A BIBLIOGRAPHIC PUNCHED CARD IN ANALYTICAL AND INORGANIC CHEMISTRY DESIGNED FOR THE INDIVIDUAL RESEARCH CHEMIST*

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A number of comprehensive reviews as well as many designs of punched cards have appeared.[1,2,3] None of the punched cards which have been described were found to be sufficiently versatile for use by an individual chemist in his continuing efforts to keep abreast of the literature. The authors have tested various designs of punched cards over a period of years. The results of this study are represented in the punched card for analytical and inorganic chemists which is described in this paper. The design of the card is directed toward use by practicing chemists in the hope that it will help in their constant fight against the increasing flood of literature.

GENERAL DESIGN OBJECTIVES. -- Many of the objectives described below may appear to be obvious, but since they are not met by many small files it is worthwhile to formulate them. For the small user one of the most important objectives to strive toward is that the operations of coding, punching, and searching be done with little or no reference to a code book. Thus, while the use of a system based upon a generalized numerical or letter code reduces the card cost slightly, it is annoying and time-consuming for the small user since reference to a code book is required during both the storing and retrieving operations. For this reason the private files in the offices of many research organizations contain punched card systems based upon a generalized code which are dead in the sense that the cards are not being used as punched cards, but merely as weak-edged file cards. Most small or private punched card systems which require extensive use of a code book die in this sense within about two years, and those that remain do not save time for the user as effectively as they should. It would seem that the penalty paid for the use of a code book is death. For these reasons the meaning assigned to each punching position must be obvious from the printing on the card. Thus, it is necessary to have appropriately printed cards available.

Since the object of the system is to save time, coding and punching should involve the making of only a few obvious decisions. Refined classifications and extensive subdivision of topics waste the time of the user through his having to make many hairline decisions. In addition, the fine subdivisions are difficult to recall, and are consequently of little value as a searching aid for the individual.

A punched card system should be such that coding and searching do not become awkward when one's interests change or when the field of learning itself undergoes drastic modification. The design, in other words, must be versatile enough to allow for growth of the subject and widespread change of interest and still be valuable after decades of use. Partial or complete obsolescence of items in the file which have decreased value must also be provided for. With proper provision for obsolescence, a filing system need not grow indefinitely but can be kept of manageable size.

The design should be such that an effective searching strategy is apparent and requires little time to execute. The effectiveness of searching may be evaluated in terms of the recall factor and the elimination factor.[2] The recall factor has been defined as the number of items of pertinent interest retrieved divided by the total number of items of pertinent interest in the system. Thus, the recall factor is a measure of the reliability of the searching strategy and, of course, it is important that it be unity. For the purposes of this study the elimination factor is defined as the number of items not of pertinent interest which are eliminated divided by the total number of items not of pertinent interest. A high elimination factor is essential, but an attempt to make it unity is a mistake, since, in the process, the recall factor will probably be reduced below unity. To the extent that a search fails it should "fail safe." It is suggested that it is reasonable to define an effective search for the small user as one which gives an elimination factor of about 0.99 and a recall factor of unity.

CHOICE OF SIZE AND TYPE OF CARD. -- Two principal factors normally govern the

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decision regarding the size of card to be used: coding and abstracting space requirements. For the small user the requirements for coding space are not critical with respect to card size since even a small card provides ample coding space when properly designed. Fortunately also the holes occupy only a small fraction of the space and most of the card is available for recording abstracts, data, diagrams, photocopied material[4] and other information. An attempt to assess the requirement for abstracting space was made by examining the files of about 20 academic and research personnel with varying interests and employment. The two common sizes of file or punched cards found were 3 or 3.5 x 5 and 5 x 8. In the files of those using the smaller cards, it was found that on the average 91% of the cards had material written on only the front side. For those using 5 x 8 cards, a typical file had 94% with material on only the front side. Since both sides of a 3.5 x 5 card have an area approximately equivalent to one side of a 5 x 8 card it appears that in 94% of the cases, the abstracts prepared by those now using 5 x 8 cards could have been accommodated on a small card. Examination of the remaining 6% showed that usually only slight modification of the abstracting procedure would have made a small card practicable. There was a considerable variation in the individual needs for abstracting space, but it was usually observed that the most voluminous abstracts were prepared by people least experienced in their fields.

The small card is more desirable from the point of view of convenience because its size permits one to keep a small supply at hand, for instance, in a jacket pocket. In addition, the upkeep on the lighter small card is less because the strain on the unpunched holes is less and the need for hole repair is essentially non-existent.

In view of these considerations it was felt that a 3.5 x 5 edge-punched hand-sorted card with a single row of holes would meet the needs of almost everyone and designs for other cards have not been considered.

DESIGN OF THE PUNCHED CARD. -- In Fig. 1 is shown the punched card which has been designed for use in inorganic and analytical chemistry.[5] For convenience the coding space has been subdivided into six major fields. The first major field, in direct code, is useful for

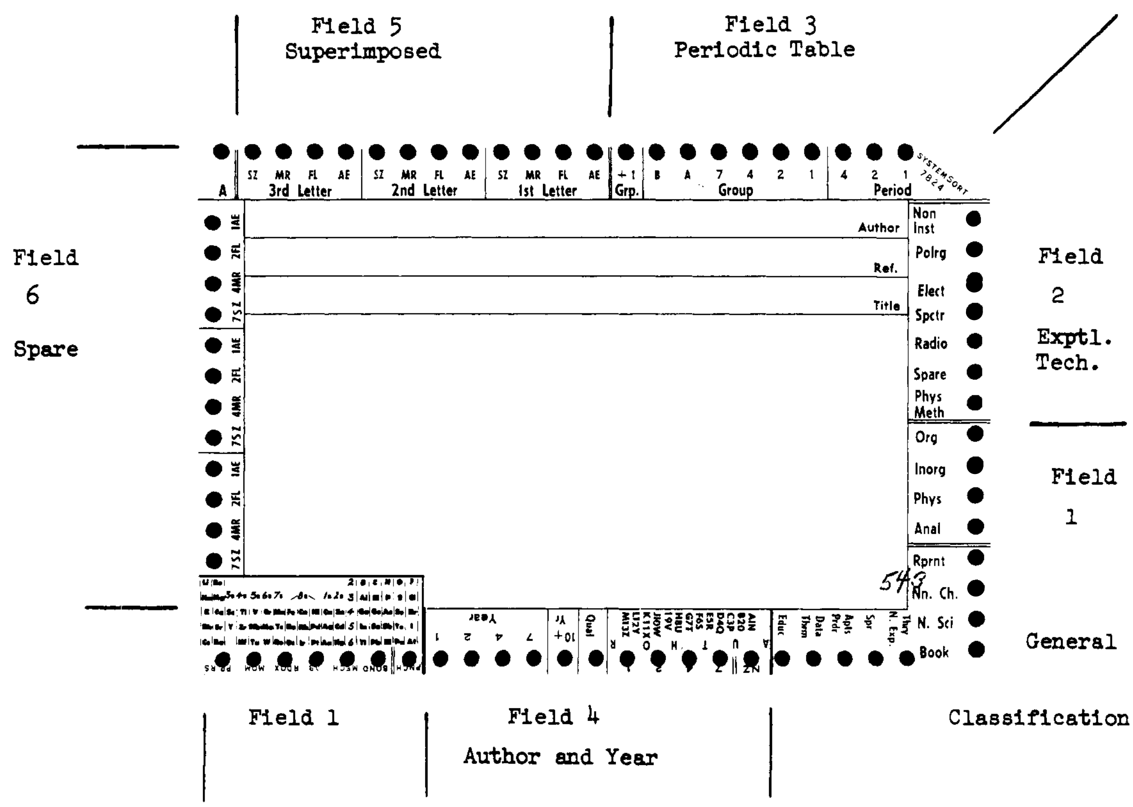

Fig. 1.—Punched card for analytical and inorganic chemistry.

classifying and describing the information on the card in a very broad general way. The second major field, also in direct code, is used to describe broadly the experimental technique. The code designations in these fields have been selected so that they are unlikely to become obsolete with time. In addition, a relatively large number of spare positions have been left to accommodate future unanticipated large areas of chemical activity. In the third major field the periodic table is denoted in combination code. To make reference to a code book unnecessary, an abbreviated version of the periodic table is printed on the card in the opposite corner. The fourth major field is also in combination code and is for denoting the authorship of the paper and the year of its publication. The fifth major field is a superimposed coding field and is used for coding details in connection with any or all of the first three fields. The sixth field is a spare and the printing provided on the card is such that either superimposed or combination coding could be used depending upon the choice of the AE, FL, MR, SZ or the 7, 4, 2, 1 portion of the printing in each minor field. Presumably it could be used also for direct code if particular meaning were assigned to the holes.

TABLE I
BRIEF INDICATION OF MEANINGS ASSIGNED TO DIRECT CODE CLASSIFICATIONS

Code Designation	Meanings Used*
Org	Organic compound significantly involved
Inorg	Inorganic
Phys	Fundamental studies
Anal	Description of specific analysis
Rprnt	Reprint acquired and identified by serial number
Nn. Ch.	Scientific reference with non-chemical aspects
N. Sci	A non scientific reference
Book	Information concerning books or journals
Thry N. Exp.	Theoretical, review
Spr	A spare, for possible future assignment
Apts prdr	New apparatus or reagents, procedures, syntheses
Data Thrm	Fundamental data such as constants, indices, optical densities, heats.
Educ	Of instructional interest
Bond	Involved with nature of chemical bond, stereochemistry, orbitals, etc.
Mech	Kinetics and mechanism of reactions
AB	Studies of formation of new bond
Rdox	Oxidation-reduction reactions
Mdm	Any medium other than aqueous
Per Res	Personal interest items, new research ideas
Non inst	Chemical as opposed to instrumental; gravimetric, volumetric
Polrg	A spare position
Elect	Electrical measurements or technique
Spctr	Emission or absorption of radiant energy involved
Radio	Isotopes used whether radioactive or not
Spare	A spare position
Phys Meth	Experimental methods not otherwise classified

*These are the meanings associated with these positions by the authors but naturally any other meanings could be assigned to these positions by other users.

DIRECT CODE. -- Direct code has the advantage of allowing for the efficient design of a card which does not require the use of a code book but usually suffers from lack of flexibility. It can be shown that an ideally designed card, using only direct code, would require one to select categories which are broad enough so that on the average card about 5 direct code holes would be randomly punched and each punching position would be punched on about 20% of all cards. It is not normally possible to devise sufficient useful direct code with the above-mentioned characteristics to meet all the needs of a small user. Thus while it is highly desirable to use some direct code on a punched card, it is unwise to attempt to use only direct code.

The direct code fields which the authors have found of continuing value are listed in Table I, in which the meaning normally associated with each punching position is indicated briefly. In the authors' files the punching frequency in the directly coded positions varies from the ideal of about 20%, and, for any one position, the frequency varies from year to year.

In the experimental technique field there are two spare holes because the interests of many persons are such that they use a single experimental technique in a large proportion of their work. Consequently a broadly designated position such as electrical might easily have a high punching frequency. One of us, for instance, has a primary interest in polarography and has accordingly wished to subdivide the "Elect" into two direct code positions with one of them being used for polarography and the other for the remainder of the electrical measurements. For this reason the code for this spare was put as "Polrg" but for other persons it may have any meaning or be simply retained as a spare.

COMBINATION CODE. -- Additional searching capacity can be provided for the small user, without a code book, with combination code, provided the concepts can be put into some obvious numerical form. Numerous combination codes have been described.[1,2,3] For the card which has been developed the simple and efficient 7, 4, 2, 1 type of code has been selected to denote the elements of the periodic table, the author and the date.

The periodic table field is used to indicate the principal element referred to on the card. For instance, to indicate iodine, which is in group 7A of the fifth period of the periodic table, punch 7 and A under "group" and 5 (4 and 1) under "period." For chromium punch 4, 2 and B under "group" and 4 under "period." This field allows one to denote unambiguously any element in the periodic table with the exception of those in groups 3B and 8B. Specific elements in subgroups 3B and 8B are denoted when necessary by additional punching in the superimposed coding field. In the periodic table field any single element or group of elements or period of elements can be selected. If the reference is concerned with more than one, only the most important can be denoted. If elements from more than one subgroup are important the "+1 grp" hole is used.

In the author field the first letter of the first author's last name is punched as follows:

A punch 1	N punch NZ and 1
B punch 2	O punch NZ and 2
C punch 3	P punch NZ and 3
D punch 4	Q punch NZ and 4
E punch 5	R punch NZ and 5
F punch 6	S punch NZ and 6
G punch 7	T punch NZ and 7
H punch 8	U punch NZ and 8
I punch 9	V punch NZ and 9
J punch 10	W punch NZ and 10
K punch 11	X punch NZ and 11
L punch 12	Y punch NZ and 12
M punch 13	Z punch NZ and 13
	ANON NZ and 14

The design of the author field, which involves the use of only five holes, was chosen because the author field is of only marginal value in searching. If author searches were of more use then a better design would be a 12 hole superimposed field as described below which would allow the punching of not only the first author of a paper but of others as well. To make it unnecessary to refer to a code book, abbreviated versions of the periodic table and the author code are printed on the card.

In the year field the last digit in the year of publication is punched, e.g., an article published in 1958 would be 7 + 1. In order to distinguish between papers published in the last decade and those which are older the +10 year position is used.

SUPERIMPOSED CODE. -- Superimposed coding has been analyzed mathematically.[3] This type, which is non-specific and open ended, is ideal for the small user in providing coding space for details and allowing for growth and change. In the card described the superimposed coding field is used principally for subdivision of direct code positions which are frequently punched. The value of superimposed code used in this way depends primarily on the correct choice of proper and broad classifications for the direct code. For the individual research scientist no more than 12 holes are needed for this purpose if it is used in the efficient arrangement of three subfields of four holes each. With this arrangement the first three letters of a descriptive word or term is denoted. Thus JOU, for journal, can be denoted by punching FL (for J) under first letter, MR (for O) under second letter and SZ (for U) under third letter. In this way one could, for example, use the superimposed field to subdivide the cards which are punched "org" by ACI (acids), ALC (alcohols and phenols), AMI (amines), KET (ketones and aldehydes), PER (peroxides), HYD (hydrocarbons), POL (polymers) and MER (mercaptans). Similarly "data thrm" has been subdivided by using FRE (free energy), ENT (entropy, enthalpy); "mdm" by using FUS (fused salts), CRY (crystalline solid reactions), ORG (organic solvent); "Elect" by using CON (conductivity), POT (potentiometry), COU (coulometry); "Spctr" by using EMI (emission spectroscopy), FLA (flame photometry), NMR (nuclear magnetic resonance), XRA (X-ray), INF (infrared), ULT or VIS (ultraviolet or visible), PHO (photochemistry); "Radio" by using TRA (tracer), ACT (activation analysis), ISO (isotope effects); "Phys Meth" by using CAL (calorimetry), MAG (magnetic susceptibility), GAS (gas-liquid or gas-solid chromatography), ION (ion exchange chromatography), PAP (paper chromatography).

The subdivisions in the superimposed coding field can be made as general or as specific as desirable. For example, the crude and apparently casual classification used in connection with the ORG position is both adequate and desirable for inorganic and analytical chemists. So long as the total number of entries under a direct code punching position remains small it is not necessary to further classify it by means of the punching in the superimposed code field. Subdivision can be made at a later date by this means should the punching frequently in a particular hole become large enough to reduce the elimination factor undesirably.

GENERAL UPKEEP OF A PUNCHED CARD FILE

PARTIAL PUNCHING. -- It is frequently inconvenient to punch cards at the time an abstract is prepared, and at other times it is convenient to only partially complete the punching. This matter of partial punching is particularly important for a person who is unfamiliar with coding, and he should deliberately withhold completing any but the most obvious punching until experience indicates that more is necessary.

In many cases a reprint is requested and punching cannot be completed until its arrival (see below). With the card described it is unnecessary to maintain a separate file for unpunched or partially punched cards. The position marked "Pnch" is not removed until a card has been completely and satisfactorily punched. Thus, it is possible to keep punched, partially punched and unpunched cards in a single file. The cards which are incompletely coded can then be recovered in a single sort, reviewed, and the punching on them improved at leisure.

LIMITATION OF GROWTH. -- Bibliographic files grow with time, and it becomes increasingly difficult to retrieve stored information from them. The difficulty is compounded by the presence in the files of information which is no longer pertinent as a result of being superseded by more up-to-date information or as a result of the individual's changing interests. The removal of such obsolete items becomes not only desirable but necessary if the file is to be kept to a manageable size. The position marked "Qual" is designed to facilitate the removal of such dated material. This position is punched whenever it becomes apparent that the material abstracted is not of long range interest. Sometimes such a decision is obvious when the abstract is first prepared. At other times, it becomes obvious during a later review of the available information on the particular subject. More frequently it will become obvious during the decade review which is described below, and which is provided for by the "10 + Yr" position.

During the first few weeks of any year one should sort the year field of his file for all cards bearing the same last number as the upcoming year. Thus, all cards which are for references 10, 20, 30, etc., years old, will drop and can be reviewed. All such cards should now be punched in the "10 + Yr" position and if they are obsolete punched in the "Qual" position and stored in an inactive file. Those cards which are still pertinent can be kept in the active file to remain until a subsequent review. In this way, the obsolescence rate and the accumulation rate will eventually be nearly equal and the size of the file will stabilize. This review requires about 2 to 3 hours per year.

REPRINTS AND PUNCHED CARDS. -- Review of the filing systems of a number of chemists indicate that many persons have a reprint collection equivalent to about 5% of the total number of file cards in their system. This number seems to be independent of the size of file cards or whether a punched card is used or not. When a reprint collection grows to a large size it becomes increasingly difficult to file the individual reprints in a way which will ensure their recovery at an appropriate time. This problem can be simplified if each item in the reprint collection is entered on a punched card and the "Rprnt" hole punched. Since searching in the punched card file is mechanized, the most convenient way to search a reprint collection is by way of the punched cards provided the two systems can be related to each other. The two systems can be very simply related by assigning each reprint a serial number[3] which is entered on both the punched card, as in Fig. 2, and the reprint. The reprints then need only be kept in the order of their serial numbers and no decisions about classification need be made. Any reprint relevant to a problem can then be revealed most readily by a search of the punched cards and the reprint recovered by means of its serial number.

PUNCHING. -- Punching and searching operations are not mutually independent and each must be done with some thought of the other. In this connection it is a waste of time to punch concepts into a card when these will not be used at a later time for searching or will be used very little. Punching of this kind fits easily into two categories. The first of these involves redundant punching. An example of this is punching in both of the last two numbers involved in the year merely because one can do so very easily. The authors have found that for searching purposes one needs only the last number of a year and one additional punch position to indicate whether or not a particular card is more

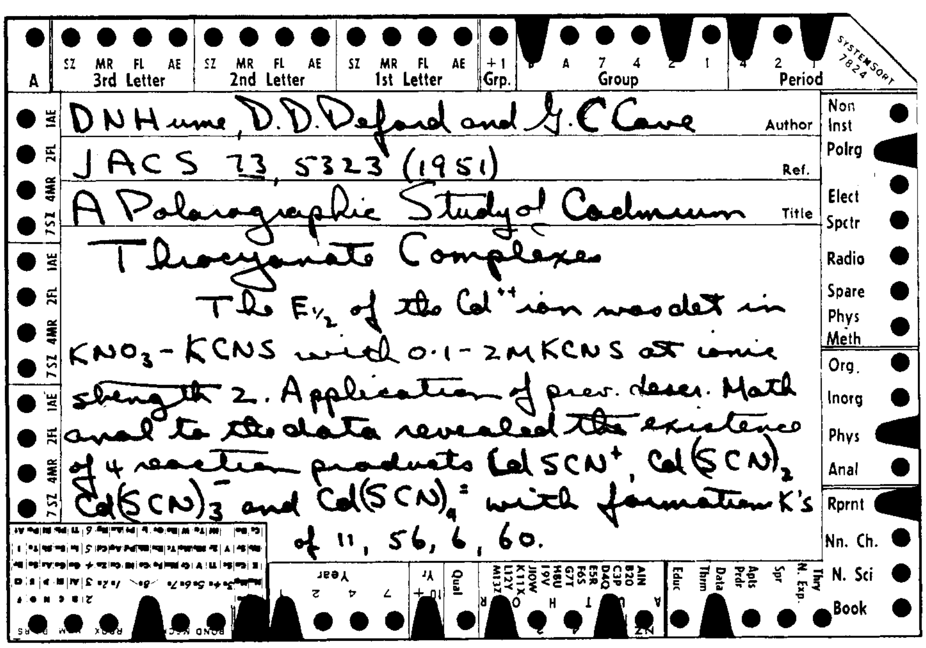

Fig. 2.--Example of a punched card with an abstract and related punching decisions.

than a decade old. The other involves the use of ambiguous punching. This is punching which does not clearly and unquestionably point to the article which is being sought. For instance, a paper which deals with electron transfer reactions in phenanthroline complexes might justifiably be encoded under a specific designation, electron transfer. Retrieval of this reference at a later date might prove difficult unless it was recalled that the mechanism was electron transfer rather than atom transfer. The less specific but more foolproof designation of oxidation-reduction for the reaction is preferable.

When the directly coded portion of a card is punched the punching should be such that the search will fail safe, that is, no attempt should be made to choose only one hole for punching any one field. All holes which can be considered relevant should be punched. With the combination coded fields only the single most important concept, of course, should be chosen and the others normally cannot be coded.

The designs of many cards place double holes in the corners. When this is done and if both holes next to the corner are punched then the corner of the card is so weakened as to be pulled off easily. A properly designed punched card has the holes next to the corner arranged as in Fig. 1. Further, it seems desirable to assign to the corner holes categories which are infrequently punched. The lower right corner in the card described is used for "Book," and the lower left for "Res-Pers." Both of these items are used only sparingly. The remaining position in the upper left corner, denoted A, is a spare.

EXAMPLES OF PUNCHING DECISIONS. -- In Fig. 2 is one reference chosen from our files which shows the abstract, and the punching of the holes.

The following five examples were chosen to further illustrate typical punching decisions which the authors have made in their own bibliographies.

(a) D. Fleischer and H. Freiser, J. Phys. Chem., 63, 260 (1959). "The Calorimetric Determination of Heats of Coordination Reactions". This article dealt with the reaction of 8-hydroxyquinolines with Co(II), Ni(II), Cu(II). The card was punched in the following way: superimposed field as "AMI" to denote a reaction dealing with a nitrogen donor, "Phys" to denote a physical chemical type of study, "Data Thrm," subdivided as ENT for enthalpy of reaction, "Phys Meth," subdivided as "CAL" in the superimposed field to denote calorimetry, "AB" to denote the formation of a chemical bond, 1B under group and 4 under period to denote copper and "+1 grp" since nickel and cobalt were also important, "2" and "4" in the author field to denote F as the initial of the first author "7" and "2" to denote publication in 1959.

(b) F. T. Eggertsen and H. S. Knight, Anal. Chem., 30, 15 (1958). "Gas Chromatography, Effect of Type and Amount of Solvent on the Analysis of Saturated Hydrocarbons". The following were selected for punching in this example: "Org" subdivided "HYD," "Anal," "Phys Meth" subdivided "GAS," "E" under author and "8" under year.

(c) H. A. Laitinen and E. R. Onstott, J. Am. Chem. Soc., 72, 4565 (1950). "Adsorption and Reduction of Tetrachloroplatinate(II) Ion at the Dropping Mercury Electrode." The punching was: "Phys," "Polrg," 8B under group, 6 under period, "L" under author and "O" (7, 2, 1) under year and "10 + Yr."

(d) C. G. Cannon, "Electronics for Spectroscopists," Hilger and Watts, London, 1960. This was punched: "Nn Ch," "Book," "Elect.," "Spctr," "C" under Author and "O" under year.

(e) T. R. Sweet and J. Zehner, Anal. Chem., 30, 1713 (1958). "Circulation Type Apparatus for Spectrophotometric Titrations." This was punched "Anal," "Apts Prdr," "Spctr" subdivided "VIS," "Non Inst," "S" under author and "8" under year. In this example the punching of "Non Inst" represents a marginal decision but was punched because titration was involved and a search for an article of this type by way of this hole will fail safe.

SEARCHING. -- In devising a searching strategy the object must be to eliminate irrelevant cards with the least effort, and as a consequence it must be remembered that asking a broad question will likely produce a large answer. Generally the highest elimination factors resulting from a search of a single hole are obtainable in the direct code fields. Therefore, it is best to start a search by choosing one of the holes in such a field. The second hole chosen for searching should be a single hole in a different direct code field. It is unsafe, however, to exhaustively search one direct coded field since the recall factor will be in danger of being brought below unity. However, after one or two searches in direct coded fields 90% or more of the cards in the file usually will be eliminated and now it is most efficient to proceed to a field which is characterized by a high over-all elimination factor for a search of the entire field. This is true of both the combination and superimposed code types. While these fields have a poor elimination factor per hole searched, a field as a whole has a high elimination factor and it can usually be searched in its entirety without endangering the recall factor.

The search naturally should not be carried on to the point where all irrelevant cards are eliminated since it will be more efficient to examine the cards individually when only a small pack remains.

RETRIEVAL CHARACTERISTICS OF THE FILES OF TWO PRACTICING CHEMISTS. -- The authors' experience is that the accumulation rate has stabilized at about 300 to 400 cards per year. With the provision for obsolescence this means that the total active file should not ever exceed three or four thousand cards for an individual file.

The data presented in Table II illustrate the response of the system described to the items placed in two different files. One of these was the file of an analytical chemist which contained about 2000 cards and the other that of an inorganic chemist which contained about 1400 cards.

TABLE II
CHARACTERISTICS OF THE PUNCHED CARD FILE OF AN ANALYTICAL AND INORGANIC CHEMIST

	Fraction of all cards with punching in this field		Elimination factor	
Field (Fig. 1)	Anal. file	Inorg. file	Anal. file	Inorg. file
General	1.0	0.82	0.83*	0.84*
Experimental	0.90	0.86	0.85*	0.85*
Periodic table	0.50	0.41	0.98**	0.95**
Year	1.0	1.0	0.9**	0.9**
Author	0.96	0.99	0.93**	0.93**
Superimposed	0.45	0.92	0.98**	0.90**

*Average elimination factor per hole for a single hole search.
**Average elimination factor per field for a full field search.

It is apparent that a search initiated in a single direct code hole can be expected to eliminate an average of about 84% of the cards. If the search is continued in a second direct code hole about 84% of the remainder or about 97% of all of the cards in the initial pack are eliminated. If this is followed by a full field search in one of the combination fields or the superimposed field, one can normally expect that 99% of the original cards will be eliminated. It can be seen from Table III that these expectations are realized.

It should be observed that although judicious choice of the first search may expedite retrieval of the desired information, a variety of roughly equivalent routes are available to any one item of information. Thus, the system described is not restrictive in the sense that a particular searching sequence is required. In none of these examples was the author or year used for a search. The principal function of the year field is to enable one to separate recent from old material. The author field is used in a search for the work of a particular person or for a particular publication whose existence is already known.

In Table III are shown the data relating to the recovery of the items chosen as punching examples in a preceding section. This table indicates the ease with which an elimination factor of 0.95 or better is obtained. Two or three searches are all that are necessary to retrieve the desired specific pieces of information. In most cases the elimination factor could have been considered to have been higher than the gross eliminations shown had relevant items which fell together with the desired item been discounted. For instance, two searches of a

TABLE III
EXAMPLES OF RECOVERY OF SPECIFIC INFORMATION

	First search		Second search		Third search	
Item sought	Position searched	Elimination*	Position searched	Gross Elimination*	Position searched	Gross Elimination*
Fig. 2	Polrg.	0.72	Data Thrm	0.997		
Fig. 2	Phys	0.82	Cadmium	0.999		
A**	Phys. Meth	0.93	Data Thrm	0.95		
A**	Org.	0.70	Phys. Meth	0.96		
B	Anal	0.61	Phys. Meth	0.95	GAS	0.96
B	Phys. Meth	0.83	Org	0.97	Anal	0.98
C	Polrg	0.72	Platinum	1.00		
D	Nn. Ch.	0.93	Elect	0.99	Spctr	1.00
D	Elect	0.83	Book	0.95	Spctr	1.00
E	Apts Prdr	0.90	Spctr	0.99		
E	Spctr	0.90	Anal.	0.95	Apts Prdr	0.99

*The numbers reported can be considered to be equal to the elimination factor if all items other than the one sought are considered to be non-pertinent.
**The search was carried out in a portion of the inorganic file for this item. The remainder of the examples were searched for in the analytical file.

pack of 600 cards according to the first strategy suggested for item A reduced them to 27 cards. Of these cards 13 had high relevance, 10 low relevance and only 4 were irrelevant. Thus the elimination factor is at least 0.98. In this example, search in the superimposed field for "ENT" eliminated all of the completely irrelevant cards and only 2 of the cards of low relevance. An alternative additional search of the periodic table field for copper eliminated all items except A and one other which dealt with the thermochemistry of anthranilates. If the particular study designated in A was being sought then the search for copper is obviously the one of choice. However, in a general search this would be unnecessarily restrictive and the superimposed search would be preferable. These alternatives illustrate the use of the system to yield either specific or general information.

If one particular piece of information is sought, then so long as it is in the file and is recovered the recall factor is unity. In a more general search the recall and elimination factors are somewhat interdependent and the search should be stopped before the recall factor is significantly impaired.

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(3) R. S. Casey, J. W. Perry, M. M. Berry and A. Kent, "Punched Cards, Their Applications to Science and Industry," Second Edition, Reinhold Publishing Corp., New York, N. Y., 1958.

(4) M. Passer, J. Chem. Ed., 33, 581 (1956).

(5) Obtainable from Systems Equipment, Ltd., Winnipeg 13, Manitoba, Canada: No. 7824, $13.39 per 1000 cards at the 5000 card level.

BOOK REVIEW

Physical Properties of Chemical Compounds-III, Advances in Chemistry Series, No. 29, American Chemical Society, Washington, D. C., 1961, 489 + v pp., $6.50.

This book is the third volume of the series under the title "Physical Properties of Chemical Compounds," the other two having appeared as Nos. 15 and 22. No. 29 is concerned with the physical properties of 434 aliphatic compounds, e.g., halo-, amino-, cyano-, thiaalkanes, and aliphatic acids, and 22 miscellaneous compounds and elements.

The series has been prepared by R. R. Dreisbach of the Dow Chemical Company. Mr. Dreisbach was largely responsible for the formation of the Manufacturing Chemists' Project on the Properties of Chemical Compounds, which, with the American Petroleum Institute's Project on Properties of Hydrocarbons, will constitute the most important and reliable source for data on physical properties. In the meantime, the three volumes in this series bridge the data gap for the 1421 compounds now included. This third volume contains a combined index to the tables in all three volumes.

Chemists concerned with the literature welcome the publication of this series. As important as the tabulating of the best literature values are on physical properties, the major contribution of these volumes is the parameters which Mr. Dreisbach provides for the interpretation and extrapolation of data in any given homologous series.