**Mr. F. Martin Duncan,** President of the Photomicrographic Society, then gave a résumé of his paper, "Some Notes on the History and Design of Photomicrographic Apparatus."

# SOME NOTES ON THE HISTORY AND DESIGN OF PHOTOMICROGRAPHIC APPARATUS.

By F. Martin Duncan, F.R.M.S., F.R.P.S., F.Z.S.
President of the Photomicrographic Society.

No survey of the present position of microscopy would be complete without a reference to the very important part which photomicrography plays as a means of accurately recording the various objects which are submitted to microscopic examination. To the investigator in bacteriology, biology, and metallography, a photomicrographic apparatus is to-day an essential part of his microscopic outfit, and therefore the consideration of the design of such apparatus has become a matter of prime importance.

Scientific workers were quick to realise the value of photography as a means of obtaining an unbiased graphic record of their observations, and it was only the limitations and technical difficulties of the early processes that prevented its wider use. From the time of its first discovery there have been microscopists who have employed photography in preference to the pencil. Thus in 1845 Doune and Foucault illustrated their "Atlas of Microscopic Anatomy" by etchings from photomicrographs taken on Daguerreotype plates, while as early as 1835 Fox-Talbot had obtained images of objects in the solar microscope by means of his recently discovered process. It would be out of place here to enter into a description of the early pioneers of photography, intensely interesting though the subject be, but in passing one cannot help feeling proud of the fact that the discovery of photography was due to British and French scientists alone, and that the first to apply it successfully to the recording of microscopic objects were Fox-Talbot in England, Daguerre in France, and Draper in America. And since those first days of the history of photomicrography, it has been in France, in Great Britain, and in America that the greatest experts, the most notable advances and inventions, and the most perfect apparatus for photomicrography have been produced.*

Naturally the apparatus used in the early stages of the application of photography to microscopy was of a somewhat crude character. The earliest cameras were little more than light-tight boxes, while many of the pioneers dispensed with any form of camera at all, the

* For a short account and early bibliography see an article entitled "Chapters in Photomicrography," which I contributed to the *British Journal Photographic Almanac* for 1903, pp. 691-725.

eye-piece end of the microscope being inserted through a circular hole in the wall of the dark-room, and the Daguerreotype plate, or the wet collodion plate placed upon a board in the dark-room, on which the image formed by the microscope had previously been focussed. Considerable difficulties had to be overcome in obtaining the correct adjustment that would yield a sharp, crisp image, owing to the, at that time, imperfect corrections of microscope objectives; but gradually from such crude beginnings the practice of photomicrography has attained to its present high standard of technique. That the rapid improvement and high standard of perfection to which microscope objectives, eye-pieces, and substage condensers have reached are largely due to the investigations and labours of Abbe, Schott, and Zeiss, all microscopists will readily admit; but that is about all, though admittedly it is a very important contribution, that can honestly be claimed by Germany as her share towards the perfection of photomicrography.

I know that opinions are very sharply divided on the subject of the microscope stand as made by British and German manufacturers, and I feel that much of the criticism that has been levelled at the British manufacturers is grossly unfair and inaccurate, because in nine cases out of ten the would-be critic is already prejudiced in favour of the German, has not a thorough technical knowledge or experience, and frequently has never used a really first-class British stand. I am quite ready to admit that the British maker has turned out some very poor models, but so has the German; but because the Britisher has produced some cheap models of poor quality, surely that is no reason for damning at sight everything he produces. You are not going to encourage home enterprise or industry by such methods. I have now used the microscope practically daily for over thirty years in my biological investigations, and during that time models by all the leading British and Continental manufacturers have passed through my hands, and have been, I hope and believe, honestly, critically, and impartially tested. Out of that long experience I am bound to say that for comfort in working, rigidity, and perfection in design and workmanship, I have yet to see the German or Continental model that will touch the very best productions of our leading British manufacturers. In no branch of microscopy is the superiority of the first-class British microscope stand more readily demonstrated and realised than in critical high-power photomicrography, for to produce the best results, rigidity, whether in the vertical or horizontal position of the microscope body, and ease of manipulation of the mechanism of the substage and the top or object stage are factors of vital importance—factors which are not present in the horseshoe foot, or the finicky studs and knobs provided for the adjustment of substage and substage-condenser, and mechanical stage, in the German models. Even the large Zeiss model specially designed by that firm for photomicrography, though of good workmanship, suffers from these inherent defects of the Continental model, its substage mechanism being very cramped, and the mechanical stage provided with wretchedly small pinion heads.

The microscope stand intended for critical photomicrography and original research should have a solidly cast broad tripod foot, such as is present in the large research model of Swift, the R.M.S. model

of Baker, or the Royal and Van Heurck models of Watson. The focussing of the substage condenser should be by a stout pinion of such a length that the hand does not have to grope for it beneath the stage, and should be provided with a good milled head. Fairly stout pinions and milled heads should also be provided for controlling the vertical and transverse movements of the mechanical stage, while the body-tube should be of large diameter to admit the use of low-power objectives required when photographing comparatively large fields.

Between the years 1889 and 1899, Messrs. Swift and Messrs. Baker produced two very fine photomicrographic cameras that might well to-day rank as standard models for critical high-power work. That made by Messrs. Swift incorporated designs suggested by Mr. Andrew Pringle, and that by Messrs. Baker the ideas of the late Mr. C. Lees Curties—both experienced microscopists and photomicrographers. The essential features of each outfit are very similar, and consist of (1) a long solid baseboard forming a rigid foundation on which the whole apparatus is built; (2) a substantial square-bellows camera travelling on a wide base and capable of considerable extension; and (3) a substantial turntable for the support of the microscope condensers and illuminant. On account of the wide, solid base on which the square-bellows camera travelled, the camera could be extended to its fullest degree and used in that position without fear of vibration during long exposures. With such apparatus the formidable task of obtaining sharp negatives at a magnification of upward of two thousand diameters linear, could be accomplished with certainty, and, given the necessary technical knowledge, celerity and ease. It is no light task to be called upon to produce large numbers of photomicrographic negatives at such high magnifications, when the work has to be carried out in a house past which heavy street traffic is continually travelling, yet such formed a part of my duties during the terrible years of the war, and was made possible only by the use of apparatus of the design I have just described. Before the work was placed in my hands, attempts had been made to carry it out with photomicrographic apparatus mounted on iron rods, the typical German design; and therefore, of course, supposed to be vastly superior to anything British. The failure was due to no want of skill on the part of the users of the apparatus, but to its inherent faulty design, for it is obvious that vibration will be more readily conducted and its amplitude increased along the rods than through a solid base. Both from long pre-war experience and from the result obtained in that part of my war work just described, I feel that I am fully justified in stating that the right design for photomicrographic apparatus intended for critical high-power work is on the lines of the Pringle-Lees Curties models, or the more recent designs of Singer made by Messrs. Watson and Sons, and of Barnard, made by Messrs. Baker.

It frequently is necessary to take photomicrographs with the microscope in the vertical position, and here again to employ a camera clamped to an upright iron rod is asking for trouble, to say the least, yet that is the design dear to the heart of the German manufacturer. Many years ago now, Messrs. Watson and Sons placed on the market a vertical model made to the design of the veteran microscopist, the

late Dr. Van Heurck. The apparatus consists of a vertical box-form camera supported on four stout square legs, between which, and immediately beneath the camera, the microscope is placed. The whole is very rigid, and we all know the magnificent work Dr. Van Heurck and others produced with it. The chief objection, and, when considered on optical grounds, to my mind not a very real one, is that it precludes the employment of extended camera lengths. But ten inches from the eye lens of the eye-piece to the focussing screen of the camera is, I believe, the ideal extension for critical work with modern objectives. In the *Journal of the Royal Microscopical Society* for 1916, pages 258-9, I have figured and described a simple home-made vertical stand to carry microscope and camera, and although there shown as used for stereo-photomicrography, I have since used it successfully for high-power work with the monocular microscope with magnifications up to two thousand diameters.

A vertical apparatus of good, rigid design is of such importance for a great deal of microscopical research work that is being carried out to-day, that it is a matter deserving the immediate and serious consideration of our British manufacturers.