

when well practised gives results, perhaps more spirited and life-like—more artistic in short—than any mere camera drawing can do; it is evident that the skill required is greater than can be brought to bear by the greater number of microscopists, and, moreover, in the best case it offers no unquestionable guarantee of faithfulness. To obviate these difficulties, to lighten the labour on the one hand, and to ensure perfect accuracy, at least of outline, on the other, the instruments in common use are the camera lucida of Wollaston and the steel disc of Sömmering. These are adapted to the eye-piece of the microscope, and by throwing the image down on to the table, so that its outline may be easily traced on a sheet of paper, they offer very great advantages. But even with these appliances, when the object to be drawn is very elaborate in its details, the labour involved is great, and in the case of living organisms their movements are a source of great perplexity, as an unlucky twitch of a limb may in a moment render useless the work perhaps of hours. Photography of course very early suggested itself as the remedy for all these hindrances, and a very encouraging amount of success attended the first attempts which were made in this direction: Mr. Shadbolt, many years ago, published, in the *Microscopical Society's Journal*, one or two very good photographs of microscopic objects, with an account of the process which he adopted, but it does not appear that any great practical results have followed so auspicious a beginning. For a long time, indeed, the cumbrousness of photographic appliances was a sufficient bar to any general use of them. In the midst of microscopic investigation, to have to busy oneself with preparing sensitive plates, and going through the whole processes of exposure, development, and fixing, was more than could be tolerated; but now that iodized plates can be kept always ready for use, and after exposure may be left any length of time for development, there is very little to be urged as to the *unhandiness* of the process, which is indeed exceedingly simple.

The body of the microscope being brought to the horizontal position must be inserted into the front of an ordinary portrait camera, from which the lens has been previously removed. In the absence of a special adapter, the aperture round the tube must be stuffed with some convenient material so as to exclude light. The image of the object is then to be accurately focussed on the ground-glass by means of the ordinary coarse and fine adjustment-screws of the microscope.* After focussing, however, it will be found necessary to make a trifling alteration in the adjustment, for the object-glasses being made with an "over-correction," in order to compensate for the "under-correction" of the eye-piece, their visual and chemical foci do not correspond; and thus the actinic rays are brought to a focus slightly beyond the visual rays. On this account the object-glass will need a certain amount of depression varying with the power, and the higher the power the less alteration will be required; usually, with a quarter of an inch objective, the chemical and optical foci are so nearly coincident, that the difference may be overlooked in practice. The amount of depression required for each lens can only be ascertained by repeated experiment, but the following data which apply to my own object-glasses (Powell and Leland's) may be taken as an approximation. The one inch glass requires a depression amounting to one turn and a half of the fine adjustment screw (about one seventy-fifth of an inch). The half inch requires about half a turn of the same screw.

The most satisfactory illumination is a strong sunlight, reflected directly upon the object by the concave mirror. Light reflected from a white cloud opposite the sun, will indeed answer the purpose, but the time of exposure is necessarily greatly increased, and the impression, when obtained, is much inferior in point of brilliancy and distinctness.

The "collodion" process is doubtless the best that can be

* It is not the aim of this paper to explain the details of ordinary photographic manipulation. For information on these points, the reader must consult some one of the numerous manuals of photography.

used for microscopic purposes. Indeed, if the direct sunbeam be employed as the illuminating agent, no good result can be obtained with a less sensitive material, for the situation of the image on the prepared plate is continually altering with the altering position of the sun. The time of exposure must differ considerably according to the intensity of the illumination, the medium in which the object is mounted, and the nature of the object itself. When using the direct rays of the sun I have generally found from fifteen to forty-five seconds sufficient for a collodion negative.

Recent discoveries, by means of which sensitive plates may be constantly kept ready for use, have, as previously stated, removed one great impediment to the prosecution of microscopic photography. The point to which attention should now be directed, is the attainment of some simple method of artificial illumination. The illuminating agents now in common use are all greatly deficient in actinic power; and though photographs have been taken by their light, they are practically unavailable. It is evidently impossible that this application of photography should become at all general, so long as it is entirely dependent on a brilliant sunlight, or on such agents as the electric or oxyhydrogen light, but if some easily produced flame, rich in actinic rays, could be devised, then we might reasonably look for a very extensive development of this branch of the art. It could then be practised in all weathers, and at all hours, and there are few objects which could not be represented successfully by its means.

CURE FOR A FOGGY BATH.

BY F. B. GAGE.

[We repeat the following, which appeared in *Humphrey's Journal* some time ago, because we have been repeatedly asked to give the details of this method of purifying a disordered bath]

Put the foggy solution into a strong bottle, about three times larger than the bulk of the solution; then pulverise and add pure bi-carbonate of soda, until the silver is all precipitated to the bottom, in the form of carbonate of silver. If there is any acid in the solution, the soda must be added with caution, (stirring mean while, with a glass rod), as the soda will dissolve "fuming," and boil up and run over to your loss. After you have added soda until the silver is all precipitated, fill the bottle with soft water, stir it up thoroughly with the glass rod, then let the precipitate settle. When it has done so, pour off the water, as closely as you can, without letting any of the precipitate escape.

Repeat this six or eight times, so as to be sure of washing off all the free soda. Now drain off all the water as closely as possible.

It would be well to use distilled water for the last washing, or the kind that you intend to make your bath with. After having drained it as closely as possible, proceed to add chemically pure nitric acid, to dissolve the precipitate, add it stirring with the glass rod at the same time, and with some caution, as it will fume strongly; continue to add until the precipitate is nearly, but not quite, all dissolved.

The solution at this point of the proceedings will probably be opaque and almost inky-black. This need not cause any alarm, as it will filter out clean and pure. Then take a quantity of clean cotton in your hand, hold it under water and squeeze and work it in your hand until it is thoroughly saturated, then press out the superabundance of water, put it into a funnel and filter the solution through it, test it with the hydrometer, and add water until it is of the right strength, wash your funnel, and put in some clear cotton, filter it again thoroughly, and it is right for a negative bath. For positives, it is only necessary to add one drop of nitric acid, chemically pure, to each three ounces of the solution. Baths for negatives treated in this way I have decidedly clearer, better, and quicker than in any way I have ever tried. It also gives better delineations in positives. The experimenter, by this method, will be astonished at the amount of black or green matter that will be found in the funnel after filtering the first time, and will be able to see what fogged his pictures.

* Add the soda until you are sure the silver is all thrown down. Any excess of soda will be carried off in the subsequent washings, and will do no harm.