Notes on the Cleaning and Restoration of Modern Microscopes

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INTRODUCTION

The article describes methods that I have found useful during the restoration of (mostly) post-war instruments rendered shabby by years of neglect or careless use. There is no pretence that it represents the last word on the subject and one of the main reasons for writing it is to encourage readers to reveal their own techniques. Please note that the cleaning methods advocated would prove lethal to lacquered brass!

When first obtained, second-hand microscopes, particularly those disposed of by research laboratories after twenty or more years of hard use, often present a sorry sight to the enthusiast, who, if the truth were told, probably gains almost as much pleasure from looking at a fine instrument as *through* it. Grimy and chipped enamel, dull or discoloured chrome and rusty screws are, however, all more or less redeemable with a little effort (and more patience) and the resulting transformation brings with it a rare sense of achievement.

INSTRUCTION MANUALS

Most larger microscopes were supplied along with a fairly comprehensive users' manual which has usually been lost by the time the instrument is disposed of. Should this have happened, make every effort to borrow one for photocopying and hence avoid making possibly expensive mistakes.

DUST

Instruments are occasionally found which are so dusty that it is difficult to get anything but the most general impression of the condition of what lies underneath. Since such dust may be highly abrasive it must be removed from the stand with the greatest of care, using a vacuum cleaner and/or dabbing with moist paper towel. On no account attempt try to operate the mechanical stage or other movements before this has been done or particles may be forced into the slideways. Once the superficial dust is removed, it is time to take a long hard look at the patient in order to see what remedial work needs to be undertaken and at this juncture it is probably best to remove the objectives, substage condenser, eyepiece(s) and any other part which is obviously meant to be detachable by the user, such as a binocular tube or a rotating nosepiece fitted with a dovetailed slide, carefully sealing the resulting apertures with cork, plugs or masking tape against the entry of dust or cleaning fluids.

GREASE

Where an instrument has not been used for some time, slideways and centring adjustments may be more or less immovable and attempts to force them may well cause permanent damage. The most common cause for seized movements is thickened grease but on better class microscopes, tension adjustments are usually provided for the coarse, fine and substage focusing and the X and Y movements of the mechanical stage and it is worth while checking if these have been over-tightened. The rotation of the stage may have been clamped. If the grease *has* solidified, run WD40 into the ends of slides, the bearings of

rotating stages and the mating surfaces of centring rings, gently actuate the movements, add more WD40 and wipe off the (usually black) lubricant which oozes out. Gummed up iris diaphragms should be treated in the same way. Eventually this treatment will free almost any seized movement but it may require repetition on a number of occasions before the grease is suitably thin again. Should it prove necessary (and possible) to re-lubricate bearing surfaces, remove any old grease and dirt with a rag moistened with petrol or xylene and apply a small quantity of a suitable instrument lubricant such as a light or medium grade of *Kilopoise* grease, keeping it away from rackwork, pinions or other gears.

SCREWDRIVERS AND THEIR USE

If you are forced to take a screwdriver to a microscope:

(1) Make sure that its blade is in good condition.

(2) Thoroughly clean the slot or other recess in the screwhead with a toothpick so that the blade will "seat" properly.

(3) Ensure that the blade of a slot-head screwdriver is (almost) as wide as the slot in the screw and fits it snugly to *the bottom of the slot*. (Since some instrument makers used screws with tapered or unusually narrow slots, it may be necessary to grind the blade to fit.) The penalty for using a screwdriver with too narrow (or too thin) a blade, or one which does not "bottom" is the eternal reproach of a mauled screw head.

(4) Hold the screwdriver exactly in line with the screw and apply as much force to the seating of the blade as you do to turning it, otherwise the blade will "ride up" and maul the head, particularly if it be domed.

(5) Fully support the microscope or component being dismantled so that it cannot move as force is applied to the screwdriver, otherwise the blade will slip and scratch the surrounding enamel or chrome.

(6) When finally replacing the screw, lightly oil the thread and do not over-tighten it.

(7) Where a component is fixed by a number of screws, do not tighten any until all are in position.

(8) Magnetized screwdrivers (just stroke with a magnet) are sometimes useful in replacing steel screws where access to the hole is difficult, but in these situations, it is generally easier to choose a driver which fits in the slot of the screw really tightly. They can also be used to retrieve ball bearings or screws which have fallen into the "works". (Non-magnetic screws, etc., can often be rescued with the help of pearl forceps or a knitting needle with a small blob of grease or Blu-tack on the end.)

CHROME

I usually begin my work on the stand by cleaning the chrome, using a centimetre wide strip of Flotex carpet, dipped first into hot water and then washing powder, to scrub the grime from the milled edges of the adjustment knobs. If a component can easily be removed, as in the case of the knobs used for centring the substage, this is done prior to treatment: if not, care must be taken to prevent damage by this fairly caustic solution to other parts of the stand. Cotton thread is wrapped tightly round the shafts near any joints or bearings (leaving a long loose end so that it can be removed later) and soaked with WD 40. Masking tape and polythene bags are used to protect the enamel. Carefully remove any traces of the

detergent by wiping all the treated surfaces with clean, hot water before wiping them dry. Only the most tenacious dirt should survive this treatment and this is removed by pushing the tip of a hawthorn spine, chisel-fashion, along the grooves. (I cut short lengths of stem from the previous year's growth to form a tool with a spine at each end.) Other dull and discoloured polished chrome surfaces are cleaned with Brasso wadding, using small twists of the material, held with plastic forceps, to reach otherwise inaccessible areas. The bases of shafts and other cylindrical components are repolished by wrapping half a turn of a pipe cleaner (Parker tapered are the least likely to scratch), moistened with Brasso, round them and pulling it to and fro. Satin chrome is scrubbed with Flotex and washing powder, swabbed using cotton wool moistened with hot water and given a final coat of silicone spray polish applied with a cotton swab.

Chrome-plated screws with rusty heads are best removed, if possible, and the rusty metal cut back with progressively finer grades of wet & dry abrasive paper, followed by metal polish on leather and a coat of wax polish. (One way of speeding up this process, as well as producing a better finish, is to mount the screw in the chuck of a lathe or electric drill but the jaws must not be over tightened because of the danger of damaging the thread. The abrasive papers are then merely held against the rotating screw head.) If the head is very badly mauled, remove the burr with a fine file (a Boot's synthetic sapphire nail file is excellent) before de-rusting. The slot of the screw can be tidied up with the file, if necessary, and cleaned with folded abrasive cloth or paper. De-rusting milled or knurled heads is more difficult: I scrape the grooves as clean as possible with the blade of a cheap watchmaker's screwdriver (the only good use for them), scrub with Flotex and washing powder, rinse in hot water and then give a coat of wax polish. Screws cleaned in this way are scarcely as good as new though considerably less of an eyesore than they were. G J Mould has suggested refinishing the cleaned heads (not the threads) by non-electrolytic nickel plating and I look forward to trying this but the ideal solution would obviously be to get them re-chromed: perhaps a reader knows of a company offering such a service? The chrome or nickel mounts of objectives are frequently grubby, dull or corroded but can usually be resuscitated quickly enough with Duraglit wadding. I use an old nosepiece extension tube to mount objectives in the 4-jaw self-centring chuck of my woodworking lathe and briefly hold the wadding against the mount, rotating at about 300 rpm, followed by polishing with a small cotton "patch". Be very careful when repolishing near to identification colour bands since the adhesion of the paint may be poor (the paint used in the '60s by Zeiss (Oberkochen) is not only fragile but appears to be water soluble!). Tarnished nickel "noses" of mounts are treated with cotton buds moistened with Brasso (taking care to keep .them away from the lens) and polished with clean cotton buds. Alternatively, place a very small twist of Brasso-soaked wadding under a finger nail, wrap a single thickness of handkerchief over the finger end and apply this to the rotating objective. The advantage of this method, suggested by J G Mould, is that the end of the finger nail can be located accurately against the lens mount and the nose safely polished right up to it. Milled rings may be cleaned with hawthorn spines as mentioned above.

PAINT

Actual damage to the enamel may include chips and scratches and areas of wear showing the underlying primer or even bare metal. The toes and heels of the feet of classic bench microscopes are often chipped as a result of careless removal from or replacement in their boxes, while actual wear is usually confined to the upper surface of the stage and the part of the limb that forms a handle. On large research instruments which, once installed, are seldom moved, large areas of wear often occur at the front and sides of the base, presumably resulting from rubbing by the operator's cuffs. Such bases are also commonly chipped fairly badly, offering, as they do, an extensive target area for anything that falls off the upper parts of the microscope. One of my Ultraphots arrived with a large self-adhesive metal foil label, printed with the name of the department that it had previously graced, stuck to the front of its base. Careful and time-consuming removal of the label revealed an enormous chip in the enamel which, it transpired, was caused when a research student dropped a Hasselblad on it! In addition to all this there is always a certain amount of shear grime and often paint, either as splashes from the occasions on which the laboratory was decorated or in the form of security marks.

Various media have been used for the paintwork on post-war microscopes so it is always wise, when choosing a means of cleaning it, to test it first on a small area of the stand where any resulting damage will not be noticed. Dirty grease at the ends of mechanical stage slides, etc. is safely removed with WD40 on a cloth or cotton buds. For the general cleaning of shiny or smooth finishes I use old handkerchiefs moistened with meths, isopropyl alcohol or a commercial wax-free multi-surface polish, which are usually safe, but it is always prudent to avoid rubbing sharp external angles, particularly if there is any metal showing through. A problem arising with satin finishes is that areas subjected to wear become polished even though the superficial paint film remains intact. The only solution to this is to use a very mild abrasive such as Duraglit and gently polish the unworn areas to match. Crackle finishes can be scrubbed with Flotex and hot water containing a few drops of washing-up liquid and blotted dry. Any lint left by the blotting process is removed with masking tape. The retouching of chipped or scratched enamel is bedevilled by the enormous range of colours with which manufacturers have sought to brighten post-war stands, ranging from white through cream and various yellows (Vickers) and an infinite series of greys, metallic and otherwise, to the bilious green of Vision Engineering's early productions and the Marion blue of the Polyvar. The greys are particularly troublesome since the differences between them are so subtle and they may vary even between batches of the same instruments. When attempting to match light shades of grey it is important to realise that they often darken considerably on drying and, since they are seldom neutral, a repair that is invisible in daylight may stick out like the proverbial sore thumb under fluorescent lighting. Probably the best procedure is to obtain a tube or aerosol can of cellulose paint of approximately the correct colour and to apply a patch of it to a damaged area which has been carefully degreased; then, after leaving it for a few days to dry, to examine it very carefully in the type of lighting in which it will normally be seen in order to decide how it needs to be modified. Then follows the painfully slow process of adjusting the colour until a match is achieved. After prolonged shaking of the can or tube, transfer one or

two ml. to a small glass tube with a screw top (with a can, first spray into the cap) and then add a small quantity of black or white cellulose, as required, shake vigorously and try again, removing failures with a cloth moistened with a suitable solvent such as ethyl acetate. Once the correct shade is reached, minute amounts of coloured cellulose may need to be added to obtain the precise match. (It is perhaps worthwhile mentioning here that not all "spray" paints are based on cellulose and some mixtures may not be compatible.) Scratches and small chips are fairly easy to repair if the finish has an "orange-peel" texture by the use of a fine brush with a stippling action. Deep chips will require several coats, allowing plenty of time for the cellulose to completely harden (the use of a hairdryer will accelerate the process) until the surface of the repair is flush with the surrounding area. If the repair is more than 2 or 3 mm in diameter it will almost certainly sink in the middle after a few days so it pays not to be too hasty in attempting to produce a final finish. If the enamel is thick and highly polished, it may be possible to build up the repair so that it is proud of the surrounding area and then, when it has fully hardened, cut it back with 400 grit wet-or-dry abrasive paper before polishing with T Cut and metal polish. Hammer textured metallic finishes like those found on the larger Zeiss (Oberkochen) stands of the '60s are difficult to repair invisibly: I have had some success with small chips and scratches by using Hammerite silver grey (spray) enamel, suitably tinted and applied with a very fine brush but progress is tediously slow and is best performed with the help of a magnifier. Even more difficult, in all probability, is the ultra fine "silk" finish of the silver grey and even the black Zetopans.

Wear on the upper surface of a traditional plain stage is fairly easily remedied by respraying with matt or satin black cellulose after thoroughly degreasing it with a suitable solvent and preferably removing it from the stand. (Always begin each sweep of the spray to the side of the target area and stop immediately at the first sign of spluttering.) For a perfect result, a surface with uneven wear or scratches and pits must be flattened by giving it several thin coats of primer and lapping it with 200 grit carborundum on glass, before applying the finish. In the case of mechanical stages, this is usually impossible unless it first be dismantled. A less satisfactory, but lower risk strategy is merely to remove any "loose" fittings and mask the rest with carefully cut pieces of tape before spraying. The masking tape is removed as soon as the final coat is dry, but before hardening occurs, using forceps and being careful to keep it away from the paint surface, which at this stage is very delicate. Any paint that has penetrated beneath the edge of the tape, say onto a chrome vernier, is easily scraped off with the point of a toothpick or a sharpened quill. Vernier scales which are engraved on the stage surface itself and then filled with white enamel cannot be masked satisfactorily but it may be possible to spray over them and then to scrape away the black paint from the vernier divisions using a dissecting needle, ideally under a low power stereo microscope. If it is any other colour but black, the use of aerosol cans of car paint to re-spray worn areas elsewhere on the stand presents much greater difficulties because of the virtual impossibility of finding a ready mixed paint that exactly matches the original. In any case, there would still be the problem of matching the texture, if it is other than plain glossy. Examination of the display of cans of cellulose and "touch-up" sticks in motor accessories stores reveals a dearth of non-metallic paints and it is difficult to discover just what is available because colours are listed solely under the name of the car manufacturer and the

(usually fanciful) name of the paint. Nevertheless the following might be useful: Vauxhall Anthracite (for dark grey Baker stands), Ford Polar Grey (pale medium, slightly warm, dilute with white for Zeiss), Plasti-kote Smoke Grey (dark medium, spray only, from DIY stores). New cellulose paint needs to be "baked" by the judicious use of a hair-drier or exposure to a high wattage electric bulb. Attempts to use a brush to repaint areas of worn enamel are seldom effective because of the difficulty of disguising the edge of the repair, while the repainting of a whole component, such as the limb or the foot, in order to avoid this problem usually results in an even worse eyesore because brush marks (or ripples resulting from trying to polish them out) are so difficult to avoid. Paint splashes and daubed identification numbers, etc., can sometimes be removed with a razor blade if the underlying surface is hard and glossy. The trick is to try to get the cutting edge between the paint and the finish and to flake it off. Faint hearts may try applying paint stripper (B J Capey once suggested hydraulic brake fluid as being less drastic) with a fine brush and then gently scrubbing with a fine nylon pan scourer dipped in vinegar as soon as the paint seems to be softening. Old self-adhesive labels (and the sticky patches left where they have been removed) can be softened with white spirit and will usually yield to gentle scrubbing with isopropyl alcohol on Flotex or a nylon scourer, but check that this treatment will not damage the enamel.

GLASS

It pays to remember that most optical surfaces become scratched as a result of efforts to clean them! The tops of eyepieces and the top lenses of substage condensers are usually the dustiest and are best cleaned by washing them under the cold water tap and gently wiping them dry with lens tissue or a well-laundered old handkerchief. The upper surfaces of the prisms in a binocular tube may also be dusty, particularly if the eyepieces have been left out and it is probably kindest to use *Opticlean* on these as well as on any first-surface mirrors. This (fairly expensive) product is available from most good camera shops and consists of a lacquer which is painted onto the soiled surface and then peeled off, taking finger marks, grease and dust with it. Alternatively, wet a sheet of lens tissue with distilled water and slowly "drag" this across the face of the prism to remove the dust before gently polishing with dry tissue. If any streaks or smears remain, breathe on the surface and repolish. The special lint-free lens-cleaning cloths, such as that marketed by Pentax, are particularly useful here. *Opticlear* moist cleaning tissues and the smaller *Medi-Swab* pre-injection swabs are impregnated with isopropyl alcohol and are useful if optical surfaces are at all greasy. The surfaces of lamphouse collectors and filters which have been subjected to very high temperatures sometimes develop a white film which defies attempts at removal by orthodox methods. In such cases it is worth trying *Harpic* lime scale remover, applied with a small brush, followed by a good rinse under the cold water tap before drying polishing with an old handkerchief. Always try to resist the temptation to use your mouth to blow away dust since it is usually fairly ineffective anyway and merely adds saliva droplets to the dust! Use a Kenair or similar spray to dislodge dust and fluff but fix a length of flexible tube to the nozzle so that the jet can be directed downwards, if necessary, without tilting the can and so spraying freezing liquid. Avoid using these sprays on first-surface mirrors. I remove dust from the back lenses of objectives by turning them upside down and

giving them a short blast of Kenair, followed, in acute cases, by the gentle application of a cotton bud only slightly moistened with isopropyl alcohol and a polish with breath and a new cotton bud or lens tissue wrapped round a blunted wooden cocktail stick. A further short blast is usually necessary to remove any lint. The use of a ×10 magnifier (an inverted eyepiece is convenient) to examine the specular reflection (of, say, a fluorescent ceiling light) from the front lenses of objectives will clearly reveal the most minute scratches or particles of dirt. Solidified immersion oil or mountant on flat lens surfaces is removed with repeated applications of lens tissue merely moistened with xylene, finally polishing with saliva and tissue, otherwise try to avoid the use of organic solvents. The strongly concave front lenses of flat-field objectives need a different technique: to remove immersion oil, invert the objective on the bench and hold a folded sheet of tissue over its front. With the other hand pick up a small drop of xylene on a wooden cocktail stick, touch the tissue with it and using the point of the stick, feel for the concavity through the tissue and clean it with a gentle circular movement, repeating as often as is necessary. It sometimes helps if the point is slightly frayed. Use a similar technique, but with saliva on the tissue, to clean lenses soiled with most other materials, or a dry tissue to remove water. Keep lens tissues, handkerchiefs, cotton buds, cocktail sticks and anything else used for cleaning lenses in a dust-proof container such as a Tupperware sandwich box.

NOTES:

SAFETY

(1) When using organic solvents or paint stripper, wear protective gloves and work in well-ventilated surroundings. Do not smoke or work in the vicinity of naked flames.

(2) Wear protective gloves when using concentrated washing powder solutions, particularly if these are of the “biological” variety.

(3) When using aerosol paint sprays, carefully follow the instructions printed on the label.

ELECTRICAL

Where relevant, newly acquired instruments .should always be checked for electrical safety and any suspect cables or damaged plugs replaced. Fit a fuse which is compatible with the current requirement of the instrument (seldom, if ever 13 amps!) and tighten any loose connections. If electrical plugs have been removed and the colour coding of the wires of a 3-core cable is not brown (L), blue (N), green+yellow (E), or red (L), black (N), green (E), or red (L), blue (N), green+yellow (E), proceed carefully. A confusing and potentially dangerous cable found on some older continental instruments has grey (L), black (N), red (E) and I recently bought, from a service engineer, a microscope wired like this in which all the earth and live wires were “crossed”! Another cable of continental origin has black (L), blue (N), green+yellow (E). If you are in any doubt, seek the advice of a competent electrician before proceeding. Always check the cable restraint where cable enters the microscope or transformer housing and tighten or replace it if loose. Electrical leads and plugs are usually fairly grubby and are best cleaned with a rag moistened with a mildly abrasive cream such as Jif.

WD40

This invaluable material has two serious disadvantages if used as a spray: the first jet will invariably go in any direction but the intended one and it will travel far further than would be thought possible. Even the use of the fine delivery tube supplied with the can is not entirely hazard-free so the secret of success is to spray the lubricant into a small container (well away from instruments) and to apply it by means of a disposable plastic pipette.

FLOTEX

This is marketed as an extremely hardwearing floor-covering for kitchens and other areas where its capacity to survive repeated scrubbing is an advantage. The nylon fibres which form its pile are about 45 µm in diameter and there are approximately 50 to the square millimetre. It is invaluable for cleaning and polishing metal surfaces, particularly those with a textured surface. Free samples are often available from stockists.

STRIP-DOWN

A large research microscope is a complex instrument, containing an enormous number of screws in a bewildering range of sizes and which, while being dismantled, is apt to spout springs, or torrents of roller bearings, at any time. The ideal environment in which to strip one would therefore be an unfurnished room of infinite dimensions, its floor covered with seamless white linoleum. Failing that, work over a large tray lined with white paper. Small screws should be stuck to a strip of masking tape in the order in which they are removed and ball bearings and other small components confined to Petri dishes or shallow pots which are unlikely to be knocked over. The method of construction of stands designed in the ‘50s and ‘60s often appears unnecessarily complex and it is frequently difficult to decide exactly how a component is fixed. Screws were often used in conjunction with tightly-fitting locating pins and special tools may be needed for some operations, so be prepared for some frustration. The best advice which I can give is probably to work in a good light, use a magnifier if necessary and take plenty of time when trying to decide what to do next. You are more likely to make errors of judgement when you are tired, and a “second opinion” often proves fruitful. Finally, DO NOT PANIC: if you really reach an impasse and even an appeal for help in the *Bulletin* draws a blank, you may be able to find an indulgent service engineer who will come to your aid with the loan of a service manual if nothing else!

In conclusion, I would like to thank B J Capey, S V Dodge, J G Mould, G Oppermans, P C Robinson and Dr M L Salmon for reading the manuscript and for their helpful criticisms and suggestions.

This document was originally published in 2 parts:

Walker, M. I. (Spike) (1995) Notes on the Cleaning and Restoration of Modern Microscopes, *Bulletin of the Quekett Microscopical Club* No. 26 (Autumn 1995) pp. 14–16.

Walker, Spike (1996) Notes on the Cleaning and Restoration of Modern Microscopes (Pt II), *Bulletin of the Quekett Microscopical Club* No. 27 (Spring 1996) pp. 18–24.