An explanation of this constancy is offered based on the solid solutions formed between these two acids. This requires that "stearic" acids showing this effect should have as their source acid mixtures, the saturated acids of which contain between 53 and 72 per cent of palmitic acid.

As the explanation given must stand or fall with the necessity of the fulfillment of this condition, and as the writer is not sufficiently familiar with the manufacture of "stearic" acid to know whether in general it is fulfilled, discussion on this point is particularly invited.

LABORATORY AND PLANT

PHOTOBIBLIOGRAPHIC RESEARCH METHODS—THE COMPILATION OF TECHNICAL DATA WITH THE AID OF PHOTOGRAPHY

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The methods employed by professional searchers, compilers and "experts in patent causes," although not yet standardized, have nevertheless been very ably described.¹

The weakest point in any system of searching and collating technical data is the accurate transcription of tabulated matter and the reproduction of illustrations when these occur in the text. In the author's opinion, it should be possible to copy articles, tables, complicated diagrams and even entire chapters of textbooks by means of some cheap and simple process and without causing annoyance to fellow readers or damage to the books consulted. If a journey to a distant library is necessitated it should be possible to so plan the trip that copies of all the data needed in a given investigation may be brought home in a convenient form. A research worker would then be able to compile his own textbook on any given subject and arrange the subject matter to suit his own particular convenience and needs.

The author having had occasion to undertake extensive research searching during the past few months was struck by the lack of any simple method for copying articles and diagrams. Tedious scribbling appears to be the method exclusively employed, with occasional laborious and time-consuming tracing. A search through the literature revealed a number of attempts along this line, all based upon some adaptation of photography.²

Microphotographic copying of printed matter was employed for the transmission of intelligence during the siege of Paris in 1870.³ Despatches were printed on a large sheet of paper which was then microphotographically copied onto a film of collodion. According to Tissandier⁴ each page contained some 5,000 letters,

equivalent to 300 despatches, and 16 of these pages were copied onto a collodion film 2 in. long and 1 in. wide, weighing less than one grain. These films were transmitted by carrier pigeons and upon arrival at headquarters were placed in a projecting lantern and thrown upon a screen, while a number of copyists or scribes transcribed the despatches.

Fessenden¹ described a method for photographically compiling his own data collection. His method consisted in copying pages of books onto standard sized plates from which standard sized prints could be made, suitable index numbers being marked upon the film before printing. Other workers have also proposed similar schemes and a method was described in 1909² in which the book to be copied was placed upon the floor and copied by means of a camera equipped with a reversing mirror and using bromide paper instead of plates. In the "reflection by contact" or "catatype" method³ a sheet of sensitized paper is placed with its sensitive side in contact with the print to be copied, the light being allowed to pass through the paper. The method does not, however, appear to have come into practical use.

J. L. Mauch⁴ has obtained a patent for a "photogenic copying device." He has combined "means for applying a sensitized strip to a surface to be copied with means for projecting light through said strip upon said surface and means to obtain a uniform exposure of said strip." The apparatus is to be held in the hand and "rolled" over the page of a book, etc., the unexposed sensitive paper being drawn from one spool and the exposed paper wound up on another spool. This, therefore, appears to be a mechanically controlled application of the "reflection by contact" method. A patent by H. H. Curtiss⁵ relates to a similar device.

Various commercial methods have been proposed for copying directly upon bromide paper without the intermediary of a negative.

A number of years ago there was introduced a commercial bromide paper copying machine known as the "Record Camera,"⁶ which was equipped with a

¹ A. B. Eason, "Sources of Technical Information," *Electrician (Lon.)*, **82** (1919), 326-7; E. D. Greenman, "Technical Literature and How to Use It," *Special Libraries*, **9** (1918), 89; H. Hibbert, "The Art of Searching Chemical Literature," *Chem. & Met. Eng.*, **20** (1919), 578; W. F. Jacob, "The Technical Library and Its Use," *Polytech. Eng.*, **16** (1916), 36; E. N. Jessop, "German Patent Bibliography," *THIS JOURNAL*, **8** (1916), 1053.

² For an extensive bibliography on the subject of "Photography in Library Work," see G. A. Evers, *Maandblad voor Bibliotheekwezen ('sGravenhage)*, **1** (1913), 10, 225.

³ Dagron, "The Preparation of Microphotographic Despatches on Film," *J. Phot. Soc. London*, **15** (1871), 102; *Brit. J. Phot.*, **18** (1871), 616.

⁴ "History and Handbook of Photography," London. Translated by J. Thomson. Low, Marston, Low and Searle, 1876. "Microscopic Despatches during the Siege of Paris," Chap. 6, pp. 234-48.

¹ "Use of Photography in Data Collections," *Elec. World*, **28** (1896), 222.

² "Photographing Rare Books and Manuscripts in Libraries," *Bull. de la Soc. Franc. de Phot.*, [2] **25** (1909), 396.

³ E. E. Fournier d'Albe, "On Photography by Reflection under Contact," *Sci. Proc. Roy. Dublin Soc.*, (New Series) **12** (1909), 97; G. de Fontenay, "Cataphotography; Reproduction of Documents by Reflection," *Compt. rend.*, **152** (1911), 1055, 1298.

⁴ "Photogenic Copying Apparatus," U. S. Patent 1,251,076 (Dec. 25, 1917); *Off. Gaz. U. S. Pat. Office*, **245** (1917), 894.

⁵ "Method and Apparatus for Photography," U. S. Patent 1,007,120 (May 19, 1914); *Off. Gaz. U. S. Pat. Office*, **202** (1914), 745.

⁶ "Making Photographic Copies without a Negative," *Am. Machinist*, [1] **31** (1908), 781; Eastman's "Record Camera."

reversing prism and a magazine containing a roll of bromide paper. Upon development a reversed negative (white on black) was obtained. This machine was followed by the well-known "photostat"¹ which embodies the basic principles of the earlier machine but is equipped with means for immediately developing and fixing the print. The cost of a photostat print ranges from 25 to 35 cents per page. Positives (black on white) are secured by copying a negative print, and enlargements and reductions within the capacity of the machine are readily made. S. C. Williams² has discussed the cost of photostat work from a scientific viewpoint, and gives formulas for computing the various elements of expense involved. A comparison of the relative costs of brown prints, blue prints, and photostat copies (on a square foot basis) has been made by the Ordnance Department, U. S. Army.³ The "rectigraph"⁴ and the Powers "cameragraphs" (simplex and duplex)⁵ are similar machines, the last mentioned being designed to photograph on both sides of a sheet.

In addition to methods intended purely for the copying of printed matter there has been developed a portable camera for use in reading electric and gas meter indices. This is termed the "factograph" camera⁶ and is arranged to carry its own source of illumination in the form of several small battery-operated lamps which are lighted by means of a lever which latter also automatically opens the shutter for any desired length of time. A modification of this camera is termed the "finger-print camera" and is used for keeping uniform-sized finger-print records.

EXPERIMENTAL

The author modified Dagron's microphotographic process by substituting motion picture film for the wet collodion pellicle and an f 3.5 anastigmatic lens for the slow doublet of 1870. Textbook and periodical pages were photographed, the process used being essentially the same as that used by the cinema companies in copying titles, telegrams, and letters for incorporation into film plays. It was found possible to enlarge the negative film onto bromide paper up to a certain limit in size, *e. g.*, about 5 by 7 in., and although the image was slightly blurred the outlines of the diagrams could nevertheless be distinguished and could be strengthened by inking in. When the film (both negative and positive) was projected onto a screen the print and diagrams were distinctly readable. Oswald,⁷ however, has little faith in the use of cinema film for purposes of direct enlargement.

Reasoning from Simpson's and Dagron's postulates,

¹ L. D. Burlingame, "Photostat and Its Uses," *Machinery*, **21** (1915), 951. J. X. Cohen, "Methods and Cost of Reproducing and Reducing Engineering Drawings," *Eng. & Contr.*, **46** (1916), 198; "New Reproducing Machine of the Commercial Camera Co.," *Iron Trade Rev.*, **56** (1915), 1106.

² "Photostatic Reproduction Cost," *Am. Machinist*, **44** (1916), 487.

³ U. S. Army, Ordnance Dept., "Cost of Photostats, van Dykes, Blue Prints, Compared," *Eng. News-Record*, **82** (1919), 1065.

⁴ *Lumière Elec.*, **25** (1914), 217.

⁵ *Eng. Rec.*, **72** (1915), 32; *Iron Age*, **95** (1915), 1122.

⁶ "Camera for Reading Meters," *Am. Gas Lt. J.*, **103** (1915), 141; *Machinery*, **22** (1915), 75. Folmer, U. S. Patents 1,139,022, 1,139,023 (May 11, 1915); *Off. Gaz. U. S. Pat. Office*, **214** (1915), 497.

⁷ "The Movie and the Still Picture," *Literary Digest*, July 5, 1919.

cited above, there appears to be no reason why entire works like Beilstein could not be photographed onto a continuous film¹ (larger in size than ordinary cinema film if necessary)² and projected with a suitable apparatus.

A second series of experiments involved the construction of a portable machine of the "photostat" or "rectigraph" type.

This was accomplished, as shown in Fig. 1, by using an Eastman double-extension bellows, revolving back, 3.25 in. by 4.25 in. Auto-Graflex camera. The advantage of the reflex camera resides in the ease with which focusing may be effected, although any ground-glass focus camera may, of course, be used. The lens was equipped with a photoengraver's reversing prism and a simple type of studio shutter, although the camera's own focal plane shutter could also be used. Eastman "Insurance Bromide" paper, Grade B, was used instead of film, being wound on the regular film spools. An exposure (ordinary daylight) of 15 to 20 sec. at f 4.5 to f 6.3 produced a perfect miniature "photostat" print. Exposure under one 16 candle-power incan-

FIG. 1—INSTANT-FOCUSING REFLEX CAMERA EQUIPPED WITH PRISM AND LARGE-CAPACITY BROMIDE ROLL HOLDER, SHOWING METHOD OF USE

descent lamp, representing ordinary New York library lighting conditions, required about 10 sec. longer. Experiments were made using a 5 by 7 view camera, equally good results being obtained, the detail and sharpness of the prints being remarkable. A whole page of Beilstein when reduced to 3.25 by 4.25 in. in size was as distinctly readable as the original, and when such a small print was recopied and enlarged several times by a regular "photostat" machine its size was restored to that of the original page without any material sacrifice in sharpness of definition.

Such spools of bromide paper when tightly wound so as to fill completely the regular film spools in the case of the camera mentioned above represent 15 to

¹ Olet, in 1918, exhibited examples of such work before various American library gatherings.

² "Projecting Larger Pictures with the Standard Motion Picture Film," *Phot. J. Am.*, **56** (1919), 180. Standard size of film retained. Film is moved horizontally and picture is as high as the ordinary image is wide and twice as wide as the regular image is high. The greater size of the film permits greater enlargement.

20 exposures, and a dozen or two of such spools are sufficient for copying a book of respectable size.

The development of a roll of 20 exposures is of course an extremely simple matter, requiring but a few minutes, while the developed paper may be accorded much rougher handling than would be withstood by film. It may, for example, be cut and trimmed while still wet, pasted onto sheets and reports while still damp and portions of illustrations may be inked in with waterproof India ink, the rest of the image being bleached out by some suitable means¹ and the "line cuts" so obtained used for reproduction. After the first print is made it may be recopied to produce black-on-white copies or "positives."

It should, of course, be noted that a suitable "head" or starting piece and "tail" or ending piece of non-

controlled winding jig is also a great aid in rolling up such homemade spools. The numbering and marking of 10 to 100 ft. of bromide paper proved to be somewhat tedious and a solution of the difficulty was found in the use of the magazine film holder corresponding to the Bannister patent.¹

This type of holder was intended for the use of unbacked, un-numbered film, contained on a wooden spool. The film was caused to pass over a large measuring roller carrying two needle points which punched the film at regular intervals corresponding to the size of the picture desired, and the film was prevented from progressing until a suitable release lever had been depressed, or else some external indicating device signaled readiness for a fresh exposure.

Although the apparatus described above is an extremely convenient device for copying books in a distant reference library, it nevertheless appeared possible to render the process of copying more automatic in operation and less dependent upon the operator's judgment regarding sharpness of focus and conditions of illumination. The author, therefore, utilized the principle of the self-illuminated meter reading and finger-print camera mentioned above and built the experimental apparatus depicted in Fig. 2. It was of course necessary to employ the reversing prism used with the reflex camera previously described. This feature makes the apparatus rather awkward and cumbersome, one portion being at right angles to the other, and there are slightly "top-heavy," but if such a device were to be produced on a commercial scale, a more convenient form, possibly involving the use of a suitable system of reversing mirrors, would undoubtedly be evolved. Pressing the antinous release opens the shutter leading to the lens and prism and simultaneously lights the battery-operated lamps which illuminate the object to be copied. A suitable clock-work or other timing device may, if necessary, be used to actuate the shutter and light-controlling levers so as to insure uniform length of exposure. We would thus have the following practically ideal operating conditions: fixed focus lens, constant intensity of light, uniform time of exposure, and fixed size of object to be copied with a fixed ratio of original to the copy. The apparatus may be built in various forms and sizes, *i. e.*, "page-copier," "diagram-copier," "equation-copier," etc., depending upon the size and use to which the device is to be put. The device might also be so designed as to operate somewhat like a numbering stamp, a simple downward push sufficing to open the shutter and illuminate the object for the required length of time, the mechanism being arranged to automatically supply and wind up the sensitive paper used. H. S. Leach² has suggested the advisability of sending expeditions of research workers abroad equipped with photostat machines to copy and bring back material for scholarly study, and the present author would modify the suggestion to the effect that a more portable machine of this type

FIG. 2—SELF-ILLUMINATED COPYING DEVICE SHOWING PRISM, METHOD OF ILLUMINATION, AND 50 EXPOSURE BROMIDE PAPER ROLL HOLDER

actinic or "post office" paper must be pasted onto each end of the sensitive strip for the purpose of starting and ending the spool without spoiling the first and last exposures made. It was discovered, however, that simple blackening of both sides of the bromide paper with India ink for a distance of about one foot from each end of the roll served the same purpose. Inasmuch as no black "duplex" backing paper is used with the bromide paper as in the case of film, the number of the exposure must be indicated in some manner. This is readily accomplished by marking the number of the exposure on the back of the paper with the aid of a cardboard template; a ratchet-

¹ E. Senior, "Converting a Photograph into a Line Drawing," *Knowledge*, 11 (1914), 71.

¹ Bannister, "Roll Film Holder," U. S. Patent 316,933 (May 5, 1885); *Off. Gaz. U. S. Pat. Office*, [1] 31 (1885), 523.

² "Photostat as an Aid to Research," *Sci. Am.*, 122 (1920), 276, 291.

would be a valuable aid to anybody having occasion to make use of a reference library, and the above-proposed small portable machines carried by investigators and translators may very well be used as "feeders" for the large machine in the home plant. The cost of the bromide paper is about \$1.75 per 100 ft., and a 100-ft. roll of paper measures only 4.375 in. wide by 4 in. diameter and has a capacity of about 300 exposures. The entire apparatus weighs but a few pounds and does not occupy more than the table space allotted to any one reader or the space occupied by a large dictionary or several volumes of some periodical, and no reasonable objection to its use can be interposed by any librarian, the argument, if any, being on the side of the reader, inasmuch as the book to be copied may be released for issue to another reader in an incredibly short time after "pushing the button."

CONCLUSION

There is apparently a need for a portable and cheaply operated photographic device for copying illustrations and articles on file in reference libraries—for the purpose of compiling the technical data needed in an investigation. The experiments described indicate that the use and manufacture of such a device are both within the range of commercial possibility. It is believed that a device combining the operating principles of the existing bromide paper copying machines and the self-illuminated meter-reading cameras would prove to be a valuable aid in data compilation, and simple enough in operation for use by non-technical clerical assistants. There appears to be no reason why it should not be possible to simply "push the button—and read the book at home."

POTASH FROM KELP. II—THE EXPERIMENTAL DISTILLATION OF KELP AT LOW TEMPERATURES¹

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A study of the experimental, destructive distillation of dried kelp was undertaken to determine whether or not under carefully controlled conditions any relationship could be established between the temperature at which distillation was taking place and the nature of distillation products. The work was done in the Forest Products Laboratory of the U. S. Department of Agriculture, Madison, Wis., in order that the apparatus and technique developed there in the destructive distillation of wood might be available for the research in hand.²

Kelp was distilled in an oil-jacketed retort which was built for experimental wood distillation, which has been fully described and illustrated by L. F. Hawley and R. C. Palmer.³ While this retort was adapted for

¹ The first paper of this series, entitled "The Experimental Plant of the U. S. Department of Agriculture," by J. W. Turrentine and Paul S. Shoaff, appeared in *THIS JOURNAL*, 11 (1919), 864.

² Acknowledgments are due to Director Winslow, to Drs. Hawley, Mahood, and others at the Forest Products Laboratory for assistance and courtesies extended, and to Prof. O. L. Kowalke of the University of Wisconsin for the use of laboratory space and apparatus for supplementary work.

³ "Yields from the Destructive Distillation of Certain Hardwoods," U. S. Dept. of Agr., *Bulletin* 129.

wood distillation, experience showed that it was not suitable for kelp. However, an interesting collection of data was obtained which is summarized in the paragraphs which follow.

Reference to the specimen log of a distillation run which is here reproduced, as well as a glance at the composite time-distillate curve, will show how the high moisture content of the dried kelp prevents a rapid rise of temperature when the kelp starts to distil. This gradual expulsion of water vapor with its accompanying organic matter undoubtedly tells a story of the volatile kelp constituents that the more rapid heating in a much hotter retort would fail to do.

The retort was preheated by lighting the gas flames of the retort the evening before the run was to be made.

COMPOSITE TIME-TEMPERATURE CURVE OF KELP DISTILLATION IN OIL-JACKETED RETORT REPRESENTING RUNS 2, 3, 5, 6, AND 7

The kelp was charged into the retort in a cylindrical iron cage 3 ft. long and 1 ft. in diameter, inside dimensions. This cage was lined with heavy wire netting preparatory to distilling the dried kelp, and two partitions of the same material were set lengthwise in the middle of the cylinder to provide an air space for the escape of vapors from the middle of the kelp charge.

Sixteen distillations of kelp (average weight of charge 30.2 lbs.) were made in this manner. The first runnings of distillate were always clear and of a bright green color. This condition continued with only a slight increase in density until a temperature, usually above 150° C., was reached, when a turbidity became noticeable in the liquid, which also changed from green to amber. This turbidity indicated a change