described in the former which I had found to belong in the latter. A facetious abstractor had commented: "*Oxytropis* wins with a new combination." On my complaint he graciously inserted the correction, "with a new name." Since I had no access to the original, I still do not know what species was involved.

The preparation of an index containing some 400 titles in ornithology revealed other examples. In the following titles, words which might be deleted are indicated in parentheses: "Reverse migration (of birds) as (a) result of unfavorable weather (in spring)"; "Notes on (the habits and distribution of the) white-tailed eagle in northwestern Iceland"; "Results of catbird banding in (Camden), New Jersey"; "Rhythm in (brooding and feeding) nest routine of (the) black-chinned hummingbird"; "Adaptability of birds to (changed) environments (in early fall)."

This task raised the question: Why do we use 'the,' 'of,' etc. so much? The index was first prepared with abbreviated titles. The matter of quoting literally was brought up, and restudy showed that in many cases this would require only a generous sprinkling of these superfluous words. Of 10 titles in a current journal number, four begin with "a," "an," or "the," and one with "notes on." A recent title, "A systematic study of the main arteries in the region of the heart—Aves VI" (*Auk*, Vol. 62, p. 408), is specific but too long. The running page title, "Study of arteries in the heart," is incorrect and has two superfluous words. A new book of high merit is *The distribution of the birds of California* (*Pac. Coast Avifauna No. 27*). Surely *Distribution of California birds* would serve as well and would reduce the length by 25 per cent.

On the Preparation of Extensive Bibliographies[1]

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There are many mechanical methods of procedure in bibliographic work, but we believe that the following steps will approximately represent the average stages of action: (1) location of a publication in an index or elsewhere; (2) exactly and legibly preparing an abstract and copying it on a card; (3) checking copied abstract; (4) numbering, sorting, and indexing; (5) stenciling; (6) checking stencils; and (7) mimeographing and binding.

The last three steps, which can be handled by an office assistant, will not be considered here. The other four processes should be attended to by the researchist himself, and for the third item he can use the aid of an intelligent clerk. Copying abstracts day after day, exactly and legibly, including punctuation and checking the copy, is regarded as routinism by most technically trained men. It is this part of the work which we think can be largely eliminated.

In a conversation about 25 years ago H. J. Rose (formerly a senior fellow of Mellon Institute and now vice-president, Bituminous Coal Research, Inc., Pittsburgh) mentioned to one of us that, if a piece of sensitized photographic paper is placed face down on a printed page and held in place by a sheet of plate glass, a negative image copy of the printed words or other markings can be developed after exposure to the rays of an electric light. Positive prints can be obtained from the negative by printing in the conventional manner. While this idea is certainly not new at present, it is by no means in general use by scientific workers. Upon extensive inquiry we have found only an occasional individual, not closely identified with photographic work, who is even aware of this bibliographic aid, which we have applied with success and enthusiasm.

At least two brands of photographic paper for this work are on the market. It is a thin stock paper frequently referred to as "Reflex" printing paper and sells for slightly over $4.00 per 100 sheets ($8\frac{1}{2} \times 11$ inches). Items average about 5.5 abstracts to such a page. The paper cost, including the first positive print, is about $.007 per abstract, and the developing work, which can be turned over to unskilled labor, costs in large batches well under $.01 per abstract. To this expense is to be added the cost of attaching the untrimmed print to a card for sorting. The total cost should be below $.02 per abstract. A darkroom is desirable but not essential for this work.

A young scientist receiving $250.00 per month is paid at a rate of about $.03 per minute. We find it requires about seven minutes to copy in longhand the average item in a 3,000-item bibliography. It costs nearly as much for two people to check it, and experience shows that usually 2 per cent of the errors will not be caught. The cost for the old procedure would therefore be in excess of $.40 per abstract placed on a sorting card.

We have found in our suggested procedure that, with an unshaded 150-watt lamp 30 inches above the page, an exposure of 10 seconds is usually satisfactory. Connecting the light and an electric timer in series with a foot switch greatly facilitates this operation. This means that the worker can copy a desired abstract in little more than the time it would take to put the book back on the library shelf. If we accept the foregoing rough approximations, some of which are ultraconservative, we have a total saving of $350.00 per 1,000 abstracts. In addition, there will be no cross-checking and no transfer errors, most of the drudgery will have been removed, and the work of stenciling will be much facilitated owing to excellent legibility and exact spacing. This inexpensive setup would, of course, also be available for copying letters, graphs, small drawings, or lengthy tables for other purposes.

It is also suggested that work in copying abstracts would be much expedited if the publishers of abstract journals would put at the head of each item the initials of the abstract journal, a serial number, and the number

[1] Contribution from the Multiple Fellowship on Gas Purification sustained by Koppers Company, Inc., Pittsburgh, Pennsylvania.

of the current year or volume—for example, "C.A. 12345–46." *Science Abstracts* and *Biological Abstracts* already employ approximately this system. It makes the abstract journal indexing slightly more definite and in the proposed procedure eliminates labeling of each item.

Punch Cards for Indexing Scientific Data

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Files containing large volumes of scientific data can, and often do, become unwieldy and cumbersome to use. The principal reason is that in the preparation of such files emphasis is usually placed on the manner of putting data *into* them rather than on ease and facility of getting information *out* of them. The result is that maximum utility either is not realized or at best is attained at the expense of unnecessarily great time and effort.

In the indexing and analysis of chemical subjects, we have, through the use of punch cards, avoided the difficulties which are inherent in ordinary filing systems, since these cards stress the matter of prime importance—ease and versatility of obtaining any desired information from the file. In most instances only one card is required for each reference, even though it may deal with multiple phases of the subject under consideration. All of those cards pertaining to a specific phase may readily be sorted from the file. The cards need not be filed in any particular order; indeed, there is little loss of efficiency when they are placed at random in the file.

Success with the new system led us to report our experiences in our fields of research (*1, 2, 3*). The experiences of a few workers in physiology (*5*), metallurgy (*6, 7, 9*), and pharmacology (*4*) are also recorded in the literature, and a spectroscopist has made an oral report (*8*). In addition, through correspondence and conversation we have learned of a few others who have adapted punch cards to their problems. We feel, however, that this powerful indexing tool has not been publicized as widely as it deserves.

The cards[1] may be obtained in different sizes, although the five- by eight-inch size is probably best suited to most applications. Holes one-eighth inch in diameter are punched one-fourth inch apart along the edges, one-sixteenth inch from the margin. The upper right corners are cut diagonally, so that it can quickly be noted whether all the cards are right side up and facing the same way. Since the holes occupy but a small amount of marginal space, ample room is left for the recording of references, abstracts, experimental data, or other desired information.

A general idea of the purpose of the holes can be conveyed by quoting from one of the above literature citations (*2*): "Meanings are assigned to individual holes, and on each reference card at the appropriate holes the portion of the card between hole and margin is clipped open with an adaptation of a ticket punch, changing the hole to a notch. When the sorting needle, resembling a single-tine ice pick, is inserted into a given hole in a group of cards and lifted, the cards, on which that hole has been clipped, drop out and the others stay on the needle."

In this necessarily brief description we make no attempt to give any of the details which should be understood before the punch-card system can be put into operation, since they have been discussed at length in the chemical literature (*1, 2*). Bulletins published by the card manufacturers are also valuable in furnishing instruction in methods and technique.

Although a number of suggestions could be made to those planning to adopt the indexing system which we have found so satisfactory, we shall confine ourselves to two of fundamental importance. First, the problem at hand must be carefully analyzed, in order to make certain just what kind of information it is desired that the file shall be capable of furnishing. Second, an outline must be prepared to serve as a framework into which all the reference material can be fitted for coding purposes; it is obvious that this step cannot be taken effectively until a considerable familiarity with the field has been acquired. In most cases the outline for a specific investigation can be printed on the card, but for diverse purposes the use of relatively blank cards with separate outlines is advisable.

[1] The cards and necessary inexpensive accessory equipment are manufactured by the McBee Company ("Keysort"), Athens, Ohio, and the Charles R. Hadley Company ("Rocket"), Los Angeles, California.

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A Simple System for Reprint Filing

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The organization of a reprint collection is a problem which must be faced by every serious research worker. Initially there is the accumulation of reprints, but ultimately, if this collection is to retain value, some system must be developed. The desiderata are obvious. The system must be one in which any reprint can be located without waste of time or effort in search. It must be equally possible to return any reprint to its proper place. The system must be capable of continuous extension. The system must be simple and require a minimum of effort to develop and keep in order. Less obvious,