Lamp housings

For the DIAPLAN two types of lamp housing are available, the LH103 for the 12V 100W tungsten halogen lamp and the LH103Z, which is specially equipped for fluorescence microscopy with gas discharge lamps of up to 100W, but can also be converted for accepting the conventional tungsten halogen lamp where the demands of lamp centration are most exacting.

In the LH 103 the reflector, serving for increasing the light intensity, and the lamp mount are fixed. The tungsten halogen lamp is quickly and easily exchanged. After insertion in the push-in base it is always correctly fixed and also centred.

All that is required to optimise the illumination of the field of view is the correct adjustment of the horizontally adjustable lamp condenser. Once correctly positioned, no readjustment is necessary for subsequent magnification change. The microscopic image now remains illuminated with all the methods of illumination used in microscopy as well as for photomicrograph or cinemicrography.

The lamp housing is attached to the microscope with the aid of the well-tried metal bayonet mount. The filter slot between this changing device and the lamp housing (LH 103 or LH 103Z) consists of a special material which largely prevents heat transfer from the lamp housing to the stand.

In conjunction with the Lamp housing 103Z the particularly good colour correction of its apochromatic condenser system must be mentioned. This makes a condenser adjustment for the preservation of the homogeneous illumination of the field of view after the change of the excitation region (especially from UV to green excitation) unnecessary. Maximum brightness and optimum illumination of the microscopic image are ensured by not only the adjustable lamp condenser but also by a reflector which can be adjusted in three dimensions and by a horizontally or vertically centrable lamp mount.

A centring aid which can be swung into the optical path facilitates correct lamp centration in the LH 103Z.

6) Illuminating optical system

The part of the built 'in illuminating optical system of the DIAPLAN is housed in a real "illuminating channel" where it is protected against dust. The nucleus of the illuminating optical system in a microscope is without doubt the condenser. In the DIAPLAN it is the LEITZ-Universal Condenser, entirely newly conceived both mechanically and especially optically. In particular the correction of its optical properties has been newly computed, and made even more effective to accommodate the large object areas to be illuminated.

According to long-established LEITZ practice the lowering of the universal condenser for observations through low-power objectives is not necessary. Because whenever the front lens of the condenser has normally to be swung out (objective aperture < 0.25), another lens below the condenser simultaneously swings into the optical path for the necessary compensation. This ensures full preservation of the illumination of the object and of "Koehler's Illumination" down to the 1.6 : 1 objective.

For the first time in microscope design, and in contrast to all conventional condenser systems used so far, the aperture diaphragm has been taken out of the condenser and installed in the base of the microscope.

The aperture diaphragm in the DIAPLAN is therefore fully effective also with objectives of low primary magnification, i. e. its function for the regulation of the contrast, of the depth of field, and of the resolution of the microscopic image can be effective without limitation. This is of particular advantage in photomicrography.

The aperture diaphragm is adjusted with a knurled wheel, which has been placed conveniently next to the control of the field diaphragm adjustment in the foot of the microscope (Fig. 3).

Through the insertion of an annular disc the universal condenser can be converted into a phase contrast or into an interference contrast condenser. Because light rings, Wollaston prisms and darkground diaphragm can be freely combined and also inserted by the microscopist himself a practice-oriented individual equipment of the annular disc is possible.

In addition to the standard condenser top Achr. 0.90 one of aplanatic-achromatic correction and n. A. 1.40 is available where special demands are made on resolution, as well as condenser tops of long intercept distances (for instance S4/0.70) for investigations in thick glass vessels.

For observation in darkground the universal condenser can be exchanged alternatively with the two special darkground condensers D0.80-0.85 and D1.20-1.40 OIL. The condenser for the LEITZ DIAPLAN is in fact a universal condenser system for brightfield, darkground, phase contrast, and interference contrast observation. It allows all the users of a DIAPLAN the microscopic observation of their specimens at the greatest possible operating convenience even if their special properties demand a quick change of the methods of observation.

7) Image-forming optical system

A newly-developed semi-apochromatic series of objectives, the PL FLUOTAR® is available for the LEITZ DIAPLAN in a brightfield and a phase contrast version (Fig. 4).

The development of this new series of objectives is based on experiences gained from the well-tried NPL FLUOTAR objectives. This made the optimisation of the newly-computed objectives possible to the extent that they will satisfy even critical demands of resolution, contrast, field performance (field of view at least 25 mm) and colour rendering.

Furthermore they will offer additional considerable advantages, such as improved transmission in the near UV

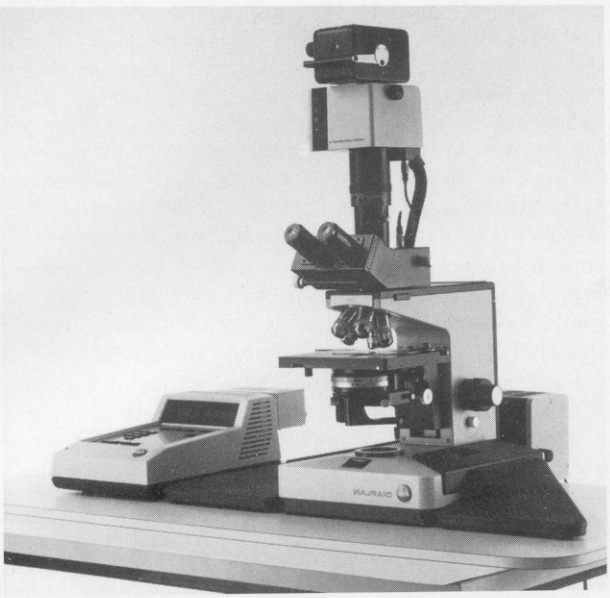

Fig. 2: DIAPLAN largefield microscope (SFZ 28) with FSA-GW-R phototube, LEITZ VARIO-ORTHOMAT 2; objectives of the new PL FLUOTAR series.

region, minimum primary fluorescence, freedom from strain, as well as appreciably longer free working distances. To sum up, the new PL FLUOTAR objective series can be considered a LEITZ top-quality product for all the current methods of microscopy. The plan-achromats PL1.6/0.05 and PL2.5/0.08 serve as low-power objectives to supplement the PL FLUOTAR objective series.

For those microscopists who do not need large flattened microscopic fields of view (from SFZ 22.5 onwards) another, also newly-developed series of plan-achromatic objectives engraved "PLAN" is offered in brightfield and phase contrast versions for the DIAPLAN (Fig. 5). The price of this new series of objectives, is particularly cost-effective.

Other important features of the new PL FLUOTAR and PLAN objectives will be dealt with elsewhere in this issue (see p 19). Here it is merely pointed out that in addition to the new PL FLUOTAR and PLAN objectives large-aperture special objectives for fluorescence microscopy in the well-tried NPL FLUOTAR quality are available.

8) Observation and photo tube

As already indicated, the LEITZ DIAPLAN can be equipped for any tasks in scientific diagnosis as well as for the solution of partial problems within the framework of a research programme in usefully graduated stages of extension from a microscope for normal field to one of large field observation. This flexibility also allows for spending limits in a budget for microscope purchases especially at a time of general lack of funds.

The concept considerations necessary for the production of the various field-of-view sizes led to, among other features, to a complete reworking and supplementary new development of the existing range of LEITZ tubes. The tube S currently offered for visual observation is now suitable, like the photo tubes FSA (for the WILD photomicrographic systems) and FSA with fading-in (for the LEITZ VARIO-ORTHOMAT 2 camera system) for the insertion of the PERIPLAN GF 10 and PERIPLAN GF 12.5 of field-of-view index 20, specially developed for the DIAPLAN after the widening of their optical passages. With the new PLAN objective series by LEITZ completely flat fields of view of at least 20 mm diameter can be obtained through any of the tubes mentioned above, a favourably priced product which often will meet the practice-oriented field-of-view requirements of the users. When a revolving nosepiece with tube length 0.8× is used in the DIAPLAN, the field of view is enlarged to 25 mm.

With such a variant of microscope equipment the microscopist will without doubt accept a compromise between the flatness performance he achieves with it and the financial outlay required. In our view, however, this compromise is clearly in favour of the advantageous price, because the loss of flatness in the microscopic image is in fact negligible compared with the price advantage offered by the new LEITZ PLAN objective series. Obviously, users must form their own opinions on this question.

Fig. 3: Control of the aperture and field diaphragm in the base of the microscope.

Fig. 4: Revolving nosepiece 0.82, with PL FLUOTAR objectives.

Fig. 5: Revolving nosepiece (1×), with PLAN objectives.

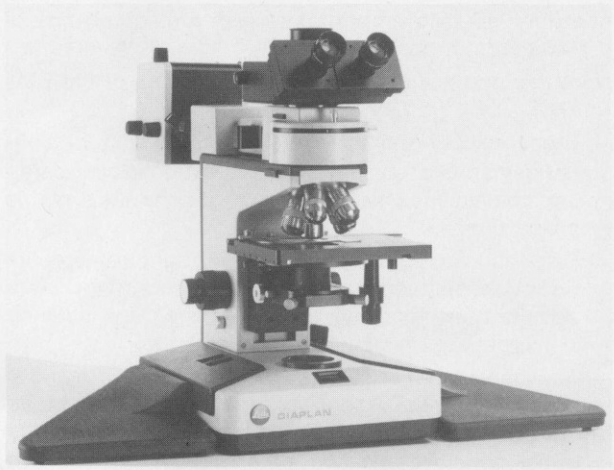

Fig. 6: DIAPLAN with 3-λ PLOEMOPAK (1×).

The newly-developed PL FLUOTAR objective series guarantees a totally flat field of view of 25 mm diameter, i. e. with critical marginal definition in the previously described conditions (moderately-priced normal tube for eyepieces 20 field plus revolving nosepiece 0.8×). The objectives of this series are primarily corrected for a field-of-view index 25, but some of them can also be used without restrictions for the large field of 28 mm.

The optically most matured DIAPLAN extension variant is surely that for largefield observation of 28 mm fields of view. This extension stage is achieved through the optional use of two newly-developed FSA-GW-R photo tubes. The simpler of these largefield tubes can be fitted with an image recording system such as the LEITZ VARIO-ORTHOMAT 2, the other one is additionally suitable for connection of, for instance, a video camera. It thus offers optimum inclusion of image recording or storage in the conventional microscopic investigation. When the above-described largefield tubes are used, the effective field-of-view index of the DIAPLAN corresponds precisely with that of the eyepieces used. This performance criterion is already known from the first largefield microscope available worldwide, the LEITZ ORTHOPLAN®. For the DIAPLAN, the newly-developed GW 10× and GW 8× widefield high-point eyepieces, of field of view index 26 and 28 respectively, are available.

For the unrestricted utilisation of a large field of 28 mm, i. e. an observation at perfect sharpness right up to the edge of the field, the use of the objective series of the LEITZ PLAN apochromats specially computed for this purpose is recommended.

The table below will assist the microscopist in the better assessment of the importance of enlarged microscopic fields of view for his own uses. It demonstrates the information gain which he will enjoy through the addition to the object area he can survey in field of view of 20, 25, and 28 mm compared with the conventional 18 mm:

Enlarged field of view mm	Information gain compared with the 18 mm field of view
20	20%
25	90%
28	140%

9) Interference contrast T

The interference contrast method for transmitted light is suitable for the contrasty relief-like and halo-free representation of unstained objects with refractive index and thickness differences generally found, amongst others, in the investigation of cell and tissue cultures as well as of microorganisms.

Allowing for the continuously increasing importance of this method for new, progressive areas of research, such as, among others, gene technology, a new interference contrast device has been specially developed for the DIAPLAN.

Here the Wollaston prisms on the objective side are incorporated special intermediate pieces, which, once screwed on to the appropriate objective threads, can be

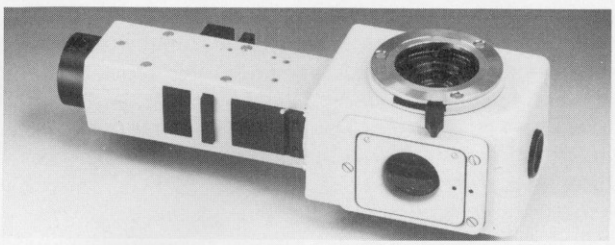

Fig. 7: 1-λ PLOEMOPAK (1 ×) for the DIAPLAN.

fixed to the revolving nosepiece together with the objectives. Wollaston prisms are available for the PL-FLUOTAR series objectives of 10, 25, 40 and 100 : 1.

The Wollaston prisms on the illumination side can, as already mentioned, be freely combined with the light rings for phase contrast observation for insertion in the annular disc of the universal condenser. As a result, and because of the convenient operation of polariser and analyser, a quick change from interference contrast observation to other methods of illumination is guaranteed in the LEITZ DIAPLAN.

10) Fluorescence

There is no need here to describe the importance of the incident-light fluorescence method. Its diagnostic value, especially in immunology, is beyond dispute. For the DIAPLAN, two variants of fluorescence device are available for incident-light excitation of fluorescence. 1) A three-wave-length PLOEMOPAK® with built-in changing device for three quickly and easily interchangeable filter blocks (combination of exciting and suppression filters) (Fig. 6). The fluorescence vertical illuminator has a special stop, which allows the interchange between two neighbouring filter blocks whenever required.

This possibility always offers advantages when the specimen investigated has been treated with two fluorochromes to be excited with different wave lengths. 2) A moderately-priced single wave length PLOEMOPAK. Through a laterally insertable rapid filter changing device this accepts one of the usual filter blocks of the LEITZ range. To change the filter block the single wave length PLOEMOPAK can remain on the stand. A built-in centring disc facilitates correct lamp centration (Fig. 7).

In addition to the 1x tube factor enhancing the brightness of the fluorescent image both vertical illuminators for the DIAPLAN have a swing-out BG38 filter. This allows the use of the full intensity of the lamp for the fluorescence excitation whenever a red background in the fluorescent image is acceptable. The holder for the Lamp Housing 103Z, which, as already mentioned, should preferably be equipped with gas discharge lamps of up to 100W, can be screwed on to the stand of the DIAPLAN. Through fixation on the microscope stand the lamp housing is rigidly attached, so that the PLOEMOPAK can be removed independently of the light source, for instance for the purpose of changing the filter block. This avoids damage of the lamp through vibration.

11) Accessories

As already pointed out, a newly-conceived microscope for scientific microscopy and microscopic diagnostics requires, in addition to optimum reliability, operating convenience and ergonomy, especially extension facilities also for investigations of partial problems within the framework of scientific research as an important feature. In other words, the user must have the widest possible range of accessories at his disposal.

Owing to the well-tried LEITZ modular principle this requirement has been met by the adoption of suitable components from the already existing programme of the LABORLUX K/D and DIALUX 20/22 microscopes for the DIAPLAN. All the LEITZ and WILD camera systems available for photomicrography as well as the tracing device and projection attachment can be fitted to the DIAPLAN. Magnification changers, comparison bridge, and discussion device for two or three persons respectively are offered for fields of view of up to 20 mm diameter.

The DIAPLAN can of course also be adapted for high-temperature and television microscopy and orientating polarised-light microscopy.

An illumination attachment which considerably exceeds the performance range of a conventional light filter device is in preparation. Its main functions are:

1) Intensity regulation at unchanged colour temperature
2) Regulation of the colour temperature at unchanged lamp current and
3) Continuous change of the colour mixture for optimum colour contrast between the object and its surrounding field.

Other features of the illuminating attachment for the DIAPLAN will be described elsewhere in this issue (see p 28).

Conclusion

To sum up, a newly-designed instrument the extension facilities of which the user is offered allow for the wide range of uses demanded in scientific microscopy to the greatest possible degree.

In addition, it permits the microscopist through optimum operating convenience and ergonomy to concentrate his full attention on the diagnosis of his specimens at all times. As a result he is not required to divert his attention to operating his instrument when, for instance, specimen-specific properties require a quick change of the methods of observation.

Here is a short summary of the advantages of the DIAPLAN:

- Ergonomically optimised microscope design for highest demands of stability and greatest possible operating convenience with harmony and balance of the proportions.

  Fine-focusing control functions throughout the entire vertical adjustment range of the object stage. This unlimited fine focusing has advantages, for instance in microscopic thickness measurements.
- Adjustable vertical stop for the coarse adjustment. It allows the reproduction of a focal plane, once set, as often as required, quickly, and without risk of damage to the objective and specimen with the coarse drive (time saving).

- Mechanical stage with rotating facility of 90°. It is useful with the ICT method or for the alignment of microstructures during image recording.
- Electronically-controlled current supply built into the foot of the stand and therefore not obstructing the workbench: easily legible precision digital voltmeter.

  Two types of lamp housing, priced to allow for different practical requirements.
  - Lamp housing LH 103: precentred for 12v 100W tungsten halogen lamps
  - Lamp housing LH 103Z: centrable for tungsten filament and gas discharge lamps of up to 100W.
- New PL-FLUOTAR objective series (semi-apochromats) guarantees fields of view of up to 25 mm diameter at maximum brilliance. New PLAN objective series (plan-achromats) for flat field of view of up to 20 mm diameter.
- Both series of objectives also in phase contrast version. New interference contrast device for the production PL FLUOTAR objectives, reproduction ratios 10, 25, 40 and 100 : 1.
- Reproduction ratios from 1.6 : 1 to 100 : 1 matched, illuminated by a single condenser.
- Field illumination and Koehler setting down to objective 1.6 : 1 without lowering of the condenser. The image of the field diaphragm always remains in sharp focus.
- Aperture diaphragm built into the foot of the microscope. Its function for the regulation of contrast, resolution and depth of field of the microscopic image is thereby fully preserved even with objectives of low primary magnification (from 2.5 : 1 onwards).
- Universal condenser for all methods of microscopy (brightfield, darkground, phase contrast, transmitted-light interference contrast) with optimised correction of the optical performance.
  - Easily interchangeable annular disc. Light rings, Wollaston prisms and darkground diaphragm can be freely combined (according to need) and inserted by the user.
  - Interchangeable condenser tops for long intercept distances.
  - Aplanatic-achromatic immersion condenser top n. a. 1.40. Condensers for darkground microscopy.
  - Extension facilities for 20, 25, and 28 mm fields of view through:
  - New binocular observation and photo tubes for eyepieces of field-of-view index 20.
  - New largefield tubes—with one or two exits for imagerecording systems—for largefield eyepieces of field-of-view index up to 28.
  - Two fluorescence vertical illuminators.

    3-λ PLOEMOPAK with changing device for three filter blocks.
  - 1-λ PLOEMOPAK for the use of one filter block.
- Wide range of accessories.

® = Registered Trademark.

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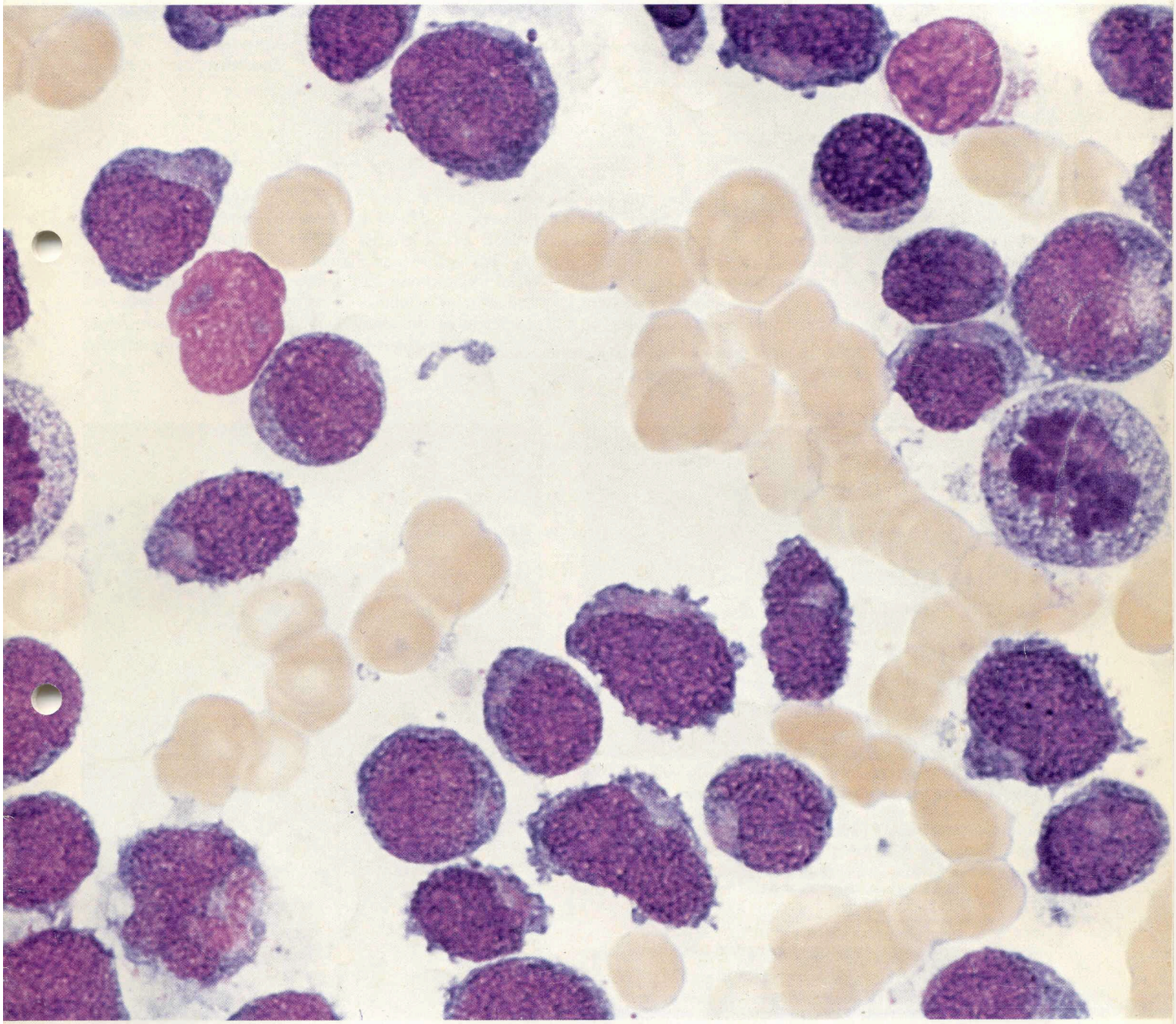
Scientific and Technical Information

Informations for ACHEMA 85



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