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MICROPHOTOGRAPHIC EQUIPMENT¹

AS LONG as cotton and sand hold out microphotography might be said to be safe. The one supplies film, the other the glass—film for base, glass for lens and lamp. It is the machines you want to hear about, but we may well look first into this food of theirs.

Motion pictures gave us our chance in more ways than one. They have provided an international conditioning to the acceptance of a substitute for life. You would not enter the playhouse if you could see reality outside. The drama was an initial preparation, but after all the pretenders in this case were flesh and blood. The screen, however, carries only lights and shadows, not even skin deep, and millions every night accept this filmy release. So we are not nearly so stubborn about tolerating the textual make-believe of reading machines as we might have been without the universal familiarity with movie projection.

To this same performer we owe the cheapness of our new carrier of the light sensitive material. We have had to alter the specifications, to be sure, in the interest of safety and permanence on the one hand, and of legibility on the other. We shift from cellulose nitrate, despite its superior flexibility, over to cellulose acetate, and thus get out of the gas and gunpowder range, while preserving nimbleness by keeping an eye to humidity. Film will not stand the 15 per cent that afflicts many of our living rooms. Nearer right is 50 per cent. Fortunately it is hygroscopic; that is, it will pick up the moisture of its neighborhood. A 52 per cent humidity at 68°F. can be obtained by keeping at hand a saturated solution of sodium dichromate, of which ten pounds can be had for \$2.50.

Emulsion, the seat of the miracle, requires our particular attention. Here we are showing more and more divergence from motion-picture practice. Our emulsion may be fully sensitive to color, partially so, or

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color blind. That is to say, we can at will have our copy entirely faithful to the original; present it in black and white with, however, record of all stains or other imperfections; or, finally, by canceling these blemishes, we may show letters and background in sharp contrast. Thus, under the last choice, we may get a text more legible than the original, whether read in projection or in enlarged paper print made from the film. Or clarity may be secured by introducing a filter to block some color while others pass through. Further, by the use of infra-red sensitive film, we may recover lost text, such as due to censor, palimpsest, or charring by fire.

A camera's excellence may be largely nullified by adoption of inappropriate emulsion in a given instance. This is notably true in the case of high reduction. The emulsion consists of a silver salt suspended in gelatin. The finer the silver grains the smaller the characters that may be recorded there. A book page may require an 8:1 reduction; a newspaper, 18:1. But 50:1 is already attainable, as shown here today by a telephone directory page so reduced, *i.e.* to $\frac{1}{2500}$ of natural size. It is clear under the microscope.

Much experimentation is yet required before we reach the chart stage where we can instrumentally select the emulsion indicated as demanded by a given text and have any variations from page to page therein corrected at the camera by change of voltage. We are embarked on that path and sure to succeed.

Needless to say, the emulsion surface is subject to damage by scratching. A bit of metallic dust may play havoc. No satisfactory coating has yet been reported from Washington. Hence the necessity of careful storage and projection. Relief in this particular, however, has just appeared in an unexpected quarter, at least so far as second copies are concerned. This is a process of impregnating a transparent base with a "diaz" dye instead of covering it with an emulsion. This makes the image relatively safe from abrasion. It is too slow for use in the camera, but being grainless it gives exceptional contrast in prints up to very high degrees of reduction. It has the peculiar quality of yielding negative from negative and positive from positive. The processing is much simpler and the product cheaper than the emulsion type. It was first applied to cellophane but found unstable. More recently a cellulose acetate base has been tried. The results of accelerated age testing at the National Bureau of Standards "are indicative of a high degree of stability and in our opinion film of this quality is suitable for permanent records," I am privileged to report,

according to written advice from the director, dated September 21, 1938. Diazonium formulae are numerous but not all yield stable solutions. Hence testing is necessary in every case.

In processing, it is standard equipment that has thus far been employed in microphotography, though the same experimentation with tanks as with emulsions has to occur before procedure can be scientific and foolproof. There must be correlation between the two, of course, and with the camera exposures as well. Large commercial operators have continuous machines. Such a unit was hurriedly put together for University of Chicago use at the Paris Exposition in 1937 under the auspices of the American Library Association. Revision of this apparatus is under study. In this method, the film is driven by motor under cover through the various solutions and baths at fixed rates of speed and then delivered into a drying cabinet. Control is thus automatic throughout, and uniformity of results is more assured. Such machines must as yet be hand built and may thus be expected to cost around \$1000. Only quantity production of film would justify acquisition of them.

Needless to say, the best results of camera and emulsion can be ruined by mistakes in the development. Fine as the grain may be and however highly corrected the lens, grains may clump in the solution if mismanaged. On the other hand, either contrast or tone of the film as delivered to the processor can at choice be improved there. You may sharpen or grade at pleasure.

If the first copy is excellent, then duplicates may be needed. These are currently made by contact print on film or projection print on paper.

Emulsion film duplicates are quoted at 5-8 cents a foot. Dye film ones ought to come much cheaper.

No satisfactory printer is yet in the market. Institutional laboratories are still dependent on either slow, cheap, amateur instruments requiring perforation of film and full stoppage during each exposure or adapted motion-picture machines, likewise requiring perforation, or commercial contract. Perforation is in microphotography a meaningless hang-over from cinematography. What we need is a continuous, nonperforate, contact printer. It has to be designed and built. The University of Chicago has had such a machine constructed and this is now undergoing final tests. A full description will be published at an early date.

Projection prints on paper in a 6" x 8" size are being quoted at

10 cents. This is less than half the present charge for photostats, though a general adoption of such enlargements would forfeit much of the economy of filming. They have their definite uses, however, and good apparatus for their production is a necessity. This is likewise not yet on the market. Enlargers giving excellent copy are available, to be sure, but none with a satisfactory mechanism for advancing film and paper automatically. Certain work is under way, particularly in the hands of a New York manufacturer, but once more we must await results a while. It is interesting to note, however, that projection printing on paper from microfilms can now be done on a photostat machine. A unit fashioned for this purpose is mounted in place of the usual lens and prism assembly. No reports of experience with this late attachment are yet available.

And speaking of photostats, there is no reason why we may not produce paper miniatures directly on a microfilming camera adapted for the purpose. The cost of 70 mm. paper would be about the same as 35 mm. film but yield copy of quadrupled area, well within the range of hand or desk lenses. Individuals might prefer this, especially in field work, and it could be kept either rolled or flat.

Granted now that the new medium promises faithful reproduction which costs little and will last, can we use it? We must admit that utilization means have not advanced as fast as the camera and its train, though there is no reason to doubt ultimate satisfaction.

We turn either to a reading machine or, as just seen, to paper enlargements, though wall projection and magnifying glasses remain available. In the first case there has till now been no choice, at least for institutions. Only two machines have stayed in the market and both have had to be bought if all types of film now produced were to be read with reasonable convenience. Taken together they have fallen short of satisfaction. The one, using an opaque screen and thus reflected light, is the Recordak Library Projector—Model IX, manufactured by the Recordak Corporation, a subsidiary of the Eastman Kodak Company, Rochester, New York, and sold at \$185. The other, employing a translucent screen and, therefore, direct light, is the Argus Microfilm Reader, manufactured by the International Research Corporation, Ann Arbor, Michigan and now sold at \$87.50.

The Recordak was designed with newspaper films particularly in mind. Only a little over half a single frame, *i.e.* a quarter of a newspaper page can be seen at one time, but this is viewed at about 33⅓ per cent above natural size, and the other three quarters are brought

lightly into command by a skimming arm at the side. This arrangement suits columnar material in high reduction or texts with two pages set in single frame dimension across film. But if the lines are laid down in the other direction and in medium or low reduction, the instrument is ill suited to use, because having no rotating head it forces the reader to use a window at the side to get the lines horizontal to him, and having only one ratio of magnification (22x) it blurs the lines by excessive enlargement. Even in newspaper consultation scanning is slow. It is a well built machine, however, easy to manipulate, and considerate of both eyes and film.

The Argus, on the other hand, was designed with periodicals particularly in mind. Here the magnification is limited to twelve diameters and so can show high reduction material only in reduced size. It accommodates lines laid either direction, since the head rotates, and by raising a panel therein it can be instantly converted to wall projection. In this instance, however, the film must shift position in order to correct the reversal following the elimination of two mirrors. This is a neat looking instrument of good focusing mechanism and for low reduction work the lens definition is adequate. In view of its more attractive price and likelihood of wide use, certain improvements might make the machine more satisfactory. Thus:

1. A better screen, since the present one of plastic material has shown a tendency to warp. A superior ground glass screen is promised.

2. Bevel gears for the film spools to be faster (60 seconds required now to advance the film 100 feet with reasonably fast turning, though the company claims 40 seconds), and be more sturdily mounted, as in fact the company now promises.

3. A platform for viewing short strips. Contemplated.

4. A control to hold pressure plates open for easier cleaning and for facilitating the loading and unloading of film. To do a good job now you have to take the head apart, for a soft cloth (not a handkerchief, please) drawn between the flats will remove only loose particles not gelatin or other sticking substance.

5. The film advancing crank in a less tiring position, though the change would add considerably to the cost of construction, and thus most people would doubtless choose the lesser evil.

6. A simple, inexpensive spring brake action on the "dead" spool to correct tendency of film to jerk and tightly wound spools to unreel.

7. Improved rotation of the head in the latest model, especially through metal doors swinging further back, is acknowledged, and the

lower price of the machine excuses the awkward position of the head when accommodating film at right angles.

8. Rotation of film guiding spools, though this would add to cost and is not of the same necessity in a machine limited to film with double perforation or an equivalent amount of space on either side of the picture area.

9. A change whereby the condenser mount is smoother and film insertion can be more readily effected is another pleasant acknowledgement for the newest model.

The company lists several changes of minor importance but attributes the advance in price from \$75.00 to \$87.50 chiefly to "an improved method of centering the lens elements to give a flatter field and finer correction of spherical aberration," but we have to observe that spherical aberration in the lens still requires an adjustment of focus to correct from good center focus to good edge focus, and this necessity for refocusing prevents the use of the machine for the making of enlargement prints where any considerable detail is required.

In other words, you simply cannot get everything you want in a projector at a typewriter price till at least quantity production is allowed.

As this article goes to press four new projectors are being demonstrated and announced ready for late summer distribution. Three are floor models aiming at universality. All have larger translucent screens, capable of showing a full newspaper page somewhat reduced. All have wide range of instant magnification, and all accommodate film printed either direction. But no price will be under \$200. These are offered respectively by the Recordak Corporation (350 Madison Avenue, N. Y. C.), Holbrook Microfilms, Inc. (33 W. 60th St., N. Y. C.), and Graphic Service Corporation (663 Beacon St., Boston).

The fourth is *sui generis*. This machine, invented by Albert Boni (of the publishing firm at 26 W. 56th St., N. Y. C.) and to be sold by his Readex Microprint Corporation, aims primarily to accommodate miniature print on paper up to an 11-diameter minification. The instrument is, therefore, a reflector rather than a projector, but it can handle at least strip positive film and perhaps in the final design roll positive film as well within such reduction limit by placing a sheet of paper beneath the film.

In this process an octavo sheet of paper would carry a hundred pages. The steps are filming, cutting of film in strips, and then either

printing with a plate made from this collective film or directly on "diaz" paper. This invention bears close watching, since it offers publication at low cost. The price of the Readex is \$100.

The individual in his office will be pretty well served for \$42.50 by an Argus projector manufactured by the Society for Visual Education, Chicago, Illinois, and provided by Eugene B. Power, of University Microfilms, Ann Arbor, Michigan, with a supplementary lens, film advancing mechanism, and spools. This requires a dimly lit place and a screen three or four feet away.

We have now backed to the entrance and reached the camera, which merits climactic consideration, since its product has been found usable and indeed epochal. Here America has registered a striking success by introducing full mechanization. It was this accomplishment that justified last year's demonstration at the Paris Exposition.

It all began with a banker's desire for copies of his depositors' checks. His camera taken over by the Eastman Kodak Company and improved to meet this desire is now widely used not only in banks, but in department stores for statements, insurance companies for application records, etc. For three years the Bank of England has been filming its commercial paper and storing in safety outside. During the recent war scare, demands for such service could not begin to be met. It was this instrument that copied the NRA and AAA Hearings—some 300,000 pages at a little over \$400 for upwards of a dozen subscribers, the 2,600,000 cards of the Veterans' Administration index for the National Archives at a cost of \$2000, and the 34,000,000-card index of the 1900 federal census with reduction in floor space from 7000 square feet to 50.

The next step was to build such a rotary camera to accept large loose sheets. Hence the filming of more than 80 newspapers currently, with the number steadily increasing. The charge is 11 cents a film foot, or 8 pages, for the negative and 5 or 6 cents for the positive, according to number of subscribers. Thus the five-year war file of the *New York Times* sells for something over \$400—about the price of the wood pulp issue when bound or half that of the all-rag edition.

Step 3 was to devise an instrument for handling bound volumes. This camera unlike its predecessors will be put on the market in the summer of 1939 and fortunately at three prices according to the nature of the mounting. This announcement is highly significant. It is this camera that is engaged in copying the population records of the Census Bureau from 1790 onward. An excellent instrument to

the same end has been hand-constructed for several government libraries and for the University of Chicago by Dr. Rupert H. Draeger, of the Medical Corps, U. S. N. This is the instrument used so strikingly in the Bibliofilm Service at the U.S. Department of Agriculture Library and by the University of Chicago at the Paris Exposition last summer.

Meanwhile the generality of institutions have come to be served by a \$295 (formerly \$265) camera designed, manufactured, and sold by the well-known optical house, the Folmer Graflex Corporation, of Rochester, New York, under the name, Photorecord. This is a portable instrument that weighs 45 pounds when packed in its case, which also serves as base in photography. This camera aims to secure the maximum of mechanization consistent with portability. It carries an easily removable magazine for 100 feet of 35 mm. film, which is handled in either single or double frame. Film advance and exposure respond automatically to 20-lb. pressure on a foot bellows operating in a pneumatic cycle. The necessity of such pressure and its attendant standing position can now be avoided by acquisition of a motor compressor provided as a \$50 accessory. A book cradle with plate glass lid for bringing bound volumes to a plane can also be had at \$60.

As this camera carries so many of our hopes and gets wide adoption, the Eastman organization, for example, accepting it for distribution in Europe, it was important that certain faults developing in steady usage be remedied. It is a pleasure to say that in the interval between the presentation of the present paper, when these faults were listed, and the time of going to press, most criticisms have been met by the extensive changes made in the instrument. These include a new sliding type vernier focusing scale, a new lens, a heavy duty shutter, and various improvements in the magazine. The changes effected are well worth the \$30.00 charged for them. It remains only to add that the new lens, like the old, is satisfactory for medium and low reductions, but not for the high reduction required in newspaper copying; that the new shutter is sturdier but can be improved yet; and that while the support had not only best be squared by means of a keyway or other device and calibrated to eliminate the measuring tape but be of a rack and pinion or screw type, since critical adjustment with rod and clamp is tedious and difficult, yet these changes would be costly and are more important in permanent laboratory installation than in portable operation. The delay in meeting this need is understandable.

There are other instruments, of course, built or building for special purposes but these have the center of the stage at present.

Thus there is clearly emergent a technique the most significant in the field of recording since the invention of the printing press five centuries ago. Fortunately they are not rivals but allies, the newcomer getting where his heavier associate cannot reach. With prices already a cent a page and much less for numbers or quantity, we can at last begin to descry swift massing of universal reserves at the hand that can therewith penetrate the unknown or otherwise break human bonds.

Homo sapiens is a great talker. He does too much of it for his own good. As Robert Frost says of the tree at his window,

Not all your light tongues talking aloud
Could be profound.

And I am afraid you archivists cannot be said to confine your efforts to recording him when he is "taken and tossed." But of the significance of record there can be no dispute. The future is constructed out of the past. If Death sweeps as fast as we can heap, most of our lives must be spent in rewinning the lost. But when the essence of us could crouch in record too low for his scythe we could then rise in accumulating strength from generation to generation. So it is in the ten thousand years of writing that we have scored more than in the remaining half million of our divergence from the beast. Any device for safeguarding the record from dust and giving it mobility is a friend of man. In this service no more gallant a figure has appeared in five hundred years than Microphotography.

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