TECHNICAL METHODS

AN IMPROVED MICROSCOPE LAMP

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The new inclined binocular microscopes when used with high-power objectives require much light to illuminate adequately the field of view. At least three times the light is necessary as for a similar optical combination on a monocular instrument. The ordinary opal bulbs even when over-run do not provide sufficient illumination, and of course with them there is no possibility of employing a light filter when using the highest powers.

There is on the market a number of high-intensity lamps using a 6-volt 5-amp. or 8-volt 6-amp. short spiral filament bulb. These have several disadvantages. The light source is so small that when using the Köhler system of illumination the back lens of the objective will not be filled unless there is a short focus lens condenser, which means that its effective diameter is small. Moreover, these lamps are small, the concentration has to be accurate, and, as the bulb has to be run almost at its full capacity, the lamp-house gets very hot. When a new bulb has to be used the centration must again be adjusted, and it may take some time to set up the whole lamp before the best working conditions are obtained. Also, on the existing lamps the filter holder is not convenient, particularly when rapid changes from one filter to another are required. These disadvantages are overcome in the design to be described.

The bulb employed is of the projection type made by Siemens (No. A 1/4), and is known as a "solid source." It has four horizontal spiral filaments arranged closely one above the other in the vertical plane, and in effect gives a solid source of light about 5×6 mm., which is considerably larger than the area of the low-wattage filaments in existing lamps. The bulb has a prefocus cap so that centration is done on the lamp by the maker and replacement bulbs will give the same accuracy of centration.

The body consists of an aluminium casting with lens holder and a pressed metal back. The condensing lens, specially computed for the purpose, has a focal length of 50 mm. and consists of two convex lenses. It works in a sliding mount and is focused by a convenient handle. The iris diaphragm has an aperture of 50 mm. and a long handle for easy manipulation. The filter holder is a double sliding type similar to the slide carrier on a lantern slide projector. It accommodates two 2×2 in. Wratten filters, which are moved into position by a touch of the finger.

The base is a hollow iron casting with four rubber feet, to which the body is hinged allowing a range of vertical movement. The body can be clamped rigidly in the required position.

Where a more diffuse source of illumination is required, as in low-power work, a finely etched ground glass screen can be brought into position immediately in front of the lamp bulb by raising the knob shown on the top right of the illustration (Fig. 1).

The full output of the bulb is 250 watts at 12 volts, and this is much too powerful for ordinary use, so the lamp is run from a 6-volt 16-amp. transformer and the intensity of light

FIG 1.

controlled by a 300-ohm sliding resistance of 0.75 amp. capacity, fitted with a switch. The resistance is connected in series with the primary of the transformer, and it is absolutely necessary for the proper working of the lamp. With the full amount of resistance, the lamp works at about 9 amps., at 4 volts giving an output of about 40 watts, which is sufficient for the 16-mm. and 4-mm. objectives on an inclined binocular microscope with 8 × eyepieces. Increased illumination for the higher power objectives is obtained by moving the slide of the resistance.

As the lamp is working at much below its rated wattage, the light is more yellow than with the ordinary bulbs, and a blue filter such as is provided with the microscope, or a Wratten No. 78A filter, must be used.

The lamp is supplied with a 15-amp. domino connector so

that it can readily be connected to or detached from the transformer.

The transformer itself can conveniently be mounted under the back of the bench, and the sliding resistance screwed either to a bench support or at the side of a nest of drawers or cupboard.

Method of Operating the Lamp

The Köhler method of illumination is recommended, in which the image of the filament of the bulb is focused by the lamp condenser on the iris diaphragm of the substage condenser of the microscope. The front lens of the lamp condenser will now act as the source of illumination, and it is focused by the substage condenser in the plane of the preparation to be examined, using the lamp iris diaphragm as a guide for this purpose.

The first step is to see that the substage condenser of the microscope is fully racked up, and that the piece of blue glass supplied with the microscope is in the ring under the condenser.

The microscope and lamp are set up so that the distance of the beam of light from the iris diaphragm of the lamp, by way of the mirror to the iris diaphragm of the condenser, is about 10 in.

The lamp is switched on, seeing that the lamp iris is fully open, and the resistance decreased so that there is a bright beam of light shining on the mirror. The lamp is adjusted

by altering its vertical tilt and by moving the base so that the beam of light is in the centre of the mirror.

The lamp is focused so that an image of the filament is formed on the substage iris of the microscope. In practice it will be found that this is so when the handle of the lamp condenser is moved to its forward limit. Once the correct setting is found, the lamp condenser needs no further adjustment.

The resistance is pushed back so that the light is as dim as possible, a preparation is placed on the microscope stage and focused with the low-power (16-mm. or $\frac{3}{8}$ -in.) objective.

The iris diaphragm of the lamp is closed and the mirror adjusted so that the image of the lamp iris is in the centre of the field.

The microscope condenser is focused up or down slightly until the image of the lamp iris is sharp.

The lamp iris is opened so that the whole of the field is illuminated. It will be found that there is a bright and evenly illuminated field with the details of the preparation clear and distinct.

In practice these adjustments can be made in a few seconds.

To obtain the maximum definition, the lamp iris should be closed and focused in the field with each objective. This will be possible with the 4-mm. ($\frac{1}{4}$ -in.) and 3.5-mm. ($\frac{1}{2}$ -in.) oil-immersion objective, but not with the 2-mm. ($\frac{1}{8}$ -in.) objective. For routine work, however, this is not necessary.

When the ground glass diffusing screen is required, and it is very useful for low-power histological examinations, raise the knob on top of the lamp to bring it into position. The illumination will now of course be less. The resistance is moved until the correct amount of light is required.

For higher-power work with the 3.5-mm. ($\frac{1}{2}$ -in.) and 2-mm. ($\frac{1}{8}$ -in.) oil-immersion objectives the ground glass screen should not be used. In all cases the degree of illumination is varied as required by means of the sliding resistance. It is surprising how often this will be necessary, and the fine control of the light obtained with it will be appreciated.

It is important to note (*a*) that before switching on the lamp the full resistance is in and then the illumination increased as required, and (*b*) before switching off the lamp, dim the bulb to its full amount. If these precautions are observed, the life of the bulb will be almost indefinite. There should be no blackening of the glass and no need of replacement for many years.

As the lamp is considerably under-run, the lamp-house only gets slightly warm, and even after several hours' use the hand can be placed on the lamp-housing without discomfort.

The lamp is suitable for dark field illumination, and more than sufficient light can be obtained for this purpose. If for special purposes the illumination obtained with the 6-volt transformer is not sufficient, an 8- or 9-volt transformer to take 18 amps. and tapped at 6 volts should be used. The 6-volt tapping is used for ordinary work and the higher voltage output only for special purposes.

The lamp also gives excellent illumination with phase contrast technique. It can be used with the Köhler system as already described, or, by focusing the lamp condenser back towards the bulb, parallel light can be used. In the latter case the ground glass screen should be placed in position and the lamp run a little more brightly.

The sliding filter holder is very useful when a filter is required from time to time. The filter can be kept always in position and placed in the beam of light by a touch of the finger, and the necessary increase of light made with the resistance.

This lamp and filter holder were designed not only for general microscopy but also for the following simple but efficient method of examining stained material for tubercle bacilli.

Method for Tubercle Bacilli Examination

The microscope should be fitted with a 3.5-mm. ($\frac{1}{8}$ -in.) fluorite oil-immersion objective. In the filter holder are placed a Wratten No. 45 (blue-green) filter, and a Wratten neutral filter No. 96, of 10% transmission.

The preparation (smear or section) is made in the usual way, and stained by the standard Ziehl-Neelsen method using dilute malachite green as the counterstain. It is important that the counterstain is not too deep.

The microscope is set up as described above, with the neutral filter in position. The specimen is focused with the 3.5-mm. objective and the microscope and lamp adjusted to obtain optimum illumination and definition. The blue-green filter is moved into position, and the background of cells will then almost disappear leaving ghosts of cells which are sufficient for focusing. Tubercle bacilli in the field appear black. When searching for tubercle bacilli the blue-green filter is used and the slide can rapidly and systematically be examined. As soon as a black bacillus-like object is seen, the neutral filter is moved into position, when the slide assumes its normal colour and any red-stained bacilli observed.

A black-coloured bacillus coming into the blue-green field is instantly recognized and verified as a tubercle bacillus by moving the screen.

If further magnification is required for a doubtful object the 2-mm. objective is swung into position. The examination is then further resumed with the 3.5-mm. objective and blue-green filter. The search is rendered easy on account of the large, flat field, great depth of focus, and excellent definition of the 3.5-mm. fluorite lens.

This procedure enables a much larger area of the specimen to be examined without fatigue.

I consider that this method is superior to fluorescence microscopy for detecting tubercle bacilli.

The only additions required to the lamp are the two filters, and most new binocular microscopes are now supplied with a 3.5-mm. fluorite oil-immersion objective.

The examination can be carried out by any technician, and it is of particular value in doubtful clinical cases, as the recognition of a stained tubercle bacillus is of true diagnostic significance whereas a fluorescent bacterium is not.

This lamp is made by R. R. Beard, Ltd., 10, Trafalgar Avenue, Old Kent Road, London, S.E.15.