

## SOME NEW POINTS IN PHOTO-MICROGRAPHY AND PHOTO-MICROGRAPHIC CAMERAS.

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Photography in connection with the microscope, Photo-Micrography as universally termed, is now such an every-day affair that one unacquainted with the facts can scarcely realize that only a few years ago, its practice was confined to a very few enthusiasts at home and abroad, and its results looked upon as interesting and beautiful, but practically valueless. Yet such was the case in the later '70s, when Dr. J. J. Woodward was producing his marvelous Photo-Micrographs at the Army Medical Museum in Washington. His work was such a vast step in advance of any that preceded it, as to attract the attention of the entire scientific world, and in many respects it has never been excelled. Being confined, however, almost exclusively, to the resolution and delineation of difficult test objects, as diatoms and rulings on glass, its sole practical value consisted in the improvements in objectives, brought about by the efforts of many eminent opticians, both American and foreign, to meet his exacting requirements. "The Battles of the Lenses" will doubtless be remembered by most of you, and there can be little doubt that the wonderful improvements in and perfection of modern objectives, are due in a large measure to the impetus given by Dr. Woodward in his efforts to obtain the best, for use in photo-micrography. Indeed, Nobert saw for the first time the lines of his nineteenth band in a photograph made by Dr. Woodward with one of these object-glasses.

But even more marked in their effect upon photo-micrography, than the improvements in objectives, have been the changes in photographic methods, since Dr. Woodward's day. He worked within his camera itself; his work-room constituting a gigantic camera box, to which no ray of light was admitted during the



focusing of the object and exposure of the plate, save that which passed through the microscope. The source of light varied according to time and circumstances. Usually he employed that of the sun through an immense heliostat, which is still in use at the museum. But as a large portion of his work was done at night, he also called in the aid of various artificial illuminants: Magnesium ribbon, the lime light, and toward the end of his work the electric arc lamp, each with unvarying success. Not being an expert photographer himself, this portion of his work was done by a professional, and it may not be uninteresting to know that collodion or wet plates alone were used. Gelatine emulsions were as yet unknown, or practically unattainable.

It will thus be seen, that in addition to his own wonderful skill as a manipulator, Dr. Woodward had at his disposal, unlimited Government resources, as aids to his researches and experiments. Indeed it may be safely said, that no other worker in the same field was ever so liberally provided with the means for prosecuting it. The cost in every direction was deterrent to the most of less fortunate mortals, and, as stated before, but for the many radical changes since made in photographic methods, photo-micrography would still be the recreation of the few, instead of the practical realization of the many.

With the general introduction of gelatine dry plates, of such exalted sensitiveness that the light of an ordinary lamp sufficed for exposures with quite high powers; and portable cameras adapted for use with any microscope having an inclinable body, the making of a negative of almost any microscopical object was brought within reach of every worker. The printing, however, was not so satisfactory, especially where large numbers were required in the illustration of papers or books, but, as in the past, the steady advance in photographic methods speedily supplied the existing need; photo-gravure and other process-methods reproduced the negative in positive form with wonderful exactness, delicacy, and cheapness, so that at the present day, papers upon any subject may be illustrated in a manner utterly unattainable a short decade ago. By the same means the optical lantern has



been brought to the fore as one of the indispensable adjuncts of a well appointed lecture room. Ready sensitized plates of thin glass are now furnished at reasonable cost by several eminent makers, by use of which one can make his own slides and from his own negatives, either by contact printing, or by reduction in the camera, if he is provided with one adapted to the latter purpose. In short, the microscopist of the present day finds at his disposal the ready means of illustrating his work at every stage; and one who publishes his notes without illustrations, finds himself at a disadvantage as compared with his more progressive brother.

It is not the object of this paper to do more than glance at the new points in photo-micrography which have fallen under the notice of the writer during the past score of years, and to call attention to a new form of camera combining some novel features, which he has recently introduced under the name of the "Auto-graph." It may be not uninteresting, however, if a very brief allusion is made to his preceding work in this direction, as he takes a perhaps pardonable pride in the belief, that to his efforts a considerable portion of the present acknowledged value and popularity of photo-micrography are due.

Without the slightest previous knowledge of photography in any form, I became greatly interested in its application to the microscope by my friend and mentor, the late Dr. Woodward. Many days passed in his work-room during my then frequent visits to Washington, gave me a keen relish for and desire to engage in this fascinating pursuit, without, however, the slightest expectation of ever being able to do so. The costly and complicated apparatus and appliances necessary placed it quite beyond my reach. But in a few years, with the advent of portable cameras and gelatine dry plates, I became one of the numerous army of amateur photographers, and very shortly afterward by means of a make-shift attachment to my microscope produced my first Photo-Micrograph, a little affair, on a plate scarcely three inches square, and not at all well done, but esteemed as almost a sacred treasure to the present day.



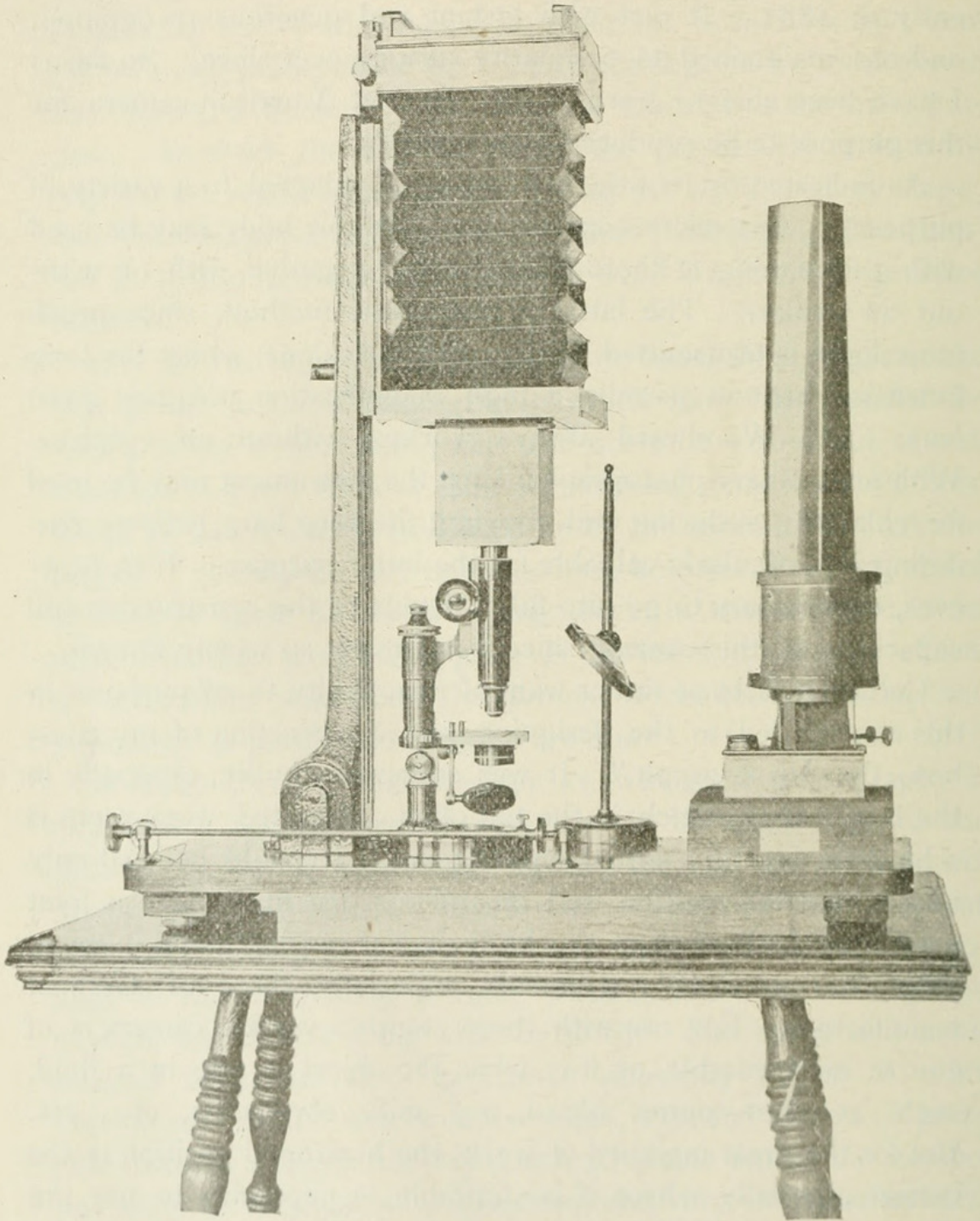
From this crude beginning was evolved the instrument known by the lengthy title of the "Enlarging, Reducing and Copying Photo-Micrographic Camera," which I placed on the market early in 1882. It met with instant and generous recognition, and has maintained its popularity steadily ever since. So far as I have been able to learn, it was the first American camera for this purpose to be produced commercially.

As indicated by its title, this camera is adapted to a variety of purposes. Any microscope with an inclinable body may be used with it in making a Photo-Micrographic negative, with or without an ocular. The latter is the usual method, since much more light is transmitted by the objective alone, whilst the long extension bellows permits a high magnification with any given lens. Dr. Woodward always worked without an eyepiece. With an ordinary photographic lens, the instrument may be used for enlarging, reducing and copying; the very long bellows rendering it particularly valuable for the latter purpose. It is, however, unnecessary to go into fuller details of the construction and capacities of this camera, since it is already so widely known.

Certain defects or rather want of adaptability to *all* purposes in this camera led to the designing and construction of my latest box, the "Autograph." It was somewhat bulky, especially in the larger sizes, which in the too often contracted work-room is a hindrance to its habitual employment. It could be used only in a horizontal position, and the microscope must have a joint permitting inclination of the body, a feature not found in many otherwise excellent instruments, especially those of German manufacture. For use with these stands a vertical camera is of course indispensable, as it is when the object is free in a fluid, such as yeast spores, blood, pus, milk corpuscles, etc., etc. But for the great majority of work, the horizontal position is the better, especially where it is desirable or necessary to use the direct rays of light from a lamp, without the intervention of the mirror. To meet these varying demands, the "Autograph" camera was designed, and it is believed successfully. It may be described as follows, the dimensions given being those for a



camera carrying 4x5 plates, the only size so far constructed. They would have to be proportionally greater for a larger sized box.



The base or platform is of polished mahogany or other hard wood twenty-six inches long, standing upon three very short feet, to insure steadiness on any table or other support, the front

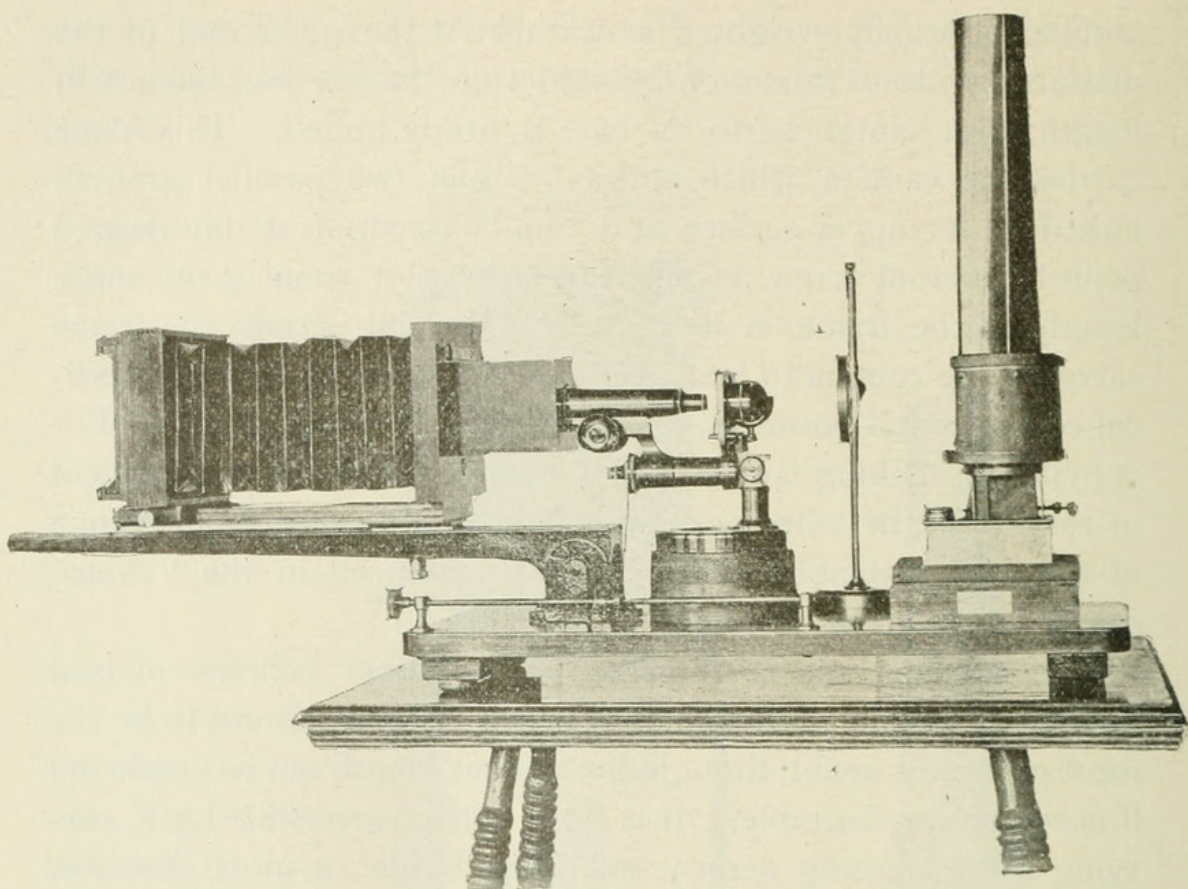


end being heavily weighted beneath. At the other end of the platform a stout frame of japanned iron, twenty-four inches in length, with joint close to its base is firmly bolted. This frame carries the camera, which slides freely in two parallel grooves milled in its upper surface and can be secured at any desired point by a stout screw passing through a slot running the entire length of the frame, in its centre. The joint permits the frame carrying the camera to be placed and firmly held, in either vertical or horizontal positions, or inclined at an angle of  $45^{\circ}$ . For copying or making lantern slides from negatives by enlargement or reduction, the latter position is almost indispensable and is one of the most valuable "New Points" embraced in the "Auto-graph" camera as will be seen presently.

The camera box is furnished with leather bellows of best quality, extending twelve inches, which has been found to be the most generally useful, though double that length can be employed if necessary or desirable. It is fitted with a reversible back, carrying both focusing screen and plate holder, a most desirable feature, as it greatly facilitates the proper arrangement of the object in relation to its position on the plate, where the microscope is unprovided with a rotating stage. The ground glass focusing screen is mainly useful for arranging the illumination, and the object in the field of view, its surface being too coarse to permit fine focusing with high powers. It may, however, be easily removed from its frame and replaced by a sheet of plate glass, when by means of a suitable lens the nicest adjustment can be made. The plate holder is double, and fitted with inside kits to carry  $3\frac{1}{4} \times 4\frac{1}{4}$ ,  $2\frac{1}{2} \times 2\frac{1}{2}$  or lantern plates, in addition to those of its full size,  $4 \times 5$  inches.

The front is fitted with a removable plain board, to which an ordinary photographic lens may be attached, and an additional board carrying an extension (which may be oblong or cone-shaped as desired), with an opening in its front end to receive the tube of the microscope. The flange of the photographic lens can be attached to this extension front, if it be necessary to increase the length of the camera in copying and enlarging.





When the camera is used in the vertical or inclined positions, both coarse and fine adjustment screws are within easy reach of the hand and may be manipulated in connection with observance of the focusing upon the screen. But when the horizontal position is assumed, the distance is too great from screen to microscope to permit this, and other means must be provided. A short rod, turning freely in suitable bearings, is attached to the base board on right hand side of the camera. To the end nearest the observer is fitted a large milled head, and to the other a pulley wheel, with V-shaped groove in its periphery; a corresponding groove being also turned in the Micrometer Screw of the microscope. This pulley-wheel slides freely upon the rod or shaft, allowing it to be placed in line with the fine adjustment screw, where it is firmly held by a small set screw. A fine cord passed around the two grooves, suffices to move the micrometer screw when the milled head is revolved. This, of course, is an old and well-known device, but being a good one has been adopted in this case.



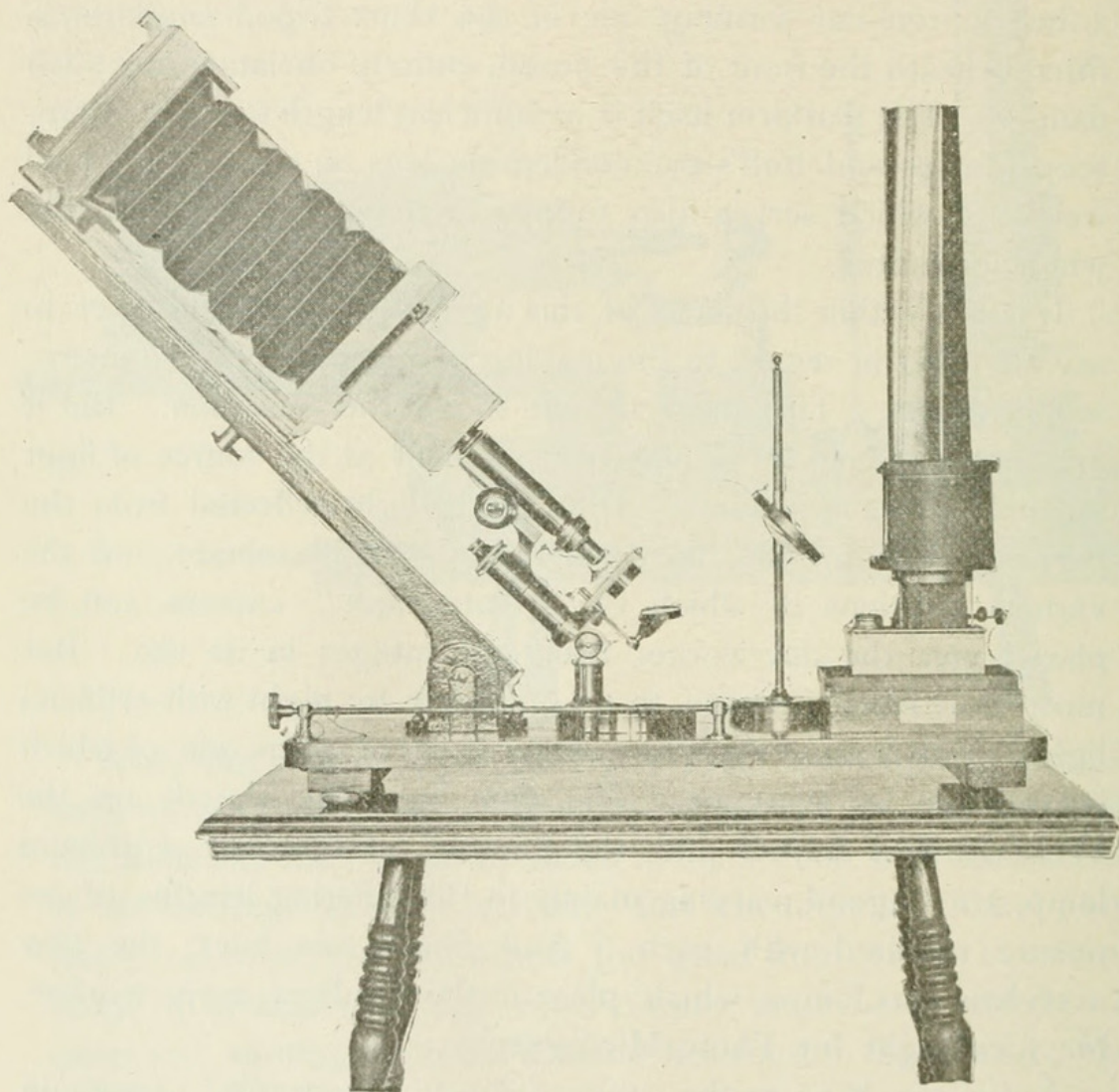
The extension of the iron carrying frame beyond the end of the base board, with the additional weight of the camera acting as a lever, having a tendency to tip the front of the base upward, a heavy iron bar forming one of the short tripod supports, is fitted beneath the front of the board, entirely obviating any such danger. The platform itself is of sufficient length to carry microscope, lamps and bull's-eye condensing lens on stand, the added weight of which serves also to give increased steadiness to the whole apparatus.

It is not within the scope of this already too lengthy paper to say anything in regard to the making of a negative from a microscopic object. This must be left to another occasion. But it may not be amiss to glance for a moment at the source of light for making the exposures. Diffused daylight reflected from the mirror is probably the most generally useful illuminant, and the various positions in which the "Autograph" camera can be placed give the day-worker many advantages in its use. But most of us have, perforce, to do our work by night with artificial light. Fortunately there are many of these, some one of which is available to everyone. The lime light, the electric arc, the Welsbach gas burner and the humble, omnipresent petroleum lamp, are all good, varying mainly in the differing lengths of exposure required with each. And finally we have the new acetylene gas lamps, which place in the hands of every worker, *the ideal* light for Photo-Micrography.

A few words as to the value of the "Autograph" camera in copying and in making lantern slides by enlargement or reduction, and I will tax your patience no longer. For both these purposes, the camera, fitted with a photographic lens of not more than nine inches focal length and inclined at the angle  $45^{\circ}$ , is to be placed near a window and its base cleared of the microscope, lamp, etc: A carrying frame with its upper surface parallel with the camera front, takes their place upon the platform, to which the book or print to be copied is fastened. The lighting, focusing and all such subsequent details are of course familiar to every photographer. I cannot even hint at them here and would



suggest that if the copy is for lantern purposes, it would be well to make it at once of the proper size to permit printing by contact, thus effecting a considerable saving of time.



Negatives of microscopic objects are generally made considerably larger than the dimensions of a lantern slide, though in some cases, as a minute diatom for instance, they are much too small. In either case the lantern slide must be made by reduction or enlargement as necessary. For these purposes, the camera is arranged precisely as for copying, except that its front end must face the window and be close to the latter. A large sheet of white paper is to be laid upon the platform as a reflector, and on this the stand used in copying (and carrying a frame containing the negative), must be placed. A focusing cloth or other covering



is then spread over the space between the frame and camera, so that no light may enter the lens, save that which passes through the negative. The camera is then moved to or fro upon its ways, until the image projected upon the screen is of proper dimensions, when it is to be fastened in that position, the focus sharpened by moving the bellows, and the balance of the necessary work, of exposure and development, done in the manner familiar to all who have mastered the simple mysteries of photographic manipulations.

The accompanying cuts fully illustrate the various methods of using the instrument.





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