

ASLIB
CRANFIELD RESEARCH
PROJECT

A REPORT ON A TEST OF THE INDEX OF
METALLURGICAL LITERATURE OF
WESTERN RESERVE UNIVERSITY

by
Jean Aitchison and Cyril Cleverdon

An investigation supported by a grant to ASLIB
by the National Science Foundation

ASLIB CRANFIELD RESEARCH PROJECT

A REPORT ON A TEST OF THE INDEX OF
METALLURGICAL LITERATURE OF
WESTERN RESERVE UNIVERSITY

- by -

Jean Aitchison and Cyril Cleverdon

An investigation supported by a grant to
ASLIB by the National Science Foundation

The College of Aeronautics
Cranfield

October 1963

PREFACE

For many years the index to metallurgical literature at the Center for Documentation at Western Reserve University has been recognised as one of the most advanced indexing systems in use. It has been developed over many years with the assistance of grants from the American Society of Metals, and was put on an operational basis in 1960, when it was made available to members of the Society by subscription.

At Cranfield, a by-product of the test on the efficiency of indexing systems had been the development of a method for testing existing systems. The opportunity of trying-out this method on the W.R.U. index was greatly appreciated by the Cranfield group; that it was an experiment in the use of the technique, equally as much as a test of the W.R.U. index, was accepted by both groups from the start. However, as the work developed, it became clear that the test was also becoming a research investigation in its own right, and that it was making significant additions to our knowledge of the operation of indexing systems. The following report covers all three stages of this work.

ACKNOWLEDGMENTS

Primarily we would wish to acknowledge the co-operation we have received from the staff of the Center for Documentation at Western Reserve University. In particular we would mention Mr. Alan Rees, who was mainly responsible for the organisation of the test in Cleveland, and whose keen interest in the work was reflected in the useful suggestions which he made on many occasions.

In addition, we have had the assistance of other members of the Aslib-Cranfield group, and in particular Mr. Michael Keen, who has been responsible for carrying out a number of the supplementary tests.

Finally, we most gratefully acknowledge our debt to the National Science Foundation, whose financial assistance made the work possible, and, as always, to Mrs. Helen Brownson for the considerable help which she has given throughout the test.

CONTENTS

	<u>Page</u>
List of definitions	x
Chapter 1 Introduction	1
Chapter 2 Test Procedure	2
Chapter 3 Test Results	3
Chapter 4 Analysis of Search Failures	19
Chapter 5 Discussion of Results	43
Chapter 6 Test of Patent Searches	57
Chapter 7 Conclusions	60
References	63
Appendix 1A The Western Reserve University Index Language for Metallurgy	64
Appendix 1B Excerpt from W. R. U. Code - English Dictionary	70
Appendix 1C The English Electric Faceted Classification for Engineering	71
Appendix 1D Excerpt from English Electric Facet Schedules	83
Appendix 2A List of Questions	84
Appendix 2B List of Source Documents for Final Group of 114 Questions	92
Appendix 2C Questions Searched by W. R. U. and Cranfield	98
Appendix 3A Original Record of the Results of 125 Searches Made by W. R. U.	99
Appendix 3B Searches Retrieving Large Number of Documents	102
Appendix 3C Relevance Assessments of Documents, Showing Recall by W. R. U. and Cranfield.	103
Appendix 3D Number of Documents Retrieved in 114 Searches by W. R. U. and Cranfield.	107
Appendix 3E Recall Results for W. R. U. Failures using Cranfield Search Programmes with W. R. U. Concept Indexing.	110
Appendix 4A Analysis of Failures by W. R. U. to Recall Relevant Documents.	112
Appendix 4B Analysis of Reasons for Retrieval of Non-relevant Documents by W. R. U.	147
Appendix 4C Analysis of Failures by Cranfield to Recall Relevant Document.	222
Appendix 5A Comments on Test Procedure	270

LIST OF TABLES AND FIGURES

	<u>Page</u>
TABLE 2.1 Comparison of search programmes: matching of concepts in search programmes and questions	10
2.2 Comparison of search programmes.	11
3.1 Recall of source documents for 114 common searches	12
3.2 Average number of documents retrieved in searching	13
3.3 Recall and Relevance Ratios for Relevance 2 documents	14
3.4 Recall and Relevance Ratios for Relevance 2 & 3 documents	15
3.5 Recall and Relevance for Relevance 2 documents eliminating searches retrieving excessive number of references.	15
3.6 Recall and Relevance for Relevance 2 & 3 documents eliminating searches retrieving excessive number of references.	15
3.7 Recall and Relevance ratio in Cranfield index at varying levels of exhaustivity.	16
3.8 Performance of Cranfield index at varying levels of exhaustivity	17
4.1 Summary of reasons for failure by W. R. U. to recall relevant documents	20
4.2 Analysis of W. R. U. failures with allowance for joint reasons for failure.	20
4.3 Selection of sample of non-relevant documents	24
4.4 Frequency of occurrence of types of non-relevance	26
4.5 Summary of reasons for retrieval of non-relevant documents by W. R. U.	26
4.6 Summary of reasons for retrieval of non-relevant documents by W. R. U., with allowance for joint causes	27
4.7 Effectiveness of roll indicators, levels and interfixing	29
4.8 Effectiveness of levels and interfixing in relation to roles	29
4.9 Effectiveness of role indicators and interfixing in relation to levels	29
4.10 Effectiveness of role indicators and levels in relation to interfixing	30
4.11 False Drops: Types 1 and 2. Effectiveness of role indicators, levels and interfixing	30
4.12 Summary of reasons for failure by Cranfield to recall relevant documents	34
4.13 Analysis of Cranfield failures with allowance for joint reasons for failure.	35
4.14 Reasons for non-recall by Cranfield of non-relevant documents	39
6.1 Results of patent searches	57
6.2 Breakdown of patents assessed for relevance	58
6.3 Performance figure for patent searches	58

		<u>Page</u>
Fig. 1	W.R.U. Indexing Sheet	3
Fig. 2	Facet Master Indexing Card	5
Fig. 3	W.R.U. Search Programme	6
Fig. 4	Facet Search Programme	8
Fig. 5	Variation of performance with indexing devices	50
Fig. 6	Effect of adding various devices to basic index language	52

DEFINITIONS

An information retrieval system is the complete organisation for obtaining, storing and making available information. This could be a definition of a conventional library, but an I.R. system would be expected to exploit the information in a positive manner and to have extra facilities such as, for instance, persons on the staff capable of evaluating information before it is passed to the enquirer. It would also be expected to have a subject index to the items in the store, the index being the physical equipment which permits of the retrieval of references in the searches. The index may be in the form of a card catalogue, a printed list, a set of peek-a-boo cards, a computer, or any other convenient equipment. The arrangement within the index will depend upon the index language and this may be a straightforward alphabetical arrangement of terms, or a classified arrangement of terms, or any variation of these methods. The index language may be used in a pre-co-ordinate or post-co-ordinate manner. The former implies that the co-ordination of separate concepts is done at the time of indexing and the entries in the subject index will show this co-ordination. The latter implies that the co-ordination of concepts is done at the time of searching, so the entries in the subject index will refer only to single elements.

The lead-in vocabulary of the index language is the complete collection of sought terms in the natural language, including all necessary synonyms, that are used in the set of documents and are therefore required for entry points to the index language. An index term, on the other hand, is an actual term or heading used in the index language, and may be a word or words, as with alphabetical subject indexes, uniterm indexes or zatocoding, or may be notational elements, such as a group of numbers in U.D.C., or may be non-meaningful groups of letters, as in the W.R.U. Metallurgical Index.

Concept indexing is the intellectual process of deciding which are the concepts in a particular document that are of sufficient importance to be included in the subject index. Conventionally, this involves a "Yes" or "No" assessment, for a concept either is, or is not, considered worthy of inclusion in the subject index. It is possible for the indexer to indicate the relative importance of different concepts in a document by weighted indexing, which involves the assignment to each concept of a weighting number.

Conventionally one speaks about indexing in "depth", or the use of "broad" search programmes. These terms can be used in either of two senses, and it has

been found necessary to state precisely which sense is meant. For this reason, we use the terms exhaustivity and specificity.

Exhaustivity in relation to input is a comparative term which refers only to the decisions of concept indexing; at a high level it implies that an entry is made for every possible concept in a document. At a low level it implies that a selection has been made and a smaller number of concepts has been used. Specificity is also a comparative term. A concept can be translated into an indexing language in such a way that the index term is co-extensive with a concept. This is a high level of specificity and implies that the index terms cover the concept but nothing else besides the concept. Alternatively, the translation can be to a less specific (often called "broader") index term which includes the concept being indexed as well as other concepts.

These terms have proved difficult to understand, and an example, is given. Assume a document entitled 'Seam welding of tubes of aluminium alloy X-769 for mountings for aircraft engines'. This document clearly deals with the five concepts underlined. If it was decided that the concept 'aircraft engines' was not sufficiently important to include in the concept indexing, then the indexing would be at a lower level of exhaustivity than if it had been included.

Specificity operates quite separately of this. A high level of specificity would require that each of the concepts should be translated into the index language at a matching level. To use "welding" for 'seam welding' would be to use a less specific term; to use 'joining processes' would be still less specific.

The complete search programme is the formalisation of the search request, and is made up (normally) of a number of separate programmes and thereby contains all the concepts used in the search. In the present test, the separate programmes of W. R. U. were combined in the complete search programme, and this was searched in one operation with the computer. In the Cranfield card index, each separate programme was used on its own, in sequence, and in such cases, the complete search programme may only become apparent at the completion of the separate programmes.

As with indexing, search programmes can vary in their levels of exhaustivity and specificity.

The exhaustivity of a complete search refers to the decision as to which concepts in the question will be used for searching; the more of the concepts that are used, the higher the level of exhaustivity. Exhaustivity of a separate search programme, refers to the number of concepts which are required to be co-ordinated in a single search. A complete search programme of high level of exhaustivity can be made up of a number of separate search programmes of a low level of exhaustivity. For instance, assume a question with concepts A, B, C and D; four separate search programmes, consisting first of 'A', then of 'B', then of 'C' and then of 'D', will all be at the lowest possible level of exhaustivity, but the complete search programme will be at the highest possible level of exhaustivity. Specificity in searching has exactly the same connotation as in indexing, and the example given earlier is equally applicable. That is to say, if the question asks for 'seam welding', and in the search programme the more generic term of 'welding' is used, then the search would be less specific.

Syntactic indexing implies the use of headings which display the relationship between the various elements, as distinct from those which merely show the existence of several attributes relevant to the subject indexed.

The operating efficiency of an index language will depend upon its performance as regards recall and relevance. Recall ratio equals $\frac{100R}{C}$, where C equals the total number of documents in the collection which have an agreed standard of relevance to a given question, while R equals the number of those relevant documents retrieved in a single search. On the other hand, relevance ratio equals $\frac{100R}{L}$, where L equals the total number of documents retrieved in a single search. Operating efficiency is affected by the exhaustivity and specificity of the indexing, as well as the search programme, and by varying any of these factors, one will obtain a performance curve which plots recall ratio against relevance ratio. Economic efficiency deals with the performance of the complete index.

A set of documents is any collection of documents which is, or will be, used as the basis of a single subject index. The set can be large or small, restricted to an organisation's research papers, or be a heterogeneous collection of journal articles, research reports, patents, etc., in many different languages, but homogeneous in that they will be used as the raw material of a single index. A set of questions is a collection of questions to be put to a single subject index, either at present, or at any time in the future when the index is still intended to be operating.

CHAPTER 1

INTRODUCTION

In February 1961, The Aslib-Cranfield group was invited by the National Science Foundation to undertake a test of the Western Reserve University Index of Metallurgical literature. The opportunity was taken of a visit to the United States for the project director to discuss the organisation of the test with Professor Allen Kent and the staff of the Center for Documentation and Communication Research at W.R.U., and the arrangements for the test were subsequently agreed by correspondence. Under the arrangement, it was decided that the Aslib-Cranfield group would be solely responsible for the operation of the test and for the publication of the results. The objective of the test would be the evaluation of the operating efficiency of the index, this involving evaluation of the code or index language*, and of the intellectual processes of indexing and search programming. It was not part of the programme to carry out any tests on the economic efficiency of the complete system, although any incidental figures obtained on indexing and retrieval times and costs would be recorded.

It was later decided that, to give comparative figures for the performance of a conventional catalogue, the documents being used in the test should be indexed at Cranfield, using the 'Facet Classification for Engineering' which had been prepared by the first author while librarian at English Electric Co. Ltd., at Whetstone. Notes on the salient features of the two index languages are given in Appendices 1A, 1B, 1C and 1D.

* Definitions of this and other terms so marked are included in the List of Definitions on page xi

CHAPTER 2

TEST PROCEDURE

The items to be indexed were mainly periodical articles from metallurgical journals, received and abstracted by W.R.U., which were published between December 1960 and April 1961. In addition, there were a few research reports and approximately 100 patents, making a total of some 1300 references. In February 1961, W.R.U. were awaiting delivery of a G.E. 225 computer, and it was proposed to use this computer in the test. Originally we had suggested that the test should be made on the whole of the collection of metallurgical documents indexed by W.R.U., but this would have involved excessive search times. The decision was therefore taken to restrict the size of the collection and prepare a special tape for search purposes.

It was the responsibility of the Aslib-Cranfield group to obtain the search questions, and to do this we had the assistance of a number of metallurgists. 137 questions were obtained from eleven individuals in ten different organisations. To each individual were sent about 200 references to documents in the collection that fell within his particular subject field. From these he selected a dozen or so, consulted the actual papers, and framed questions of such a nature that at least one paper would have been of reasonably high relevance; this is to say that there would always be at least one paper which would have provided a satisfactory answer to each question. In subsequent discussion, such a paper will be called the "source document". Discussion on the validity of tests based on such questions is given in Chapter 5. The complete set of questions is given in Appendix 2A while the list of source documents is given in Appendix 2B.

Indexing

The indexing at W.R.U. is done by a number of part-time abstractors who have technical subject knowledge. After preparing a conventional abstract of the paper, the abstractor prepares a telegraphic abstract as in the example shown in Figure 1.

The role indicators and the punctuation signs are given in the left hand column of the abstract sheet, and the corresponding terms in the right hand column. The work is checked by the W.R.U. staff, the terms are translated into the code mechanically and finally the whole abstract, with all its characters and phrases, is converted into the language of the computer. The indexing in the telegraphic abstract is very detailed. From examining a random group of 100 abstracts, it was found that the average number of terms in the right hand column was 30, and,

209 34

Page 34

Col. 6-8	Role Indicator (Col. 28-80)	Col. 6-8	Description (Col. 9-27)	Col. 6-8	Role Indicator (Col. 28-80)	Col. 6-8	Description (Col. 9-27)
51		52	GLIDE	1	• K _{UJ} K _{UJ}	2	SINGLE CRYSTAL
53		54	STRAIN	3		4	DEFORMATION SHEET
55	• K _{UJ} K _{UJ} K _{UJ}	56	ELONGATION	5	• K _{UJ}	6	AL
57	• K _{UJ}	58	MATRIX	7	• K _{UJ}	8	AC (20X)
59		60	LATTICE	9	• K _{UJ}	10	SIGMA PHASE
61		62	POINT	11	• K _{UJ}	12	AGING
63	• K _{UJ} K _{UJ} K _{UJ}	64	HOMOGENEOUS	13	• K _{UJ}	14	HIGH
65		66	SLIP	15		16	TEMPERATURE (20°C)
67	• K _{UJ}	68	COMPOSITION	17	• K _{UJ}	18	TIME
69	• K _{UJ} K _{UJ} K _{UJ}	70	DISLOCATION	19	• K _{UJ}	20	DEFORMATION
71		72	Movement	21		22	TENSILE
73		74		23	• K _{UJ}	24	X-RAY
75	10205 M 10/7	76		25		26	MEASUREMENT
77		78		27	• K _{UJ} K _{UJ}	28	SINGLE CRYSTAL
79		80		29		30	SCATTERING ANGLE
81		82		31		32	SCATTERING SCATTERING
83		84		33	• K _{UJ} K _{UJ} K _{UJ}	34	GUINIER-PRISTON ZONE
85		86		35		36	FORMATION
87		88		37	• K _{UJ}	38	DEFORMATION
89		90		39	• K _{UJ} K _{UJ} K _{UJ}	40	ORIENTATION
91		92		41	• K _{UJ} K _{UJ} K _{UJ}	42	SYMMETRY
93		94		43	• K _{UJ} K _{UJ} K _{UJ}	44	PURITY
95		96		45	• K _{UJ} K _{UJ} K _{UJ}	46	ANISOTROPY
97		98		47	• K _{UJ} K _{UJ} K _{UJ}	48	CLUSTERING
99		100		49	• K _{UJ}	50	

Abstracter Gloria McKenney

03603

FIG. 1 Western Reserve University Indexing Sheet

if the role indicators were counted as separate terms, the average number of terms per abstract would be doubled. No information has been given for the average time taken in making one abstract, although the W.R.U. have announced elsewhere that the cost of the production of one abstract as \$6.50.

All the Facet indexing was done by the first author. As can be seen from Figure 2, the indexing was done in two stages. First, the documents were analysed for subject content, and those concepts considered to be significant were listed. Second, the concepts were translated into the index language and the relationship between the terms shown by co-ordination. It was later realised that, if the relationship between the terms had been indicated at the concept indexing stage, the translation into the indexing language and the co-ordination of elements could have been a completely clerical operation. The average number of concepts for each document was 7, with an average of $12\frac{1}{2}$ entries in the catalogue. Because the results of the main Aslib-Cranfield project had shown it to be relatively ineffective, chain indexing was not used, and the elements were combined to show the relationships which appeared to the indexer to be potentially useful. (see Appendix IC for further discussion of methods of co-ordination used). It was wished to simulate as closely as possible the conditions which exist in searching with a computer, and for this reason the information on each catalogue card was restricted to the notation and the document reference number. That is to say, the cards did not have the conventional author, title, abstract or source reference. As a result when making a search, there was no chance of the searcher obtaining incidental information which might have successfully influenced the search programme. The average indexing time with the Cranfield indexing was 9 minutes, this being equally divided between the first stage of concept indexing and the second stage of translation into class numbers and combination of elements.

Searching

The questions, as received from the compilers, were sent to W.R.U., who prepared search programmes*. These were run on the computer and the output, in the form of abstract sheets of all the documents retrieved, was sent to Cranfield for checking. If the source document had been retrieved, the search was considered a success. W.R.U. were advised of the result of each search, and, if it had been unsuccessful, they were at liberty to re-programme the question, and make a further search. 24 such second searches were made.

The W.R.U. search programme (see Figure 3) has three features, namely coded terms, which are self-explanatory, the logical relationships, and the syntactical levels required by the question. The logical relationships may be either

1161/205M	Indexer	System	Date	TIME TAKEN		
				Concepts	Class No.	Total
	JA	EE Facet	6/1/61	4 mins.	4 mins.	8 mins.
DOCUMENT				CONCEPT INDEXING		
<p>Acta Metallurgica, Vol. 9, January 1961, pp 59-61.</p> <p>X ray small angle scattering from Guinier-Preston zones in deformed aluminium silver.</p>				<p>ALUMINIUM - SILVER SINGLE CRYSTALS</p> <p>GUINIER - PRESTON ZONES</p> <p>QUENCHED, AGED</p> <p>DEFORMATION, DISLOCATION</p> <p>SLIP,</p> <p>TWINNING</p> <p>X-RAY EXAMINATION</p>		

Class Number Elements				Permutation	
1.	Nalag	Aluminium Silver alloy		1:2:3	5:1:7
2	Oc	crystals, single crystals		1:2:4	6:1:7
3	Oeb	Crystal deformation		1:3	7:1:3
4	Oee	" dislocation		1:4	7:3:1
5	Oef	Slip		1:5	
6	Oej	Twinning		1:6	
7	Xulmh	X ray metallography		1:7	
				2:1:4	
				3:1:7	
				4:1:7	

FIG. 2 Facet Master Indexing Card

Question No. 3	System W. R. U.	
How does the mechanism of oxide film breakdown on zirconium differ from that on zircaloy 2 ?		
<p style="text-align: center;"><u>Encoded Programme</u></p> <p>$Q_3 \neq \emptyset 1 + + + 6\% 4\% 2\% C - PR. 10\emptyset 8 * QO -- \emptyset 2 *$</p> <p>$\% 2\% C - CR * S - HT * 2002 \emptyset 2 \emptyset S - HT. 1\emptyset \emptyset 4 \emptyset 4 \emptyset$</p> <p>$Q_3 \neq \emptyset 2 + + + 4\% HUP * M - PR. 11\emptyset 6 \emptyset 4 \emptyset 16$</p>		
Logical Statement		Code Elements
$^6 [^4 [^2 [A] ^2 \cdot [^2 [B] ^2 + C] ^4 \cdot [D \cdot E] ^4] ^6$		<p>A = C - PR.1008. QO -- . = Oxide</p> <p>B = C - CR. S-HT. 2002 = Film</p> <p>C = S-HT = Layer</p> <p>D = KUP = Property determined</p> <p>E = M-PR.1106 = Thickness</p>

FIG. 3 Western Reserve University Search Programme

logical sum (+) meaning A or B; or logical product (.), meaning A and B; or logical difference (-) A but not B. The syntactical levels are shown in the search programme by indices above the square brackets. (see Appendix 1A for more detailed discussion of the W.R.U. system).

It is understood that the average time to prepare complete search programme for each question was four hours. The first searches at W.R.U. were made in September 1961 and the searching was discontinued in March 1962.

An example of the Facet search programme is given in Figure 4. On the surface, it appears that Cranfield had more search programmes for a question than did W.R.U., but this is because, in manual searching, it is easier to split the one 'logical statement', as it would be programmed for a machine, into a series of shorter, separate searches. Unlike W.R.U., the Cranfield programmes were limited in the level of exhaustivity. For example, if the search originally asked for the terms A and B and C, a subsequent programme could demand A and B, B and C or A and C, but not A or B alone. The searchers, simulating the conditions in the W.R.U. test, did not know which were the relevant documents, so that the search continued until all reasonable programmes had been tried.

An interesting test was made for one batch of questions, when the Project Director prepared the concept programmes for fifteen questions. This is to say that the search terms in natural language were entered on the search master card, as well as the combinations of terms to be searched and the order of the searches. These cards were then passed to a junior clerical worker who had recently joined the library staff. She coded the terms, and made the searches in the card catalogue. Of the fifteen searches, fourteen were, in fact, successful, and the only failure by the clerical assistant was where subsequent checking showed that a card had been incorrectly filed in the catalogue. The time taken for preparing the concept programmes was 47 minutes and the time for the untrained clerical worker to do the coding, carry out the searches and record the results was 105 minutes, an average of 10 minutes. For all other searches, for which all stages were carried out by the first author, the average time was 7.3 minutes for a complete search.

Of the 137 questions available, only 125 were searched by W.R.U., and it was later found that in six of these searches, the source document was not included on the special tape searched by W.R.U. At Cranfield a total of 129 searches was made; the remainder could not be done because it had not been possible to obtain the source document for indexing. Appendix 2C gives details of the searches made

Question No.	System	Searcher	Time	Date	Result	
3	EE Facet	JA		29.3.62.	1676 (source) 1st search.	
How does the mechanism of oxide film breakdown on zirconium differ from that on zircaloy 2 ?						
1st search	2nd search	3rd search	4th search	5th search	6th search	
Oxide films. Om Mehn (A) Zirconium. Nzr (B) A B 1676 B. A 1691	Zircaloy N.d [Zircaloy] 1396 1264 1461 1698 1108	Zirconium Nzr (A) oxidation. Om (B) A B. 1825 1695 1344	Zirconium Alloy Nzr. d (A) Oxidation Om (B) A. B 1676 B. A 1676			

FIG. 4 Facet Search Programme

by both groups; there were 114 such searches, and the detailed test results are based on these common searches. Later checking of the W.R.U. tape and the indexing at Cranfield showed that a total of 950 documents had been indexed by both groups, and again it is only this set of documents which has been considered in the analysis.

An analysis was made of 90 of the 114 search programmes used by the two groups to compare the degree of matching between concepts in the complete search programme and the questions, the number of programmes contained in the complete programmes, and the level of exhaustivity¹¹ (or co-ordination, i.e. the number of concepts required to occur together in a single programme). The remaining 24 complete programmes could not be analysed, as sufficient information on the exact translation of the code had not been received for these programmes from W.R.U. The details of this analysis are given in Tables 2.1 and 2.2. It should be noted that in both tables role indicators are excluded from the analysis.

In Table 2.1, in regard to the item for concepts in the search programme more specific than the concepts in the question, the figure for W.R.U. is higher than for Cranfield, since in the latter case a containing head such as 'heat treatment' can be stated in the programme as Vm +. This will cover all specific types of heat treatment, whereas in the W.R.U. system there is not one generic term which may be used for this purpose, and the species have to be listed individually.

The Cranfield programmes are shown to be more closely matched with the question than W.R.U. programmes (69% Cranfield, 47% W.R.U.). For a single computer search, W.R.U. were making an average of 4.7 separate programmes, a slightly lower number than were made by Cranfield. The average number of concepts in a complete search programme was 4.2 for W.R.U. and 4.4 for Cranfield; in the separate programmes, 2.3 for W.R.U. and 2.1 for Cranfield. In regard to level of concept exhaustivity, W.R.U. had 144 single programmes in which four or more concepts were co-ordinated as compared with 79 for Cranfield, and 280 programmes in which three or less concepts were co-ordinated, as compared with 372 for Cranfield. Therefore one can say that overall W.R.U. had a slightly higher level of exhaustivity of single programmes.

	<u>W. R. U.</u>	<u>Cranfield</u>
Concepts in 90 questions	359	359
Individual concepts in 90 search programmes	379	403
Average concepts per search programme	4.2	4.4
Concepts in questions matching concepts in search programmes	170(47.4%)	249(69.4%)
Concepts in question but not in search programmes	189(52.6%)	110(30.6%)
Omitted entirely	148(41.2%)	83(23.1%)
Replaced by more generic/ specific concepts	41(11.4%)	27(7.5%)
More generic	34(9.5%)	17(4.8%)
More specific	7(1.9%)	10(2.7%)
Concepts in search programme but not in question	209	154
Concepts more generic than concepts in the question	79	68
Replacing concepts in the question	34	17
Additional	45	51
Concepts more specific than concepts in question	76	49
Replacing concepts in the question	7	10
Additional	69	39
Concepts not in the question but implied (other than those which are more generic or more specific)	54	37

TABLE 2.1 Comparison of search programmes: matching of concepts in search programmes and questions

	<u>W. R. U.</u>	<u>Cranfield</u>
Total number of separate programmes within the complete programmes	424	451
Average number of separate programmes per question	4.7	5
Concepts occurring in the separate programmes (some concepts occurring more than once per complete programme)	958	953
Average concepts per separate programme	2.3	2.1
Level of co-ordination (exhaustivity) of concepts within the programmes:		
No. of programmes with 2 concepts co-ordinated	41	33
No. of programmes with 3 concepts co-ordinated	239	339
No. of programmes with 4 concepts co-ordinated	139	74
No. of programmes with 6 concepts co-ordinated	1	0

TABLE 2.2 Comparison of search programmes

CHAPTER 3

TEST RESULTS

Provisional figures for the original test results were given in a paper presented at Cleveland in April 1962 (Ref. 1); these were later corrected to allow for cases where, as explained in the previous section, the source documents were not on the tape used for searching by W.R.U. The provisional figures for the recall of source documents showed that, in 119 searches, W.R.U. retrieved the source document on 96 occasions, a success rate of 80.7%. Cranfield, in 129 searches, retrieved the source document on 116 occasions, a success rate of 89.9%.

As stated earlier, it was found that 114 questions had been searched by both groups, and all further results and analysis considered in this report (with the exception of Table 3.7 and its argument) will deal with this set of 114 questions. Table 3.1, shows the basic figures for retrieval of source documents.

	Source documents		Success rate
	Retrieved	Not retrieved	
W.R.U.	94	20	82.4%
Cranfield	103	11	90.3%

TABLE 3.1 Recall of source documents for 114 common searches

An immediately striking feature of the tests was the marked disparity between the number of documents retrieved by each system, 1703 by W.R.U. and 821 by Cranfield. The average for each Cranfield search was 7.2 documents, as compared with 14.9 for W.R.U. On analysing the figures for W.R.U., it was found that 61% of the documents were recalled by 18 searches which retrieved more than 25 documents, that 46% of the documents were recalled by 10 searches retrieving more than 50 documents, and 21% of the documents by the 3 searches each retrieving over 100 documents. (See Appendix 3B). In contrast, Cranfield had only 7 searches recalling more than 25 documents (accounting for 31% of the total documents retrieved), a single search recalling more than 50 documents and no searches retrieving more than 100 documents. In Table 3.2 figures are given for the average numbers of documents retrieved, discounting questions retrieving more than 25, 50 and 100 documents, and it will be seen that in the remaining questions, there is much less discrepancy between W.R.U. and Cranfield for average number of documents retrieved.

Average Number Retrieved

	Number of Searches	Total Documents Retrieved	Average Number
W.R.U.	114	1703	14.9
Facet	114	821	7.2

Average Number Retrieved - Less Searches Retrieving more than 100

W.R.U.	111	1330	11
Facet	114	821	7.2

Average Number Retrieved - Less Searches Retrieving more than 50

W.R.U.	104	917	8.8
Facet	113	746	6.6

Average Number Retrieved - Less Searches of more than 25

W.R.U.	96	658	6.7
Facet	107	560	5.2

TABLE No. 3.2 Average number of documents retrieved in searching

The main Cranfield test had shown that recall^{*} figures could not be considered in isolation, but had to be related to the relevance^{*} figures. An attempt to obtain this latter figure in the first Aslib-Cranfield project had been made (see Ref. 2, Chapter 6), but due to the emphasis which had been placed on obtaining figures for recall, it proved impossible to obtain reliable figures for the relevance ratio. From the commencement of this particular test, it had been the intention to find this figure. When the searches had been made, a sample of the recalled non-source documents was taken, and the documents sent to the appropriate compilers of the questions. They were then asked to assess them in relation to the question, using the following values:

1. More useful than the source document
2. As useful as the source document
3. Of some relevance
4. No relevance
5. False drop

In practice, the question compilers found difficulty in differentiating between 4, "No relevance" and 5, "False drops", so these two groups were combined. As few documents were rated at 1, this was joined with 2, leaving categories 2, 3 and 4.

295 non-source documents were so analysed by the question compilers, and the details are given in Appendix 3A. From this it will be seen that 13 documents were assessed at Relevance 2, 47 at Relevance 3 and 239 as non-relevant. If an extrapolation is made of these figures to the total of 1703 documents retrieved, the breakdown of the documents would be approximately as follows:

Source documents	94
Relevance 2	70
Relevance 3	251
Non-relevant	1288

The recall figures given in Table 3.1 are based only on the recall of source documents, and it was considered desirable to ascertain whether, with source documents, there was any particular bias which would make the recall figure unrepresentative. To find this out, it was necessary to match every document in the collection against each question, a major task which involved over 100,000 individual assessments, and it was only made possible by the relatively small size of the collection. The details of this analysis are given in Appendix 3C, from which it can be seen that 42 documents were graded as relevance 2 (i.e. as useful as the source document) and 254 were graded as relevance 3 (i.e. of some interest). These figures are lower than would be obtained by the extrapolation of the analysis done by the question compilers, but, in view of the size of the sample, they are within the range that could be accepted.

Appendix 3D completes the figures by showing the number of documents retrieved in each search and, with this information, it was possible to work out the complete recall and relevance ratios for the two indexes (see Tables 3.3 and 3.4).

		Relevant			Precision Ratio
	Total Recalled	Total	Recalled	Recall Ratio	Relevance Ratio
W.R.U.	1703	156	127	81.4%	7.5%
Cranfield	821	156	133	85.3%	16.2%

TABLE 3.4 ¹⁴ *Admonition with major relevance documents*
Recall and Relevance ratios for Relevance 2 documents

N.B. In this and subsequent tables, source documents are combined with other relevance 2 documents.

	Total Recalled	Relevant Documents		Recall Ratio	<i>Precision</i> Relevance Ratio
		Total	Recalled		
W. R. U.	1703	400	303	75.8%	17.7%
Cranfield	821	400	278	69.5%	33.7%

TABLE 3.4. *Performance with major & minor relevance documents*
Recall and Relevance ratios for Relevance 2 and 3 documents

From these tables it is shown that W. R. U. had to accept a relevance ratio of about half that of Cranfield in order to obtain a comparable recall ratio. Since it is known from other work that recall ratio and relevance ratio vary inversely, it was reasonable to assume that the W. R. U. recall ratio would have dropped by several points if they had operated at a level which would produce the same relevance as Cranfield. However, the figures given in Table 3.2 implied that there might be a more level performance if searches retrieving high numbers of documents were eliminated, and Tables 3.5 and 3.6 show the effect of this factor.

	W. R. U.		Cranfield	
	Recall	Relevance	Recall	Relevance
All searches	81.4%(127)	7.5%	85.3%(133)	16.2%
Eliminating searches retrieving more than 50 documents	79.6%(113)	12.3%	84.5%(132)	17.6%
Eliminating searches retrieving more than 25 documents	78.2%(104)	15.8%	84.5%(127)	22.7%

TABLE 3.5. Recall and Relevance for Relevance 2 documents eliminating
searches retrieving excessive number of references

	W. R. U.		Cranfield	
	Recall	Relevance	Recall	Relevance
All searches	75.8%(303)	17.7%	69.5%(277)	33.7%
Eliminating searches retrieving more than 50 documents	72.7%(243)	26.4%	69.2%(276)	37.1%
Eliminating searches retrieving more than 25 documents	68% (185)	28.1%	66.5%(242)	43.2%

TABLE 3.6. Recall and Relevance for Relevance 2 and 3 documents
eliminating searches retrieving excessive number of documents

It would be unwise to read too much into these tables, since they use figures which are achieved as the result of hindsight, that is by eliminating what turned out to be "bad" searches. This, of course, is the reason that 10% increase in relevance can be achieved with a drop of only about 3% in recall; as discussed later, it has generally been found that a 1% increase in relevance involves a 3% drop in recall. It is also the case that the tables cannot be strictly compared as between W.R.U. and Cranfield, since different searches are eliminated. However, it may be pointed out that in neither case does the W.R.U. relevance figure reach that achieved by Cranfield for all searches.

A test was made of the Cranfield index to determine the effect of exhaustivity of indexing, but it was not possible to carry out an analysis of this nature with the W.R.U. indexing. As stated earlier, the average number of elements used for indexing a document at Cranfield was 7; these elements were combined to form complete notations so that, on an average, $12\frac{1}{2}$ cards were included in the index. The first operation in this test was for the indexer to go through the entries for each document and reduce the average number to 8. An analysis was then made of the documents that had been originally retrieved to find which, using the same search programmes, would not have been retrieved by the eight entries. The next stage was to reduce the number of entries to 5, and again recheck. Finally the entries were reduced to an average of 3.

As can be seen from Table 3.7 and 3.8, the result of dropping from $12\frac{1}{2}$ to 8 entries was comparatively moderate in its effect, but the two further stages brought sharp drops in recall.

No. of entries	No. of documents retrieved	Relevance-2		Relevance 2 & 3	
		Recall Ratio	Relevance Ratio	Recall Ratio	Relevance Ratio
$12\frac{1}{2}$	891	83%	16.3%	64.1%	34.6%
8	824	80.6%	17.1%	60.6%	35.5%
5	643	73.1%	19.9%	50.7%	38%
3	491	64.6%	23%	42.1%	41.3%

TABLE 3.7. Recall and Relevance Ratio in Cranfield index at varying levels of exhaustivity

⁺ These figures differ slightly from those in Table 3.3. This is because the figures in this Table were calculated before the final amendments were made to the test results.

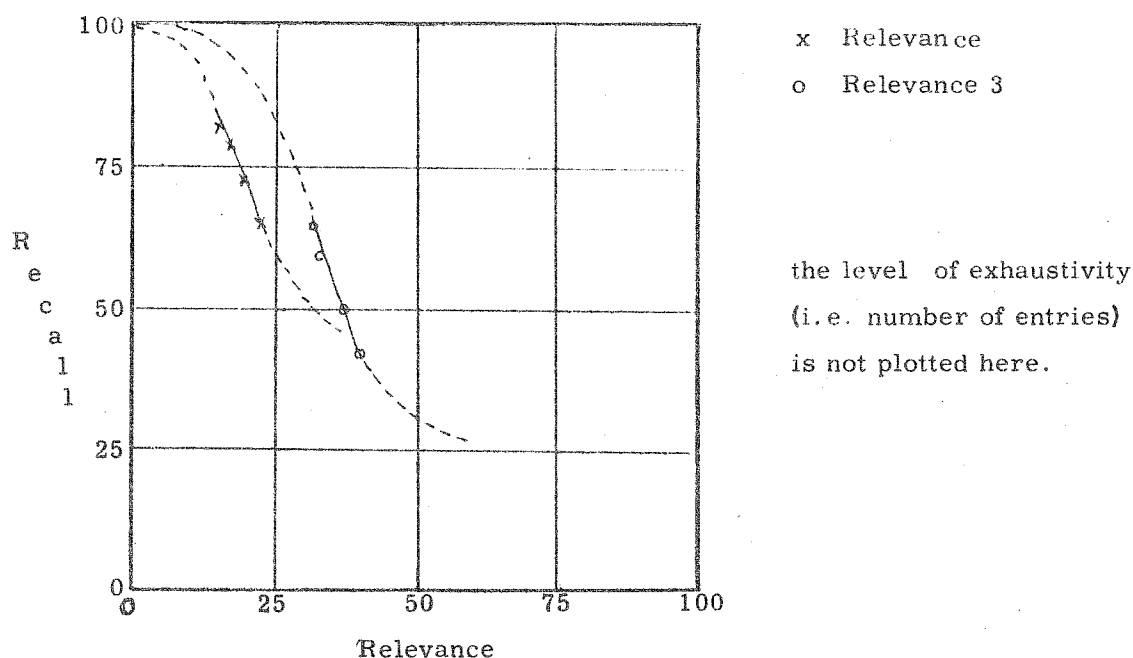


TABLE 3.8. Performance of Cranfield index at varying levels of exhaustivity

Looking at the figures in reverse, the fact that the increase from 8 to $12\frac{1}{2}$ entries only gave an increase of 2.4% in recall leads to the conclusion that we were approaching the maximum level of recall dependent on the number of entries. If, however, the search rules were relaxed, so that one could accept a "broader" search, then the recall figure could be improved; conversely, stricter search rules, requiring, for instance, that all the concepts in the question must be included in the search programme, would have lowered recall but improved relevance; possible extensions of the performance curve that could be obtained by variations of the search programmes are shown in Graph 3.8 by dotted lines.

This particular test was the first occasion when it was shown that, in the normal operating range of an index dealing with engineering or metallurgical literature, a 1% increase in relevance results in a 3% drop in recall. This figure has since been verified in preliminary tests in the present Cranfield project.

Finally, a test was made on the effect of combining the Cranfield search programmes with the W.R.U. indexing for all questions where W.R.U. had failed to retrieve one or more relevant documents. It should be made clear that the use of Cranfield search programmes was based on an analysis with the W.R.U. concepts only, and does not take into account possible recall losses

due to code. The details given in Appendix 3E, show that of the 20 source documents not retrieved by W.R.U., only three of these would have been failures if the Cranfield programme had been used. Considering all relevant documents, 71 not retrieved by W.R.U. would have been found with Cranfield programmes. Added to the 303 relevant documents which were found by W.R.U., this gives a combined total of 374. Discounting W.R.U. code failures, the recall ratio with W.R.U. was 79.5; Cranfield programmes raise this to the high figure of 93.5%. Undoubtedly the use of Cranfield search programmes would have resulted in an increase of the number of non-relevant documents retrieved, and it would be expected that this improvement in the recall ratio would result in a drop in the relevance ratio, but it was not possible to investigate this point.

CHAPTER 4

ANALYSIS OF SEARCH FAILURES

The most useful information obtained from the first Aslib-Cranfield project was provided by the detailed analysis of search failures. This work has been repeated in the present test for all cases of failure to retrieve, by either the W.R.U. or Cranfield indexes, any of the 400 documents which were assessed as relevance 2 and 3. In addition the work was extended to include an analysis of 200 non-relevant documents which had been retrieved by W.R.U.

4.1 Analysis of results of W.R.U. searches: relevant documents

The detailed analysis of reasons for failures to recall relevant documents is given in Appendix 4A and is summarised in Table 4.1. Approximately two thirds of the failures are shown to be due to the search programmes, while concept indexing and the indexing language are equally responsible for the remainder.

It will be noted that the number of reasons for failure is greater than the actual number of relevant documents not retrieved, and this discrepancy is due to the fact that frequently two different causes seemed equally responsible. If allowance is made for this by allocating, for instance, one half-point to the indexing and one half-point to searching when these were the joint reasons for failure, the broad analysis comes out as in Table 4.2.

Concept Indexing

In spite of the indexing being so exhaustive, 16% of the failures are judged to be due to the omission of a vital concept in the concept indexing. As examples, Document 318Q was not recalled for Question 22 (page 122) because the term "extruding" did not appear in the abstract, and Document 279L was lost in answer to Question 42(p 128) due to the indexer overlooking the concept "adhesion".

Searching

Searching failures fall mainly into two categories, either in matching of the concepts in the search programme and the concepts in the question or the number of concepts which had to be co-ordinated in a single programme. Specificity of matching caused recall failure on the one hand because the search programmes were too closely matched with the question, and did not allow the search to be broadened to concepts implied in the question or to concepts less specific than those in the question

	GRADE OF DOCUMENT		TOTAL
	Relevance 2	Relevance 3	
INDEXING: Concepts omitted	7	11	18
SEARCHING (Totals)	23	51	74
1. Specificity (Totals)	9	18	27
a. Search broadened to concepts less specific than question	2	3	5
b. Search not broadened to concepts less specific than question	3	10	13
c. Search not extended to implied concepts	4	5	9
2. Exhaustivity (Totals)	11	32	43
a. Concepts omitted from complete search	10	20	30
b. Too high level of co-ordination demanded in single programme	1	12	13
3. Clerical errors in code translation	3	1	4
QUESTION	1		1
INDEX LANGUAGE (Totals)	8	10	18
1. Role indicators	1	1	2
2. Punctuation		1	1
3. Semantic code	7	8	15

TABLE 4.1 Summary of reasons for failure by W.R.U. to recall relevant documents
(Figures omit results for 18 failures for which search programmes were not received).

Indexing	14	18.4%
Searching	51	67.1%
Index Language	10	13.2%
Question	1	1.3%

TABLE 4.2 Analysis of W.R.U. failures with allowance for joint reasons for failure

On the other hand, some programmes were not sufficiently well matched, requiring concepts on a broader generic level than those in the question (5%). Exhaustivity accounted for 40% of the failures; as much as 28% of these were due to the omission from complete search programmes of concepts which were in the questions. The other cases resulted from too high a level of concept co-ordination within single search programmes.

These figures tally with investigations made elsewhere in the report on the nature of the search programmes. A comparison of ninety search programmes used by Cranfield and W.R.U., given in Table 2.1 (page 10), shows that Cranfield programmes had better concept matching than W.R.U., omitting fewer concepts, adding fewer additional concepts, whether more or less specific than the question or implied in the question. As would be expected, therefore, for W.R.U. the heaviest recall loss through searching was due to omission of concepts, rather than through failure to broaden the search. Table 2.2 shows that the level of concept co-ordination in single searches is higher with W.R.U. than with Cranfield, but even so this feature accounts for only 12% of the W.R.U. recall failures. In Appendix 3E an investigation of the effect of using Cranfield search programmes against W.R.U. concept indexing for all cases where W.R.U. failed to recall relevant documents shows that Cranfield programmes would have retrieved 71 of the documents not found by W.R.U. Improved concept matching (particularly the inclusion of concepts omitted by W.R.U.) probably accounted for this success. Clerical errors in translating search programmes into the code accounted for 3% of all failures.

An illustration of a concept omitted completely from a search programme is found in Appendix 4A (p. 114). Question 3 asks for 'the mechanism of oxide, film breakdown on zirconium and zircalloys. The search programme ignores zirconium and its alloys which had been included in the abstract of Document 185R.

A few searches failed because the search programme was less specific than the question, as for instance in Question 82 (p. 136). All four documents would have been retrieved had the programme used the term 'electrical conductivity' instead of the broader term 'electrical properties'. This broader term should, of course, have retrieved the specific term (as broadening the search normally improves recall) but faults in the code, as considered later, prevented this.

An example of failure to broaden search by the addition of concepts implied in the question is found on page 145, Appendix 4A. Question 134, asks how the toughness of a fracture may be evaluated. The document, 650Q, includes the concept 'impact testing' which if used in the search programme would have recalled.

In Appendix 4A p. 117, there is an example of how failure to broaden the search programme to include concepts less specific than concepts in the question prevented recall. Question 11 asks for "jigging methods for seam welding thin titanium sheets". The search programme did not broaden to 'welding' and 'titanium' which would have retrieved all three relevant documents.

Finally, an illustration of high concept co-ordination preventing recall is found in Appendix 4A (p. 126). Question 34 asks for the effect of the composition of hypoeutectic cast iron on shrinkage unsoundness. The search programme demanded 'hypoeutectic' 'cast iron' and 'shrinkage' together. A programme leaving out 'shrinkage' would have retrieved the document 65E.

Index Language

The full effect of role indicators on recall is not known, since they were used in only 27% of the search programmes. Role indicators make a search more specific, and therefore more likely to exclude both relevant and non-relevant material. For instance, in Appendix 4A, Document 163N was not recalled in answer to Question 23 "What methods can be used to identify the microconstituents in alloy steel", because although the search programme asks for 'iron' and 'composition' both of which are terms in the telegraphic abstract, the 'composition' in the abstract is preceded by the role indicator KWV (property given) and the search programme demands KUP (property determined), KWJ (product) or KIJ (minor component) with the term.

A minor cause of recall loss is the use of "levels" in the search programme. The use of "levels", particularly "level 5" and, to some extent, "level 4" could limit recall quite drastically, whilst excluding irrelevant information also; and for this reason "levels 4 and 5" are not frequently used in the search programme. "Level 4" requires that the terms in the programme should occur in the abstract only after one role indicator and before the next. "Level 5" requires that the terms in the programme should occur within one phrase of the abstract. These phrases, as is mentioned in Appendix 1A, are of a standard pattern but processes and materials, for instance, rarely occur in the same phrase, so that to demand that 'aluminium' and 'welding' should occur in the same phrase is almost asking for the impossible. The fifth level therefore can only be used with great discretion, and where it does occur in the test, it did not exclude relevant documents. On the other hand there is an example of recall loss due to the use of "level 4". Question 3 would have retrieved document 414R if 'oxide' and 'film' had followed the same role indicators; but although the terms occur in adjacent columns in the abstract they are separated by role indicators, 'film' is preceded by KWJ (cols. 33/34) and 'oxide' by KUJ, KWJ (cols. 35/36).

The semantic code was responsible for 14.8% of the recall failures, and analysis revealed two important defects in the code. Firstly, some closely related terms have widely differing codes, and secondly the code does not always provide a hierarchical notation, that is to say that the code for a term will not retrieve the terms generic to it. An example of the first mentioned fault can be found in Appendix 4A, Question 81, Document 616Q. One of the reasons for failure is that the code for 'aerospace' is at LACN 1641 with the group of terms with the semantic stem L-CN 'Location' whilst 'missiles' and 'rockets' are coded with the group of terms S-SP 'Space'. The indexer uses 'aerospace' to denote missile application, but the search programme uses the term 'missile'. The separation of the two terms by the semantic code causes the loss of the document. An example of the second fault can be seen in Question 38 Document 188E. The document would have been found if the term 'microcrack' DASM 1020 had been retrievable by the code in the search programme for 'crack' DASM 1010.

4.2 Analysis of retrieval of non-relevant documents by W. R. U.

After completing the analysis of failures to recall relevant documents, it was decided to ascertain the reasons for the recall of non-relevant documents by W. R. U. (Appendix 4B). It was not practical to do this in every case because of the large number , and only 200 such analyses were made. The selection of the documents for this sample may not be entirely representative, and therefore the breakdown between the different reasons may give undue prominence to certain features, so the figures should be treated with some reserve. 86 separate documents were included in the analysis; of these 39 were selected at random and resulted in 54 analyses. The other 47 documents were those which had been retrieved by at least five separate searches, and 146 analyses were made of these. The breakdown according to questions is given in Table 4.3.

Total number of questions used	55
Questions retrieving more than 100 documents	3 questions 37 analyses
Questions retrieving more than 50 documents	7 questions 53 analyses
Questions retrieving more than 25 documents	7 questions 29 analyses
Total more than 25 documents	17 questions <u>119</u> analyses
Questions retrieving less than 25 documents	38 questions <u>81</u> analyses

TABLE 4.3 Selection of Sample of non-relevant documents

However, if the analyses falling in each category are compared with the number of documents in each category, one finds an unexpected correlation. 18.5% of the analyses and 22% of the documents retrieved were for searches retrieving more than 100 documents. 26.5% of the analyses and 25% of the documents retrieved were for searches retrieving 51 - 100 documents; for the group of searches retrieving 25 - 50 documents the figures are 14.5% and 14% respectively, and for searches with less than 25 documents, 39% and 40.5%.

In this respect, at any rate, the sample proves to be representative.

The detailed analysis is given in Appendix 4B and four main categories could be distinguished in the non-relevant documents analysed. These were:

Type A. Insufficient matching between concepts in question and document. Question 52, Document 54H (p. 172) asks for 'precision casting' but the document mentions only other types of casting'.

Type B. Matching between concepts in question and minor concepts in the document. For instance, Question 22, Document 803Q (p. 163) asks for extrusion of steel, but the document mentions 'extrusion' only as the method for preparing the specimen for the study of recrystallization, and it is of secondary interest.

Type C. False Drop: Matching between concepts in the question and those in the document, but either the role of the concepts or the relationship between them is not the one required.

Type C.1. The role of the concept is not the one required by the question, Question 20, Document 163N (p. 160) asks for the laboratory melting of reactive metals, but the document mentions reactive metals which are in the condition of having been vacuum melted. 'Melting' as a process is not mentioned.

Type C.2. The concepts are present in the document but the relationship is not the one required. Question 95, Document 458Q (p. 198) asks for the properties of a 'Silver-aluminium alloy', but the document mentions 'silver' and 'aluminium' only as separate metals considered for their solderability.

Type D. There is no matching between concepts in the question and concepts in the document, but error in the code brings out the document. Question 52, Document 358G (p. 172) asks for 'precision casting', but the document is concerned with explosive forming, mentioning various properties required by the metals formed. One of these is 'green strength' which has 'casting' in its code, and is brought out by the search programme which will accept 'casting' alone.

Categories of non-relevance

The types of non-relevance are indicated in Appendix 4B by the letters A, B, C(1), C(2), and D against each analysis. Frequently one document shows more than one type of non-relevance, and the occurrence of each type is given in Table 4.4 below:

Type A	Insufficient matching	148
Type B	Minor concepts	152
Type C	False drop	85
Type C.1	Role incorrect	50
Type C.2	Relationship not the one required	71
Type D	Code errors	5

TABLE 4.4. Frequency of occurrence of types of non-relevance

On analysing the causes for each type of non-relevance, it was found that broad search programmes were the cause of type A, over-detailed, exhaustive indexing the cause of type B, and the wide generic base of the semantic code the cause of type D. Type C, false drops, were found to be the fault of omitting role indicators and other limiting devices, lack of role indicators causing type C.1, and lack of interfixing and levels, type C.2.

Analysis of Reasons

In Table 4.5 is shown the breakdown of the reasons for retrieval of non-relevant documents

INDEXING	Too exhaustive	152(34.4%)
SEARCHING (Total)		157 (35.6%)
Specificity		
	Concepts added that were only implied in question	18 (4.1%)
	Concepts added less specific than question	32 (7.2%)
Exhaustivity		
	Concepts omitted from complete search	84 (19.1%)
	Insufficient co-ordination in single programme	23 (5.2%)
INDEXING LANGUAGE (Total)		132(29.9%)
	Role indicators lacking	50(11.3%)
	Levels lacking	13(2.9%)
	Interfixing lacking	64(14.6%)
	Semantic code	5(1.1%)

TABLE 4.5. Summary of reasons for retrieval of non-relevant documents by W.R.U.

To take into account cases where one non-relevant document is retrieved for more than one of the reasons listed above, the table was recalculated giving a weighting of a full point if there is one reason only, a half-point if there are

two reasons, a third of a point where there are three reasons. The resulting figures are given in Table 4.6 below; the main difference is a lower figure for index language failures.

Indexing. Too exhaustive	73 (40.7%)
Searching.	72 (40.2%)
Indexing language. Role indicators, etc.	32 (17.8%)
Indexing language. Semantic code	2 (1.1%)

TABLE 4.6. Summary of reasons for retrieval of non-relevant documents by W.R.U. with allowance for joint causes.

The exhaustivity of the concept indexing was directly responsible for the retrieval of 34.4% of the non-relevant documents. In all these documents, there was correlation between the concepts in the question and the concepts in the document, but the concepts in the document were of minor importance. Question 20, Document 24119 (p. 162), asks for melting of reactive metals on a laboratory scale. Although the document mentions 'melting' of some reactive metals, it is really concerned with a process of separation using anhydrous hydrogen, and refers to 'melting' only as the method which is to be surpassed by the new one.

With 157 (35.6%) of the documents, retrieval was due to weakness in the search programmes. There was either insufficient matching between the concepts in the complete programme, or the concepts in the single programmes were co-ordinated at a level that was low enough to retrieve irrelevant documents. In this latter case, a search programme asking for A or B or C is at too low a level of co-ordination (or exhaustivity) if the document would only be excluded by a search which demanded 'A and B', 'A and C' or 'B and C'. Insufficient concept matching accounted for 36.6% of retrieval of non-relevant documents, and low concept co-ordination for only 5.1%. This result is not unexpected when it is considered that, in the comparison of Cranfield and W.R.U. search programmes (Table 2.1), concept matching for complete W.R.U. programmes was 47.3% compared with 66.5% for Cranfield. In the comparison of single programmes, on the other hand, concept co-ordination was at higher level for W.R.U. than for Cranfield, W.R.U. having 280 programmes with three or less concepts co-ordinated compared to 372 for Cranfield. Therefore, the low figures of 5.1% for insufficient co-ordination as a cause of W.R.U. retrieval of non-relevant documents is not unexpected.

To illustrate the part played by the search programmes in the retrieval of non-relevant documents, reference is made to actual analyses in Appendix 4B.

A case of concept omission causing unwanted recall is found with Question 80, document 202M (p. 185), which asks for equipment testing the mechanical properties of metals at temperatures down to 1423°F. The search programme omits all the concepts in the question except 'low temperatures'. Consequently it retrieves document 202M, although it contains nothing about mechanical properties or testing equipment, but is concerned with heat treatment at low temperatures among other subjects. An illustration of the effect of adding implied concepts is found on p. 189, Question 81, Document 212P, which asks for the advantages given by aluminium and titanium alloys over stainless steels for rockets using liquid oxygen and hydrogen. The W.R.U. programme includes the additional concept 'aircraft' and so retrieves document 212P which is concerned with metals for jet engines. The effect of using in the search programme concepts which are less specific than concepts in the question is illustrated on p. 190, Question 83, Document 116J. The question asks for means to reduce warpage in the austempering of alloy steel parts of complex shapes. The search programme replaces the concept 'austempering' with 'heat treatment' and the concept 'warpage' with 'deflection', so that it retrieves document 116J which contains nothing on warpage or austempering but is concerned with the stress relieving of alloy steel. Finally, an illustration of low concept co-ordination causing retrieval of unwanted documents is found on p. 194, Question 91, Document 358G, which asks for phases that precipitate at grain boundaries in austenitic alloys. The search programme includes the concepts 'steel', 'precipitation' and 'grain boundaries', but does not ask that all these concepts should occur together in a document: the programme will accept 'steel' co-ordinated with either 'precipitation' or 'grain boundaries'. Consequently the programme retrieves Document 358G, which indexes 'grain boundary' as a minor concept, a property of an alloy which has been explosive formed, but which contains no reference to precipitation at grain boundaries.

The system uses two devices to prevent false drops. These are role indicators, and telegraphic punctuation with associated levels in the search programmes. (A description of the two devices is given in Appendix 1A). It does not employ the pre-co-ordinate device of interfixing in the telegraphic abstract. The analysis showed that the failure to use role indicators and levels in the search programme and the lack of an interfixing device was responsible for 38% of the retrieval of unwanted, non-relevant material. In addition, a study was made of the comparative effectiveness of the three devices, supposing that

they had been used and the results are given in Tables 4.7 to 4.11. Table 4.7 shows the potential performance of each device in preventing recall of all the 85 false drops analysed. Interfixing would have prevented 75%, role indicators 59% and levels only 15%. Tables 4.8, 4.9 and 4.10 measure the effectiveness of the three devices against each other, and perhaps the most significant figure arising from this shows (in Table 4.10), that levels would not have been effective with any of the 21 cases where interfixing would be ineffective.

If the false drops are classified into Type C.1 (the role of the term in the document does not match the role required by the question) and Type C.2 (the relationship between the terms in the document is not the one required by the question), it is found (Table 4.11) that role indicators would have been 100% successful in preventing false drop Type 1, but 0% successful in preventing Type 2. Interfixing and levels would have been entirely ineffective in preventing false drop Type 1, but for Type 2 interfixing would have been 88.4% effective whereas levels would have been only 18.4% effective.

Total number of False Drops		85	
	Role Indicator	Levels	Interfixing
Effective	50	13	64
Ineffective	35	72	21

TABLE 4.7 Effectiveness of role indicators, levels and interfixing

Role Indicators		Levels		Interfixing	
Effective	50	Effective	3	Effective	39
		Ineffective	47	Ineffective	11
Ineffective	35	Effective	6	Effective	22
		Ineffective	29	Ineffective	13

TABLE 4.8 Effectiveness of levels and interfixing in relation to role indicators.

Levels		Role Indicators		Interfixing	
Effective	13	Effective	7	Effective	13
		Ineffective	6	Ineffective	0
Ineffective		Effective	44	Effective	50
		Ineffective	28	Ineffective	22

TABLE 4.9 Effectiveness of role indicators and interfixing in relation to levels

Interfixing		Role Indicators		Levels	
Effective	64	Effective	39	Effective	9
		Ineffective	25	Ineffective	55
Ineffective	21	Effective	13	Effective	0
		Ineffective	8	Ineffective	21

TABLE 4.10. Effectiveness of role indicators and levels in relation to interfixing

False Drop Type C.1 (The role of the concept in the document differs from the one required by the question)

Role indicators effective*	50	100%
Levels effective	0	0%
Interfixing effective	0	0%
Total Type C.1	50	

False Drop Type C.2 (Concepts required by the question are in the document but the relation between them differs from the one sought)

Role indicators effective	0	0%
Levels effective	13	18.3%
Interfixing effective	63	88.7%
Total Type C.2	71	

TABLE 4.11. False Drops: Types 1 and 2. Effectiveness of role indicators, levels and interfixing.

* Effective here implies the performance of the device supposing it had been used.

Role Indicators

An instance of recall due to the lack of role indicators is found in Question 22, Document 268Q (p. 162). The question asks for information on the process of extrusion. The document mentions extrusion only as the condition of metals which are to be electroplated, and there is nothing about extruding as a process. The indexer used the role indicators KWV (property given for) against 'extrusion', so that the document would have been excluded if the search programme had given KAM (process) with 'extrusion'.

This false drop is of type 1, where the role of the term in the document is not the one required by the question. The next example shows how role indicators may be ineffective in preventing false drops of type 2, where the relationship between terms is not the one required by the question. This is question 20, Document 250Q (p. 160) which asks "Can high melting point and reactive metals

be melted in small quantities in the laboratory?" The document contains the terms 'Rhodium' and 'melting' but they are quite unrelated. 'Melting' refers to the weld metal and 'Rhodium' is the metal of the thermocouple. The role indicator KAM (process) is used with 'melting' and KUJ (component) is used with 'Rhodium'. The search programme omitted role indicators, but, if they had been included, KAM would have preceded 'melting' and KEJ / KUJ would have preceded 'Rhodium', and the recall of the unwanted document would still not have been prevented.

Telegraphic punctuation and levels

Punctuation within the abstract ensures that the terms are arranged into sub-phrases, phrases, sentences and paragraphs. This makes it possible for the machine to select a term within a particular area of the abstract, by programming it to search at a given 'level'. The levels in the search programme correspond to the phrases, sentences and other divisions of the telegraphic punctuation (see Appendix 1A). The fifth level, corresponding to the phrase in the abstract, is the most important of the levels as a device to prevent false drops, but the fourth and sixth levels do have limited use for this purpose. The fourth level requires that related terms forming a main concept should appear after the same role indicator. This level was omitted from the search programme of Question 81, Document 168N (p. 188), with the result that the document was recalled because it contained 'hydrogen' and 'liquid', though only as unrelated terms widely separated in the abstract. If, by the fourth level, they had been required to occur as a noun and its related adjective behind the same role indicator, the false drop would have been prevented. However, it is only occasionally that terms are expected to be so closely related, and to state the fourth level, except for instances such as this, would exclude all relevant as well as non-relevant documents. The sixth level, which corresponds to the sentence in telegraphic punctuation, also has rather limited use in this respect. In practice not many documents contain more than one telegraphic sentence, but where this does occur and the separate sentences are punctuated, the request for the sixth level will prevent the selection of terms from more than the one sentence. For example, in Question 7, Document 115D (page 156), the false drop would have been avoided if the document had been partitioned into sentences. As it was, the original punctuation showing the distinct subjects covered by the document was erased. The fifth level, on the other hand, can be used more frequently, but, as the analysis has revealed, the device is not without its serious limitations. To require that terms should appear at the fifth level

means that they must occur within one specified phrase. The phrase is a grouping of terms according to five basic combinations of role indicators (see Appendix 1A). The standard pattern will allow, for example, KEJ (material processed) to be combined with KWV (property given), and KWJ (product) with KUJ (major component), but will not allow KAM (process) to be combined with KEJ (material processed), although KAM may be combined with KAH (condition). Consequently, it is only where the terms in the question are likely to occur in the same phrases in relevant documents, that the fifth level can be used safely to exclude irrelevant material occurring in different phrases. Question 78, Document 617Q (p. 184), is a good example of where the fifth level could have been used successfully without undue loss of relevant data. The question asks how molybdenum affects the ductility of stainless steel at low temperatures. The document contains the terms 'ductivity' and 'low temperatures', but they are unrelated and occur in different phrases. The search programme could have stated fifth level for these two terms, as, if related, they would be likely to occur in the same basic phrase combining KWV (property given) and KAH (condition).

On the other hand, it frequently happens that the terms required by the question would not occur in the same phrase in the relevant documents, and so the fifth level could not be used without excluding relevant with the non-relevant documents. In Appendix 4B there are 21 instances of the fifth level rendered useless as an anti-false drop device for this reason. For example, in Question 91, Document 628Q (p. 195), the document includes the terms 'steel' and 'precipitation', but they are not related and occur in different phrases in the abstract. The fifth level cannot be used in the search, because the terms 'steel' (material processed) and 'precipitation' (property determined) or (property influenced) are not bound to occur in the same phrase in the relevant documents.

Another weakness, noted in the analysis, is that the fifth level is not always successful in preventing false drops even when it can be used without loss of relevant data. In Appendix 4B there are 52 occasions when either the fifth level was used without success, or where it would have been unsuccessful if used. For example, Question 96, Document 310M (p. 200), asks if the presence of vacancies in the grain boundaries of copper-aluminium solid solution affects grain boundary relaxation. The search programme requires that only the terms 'copper' and 'aluminium' should occur in the document. These terms are mentioned in the document but they occur as unrelated metals (False drop Type C.2), with aluminium playing the role KEJ (material processed) KUJ (major component), and not the role

of KIJ (minor component) as required by the question. (False drop Type C.1). Since the terms occur in the abstract in the same phrase, the fifth level in the search programme could not prevent recall. The fifth level fails in false drops of this type because it cannot distinguish unwanted from wanted terms by the roles they play, as could role indicators in this example, or show the direct relationship between particular terms within the phrase, as could interfixing.

Interfixing in the telegraphic abstract

Interfixing is not a device used by the W.R.U. system, but, in the analysis of the reasons for retrieval of unwanted documents, a study of the possible effect of interfixing was included. Interfixing is linking concepts into themes which may cut across the phrases marked out by the telegraphic punctuation. It could, for example, link a material, with a process with a property. In this way, interfixing is doing a job very similar to the pre-co-ordination achieved by permuted entries in the Facet system. Interfixing, as has already been noted, would have prevented 75% of all false drops, and 88% of false drops of type C.1. In 19 of the cases analysed, interfixing was the only device which could have prevented recall. For example, Question 102, Document 358G (p. 205), asks for the damping characteristics of SAP. The search programme requires 'aluminium' with 'powder', both of which have to be at the fifth level, in the same phrase. The document is retrieved because 'aluminium' is present in the indexing as is 'powder metal'. They are, in this document, two quite unrelated metals which are explosive formed. The false drop occurs because there is nothing to prevent the false association between 'aluminium' and 'powder'. The use of the role indicator KUJ to show that aluminium is required as a major component (which it is in SAP), would not have excluded this document as 'Aluminium' is indexed with the role KUJ. The use of the 'level 5' in the search programme, to ensure that 'aluminium' and 'powder metal' occurred in the same phrase did not help, as the terms are in the same phrase. The only way to prevent this false drop would be to have used interfixing to show that there were two separate themes.

A. Aluminium

B. Powder metal

A. Explosive forming

B. Explosive forming

A study of the effect of interfixing on recall of relevant documents was not made, but it is thought that the risk would not be so great as that taken by using the fifth level as a device to prevent false associations.

Index Language - Semantic code

Faults in the semantic code were only a minor cause of recall of unwanted material. The fault was, in all cases, that the code included too wide a selection of semantic factors for a specific term. For example, in Question 52, Document 82F (p.171), the term 'trapped rubber forming' is retrieved in response to the search programme 'casting' CUNS 1025, because it unexpectedly includes this semantic factor in its code. Again, in Question 73, Document 192K (p. 182), the unwanted term 'fusion welding' is retrieved because its code contains the broad factors 'Heat/metal process' required by the search programme.

4.3 Analysis of results of Cranfield searches: relevant documents

The detailed analysis of all failures to retrieve relevant documents in the Cranfield index is given in Appendix 4C, and is summarised in Table 4.12.

	Grade of document		Total
	Relevance 2	Relevance 3	
INDEXING (Totals)	26	69	95(52.2%)
1. Concepts omitted	9	33	42(23.1%)
2. Lack of index entry to term in schedules	1	1	2(1.1%)
3. Errors in translating concept into notation	7	14	21(11.5%)
4. Lack of permutation of elements	9	21	30(16.5%)
SEARCHING (Totals)	11	56	67(36.8%)
1. Specificity (Totals)	7	31	38(20.9%)
a. Search extended to concepts more specific than in question		1	1(0.6%)
b. Search not extended to concepts less specific than in question	2	5	7(3.8%)
c. Search not extended to concepts more specific than in question	1	2	3(1.7%)
d. Search not extended to implied concepts	4	23	27(14.8%)
2. Exhaustivity (Totals)	4	20	24(13.2%)
a. Concepts omitted in complete search	2	5	7(3.8%)
b. High level of co-ordination demanded	2	15	17(9.4%)
3. Clerical errors	1	4	5(2.9%)
QUESTION	1	0	1 (0.6%)
INDEX LANGUAGE (Totals)	2	17	19(10.4%)
1. More than one place in schedules for subject		2	2(1.1%)
2. Different places in schedules for subjects with fine difference		7	7(3.8%)
3. Enumeration in schedules where synthesis could have been used		3	3(1.7%)
4. Synthesis in schedules		1	1(0.6%)
5. Inability to permute in parts of the schedules	2	4	6(3.4%)

TABLE 4.12. Summary of reasons for failure by Cranfield to recall relevant documents.

In the same way as with the analysis of W.R.U., the number of reasons for failure is greater than the actual number of relevant documents not retrieved, due to the fact that frequently two different causes seem equally responsible. Making appropriate allowance for this, the broad analysis comes out as in Table 4.13.

Indexing	65	56%
Searching	45	38.8%
Index Language	5	4.3%
Question	1	.9%
	<u>116</u>	

TABLE 4.13. Analysis of Cranfield failures with allowance for joint reasons for failure

It will be noted that the percentage for indexing and search alters comparatively little, but the Index Language is less than half of the figure given in Table 4.12. This was because there was no single occasion when the index language was considered to be the sole reason for failure; in all cases searching or indexing were contributory factors.

In the following summary of the analysis, the figures that are quoted will be those shown in Table 4.12.

Indexing

Indexing errors were responsible for 52.2% of the failures. There are three main types of indexing errors, namely, concept indexing, errors in translating the concept into the class number, and failure to associate related terms in permutation.

Failures due to omitting concepts from the indexing accounted for 23% of the total recall loss. The fault on the part of the indexer could either have been lack of understanding or merely carelessness, but the nature of the error is difficult to analyse in retrospect.

To illustrate failure due to concept indexing, see Question 13, Document 1062 (p. 227), which asks if it is possible to weld stainless steel into a large structure by automatic welding. Although the document contains the concepts 'stainless steel' and 'welding' the indexer omitted 'stainless steel' and indexed 'high tensile steel' only.

Also Question 37, Document 1376 (p. 236), asks to what extent do stress

concentrations affect the structural tensile strength of aircraft and space vehicles. Although the document contains all the concepts required by the question, the indexer omitted 'tensile strength', 'aircraft' and 'aircraft structures', indexing only 'missiles, rockets', 'space vehicles', 'stress concentrations'.

12% of the failures were due to the clerical error on the part of the indexer in omitting to give the class number for the concepts indexed. For instance, Question 15, Document 1520 (p. 228), asks for the stretch-forming of titanium, but, although the concept 'stretch forming' had been noted by the indexer, it was not translated into the code Vhs, and consequently did not appear in the index.

Failure to pre-co-ordinate related concepts by means of permuted entries accounts for the loss of 16% of the relevant documents. As was the case with concept indexing, it is difficult in retrospect to analyse whether the permutation was omitted through lack of understanding of the importance of the relationship, or through an oversight on the part of the indexer. A third and more discernable cause of omission could be that the indexer considered that further entries were not economic or reasonable. Referring again to Appendix 4C, an example of a typical permutation failure can be found in Question 6, Document 1240 (p. 225). The question asks for porosity in iron castings, but although the indexer included the concepts 'Grey cast iron' and 'porosity' these concepts were not brought together by permutation. An example of permuted entries omitted for reasons of economy may be found on page 251 with Question 81, Document 1630. The question asks if stainless steels have any advantages over Aluminium and Titanium alloys as structural materials for rockets using liquid oxygen and hydrogen. The document was indexed 'missiles' and among many other concepts 'metals'. The two concepts were not brought into relationship by the indexer, as there were already numerous and more obvious permuted entries to make, but if the terms had been pre-co-ordinated the document would have been found, as the tenth search programme asked for 'missiles' with 'metals'.

Searching

Searching errors accounted for 37% of the recall failures, as compared with 52% caused by indexing errors. As has already been seen in Table 2.1, where the Cranfield and W.R.U. search programmes are compared, there was better concept matching between the concepts of the questions and the concepts in the Cranfield search programmes. This means that Cranfield was likely to lose

relevant documents by correlating too closely with the concepts in the question, but was not likely to lose recall through the omission of concepts in the question. The results in Table 4.12 confirm this. Only 7 documents were missed by Cranfield due to omitting from the search important concepts that were in the question and only 1 document for using a concept less specific than in the question. On the other hand, too precise matching was responsible for failure to retrieve 36 documents. 27 of these were due to failure to extend the search to concepts that were implied in the question. 7 due to not broadening the search to less specific concepts and 2 due to not using more specific concepts.

Table 2.1 also showed that W.R.U. programmes were asking for a slightly higher level of concept co-ordination than Cranfield; insisting on too many concepts in a programme caused 9.4% of Cranfield failures against 11.7% for W.R.U.

Illustrations of the various categories of searching failures may be found in Appendix 4. C. An example of a search programme omitting a concept entirely is found on page 244. Question 70 asks for corrosion of steel in reinforced concrete by the action of seawater. The five relevant documents which were not retrieved would have been recalled if the search programme had included the concept 'steel', which was omitted. An example of recall loss through omitting concepts implied in the question - a major searching loss, is found on page Question 107 asks "what are the effects of increasing the molybdenum content of carburising steels". The search programme includes 'steels' 'carburising' and 'molybdenum', but does not broaden to the implied concept 'hardness', if it had done so, it would have retrieved the document 1740 which contains this term. An example of failure to search less specifically than the question is found on page 265, Question 131, which requires crystal orientation of uranium and the search programme will accept nothing less specific than 'orientation' with 'uranium' or 'uranium alloys'. If the programme had been broadened to 'microstructure' with 'uranium' or 'uranium alloys', document 1717 would have been found. Finally, an illustration of the effect of too high a level of concept co-ordination is found on page 240. Question 46 asks for fluid bed furnaces for heat treating metal components. The search programme will accept only 'fluid bed furnaces' with 'heat treatment', although a broader search for 'fluid bed furnaces' alone would have recalled all the relevant documents lost with the search.

Indexing language

Errors in the indexing language, causing 10.4% of all recall failures, were of five types. With Question 112, Document 1636 (p. 261), one cause of failure was that there are three separate places in the schedules for 'twinning', and the searcher omitted the one used in indexing. A second error was in those cases where there were different places for subjects with fine shades of meaning, as Question 41, Document 1999 (p. 239), which asks for the properties required of resins for the coating of metals by thermoplastics. The document was indexed 'epoxide coatings' but it is not retrieved because the search programme stated 'plastic coating' (the process) and not 'plastic coatings' (material) as indexed. If there was a single place for 'plastic coatings', recall losses such as this would be prevented. Another error was enumeration rather than synthesis in the schedules. Question 133, Document 1638 (p. 267) asks how to avoid defects in enamelling of ferrous articles due to combustion gases and process vapours. The document includes the concept 'vitreous enamels', and translates this as Lg 'Enamels'. There is another place in the schedules for 'vitreous enamelled coatings' enumerated under Ld 'coatings' at Ldk. If 'vitreous enamelled coatings' had been coded by synthesising the number for 'enamel (Lg) with the number for coatings (Ld) i.e. Lg Ld, the searcher might have come across the document coded Lg 'Enamels' during the search for Lg Ld.

Inability to permute in parts of the schedule is another fault discovered in the Facet index language. The schedules allow only for preferred order when synthesising the code for alloys. The rule is that the elements occur in order of importance in the alloys, and that distributed elements are then located by the searcher in the code index. On five occasions analysis showed that either the searcher did not search the index or the indexer did not make the index entry. If a number of permuted entries had been made in the class sequence with the elements in varied order, the documents would have been found. For example, Question 82, Document 1452 (p. 252) asks for copper alloys with good electrical properties. The term 'zirconium copper alloy' is indexed, but the entry in the index 'Copper: Zirconium-copper alloys' was omitted. The search programme requiring 'copper alloys' would have retrieved the document if a permuted entry 'copper-zirconium' alloys had been made.

4.4 Analysis of non-recall by Cranfield of non-relevant documents

Of the 190 non-relevant documents retrieved by W.R.U. and considered in Appendix 4B, 182 were not retrieved by Cranfield. An analysis has been made of 50 of these documents to find the reasons for Cranfield's comparative success in excluding unwanted material. For this analysis, the Cranfield indexing was examined in relation to W.R.U. search programmes, and the W.R.U. indexing as against the Cranfield search programmes.

	<u>Documents</u>
<u>INDEXING</u>	
W.R.U. more exhaustive than Cranfield	42
<u>SEARCHING (Total)</u>	33
<u>Specificity</u>	
W.R.U. added concepts not in question	8
W.R.U. added concepts less specific than in question	9
<u>Exhaustivity</u>	
W.R.U. omitted concepts in question	11
W.R.U. had lower co-ordination in single programmes	5

TABLE 4.14. Reasons for non-recall by Cranfield of non-relevant documents.

As can be seen from Table 4.14, if W.R.U. had indexed at the same level of exhaustivity as Cranfield, 42 of the 50 documents would not have been retrieved. Alternatively, even with the indexing at the high level of W.R.U., Cranfield search programmes would have eliminated 33 of the documents. The main error in the search programmes was failure to match the concepts with those in the question, and this analysis bears out results to be expected from the figure given in Table 2.1.

Exhaustivity of indexing, as a noise creating factor, is illustrated in Document 358G/1429 brought out by W.R.U. in response to Question 37 (see Appendix 4B page 168). The question asks to what extent do stress concentrations affect the structural strength of aircraft and space vehicles. The document is concerned with explosive forming of various metals, and the indexing in the W.R.U. abstract includes 'tensile strength' as a property of one of the metals, and 'rocket nozzles' as an example of a component manufactured by the process. Neither concept is of major importance. The Cranfield indexing ignores these concepts, and so it would be overlooked by the W.R.U. search programme which will accept 'rockets' with 'tensile strength'. The Cranfield search programme

would also have retrieved this document at the W.R.U. level of indexing.

Lack of matching between concepts in the question and concepts in the search programme, as a noise factor, is illustrated in three following examples. First, an instance where the search programme omits a concept altogether. Document 102J/1785 was brought out by W.R.U. for question 24. (Appendix 4B, p. 164). The question asks for equipment and procedure to determine the complete orientation of an uniaxial crystal. The document is not concerned with orientation, but it is brought out by the W.R.U. programme which omits the concept and requires only various x-ray and diffraction analysis techniques. Since 'x-ray' is amongst the concepts indexed (not, however, indexed by Cranfield) the document is retrieved; but it would not have been brought out by the Cranfield programme which demands 'orientation' in both its programmes. Second, an instance where the choice of a less specific concept than the concept in the question causes the retrieval of unwanted material. Document 115D/1727 was brought out by W.R.U. for question 52, (Appendix 4B, p. 171). Both systems index the concept 'casting', but the document contains nothing on 'precision investment casting', which is required by the question. The Cranfield programme asks for 'precision investment casting' in a search as specific as the question, but W.R.U. will accept the more generic concept of 'casting'. The result is that the W.R.U. programme retrieves the document whilst the Cranfield programme excludes it. Third, to illustrate how the addition of a concept which is neither more nor less specific than concepts in the question may cause the retrieval of unwanted material. Document 526Q/1836 was brought out by W.R.U. for Question 8, (Appendix 4B, p. 157). W.R.U. indexed the document 'cast' and 'weldability'. The question asked for methods of repairing castings, and this document was retrieved because the W.R.U. search programme introduced the concept 'welding, weldability' into the programme, and would accept 'repairing' with 'castings/cast' or 'welding/weldability' with 'castings/cast'. The Cranfield programme, on the other hand, would accept only 'castings' with 'repair', and so would not have retrieved the document.

Low concept co-ordination as a factor in the retrieval of irrelevant documents is illustrated by Document 51A/1726 brought out by W.R.U. in answer to Question 26 (see Appendix 4B p. 165). The question asks if repeated stresses due to varying thermal gradients cause fatigue cracks. The W.R.U. complete set of search programmes includes the concepts 'thermal cycling', 'fatigue testing',

'cyclic', 'fatigue' and 'heat deflection', but no co-ordination is required between the concepts. The Cranfield programme, on the other hand, has the concepts 'fatigue', 'thermal fatigue' and 'cracking' and 'thermal stress', but requires that 'fatigue' should be co-ordinated with either 'cracking' or 'thermal stress'. The W.R.U. indexing includes the concept 'fatigue' (although Cranfield does not) and so the W.R.U. search programme retrieves the document, even though none of the other concepts required in the question are present, whilst the Cranfield programme would have excluded it.

A less detailed survey was also made of the remaining 132 documents, analysed in Appendix 4B, that were not retrieved by Cranfield. It was found that in every case the same two reasons for W.R.U. retrieval, a high level of exhaustive indexing and weak programmes, featured either together or singly. However, there were 9 occasions when an additional reason for the exclusion of the Cranfield document was discernible. In these cases the exhaustivity of the indexing was the same in both systems, but the W.R.U. document was brought out and the Cranfield was not, because of the effectiveness of Cranfield's anti-false drop device as compared with that of W.R.U. The concepts in the Cranfield indexing were pre-co-ordinated in permuted entries in such a way that falsely associated concepts could not be retrieved by the search programme. In the W.R.U. system, on the other hand, the post-co-ordinate anti-false drop devices, i.e. levels and role indicators, either were not used, or, if they had been used, would not have been effective. Out of the 9 instances mentioned, 7 W.R.U. documents could have been excluded if the role indicators had been used in the search programme, and 2 would not. The use of levels in the search programme would have been effective in all cases. Document 167L/1831 brought out by Question 137 (Appendix 4B p. 219) illustrates this third cause of W.R.U. non-relevance recall. The question asks for the separation of the metals aluminium, copper and iron from the metals tin, zinc and lead. Both documents index the metals zinc, tin and copper, but in the Cranfield indexing pre-co-ordination ensures that the lack of relationship between the metals in this particular document is made clear. In the W.R.U. abstract, the metals are preceded by the role indicators KUJ (major component) and KIJ (minor component). The W.R.U. programme will accept, without co-ordination with any other concept in the question, a document in which any one metal from the one group occurs with any one metal from the other group. There are no role indicators in the programme, so that the document indexed by W.R.U. is retrieved, because it fulfils these requirements, but the Cranfield document would not be retrieved by the programme, because

the metals are not pre-coordinated in the indexing. Even if role indicators had been used in the search programme, they would almost certainly have included KUJ and KIJ along with KEJ (material processed) so that they would not have excluded the document. A full comparison of the effectiveness of permutation and post-co-ordinate devices for preventing false drops was not possible in this test, due to the difference in the level of indexing, which meant that concepts falsely associated in the W.R.U. system were frequently omitted altogether from the Cranfield indexing. As discussed earlier in this Chapter, the indications are that pre-coordination by permutation, or interfiling in a post-co-ordinate system, are more effective than role indicators and levels.

CHAPTER 5

DISCUSSION OF RESULTS

In this report, we have so far presented the facts and results without making any serious attempt at interpretation and comment. The evidence presented in the text and appendices is, we hope, sufficient to enable the reader to form his own conclusions, and these may differ from those offered in this chapter.

It is obvious that many of the results in this test are based on subjective assessment, in particular with the decisions as to whether or not a particular document is relevant to a particular question. Relevance is a problem which will almost certainly continue to bedevil experimental investigations into the efficiency of indexing systems, but we have, in this test, tried to take all reasonable steps to ensure the validity of the results in this respect. There were, of course, many marginal cases, when another person doing the assessment might have put a particular document into a different category. However, the detailed analysis that was made of the reasons for failures to retrieve relevant documents acted as a check, and we would be willing to argue the correctness of the decisions in regard to all the documents which are included in the analyses in Appendices 4A, 4B and 4C. Full references are given to documents, so they are open for checking.

Another controversial matter in this and other Cranfield tests has been the use of "prepared" questions. The purpose of using these in the first Aslib-Cranfield project had been to bypass the relevance problem and also to enable testing to be carried out over the whole range of indexing conditions (see Ref. 2, Chapter 2). This situation no longer existed in the present test, but it was considered desirable to use again the method, with questions that had been based on documents in the collection. If actual questions had been used, there was the strong possibility that, because of the relatively small size of the collection, only a few documents would have proved to be relevant, with the result that there would be insufficient data for analysis. In fact, with the 114 common searches, only 42 documents, apart from source documents, were found to have a reasonably high level of relevance, and this would certainly have been too small a group on which to base any conclusions

The questions, as received from the compilers, appeared to the Cranfield staff to be reasonably representative of the type of question which might be made in normal conditions. Possibly they were more precise than most users of the library would have first made, but no more precise than would have emerged after the cross-questioning which normally precedes a search. However, at W.R.U. the staff felt that the synthetic nature of the questions was obvious from the start, and their viewpoint was put by Mr. Alan Rees in a paper presented at the conference "Information Retrieval in Action" (Ref. 1, pages 93-99), as in the following quotation.

"It is difficult to state explicitly how these differ from natural questions. Their artificial nature is obvious at once to all of our programmers. A synthetic question is based upon an association of concepts often peculiar to the document described and is therefore derived from an artificial environment. A real question, on the other hand, is derived from a wide background of associated ideas and represents concepts which a questioner feels are likely to be found in a document or documents. Such questions can be formulated in many ways due to the difficulty of individuals in real question-asking situations in expressing their information needs.

"I have three points I wish to make in relation to the synthetic nature of the questions:

"First, since a synthetic question is based upon one document, the formulation of the question reflects the individual, subjective interpretation by the questioner of the significance of the document. It is, therefore, analogous to the problem of indexing a document which is dependent upon point of view, subject background and insight of the indexer.

"I raise this point here since a preliminary check reveals that although some questions are based upon the title or author abstract of the source document, at least one question asks for concepts of minor importance in the text and, more seriously, another asks for "processes available for producing sound, contamination-free welds in titanium and its alloys" (Q121), whilst examination of the text of the source document by several members of our staff reveals nothing beyond an oblique mention of titanium in an eight page article. In the text there is no indication that contamination-free welds have been achieved for titanium.

"The subjective judgement of our indexers is, therefore, to be balanced

against the subjective judgement of Mr. Cleverdon's question compilers. Or, put it in another way, the language of the question and the language of the indexing are not equidistant from the document.

"Second, since in many instances the association of concepts in the question is peculiar to the document from which it is derived, being perhaps an inverted statement drawn from the text, the relevance of any items identified, other than to source document, is artificial and it is to be questioned whether we are discussing the same kind of relevance as found in searches based on real questions. This is a matter for further investigation.

"Third, the synthetic nature of the questions naturally precluded any negotiation with the question-asker as to their precise meaning. Our experience in the analysis and machine searching of some six hundred questions now permits us to identify those questions where further clarification is needed prior to final definition of search strategy.

"In at least ten cases in the present series of test searches we were able to predict failure prior to searching. If the same requests were received from real question-askers, a concerted effort would have been made to clarify them. We have found that the degree of success achieved in searching is directly proportional to the amount of insight possessed in the nature, purpose and environmental origin of the requests. It is particularly difficult to plan an effective search on the face value of a written request".

There is, undoubtedly, truth in the comments by Mr. Rees, but we would maintain that, in a comparative test of this nature, the weaknesses are not such as necessarily to invalidate the results. This is more particularly true concerning the detailed analysis of individual searches discussed in Chapter 4, for here the question has really been used to set up a situation for analysis. However, it can be argued that a particular type of question might be found to favour one system more than another, especially if a system has been designed for a particular type or level of question. As mentioned earlier, we at Cranfield accepted the questions as reasonable, although Mr. Rees claims that W.R.U. immediately recognised them as artificial. At the same meeting, Mr. Fairthorne, who was at that time at W.R.U. (Ref. 1, pages 109-113), made the generalisation "almost always they (i.e. artificial requests based on known documents within the system) can be spotted when inserted among genuine requests". No supporting evidence for this statement has been produced and we cannot accept this assertion.

What is, of course, true is that genuine requests put to one I. R. system might be easily spotted if inserted among genuine requests put to another I. R. system. For instance, questions put to the I. R. system of a research library in a specialised subject field would be quite different to those put to the catalogue of a public library.

A slightly different aspect of prepared questions is whether they give false figures because of an unnatural matching between the language of the question and the language of the source document. This matter has generated such statements, as that of Mr. Fairthorne (Ref. 1, pages 109-113) "... tests using requests based on known documents necessarily tend to favour systems based on the actual words used in the document". No evidence has been produced to justify this or similar statements, and it would be difficult to do so. It would be verbal quibbling to argue that indexing can ever be based on anything else except the words in the documents; the fact that these actual words are translated into other symbols, which may be different words, groups of figures, non-meaningful combinations of letters, holes in cards, marks on tape, etc., is immaterial. The lead-in vocabulary is established by the documents being indexed and should be the same whatever index language is used. (For further argument on this matter see Ref. 3).

Countering such arguments, we find that some 286 non-source documents in the test collection were judged to be relevant, of which 42 were of the same level of relevance as the source documents. If the above arguments were correct, these non-source relevant documents should be definitely more difficult to retrieve. In fact, W.R.U. found 33, Cranfield found 30 (see Table 3.3, page 14). This recall ratio is slightly lower than the recall of source documents, but in view of the small sample, it is not significantly lower. Also of interest in this respect are the results of a small test using true questions. We obtained, from an industrial research library, 26 bibliographies which had been prepared by the information staff in reply to actual requests for information. It was assumed that the documents listed in the bibliographies have some relevance to the original information request; not to make this assumption would be a gratuitous insult to the information staff of the organisation who kindly made their material available.

From these bibliographies, 75 references were selected at random, at least one from each, never more than four. These documents were then

indexed by a new member of the project staff, Mr. M. Keen, and the entries inserted into the Cranfield index. Mrs. Aitchison, who had had no contact with this additional test up to this stage, then prepared search programmes for each of the questions, and searches based only on these programmes were made in the facet index. 60 of these documents were retrieved, giving a recall ratio of 80%. In the course of the searches, 316 other documents were found; it is unlikely that included amongst the total there would not be some other relevant documents, but even if we assume that they are all non-relevant, we still have a relevance ratio of 16%. 80% recall with 16% relevance is a very reasonable figure, matching almost exactly the points on the performance curve given in Table 3.8. Admittedly, one swallow does not make a summer, and we intend to use other sets of true questions on the Cranfield index, publishing the full results as a separate report. However, so far the experimental evidence appears to be supporting our reply to the arguments of the critics of our methods.

To turn now to the actual results of the tests and the consequent analysis, we have attempted to include in this report sufficient data to allow the reader to draw his or her own conclusions, and we would agree that there is scope for differences of opinion in the interpretations that are made. It is definite that the results of this test have exerted a considerable influence on the present research programme of the Aslib-Cranfield group (see Ref. 3), and the points which are made here will be those which have been particularly important in developing our views.

The W.R.U. system, designed, developed, tried over many years, is generally considered to be one of the most sophisticated I.R. systems in operation. Before the test started, we were convinced that W.R.U. would be able to achieve one of three results.

- a. Obtain a high recall figure
- b. Obtain a high relevance figure
- c. Obtain a recall figure and a relevance figure which would both be somewhat higher than that achieved with the Cranfield facet index.

The high level of exhaustivity of the indexing and the complex semantic factoring in the index language gave them the ability to achieve (a); the specific index language, with the added controls would allow them to achieve (b); the combination of these factors could bring about (c). It would be the W.R.U. search

programmes that would decide which figure was obtained, and we awaited the results of their searches with considerable interest.

In gloomier moments, we feared that they might obtain a combination of (a) and (b), something such as 95% recall and 50% relevance, and thus demolish our theories on information retrieval. In fact, the results did appear to upset the theories, but for the opposite reason, for the W.R.U. results were lower, both as regards recall and relevance, than those obtained by the Cranfield facet index. The original figures first quoted at Cleveland in April, 1962 (see Ref. 1) were particularly unfavourable to W.R.U., but later checking of exactly what was - as opposed to what we had understood was - on the W.R.U. tapes resulted in an improvement in the recall figures, so that there is no statistical significance in the difference between the Cranfield figure for recall of 85.3% and the W.R.U. figure of 81.4%. However, it appeared inexplicable that the relevance figure for W.R.U. should, at 7.5%, be less than half the 16% achieved by Cranfield for documents of high relevance.

In attempting to explain the difference between the performance of the two systems, Cleverdon suggested at Cleveland (Ref. 1) that it would be found to lie in the inability of the W.R.U. technical abstractors to do the concept indexing as effectively as the trained indexer at Cranfield. This was said before any analysis had been done, and proved to be incorrect. The indexing done by the W.R.U. abstractors was of a very high standard, and the omission of important concepts was negligible. In contrast W.R.U. staff felt that their search programmes were not satisfactory, and in this the analysis showed them to be correct. The main factor in W.R.U. failures to recall relevant documents was the relatively poor standard of many of their search programmes, a point strikingly illustrated by the analysis showing that the use of Cranfield programmes with W.R.U. indexing would have retrieved 73% of the W.R.U. failures. The W.R.U. weakness lay in failing to match the concepts used in the search programme with those in the question; either they were omitted entirely, or were used at a different level. These points, however, did not provide a satisfactory explanation of the discrepancy in the relevance ratios, and it was the analysis of reasons for recall of non-relevant documents which has shown the most probable cause. Of the sample of 200 non-relevant documents assessed a total of 441 reasons were found to be at least partly responsible, but, in 75% of the cases, the high level of exhaustive indexing was partly to blame. In 78% of the cases the search programmes were at fault; in 61% of the cases the index language shared the blame by permitting false drops.

Consider the main characteristics of the facet indexing at Cranfield. An average of seven concepts was used for each document as against thirty by W.R.U. This represents a much lower level of exhaustivity of indexing, and it is shown that thereby fewer non-relevant documents were retrieved on minor concepts. The second characteristic, which is quite contrary to the W.R.U. system, is that the separate concepts were pre-co-ordinated at the time of indexing. Undoubtedly the freedom of combining concepts in a post-co-ordinate system does enable a higher level of recall to be obtained, and the lack of permutation of the concepts was shown to have been partly responsible for failure by Cranfield to retrieve 30 relevant documents. However, from the analysis that was made on the W.R.U. non-relevant documents, it was shown that inter-fixing, which is given by the pre-co-ordination of concepts into a single theme, would have been for W.R.U. a very powerful device in preventing the recall of non-relevant documents. In addition, it appears that the grouping of elements, as in the facet notation, even when done without strict rules, implies to some extent the roles of the various elements.

Before continuing the argument, we now refer to Table 3.7, where is shown the effect on recall and relevance of decreasing the exhaustivity of the indexing. This table shows the inter-relationship of recall and relevance, clearly demonstrating that an improvement in one can only be gained at the cost of a decrease in the other. If we assume that the same search programme is being used in both cases, post-co-ordinate indexing must be expected to give a higher recall figure than pre-co-ordinate indexing, because of the practically inevitable failure of the latter to foresee correctly all possible useful combinations of the elements. In doing so, however, it will have a lower relevance figure. Since (for Relevance 2 document) Cranfield had a recall figure slightly higher than W.R.U., it appeared to indicate that we used "broader" search programmes than W.R.U. Theoretically, in doing this, the relevance figure should have dropped to that of a post-co-ordinate system. The fact that it remained twice as high could only be due, it was thought, to the combination of the following facts:

- (a) the pre-co-ordination of elements is a very powerful device in preventing the recall of non-relevant documents
- (b) the role indicators and levels used by W.R.U. are less powerful devices in preventing the recall of non-relevant documents
- (c) the role indicators and levels used by W.R.U. can prevent the recall of relevant documents.

This appeared a satisfactory and, on the evidence, a reasonable set of conclusions to have reached, but it was considered desirable to check their validity. This was done, as discussed in Chapter 4.4 by finding why Cranfield had not retrieved 50 of the 200 non-relevant documents that were retrieved by W.R.U., and also by a detailed comparison of search programmes, as given in Table 2.1. After this had been done, no evidence was available to justify (a) above; (b) and (c) can remain as contributory factors. However, two particular points emerge from this further analysis, and suggest two fresh hypotheses. Firstly, indexing beyond a certain level of exhaustivity will lead to a major drop in relevance and this will occur without necessarily achieving a corresponding improvement in recall. Secondly, and most interesting, it appears that omission of an important concept in the search programme (which was a major cause of W.R.U. errors) can quite frequently result in failure to recall relevant documents, at the same time as it results in additional recall of non-relevant documents.

Both these hypotheses are modifications to the basic argument of the inverse relationship of recall and relevance, and will have to be tested most carefully in the present main project. This work has been considerably influenced by this test, which has strengthened our view that the present Aslib-Cranfield project (described in some detail in Ref. 3) is aiming at the correct objective, in evaluating the effects of different levels of exhaustivity of indexing and search programmes in relation not to complete index languages or systems, but to the various devices which are used to make up a complete index language.

All such devices can be divided into two groups; either they are intended to improve recall or they are designed to improve relevance. This can be shown by Fig. 5.

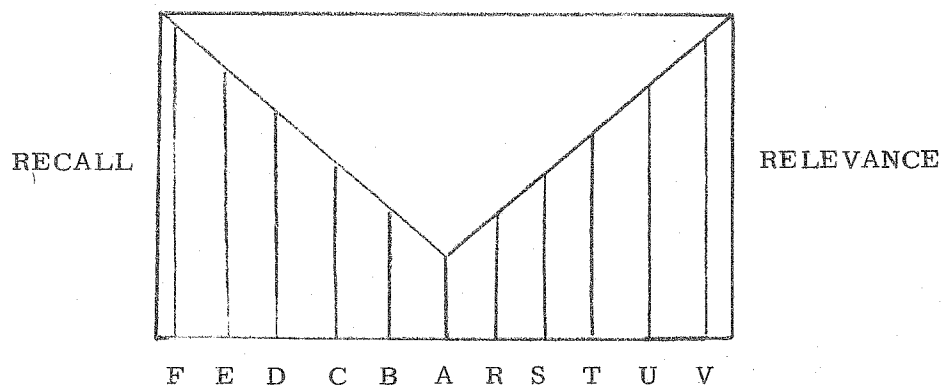


FIG. 5. VARIATION OF PERFORMANCE WITH INDEXING DEVICES

Assume that A represents the simplest possible index language, using uncontrolled natural language terms, and operating under the fixed rule that only a single term can be used for each search. Such an index language would, in a given situation, have a certain recall ratio. To this index language A, we now add the device of combining synonyms to produce index language B. All documents retrieved by A would also be retrieved by B, plus other documents which had used synonymous terms, with the probable result that the recall ratio is increased. To B now add the further device of confounding word endings to produce index language C. Again all documents recalled by B will be retrieved, plus any additional documents retrieved by the confounding of word endings. These devices, it will be noted, are reducing the number of separate terms in the index language and this process can be continued in a number of ways by devices which form new groups of terms, such as, for instance, "see also" instructions, use of thesaurus headings, or semantic factoring. Index languages containing such devices will, as represented by D, E and F, all lead to improved recall.

Inevitably, however, this improvement in recall will (if, as we assume, exhaustivity of indexing and search programmes is held constant) result in a lowering of the relevance ratio that was obtained by index language A. One attempts, therefore, to balance this drop in relevance by including in the index language, devices which are intended to improve relevance, and these are shown on the right hand side of Fig. 5. The order in which these are considered is quite arbitrary, since the order in which they can be most satisfactorily used is by no means agreed. However, let us start with co-ordination of terms, giving index language R. Instead of retrieving all documents which were indexed by either x or y, we now demand documents that were indexed by x and y. In so doing, we have reduced the number of documents retrieved, by eliminating all documents which do not deal with these two concepts conjointly. To this index language R, add now the device of interfixing, thus ensuring that, if information is required about 'copper pipes', the system does not produce a document which deals with 'copper coating of lead pipes'. Eliminating such false drops will again improve the relevance ratio. For index language T, a further device, such as "weighting" is added, thus ensuring that minor concepts will not be retrieved if major concepts are required; on this "roles" can be superimposed to improve still further the relevance ratio. This improvement, it should be noted, is never achieved by such devices locating extra relevant

documents, but only by eliminating non-relevant documents.

At the completion of the second Aslib-Cranfield Project, it is hoped that it will be possible to give actual figures for the effect on recall and relevance of each of the devices listed, but to illustrate the present argument, we assign arbitrary figures. Assume that the simple index language A was operating at 75% recall, and that each recall device gave 4% improvement, so that the potential recall figures for the other index languages would be

Index Language B	79%
C	83%
D	87%
E	91%
F	95%

Assume also the index language A achieved the recall ratio of 75% at a relevance ratio of 15%, and that each additional device improved the relevance ratio by 2%, so that the potential relevance figures would be

Index Language R	17%
S	19%
T	21%
U	23%
V	25%

If these performance figures are superimposed on a conventional performance curve for this subject field, the position is as in Fig. 6.

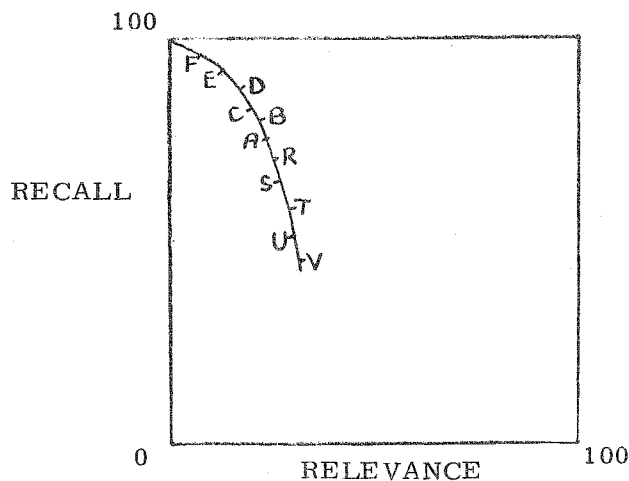


FIG. 6. Effect of adding various devices to basic index language.

With index language A, it is known that it has a single operating point, namely 75% recall at 15% relevance, and it has no flexibility in performance which allows it to move from that point. If we make a new indexing language which combines the devices used in B and R, then it is possible to introduce variations into the search programme used, and the performance can range between points B and R on the graph. Combine the devices of C and S, and the performance range is increased, and so on until, by combining all the devices of F and V, one has an index language which can give either 95% recall at about 7% relevance, 25% relevance with about 45% recall, or any intervening point on the curve. Such an index language would, in fact, have the maximum possible flexibility of performance; the price to pay for this is the extra time-cost entailed, certainly in the compilation and probably in the use, e.g. W.R.U. require 5 hours to programme a question of average complexity (Ref. 1, page 207); Cranfield completed a search in average time of 9 minutes). However, this flexibility of performance may be required in some cases, such as that of a patent department in an industrial organisation. Here there are two distinct requirements. To make certain that one of the firm's proposed patents will not infringe any existing patent, it is necessary for the staff to find, ideally, every patent which might be relevant; in other words, this situation demands maximum possible recall. On the other hand, if it wishes to invalidate a proposed patent of another organisation, it does not need to have every document which could invalidate the claim, but is quite satisfied if it can find a couple such; in this situation, the need is for maximum relevance.

The W.R.U. index language includes many of these devices considered in the previous pages. The semantic factoring enables it to retrieve at several different levels of specificity, and the more general the term used, the greater the expectation of high recall. In addition the high level of exhaustivity of indexing (a policy decision which is, it should be noted, quite divorced from their index language) could also be expected to result in high recall. To balance these factors, the index language makes use of the devices of co-ordination, roles and levels, which should enable them to obtain when required, a high relevance ratio.

To use an index language which is capable of this nearly maximum flexibility of performance and then to operate it at a level could be obtained by a simple index language containing no complex devices, is to obtain the worst of both worlds. In fact, in this particular test, W.R.U. appear to have operated in this way, not, we suspect, from deliberate choice, but rather because of the difficulties involved in operating consistently at any other level. It is doubtful if any other organisation has done more than a small fraction of the analysis of searching techniques which has been undertaken by W.R.U. The fact that they are still not operating at maximum efficiency is in no way a reflection on the staff at W.R.U., but is rather an illustration of the immense difficulties which are encountered in trying to solve practical, as apart from theoretical, problems of information retrieval.

Nothing which has been written should be taken as in any way expressing opinions on the importance, relative to each other, of recall and relevance. Different organisations will, as mentioned above, have requirements which make one more desirable than the other. Questions to individuals on this point tend to produce replies ranging from the vague requirement "Maximum possible recall with not too many non-relevant documents", to the statements of the naive who claim that their own pet system meets their requirements by giving 100% recall with 100% relevance. In fact, the acceptable relevance ratio seems to be the determining factor, and this can depend on many things, such as the size of the document collection, or the number of searches in relation to the number of documents indexed. Possibly the average number of documents retrieved in each search in the present test does not appear excessive, but it has to be remembered that the collection of documents was small. Assuming a collection of 50,000 documents, the average Cranfield search would have recalled some 330 documents, while W.R.U. would, on an average, have recalled 700 documents, with one search in eleven bringing out anything from 2,000 to 6,000 documents.

Any question of the possible saving in time-costs by the use of a computer as not within the scope of this test. As purely personal opinions, we are in agreement with the views expressed by Professor Ralph Shaw, in a recent paper concerning the inadvisability of using computers for I.R., but we would not try to adduce from these test results any support for this opinion in respect of time-costs. The fact that these were at least twenty-five to one in favour of the conventional card catalogue is quite incidental, but it is possibly more relevant to examine the implication which is so often made, that machine searching adds an extra dimension which is not available with more conventional methods, so that the retrieval potentialities with a computer are on a different level than those that can be obtained, for instance, with a card catalogue.

There is absolutely nothing revealed by this test or by the analysis which can begin to justify any such assumption. The analysis of the search programmes used by the two groups did not reveal any fundamental difference. Admittedly, a complete search programme of W.R.U. appears, to the uninitiated, to be forbiddingly complex, but it is, in reality, a number of relatively simple separate programmes, which compare very closely with the programmes used at Cranfield. The computer as such could do nothing which would bring about an improved recall of relevant documents or prevent the recall of non-relevant documents.

The original purpose of this test was to measure the effectiveness of the W.R.U. index; the happy chance of using a small collection allowed the documents to be indexed also at Cranfield, with the result that it was possible to expand the scope of the work considerably. The first Aslib-Cranfield project appeared to establish certain basic points which are now, in fact being supported by independent work (e.g. References 4 and 5). Arising from the test, one sees that the high level of exhaustive indexing employed by W.R.U. is not completely justified by the results. Clearly an additional input cost must be involved with every extra concept; the improvement in recall of the most relevant documents is very small, while the cost in relevance is high. It is true that W.R.U. appeared to show, as compared to Cranfield, a significant improvement in recall with lower relevance documents, but even this gain is wiped out by changing the Cranfield index from pre-co-ordinate to post-co-ordinate. As would be expected from the analysis of Cranfield failures, the number of relevant documents retrieved in a post-co-ordinate index rose from 278 to 305, giving a recall ratio of 76.3% (as against the W.R.U. recall ratio of 75.8%). What could not be forecast precisely was the number of additional non-relevant documents that would be retrieved; the searches showed that, using exactly the same programmes as in the main test, the total number of documents recalled rose from 821 to 1020, so at 29.9% the Cranfield relevance figure was still significantly higher than W.R.U. at 17.7%. This post-co-ordinate search of the Cranfield indexing also raised the recall figure for Relevance 2 documents from 85.3% to 90%, with a lowering of the relevance figure from 16.2% to 13.8%. It will be noted that there is here a change from the 3:1 ratio for recall and relevance, which was suggested in Chapter 4 as being normal in the operating range of a system in this particular subject field. In this area it drops to 2:1, and this, of course, is due to the fact that in this range the performance curve is starting to level out.

The figures given in the previous paragraph are, to our knowledge, the first which show precisely the effect of pre-co-ordinate and post-co-ordinate indexing when other possible variations are held constant, and illustrate yet again the inexorable fact that improved recall can only be obtained at the cost of lowered relevance. To argue that the use of certain devices such as roles, levels, interfixing or weighting, can significantly improve the relevance figure without affecting recall, would be to go against all the analyses of W.R.U. failures which are contained in this report. Admittedly, the contrary has not been proved, but the present Aslib-Cranfield project should be able to settle this matter, in one subject field at least. This latter qualification has to be made, for logic suggests that the more precise the terminology of a subject, the more benefit might be obtained by the use of relevance-improving devices.

The other main point thrown up by this test is the difficulty of preparing consistently reliable search programmes. As a facile comment, one might say that W.R.U. frequently tried to be too "clever"; they distrusted the question as given to them, and did not match the search concepts with the concepts in the question. Yet here, probably more than anywhere else, one must hesitate to condemn W.R.U. for doing this, since their experience of searching with actual questions, as against the prepared questions used in the test, may have convinced their programmers that this was, in fact, the better approach. More significant, perhaps, was the fact that less than one-third of the search programmes included any role indicators, stressing again the difficulties involved in the use of relevance-improving devices.

For any organisation which is contemplating the carrying out of a test of this nature on an existing system, an account of some of the practical aspects of this test is given in Appendix 5A.

CHAPTER 6

TEST OF PATENT SEARCHES

As a supplement to the main test on the W.R.U. index, we were pleased to accede to a request by Mr. S. Newman on behalf of the National Academy of Sciences, that a further comparison test should be made of the Uniterm Index to Chemical Patents (issued by Documentation Inc.) as against searches by Mr. L. Field, a member of the firm of Grobman and Field, Patent Attorneys. For this purpose ten questions were used having patents as the source documents. These questions were sent to the two groups, with four other questions which did not have patents as source documents, the intention of this being to complicate the searches by adding some uncertainty as to whether or not there must be a "correct" answer. The ten questions were included in the main test, and were searched by W.R.U. and Cranfield. The results of all the searches in relation to the retrieval of the source document are given in Table 6.1.

<u>Question No.</u>	<u>Patents</u>	<u>Mr. Field</u>	<u>Uniterm</u>	<u>W.R.U.</u>	<u>Cranfield</u>
Q 122	2979814	S (2)	S (4)	S	S
Q 123	2978369	S (5)	S (16)	S	S
Q 124	2977260	F (3)	F (6)	S	S
Q 126	2977222	S (12)	S (19)	S	S
Q 128	2974038	S (2)	S (7)	S	S
Q 129	2974033	F (9)	S (21)	S	S
Q 132	2972530	S (10)	S (14)	S	S
Q 133	2971753	F (1)	F (18)	S	S
Q 136	2967792	S (9)	S (29)	S	S
Q 137	2967769	S (4)	S (6)	S	S

TABLE 6.1. RESULTS OF PATENT SEARCHES

Figures in brackets represent number of patents retrieved

It should be mentioned that the search by the patent attorneys was limited to Classes 29, 75, 148, 266, and sub-Classes 43, 44, 55 and 68 in Class 106 and sub-Class 53 in Class 263. The source patent 2971753 for QP8 was classified in 263/52 and therefore could not have been retrieved. It may be noted that the one patent which was retrieved in this search (2956906) was assessed as being equally relevant, and

it might be a matter for comment as to why two such related documents should have been in separate classes with no cross reference.

In such a small test, with varying conditions between the two groups, it is difficult and dangerous to attempt to work out any detailed figures. The searches by Mr. Field cannot give comparative figures, since once he had decided on the field of search, he went straight to the files and examined each patent in the sub-class outlined. The 57 references which Mr. Field listed are therefore only those which, after personal examination, appeared to be of possible interest. On the other hand, with the Uniterm Index, the searches were carried out in the normal way and the documents retrieved were the complete set of those that met the requirements of the search programmes.

The patents retrieved by both groups are listed in Appendix 6A, together with the relevance assessment assigned to them by the question compiler. Not all were assessed in this way, and the efficiency figures are based only on those non-source documents which have been so assessed. This gives a collection with a total of 77 documents, with the characteristics as set out in Table 6.2.

	Documents	Retrieved by	
		Field	Uniterm
Relevance 2	11	8	8
Relevance 3	26	21	17
Non Relevant	40	17	29
Total	77	46	54

TABLE 6.2. Breakdown of patents assessed for relevance

From this the recall and relevance ratios can be obtained, and these are shown in Table 6.3.

	Field		Uniterm	
	Relevance 2	Relevance 2 & 3	Relevance 2	Relevance 2 & 3
Recall	73%	77%	73%	64%
Relevance	17%	63%	15%	46%

TABLE 6.3. Performance figures for patent searches

The high figures obtained by Mr. Field are due to his personal assessment of every document; the unusually high figure for relevance of Uniterm is due to a

"weighting" which has been given to their recall figures by including the assessment for patents which were also assessed for Mr. Field.

In fact, in whatever way one tries to manipulate the figures by making allowance for various factors, it is impossible to arrive at anything which can be considered valid. It is, in fact, obvious that this test was on too small a scale to have any real scientific value.

CHAPTER 7

CONCLUSIONS

This test has compared the performance of two separate I.R. systems, which operated under widely varying conditions, and which were, moreover, based on different philosophies. The Cranfield index was possibly slightly more detailed than would be conventionally found in an industrial research library, but it was of this genre. It showed many of the faults that can be expected under such circumstances; careless clerical errors in transcription and evidence of insufficient regard to minor concepts in indexing. The W.R.U. index, on the other hand, was of a kind that few organisations could contemplate for their exclusive use. The indexing was thorough and of a very high standard. The clerical operations were carried out far more meticulously than at Cranfield. The index language was detailed and complex.

One might say, not unfairly, that if the Cranfield philosophy was to have an index which operated below maximum efficiency but which was economically acceptable, the view of W.R.U. was that no expense should be spared to have an index as near perfection as possible. Unexpectedly, their striving for perfection resulted in an operating performance which was no better than that of Cranfield, and an economic performance which, clearly, compared very badly.

Is one, therefore, justified in condemning the work that has been done at W.R.U. ? We would unhesitatingly reply in the negative, for the general direction is undoubtedly correct even if an occasional wrong turning has been taken. Probably the most important factor in the present operating performance is their level of exhaustivity of indexing. None of the index language devices which are intended to maintain a high relevance ratio, act as a satisfactory check on this high level of exhaustivity in indexing. We would query whether such a level is in any circumstances justified; if it is definitely shown to be so justified, then there must also be included a compensating device, specifically designed to mitigate the resulting weakness; 'weighting' appears an obvious choice. The 'levels' used by W.R.U. appear to be somewhat complicated to apply and yet are comparatively of little value in eliminating non-relevant documents. On the evidence of the analysis, the relatively simple device of interfixing would appear to be more useful, but further investigations on this point are required.

This test confirms the practically total lack of importance of the arrangement

of terms in the index language. Many working in the field of information retrieval believe that a new classification, 'association of terms' or similar idea will be the philosopher's stone that will transform the dross of present techniques to the pure gold of perfect I.R. systems. The analysis of this test shows yet again the insignificant difference which would have been made to the results by any variations in the grouping of the terms within the index language, and it is doubtful whether the considerable effort which has been put by W.R.U. into their semantic code can be justified, either operationally or economically.

Finally we can see from the test the difficulties in, and the importance of, preparing good search programmes. Here the computer, as used by W.R.U., is possibly adding to their difficulties. Logically, a series of separate programmes should be tried in descending order of probability of relevance. If the request is for ABCD, then document indexed ABCD and nothing else, must be considered to be of maximum relevance. From this there can be many graduations of relevance, by omitting a concept entirely, by substituting a concept at a different level, by substituting one concept by another, or by combinations of these variations. A conventional card catalogue is able to carry out such separate searches in the most appropriate order, and stop whenever the results show that further searches are unnecessary. W.R.U., on the other hand, had to combine, into one complete search, all the separate search programmes which were, inevitably, of different degrees of relevancy. It is true that a computer could print out results based on the probability of relevancy; unless it does so, it will be less satisfactory than a manual method.

Some organisations, which use computers for searching, do have programmes which permit the recall of separate searches to be printed out in an order of the probability of relevancy. There is nothing in this test which in any way indicates that a computer is more effective as a retrieval mechanism than a conventional card catalogue, but plenty which suggests that it is vastly more expensive. However, it does appear that if a computer is to be used, it must simulate as far as possible the search procedure in a card catalogue, and be able to print out results in an order of probable relevance.

Finally, we see that W.R.U. have a system which has a potential range of performance which is wider than that of the Cranfield index. However, in spite of all the investigations which they have already carried out, it appears

that more work is necessary, almost certainly involving modifications in procedure, to enable them to make full use of the potential.

REFERENCES

1. Center for Documentation,
Western Reserve University. Information retrieval in action. Proceedings of a Conference held at Cleveland, April 1962. The Press of Western Reserve University. 1963.
2. Cleverdon, C.W. Report on the testing and analysis of an investigation into the efficiency of indexing systems. Cranfield. 1962.
3. Cleverdon, C.W. and Mills, J. The testing of index language devices. Aslib Proceedings, Vol. 15, April 1963, pp. 106-30.
4. Painter, A.F. Thesis. Rutgers University. 1963.
5. National Science Foundation. Current Research and Development in Scientific Documentation, No. 11, 1962, Section 2.83 'National Bureau of Standards'.
6. Perry, J.W. and Kent, A. (eds.) Tools for machine literature searching. New York, 1958.
7. Taube, M. A note on the evaluation of the W.R.U. Semantic Code as an example of generic coding. American Documentation Vol. 13, 1962, pp. 185-6.
8. Vickery, B.C. On retrieval system theory. London. Butterworths, 1961.
9. Binns, J. and Bagley, D. The English Electric faceted classification for engineering. 3rd ed. English Electric Co. Ltd. 1961.
10. Vickery, B.C. Classification and indexing in science. London, Butterworths. 1961.
11. Aitchison, J. Classification Research Group Bulletin No. 7. J. of Documentation, Vol. 18, 1962, pp. 80-88.

APPENDIX 1A

THE WESTERN RESERVE UNIVERSITY INDEX LANGUAGE FOR METALLURGY

The Western Reserve University indexing language is one of the most complex co-ordinate systems yet developed. It has three distinctive features: (a) generic relationships built into the code by means of semantic factoring; (b) role indicators; (c) punctuation in the abstract. While the first device is intended to obtain maximum recall, the last two devices are designed to prevent unwanted association between the terms indexed, and thereby improve the relevance. A full account of the language is given in "Tools for machine literature searching", Chapter 5 (Ref. 6), but a short summary of the salient points is given here.

The Semantic Code

The basis of the semantic code is the semantic "stem" or group of homogeneous terms. The semantic stem is represented by a four digit code, three characters and a dash. For example, the groups of terms 'Deflection' is coded D-FL (see excerpts from the W.R.U. code, Appendix 1B). There are about 250 of these basic groups of terms. The individual terms are built up by inserting a one character "infix" in the three character stem and possibly by appending a four digit suffix, as for example, with the term 'deform' which is encoded DUFL 1006. There are 13 analytical infixes which allow for the expression of fine differences of meaning. These infixes are:-

- A is a
- E is made of
- I is a part of
- O is made up of several
- Q makes use of, is produced, by means of
- U is used for, produces (frequently used for verbs ending in ing)
- V acts upon
- W brings about, affected by, is acted upon by (frequently used for verbs ending in ed)
- X is characterized by the absence of
- Y is connected with, characterized by, characteristically
- Z resembles, but is not
- *P is characterized by an increase of
- *M is characterized by a decrease of

* Rarely used.

The effect of the infixes inserted in the stem D-FL 'Deflection' illustrates the shades of meaning which may be produced.

DAFL 1006 Deformation

DUFL 1006 Deform

DWFL 1006 Deformed

The numerical suffix distinguishes between the terms having the same stem and infix.

DUFL 1004 Bending

DUFL 1006 Deform

Some terms, such as 'deformation' and 'bending' may be coded by one semantic factor, but many terms have a combination of semantic factors built into the code. For example,

	DYFL 1006	CYTT 1002	PAPR 1001	Shear Stress
where	D-FL	is	Deflection	
	DYFL 1006	is	Deformation	
	C-TT	is	Cutting	
	CYTT 1002	is	Shear	
	PAPR	is	Physical property	
	1001	Distinguishes this term from all other terms having the same factor.		

A maximum of four semantic factors may be combined to form a code for a single term, but even with this limitation, there is the danger of assigning dissimilar factors to essentially related terms. Mortimer Taube has recently (Ref. 7) criticised the codes given to antibiotics, alike in composition, which had only one semantic factor in common. Vickery (Ref. 8) has also noted that terms, quite as complex in derivation as those given four factor codes, are sometimes assigned codes with one factor only.

Role Indicators

The purpose of the role indicators is to "designate the manner of involvement or role of the term which is to be prefixed". The role indicators show that a term is for example, a "process" and not a "property", that it is a "starting material" and not a "product", or that it is a "minor component" and not a "major component". Role indicators extend the meaning of the term, but do not link the terms with other terms in the abstract. The W.R.U. scheme

employs the following role indicators :-

KEJ	material processed
KUJ	major component
KIJ	minor component
KOV	property given for
KWV	property given
KAM	process
KQJ	means of process
KAH	condition of process
KUP	property affected or determined by process
KAP	property affected by KAL
KAL	factor influencing KAP
KWJ	product
* KAD	machine or apparatus
* KAG	subassembly of machine or apparatus

* Not used on 1962 tapes: KQJ is substituted.

An illustration of the use of the role indicators is shown in an example taken from Chapter 5 of "Tools for machine literature searching" (Ref. 6).

Document	Ac metal was obtained by the reduction of the Ac fluoride by Li vapour	
Abstract	KEJ (material processed)	Ac fluoride
	, -KAM (process)	reduction
	, KQJ (by means of)	vapour
	, KUJ (component)	Li
	, -KWJ (product)	Ac metal

Telegraphic punctuation

Telegraphic punctuation gives an orderly arrangement to the terms and role indicators in the abstract. It creates a standard pattern of subphrases, phrases and sentences to which the abstractor has to conform.

Subphrases The sub-phrase is the combination of one (or more) role indicators with the term to which it is prefixed, for example,

KEJ (material processed) Ac fluoride

Phrase The phrase, or "set of closely related terms" is the basic unit in the punctuation system. There are five standard phrases, and these are

printed on work sheets, known as role indicator charts, to guide the abstractor. The five basic combinations of role indicators allowed are:-

1. Material processed/
Property given

KEJ	(material processed)
KUJ	(major component)
KIJ	(minor component)
KWV	(property given)

2. Process

KAM	(process)
KQJ	(means of process)
KAH	(condition of process)

3. Product

KWJ	(product)
KUJ	(major component)
KIJ	(minor component)
KWV	(property given)

4. Property determined or influenced

KUP	(property determined)
KAP	(property affected)
KAL	(factor influencing KAP)

5. Material

KOV	(property given for)
KUJ	(major component)
KIJ	(minor component)
KWV	(property given)

Variables of the basic combinations are allowed, the most common being:-

1.	2.	3.	4.
..KEJ KWJ,	.KAM,	.KWJ KEJ,	..KUP KAP,
.KUJ,	.KQJ,	.KUJ,	.KAL,
.KIJ,	.KUJ,	.KIJ,	..KUP KAP KAL,
.KWV,	.KIJ,	.KWV,	.KUP KAP,
..KEJ KQJ,	.KWV,	.KWJ KQJ,	.KAL,
.KUJ,	.KAH,	.KUJ,	..KUP KAP,
.KIJ,		.KIJ,	.KUP KAL,
.KWV,		.KWV,	
..KEJ KUJ,		..KWJ,	
.KEJ,		.KUJ,	
.KIJ,		.KIJ,	
.KWV,		.KWV KAP,	
..KEJ,		.KAL,	
.KUJ,			
.KIJ,			
.KWV KAP,			
KAL,			

Using the completed work sheets the phrases are then built up into sentences, again according to standard patterns.

Sentence

A sentence may cover "a product and its manufacture, a process and related initial and final materials, a testing operation and related instrumentation, material tested and properties determined, and the like".

Paragraph

A paragraph is a "set of sentences and is more often than not co-extensive with the abstract itself", but it can be used to distinguish between widely different subjects in one abstract, as when conference proceedings, for instance, are indexed.

Levels in the search programme

Levels in the search programme and punctuation in the abstract are complementary. By stating the level required, the machine can be programmed to select terms within certain limits designated by the punctuation. Levels can be compared in the natural language as follows:

- level 0 - basic concept of a class (e.g. F-ST = fastening)
- level 1 - subclass (e.g. F-ST 1008 = fastening - specifically welding)
- level 2 - a word, combination of concepts (level one is a word too)
- level 4 - a phrase (e.g. a noun with its modifiers) (N.B. Sub-phrase in Telegraphic punctuation)
- level 5 - a sentence (N.B. Phrase in Telegraphic punctuation)

- level 6 - a chapter (or a document in its own right) with a singular subject) (N.B. Sentence in Telegraphic punctuation)
- level 8 - a book (or a document) with various subject i.e. within level 8 there could be any number of level 6. (N.B. Paragraph in Telegraphic punctuation).

In the machine language levels are distances from one particular symbol to another, so when a level requirement is stated, everything that is within the symbols for that particular level is searched and identified.

In machine terms levels are:

- level 0 - a combination of four characters (numeric or alphabetic)
- level 1 - computer recognizes it as a combination of a zero level semantic code followed by a period and a four digit number. The first digit of that number is always one.
- level 2 - a distance between the comma written after the role indicator and the comma after the word. While automatically encoding a comma is punched after each word.
- level 4 - a distance between a dot in front of one role indicator and a dot in front of the next role indicator.
- level 5 - a distance between two dots in front of a role indicator that starts a phrase and the next two dots in front of a role indicator that starts the next phrase.
- level 6 - a distance between a box and three dots (. . .) in front of a role indicator til next box and three dots.
- level 8 - a distance between the slash (/) of the preceding document up to the next slash (which represents the end of a single record).

Level three and seven are not defined at the present time.

Within a higher level there could be any number of lower levels.

Excerpt from W.R.U. Code-English Dictionary

PASS.	TOMS:	2X.	AERATION
DUFF.			DISTRIBUTED
DWFF.			016.
RANG.			DISTRIBUTION
DYFF.			016.
RAPR.			STRAY
DYFF.			001.
DOFF.			DISTRIBUTION SYSTEM
16X.Supp.			001.

D. F. L.

[illegible]

D-T-R. Corrosion, erosion, and other physical or chemical deterioration.

[illegible]

F. B. I.

Fiber

FABR.	001*	FIBER
FABR.	001*	FIBRE

APPENDIX 1C

THE ENGLISH ELECTRIC FACETED CLASSIFICATION FOR ENGINEERING

The English Electric Faceted Classification for Engineering (Ref.9) is one of several subject classifications constructed by facet analysis, a technique originated by Ranganathan, and developed by members of the British Classification Research Group from 1950 onwards.

1. Characteristics of Facet Classifications

Facet analysis is not easy to define. For one reason, even leading exponents of facet analysis do not interpret all aspects of the technique in the same way. Again, there may be confusion when seeking illustrations of the method in practice, as most "pure" facet systems have some sections which appear little different from the hierarchies of a conventional classification system, while supposedly non-facet, enumerative systems, such as the U.D.C., (especially in its later revisions) have tables which have, consciously or unconsciously, been facet analysed. All the same, there are certain features which facet analysis gives to a classification system which should distinguish it from other forms of schedules. The English Electric classification shows all these distinctive features.

1.1 Fundamental categories replace traditional main classes.

Conventional classification systems have main classes corresponding to the traditional divisions of knowledge, based on the "scientific and educational consensus". This imposes on the system a rigid framework, which becomes outdated as the pattern of knowledge changes. The practice in facet classifications is to ignore the academic divisions of knowledge and to seek new primary classes. The main classes of a facet system are not traditional subject fields, but "fundamental categories". Ranganathan was the first to recognise the use of the fundamental, or basic category in schedule construction. He argued that all concepts fell within one of five categories: personality (the "thing" itself): matter: energy: space: and time. Subsequent writers while considering "P.M.E.S.T." categories helpful, have not regarded them as immutable. Vickery (Ref.10 p.23) shows that fundamental concepts can vary between subject fields, but on the whole the number of possible categories seems limited, and they remain fairly close to those isolated by Ranganathan. This is very much the case with the fundamental categories in the English Electric classification.

Industries (Personality)
Machines and systems (Personality)
Ancillary plant and components (Personality)
Materials (Matter)
Physical phenomena (Energy)
Operations (Energy)
Agent (Instruments and equipment) (Personality)
Language and form divisions
Geographical divisions (Space)

Within the fundamental categories, concepts are analysed into more specific groups and categories. The first division in most facet systems is into the main "facets" of the scheme, that is the main notational blocks. In the English Electric scheme, the main facets are as follows:

A Industries
B/E Machines and Systems
B Electrical Systems and Machines
C Telecommunication Systems and Plant
D Mechanical and Thermal Plant and Machines
E Transport Systems and Machines
F/K Ancillary Plant and Components
F Special Components
G Electric and Electronic Circuits
H Electric Ancillary Plant and Components
I Electric Components
J Mechanical Sub-Assemblies and Components
K Mechanical Components
L/N Materials
L Materials According to Use
M Materials According to Composition: Compound Substances
N Materials According to Composition: Elements, Metals, Alloys
O/T Physical Phenomena
O Chemical Phenomena and Properties
OA Astronomical, Geological and Meteorological Phenomena
P Physics of Solids
Q Fluid Mechanics, Heat, Thermodynamics
R Electricity and Magnetism

S	Nuclear, Atomic and Molecular Physics
T	Theoretical Physics, Mechanics, Sound, Vibrations, Light
U/Y	Operations
U	Specialised Operations
V	Production Engineering
W	Management
X	Control, Testing and Analysis
Y	Mathematics
Z	Agent
	Instruments and Equipment

These main facets were analysed into further groups and categories as the concepts in them demanded. The primary breakdown of the facet B 'Electrical systems and machines', for example, is as follows:-

Ba	Electrical machines in general
Bb/c	D.C. machines
Bd/h	A.C. machines
Bj	Motor Generator sets
Bl	Direct Conversion devices
Bp/t	Power systems
Bq/t	Transmission and distribution
Bw	Electronic Plant and machines

1.2 Homogeneity of concepts within categories and facets

Classification theorists have long advocated that classes should be divided by "well-defined characteristics" to produce the sub-classes which are "mutually exclusive", but a conventional enumerative system cannot hope to have categories as consistently homogeneous as those in a facet system. Conventional systems enumerate the contents of traditional subject fields, sometimes in a logical and orderly way, sometimes not. The sub-classes produced may or may not include terms which are homogeneous, but in any case, if all the "entities" in one subject field are to be listed, terms with different basic characteristics will appear together in that class. For example, the class 625.7 'Highway engineering' in U.D.C. has three sub-classes in which the concepts are reasonably homogeneous, but one sub-class is concerned with 'Highways according to purpose' ("the thing itself", Ranganathan's "personality" category), another with 'Road construction' (process) and the third with 'Paving of roads. Wearing surface' (materials). In contrast,

in a facet system all terms in the facets and their further sub-divisions have the same basic characteristics. For example, in the English Electric scheme, in the facet N 'Metals', there is no mention of any concept which could be classified as a property or a process. Further, before each step in the division of the facets the new characteristic of division is clearly stated, so that the homogeneity of each new group of concepts is assured. See, for example, the division of the category Hh 'Switches' in the English Electric scheme.

Hh	Switches, Switchgear
	<u>By method of connection:</u>
Hhb	Interrupters
Hhc	Contractors
Hhd	Relays
Hhdd	Polarised, hinged, armature
Hhdg	Differential
Hhdl	Slugged
Hhdp	Line
Hhdy	Buchholtz
Hhe	Isolation switches
Hhf	T.R. Switches
Hhg	Selector switches
Hhgb	2-way reversing
Hhgc	Multi-way
Hhgd	Uniselectors, step switches, rotary switches
Hhgm	Combination switches
	<u>By operating mechanism:</u>
Hhh	Beam switches
Hhi	Key switches
Hhj	Lever switches, knife switches
Hhl	Drum switches
Hhm	Push button switches
Hhn	Toggle action switches
Hho	Sliding switches
Hhp	Rolling switches
Hhq	Butt switches

1.3 Unique location of concepts

In facet analysis concepts are defined by their basic characteristics, and are usually given a unique placing in the schedules, whereas in an enumerated system they may be listed as they occur in not one, but possibly many, subject fields. For example, the concept "glass" in the U.D.C. is mentioned in several different schedules.

Glass technology	666.1
Glass. Melting and working	666.1.03/05
Glass. Breakage insurance	368.186
Glass. Building material	691.6
Glass. Insulating material	621.315.612.6
etc.	

In the English Electric scheme 'glass' occurs once only, classified by composition in the category L/M 'Materials' at Md. It can be combined with other class numbers to express the subjects enumerated individually in the U.D.C., e.g. Lb Md 'glass insulation' and Md Wi 'glass insurance'. There are some concepts which are located in more than one place in the facet schedules, for example, 'waves', which occur under electromagnetism and also under fluid dynamics, but these are all terms with more than one distinct meaning. In other facet schemes, it is also found necessary to place terms with only one meaning in more than one category when the "generic relations of certain concepts are not suitable for another section" (Ref.3, p.37); this arises infrequently in the English Electric scheme). A side effect of unique placing of concepts is to reduce the size of facet schedules, and this does facilitate handling.

1.4 Synthetic Capacity - freedom of concepts to combine

The foregoing characteristics of facet schemes, namely fundamental categories, homogeneity within categories and unique location of concepts, produce concepts which are clearly defined, easy to locate and free to combine with any other term within the schedules. This is in contrast to enumerative systems where concepts are already tied to other terms, so that the indexer may have to examine many class numbers to see in which one the concept is associated with ideas nearest the subject of the document being analysed. In some cases there may not be a class number which exactly fits the requirements of the document, so that a number has to be used in the new combination which brings with it an unwanted and misleading association. An example of tied concepts is found in

the U.D.C. treatment of "supporting structures". There are places for the term at -210/219 machines and apparatus, at 77.07 for photographic equipment, for vehicles at 629.015, for insulators at 621.315.65, whereas in the English Electric scheme there is only one place for the subject, Kb under components, which is easy to locate and free at once for combination.

Be	Kb	A.C. Machines - supports
E1	Kb	Automobiles - supports
Hx	Kb	Insulators - supports
Kd	Kb	Valves - supports
Uv	Z Kb	Photographic equipment - supports.

Using the facet scheme, the selection of class numbers for co-ordination becomes a semi-clerical operation, compared with the intellectual difficulties which arise when co-ordination is attempted with an enumerative system.

2. Methods of Co-ordination in Facet Classifications

2.1 Preferred Order

The first Cranfield project tested a facet system and found defects in the technique of combining concepts in preferred order. Until then, most exponents of facet analysis were convinced that a preferred order was the most effective and economic method of pre-coordination. The English Electric scheme, designed before the Cranfield results were available, was constructed with preferred order pre-co-ordination in mind. Users were instructed to combine concepts in the order

Machine/ component/ matter/ physical phenomena/ operation/

A document on the 'heat treatment of pressure vessel steel' would be analysed into the concepts

Heat treatment (Vm)

Steel (Ns)

Pressure vessels (Kks)

Then concepts would be combined in the following order to form the co-ordinated class number

Pressure vessels (Kks): Steel (Ns): Heat treatment (Vm)

A device, known as the "chain index", would be used for the location of the concepts not in the leading position in the co-ordinated class number. With only a single entry appearing in the classified section of the catalogue, namely Kks Ns Vm, the "chain index" entries would be as follows:-

Heat treatment; Steel: Pressure vessels	Kks Ns Vm
Steel: Pressure vessels	Kks Ns
Pressure vessels	Kks

The disadvantage of preferred order have been discussed in detail elsewhere (Ref.11). Briefly, although preferred order gives economy in the number of cards required in the class sequence, this is outweighed by the size of the chain index. What is an even worse disadvantage is the scatter of related concepts not only in the class sequence, but in the chain index. This fault becomes more pronounced the greater the number of concepts combined in one class number.

2.2 Permutation

In the W.R.U. Test it was decided to experiment with the pre-co-ordination of concepts by permutation. Using this method, the indexer arranged the concepts of a document in a series of permuted class numbers, and a card for each class number was inserted in the class sequence of the catalogue. On average there were $12\frac{1}{2}$ entries per document. The document mentioned above on 'heat treatment of pressure vessels steels' was given six permuted entries in the classified catalogue

Kks Ns Vm (Pressure vessels: steel: heat treatment)
Kks Vm Ns (Pressure vessels: Heat treatment: steel)
Ns Kks Vm (Steel; pressure vessels: heat treatment)
Ns Vm Kks (Steel: heat treatment: pressure vessels)
Vm Kks Ns (Heat treatment; pressure vessels: steel)
Vm Ns Kks (Heat treatment: steel: pressure vessels)

The choice of permuted entry was left to the indexer; selection was intuitive rather than one guided by any fixed rule. This type of pre-co-ordination does no more than fix certain concepts together in one theme; it does not show the nature of relationship between the terms or the function of the terms, which role indicators, or, sometimes, preferred order achieve. Searching for permuted entries proved far speedier than for preferred order class numbers. Searching involved first looking in the alphabetical index to the schedules for the class numbers of the concepts in the question. Next the class numbers were permuted in a series of search programmes. A search for the question "Heat treatment of pressure vessel steels" could involve the permutation of the three concepts 'heat treatment', 'steel' and 'pressure vessels' in a maximum of six permuted searches, followed by searches for the concepts permuted in pairs; a total altogether of not more than twelve searches in the catalogue. More important only three areas

in the catalogue would have to be searched, as the permuted searches would all be within the sections starting Kks 'pressure vessels' Ns 'steel' or Vm 'heat treatment'. This is very different from a preferred order search which might possibly involve checking through more than a hundred cards in the chain index for class numbers where the concepts in the question were associated, followed by searches in numerous places in the classified catalogue for the widely scattered class numbers containing the required concepts.

2.3 Post-co-ordination

A subsequent test was made to find the effect of post-co-ordination of the concepts indexed at Cranfield. This is briefly reported on page 55, and as would be expected, shows an improved recall with a decreased relevance. Further tests are to be made with this post-co-ordinate index, showing in particular the effect of variations in the search programmes, the effect of weighting, and the effect of breaking down concepts into single terms.

3. English Electric Classification and the W.R.U. Code - Compared

The English Electric scheme is less sophisticated, less complex, and less fully developed than the W.R.U. code, but it does have certain features in common with it, notably that they are both analytico-synthetic classifications. That is they are constructed by the analysis of terms, rather than the breakdown of traditional "universes of knowledge". The resulting terms are readily available for synthesis into more complex themes and subjects.

3.1 Categories and Analytical methods

Both systems abandon the traditional subject fields and seek other categories. Both set about finding new categories by analysing the terms in the literature. It is interesting to read (Ref. 8) that, as a preliminary exercise, the compilers of the W.R.U. code examined terms and classified them according to five fundamental categories, a process very like the first step in facet analysis. These five categories were:-

- a. Machines, apparatus, devices
- b. Processes
- c. Materials, substances
- d. Attributes, characteristics
- e. Abstract concepts.

This exercise presumably assisted in the selection of the main categories in the

W.R.U. code, the 250 semantic stems. These categories do not correspond exactly with any category in the English Electric system. They are most nearly related to the primary divisions within the facets, for instance Op 'Corrosion' in the facet "Chemical phenomena". The English Electric facet P "Physics of solids" (see excerpt: Appendix 1D) contains concepts which occur in more than half a dozen semantic stems, among them

B-RS Abrasion
D-DD Damage
D-FL Deflection
D-FT Defect
D-SM Dismantling.

The W.R.U. code arranges these semantic stems, or main classes, in alphabetical order, and unlike the facet scheme, does not attempt to display them within broader facets and categories. There is a classified index of the semantic stems, but this is an auxiliary tool and not an integral part of the system, as in the English Electric classification.

Again, the W.R.U. code uses analytical techniques to classify the semantic factors. These are developed from the semantic stems by adding an "analytical infix". The analytical infix classifies the semantic factor according to its relationship with its stem (the broad class to which it belongs). Ten relationships are recognised, ranging from the generic/specific and whole/part relationships to the less familiar, such as the analytical relationship "Q" 'Affective'. This means that the concept coded represents something which makes use of, is determined by, or is influenced by the subject which is represented by the semantic stem, so that "electroplating" which makes use of "electricity" L-CT is coded LQCT. Most of these relationships occur also in the facet scheme, but they are not consistently recognised and reflected in the notation as they are in the W.R.U. code.

3.2 Generic Level

The W.R.U. code is capable of providing a higher generic search than is possible with the English Electric classification. This is because it can employ the technique of semantic factoring to describe a concept by combining the code numbers for its attributes. For example, the concept 'annealing' may be expressed by the combination of three semantic factors.

W.R.U. Code. MWTL PUSS RQCT 003 Annealing.

Made up as follows:

NWTL Metal (acted upon)
PUSS Process (produces, used for)
RQCT Heat (makes use of)
003 Numerical suffix distinguishing this concept
from others with the same semantic factors.

The search could be broadened by dropping infixes and suffixes to recall any document having the semantic stems M-TL with P-SS and R-CT, that is any document combining the concepts 'metal', 'process' and 'heat'. For an even broader search 'metal', 'process' and 'heat' could be searched separately. In comparison, the English Electric class number for annealing will provide only a search for 'heat treatment', (a more specific concept than 'metal/process/heat/') or, more broadly for 'production engineering processes; fabrication' and ultimately 'operations'. The class number does not lead to 'heat' generally nor to 'metal' generally.

English Electric Vme Annealing
classification Made up as follows
Vm Heat treatment
V Production engineering process;
Fabrication
U/Y Operations

However, there are occasions when the concept is given only one semantic factor in the W.R.U. code, and then it may happen that the facet scheme gives a higher generic search. For example the concept, 'Forging' CUNS 030, is made up of

CUNS Fabrication (produces, used for)
C-NS Fabrication
030 Numerical suffix

In the English Electric classification, Vhc 'Forging' is made up of

Vh Mechanical working
V Production engineering operations; Fabrication
U/Y Operations

Both searches may be broadened to 'fabrication', but the facet scheme allows for the search to be taken to the higher generic level - 'operations' generally.

3.3 Display of hidden relationships

Both systems fail at times to show relationships between concepts. For example, there is an affinity between the terms 'wear' and 'lubrication' but this is not brought out by the display of coordinate categories in the tables of English Electric classification nor by semantic factoring in the W.R.U. code. The class number in the facet scheme for 'lubricant' is Ld in the basic category 'Materials' and the class number for 'wear' is Pel 'surface properties' in the basic category O/T 'Physical Phenomena'. The W.R.U. code for "lubricant" is GARS 002 (Broad class G-RS 'Grease'), while the code for wear is DATR 006 (Broad class D-TR 'Deterioration'). The only way to ensure that such hidden relationships are brought to light is to supplement the systems with a thesaurus-type index.

3.4 Synthetic capacity

As has already been discussed in para. 1-4, the English Electric classification and the W.R.U. code are both capable of synthesis, that is, the terms are readily available for co-ordination, since they were both constructed with this purpose in view, the one primarily for pre-coordination and the other for post-coordination.

3.5 Hospitality to specific concepts

Both systems have the capacity to accommodate highly specific concepts, but, in the case of the W.R.U. system, the coding for many more specific terms has been worked out and recorded. Many of the specific terms used in the test in the facet catalogue were made up by the indexer, as required, from the facet schedules by synthesis (especially class numbers for particular alloys synthesised from the element numbers). These synthesised numbers are not enumerated in the printed schedules and its index. New terms which could not be synthesised were accommodated in the schedules without difficulty.

Conclusions

The English Electric classification is a representative example of a scheme constructed on the principles of facet analysis. It has all the distinctive features found in facet schedules, with its fundamental categories, homogeneity within categories, unique location of terms and capacity for synthesis. In addition, it is interesting because it is not merely an experimental tool, but has been used in a technical library for several years. In comparison with the W.R.U. code The English Electric scheme is less sophisticated, but the systems have several

features in common, since both are analytico-synthetic in character. The results of the test show a parallel figure for the influence of the code and the classification on the performance of the two systems in the recall of relevant documents. This may be due in part to the similarities between the W.R.U. code and the English Electric classification which have been analysed in this appendix.

APPENDIX 1D

Excerpt from Facet Schedules

P

PHYSICAL PHENOMENA

PHYSICS OF SOLIDS (cont'd.)

Pe	Other Physical Properties of Solids (cont'd.)
Pej	Surface properties (cont'd.)
Per	Roughness
Pea	Wettability
Peu	Transparency, translucence
Pev	Opaqueness
Pg/s	Strength of Materials; Stress Analysis
Pg/n	Modes of Failure
Pg	Stress, deformation, deflection, stress resistance
	<i>Stress resistance at Pg applies to components only, for materials strength see Pb</i>
P, b	Elastic deformation including elasticity theory
P	Plastic deformation including plasticity theory
P, b/d	Permanent deformation phenomena
P, bcb	Hardening, Bauschinger effect
P, gcc	Stress relaxation
P, gcd	Hysteresis
	<i>Yield Point see Pbbe</i>
P, ge	Dimension changes, volume changes
P, gg	Shrinkage, contraction
P, gh	Swelling, expansion, dilation
Ph	Creep
Pj	Fracture, rupture, cracking
	<i>For Stress Rupture see Creep</i>
P, jb	Brittle fracture
P, jg	Buckling, elastic instability
P, jh	Denting
Pk	Fatigue
P, ks	Corrosion fatigue
Pn	Deterioration generally
Pnt	Ageing
Pny	Failure

Pg/z Strength of Materials; Stress Analysis (cont'd.)

Pp/x Type of Load, etc.

May be applied to Pg/n above. e.g. Pphj Compression Creep

Pp	Stresses and loads
Ppb	Tensile
Ppd	Torsional
Ppf	Shear
Ppg	Bending and bowing
Ppj	Compression
Ppk	Contact, hertzian
Ppl	Combined
Ppm	Shock, impact
Ppq	Manufacturing, working, residual
Pps	Stress corrosion

For Stress Distribution see .b

Overall Causes and Conditions *May be added to Pg/p above,*

e.g. Pprb Thermal Stress.

Causes not listed here may be expressed by < affects sign followed by notation for appropriate term from another Schedule.

Prb	High temperature, thermal
Prd	Low temperature
Pre	Atmosphere
Prf	Humidity, tropical conditions
Prg	Atmosphere - gaseous
Prgh	Atmosphere - steam
Pt	Radiation (see also St)
Pu	Earthquakes
Pv	Foundation conditions, support conditions, soil mechanics
Pz	Local causes, stress raisers

e.g. Pkx Stress Raisers in Fatigue

APPENDIX 2 A

LIST OF QUESTIONS

- Q1 To what extent do the materials used by highway authorities for de-icing in winter contribute to car deterioration.
- Q2 What information is available on the flux level required to produce sufficient damage in an oxide film to affect the oxidation rate of the underlying metal.
- Q3 How does the mechanism of oxide film breakdown on zirconium differ from that on zircaloy 2.
- Q4 What methods are available for the determination of the thickness of thin oxide films.
- Q5 Survey of steels suitable for precision gears.
- Q6 We are having a high incidence of porosity in iron castings. Chemical analysis gives satisfactory results. What might be the case and the remedy.
- Q7 What are effects of size and geometry of weld defects, and specifically the effect of damage to heat affected zone due to plastic strain.
- Q8 What processes can be used to repair castings. Factors affecting choice of method.
- Q9 How can stove-pipe welding be used in erection of storage tanks. Specify electrodes and welding preparation procedures.
- Q10 Material on hot and cold pressing and stretch forming of titanium sheet.
- Q11 Jigging methods for seam welding thin titanium sheets and butt welding tubes. Must be suitable for open air welding.
- Q12 What modern technological practice is used for melting, casting and machining alloys of Lead/4% Antimony.
- Q13 Is it possible to weld stainless steel up to 3in. dia. into a large structure by automatic controls, and what economic savings result.
- Q14 What are the best lubricating methods for the cold extrusion of steels.
- Q15 Can high-strength Titanium alloy sheet be stretch formed.
- Q16 What temperatures should be used for the hot forming and subsequent stress relief of pure Titanium sheet.
- Q17 Are there any aluminium alloys suitable for the manufacture of cylinder castings for internal combustion engines.

- Q18 Do fatigue fractures give any information of the contributory causes to the failure.
- Q19 What considerations will decide the choice of steels for superheater tubes for boilers.
- Q20 Can high melting point and reactive metals be melted in small quantities in the laboratory.
- Q21 What are the best temperature/strength properties available in present alloys of Molybdenum. Are they amenable to casting and shaping processes.
- Q22 What are the theory and practice of extruding metals, with some reference to steel.
- Q23 What methods can be used to identify the microconstituents in alloy steels.
- Q24 What equipment and procedure can be used to determine the complete orientation of an uniaxial crystal.
- Q25 What controls are necessary to maintain quality of a stainless steel cast continuously on a production basis.
- Q26 Do repeated stresses due to varying thermal gradients cause fatigue cracks.
- Q27 Are there any new processes to improve the soundness of castings of grey-iron.
- Q28 What alloys are likely to have the best tensile and impact properties in the range of temperature - 100 to 200°C.
- Q29 What effect does electrolytic polishing have on the fatigue strength of cold worked copper.
- Q30 Is it possible to approach the close tolerance of metal die casting by any sand-type process for alloys of aluminium.
- Q31 How effective can a sprayed plastic coating be for the protection of metals from corrosion in service.
- Q32 What effect do variations in microstructure have on the electro-deposition of metals on iron castings.
- Q33 How can binary phase diagrams of ceramics, particularly solid-liquid equilibria, be calculated from thermochemical data.
- Q34 How does the composition of a hypoeutectic cast iron affect its shrinkage unsoundness.
- Q35 How does the degree of inoculation in cast irons effect the soundness of a casting.

- Q36 Can grain size be controlled at preselected sites in vacuum-investment-castings.
- Q37 To what extent do stress concentrations affect the structural tensile strength of aircraft and space vehicles.
- Q38 What changes in pattern design are possible when microcracks are deliberately introduced into a mould.
- Q39 What advantage has extrusion over rolling for the production of steel shapes.
- Q40 What factors influence the machining rate in the ultrasonic cutting of metals.
- Q41 What are the properties required by resins for the coating of metals by thermoplastics.
- Q42 What methods are available for determining the adhesion of electro-deposits.
- Q43 What are the effects of friction during cold extrusion of steel, and how can this friction be overcome.
- Q44 What influence have sulphide inclusions on hydrogen absorption during the pickling of steel.
- Q45 To what use is calcium fluoride applied to iron and steelmaking processes.
- Q46 What are the underlying principles and advantages of the fluidized bed furnace in the heat treating of metal components.
- Q47 Has there been a recent increase in the production of carbon steel in foundries by direct processes.
- Q48 In what way are the mechanical properties of steel influenced by the removal of gases from the melt under vacuum.
- Q49 What improvements can be made in salt bath furnaces, in order to increase their thermal efficiency.
- Q50 When drawing mechanically descaled rod, which is the best lubricant to use.
- Q51 In the final inspection of castings, how great a part in testing is played by non-destructive methods.
- Q52 Is it possible to produce castings of the order of three tons by precision investment casting.
- Q53 What measures can be taken to ensure reasonable economic and technical efficiency, in a steelmaking foundry, using the basic arc furnace, with reference to the preparation of raw materials, particularly that of scrap.

- Q54 Are there any automatic installations producing laminations in the United Kingdom.
- Q55 Does the injection of gas into the blast furnace produce any significant increase in iron production, or saving in coke consumption.
- Q56 Is it possible to cut metal with a machine designed for welding.
- Q57 In the study of the martensitic structure of alloy steels by transmission electron microscopy, using the thin foil technique, to what extent can the behaviour of the steels during tempering be explained by the findings.
- Q58 In what ways can the pressure conditions in the regenerative chambers of Open Hearth furnaces be made to produce as homogeneous a distribution as possible, of the gases in the checkers.
- Q59 If the oxide film is removed from steel strip by liquid fluxes, is the flow of liquid tin over the surface more satisfactory.
- Q60 Is it possible for the thickness of phosphate coatings on steel, which is to be extruded, to differ widely.
- Q61 What are the requirements of a roll force-measuring device, and in what ways, if any, would these differ from those of a torque-measuring device.
- Q62 How do the properties of different solder alloys (Liquidus temperatures ranging from 120-450⁰F) vary, and which alloy suits each of the various soldering techniques.
- Q63 What recent work has been done on the resistance to corrosion of nickel electrolytic deposits.
- Q64 What methods would be suitable for testing rapidly the suitability of reinforced epoxy resins for equipment for use in corrosive conditions.
- Q65 What types of austenitic stainless steels are suitable for use in nuclear reactors when in contact with reactor slurries.
- Q66 What methods are used to survey an uncoated steel pipeline to locate galvanic 'hot spots'.
- Q67 How can heat exchanger equipment be kept free from scaling, as a supplement to water treatment, without dismantling.
- Q68 What types of plastic tubing are suitable for handling hydrochloric acid up to 200⁰F.
- Q69 What work has been reported on the electrochemical corrosion of iron and aluminium alloys by a. c. currents.
- Q70 What is the mechanism of the corrosion of the steel in a reinforced concrete structure exposed to the action of sea water.

- Q71 What is the effect of hydrogen on steel tubing in use at high temperatures (up to 800^oF) and at pressures up to 950 p.s.i.
- Q72 What chemicals are used for solvent degreasing systems.
- Q73 How is the flow pattern in a U-fired soaking pit dependent on ingot placement and port and burner design.
- Q74 What is the effect of high-pressure steam on the stress-corrosion behaviour of austenitic stainless steels.
- Q75 What methods are used to control distortion in the manufacture of reactor fuel elements.
- Q76 How can stainless steel tube be expanded by explosive forming.
- Q77 What are the properties of the stainless steel Uniloy 303 MA.
- Q78 How does the presence of up to 3% molybdenum affect the ductility of 18/8 austenitic stainless steels at low temperatures (from ambient down to approximately -200^oC).
- Q79 What is the effect of humidity on the microstructure of titanium at elevated temperatures.
- Q80 What type of equipment can be used for testing the mechanical properties of metals at temperatures down to -423^oF.
- Q81 Do stainless steels have any advantage over Al and Ti alloys as structural materials for rockets using liquid oxygen and hydrogen as propellants.
- Q82 What is the best type of copper alloy to use in electrical applications where high electrical conductivity and good resistance to softening on heating is required.
- Q83 What means can be employed to reduce warpage in the austempering of alloy steel parts of complex shape.
- Q84 What methods can be used to demagnetize parts after they have been subjected to magnetic-particle testing.
- Q85 What kind of pre-treatment should be applied to a steel base which is to receive a heavy vinyl plastisol coating (as a replacement for vitreous enamel).
- Q86 Which type of copper alloy possesses the best machinability, and why.
- Q87 Is it possible to ascertain the ductility of sheet metal if no standard testing instruments are available.
- Q88 What is the effect of pressure on the solubility of nitrogen in molten Fe-Mn alloys.

- Q89 What are the strain-hardening rates of columbium in the temperature range - 100 to 1000°C.
- Q90 What are the values of thermal conductivity and specific heat of Armco iron at 1000°C.
- Q91 What are the phases that precipitate at grain boundaries in austenitic alloys.
- Q92 What is the effect of deformation on the low temperature resistivity of silver with alumina dispersions.
- Q93 What is the value of the activation energy of diffusion of copper in molten copper in the temperature range 1400-1550°C.
- Q94 What increase in hardness can be brought about by explosive loading of gold-silver alloys.
- Q95 What are the tensile properties of Ag-Al alloys (Al, 1-6%) and does the alloy exhibit yield point behaviour.
- Q96 Does the presence of vacancies in the grain boundaries of Cu-Al solid solution affect grain boundary relaxation.
- Q97 What are the creep-rupture strength of Cu-Al₂O₃ at 850°C.
- Q98 Is there a structural transition in Bainite and does it depend on the composition of the steel.
- Q99 What optical methods can be used in determining the orientation of metal single crystals.
- Q100 What is the solubility of nitrogen in liquid manganese at 1400°C.
- Q101 What are the strain-hardening rates of zinc single crystals at low temperature (-200 to 70°C).
- Q102 What are the damping characteristics of SAP.
- Q103 What are the effects of reducing pressure from 10⁻⁵ torr to 10⁻¹⁰ torr when producing thin films of gold and aluminium by vacuum deposition.
- Q104 Is the heating effect of an electron beam sufficient to cause dislocation rearrangement in thin metal foils examined in the electron microscope.
- Q105 What is the temperature range for the mechanical working of beryllium.
- Q106 Is there a metallographic mounting medium available which has very low shrinkage characteristics combined with high chemical resistance.
- Q107 What are the effects of increasing the molybdenum content of carburising steels.

- Q108 What are the causes of the secondary hardening characteristics of high speed steels.
- Q109 What is the mechanism of the Cr_{17}C_3 Cr_{23}C_6 transformation in alloy steels and how does niobium affect this reaction.
- Q110 Can post-welding stress-relieving treatments be used to prevent heat-affected zone cracking in 18% chromium 12% nickel 1% niobium stainless steels.
- Q111 Is the ductile-brittle fracture transition of metals wetted by liquid metals caused by diffusion of the liquid metal, or is there any similarity to the transition occurring in body centred cubic metals as a function of temperature.
- Q112 Is there any direct evidence that preferential precipitation on non-coherent boundaries of annealing twins is due to the presence of dislocations.
- Q113 What are the factors to be considered when selecting surface hardening steels for components subjected to torsional fatigue conditions.
- Q114 Is there any apparent difference in the nucleation rates of precipitates formed at sub-boundaries and main boundaries in titanium-rich alloys.
- Q115 What is the cross-sectional shape of extrusions formed on the surface of aluminium alloys subjected to fatigue.
- Q116 To what extent can fatigue damage in metals be removed by annealing.
- Q117 How does the dislocation density of aluminium change when an annealed sample is subjected to shear strains of the order of 10^{-2} .
- Q118 Does the application of ultrasonic vibrations to a component increase the rate of pack carburising.
- Q119 To what extent are the mechanical properties of Al-Zn-Mg alloys improved by additions of silver.
- Q120 What methods are available for the accurate estimation of the hydrogen content of steels.
- Q121 What processes are available for producing sound, contamination free welds in titanium and its alloys.
- Q122 How many two pieces of Graphite be joined so that the joint has a high temperature strength equal to that of the parent parts.
- Q123 What are the limitations of zinc chloride and common organic soldering fluxes. Are there available soldering fluxes which do not leave a residue.
- Q124 How may cooling waters in an Atomic Energy power plant be treated to decrease the corrosion of aluminium-nickel alloy sheaths, which contain fuel elements.

- Q125 Can steel gears be hardened by the induction hardening process and if so is there a limit to the size of gear than can be treated by this method.
- Q126 What alloys of nickel-chromium-cobalt have useful high temperature strength at 1700^oF (927^oC) but contain no strategic columbium.
- Q127 What is the plastic behaviour of copper subjected to fatigue stressing.
- Q128 What range of alloy composition of malleable nickel will produce flake graphite in the microstructure and what particular condition of this graphite will reduce galling to a minimum.
- Q129 Purer and more uniform ingots of titanium may be produced in the electric consumable electrode process of melting titanium sponge by controlling the pressure of the atmosphere produced by the gases evolved from the metal during melting. What impurities are reduced by this method compared with those present in titanium which has been melted in an argon atmosphere.
- Q130 Which type of soft solder is most suitable for joining copper alloys if the risk of intercrystalline penetration of the copper by the molten solder is to be minimised.
- Q131 Is the crystal orientation of uranium affected by the previous history of the metal, and what effect does orientation have on properties.
- Q132 What mineral sources of Columbium are available and how may low grade ores be concentrated.
- Q133 How may defects in the enamelling of ferrous articles due to combustion gases and process vapours be avoided.
- Q134 How may the value for the toughness of a fracture be obtained.
- Q135 How does increasing the temperature from 4.2^oK influence slip in magnesium single crystals.
- Q136 Spinning nozzles for the production of rayon contain holes of the order of 0.002 in diameter. What metals having mechanical strength and resistance to corrosion and erosion are available for such uses.
- Q137 What conditions of fluxing and temperature are necessary to separate efficiently low melting point metals, lead, tin and zinc from the higher melting point metals, aluminium, copper and iron.

APPENDIX 2B

LIST OF SOURCE DOCUMENTS FOR FINAL GROUP OF 114 QUESTIONS

- Q2 Influence of reactor radiation on the oxidation of niobium. Corrosion, February 1961, pp. 77-79.
- Q3 The oxidation and corrosion of zirconium and its alloys. Electrochemical Society J., Jan. 1961, pp. 24-29.
- Q5 Properties of Ni-al age hardening steel. Metal Progress, Feb. 1961, pp. 80-83.
- Q6 Practical observations on mould stability as a factor in controlling the soundness of grey iron castings. British Foundryman, Feb. 1961, pp. 45-53.
- Q7 Brittle fracture in welded structures. Welding and Metal Fabrication, March 1961, pp. 89-94.
- Q8 Technical control of welding in the steel foundry, Foundry Trade J., 3rd January, 1961, pp. 3-8.
- Q9 Oil storage tanks: a new approach to welding vertical seams. Welding and Metal Fabrication, January 1961, pp. 2-7.
- Q10 The development of production processes for use with titanium sheet. Welding and Metal Fabrication, February 1961, pp. 50-56.
- Q11 Fusion welding titanium and its alloys. Welding and Metal Fabrication, February 1961, pp. 72-74.
- Q12 The production of nuclear components in lead and graphite. Machinery, 4th January 1961, pp. 4-14.
- Q13 Precision welding in nuclear reactor construction. Machinery, 4th January 1961, pp. 23-26.
- Q15 Titanium sheet forming. Metal Industry, 10th February 1961, pp. 103-107.
- Q16 Titanium sheet forming. Metal Industry, 17th February 1961, pp. 131-132.
- Q17 Hyper-eutectic aluminium-silicon castings. Metal Industry, 17th February, 1961, pp. 123-
- Q19 The contribution of metallurgy to electric power generation. Iron and Steel Institute J., February 1961, pp. 109-116.
- Q20 Laboratory casting of high-temperature metals. Journal of Metals, February 1961, pp. 136-138.
- Q21 Molybdenum alloy and process technology. Journal of Metals, March 1961, pp. 223-225.
- Q22 Extrusion theory and calculations. Journal of Metals, March 1961, pp. 206-210.
- Q23 Intergranular precipitation of intermetallic compounds in austenitic alloys. AIME Metallurgical Soc. Trans., February 1961, pp. 28-34.
- Q24 Metal crystal orientation using polarizing microscope. AIME Metallurgical Soc. Trans. February 1961, pp. 199-200.

- Q25 Production of stainless slabs at the continuous casting plant of Schoeller Bleckmann Stahlwerke AG. Iron and Steel Institute J. March, 1961, pp. 189-198.
- Q26 Resistance to thermal stress fatigue of some steels heat resisting alloys and cast irons. Iron and Steel Institute J. March 1961, pp. 223-240.
- Q27 Practical observations on mould stability as a factor in controlling the soundness of grey iron castings. British Foundryman, Feb. 1961, pp. 45-53.
- Q28 The properties of some metals in alloys at low temperatures. Institute of Metals J., Jan. 1961, pp. 145-161.
- Q29 The effect of persistent slip bands on the fatigue of copper. Institute of Metals J., Jan. 1961, pp. 176.
- Q31 Developments in the protection of magnesium. Light Metals, February, 1961, pp. 38-39.
- Q34 Inoculation and casting expansion. B.C.I.R.A. Journal, January 1961, pp. 103-116.
- Q35 Inoculation and casting expansion. B.C.I.R.A. Journal, January 1961, pp. 103-116.
- Q36 Developments spur interest in investment casting. Iron Age, 23rd Feb. 1961, pp. 100-101.
- Q37 Structural significance of ductility. Journal of Metals, March 1961, pp. 201-203.
- Q38 Cracks in moulds make better castings. Steel: The Metalworking Weekly, 6th March 1961, pp. 68-69.
- Q39 Extrusion of steel. Journal of Metals, March 1961, pp. 211.
- Q40 Probing the ultrasonic cutting process. Metalworking Production, 8th February 1961, pp. 51-58.
- Q41 Developments in fluid bed coatings. Metal Finishing, Jan. 1961, pp. 42-44.
- Q42 Science for electroplators Adhesion tests. Metal Finishing, 12th Jan. 1961, pp. 49-50.
- Q43 Phosphate coating and lubrication of steel for cold extrusion. Machinery, 11th Jan. 1961, pp. 84-90.
- Q46 Fluidized beds speeds heat transfer. Steel: The Metalworking Weekly, 13th Feb. 1961, pp. 108-110.
- Q47 Present trends in direct arc furnace uses. Industrial Heating, Jan. 1961, pp. 90-101.
- Q48 Vacuum degassing of steel. Canadian Mining and Metallurgical Bulletin, February 1961, pp. 163-169.
- Q51 Technical control in steel foundries in North America. Foundry Trade Journal, 2nd Feb. 1961, pp. 133-144.
- Q52 Die-making for the automobile industry. Foundry Trade Journal, 2nd Feb. 1961 pp. 149.

- Q53 Control of foundry steel making. Foundry Trade Journal, 23rd Feb. 1961, pp. 231-239.
- Q54 Quality production of laminations for transformer cores. Machinery, 1st February, 1961, pp. 250-252.
- Q55 Gas injection for blast furnace. Iron Age. 9th Feb. 1961, pp. 107-109.
- Q56 Electron beam welds cuts metal. Steel: Metalworking Weekly, 20 Feb. 1961, pp. 68.
- Q57 The morphology of martensite. Iron and Steel Institute, March 1961, pp. 199-210.
- Q58 Notes on gas-flow pattern through the regenerative chambers of open hearth furnaces. Iron and Steel Institute J., March 1961, pp. 215-222.
- Q59 The spread of molten tin on mild steel reduced in hydrogen or treated with molten fluxes. Iron and Steel Institute J. March 1961, pp. 233-239.
- Q60 Phosphate coating and lubricating steel for cold extrusion. Sheet Metal Industries, March 1961, pp. 171-189.
- Q61 An introduction to the theory and practice of flat rolling-7. Sheet Metal Industries, March 1961, pp. 211-218.
- Q62 How to choose the right soft solder alloy. Product Engineering. 6th March, 1961, pp. 39.
- Q63 Corrosion-erosion of sensitized AISI type 304 stainless steel in a thorium dioxide uranium trioxide slurry. Corrosion, Jan. 1961, pp. 93-96.
- Q65 Corrosion-erosion of sensitized AISI type 304 stainless steel in a thorium dioxide uranium trioxide slurry. Corrosion, Jan. 1961, pp. 93-96.
- Q67 Combined cathodic protection and cleaning for heat exchangers. Corrosion, Jan. 1961, pp. 9-12.
- Q69 Effects of alternating currents in causing corrosion. Corrosion, March, 1961 pp. 34-38.
- Q70 Corrosion in reinforcing steel in concrete in marine atmospheres. Corrosion: March 1961, pp. 76-80.
- Q71 Kinetics and mechanism of hydrogen attack of steel. Corrosion. March, 1961, pp. 109-115.
- Q73 Application of aerodynamic design to U-fired soaking pit. Iron and Steel Institute J., Feb. 1961, pp. 117-121.
- Q74 Comparative stress corrosion behaviour of some high alloy steels. Iron and Steel Institute J., Feb. 1961, pp. 136-141.
- Q76 Rohn puts electro forming on the line. Steel: Metalworking Weekly, 27th March, 1961, pp. 168-169.
- Q78 The properties of some metals in alloys at low temperatures. Institute of Metals J., Jan 1961, pp. 145-161.
- Q79 Contamination of titanium by water vapour. Institute of Metals J., Jan. 1961, pp. 165-168.

- Q80 Selection of metals for use at cryogenic temperatures. Metal Progress, April 1961, pp. 65-72.
- Q81 Selection of metals for use at cryogenic temperatures. Metal Progress, April 1961, pp. 65-72.
- Q82 Zirconium copper alloy ... high strength and conductivity. Metal Progress, April 1961, pp. 75-77.
- Q83 Heat treating in the fluid bed furnace. Metal Progress, April 1961, pp. 82-87.
- Q84 Non-destructive testing for management. How to use magnetic particle methods. Metal Progress, April 1961, pp. 88.
- Q85 No. 7 in a series on better finishing 1: Phosphating in cold solutions. Metal Progress, April 1961, pp. 100-102.
- Q86 Sulphur aids copper machining. Iron Age, 26th Jan. 1961, pp. 74-75.
- Q88 Solubility of nitrogen in molten iron and manganese alloys. AIME Metallurgical Soc. Trans. Feb. 1961, pp. 2-8.
- Q89 Effect of structure and purity on the mechanical properties of columbium. AIME Metallurgical Soc. Trans. Feb. 1961, pp. 19-24.
- Q90 Thermal diffusivity of Armco iron. AIME Metallurgical Soc. Trans. Feb. 1961, pp. 25-27.
- Q91 Intergranular precipitation of intermetallic compounds in austen. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 28-34.
- Q92 Effects of plastic deformation on the electrical resistibility of composite silver alumina crystals. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 60-62.
- Q93 Self-diffusion of copper in molten copper. AIME Metallurgical Soc. Trans. Feb. 1961, pp. 72-73.
- Q94 Effects of explosive shock waves on a gold-silver alloy. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 90-94.
- Q95 Strain ageing in silver base Al alloys. AIME Metallurgical Soc. Trans. Feb. 1961, pp. 103-107.
- Q96 Effect of quenching on the grain boundary relaxation in solid solution. Aime Metallurgical Soc. Trans., Feb. 1961, pp. 108-109.
- Q97 Dispersion strengthening of copper by internal oxidation. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 164-172.
- Q98 The structure of bainite in hypoeutectoid steels. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 179-185.
- Q99 Metal crystal orientation using polarizing microscope. AIME Metallurgical Soc. Trans., February, 1961, pp. 199-200.
- Q100 Solubility of nitrogen in liquid manganese. AIME Metallurgical Soc. Trans., Feb. 1961, pp. 200-201.
- Q101 The anomaly in the rate of strain hardening of zinc single crystals. Metallurgical Soc. Trans., Feb. 1961, pp. 204-205.

- Q102 Internal friction behaviour of an aluminium oxide SAP type alloy. Aime Metallurgical Soc. Trans., Feb. 1961, pp. 206-207.
- Q104 Heating of metallic foils in an electron microscope. British J. of Applied Physics., March 1961, pp. 115.
- Q105 Beryllium. Endeavour, Jan. 1961, pp. 11-18.
- Q106 Improved metallographic techniques: Nova Scotia: 1. Metallic films aid study of oxide coatings. Metal Progress, Jan. 1961, pp. 121-123.
- Q107 New carburizing steels German automobiles. Metal Progress, Jan. 1961, pp. 70-75.
- Q108 Gall resistant nickel alloy. U.S. Patent, 2,974,038.
- Q109 The carbide constitution and tempering behaviour of chromium-vanadium-niobium steels at 700°C. Iron and Steel Inst. J., Jan. 1961, pp. 9-21.
- Q111 Ductile-brittle transition in alpha brass. Acta Metallurgica, Dec. 1960, pp. 848-850.
- Q112 Electron-microscopic study of recrystallisation twins in copper. Acta Metallurgica, Dec. 1960. pp. 874-877.
- Q113 Surface hardening of steels, pt. 2, Material selection. Machine Design, Feb. 1961, pp. 110-114.
- Q114 Influence of dislocations on the microstructure of some titanium alloys. Inst. of Metals J, March 1961, pp. 235-237.
- Q115 A study of fatigue deformation by reflection electron microscopy. Inst. of Metals J., March 1961, pp. 253-254.
- Q116 Effect of annealing on fatigue damage in gold. Inst. of Metals J, March 1961, pp. 241-246.
- Q117 Unusual problems encountered in cathodic protection of Miami Seaquarium. Corrosion, Jan. 1961, pp. 16-19.
- Q118 How the Russians are using ultrasonics in metallurgy. Metal Progress, Jan. 1961, pp. 79-83.
- Q119 The properties of commercial Al-2r-Mg alloys. Practical implications of Frau additions of silver. Institute of Metals J., Feb. 1961, pp. 193-204.
- Q122 Joining of graphite members. U.S. Patent 2,979,814.
- Q123 Soldering fluxes. U.S. Patent 2,978,369.
- Q124 Inhibition of corrosion of aluminium alloys. U.S. Patent 2,977,260.
- Q126 Heat resisting nickel-bare alloys. U.S. Patent 2,977,222.
- Q127 Evidence of sub-surface cross-slip in fatigue copper. Philosophical Mag., Feb. 1961, pp. 315-316.
- Q128 Gall resistant nickel alloy. U.S. Patent 2,974,038.
- Q129 Melting titanium metal. U.S. Patent 2,974,033.
- Q130 How to choose the right soft solder alloy. Product Engineering, 6th March 1961, pp. 39.

- Q131 The recrystallisation of uranium during cold or hot forging.
J. of Nuclear Materials, Jan. 1961, pp. 115-119.
- Q132 Smelting process for recovering columbium and/or tantalum from low
grade ore materials containing same. U.S. Patent 2,972,530.
- Q133 Process and an oven for the baking of enamels on articles of ferrous
metals. U.S. Patent 2,971,753.
- Q134 Evaluating fracture toughness. (Pressure vessels for space, aerospace
and hydrospace: a symposium). Journal of Metals, March 1961, pp. 195-
197.
- Q135 New machining methods evaluated for heavier space age metals.
SAE Journal, March 1961, pp. 74-76.
- Q136 Spinnerette. U.S. Patent 2,967,792.
- Q137 Metal sweating process. U.S. Patent 2,967,769.

APPENDIX 2C

Questions Searched by W.R.U. and Cranfield

114 Searched both by W.R.U. and Cranfield

2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25,
26, 27, 28, 29, 31, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 46, 47, 48, 51,
52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 65, 67, 69, 70, 71, 73, 74,
76, 78, 79, 80, 81, 82, 83, 84, 85, 86, 88, 89, 90, 91, 92, 93, 94, 95, 96,
97, 98, 99, 100, 101, 102, 104, 105, 106, 107, 108, 109, 111, 112, 113,
114, 115, 116, 117, 118, 119, 122, 123, 124, 126, 127, 128, 129, 130, 131,
132, 133, 134, 135, 136, 137.

5 Searched by W.R.U. but not by Cranfield

75, 87, 120, 121, 125

15 Searched by Cranfield but not by W.R.U.

1*, 14, 18, 30, 32, 33*, 44*, 45, 49, 50, 64*, 66, 68, 77*, 103, 110*

(* Search made by W.R.U., but source document not on tape)

3 Searched neither by W.R.U. nor by Cranfield

4, 68, 103

APPENDIX 3A

Original Record of the Results of 125 Searches Made by W. R. U.

The search results given in this appendix were as originally received at Cranfield from W. R. U. It shows the result of each search (S = successful, F = failed), and the number of documents retrieved. Where a second search was made by W. R. U., this is indicated. These results were considerably amended in analysis; some searches were completely discounted because the source document was not on the W. R. U. tape (indicated by single asterisk), or because Cranfield did not search for that particular question (indicated by double asterisk). The number of documents retrieved was also amended by the elimination of documents not indexed by Cranfield.

The final columns show the relevance assessment as determined by the question compilers. The assessment codes denote the following:

1. Better than source document
2. As good as source document
3. Of some interest
4. Not relevant
5. False drop

Question No.	Results		Documents Retrieved		Assessments				
	1st Search	2nd Search	1st Search	2nd Search	1	2	3	4	5
*1	F		1		0	0	1	0	0
2	S		15		0	0	0	4	0
3	F	F	10	3	0	0	2	1	0
4	Not Searched								
5	F		0		0	0	0	0	0
6	F		3		0	0	1	0	0
7	F	S	3	36	0	0	1	1	0
8	S		14		0	0	2	1	0
9	S		7		0	0	0	2	0
10	S		5		0	1	1	0	0
11	F		0		0	0	0	0	0
12	S		9		0	0	0	4	0
13	F		3						
14	Not Searched								
15	S		4		1	0	1	0	0
16	F		40						
17	F		8		0	0	0	2	0
18	Not Searched								
19	S		3		0	0	1	0	0
20	S		67						
21	S		6		0	0	0	1	0
22	F	F	24	57	0	0	2	1	1
23	F		9		0	0	0	0	3
24	F	S	8	130	0	0	0	1	1

25	S		2		0	0	0	1	0
26	F	S	27	71	0	0	0	0	4
27	S		14						
28	F	S	7	46	0	1	0	0	1
29	S		2		0	0	0	1	0
30	Not Searched								
31	F	S	4	28	0	0	1	0	1
32	Not Searched								
*33	F		22		0	0	0	0	4
34	F		0		0	0	0	0	0
35	S		5		0	0	1	1	0
36	S		2		0	1	0	0	0
37	F		21		0	0	2	3	0
38	F		3		0	0	0	0	2
39	S		2		0	0	0	1	0
40	S		1		0	0	0	0	0
41	F	S	27	56	0	0	0	4	0
42	S		16		0	0	0	5	0
43	S		5		0	0	1	1	0
*44	F		11		0	0	0	0	5
45	Not Searched								
46	S		11		0	0	1	3	0
47	S		14		0	0	0	1	2
48	F		9		0	0	0	1	2
49	Not Searched								
50	Not Searched								
51	S		16		0	0	2	1	0
52	F	S	1	201	0	1	0	0	0
53	F		0		0	0	0	0	0
54	S		13		0	0	0	0	3
55	S		13		0	1	1	1	0
56	S		19		0	0	2	1	0
57	S		8		0	0	1	2	0
58	S		10		0	0	1	2	0
59	S		4		0	0	0	1	0
60	S		2		0	0	0	1	0
61	S		19		0	0	0	3	0
62	S		13		0	0	2	1	0
63	F	S	14	90	0	0	2	2	0
*64	F	F	21	56	0	0	0	3	0
65	F		5		0	0	0	1	0
66	Not Searched								
67	S		5		0	0	0	2	0
68	Not Searched								
69	S		40		0	1	0	3	0
70	F	F	15	0	0	0	0	4	0
71	F	F	1	36	0	0	1	0	0
72	Not Searched								
73	F	F	8	11	0	1	0	1	0
74	S		6		0	0	0	2	0
**75	S		6		0	0	1	1	0
76	F	F	1	7	0	0	1	0	0
*77	F		4		0	0	0	1	0

78	S		6		0 0 0 2 0
79	S		5		0 0 1 2 0
80	S		71		0 0 1 4 0
81	S		68		0 0 2 5 0
82	F		8		0 0 0 3 1
83	S	S	7	81	0 0 0 1 0
84	S		13		0 0 2 1 0
85	S		14		0 0 1 2 0
86	S		19		0 0 0 3 0
**87	F		14		0 0 0 4 0
88	S		10		0 0 0 2 0
89	S		1		
90	S		13		0 0 0 2 0
91	S		29		0 1 2 1 0
92	S		6		0 0 0 2 0
93	S		8		0 0 0 3 0
94	S		2		0 0 0 1 0
95	S		23		0 0 0 4 0
96	S		86		0 0 1 5 0
97	F	S	3	23	0 0 0 1 0
98	S		8		0 1 1 1 0
99	S		33		0 0 0 5 0
100	S		3		0 0 0 1 0
101	S		2		0 0 0 1 0
102	F		11		0 0 1 2 0
103	Not Searched				
104	S		15		0 0 1 1 0
105	S		27		0 0 0 4 0
106	S		2		0 0 0 0 1
107	S		57		0 0 0 5 0
108	S		18		0 0 0 4 0
109	S		16		0 0 0 3 0
*110	F	F	53	26	0 0 0 5 0
111	F		4		0 0 0 0 3
112	S		13		0 0 1 3 0
113	S		3		0 0 0 1 0
114	F	F	2	9	0 0 0 1 0
115	S		15		0 0 0 4 0
116	S		6		0 0 0 1 0
117	S		9		0 1 0 1 0
118	S		1		
119	S		9		0 0 0 2 0
**120	F	F	12	35	0 0 1 2 0
**121	S		12		0 0 0 2 1
122	F	S	1	25	0 0 0 0 1
123	S		2		0 0 0 1 0
124	S		10		0 0 0 0 2
**125	F	F	4	5	1 0 0 0 0
126	S		18		0 0 0 4 0
127	S		28		0 1 0 2 1
128	F	S	8	8	0 0 0 0 2
129	S		3		0 0 0 1 0
130	S		9		0 0 0 2 0
131	S		10		0 0 0 2 1
132	S		9		0 0 0 2 0
133	S		10		0 0 0 2 0
134	S		27		0 0 0 3 1
135	S		6		0 0 1 0 1
136	F	S	6	1	0 0 0 0 3
137	F	S	8	181	0 0 0 0 1

APPENDIX 3B

Searches Retrieving Large Numbers of Documents

	Question Nos.	Total Questions	No. of documents retrieved	% of total documents retrieved	Relevant documents		
					S	2	3
<u>More than 100 documents</u>							
W.R.U.	24, 52, 137	3	373	21.8%	3	0	6
Cranfield	-	-	-	-	-	-	-
<u>More than 50 documents</u>							
W.R.U.	20, 24, 26, 53, 63, 80, 81, 83, 96, 137	10	786	46.1%	10	4	46
Cranfield	56	1	75	9.1%	1	0	0
<u>More than 25 documents</u>							
W.R.U.	7, 16, 20, 22, 24, 26, 28, 41, 53, 63, 69, 80, 81, 83, 96, 99, 107, 137	18	1045	61.3%	16	7	95
Cranfield	2, 22, 56, 83, 104, 106, 111	7	261	31.7%	6	0	29

APPENDIX 3C

Relevance Assessment of Documents, Showing Recall

by W.R.U. and Cranfield

N.B. W.R.U. identify the documents with one, two or three figures and a letter e.g. 313K
Cranfield identify the documents with a four figure number, e.g. 1525
Both numbers are given in the following list, e.g. 313K/1525

Part A. Documents assessed Relevance 2 (as useful as source document)

Question No.	Document No.	Recalled by		Question No.	Document No.	Recalled by	
		W.R.U.	Cranfield			W.R.U.	Cranfield
5	66J/1722	F	S	57	130N/1971	S	S
8	313K/1525	S	S	60	229G/1399	F	S
	159L/1061	S	F	63	277R/1606	S	S
10	298G/2035	S	S		278R/1607	S	S
15	213G/1426	S	S	80	699Q/1257	S	S
	265G/1520	S	F	81	306R/1092	S	F
17	152E/1005	F	S	88	257P/1271	S	S
	201E/1028	S	S	91	801Q/1288	S	S
28	480Q/1025	S	F	97	803Q/1297	S	S
	699Q/1257	S	S	98	203N/1353	S	S
	776Q/1450	S	S	100	130P/1178	S	S
34	219E/1762	F	S		257P/1271	S	S
37	106J/1042	F	F	117	205S/1932	S	S
	776Q/1450	S	F	126	156A/2065	S	F
42	279L/2063	F	F		777Q/1456	F	F
46	139J/1454	S	S	131	239N/1712	S	S
	138J/1453	S	F	134	252Q/1068	S	S
54	22719/1886	S	S		566Q/1326	S	F
55	170D/1034	S	S		699Q/1257	S	F
	174D/1038	F	S				
	175D/1039	S	S				
	280D/1592	S	S				
	221D/1588	F	S				

Part B. Documents assessed Relevance 3 (of some interest)

Question No.	Document No.	Recalled by W.R.U. Cranfield		Question No.	Document No.	Recalled by W.R.U. Cranfield	
2	460R/1700	F	S	22	346G/1609	S	S
3	274R/1264	S	S		168F/1379	S	S
	129R/1344	S	S		229G/1399	S	S
	227N/1325	S	S		416L/1810	S	S
	138P/1461	S	S		171F/2072	S	S
	414R/1691	F	S		92J/1827	S	S
6	205S/1392	F	S		176A/1480	S	S
7	250Q/1064	F	S		123F/1016	S	S
	385K/1576	S	S		141A/1382	S	S
	246G/1840	S	F		271E/1439	S	S
	433Q/1242	S	F		159F/1989	S	S
8	322K/1588	F	F		171A/1755	S	S
9	251Q/1069	S	S		23H/1801	S	S
	216K/1446	S	F		152F/1838	S	S
10	191G/1423	F	S		361G/1811	S	S
	213G/1426	S	S		53F/1861	S	S
	297G/1433	F	S		26180/2033	S	S
	82F/1855	F	S		22716/1887	S	S
11	192K/1519	F	S		316L/1869	S	S
	314K/1527	F	S		241K/1072	S	S
13	216K/1446	F	S		20906/2012	F	S
	243K/1541	S	S	24	197N/1157	F	S
	148K/1062	S	F		202M/1947	S	S
	316K/1228	F	F		205M/1161	S	F
15	191G/1423	F	S		693Q/2022	S	F
	297G/1433	F	S		746Q/1928	S	F
16	265G/1520	F	F		231M/1332	S	F
	298G/2035	F	S		178M/1200	S	S
	213G/1426	S	S	26	649Q/2074	S	S
	314K/1527	S	S		178S/2093	S	S
	191G/1423	F	S		51W/1585	S	S
17	225G/2013	F	S		651Q/2069	S	F
19	141M/2020	F	F		809Q/1311	S	F
	61R/1749	F	F	27	313K/1525	S	F
	116J/1526	F	S		205S/1392	S	S
20	102C/1371	S	S		22579/1896	S	S
21	628Q/1713	F	F		221E/1761	F	F
	313Q/1252	F	S		219E/1762	S	S
	176A/1480	F	S	28	75Q/1744	S	S
	325K/1912	S	F		198N/1158	S	F
	519Q/1800	S	S		416Q/1181	S	F
					376R/1334	S	S

Question No.	Document No.	Recalled by W.R.U. Cranfield		Question No.	Document No.	Recalled by W.R.U. Cranfield	
31	421L/1625	S	F	62	244K/1542	S	S
	435L/2045	F	F		263K/1219	S	S
	169L/1834	S	S		313K/1525	S	S
	419L/1624	S	S		24711/1513	S	S
	291R/1486	F	S	63	228L/1793	S	S
	339R/1610	S	S		283L/2031	S	F
	168L/1832	S	S		160L/1729	S	S
	415R/1991	S	S		171R/1833	S	S
34	65E/1126	F	F	69	459R/1699	S	S
37	97T/1142	S	F		196R/1081	S	S
	164F/1975	S	F		310R/1099	F	S
	584Q/1566	S	F		394R/1109	S	S
	826Q/1259	S	F	70	438R/1116	S	F
	616Q/1374	F	F		441R/1119	S	F
39	229G/1399	F	S		308R/1094	S	F
	416L/1810	F	S		376L/1124	S	F
	361G/1811	F	S		61R/1749	F	F
41	388L/2083	S	F	71	779Q/1575	S	S
	305L/1778	S	S		385K/1576	S	F
	168L/1832	S	S	74	304R/1090	S	S
	285R/1999	S	F		413R/1690	F	S
	421L/1625	S	F		61R/1749	S	F
	415R/1991	S	F	76	323G/1618	S	F
	291R/1486	S	F		174E/1020	S	F
	339R/1610	S	F		267G/1491	S	F
	419L/1624	S	F		324G/1406	S	F
43	416L/1810	S	S	79	179M/1203	S	S
	168F/1379	S	S		22681/1979	S	S
	361G/1811	F	S	80	797Q/1273	S	F
	26180/2033	F	S		483Q/1156	S	F
46	169L/1834	F	F		480Q/1025	S	F
	49B/1821	S	F		566Q/1326	S	S
	276D/1385	S	F		170N/1215	S	F
51	225G/2013	S	F		416Q/1181	S	F
53	36D/1362	F	S	81	63T/1044	S	S
55	171D/1035	S	F		251Q/1069	S	S
	172D/1036	S	S		313Q/1252	S	S
	173D/1037	S	S		164F/1975	S	S
57	202N/1349	S	S		507Q/1256	S	S
59	54F/1859	F	F		137P/1628	F	S

Question No.	Document No.	Recalled by W.R.U. Cranfield		Question No.	Document No.	Recalled by W.R.U. Cranfield	
81	584Q/1566	S	S	104	258N/1359	S	S
	499Q/1484	S	F		256N/1905	S	S
	280K/1047	S	F		24682/1667	F	S
	617Q/1375	S	F		314M/1303	S	S
	543Q/1493	S	F	107	6J/1740	S	F
	75T/1630	F	F		672Q/1632	S	F
	148K/1062	S	F	108	729Q/1619	S	F
	616Q/1374	F	F	111	799Q/1279	F	F
	618Q/1376	F	F	112	747Q/1931	S	F
	356K/1622	S	F	113	66J/1722	F	S
	401Q/1842	S	F		41M/1796	F	S
	82F/1855	S	F		6J/1740	F	S
	267G/1491	S	F	115	178S/2093	S	S
	316K/1228	S	F		848Q/1733	F	F
	324G/1406	S	F	117	796Q/1270	F	F
82	480Q/1025	S	S		694Q/1996	S	S
	170G/1011	F	S		293M/1936	F	S
	178E/1139	F	S		205M/1161	S	S
	803Q/1297	F	S		167N/1196	F	F
83	109J/1797	S	S		292M/1930	S	S
	130J/2053	S	S		310M/1272	F	S
	526Q/1836	S	S		419Q/1217	F	S
84	39S/1750	S	S	124	138P/1461	S	F
	210S/1553	S	S	126	22561/2018	S	F
85	305L/1778	S	S		439Q/1254	S	F
	419L/1624	S	S		507Q/1256	F	S
86	255E/1665	S	F	127	480Q/1025	S	S
	227G/2026	S	F		567Q/1327	S	S
93	178K/1851	S	F	129	102C/1371	S	S
95	205M/1161	S	F	130	480Q/1025	F	F
96	231M/1332	S	F	132	24117/1494	S	F
	207M/1166	S	F	133	22946/1638	S	F
	848Q/1733	S	F		230L/1789	F	F
	691Q/1992	S	S	134	781Q/1570	S	S
98	259N/1355	S	F		511Q/1350	F	S
99	178M/1200	S	S		580Q/1524	F	S
	231M/1332	S	F		196S/2076	F	S
	205M/1161	S	F		650Q/2067	F	S
	480R/1278	S	F	135	571Q/1334	S	S
	690Q/2006	S	S				
	627Q/1712	S	S				
	202M/1947	F	S				

APPENDIX 3D

NUMBER OF DOCUMENTS RETRIEVED IN 114 SEARCHES
BY W.R.U. AND CRANFIELD

Question No.	Relevant Documents			Total Documents Retrieved	W.R.U. Relevant Documents			Total Documents Retrieved	FACET Relevant Documents		
	Source	2	3		Source	2	3		Source	2	3
2.	1	0	1	14	1	0	0	32	1	0	1
3.	1	0	5	5	0	0	4	8	1	0	5
5.	1	1	0	0	0	0	0	2	1	1	0
6.	1	0	1	1	0	0	0	1	0	0	1
7.	1	0	4	29	1	0	3	14	1	0	2
8.	1	2	1	11	1	2	0	2	1	1	0
9.	1	0	2	5	1	0	2	5	1	0	1
10.	1	1	4	4	1	1	1	9	1	1	4
11.	1	0	2	0	0	0	0	5	1	0	2
12.	1	0	0	7	1	0	0	7	1	0	0
13.	1	0	4	2	0	0	2	9	1	0	2
15.	1	2	2	3	1	2	0	4	1	1	2
16.	1	0	5	28	0	0	2	5	1	0	4
17.	1	2	1	3	0	1	0	6	1	2	1
19.	1	0	3	1	1	0	0	2	1	0	1
20.	1	0	1	52	1	0	1	14	1	0	1
21.	1	0	5	5	1	0	2	8	1	0	3
22.	1	0	21	39	0	0	20	25	1	0	21
23.	1	0	0	8	0	0	0	14	0	0	0
24.	1	0	7	111	1	0	6	21	1	0	3
25.	1	0	0	1	1	0	0	2	1	0	0
26.	1	0	5	66	1	0	5	9	1	0	3
27.	1	0	5	5	1	0	4	4	1	0	3
28.	1	3	4	37	1	3	4	7	1	2	2
29.	1	0	0	2	1	0	0	3	1	0	0
31.	1	0	8	18	1	0	6	8	1	0	6
34.	1	1	1	0	0	0	0	4	1	1	0
35.	1	0	0	2	1	0	0	1	1	0	0
36.	1	0	0	2	1	0	0	1	1	0	0
37.	1	2	5	14	0	1	4	1	0	0	0
38.	1	0	0	2	0	0	0	15	1	0	0
39.	1	0	3	1	1	0	0	8	1	0	3
40.	1	0	0	1	1	0	0	4	1	0	0
41.	1	0	9	33	1	0	9	3	1	0	2
42.	1	1	0	10	1	0	0	1	1	0	0
43.	1	0	4	3	1	0	2	6	1	0	4

Question No.	Relevant Documents			Total Documents Retrieved	W.R.U. Relevant Documents			Total Documents Retrieved	FACET Relevant Documents		
	Source	2	3		Source	2	3		Source	2	3
46.	1	2	3	7	1	2	2	2	1	1	0
47.	1	0	0	10	1	0	0	1	1	0	0
48.	1	0	0	6	0	0	0	1	1	0	0
51.	1	0	1	11	1	0	1	1	1	0	0
52.	1	0	0	130	1	0	0	8	1	0	0
53.	1	0	1	0	0	0	0	2	1	0	1
54.	1	1	0	8	1	1	0	4	0	1	0
55.	1	5	3	9	1	3	3	9	1	5	2
56.	1	0	0	10	1	0	0	75	1	0	0
57.	1	1	1	6	1	1	1	9	1	1	1
58.	1	0	0	9	1	0	0	1	1	0	0
59.	1	0	1	3	1	0	0	0	0	0	0
60.	1	1	0	1	1	0	0	3	1	1	0
61.	1	0	0	15	1	0	0	1	1	0	0
62.	1	0	4	10	1	0	4	7	1	0	4
63.	1	2	4	69	1	2	4	7	1	2	3
65.	1	0	0	3	0	0	0	9	1	0	0
67.	1	0	0	3	1	0	0	1	1	0	0
69.	1	0	4	28	1	0	3	6	1	0	4
70.	1	0	5	11	1	0	4	2	1	0	0
71.	1	0	2	24	1	0	2	6	1	0	1
73.	1	0	0	12	1	0	0	1	1	0	0
74.	1	0	3	5	1	0	2	4	1	0	2
76.	1	0	4	5	0	0	4	1	1	0	0
78.	1	0	0	4	1	0	0	2	1	0	0
79.	1	0	2	4	1	0	2	7	1	0	2
80.	1	1	6	53	1	1	6	4	1	1	1
81.	1	1	21	56	1	1	17	17	0	0	7
82.	1	0	4	7	0	0	1	20	0	0	4
83.	1	0	3	55	1	0	3	39	1	0	3
84.	1	0	2	8	1	0	2	7	1	0	2
85.	1	0	2	7	1	0	2	13	0	0	2
86.	1	0	2	12	1	0	2	12	1	0	0
88.	1	1	0	8	1	1	0	2	1	1	0
89.	1	0	0	1	1	0	0	1	1	0	0
90.	1	0	0	8	1	0	0	1	1	0	0
91.	1	1	0	23	1	1	0	4	1	1	0
92.	1	0	0	4	1	0	0	3	1	0	0
93.	1	0	1	6	1	0	1	1	1	0	0

Question No.	Relevant Documents			Total Documents Retrieved	W. R. U. Relevant Documents			Total Documents Retrieved	FACET Relevant Documents		
	Source	2	3		Source	2	3		Source	2	3
94.	1	0	0	1	1	0	0	1	1	0	0
95.	1	0	1	17	1	0	1	2	1	0	0
96.	1	0	4	62	1	0	4	4	1	0	1
97.	1	1	0	14	1	1	0	2	1	1	0
98.	1	1	1	7	1	1	1	2	1	1	0
99.	1	0	7	29	1	0	6	23	1	0	4
100.	1	2	0	3	1	2	0	3	1	2	0
101.	1	0	0	1	1	0	0	4	1	0	0
102.	1	0	0	6	0	0	0	1	1	0	0
104.	1	0	4	13	1	0	3	26	1	0	4
105.	1	0	0	17	1	0	0	6	1	0	0
106.	1	0	0	2	1	0	0	35	1	0	0
107.	1	0	2	36	1	0	2	4	1	0	0
108.	1	0	1	9	1	0	1	5	1	0	0
109.	1	0	0	12	1	0	0	7	1	0	0
111.	1	0	1	4	0	0	0	29	1	0	0
112.	1	0	1	10	1	0	1	4	0	0	0
113.	1	0	3	1	1	0	0	12	1	0	3
114.	1	0	0	7	0	0	0	6	1	0	0
115.	1	0	2	11	1	0	1	3	0	0	1
116.	1	0	0	3	1	0	0	1	1	0	0
117.	1	1	8	7	1	1	3	8	1	1	6
118.	1	0	0	1	1	0	0	1	1	0	0
119.	1	0	0	5	1	0	0	1	1	0	0
122.	1	0	0	17	1	0	0	1	1	0	0
123.	1	0	0	2	1	0	0	2	1	0	0
124.	1	0	1	6	1	0	1	2	1	0	0
126.	1	2	3	12	1	1	2	3	1	0	1
127.	1	0	2	23	1	0	2	11	1	0	2
128.	1	0	0	6	1	0	0	2	1	0	0
129.	1	0	1	3	1	0	1	3	1	0	1
130.	1	0	1	6	1	0	0	8	1	0	0
131.	1	1	0	9	1	1	0	1	0	1	0
132.	1	0	1	7	1	0	1	1	1	0	0
133.	1	0	2	4	1	0	1	1	1	0	0
134.	1	3	5	14	1	3	1	16	1	1	5
135.	1	0	1	4	1	0	1	2	1	0	1
136.	1	0	0	4	1	0	0	1	1	0	0
137.	1	0	0	132	1	0	0	13	1	0	0
TOTAL	114	42	244	1703	94	33	176	821	103	30	145

APPENDIX 3E

Recall Results for W.R.U. Failures Using Cranfield Search Programmes
with W.R.U. Concept Indexing

Question No.	Source Documents No.	Result	Relevance Two No.	Result	Relevance Three No.	Result
2					460R/1700	S
3	185R/1676	S			414R/1691	S
5	79J/1447	S	66J/1722	S		
6	210E/1240	S			205S/1392	S
7					250Q/1064	F
8					322K/1558	F
10					191G/1423	S
					297G/1433	S
					82F/1855	S
11	262K/1523	S			192K/1519	S
					314K/1527	S
13	264K/1396	S			316K/1228	S
					216K/1446	S
15					191G/1423	S
					297G/1433	S
16	297G/1433	S			265G/1520	S
					191G/1423	S
					298G/2035	S
17	196E/1431	F	152E/1003	F	225G/2013	S
19					141M/2020	F
					61R/1749	F
					116J/1526	F
21					628Q/1713	S
					176A/1480	S
					313Q/1252	S
22	381Q/1378	F			20906/2012	F
23	163N/1183	S				
24					197N/1157	F
27					221E/1761	F
31					435L/2045	S
					291R/1486	S
34	221E/1761	S	219E/1762	S	65E/1126	S
37	618Q/1376	S	106J/1042	F	616Q/1374	F
38	188E/1864	F				
39					229G/1399	S
					416L/1810	S
					361G/1811	S
42			279L/2063	F		
43					26180/2033	S
					361G/1811	S
48	211D/1819	S				
53	223D/1787	S			36D/1362	S
55			174D/1038	S		
			221D/1588	S		
59					54F/1859	F
60			229G/1399	S		

Question No.	Source Documents No.	Result	Relevance Two No.	Result	Relevance Three No.	Result
65	194R/1076	S				
69					310R/1099	F
70					61R/1749	F
74					413R/1690	S
76	325G/1913	S				
81					137P/1628	F
					616Q/1374	F
					618Q/1376	F
					75T/1630	F
82	249P/1452	S			178E/1139	S
					803Q/1297	S
					170G/1011	S
99					202M/1947	S
102	419Q/1217	S				
104					24682/1667	S
111	475Q/1952	S			799Q/1279	S
113					41M/1796	S
					66J/1722	S
					6J/1740	S
114	256M/2068	S				
115					848Q/1733	F
117					293M/1936	S
					796Q/1270	S
					167N/1196	S
					310M/1272	S
					419Q/1217	S
126			777Q/1456	S	507Q/1256	S
130					480Q/1025	F
133					230L/1789	F
134					580Q/1524	S
					196S/2076	S
					630Q/2067	S
					511Q/1350	S
<u>Total</u>						
Success	17		6		48	
Failure	3		3		19	

APPENDIX 4A

ANALYSIS OF FAILURES BY W.R.U. TO RECALL RELEVANT DOCUMENTS

This Appendix considers the search programmes and the indexing of all relevant documents which were not retrieved by W.R.U. The complete indexing is not included for reasons of space, but there are listed all the terms which have any relevance to the question or the search programme. Similarly, the role indicators are not given except in those cases where they were, or might have been, responsible for the failure to recall a particular document.

At the completion of each separate assessment are given the final decisions concerning the reasons for failure. These are coded as follows:

Indexing	An error in the concept indexing
Searching 1a	Uses terms less specific than question
1b	Uses terms more specific than question
1c	Omits to search concept implied in question
2a	Omits important concept in question
2b	Demands too high a level of concept co-ordination
3	Clerical error in encoding term
Index language 1	Roll indicators prevented recall
2	Levels prevented recall
3	Weakness in semantic code
Question	

INDEX TO W.R.U. RECALL FAILURES

INDEXING	Q11 - 262K	Q55 - 174D	Q81 - 137P
	Q16 - 191G	Q55 - 221D	Q81 - 616Q
	Q22 - 381Q	Q59 - 54F	Q81 - 618Q
	Q22 - 20906	Q65 - 194R	Q81 - 75T
	Q37 - 106J	Q69 - 310R	Q115 - 848Q
	Q42 - 279L	Q70 - 61R	Q130 - 480Q
SEARCHING 1a	Q38 - 188E	Q82 - 170G	Q82 - 178E
	Q82 - 249P	Q82 - 803Q	
1b	Q11 - 262K	Q13 - 316K	Q53 - 223D
	Q11 - 192K	Q15 - 191G	Q74 - 413R
	Q11 - 314K	Q15 - 297G	Q113 - 66J
	Q13 - 264K	Q53 - 36D	Q113 - 6J
	Q13 - 216K		
1c	Q55 - 174D	Q104 - 24682	Q134 - 580Q
	Q55 - 221D	Q111 - 799Q	Q134 - 650Q
	Q65 - 194R	Q134 - 511Q	Q136 - 196S
2a	Q2 - 460R	Q31 - 291R	Q113 - 66J
	Q3 - 185R	Q37 - 618Q	Q113 - 6J
	Q3 - 414R	Q37 - 106J	Q113 - 41M
	Q7 - 250Q	Q37 - 616Q	Q126 - 777Q
	Q16 - 279G	Q59 - 54F	Q126 - 507Q
	Q16 - 191G	Q65 - 194R	Q133 - 230L
	Q16 - 265G	Q99 - 202M	Q134 - 511Q
	Q16 - 298G	Q102 - 419Q	Q134 - 580Q
	Q24 - 197N	Q111 - 475Q	Q134 - 650Q
	Q31 - 435L	Q111 - 799Q	Q134 - 196S
2b	Q2 - 460R	Q34 - 65E	Q104 - 24682
	Q3 - 185R	Q43 - 361G	Q117 - 293M
	Q3 - 414R	Q43 - 26180	Q117 - 310M
	Q8 - 322K		Q117 - 419Q
	Q27 - 221E		Q117 - 796Q
3	Q5 - 79J	Q5 - 66J	Q38 - 188E
INDEX LANGUAGE			
1	Q23 - 163N	Q117 - 167N	
2	Q3 - 414R		
3	Q34 - 221E	Q38 - 188E	Q82 - 178E
	Q34 - 291E	Q76 - 325E	Q82 - 170G
	Q34 - 65E	Q81 - 616Q	Q82 - 803Q
	Q37 - 618Q	Q81 - 618Q	Q126 - 777Q
	Q37 - 616Q	Q82 - 249P	Q126 - 507Q
QUESTION	Q23 - 163N		

QUESTION 2 What information is available on the flux level required to produce sufficient damage in an oxide film to affect the oxidation rate of the underlying material ?

Search programme

$$\left[\left[A \left[\left[B+C \right]^2 \cdot \left[D \right]^2 \right] \right]^6 \right]^8$$

- | | |
|-----------------------------|-----------------------------|
| A. R-CT 1116 Oxidation | C. CAPR 1008 QO Oxide |
| B. CAPR QO 10-9 Metal Oxide | D. C-CR S-RT 1004.2002 Film |

Document 460R/1700 An investigation of columbium as an electrolytic capacitor metal. Electrochemical Society J. April, 1961. pp. 343-347.
(Rel. 3)

<u>Indexing</u>	Capacitator	Irradiation
	Columbium	Oxidation rate
	Tantalum	Radiation

Comments The search programme should have included the term 'radiation' which, with 'oxidation' would have retrieved this document. Failing this a search programme less exhaustive than the one used (i.e. 'Oxidation' 'Oxide' 'Film') such as 'oxidation' alone, would have retrieved the document.

Reasons for failure Searching 2a and 2b.

QUESTION 3 How does the mechanism of oxide film breakdown on zirconium differ from that on zircaloy 3 ?

Search programme

$$\left[\left[\left[A \right]^2 \cdot \left[\left[B \right]^2 + C \right]^4 \cdot \left[D.E \right]^4 \right]^6 \right]^4$$

- | | |
|--------------------------|----------------------------|
| A. C-PR. 1008 QO-- Oxide | D. KUP Property determined |
| B. C-CR. S-HT. 2002 Film | E. M-PR 1106 Thickness |
| C. S-HT Layer | |

Document 185R/1676 The oxidation and corrosion of zirconium and its alloys. Electrochemical Society J. Jan. 1961, pp. 24-29.
(Source)

Indexing 'Zirconium', 'Zircaloy', 'Oxide' among other concepts.

Comments The search programme omits the important concepts 'Zirconium' and 'Zircaloy' but it is also too exhaustive, demanding 'Oxide' with 'film' or 'layer' with 'thickness determination'. If the programme had accepted 'zirconium' or 'zircaloy' with 'oxide' the document would have been retrieved.

Reasons for failure Searching 2a and 2b.

Document 414R/1691 Effect of dissolved gases on oxide film formation.
 (Rel. 3) Electrochemical Society J., March 1961, pp. 294-295.

Indexing Zirconium Anodizing
 Annealing KWJ Film (Cols. 33/34)
 Absorption KWJ Oxide (Cols. 35/36)

Comments As with previous document. In addition, the document is excluded because 'oxide' and 'film' are required by the search programme to be indexed together in the fourth level (i.e. between one role indicator and the next). Here they appear following different role indicators, cols. 33/34 KWJ Film, cols. 35/36 KUJ. KWJ Oxide.

Reasons for failure Searching 2a and 2b.

QUESTION 5 Survey of steels suitable for precision gears.

Search programme

$${}^6_2 \left[\left[A \right] \right] {}^2_2 \left[\left[B \right] \right] {}^6_2$$

A. LALL RERN Ferrous alloys. B. M-CH M-CL 2001 Bearings.

Documents 79J/1447 Properties of Ni-al age hardening steel. Metal
 (Source) Progress, Feb. 1961, pp. 80-83.

Indexing Includes 'gears' and 'steels' among other concepts.

Comments Failure caused by a careless error in the encoding of the search programme, the code for 'bearings' being given instead of 'gears'.

Reason for failure Searching 3.

Document 66J/1722 New carburizing steels
 (Rel. 2) Metal Progress, Jan. 1961, pp. 70-75.

Indexing Indexing includes 'alloy steels' and 'gears'.

Comments Failure caused by a careless error in the encoding of the search programme, the code for 'bearings' being given instead of 'gears'.

Reason for failure Searching 3.

QUESTION 7 What are the effects of size and geometry of weld defects, and specifically the effect of damage to heat affected zone due to plastic strain ?

Search programme

$$\left[\left[A \left[\left[B \right]^2 \right]^2 \right]^2 \left[C \right]^2 + \left[D \right]^2 + \left[E \right]^2 + F \right] \right]^6 \delta$$

- A. F-ST 1008 Welding, weld.
- B. DYFL 1006. PAPR 2002 Stress
- C. MWTL P-SS RQHT 3014 Stress relieving
- D. MWTL P-SS RQHT 3014 Stress relieving
- E. DYFL 1006. PAPR PQSS 1012. 3995. Residual stress
- F. RAPR 1236. Plastic.

Documents 250Q/1064 Studies of hot cracking in high-strength weld metals.
(Rel. 3) Welding Journal Vol. 70, Jan. 1961, pp. 1s-7s.

Indexing 7340 weld metal Hot tensile strength
Hot cracking Ductility
Very high temperature Weldment
Freezing cycle

Comments If search had been made for 'welding/weld' with 'cracking', the document would have been found.

Reason for failure Searching 2a.

QUESTION 8 What processes can be used to repair castings. Factors affecting choice of method.

Search programme

$$\left[\left[\left[A + B \right] C \right]^4 \right]^6 \left[D + E \right] \right]^8$$

- A. KEJ Material processed
- B. KWV Property given
- C. C-NS 1025 Casting
- D. F-ST 1008 Welding
- E. R-CR 1004 Repair

Document 322K/1558 Tungsten arc welding saves trucking firm \$ 3000
(Rel. 3) Welding Journal, Vol. 40, March 1961, pp. 249.

Indexing Truck Tungsten arc welding
Aluminium Repairing

Comments The search programme could have been widened to 'welding/repairing' or 'repairing' alone.

Reasons for failure Searching 2b.

QUESTION 11 Jigging methods for seam welding thin titanium sheets and butt welding tubes. Must be suitable for open air welding.

Search programme

$$\left[\left[\left[A+B+C+D+E+F \right]^2 + \left[G \right]^2 \right]^2 \left[\left[H+I \right]^4 \right]^2 \left[\left[J+K \right]^2 \right]^2 \left[\left[L \right]^2 \right]^4 \right]^6 + \left[M+N \left[\left[O+P+Q+R \right]^2 + \left[S \right]^2 \right]^2 \right]^6 \right]^8$$

A. F-ST 1008 C-NT 1021	Seam welding machine
B. F-ST 1008 4215	Seam weld
C. F-ST 1008 4558	Continuous seam weld
D. F-ST 1008 4793	Mesh seam weld, welding
E. F-ST 1008 4363	Ultrasonic seam welding
F. F-ST 1008 4985	Electroslag seam welding
G. F-ST 1008 P-PR 4006	Seam welding
H. KUJ	Component
I. KEJ	Material processed
J. L-LL	Alloy
K. M-TL 1009	
L. QTQI	Titanium
M. TATB 100	Tubes
N. TOTB 100	Pipes
O. F-ST 1008 4561	Butt welding
P. F-ST 1008 4516	Flash butt welding
Q. F-ST 1008 4724	Upset butt welding
R. F-ST 1008 4559	Pressure butt welding
S. F-ST 1008 3002	Transverse butt welding

Documents 262K/1523 Fusion welding titanium and its alloys.
(Source) Welding and Metal Fabrication, Feb. 1961, pp. 72-74.

Indexing Sheet Jigging
Titanium Tungsten arc welding
Thin

Comments Indexer omitted concept 'seam welding'. Search programme could have been broadened to 'titanium/sheet/welding' or 'titanium/welding' to retrieve document. It is interesting to note that there is not a code for 'butt welding' and 'seam welding' which will retrieve all types of butt and seam welding. These have to be listed separately in the search programme, making a lengthy programme.

Reasons for failure (a) Indexing
(b) Searching 1b.

Document 192K/1519 Fusion welding of titanium and its alloys.
(Rel. 3) Welding and Metal Fabrication, Vol. 29, Jan. 1961, pp. 24-31, 36.

Indexing Titanium Fusion welding
Titanium alloys

Comments The document could have been retrieved if the search programme had been widened to 'titanium/sheet/welding' or 'titanium/welding'.

Reason for failure Searching 1b.

Document 314K/1527 Fusion welding of titanium and its alloys.
(Rel. 3) Welding and Metal Fabrication, Vol. 29, March 1961,
pp. 111-113.

Indexing Plate Titanium alloys
Titanium Tungsten arc welding

Comments Could have widened search to 'titanium/welding' and retrieved
the document.

Reason for failure Searching 1b.

QUESTION 13 Is it possible to weld stainless steel up to 3" diameter into large
structures by automatic controls, and what economic savings
result ?

Search programme

$$^6 [A [[B]^2 + C + [D]^2]] . [E]^2]^6$$

- A. F-ST 1008 Welding, weld
- B. MQCH P-SS 2001 Automation
- C. R-PR 1010 Automatic, semi-automatic
- D. FUST 1008 PASS 2002 Automatic welding
- E. LALL RERN CQR Steel, chromium

Documents 264K/1396 Precision welding in nuclear reactor construction.
(Source) Machinery, 4th Jan. 1961, pp. 23-26.

Indexing Submerged arc welding Stainless steel 347
Heliarc welding Stainless steel 308
Stainless steel 304

Comments The search could have been broadened from 'automatic welding/
steel, chromium' to 'welding/steel/chromium'.

Reasons for failure Searching 1b.

Document 216K/1446 Welding and heat treating a 60 ton cryogenic vessel.
(Rel. 3) Metal Progress, Vol. 79, Feb. 1961, pp. 88-90.

Indexing Pressure vessel Welding
Stainless steel 321 Stainless steel 347

Comments Could have broadened search from 'automatic welding/steel,
chromium' to 'welding/steel chromium' and found the document.

Reason for failure Searching 1b.

Document 316K/1228 A new way to make honeycomb. American Machinist,
(Rel. 3) Vol. 105, 20th Feb. 1961, pp. 100-101.

Indexing Stainless steel Resistance welding

Comments Could have extended search to 'welding/steel, chormium' and
retrieved the document.

Reason for failure Searching 1b.

QUESTION 15 Can high-strength titanium alloy sheet be stretched-formed ?

Search programme

$$\left[\left[\left[\left[A + B \right], \left[C + D \right] E \right] F \right] G \right]$$

- | | |
|---------------------------|---|
| A. KEJ Material processed | D. MATL Metal |
| B. KUJ Component | E. QTQI Titanium |
| C. LALL Alloy | F. P-PR 1044 Stretching, stretch-forming. |

Documents 191G/1423 Forming techniques for titanium alloys.
(Rel. 3) Metal Industry, Vol. 98, 6th Jan. 1961, pp. 3-6.

Indexing Titanium alloys Hot forming
Cold forming

Comments Could have extended search programme from 'alloy or metal of
titanium/stretch forming' to 'alloy or metal of titanium' with
'forming' and found the document.

Reason for failure Searching 1b.

Document 297G/1433 Titanium sheet forming. Metal Industry,
(Rel. 3) 17th Feb. 1961, pp. 131-132.

Indexing Titanium alloy Wheel forming
Hot forming

Comments Could have extended search programme from 'alloy or metal of
titanium/stretch forming' to 'alloy or metal of titanium' with
'forming' and found the document.

Reason for failure Searching 1b.

QUESTION 16 What temperatures can be used for the hot forming and subsequent stress relieving of pure titanium ?

Search programme $\left[\left[\left[A+B \right]^2 + \left[C+D+E+F+G+H+I+J+K \right]^2 + \left[L+M+N+O+P+Q+R+S+T+U+V+W+X+Y+Z+A'+B'+C' \right]^2 + \left[P'+E' \right]^2 + \left[F' \right]^2 + \left[G'+H' \right]^2 \right] \cdot \left[J'J' \right]^2 \right]^8$

A. RQHT L-LL R-RN	Red shortness, etc.
B. RQHT L-LL R-NG	Betatisation. (Mill annealing)
C. R-HT MWTL MACH 3568	Open flame furnace
D. R-HT MWTL MACH 3023	Pit furnace
E. R-HT MWTL MACH 3240	Heat treating furnace
F. R-HT MWTL MACH 3338	Salt pot furnace
G. R HT MWTL MACH 3797	Pusher type muffle furnace
H. R-HT MWTL MACH 3001	Mesh belt furnace
I. R-HT MWTL MACH 4019	Pusher type furnace
J. R-HT MWTL MACH 4020	Roller hearth annealing furnace
K. R-HT MWTL MACH 3226	Closed quench furnace
L. RQHT M-TL P-SS C-RB	Carburised, graphitized
M. RQHT M-TL P-SS C-RS	Spheroidised
N. RQHT M-TL P-SS C-TR	Box annealing
O. RQHT M-TL P-SS 4378	Duplex annealing
P. RQHT M-TL P-SS 4341	Strain annealing
Q. RQHT M TL P-SS LACN	Soaking pit, cold mill
R. RQHT M-TLP-SS CQCT	Electrotempering
S. RQHT M-TL P-SS LALL	Solution annealing
T. RQHT M-TL P-SS MACH	Annealer
U. RQHT M-TL P-SS 4989	(Programming error)
V. RQHT M-TL P-SS MQGN	Magnetic annealing
W. RQHT M-TL P-SS MYPR	Skin annealing
X. RQHT M-TL P-SS 4549	Spray quenching
Y. RQHT M-TL P-SS 4544	Quenchant
Z. RQHT M-TL P-SS 4422	Dual quench furnace
A' RQHT M-TL P-SS 3---	Annealing, stress relieving, etc.
B' RQHT M-TL P-SS TQMS	Vacuum annealing
C' RQHT M-TL P-SS RXHT	Bright annealing
D' RQHT 1004 MWTL MACH	Closed quench furnace
E' RQHT 1004 MWTL PWPR	Quench ageing
F' RQHT PAPR 1045 4548	Solution strengthening
G' RQHT P-SS 2001	Unannealed
H' RQHT P-SS 2004	Carbonizing
I' MATL	Metal
J' QTQI	Titanium

<u>Documents</u> (Source)	297G/1433	Titanium sheet forming. Metal Industry, 17th Feb. 1961, pp. 131-132.
------------------------------	-----------	---

<u>Indexing</u>	Titanium alloy I. C. I. 130	Stress relieving
	Hot forming	

QUESTION 16 (Continued)

Comments Could have extended the search to 'titanium alloys' with 'hot forming' or 'forming' and found the document. The search programme for this question is long and complex. One contributory factor seems to be the lack of a place in the code for 'annealing' generally, which will also retrieve all types of annealing. As there is no such place, the programmer has to list all types of annealing separately. It should have been possible to code 'furnaces' generally using R-HT MWTL MACH. The programmer has not done this but itemized individual furnace types.

Reason for failure Searching 2a.

Document 191G/1423 Forming techniques for titanium alloys.
(Rel. 3) Metal Industry, Vol. 98, 6th Jan. 1961, pp. 3-6.

Indexing Titanium alloy 011 Hot forming
Cold forming Heat treatment

Comments Indexer omitted concept 'titanium metal'. The search programme omitted the important concept 'hot forming' (CUNS 27X MWTL RQHT 1001) despite the length and complexity of the programme. Could also have included 'titanium alloys' as well as 'titanium metal'.

Reason for failure (a) Indexing.
(b) Searching 2a.

Document 265G/1520 The development of production processes for use with
(Rel. 3) titanium sheet. Welding and Metal Fabrication,
Feb. 1961, pp. 50-56.

Indexing Titanium Stretch forming
Hydraulic press forming KAM Drop hammer forming/wheel
Hot, cold forming forming

Comments Could have extended search to include 'titanium' 'hot forming' and found the document.

Reason for failure. Searching 2a.

Document 298G/2035 Titanium sheet forming. Metal Industry, 10th Feb.
(Rel. 3) 1961, pp. 103-107.

Indexing Titanium alloys Stretch forming
Rubber press forming

Comments Could have extended search to 'titanium alloys'/'forming' and found the document.

Reason for failure Searching 2a.

QUESTION 22 What are the theory and practice of extruding metals with some reference to steel ?

Search programme

(1) $\left[\left[\left[A \right]^2, B \right]^2 \right]^2$

(2) $\left[A+B \right]^2$

Programme 1.

- A. LALL RERN Ferrous alloys
- B. C-NG 1076 Extrusion etc.

Programme 2.

- A. C-NG 1076 Extruding
- B. R-LS 1010 Extruding

Document 381Q/1378 Extrusion theory and calculations. Journal of Metals,
(Source) March 1961, pp. 206-210.

Indexing Ingot Rolling
Steel

Comments Omits the concept 'extrusion' in indexing

Reason for failure Indexing.

Document 20906/2012 Process of working steel for preventing surface
(Rel. 3) defects thereof. U.S. Patent 2,968,092.

Indexing Steel Surface defect prevention
Hot working

Comments Omits concepts 'extrusion', 'rolling', 'forging' in indexing.

Reason for failure Indexing

QUESTION 23 What methods can be used to identify the microconstituencies in alloy steels ?

Search programme

$$\begin{matrix} 8 & 6 & 5 & 4 & 2 \\ \left[\left[\left[A \right] \left[A+B \right] \left[C+D \right] E \right] \right] \left[F+G+H \right] \left[\left[I+J+K+L \right] M \right] + N/O+P/Q+R+ \left[S \right] \right] \right] \end{matrix}$$

- | | |
|----------------------------|-------------------------------|
| A. KEJ Material processed | K. C-PR Vapours |
| B. KUJ Component | L. MZTL Semi-metals |
| C. LALL Alloy | M. Q--- |
| D. MATL Metal | N. GAPR 1010 Constitution |
| E. QFQE Iron | O. GAPR 1011 Content |
| F. KUP Property determined | P. LAMN 1042 Constituent |
| G. KWJ Product | Q. LAMN 1522 Microelement |
| H. KIJ Minor component | R. MATL 1022 Composition |
| I. M-TL Metal | S. CIRS 3004 Microconstituent |
| J. G-SS Gas | |

Document 163N/1183 Intergranular precipitation of intermetallic compounds
(Source) in austenitic alloys. AIME Metallurgical Soc. Trans.
 Feb. 1961, pp. 28-34.

Indexing

KUJ. KEJ S-816 alloy	KUJ. KEJ Incoloy 901 alloy
KUJ. KEJ S 540 alloy	KWV Composition
KUJ. KEJ Rene 41 alloy	KAM X-ray diffraction, electron micro-
KUJ. KEJ M-308 alloy	scopy metallographic analysis.
KUJ. KEJ M-647 alloy	KUP. KAP Microstructure
	KUP. KAP Crystal structure

Comments Recall was prevented by the role indicators in the search programme. The indexing gives 'iron' with the term 'composition' as required by the search programme, but the term 'composition' is preceded by the indicator 'KWV' (property given for) in the indexing and the indicators KUP. (property determined), KWJ (product) or KIJ (minor component) in the search programme. The KWV is used in the indexing to indicate that the metals discussed are austenitic. There is little in the document on the methods of identification of micro-constituents in steels; the interest of the paper is the microstructure and not in the methods of investigation. For this reason the question is too specific for the document.

Reason for failure (a) Index language 1 (b) Question

QUESTION 24 What equipment and procedure can be used to determine the complete orientation of an unaxial crystal ?

Search programme

$$\left[A + B + \left[C \right]^2 + \left[D \right]^2 \right]^8$$

- | | |
|------------------------|--------------------|
| A. R-DT 1010 | X-ray, x-radiation |
| B. D-FL 1020 | Diffraction |
| C. NULL 1024 3916 | X-ray micrograph |
| D. SACN RQDT RWNG 1024 | X-ray spectroscopy |

Document 197N/1157 Surface self-diffusion measurements on nickel by
(Rel. 3) the mass transfer method. ACTA Metallurgica,
Jan. 1961, pp. 23-31.

Indexing Nickel Radioactive tracer
Orientation Field emission microscope

Comments This document would have been found if the search programme had included the concept 'orientation'.

Reason for failure Searching. 2a.

QUESTION 27 Are there any new processes to improve the soundness of castings of grey iron ?

Search programme

$$\left[\left[A \right]^2 B \right]^8$$

- | | |
|--------------------|---------------------------|
| A. RERN CIC-. QFQE | Grey cast iron, grey iron |
| B. C-NS 1025 | Cast, castings. |

Document 221E/1761 Inoculation and casting expansion. B.C.I.R.A.
(Rel. 3) Journal, Jan. 1961, pp. 103-116

Indexing Grey cast iron Poling
Shrinkage Innoculation
Porosity

Comment The document would have been recalled if the programme had asked for 'grey cast iron' alone instead of 'grey cast iron' with 'cast, castings'.

Reason for failure Searching 2b

QUESTION 31

How effective can a sprayed coating be for the protection of metals from corrosion in service ?

Search programme

$$\left[\left[\left[A+B \right], \left[C/D/E \left[F+G+H+I+J+K+L+M+N \right] \right] \right] \right]$$

- | | |
|--------------------------------------|--|
| A. R-SN Plastics | H. D-TR S-HT Scale |
| B. RAPR 1236 Resins | I. D-TR CYMN 1009 Fretting corrosion |
| C. D-TR 1001 Corroded, corrosion | J. D-TR DYFL 1006 Stress corrosion |
| D. D-TR 1004 Attack | K. D-TR GANT Deruster |
| E. D-TR 1008 Pinhole corrosion | L. D-TR PAPR 1036 Corrosion resistance |
| F. D-TR N-LL Corrosion testing, etc. | M. D-TR L-TL Corrosion cell |
| | N. D-TR M-TR Springer corrosion |

Document 435L/2045 Superior plating shows the way. Metal Finishing, (Rel. 3) April 1961, pp. 45-48.

Indexing Platings Coating
 Fluidized bed coatings Plastisol
 Plated Testing
 Electroplating

Comments Search programme omitted the concept 'coatings' altogether. A search programme 'plastic coating' would have retrieved document. It is interesting to note that there is no one code for 'corrosion' which will retrieve all types of corrosion.

Reason for failure Searching 2a.

Document 291R/1486 Coatings protect materials from flight heat. (Rel. 3) SAE Journal, March 1961, pp. 78-79.

Indexing Various alloys Fibreglass
 Coatings Teflon
 Epoxy KAP Oxidation resistance

Comments Search programme omitted the concept 'coatings' altogether. A search programme 'plastic coating' would have retrieved document. It is interesting to note that there is no one code for 'corrosion' which will retrieve all types of corrosion.

Reason for failure Searching 2a.

QUESTION 34 How does the composition of hypoeutectic cast iron affect the shrinkage unsoundness ?

Search programme

$$\left[\left[\left[A \right]^2 \right]^2 \right]^5 \left[\left[B.C \right]^2 + \left[D+E+F+G \right]^2 \right]^6 \right]^5$$

- A. RERN CIB-QFQE Cast iron
- B. MYPR 1195 (Invalid code)
- C. P-PR (invalid code)
- D. LALL 1002 LYMN 3004 Hypereutectic
- E. LALL 1002 LYMN 3005 Hypereutectoid
- F. LALL 1002 LYMN 3006 Hypoeutectoid
- G. LALL 1002 LYMN 3001 Eutectics
- H. RYDC 1010 Shrinkage

Document 221E/1761 Innoculation and casting expansion. B.C.I.R.A.
(Source) Journal, Jan. 1961, pp. 103-116.

Indexing Grey cast iron (RERN CIC QFQE) Shrinkage
 Eutectic

Comments The document would have been recalled if the code for 'cast iron' (RERN CIB QFQE) could have retrieved specific types of cast iron, i.e. 'grey cast iron' at (RERN CIC QFQE).

Reason for failure Index language 3.

Document 291E/1762 Influence of cold blast cupola practice on casting
(Rel. 2) properties and iron compound. B.C.I.R.A. Journal, Jan. 1961, pp. 46-66.

Indexing Grey cast iron (RERN CIC QFQE) Shrinkage
 Eutectic

Comments The document would have been recalled if the code for 'cast iron' (RERN CIB QFQE) could have retrieved specific types of cast iron, i.e. 'grey cast iron' at (RERN CIC QFQE).

Reason for failure Index language 3

Document 65E/1126 Risering a malleable iron. Foundry, Jan. 1961, pp. 82.
(Rel. 3)

Indexing Malleable iron (RERN CIG QFQE) Shrinkage

Comments The search programme too exhaustive to recall this document. A braoder search programme (such as Facet's second programme) 'cast iron/shrinkage' would have retrieved, except that the code for cast iron (RERN CIB QFQE) would not have retrieved malleable cast iron.

Reason for failure (a) Searching 2b.
 (b) Index language 3.

QUESTION 37 To what extent do stress concentrations affect the structural tensile strength of aircraft and space vehicles ?

Search programme

$$\left[\left[\left[A+B+C \right] \left[\left[D \right]^2 + \left[E \right]^2 \right] \right]^2 \right]^6 \left[\left[F \right]^2 + \left[G \right]^2 \right]^8 \right]$$

- | | |
|--------------------------|--|
| A. S-RR Aircraft | D. P-PR P-SH 1002 Tensile testing |
| B. S-TR Celestial bodies | E. PAPR 1048 3646 Tensile yield strength |
| C. S-SP Space | |

Document 618Q/1376 Structural significance of ductility. Journal of Metals, (Source) March 1961, pp. 201-203.

Indexing Aerospace material (LACN 1641) Tensile strength
Stress concentration Fracture point

Comments The search programme ignored two important concepts in the question, 'tensile strength' and 'stress concentrations' and included less obvious ones. Although these concepts are indexed together with 'aerospace' the document still would not be retrieved with an improved search programme because the code for 'aerospace' LACN 1641 would not be retrieved by the code for 'Space' S-SP in the search programme. There should not be two separate places for concepts so closely linked.

Reasons for failure (a) Searching 2a. (b) Index Language 3.

Document 106J/1042 For stronger missile cases - decarb. Metal Progress, (Rel. 2) Vol. 79, March 1961, pp. 78-80.

Indexing Missile case Fracture toughness (DASM 1006 PAPR 1053)
Ladish 6 AC Steel

Comments Abstract omitted concepts 'tensile strength', 'stress concentration', 'notch sensitivity', but even if these concepts had been included, the search programme, which omits the important concepts of 'tensile strength' and 'stress concentration', would have failed to retrieve.

Reasons for failure (a) Indexing. (b) Searching 2a.

Document 616Q/1374 Evaluating fracture toughness. (Pressure vessels for (Rel. 3) space, aerospace and hydro-space: a symposium).
Journal of Metals, March 1961, pp. 195-197.

Indexing Pressure vessel Fracture strength
Aerospace application (LACN 1641) Stress concentration
Tensile stress Fracture toughness

Comments The search programme omits the concept 'stress concentration' which would have retrieved this document. If the code for 'aero-space' (LACN 1641) had not separated the term from other space terms at S-SP.

Reasons for failure (a) Searching (b) Index language 3.

QUESTION 38 What changes in pattern design are possible when microcracks are deliberately introduced into a mold ?

Search programme

$$\$ \left[A \left[\overset{2}{B} \right] + \overset{2}{C} \right] \$$$

- A. DASM 1010 Crack
- B. CUNS 1025 MACH 2001 Mold
- C. CWNS 1025 MWCH. PASS 3004 Molding

Document 188E/1864 Cracks in molds make better castings. Steel:
(Source) 6th March 1961, pp. 68-69.

Indexing Hot working alloy Mold
 Die steel Microcrack (DASM 1020)
 Precision casting

Comments Code for 'crack' (DASM 1010) should, but does not retrieve the more specific term 'microcrack' (DASM 1020). Also there is an error in the code used in the search programme for 'mold'. The searcher could have found the document by extending the search to 'microcrack'.

Reasons for failure (a) Searching 1a and 3. (b) Index language 3.

QUESTION 42 What methods are available for determining the adhesion of electro-deposits ?

Search programme

- A. C-CR L-CT Electroplating, electrotinplating, etc.
- B. C-CR L-TL Electrodeposited coating, etc.
- C. F-ST 1002 Adhesion, adherence.

Document 279L/2063 Evaluation of electro-deposited coatings. Metal
(Ref. 2) Finishing, Feb. 1961, pp. 38-44.

Indexing 'Electrodeposited coating', among other concepts.

Comments Omits concept 'adhesion'.

Reason for failure Indexing

QUESTION 43 What are the effects of friction during cold extrusion of steel, and how can this friction be overcome ?

Search programme

^{8 6 2 2}
[[[A] . [B] [C + D]]]^{6 8}

- A. LALL RERN Steel
B. C-NG 1076 Extrusion
C. N-BT 1021 Friction
D. G-RS Grease, lubricant.

Document 361G/1811 Tool materials for cold extrusion process.
(Rel. 3) Sheet Metal Industries, Vol. 38, March 1961, pp. 190-207.

Indexing Steel Cold extrusion Extrusions
Comments The document would have been recalled if the search programme had been broadened to 'steel/extrusion'.

Reason for failure Searching 2b.

Document 26180/2033 Cold forming lubricant and method of applying same.
(Rel. 3) U.S. Patent 2,963,391.

Indexing Alloys Cold extrusion
Metals including Ferrous Lubricant
Comments The document would have been retrieved if the search programme had tried 'extrusion/lubricant'.

Reason for failure Searching 2b

QUESTION 53 What measures can be taken to ensure reasonable economic and technical efficiency in a steel making factory using the basic arc furnace, with reference to the preparation of raw materials, particularly that of scrap ?

Search programme

^{6 2 2 6}
[[A] B]

- A. LWCR 1003. RUHT 3387 Basic arc furnace
B. SACR 1001 Scrap

Document 223D/1787 Control of foundry steel making. Foundry Trade Journal,
(Source) 23rd Feb. 1961, pp. 231-239.

QUESTION 53 (Continued)

<u>Indexing</u>	Scrap Foundry Steelmaking	Charging Furnace
<u>Comments</u>	Search programme too specific. Requires 'basic arc furnace' with 'scrap', whereas the search programme 'scrap/steelmaking' or 'furnaces' with 'scrap' would have retrieved.	
<u>Reason for failure</u>	Searching 2b	

Document 36D/1362 On England's largest electric furnace plant.
(Rel. 3) Journal of Metals, Dec. 1960, pp. 934-936.

<u>Indexing</u>	Pig Iron Scrap	Steelmaking Electric arc furnace
<u>Comments</u>	Search programme too specific. Requires 'basic arc furnace' with 'scrap' whereas the search programme 'scrap/steelmaking' or 'furnaces' with 'scrap' would have retrieved.	
<u>Reason for failure</u>	Searching 2b	

QUESTION 55 Does the injection of gas into the blast furnace produce any significant increase in iron production or saving in coke consumption ?

Search programme

$$\left[\left[\left[\overset{8}{A} \right] + \overset{2}{B} + \overset{2}{C} + \left[\overset{5}{D} + \left[\overset{5}{E}, \overset{5}{F} \right] \right] \right] \right]$$

- A. SUPP TWMS 1005. 2001 Blast
- B. MACH. MWTL RGHT TQMS 442 Blast cupola
- C. M-CH. MWTL RQHT 3001 Blast furnace
- D. SUPP. 1004 Injection
- E. KAM Process
- F. G-SS Gas

Document 174D/1038 Ferromanganese production with oxygen enrichment.
(Rel. 2) Journal of Metals, Jan. 1961, pp. 45-48.

<u>Indexing</u>	Blast furnace Concentration	Production rate Coke rate
<u>Comments</u>	The indexer omitted the concept 'injection' but the document could have been found if the search programme had tried 'blast furnace/coke'.	
<u>Reasons for failure</u>	(a) Indexing (b) Searching 1c.	

QUESTION 55 (Continued)

Document 221D/1588 The potential and limitations of high blast temperatures.
(Rel. 2) Blast Furnace, March 1961, pp. 239-245.

Indexing Blast furnace Coke consumption
 Combustion zone

Comments The indexer omitted the concepts 'oxygen' and 'injection' but the document would have been found if the search programme had not omitted the concept 'coke consumption'. A search programme 'blast furnace/coke' would have retrieved.

Reasons for failure (a) Indexing (b) Searching 1c.

QUESTION 59 If the oxide film is removed from steel strip by liquid fluxes is the flow of liquid tin over the surface more satisfactory ?

Search programme

8 6 5 2 2 5 5 5 6 8
 [[[[A].B]. [C.D]]]]

A. LALL RERN Steel C. F-ST Fastening
 B. KEJ Material processed D. QSQN Tin

Document 54F/1859 Filter system upgrades ultrothin steel strip.
(Rel. 3) Steel: 9th Jan. 1961, pp. 76-

Indexing Stainless steel Rolling Strip

Comments The indexer omitted the concept "cleaning". If this concept had been included and the search programme 'cleaning/strip' made, the document would have been found.

Reasons for failure (a) Indexing (b) Searching 2a.

QUESTION 65 What types of austenitic stainless steels are suitable for use in nuclear reactors when in contact with reactor slurries ?

Search programme

8 6 2 2 2 2 6 8
 [[[A]. [B+C]]]]

A. LALL RERN CQR Steel. Chromium
 B. MACH NQCL 2003 Nuclear reactors
 C. MACH NQCL 2007 Atomic reactors

QUESTION 65 (Continued)

Document 194R/1076 Corrosion-erosion of sensitized AISI Type 304 stainless steel in a thorium dioxide uranium trioxide slurry.
(Source) Corrosion, Jan. 1961, pp. 93-96.

<u>Indexing</u>	Test loop	Thorium dioxide
	Stainless steel	Uranium trioxide
	Intergranular corrosion	KEJ 347 Stainless steel
	Slurry	

Comments The indexer omitted the concept 'nuclear reactor' altogether, but the document could have been found if the search programme had included the other important concept in the question 'slurries', or the implied concept 'corrosion' at the same time dropping the concept 'reactors'.

Reasons for failure (a) Indexing. (b) Searching 2a.

QUESTION 69 What work had been reported on the electrochemical corrosion of iron and aluminium alloys by A. C. currents ?

Search programme

$$[[[A[[B+C][D+E]]], [F[G+H]]]]]$$

- | | |
|---------------------------|-----------------------|
| A. KEJ Material processed | F. D-TR Deterioration |
| B. LALL Alloy | G. L-CT Electricity |
| C. MATL Metal | H. L-TL Electrolysis |
| D. QFQE Iron | |

Document 310R/1099 Corrosion resistance of electrolytic tin plate. Pt. 1.
(Rel. 3) Electrochemical studies of tin. Iron-tin alloys.
 Corrosion, Feb. 1961, pp. 99-105.

<u>Indexing</u>	Electrolytic tin plate	Detinning
	Corrosion	Polarisation
	Pitting	Potential

Comments Indexer omitted concept 'iron-tin alloy'.

Reason for failure Indexing

QUESTION 70 What is the mechanism of the corrosion of the steel in a reinforced concrete structure exposed to the action of the seawater ?

Search programme

(1) $\begin{matrix} b & 2 \\ \left[\left[A \left[\begin{matrix} 2 & 2 \\ B \end{matrix} \right] + C + \left[\begin{matrix} 2 & 2 \\ V \end{matrix} \right] \right] \right] \end{matrix}$

(2) $\begin{matrix} 8 & 6 & 2 & 2 & 2 & 2 & 5 & 2 & 2 & 5 & 6 & 8 \\ \left[\left[\left[A \right], B \left[\begin{matrix} 2 & 2 \\ C \end{matrix} \right] + \left[\begin{matrix} 2 & 2 \\ D \end{matrix} \right] + E + F + G + H + I + \left[\begin{matrix} 2 & 2 \\ J \end{matrix} \right] + \left[\left[\begin{matrix} 2 & 2 \\ K \end{matrix} \right], L \right] \right] \right] \end{matrix}$

Programme 1

- A. D-TR Deterioration
- B. CARM 1008 MWNN 1005. 2002 Concrete
- C. HADR 10-- Water
- D. DAFF 1011 HQDR 2025 Salt spray

Programme 2

- | | |
|----------------------------------|-------------------------------|
| A. LALL RERN Steel | G. H-DR 1033 Brine grit water |
| B. D-TR Deterioration | H. H-DR 1002 Ocean |
| C. CARM 1008. MWNN 1005 Concrete | I. H-DR 1017 Sea |
| D. GARP. MYLT. P-PL Marine | J. H-DR 2025 Salt spray |
| E. H-DR 1018 Seawater | K. CAPR 1033 Salt |
| F. H-DR 1025 Salt spray | L. H-DR Water |

Document 61R/1749 Bimetallic heat exchangers tube solve dual corrosion
(Rel. 3) problem. Metal Progress, December 1960, pp. 115-117.

<u>Indexing</u>	Heat exchanger	Brackish cooling water
	Tubes	Corrosion
	Stainless steel	Hot gas
	Stress corrosion	Corrosion resistance
	Pitting	

Comments The document would have been found by the second search programme if the indexer had included the concept 'marine' with 'corrosion'.

Reason for failure Indexing.

QUESTION 74 What is the effect of high pressure steam on the stress corrosion behaviour of austenitic stainless steel ?

Search programme

$\begin{matrix} 8 & 6 & 2 & 2 & 5 & 5 & 6 & 8 \\ \left[\left[\left[A \right], \left[\begin{matrix} 2 & 2 \\ B, C \end{matrix} \right] D \right] \right] \end{matrix}$

- | | |
|----------------------------------|-------------------|
| A. LALL RERN CQR Steel, chromium | C. D-TR Corrosion |
| B. D-FL 1006 Stress | D. H-DR Water |

QUESTION 74 (Continued)

Document 413R/1690 Anodic behaviour of austenitic stainless steels.
(Rel. 3) Electrochemical Society J., Vol. 108, March 1961,
 pp. 222-228.

Indexing 1009. QFQE Austenitic 1013
 QCQR Chromium Stress corrosion (Corrosion not coded)
 QNQi Nickel Corrosion potential
 KEJ. KOV Stainless steel Corrosion resistance

Comments This document would have been found if the search programme had
 been made less specific by dropping the concept H-DR 'water'.

Reason for failure Searching 1b

QUESTION 76 How can stainless steel tube be expanded by explosive forming ?

Search programme

(1) $\begin{matrix} 5 & 6 & 5 & 2 & 2 & 5 & 6 & 8 \\ \text{[[[A [B]] C] } \end{matrix}$ (2) $\begin{matrix} 5 & 6 & 2 & 2 & 6 & 8 \\ \text{[[[[A] + B] C] } \end{matrix}$

Programme 1.

- A. T-TB Tubes, pipes
- B. LALL RERN CQR Steel, chromium
- C. P-LS Explosive

Programme 2

- A. LALL RERN QFQE CQR Steel, iron chromium
- B. T-TB Tubes, pipes
- C. P-LS Explosive

Document 325G/1913 Rohn puts electro forming on the line. Steel:
(Source) 27th March, 1961, pp. 168-169.

Indexing Tube Electroforming (CUNS 1027 LQTL 1003
 Stainless steel PASS 3001)
 Water

Comments This document would have been found if the close relationship
 between 'electroforming' and 'explosive forming' had been revealed
 by the semantic code. The semantic factor P-LS 'explosive'
 should appear in 'electroforming' in the same way as it does in
 'explosive forming' (CUNS 1027 PQLS PASS PASS 4555). The
 facet system uses the same code for both terms and so the document
 is retrieved by that system.

Reason for failure Index language 3.

QUESTION 81 Do stainless steels have any advantage over aluminium and titanium alloys as structural materials for rockets using liquid hydrogen propellants ?

Search programme

$$\left[\left[\left[\overset{8}{A} \overset{6}{+} \left[\overset{2}{B} \overset{2}{+} \overset{2}{C} \right] \right] \overset{2}{+} \left[\overset{2}{D} \overset{2}{+} \overset{2}{E} \right] \right] \right] \left[\overset{5}{F} \overset{2}{+} \overset{2}{G} \overset{2}{+} \overset{2}{H} \overset{2}{+} \left[\overset{5}{I} \overset{2}{+} \left[\overset{2}{J} \overset{2}{+} \overset{5}{K} \right] \right] \right] \right]$$

- | | |
|---|--------------------------|
| A. LALL RERN CQR Steel, chromium | G. S-TR Celestial bodies |
| B. LALL Alloy | H. S-RR Aircraft |
| C. MATL Metal | I. F-LD Fluid, liquid |
| D. QAQL Aluminium | J. GASS QO Oxygen |
| E. QTQI Titanium | K. GASS QH Hydrogen |
| F. S-SP Space (rockets, missiles, etc.) | |

Documents 137P/1628 Design information on titanium alloys for aircraft and missiles. DMIC Report 145.
(Rel. 3)

Indexing Titanium alloys Tensile strength, and other properties
Sheet, strip, plate, bar

Comments Indexer omitted altogether the application of the alloys in aircraft and missiles.

Reason for failure Indexing

Document 616Q/1374 Evaluating fracture toughness. (Pressure vessels for space, aerospace and hydrospace: a symposium)
(Rel. 3) Journal of Metals, March 1961, pp. 195-197.

Indexing Pressure vessels
Aerospace application (LACN 1641)
Explosive bulge crack testing
Various properties including tensile stress, fracture strength
Plate
Mild steel

Comments The indexer omitted the concept 'titanium' and so the search programme could not recall the document. Also, although the aerospace application is noted by the indexer, the code used for the term 'aerospace' separates it at LACN 1641 from the terms coded 'space' S-SP required by the programme. The terms 'aerospace' and 'space' should be linked by the semantic coding.

Reasons for failure (a) Indexing (b) Index language 3.

Document 618Q/1376 Structural significance of ductility. Journal of Metals,
(Rel. 3) March 1961, pp. 201-203.

Indexing Aerospace material Evaluation testing
Titanium alloys Various properties

QUESTION 81 (Continued)

Comments The indexer omitted concepts 'missiles', 'rockets', 'space vehicles' present in the document, but the use of the term 'aerospace' should have been sufficient to retrieve. It was not because the semantic code provides quite unrelated codes for 'aerospace' (at L-CN) and 'space' (including rockets, missiles) at S-SP.

Reasons for failure (a) Indexing (b) Index language 3

Document 75T/1630 Aerospace fasteners use new materials. Materials in (Rel. 3) Design Engineering, March 1961, pp. 110-113.

Indexing cols. 1/6 KAD Fastener, bolt, rivet
cols. 7/18 KUJ. KOV Ti alloys
cols. 33/34 KWV KAP Heat resistance, and other properties
cols. 45/48 KAL Very high temperature

Comments Indexer omitted concepts 'missiles', 'rocket' and 'aircraft'.

Reason for failure Indexing

QUESTION 82 What is the best type of copper alloy to use in electrical application where high electrical conductivity and good resistance to softening on heating is required ?

Search programme

8 2 2 2 2 8
[[A] . [B]]

A. MATL QCQU Copper

B. LYCT PAPR Electric properties

Document 249P/1452 Zirconium copper alloy high strength and (Source) conductivity. Metal Progress, April 1961, pp. 75-77.

Indexing Alloy Electrical conductivity (LYCT 1001, PAPR 1002, Copper TYRN 3001)

Comments This document was not found partly because the code for electrical properties (LYCT PAPR) will not retrieve the particular property 'electrical conductivity' (LYCT 1001 PAPR TYRN 1002. 3001). The searcher could have recalled the document by making the more specific search for 'electrical conductivity' or by broadening the search to 'copper' with 'electricity' (L-CT).

Reasons for failure (a) Index language 3 (b) Searching 1a

QUESTION 82 (Continued)

Document 178E/1139 Producing high conductivity copper castings.
(Rel. 3) Foundry, March 1961, pp. 84-87.

Indexing Copper Electrical conductivity

Comments This document was not found partly because the code for electrical properties (LYCT PAPR) will not retrieve the particular property 'electrical conductivity' (LYCT 1001 PAPR TYRN 1002. 3001).
The searcher could have recalled the document by making the more specific search for 'electrical conductivity' or by broadening the search to 'copper' with 'electricity' (L-CT).

Reasons for failure (a) Index language 3. (b) Searching 1b.

Document 170G/1011 Sulphur aids copper machining. Iron Age, 26th Jan.
(Rel. 3) 1961, pp. 74-75.

Indexing Alloy Thermal conductivity
 Copper Electrical conductivity

Comments This document was not found partly because the code for electrical properties (LYCT PAPR) will not retrieve the particular property 'electrical conductivity' (LYCT 1001 PAPR TYRN 1002. 3001).
The searcher could have recalled the document by making the more specific search for 'electrical conductivity' or by broadening the search to 'copper' with 'electricity' (L-CT).

Reasons for failure (a) Index language 3. (b) Searching 1a.

Document 803Q/1297 Dispersion strengthening in the copper-aluminium system
(Rel. 3) AIME Metallurgical Soc. Trans. April 1961, pp. 371-376.

Indexing Cermet Electrical conductivity
 Copper

Comments This document was not found partly because the code for electrical properties (LYCT PAPR) will not retrieve the particular property 'electrical conductivity' (LYCT 1001 PAPR TYRN 1002. 3001).
The searcher could have recalled the document by making the more specific search for 'electrical conductivity' or by broadening the search to 'copper' with 'electricity' (L-CT).

Reasons for failure (a) Index language 3. (b) Searching 1a.

QUESTION 99 What optical methods can be used in determining the orientation of metal single crystals ?

Search programme

${}^{565}{}^{568}[[[A.B]C]]$

A. CARS 1009 Single crystals C. R-NG 1009 Orientation, oriented.
B. MATL Metal

Document 202M/1947 The orientation of martensite in austenite. ACTA
(Rel. 3) Metallurgica, Dec. 1960, pp. 892-896.

Indexing Chromium 150 Alloy Lave back reflection
Alloy Orientation
Nickel X-ray microbeam examination

Comments This document would have been retrieved if the search programme had omitted 'metal single crystals' and substituted 'determination'.

Reason for failure Searching 2a

QUESTION 102 What are the damping characteristics of SAP ?

Search programme

${}^{552}{}^{58}[[[A+B]C]. [D+E]]$

A. MATL Metal D. C-NS 1034 Sintering
B. LALL Alloy E. M-PR 1075 Powder
C. QAQL Aluminium

Document 419Q/1217 Internal friction behaviour of an aluminium oxide
(Source) SAP type alloy. AIME Metallurgical Soc. Trans.
Feb. 1961, pp. 206-207.

Indexing SAP alloy A/2O₃
Aluminium Dispersion
Matrix Damping

Comments If the search programme had asked for 'damping' with 'metal or alloy of aluminium', the document would have been found, provided that 'sintering' or 'powder' were excluded. The search programme could also have asked more specifically for the SAP alloy with 'damping' and retrieved the document.

Reason for failure Searching 2a

QUESTION 104 Is the heating effect of an electron beam sufficient to cause dislocation rearrangement in the thin metal foils examined by the electron microscope ?

Search programme

$$\begin{matrix} 8 & 6 & 5 & & 2 & 2 & & 5 & & 2 & 2 & & 2 & 2 & & 2 & 2 & & 6 & 8 \\ [[[[A[B[C]]]] + [D] + [E]]. [F + [G] + [H]]]] \end{matrix}$$

- | | |
|-----------------------------------|--|
| A. PAPH 1006 Electron | E. P-PH 1006 PYTC Electron optical |
| B. BAMB Beam | F. MYPR 1124 Thin |
| C. M-CH NULL 1024 2008 Microscope | G. METL SAHT 2001 Foil |
| D. BAMB P-PH 1006 Electron beam | H. C-RS H-LL 1009 PAPR 3001 Dislocation. |

Document 24682/1667 The preparation of thin films of germanium and silicon.
(Rel. 3) British J. of Applied Physics, March 1961, pp. 92.

<u>Indexing</u>	Film	Measuring
	Germanium	Electron microscope
	Silicon	Diffusion

Comments If the search had been broadened to include 'film' as well as 'foil' or had asked for 'electron microscope' alone, the document would have been retrieved.

Reason for failure Searching 2b.

QUESTION 111 Is the ductile-brittle fracture transition of metals wetted by liquid metals caused by diffusion of the liquid metals, or is there any similarity to the transition occurring in body centred cubic metals as a function of temperature ?

Search programme

$$\begin{matrix} 8 & 2 & & 2 & 4 & 2 & 2 & 4 & 8 \\ [[A.C] + [B[C]]] \end{matrix}$$

- | |
|---|
| A. MWTL PAPR RYHT 1004 Critical temperature, equicohesive point temp. |
| B. PYPR 1077 Viscoelastic |
| C. DWSM 1006 PWPR 1010 2674 Brittle fracture |

Document 475Q/1952 Ductile-brittle transition in alpha brass.
(Source) ACTA Metallurgica, Dec. 1960, pp. 848-850.

<u>Indexing</u>	Alpha brass	Ductile brittle transition
	Wetting	Brittle fracture
	Liquid Cg	

QUESTION 111 (Continued)

Comments The document is not retrieved because the search programme omits important concepts in the question while including some less vital ones. If the search programme had asked for "ductile brittle transition/liquid metals/diffusion", the document would have been retrieved.

Reason for failure Searching 2a.

Document 799Q/1279 A study of fracturing behaviour of copper and zinc coated mercury. AIME Metallurgical Soc. Trans. April 1961, pp. 261-265.
(Rel. 3)

<u>Indexing</u>	Single crystals	Mercury
	Copper	Stress cracking
	Zmc	Wetting
	Coating	Embrittlement

Comments The document could have been recalled by a search programme including 'wetting' with 'embrittlement' or the specific liquid metal 'mercury', omitting the concepts in the original search programme.

Reason for failure Searching 1c and 2a.

QUESTION 113 What are the factors to be considered when selecting surface hardening steels for components subjected to torsional fatigue conditions ?

Search programme

$$8622 \quad 68$$

$$[[[A], B.[C+D]]]$$

A. LALL RERN Steel	C. D-FL 1022 Twist, twisted, twisting
B. P-PR 1091 Fatigue	D. M-TN Rotation, rotating.

Document 66J/1722 New carburizing steels German automobiles.
(Rel. 3) Metal Progress, Jan. 1961, pp. 70-75.

<u>Indexing</u>	Alloy steel	Hardenability, hardness
	Carburizing	Fatigue strength
	Direct quenching	

Comments The document would have been retrieved if the search programme had accepted the less specific 'fatigue' rather than 'torsional fatigue' with 'steel' and the other concepts in the question 'hardening/hardenability/hardness'.

Reason for failure Searching 1b and 2a.

Document 6J/1740 Does silicon accelerate decarburization.
(Rel. 3) Metal Progress, Vol. 78, Dec. 1960, pp. 78-81.

Indexing Medium carbon steel Hardenability
Decarburization

Comments The document would have been retrieved if the search programme had accepted the less specific 'fatigue' rather than 'torsional fatigue' with 'steel' and the other concepts in the question 'hardening/hardenability/hardness'.

Reason for failure Searching 1b and 2a.

Document 41M/1796 Structure of carburized and carbo-nitrided cases.
(Rel. 3) Metal Progress, Dec. 1960, pp. 86-90.

Indexing Steels Carburizing
Case hardening Microhardness

Comments The document would have been recalled if the search programme had asked for 'case hardening' or 'hardening' or 'hardness' with 'steels'.

Reason for failure Searching 2a.

QUESTION 115 What is the cross-sectional shape of extrusions formed on the surface of aluminium alloys subjected to fatigue ?

Search programme

$$\left[\left[\left[\left[A + B \right] C \right] \right] \right] \cdot \left[D + E \right] \right] F \right] \right]$$

- | | |
|-------------------|---------------------------|
| A. LALL Alloy | D. KEJ Material processed |
| B. MATL Metal | E. KUJ Component |
| C. QAQL Aluminium | F. P-PR 1091 Fatigue |

Document 848Q/1733 Some results of the examination of aluminium alloy
(Rel. 3) fracture surfaces. Metallurgia, March 1961, pp. 117-124.

Indexing Aluminium alloy Stress
Corrosion Crack propagation
Deformation

Comments Indexer omitted the concept 'fatigue'.

Reason for failure Indexing

QUESTION 117 How does the dislocation density of aluminium change when an annealed sample is subjected to shear strains of the order of 10^{-2} ?

Search programme

$$[[[{}^8{}_6{}_4[A+B], {}^2[C+D], E], {}^{24}_2[F], [G+{}^2[H+I+J+K+L]]], {}^{68}]$$

- | | |
|--|---|
| A. KEJ Material processed | G. C-TT 1002 Shear, shearing |
| B. KUJ Component | H. MWTL P-SS RQHT 3002 Annealing |
| C. LALL Alloy | I. MWTL P-SS RQHT 4281 Annealer |
| D. MATL Metal | J. MWTL P-SS RQHT 4001 Bright
annealing |
| E. QAQL Aluminium | K. MWTL P-SS RQHT 3026 Annealing
in line |
| F. C-RS H-LL 1009 PAPR 3001
Dislocation | L. MWTL P-SS RQHT 3027 Annealing
out of line |

Document 293M/1936 Guinier - Preston zones in aluminium silver alloy.
(Rel. 3) ACTA Metallurgica, March 1961, pp. 250-255.

<u>Indexing</u>	Alloy	Water quenching
	Aluminium	Dislocation
	Cold rolling	Deformation

<u>Comments</u>	<p>The document would have been found if the search programme had required only 'Aluminium (alloy or metal)/dislocation'. The search programme used asks for the terms 'shearing' or various types of 'annealing' as well as 'dislocation' and 'aluminium'.</p>
-----------------	---

Reason for failure Searching 2b.

Document 310M/1272 The dependence of wire texture in FCC metals on
(Rel. 3) stacking fault energy. AIME Metallurgical Soc.
Trans. April 1961, pp. 236-237.

<u>Indexing</u>	Aluminium	Stress
	Wire drawing	Deformation
	Stacking fault	Dislocation

<u>Comments</u>	The document would have been found if the search programme had required only "Aluminium (alloy or metal)/dislocation". The search programme used asks for the terms 'shearing' or various types of 'annealing' as well as 'dislocation' and 'aluminium'.
-----------------	--

Reason for failure Searching 2b.

Document 167N/1196 Strain aging in silver base Al alloys.
(Rel. 3) AIME Metallurgical Soc. Trans., Feb. 1961, pp. 103-107.

Indexing KUJ. KEJ Alloy Shear
KUJ Ag Dislocation
KUJ Aluminium (1-6%)

Comments This document was not recalled because the search programme asked for aluminium as major component (role indicator KUJ and semantic code QAQL) and the aluminium in the document is a minor component of Ag. alloy (KIJ AQL). The document would have been found if the role indicator had been dropped.

Reason for failure Index language I.

Document 419Q/1217 Internal friction behaviour of an aluminium oxide
(Rel. 3) SAP type alloy. AIME Metallurgical Soc. Trans.
Feb. 1961, pp. 206-207.

Indexing SAP alloy Damping
Aluminium Dislocation

Comments The document would have been found if the search programme had accepted only 'aluminium (metal or alloy)/dislocation'.

Reason for failure Searching 2b.

Document 796Q/1270 Effect of temperature on the creep of polycrystalline
(Rel. 3) aluminium by the cross-slip mechanism. AIME
Metallurgical Soc. Trans., April 1961, pp. 229-232.

Indexing Aluminium Dislocation
Heat treated Stress
Creep tensile testing Strain

Comments The document would have been found if the search programme had accepted only 'aluminium (metal or alloy)/dislocation'.

Reason for failure Searching 2b.

QUESTION 126 What alloys of nickel-chromium-cobalt have useful high temperature strength at 1700°F (927°C) but contain no strategic columbium ?

Search programme

$$\begin{matrix} 8 & 5 & 2 & 2 & 2 & 2 & 5 & 8 \\ [[[A]. [B]. [C]]] \end{matrix}$$

A. MATL QNQI Nickel C. MATL QCQO Cobalt
B. MATL QCQR Chromium

Document 777Q/1456 A new cast alloy for use at 1900° F.
(Rel. 2) Metal Progress, April 1961, pp. 97-99.

Indexing Turbine blade
 100 Nickel alloy (LALL QNQi CQO CQR TQi MQO 100)
 Stress rupture
 Very high temperature

Comments The search programme should have asked for alloy (LALL) as well as metal (MATL) of nickel chromium and cobalt. Also the programme should have included the coding for these materials as minor alloying elements (NQI, CQR, CQO). The semantic code here is over complex in providing alternative places for metals according to the role they play in an alloy. It tends to prevent recall as the compiler of the search programme forgets to list both alternatives.

Reason for failure (a) Searching (b) Index language 3.

Document 507Q/1256 Superalloy forgings.
(Rel. 3) DMIC Memo 86.

Indexing Alloys Rene Ni alloy
 U 500 nickel alloy U 700 Ni alloy

Comments The search programme should have asked for alloy (LALL) as well as metal (MATL) of nickel chromium and cobalt. Also the programme should have included the coding for these materials as minor alloying elements (NQI, CQR, CQO). The semantic code here is over complex in providing alternative places for metals according to the role they play in an alloy. It tends to prevent recall as the compiler of the search programme forgets to list both alternatives.

Reason for failure (a) Searching 2a. (b) Index language 3.

QUESTION 130 What type of soft solder is most suitable for joining copper alloys if the risk of intercrystalline penetration of the copper by the molten metal is to be minimized ?

Search programme

$$\left[\left[\left[\left[A+B \right] \right] \left[\left[C+D \right] E \right] \right] \right] \left[\left[F+G \right] \right] \right]$$

- | | |
|---------------------------|------------------------|
| A. KEJ Material processed | E. QCQU Copper |
| B. KUJ Component | F. L-LL 1003 Solder |
| C. LALL Alloy | G. F-ST 1026 Soldering |
| D. MATL Metal | |

QUESTION 130 (Continued)

Document 480Q/1025 Can copper alloys hold the line at ultralow temperatures.
(Rel. 3) Iron Age, 9th March 1961, pp. 92-94

Indexing Aluminium bronze Cupro-nickel
Beryllium copper Various properties
Copper

Comments Omitted the concept "soldering".

Reason for failure Indexing.

QUESTION 133 How many defects in the enamelling of ferrous articles due to combustion gases and process vapours be avoided ?

Search programme

$$[[[A[A+B].C]]D]]$$

A. KEJ Material processed

C. RERN QFQE

B. KUJ Component

D. P-NT 1006 Enamel, enamelling

Document 230L/1789 Institute of Vitreous Enamellers Annual Conference.
(Rel. 3) Metal Finishing Journal, Jan. 1961, pp. 26-32.

Indexing Sheet Adherence
Ferrous Vapour furnace atmosphere
Vitreous enamelling Chemical resistance

Comments The search programme should have extended to include the "vitreous enamelling/metal iron" or "vitreous enamelling/furnaces" which would have retrieved the document.

Reason for failure Searching 2a.

QUESTION 134 How may the value for the toughness of a fracture be obtained ?

Search programme

$$[A]$$

A. Toughness

QUESTION 134 (Continued)

Document 511Q/1250 Corrosion and incrustation from use of blast furnace
(Rel. 3) gas in gas turbines. Corrosion Technology, Jan.
 1961, pp. 13-

<u>Indexing</u>	Killed steel	Temperature, low
	Bessemer steel	Fracture (DASM 1006)
	Various processes including "testing"	

Comments Did not extend to "fracture/testing" to retrieve the document.

Reason for failure Searching 2a.

Document 580Q/1524 Brittle fracture in welded structures. Welding and
(Rel. 3) Metal Fabrication, March 1961, pp. 89-94.

<u>Indexing</u>	Low carbon steel	Notch strength
	Ferrite steel	Brittle cleavage
	Austenite steel	Hot cracking
	Testing	Crack propagation
	Brittle fracture	

Comments	The indexer omitted the concept 'notch tests', but the search programme would have retrieved the document if it had been extended to "fracture/testing".
----------	--

Reason for failure Searching 2a

Document 650Q/2067 Effect of hydrogen on room-temperature properties
(Rel. 3) of titanium-low-aluminium-low-manganese alloys.
Inst. of Metals J., 1960/61, pp. 249-252.

<u>Indexing</u>	Aluminium	Intergranular fracture
	Impact testing	

<u>Comments</u>	The document would have been retrieved if the search programme had asked for "impact testing/fracture" or "testing/fracture".
-----------------	---

Reason for failure Searching 2a

Document 196S/2076 Welding aluminium: quality control.
(Rel. 3) McDern Metals, 1961, pp. 58-63.

<u>Indexing</u>	Weld joint	Crack
	Fracture testing	Strength

<u>Comments</u>	The document would have been retrieved with the search programme "fracture/testing".
-----------------	--

Reason for failure Searching 2a.

APPENDIX 4B

ANALYSIS OF REASONS FOR RETRIEVAL OF NON-RELEVANT DOCUMENTS

BY W. R. U.

This Appendix analyses the reasons for the retrieval by W. R. U. of 200 non-relevant documents. The complete indexing of each document is not included, but there are listed all the terms which were in any way involved in the search programme.

As the same document comes up several times in the analysis, the titles and references of all documents are listed before the analyses, in which the document is identified by the W. R. U. and Cranfield file numbers (e.g. 115D/1727). The codes appearing under the document number refer to the reasons for 'unwanted retrieval' as discussed on page 25 of this report. These are

- A. Insufficient matching between concepts in question and document.
- B. Matching between concepts in question and minor concepts.
- C1. The Role of the concept is not the one required by the question.
- C2. The concepts are present in the document, but the relationship is not the one required.
- D. There is no matching between concepts in the question and in the document, but errors in the code bring out the document.

Throughout this Appendix, 'Exhaustive indexing' is given as a reason for retrieval in all cases where the Cranfield indexing of the equivalent document was less detailed, thereby resulting in the non-recall of the document.

INDEX TO REASONS FOR RECALL OF NON-RELEVANT DOCUMENTS

EXHAUSTIVE INDEXING	Q7 - 115D	Q54 - 143J	Q96 - 115D
	Q7 - 388K	Q56 - 316K	Q96 - 358G
	Q8 - 115D	Q56 - 388K	Q96 - 167L
	Q8 - 526Q	Q59 - 458Q	Q96 - 628Q
	Q8 - 585Q	Q61 - 54F	Q97 - 15A
	Q12 - 168N	Q61 - 137P	Q97 - 51A
	Q20 - 188E	Q63 - 115D	Q97 - 143J
	Q20 - 416L	Q63 - 313K	Q97 - 212P
	Q20 - 129N	Q63 - 290R	Q97 - 651Q
	Q20 - 163N	Q69 - 290R	Q98 - 41M
	Q20 - 212P	Q69 - 391R	Q99 - 292M
	Q20 - 250Q	Q69 - 413R	Q99 - 167N
	Q20 - 275Q	Q71 - 388K	Q99 - 694Q
	Q20 - 416Q	Q71 - 167L	Q102 - 358G
	Q20 - 507Q	Q73 - 192K	Q104 - 51A
	Q20 - 584Q	Q73 - 167N	Q105 - 115D
	Q20 - 24119	Q73 - 475Q	Q107 - 388K
	Q22 - 358G	Q73 - 798Q	Q107 - 291R
	Q22 - 268Q	Q76 - 358G	Q107 - 20922
	Q22 - 803Q	Q78 - 617Q	Q109 - 628Q
	Q22 - 805Q	Q78 - 20922	Q109 - 291R
	Q24 - 51A	Q80 - 164F	Q114 - 569Q
	Q24 - 102J	Q80 - 388K	Q115 - 569Q
	Q24 - 292M	Q80 - 202M	Q119 - 458Q
	Q24 - 163N	Q80 - 313M	Q122 - 15A
	Q24 - 167N	Q80 - 167N	Q122 - 313K
	Q24 - 803Q	Q80 - 511Q	Q122 - 291R
	Q26 - 51A	Q80 - 542Q	Q124 - 628Q
	Q26 - 292M	Q80 - 617Q	Q127 - 694Q
	Q26 - 250Q	Q80 - 746Q	Q128 - 15A
	Q26 - 799Q	Q80 - 799Q	Q128 - 313K
	Q28 - 164F	Q81 - 358G	Q128 - 291R
	Q28 - 388K	Q81 - 168N	Q130 - 298R
	Q28 - 799Q	Q81 - 212P	Q134 - 51A
	Q37 - 358G	Q83 - 350G	Q134 - 216K
	Q46 - 51A	Q83 - 97J	Q137 - 15A
	Q46 - 435L	Q83 - 501Q	Q137 - 51A
	Q52 - 176A	Q86 - 313K	Q137 - 178E
	Q52 - 115D	Q86 - 268Q	Q137 - 267G
	Q52 - 82F	Q90 - 102J	Q137 - 324G
	Q52 - 267E	Q91 - 164F	Q137 - 358G
	Q52 - 385G	Q91 - 358G	Q137 - 279L
	Q52 - 54H	Q91 - 54H	Q137 - 268Q
	Q52 - 313K	Q91 - 526Q	Q137 - 480Q
	Q52 - 316K	Q91 - 593Q	Q137 - 61R
	Q52 - 160L	Q91 - 628Q	Q137 - 298R
	Q52 - 167L	Q91 - 20922	
	Q52 - 268Q	Q95 - 15A	
		Q95 - 167L	
		Q95 - 276P	
		Q95 - 275Q	
		Q95 - 458Q	
		Q96 - 15A	

SEARCH PROGRAMME

Adds concepts implied in question

Q7 - 314K	Q20 - 188E	Q73 - 167N
Q7 - 388K	Q20 - 416L	Q73 - 475Q
Q8 - 115D	Q59 - 458Q	Q73 - 798Q
Q8 - 526Q	Q73 - 192K	Q81 - 212P
Q8 - 585Q		

Omits concepts in question

Q12 - 168N	Q80 - 202M	Q109 - 291R
Q20 - 188E	Q80 - 313M	Q115 - 569Q
Q20 - 129N	Q80 - 511Q	Q122 - 15A
Q20 - 212P	Q80 - 799Q	Q122 - 313K
Q20 - 275Q	Q88 - 593Q	Q122 - 628Q
Q20 - 507Q	Q95 - 15A	Q122 - 291R
Q20 - 584Q	Q95 - 167L	Q122 - 57T
Q24 - 51A	Q95 - 293M	Q124 - 628Q
Q24 - 102J	Q95 - 310M	Q134 - 51A
Q24 - 163N	Q95 - 276P	Q134 - 216K
Q24 - 803Q	Q96 - 15A	Q137 - 15A
Q28 - 799Q	Q96 - 358G	Q137 - 51A
Q41 - 83F	Q96 - 324G	Q137 - 178E
Q41 - 212P	Q96 - 115D	Q137 - 267G
Q41 - 499Q	Q96 - 167L	Q137 - 324G
Q46 - 51A	Q96 - 292M	Q137 - 358G
Q46 - 435L	Q96 - 310M	Q137 - 160L
Q54 - 143J	Q96 - 212P	Q137 - 167L
Q59 - 458Q	Q96 - 628Q	Q137 - 279L
Q65 - 264K	Q97 - 15A	Q137 - 310M
Q71 - 280K	Q97 - 51A	Q137 - 268Q
Q71 - 388K	Q97 - 143J	Q137 - 475Q
Q71 - 167L	Q97 - 212P	Q137 - 480Q
Q73 - 192K	Q97 - 651Q	Q137 - 799Q
Q73 - 167N	Q102 - 358G	Q137 - 61R
Q73 - 475Q	Q107 - 388K	Q137 - 298R
Q73 - 798Q	Q107 - 628Q	
Q80 - 164F	Q107 - 291R	
Q80 - 388K	Q107 - 20922	

Uses concepts less specific than question

Q52 - 176A	Q52 - 160L	Q83 - 79J
Q52 - 115D	Q52 - 167L	Q83 - 97J
Q52 - 210E	Q52 - 268Q	Q83 - 102J
Q52 - 219E	Q69 - 290R	Q83 - 116J
Q52 - 82F	Q69 - 339R	Q83 - 388K
Q52 - 164F	Q69 - 391R	Q83 - 129N
Q52 - 267G	Q69 - 413R	Q83 - 507Q
Q52 - 385G	Q76 - 358G	Q83 - 542Q
Q52 - 54H	Q78 - 20922	Q85 - 291R
Q52 - 102J	Q83 - 358G	Q85 - 339R
Q52 - 313K	Q83 - 66J	Q90 - 102J
Q52 - 316K		

SEARCH PROGRAMME (Continued)

Insufficient co-ordination of concepts

Q23 - 628Q	Q63 - 268Q	Q91 - 628Q
Q26 - 51A	Q81 - 216K	Q91 - 20922
Q26 - 292M	Q81 - 168N	Q127 - 292M
Q26 - 250Q	Q91 - 164F	Q128 - 15A
Q26 - 480Q	Q91 - 54H	Q128 - 313K
Q26 - 799Q	Q91 - 358G	Q128 - 628Q
Q63 - 115D	Q91 - 526Q	Q128 - 291R
Q63 - 113K	Q91 - 593Q	

Role indicators lacking

Q7 - 115D	Q95 - 167L	Q97 - 212P
Q8 - 115D	Q95 - 293M	Q97 - 651Q
Q20 - 129N	Q95 - 310M	Q99 - 167N
Q20 - 163N	Q95 - 276P	Q105 - 115D
Q20 - 416Q	Q95 - 275Q	Q107 - 388K
Q22 - 268Q	Q95 - 458Q	Q107 - 628Q
Q54 - 143J	Q96 - 15A	Q107 - 291R
Q59 - 458Q	Q96 - 115D	Q107 - 20922
Q61 - 137P	Q96 - 324G	Q109 - 628Q
Q63 - 115D	Q96 - 358G	Q109 - 291R
Q71 - 388K	Q96 - 167L	Q114 - 569Q
Q73 - 167N	Q96 - 292M	Q119 - 458Q
Q73 - 475Q	Q96 - 310M	Q126 - 361G
Q73 - 798Q	Q96 - 212P	Q128 - 15A
Q78 - 617Q	Q96 - 628Q	Q128 - 628Q
Q78 - 20922	Q97 - 15A	Q128 - 291R
Q95 - 15A	Q97 - 143J	

Level 4 required

Q81 - 168N

Level 5 required

Q28 - 164F	Q56 - 388K
Q28 - 388K	Q78 - 617Q
Q56 - 316K	Q78 - 20922

Q97 - 51A
Q97 - 651Q

Interfixing required

Q7 - 115D	Q95 - 167L	Q105 - 617Q
Q8 - 115D	Q95 - 293M	Q107 - 115D
Q20 - 188E	Q95 - 310M	Q107 - 628Q
Q20 - 250Q	Q95 - 276P	Q107 - 291R
Q23 - 628Q	Q95 - 275Q	Q109 - 628Q
Q28 - 164F	Q95 - 458Q	Q109 - 291R
Q28 - 388K	Q96 - 15A	Q119 - 458Q
Q37 - 358G	Q96 - 115D	Q122 - 313K
Q56 - 316K	Q96 - 324G	Q126 - 361G
Q56 - 388K	Q96 - 358G	Q127 - 694Q
Q59 - 458Q	Q96 - 167L	Q128 - 15A
Q63 - 115D	Q96 - 292M	Q128 - 313K
Q63 - 313K	Q96 - 310M	Q128 - 628Q
Q71 - 388K	Q96 - 212P	Q128 - 291R
Q78 - 617Q	Q96 - 628Q	Q137 - 15A
Q78 - 20922	Q97 - 15A	Q137 - 178E
Q81 - 168N	Q97 - 51A	Q137 - 358G
Q86 - 313K	Q97 - 143J	Q137 - 160L
Q88 - 593Q	Q97 - 212P	Q137 - 167L
Q91 - 628Q	Q97 - 651Q	Q137 - 279L
Q95 - 15A	Q102 - 358G	Q137 - 799Q
		Q137 - 324G

SEMANTIC CODE

Q20 - 416L
Q52 - 82F

Q52 - 385G
Q73 - 192K

Q97 - 143J

LIST OF NON-RELEVANT DOCUMENTS RECALLED

- 15A China's mineral wealth. Journal of Metals, Vol. 12, Dec. 1960, pp. 945-951.
- 51A Metallurgical progress in Canada. Metal Progress, Vol. 79, Jan. 1961, pp. 117-120.
- 176A Preview of recent developments in the technology of Molybdenum and Molybdenum-base alloys. OTS PB 161246, DMIC Memo 96.
- 115D How the Russians are using ultrasonics in metallurgy. Metal Progress, Jan. 1961, pp. 79-83.
- 178E Producing high conductivity copper castings. Foundry, March 1961, pp. 84-87.
- 188E Cracks in molds make better castings. Steel: 6th March, 1961, pp. 68-69.
- 219E Influence of cold blast cupola practice on casting properties and iron compound. B.C.I.R.A. Journal, Jan. 1961, pp. 46-66.
- 54F Filter system upgrades ultrathin steel strip. Steel: 9th Jan. 1961, pp. 76-
- 82F Teflon insert die tames toughies. Steel Metalworking Weekly, Vol. 148, 16th Jan. 1961, pp. 87-
- 164F Missiles and Rockets, 20th March, 1961, pp. 26-
- 267G High-energy methods shape space-age. SAE Journal, March 1961, pp. 44-45.
- 268G New machining methods evaluated for heavier space age metals. SAE Journal, March 1961, pp. 74-76.
- 324G Explosive forming of missile components. Machinery, Vol. 98, 1st March, 1961, pp. 486-490.
- 358G Explosive metal working. Metal Industry, Vol. 98, 24th Feb. 1961, pp. 149-150.
- 361G Tool materials for cold extrusion process. Sheet Metal Industries, Vol. 38, March 1961, pp. 190-207.
- 398G Single-pass 'J' grooving in heavy plate with an oxy-fuel gas flame. Welding Journal, Vol. 40, April 1961, pp. 331-339.
- 404G Automatic slag line for cold forging. Metalworking Production, Vol. 105, 29th March, 1961, pp. 60-61.
- 54H Indian Institute of Metals, Dec. 1960, pp. 351-373.
- 66J New carburizing steels German automobiles. Metal Progress, Jan. 1961, pp. 70-75.
- 79J Properties of Ni-al age hardening steel. Metal Progress, Feb. 1961, pp. 80-83.
- 97J Stress relieving fabricated girders. Welding and Metal Fabrication, Vol. 29, Feb. 1961, pp. 67-
- 102J Technical control in steel foundries in North America. Foundry Trade Journal, Vol. 110, 2nd Feb. 1961, pp. 133-144.

- 116J Preheating and stress relieving of pipes and vessels. Welding and Metal Fabrication, Vol. 29, March 1961, pp. 95-100.
- 143J Its submerged hardening for these years. Metalworking Production, Vol. 105, 5th April, 1961, pp. 50
- 192K Fusion welding of titanium and its alloys. Welding and Metal Fabrication, Vol. 29, Jan. 1961, pp. 24-31, 36.
- 216K Welding and heat treating a 60 ton cryogenic vessel. Metal Progress, Vol. 79, Feb. 1961, pp. 88-90.
- 264K Precision welding in nuclear reactor construction. Machinery, 4th Jan. 1961, pp. 23-26.
- 280K Brazing missile and electronic components in dry hydrogen. Metal Progress, Vol. 79, March 1961, pp. 93-96.
- 313K Repair welding cast iron. Welding and Metal Fabrication, Vol. 29, March 1961, pp. 104-110.
- 316K A new way to make honeycomb. American Machinist, Vol. 105, 20th Feb. 1961, pp. 100-101.
- 388K Quenched and tempered steels in ship structure. Welding Journal, Vol. 40, April 1961, pp. 175.
- 314K Fusion welding of titanium and its alloys. Welding and Metal Fabrication, Vol. 29, March 1961, pp. 111-113.
- 160L Decorative plating abroad. Metal Progress, Vol. 79, Jan. 1961, pp. 113-116.
- 167L Technical developments of 1960. Metal Finishing, Vol. 59, Jan. 1961, pp. 36B-36K, 93.
- 416L Phosphate coating and lubricating steel for cold extrusion. Sheet Metal Industries, March 1961, pp. 171-189.
- 435L Superior plating shows the way. Metal Finishing, April 1961, pp. 45-48.
- 279L Evaluation of electro-deposited coatings. Metal Finishing, Feb. 1961, pp. 38-44.
- 41M Structure of carburized and carbo-nitrided cases. Metal Progress, Dec. 1960, pp. 86-90.
- 202M The orientation of martensite in austenite. ACTA Metallurgica, Dec. 1960, pp. 892-896.
- 292M X-ray measurements of dislocation density in deformed copper and aluminium single crystals. ACTA Metallurgica, Vol. 9, March 1961, pp. 237-245.
- 293M Guinier - Preston zones in aluminium silver alloy. ACTA Metallurgica, March 1961, pp. 250-255.
- 310M The dependence of wire texture in FCC metals on stacking faults energy. AIME Metallurgical Soc. Trans. April 1961, pp. 236-237.
- 313M Phase equilibrium and evaluated temperature properties of some alloys in the system Ni CR - Ni₃Al. AIME Metallurgical Soc. Trans. Vol. 221, April, 1961, pp. 400-405.

- 129N The carbide constitution and tempering behaviour of chromium-vanadium-niobium steels at 700°C. *Iron and Steel J.*, 1961, pp. 9-21.
- 163N Intergranular precipitation of intermetallic compounds in austenitic alloys. *AIME Metallurgical Soc. Trans.* Feb. 1961, pp. 28-34.
- 167N Strain aging in silver base Al alloys. *AIME Metallurgical Soc. Trans.* Feb. 1961, pp. 103-107.
- 168N Heterogeneous nucleation in the liquid-to-solid transformation in alloys. *AIME Metallurgical Soc. Trans.* Vol. 221, Feb. 1961, pp. 157-163.
- 137P Design information on titanium alloys for aircraft and missiles. *DMIC Report* 145.
- 212P Ablation, heat sink and radiation: materials that make them work. *Materials in Design Engineering*, Vol. 53, March 1961, pp. 114-
- 260P The effect of arsenic and tellurium on the surface tension of lead. *AIME Metallurgical Soc. Trans.* Vol. 221, April 1961, pp. 266-270.
- 276P *Indian Inst. of Metals*, Dec. 1960, pp. 323-331.
- 250Q Studies of hot cracking in high-strength weld metals. *Welding Journal*, Vol. 70, Jan. 1961, pp. 1s-7s.
- 268Q Science for electroplaters, Pt. 62 Adhesion Tests. *Metal Finishing*, 1961, pp. 49-50.
- 275Q What you should know about creep rupture. *Materials in Design Engineering*, Vol. 53, Jan. 1961, pp. 89.
- 416Q Effect of structure and purity on the mechanical properties of columbium. *AIME Metallurgical Soc. Trans.* Feb. 1961, pp. 19-24.
- 458Q How to choose the right soft solder alloy. *Product Engineering*, 6th March, 1961, pp. 39.
- 475Q Ductile-brittle transition in alpha brass. *ACTA Metallurgica*, Dec. 1960, pp. 848-850.
- 480Q Can copper alloys hold the line at ultralow temperatures. *Iron Age*, 9th March, 1961, pp. 92-94.
- 499Q Materials-Metallic and non-metallic. *Royal Aeronautical Society J.*, Feb. 1961, pp. 83-
- 507Q Superalloy forgings. *DMIC Memo* 86.
- 511Q A note on brittle fracture initiation in mild steel by prior compressive pre-strain. *Iron and Steel Institute J.*, Vol. 197, Feb. 1961, pp. 131-135.
- 523Q A. C. Smith develops lighter truck frame. *Steel: Metalworking Weekly*, Vol. 148, 13th March 1961, pp. 125.
- 526Q Heat treatment of cast stainless steels. *Precision Metal Moulding*, March 1961, pp. 56-57.
- 542Q The present state of ship plate specifications. *Canadian Mining and Metallurgical Bulletin*, Vol. 54, Feb. 1961, pp. 157-163.
- 569Q The properties of commercial Al - 2r - Mg alloys. Practical implications of Fraun additions of silver. *Institute of Metals J.*, Feb. 1961, pp. 193-204.

- 584Q Use of the center notch-tensile test to evaluate rocket chamber materials. Welding Journal, Vol. 40, March 1961, pp. 130s-134s.
- 585Q Catastrophic fracture caused by ductile to brittle transition under residual stress. Welding Journal, Vol. 40, March 1961, pp. 135s-137s.
- 593Q Kinetics and mechanism of hydrogen attack of steel. Corrosion, March 1961, pp. 109-115.
- 617Q Materials for space pressure vessels. Journal of Metals, Vol. 13, March 1961, pp. 198-
- 628Q Graphite metal compatability at elevated temperatures. J. of Nuclear Materials, Vol. 3, Jan. 1961, pp. 89-100.
- 651Q A study of fatigue deformation by reflection electron microscopy. Inst. of Metals J., March 1961, pp. 253-254.
- 694Q ACTA Metallurgica, Feb. 1961, pp. 149-154.
- 746Q Easy glide of lead single crystals. ACTA Metallurgica, Vol. 9, March, 1961, pp. 184-190.
- 798Q Easy glide and grain boundary effects in polycrystalline aluminium. AIME Metallurgical Soc. Trans Vol. 221, April 1961, pp. 244-247.
- 799Q A study of fracturing behaviour of copper and zinc coated mercury. AIME Metallurgical Soc. Trans. April 1961, pp. 261-265.
- 803Q Dispersion strengthening in the copper-aluminium system. AIME Metallurgical Soc. Trans. April 1961, pp. 371-376.
- 805Q Recovery and recrystallization in 99.98 Pct Cr. AIME Metallurgical Soc. Trans. Vol. 221, April 1961, pp. 395-400.
- 61R Bimetallic heat exchangers tube solve dual corrosion problem. Metal Progress, December 1960, pp. 115-117.
- 290R Corrosion-proof metal body - why not now. S.A.E. Journal, March 1961, pp. 38-40.
- 291R Coatings protect materials from flight heat. SEA Journal, March 1961, pp. 78-79.
- 298R Copper-corrosion resistance in chemical plant. Corrosion Technology Vol. 8, Jan. 1961, pp. 8-12.
- 339R Corrosion in breweries. Corrosion Prevention and Control. Jan. 1961, pp. 32-33.
- 391R Corrosion reinforcing steel in concrete in marine atmospheres. Corrosion, March 1961, pp. 76-80.
- 413R Anodic behaviour of austenitic stainless steels. Electrochemical Society J. Vol. 108, March 1961, pp. 222-228.
- 57T The production of nuclear components in lead and graphite. Machinery, 4th Jan. 1961, pp. 4-14.
- 20922 U.S. Patent 2,967,770
- 24119 U.S. Patent 2,962,371

APPENDIX 4B

Analysis of the Reasons for Retrieval of Non-relevant Documents by W. R. U.

QUESTION 7 What are the effects of size and geometry of weld defects, and specifically the effect of damage to heat affected zone due to plastic strain ?

Search programme

$$\left[\left[A \left[\overset{8}{B} \right] \right] \left[\overset{2}{C} \right] + \left[\overset{2}{D} \right] + \left[\overset{2}{E} \right] + F \right] \right] \overset{6}{8}$$

- | | |
|---|---------------------------|
| A. F-ST 1008. Welding, weld, etc. | E. DYFL 1006 PAPR. PQSS |
| B. DYFL 1006. PAPR 2002 Stress | 1012 Residual stress 3995 |
| C. MWTL P-SS RQHT 3014 Stress relieving | F. PAPR 1236 Plastic |
| D. MWTL P-SS RQHT 3014 Stress relieving | |

Non-relevant documents

115D/1727	<u>Indexing</u>	cols. 289/294 KEJ. KOV. Cu. Mg. Alloy
B. C1. C2		cols. 299/300 KAM Welding
		cols. 319/320 KUP. KAP Plastic deformation
		cols. 323/326 KAL Ultrasonic vibrations

Comments This is a review article on ultrasonics in Russia. The abstract appears to have been partitioned originally into the several distinct subjects or "chapters" covered by the document but the symbols were later deleted. The results are that the search programme retrieves the document although the welding and the deformation are in no way related - the welding refers to the Cu Mg alloy and the ultrasonics to plastic deformation. The use of the role indicator KEJ, KOV, KWJ with F-ST 1008 in the search programme would have prevented recall. Also it is likely that only in very detailed indexing would the terms in cols. 289/326 be thought worthy of inclusion.

Reasons for retrieval

- (a) Interfixing required
- (b) Lack of role indicators in search programme
- (c) Exhaustive indexing

314K/1527	<u>Indexing</u>	cols. 3/4 KUJ. KOV Titanium
A		cols. 15/16 KAM Tungsten welding
		cols. 25/26 KAM Stress relieving
		cols. 43/44 KUP. KAP Cracking. cols. 95/96 KWJ Weldment

Comments The document does not mention the heat affected zone or the geometry of weld defects. It is retrieved because the broad search programme will accept 'welding, welds' with 'stress relieving' - terms present in this document. The concept 'stress relieving' is not in the wording but is implied in the question.

Reason for retrieval Searching. Adds concept implied but not in question.

QUESTION 7. Non-relevant documents (Continued)

<u>388K/1571</u>	<u>Indexing</u>	cols. 117/118 KAM Stress relieving
<u>A. B.</u>		cols. 141/142 KWJ, KOV, KEJ Weldment

Comments The document mentions cracking of welds but does not contain information on the size and geometry of weld defects or the effect of plastic strain. The document is retrieved because the search programme will accept alone together two of the terms indexed, that is 'weld, welding' and 'stress relieving'. The concept 'stress relieving' is implied but is not in question.

<u>Reason for retrieval</u>	(a) Searching. Adds concepts implied but not in question
	(b) Exhaustive indexing

QUESTION 8 What processes can be used to repair castings. Factors affecting choice of method ?

Search programme

$$[[[[A+B]C]^4 [D+E]]]^{68}$$

- A. KEJ Material processed D. F-ST 1008 Welding
B. KWV Property given E. R-CR 1004 Repair
C. C-NS 1025 Casting, castings.

Non-relevant documents

115D/1727 Indexing cols. 111/112 KEJ. KOV Castings
A. B. C1. C2 cols. 299/300 KAM Welding

Comments This document is a review article on the use of ultrasonics in Russia. The items in cols. 112 and 300 of the abstract were originally separated into different chapters by partitioning which was later deleted. The false drop could nevertheless have been avoided by the use of the role indicator KQJ (By means of) in the search programme before 'welding'. Also if the search programme had not introduced 'welding' with castings document would not have been retrieved. The concept 'welding' is implied but is not in the question.

Reasons for retrieval

- (a) Partitioning required in abstract. (c) Searching. Adds concepts implied but not in question.
(b) Lack of role indicators. (d) Exhaustive indexing.

526Q/1836	<u>Indexing</u>	cols. 1/2 KEJ. KOV Stainless steel
A.B.		cols. 3/34 KWV Cast
		cols. 16 MWV Weldability

Comments The document contains nothing on the repair of castings, and is retrieved because the search programme will allow 'welding', or 'repair' with KWV (property given for) or KEJ (material processed) with 'cast, castings'.

Reason for retrieval

- (a) Searching. Adds concept implied but not in question.
(b) Exhaustive indexing

QUESTION 8. Non-relevant documents (Continued)

585Q/1567 Indexing cols. 1/2 Steel
A B cols. 7/8 KWV Arc cast
 cols. 13/14 KAM Welding

Comments Reasons for retrieval as for document 526Q above.

Reason for retrieval (a) Searching. Adds concept implied but not in question
 (b) Exhaustive indexing

QUESTION 12 What modern technological practice is used for melting casting and machining alloys of lead and antimony ?

Search programme

$$\begin{matrix} 8 & 5 & 2 & & & & 5 & 8 \\ \left[\left[\left[A+B \right] C \right] \left[D+E \right] \right] \end{matrix}$$

- | | |
|---------------|------------------|
| A. LALL Alloy | D. SQB Antimony |
| B. MATL Metal | E. QSQB Antimony |
| C. QPQB Lead | |

Non-relevant document

168N/1204 Indexing cols. 1/2 KEJ. KOV Binary system
A.B. cols. 3/4 KEJ. KOV Alloy
 cols. 5/36 KUJ. KIJ (List of elements including Pb at col.6 and Sb at col.12)

Comments No mention of 'casting'/'machining' or 'melting'. The article mainly concerned with heterogeneous nucleation in binary systems. No mention in the search programme of the processes required, and for this reason the article is retrieved.

Reason for retrieval (a) Searching. Omits concept in question
 (b) Exhaustive indexing

QUESTION 20 Can high melting point and reactive metals be melted in small quantities in the laboratory ?

Search programme

$$\begin{matrix} 8 & & 2 & 2 & 2 & 2 & & 8 \\ \left[\left[\left[A \right] + \left[B \right] \right] \cdot \left[C+D+E+F+G+H+I+J+K+L+M+N \right] \right] \end{matrix}$$

- | | |
|----------------------------|--------------------|
| A. C-NG P-SS R-HT Melting | H. QCQB Columbium |
| B. C-NG R-HT Heat treating | I. QTQA Tantalum |
| C. QTQI Titanium | J. QMQO Molybdenum |
| D. QZQR Zirconium | K. QW Tungsten |
| E. QHQF Hafnium | L. QU Uranium |
| F. QTQH Thallium | M. QRQH Rhodium |
| G. QV-- Vanadium | |

QUESTION 20 (Continued)

Non-relevant documents

<u>188E/1864</u>	<u>Indexing</u>	cols. 1/2 KEJ Hot working alloy (1st phrase)
<u>A.B.C2.</u>		cols. 5/6 KUJ Cr
		cols. 7/8 KIJ W
		cols. 13/16 KAM Precision casting
		cols. 18/20 KUJ. KOV Mold ceramic
		cols. 21/22 KWV Microcracked
		cols. 45/46 KAM. KAP Preheating (3rd phrase)

Comments This document is mainly about microcrack moulding and the preheating applies to the mould and not to the tungsten. This false drop could not be avoided by the use of role indicators although interfixing in the abstract would eliminate the document. Use of fifth level in search programme could have avoided the false drop at the risk of eliminating relevant documents. If 'laboratory (a term in the question) had been included or 'heat treating' (not in the question) been omitted, the document would not have been retrieved.

Reasons for retrieval

- (a) Interfixing required in abstract
- (b) Searching. Added concept not in question and omitted concept in question
- (c) Exhaustive indexing

<u>416L/1810</u>	<u>Indexing</u>	cols. 5/6 KUJ Steel
<u>A.B.D.</u>		cols. 43/44 KAM Phosphating
		cols. 83/84 KAM Lubricating
		cols. 131/132 KAM Cold extrusion (CUNG 1076 RXHT 2004)
		cols. 149/150 Titanium

Comments This document contains nothing on the melting of the reactive metal titanium, but it is retrieved because the search programme will accept titanium with any term encoded 'heat treating' (C-NG R-HT). The code for 'cold extrusion' with its broad generic base answers this requirement, and so the document, though irrelevant, is recalled.

Reasons for retrieval

- (a) Searching. Adds concept not in question
- (c) Exhaustive indexing
- (b) Semantic code

<u>129N/2019</u>	<u>Indexing</u>	cols. 2 Steel (1st phrase)
		cols. 7/8 KIJ/Vanadium
		cols. 9/10 KIJ/ Niobium
		cols. 16 Melting (Vacuum)(2nd phrase)
		cols. 26 Heat treatment

Comments Use of role indicator KEJ in the search programme before the metals listed would have eliminated documents such as this one where the elements are minor alloys in steel (KIJ). Search programme could have been more specific limiting to laboratory melting. Use of 5th level in search programme would have eliminated but at too great a risk. Interfixing would not have prevented recall.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators in search programme.
- (c) Exhaustive indexing

QUESTION 20. Non-relevant documents (Continued)

163N/1183	<u>Indexing</u>	cols. 4/14 Alloys by name. Containing molybdenum
B. C1		S-816. Rene 41. Incoloy 401.
		cols. 21/24 KWV Vacuum melted.

Comments The document is concerned with the microstructure of these alloys. The fact that they have been vacuum melted is of secondary importance. The document is not discussing the vacuum melting of mo. containing alloys. Use of role indicator KAM with 'melting' in search programme would have eliminated. The use of 5th level would not. Neither would interfiling.

Reasons for retrieval

- (a) Role indicator lacking in search programme
- (b) Exhaustive indexing.

<u>212P/1631</u>	<u>Indexing</u>	col. 40 Titanium
A.B.		col. 46 Molybdenum
		col. 128 Melting

Comments The document is concerned with heat sinks and the materials used as insulators, and the thermal properties of the materials. 'Melting' a concept of minor importance. 'Laboratory melting' not considered. The search programme could have specified laboratory melting.

Reasons for retrieval

- (a) Searching. Omits concept in question.
(b) Exhaustive indexing

<u>250Q/1064</u>	<u>Indexing</u>	col. 2 Weld metal
<u>B. C2</u>		cols. 9/10 KQJ Thermocouple (2 phrase)
		cols. 11/12 KUJ Rhodium (2nd phrase)
		cols. 27/28 KAM Melting (3rd phrase)
		cols. 29/30 KQJ Crucible (3rd phrase)

Comments This document is a false drop, as the Rh.metal is not the one which is melted. The melting refers to the weld metal (col. 2) and the 'Rhodium' is a component of the thermocouple. Role indicators here would have been ineffective, but if the 5th level had been used in the search programme it would have prevented recall because the 'Rhodium' and 'melting' are in different phrases. But the 5th level could only be used with great risks of losing relevant documents also, so interfixing is the only sure method of avoiding this false drop.

Reason for retrieval (a) Interfixing required.

- (b) Exhaustive indexing.

QUESTION 20. Non-relevant documents (Continued)

<u>275Q/1411</u>	<u>Indexing</u>	col. 4 Tungsten
A. B.		cols. 15/16 KEJ. KIJ Molybdenum
		cols. 23/24 KIJ Vanadium
		col. 44 Annealing
		col. 64 Tempering
		col. 66 Quenching
		col. 126 Melting point
		col. 170 Tantalum

Comments Document not concerned with laboratory melting. Mention of 'laboratory' in search programme would have eliminated.

<u>Reason for retrieval</u>	(a) Searching. Omits concept in question. (b) Exhaustive indexing.
-----------------------------	---

416Q/1181	<u>Indexing</u>	cols. 7/8 KUJ. KIJ Cb (1st Phrase)
B. C1.		cols. 19/20 KWV Arc melted (1st Phrase)
		cols. 21/22 KWV Electron beam melted (1st Phrase)

Comments The arc melted and electron beam melted refer to the condition of the columbium, document does not discuss the process of melting. The addition of role indicator "KAM" before melting and heat treatment in the search programme would have eliminated. It is only with exhaustive indexing that condition of the specimen would be included. As melting and the metal are in the same phrase the use of 5th level would be useless in preventing false drop, also interfiling.

<u>Reason for retrieval</u>	(a) Lack of role indicators
	(b) Exhaustive indexing

<u>507Q/1256</u>	<u>Indexing</u>	cols. 1/42 KEJ. KOV Proprietary alloys (Containing the metals in the search programme)
A.B.		cols. 43/44 KAM Induction melting
		cols. 45/46 Arc melting
		cols. 49/50 KQJ. KAH Vacuum

Comments 'Melting' not on a small scale. A more specific search programme including 'laboratory' with 'melting' would have prevented recall.

<u>Reason for retrieval</u>	(a) Searching. Omits concept in question.
	(b) Exhaustive indexing

584Q/1566 Indexing cols. 1/32 KEJ High strength steels having metals
A.B. mentioned in the question in the coding
cols. 45/46 KAM Heat treatment
cols. 51/52 KAM Melting

Comments The document is concerned with the tensile testing of high strength steels to determine effects of processing variables such as rolling direction, melting practice and heat treatment on mechanical properties. A search programme mentioning 'laboratory' with 'melting' would have prevented recall.

<u>Reason for retrieval</u>	(a) Searching. Omits concept in question
	(b) Exhaustive indexing

QUESTION 20. Non-relevant documents (Continued)

<u>24119/2010</u>	<u>Indexing</u>	col. 10 Uranium (fuel element)
B		col. 34 Mo (KIJ of Uranium)
		cols. 63/64 KAM Melting
		col. 70 Heating

Comments The document concerned with method of separating core and cladding material without melting by treating with anhydrous hydrogen. Melting is mentioned only as a method which the new process would avoid, but nevertheless it has been indexed.

Reason for retrieval Exhaustive indexing.

QUESTION 22 What are the theory and practice of extruding metals, with some reference to steel ?

Search programme

Programme 1.

A. LALL RERN Steel

B. C-NG 1076 Extruding, extrusion, etc.

Programme 2. $\overset{\circ}{[A+B]}\overset{\circ}$

A. C-NG 1076 Extruding, extrusion, etc.

B. R-LS 1010 Extruding, extrusion, etc.

Non-relevant documents

358G/1429 Indexing col. 56 Extrusion

Comments The abstract contains 142 terms. The main theme is the explosive forming of alloys of ti, co, cu, mg, and al, and of powdered metals. 'Extrusion' is mentioned as an auxiliary and minor process.

Reason for retrieval	Exhaustive indexing.
----------------------	----------------------

<u>268Q/1830</u>	<u>Indexing</u>	col. 2 Cast iron (1st Phrase)
B. C1.		col. 4 Brass (1st Phrase)
		col. 6 Nickel brass (1st Phrase)
		col. 7 KWV Extruded (1st Phrase)

Comments The document is not about 'extruding', but is concerned with the adhesion of electrodeposited coatings. The fact (which the indexer has recorded) that the starting metals are extruded is of minor interest. Use of the role indicator KAM process, in the search programme, would have excluded this document. Interfixing in this case would not prevent recall. As the metal and the process are in the same phrase the use of level 5 in the search programme would be ineffective.

<u>Reason for retrieval</u>	(a) Lack of role indicators in search programme
	(b) Exhaustive indexing.

QUESTION 22. Non-relevant documents (Continued)

<u>803Q/1297</u>	<u>Indexing</u>	col. 2 Cermet
B.		col. 4 Powder metal
		cols. 11/12 Powder metallurgy
		col. 18 Hot extrusion

Comments The document deals mainly with the physical properties of Cu-Al dispersions. The information that the dispersion was prepared by extrusion, among other processes is of minor interest.

Reason for retrieval. Exhaustive indexing.

<u>805Q/1301</u>	<u>Indexing</u>	col. 2 Wire
<u>B</u>		col. 4 Specimen
		col. 18 Extrusion
		col. 22 Wire drawing
		(among 100 terms)

Comments The documents theme is the recovery and recrystallisation of 99.98% Cr. The 'extrusion' in col.18 refers to the method of preparing the wire specimen and is of small interest as an answer to question 22.

Reason for retrieval	Exhaustive indexing.
----------------------	----------------------

QUESTION 23 What methods can be used to identify the microconstitution in alloy steels ?

Search programme

Search programming

$$[[[A [A + B] [C + D] E]] . [F + G + H] [[I + J + K + L] M] + N / O + P / Q + R + S]]]]$$

- | | |
|----------------------------|-------------------------------|
| A. KEJ Material processed | K. C-PR Vapours |
| B. KUJ Component | L. MZTL Semi-metals |
| C. LALL Alloy | M. Q--- |
| D. MATL Metal | N. GAPR 1010 Constitution |
| E. QFQE Iron | O. GAPR 1011 Content |
| F. KUP Property determined | P. LAMN 1042 Constituent |
| G. KWJ Product | Q. LAMN 1522 Microelement |
| H. KIJ Minor component | R. MATR 1002 Composition |
| I. M-TL Metal | S. CIRS 3004 Microconstituent |
| J. G-SS Gas | |

Non-relevant documents

<u>628Q/1713</u>	<u>Indexing</u>	cols. 33/34 KIJ. KIJ Iron (1st Phrase)
		cols. 15/38 KIJ Various metals (1st Phrase)

Comments The document contains nothing on the identification of micro-constituents but it is retrieved because the search programme will accept iron with the role indicator KIJ preceding any other metal. The iron and most of the other metals in this document are not related, but the use of role indicators and levels cannot prevent the false association. Only interfiling can show the lack of relationship.

<u>Reasons for retrieval</u>	(a) Searching. Insufficient co-ordination.
	(b) Interfixing required in the abstract.

QUESTION 24 What equipment and procedure can be used to determine the complete orientation of an uniaxial crystal?

Search programme

$$\begin{matrix} 8 & & 2 & 2 & 2 & 2 & 8 \\ [A+B+[C]+[D]] \end{matrix}$$

- A. R-DT 1010 X-ray
- B. D-FL 1020 Diffraction
- C. NULL 1024 3916 X-ray micrograph
- D. SACN RQDT RWNG 1024 X-ray spectroscopy

Non-relevant documents

51A/1726 Indexing 6 pages of indexing
A. B. col. 278 Diffraction
 (No mention of orientation)

Comments Review article on metallurgical processes in Canada. 'Diffraction' is included in the indexing because there is a passing reference to neutron diffraction to determine atomic structure. Document retrieved partly because the search programme did not include 'orientation' and partly because of the very detailed indexing.

Reasons for retrieval (a) Searching. Omits concept in question.
 (b) Exhaustive indexing

102J/1785 Indexing col. 2 Castings
A. B. cols. 3/4 KUJ Steel
 col. 14 Heat treatment
 col. 24 Testing
 col. 30 Inspection
 col. 38 Radiographic
 cols. 81/82 KQJ X-ray
 No mention of orientation

Comments The document does not consider the determination of orientation. Recalled because the term 'orientation' is omitted from the search programme.

Reason for retrieval (a) Searching. Omits concept in question.
 (b) Exhaustive indexing.

292M/1930 Indexing col. 34 Laue back reflection
B. col. 36 X-ray diffraction
 cols. 63/64 KUP. KAP. KAL Orientation

Comments Document about dislocation density in annealed and plastically deformed crystals of cu. and al. Determination of orientation of the specimen by Laue back reflection technique is mentioned in passing on page 23, but no details are given and the reader is referred to references at the end of the paper for this subject. The document was retrieved because of this over-detailed indexing.

Reason for retrieval Exhaustive indexing.

QUESTION 24. Non-relevant documents (Continued)

163N/1183 Indexing cols. 4/14 Proprietary alloys
A. B. col. 46 X-ray diffraction
 col. 48 Electron microscopy
 col. 50 Metallographic analysis
 cols. 60/98 (terms relating to microstructure)
 No mention of orientation

Comments The article contains nothing on 'orientation' determination but is recalled because the search programme omits the concept 'orientation' and will accept 'diffraction'.

Reason for retrieval (a) Searching. Omits concept in question.
(b) Exhaustive indexing

167N/1196 Indexing col. 2 Single crystal
B cols. 11/12 KWV Orientation
 col. 72 X-ray back reflection

Comments The emphasis of this paper is on yield and strain aging of crystals. There is only a brief paragraph on 'orientation determination'.

Reason for retrieval Exhaustive indexing.

803Q/1297 Indexing col. 2 Cermet
A. B. col. 4 Powder metal
 col. 12 Powder metallurgy
 col. 22 X-ray
 No mention of orientation

Comments The document contains no reference to the determination of orientation, but was retrieved because the search programme omits the concept 'orientation' altogether and will accept 'X-ray'.

Reason for retrieval (a) Searching. Omits concept in question.
(b) Exhaustive indexing.

QUESTION 26 Do repeated stresses due to varying thermal gradients cause fatigue cracks ?

Search programme
$$\left[\left[P + B \right]^2 + C + D + \left[E \cdot F \right]^4 \right]^8$$

- A. M-CH M-TL N-LL P-PR 4006 Thermal cycled, thermal cycling, thermal cycling apparatus
- B. M-CH M-TL N-LL P-PR 4007 Fatigue tester, fatigue testing, fatigue testing machine
- C. C-RT 1002 Cyclic, cycle
- D. P-PR 1091 Fatigue
- E. R-HT 1091 Heat
- F. D-FL Deflection

Non-relevant documents

51A/1726 Indexing 342 terms
A. B. col. 269/270 KUP Fatigue strength

Comments Review article on metallurgical processes in Canada. All topics included although some given a very superficial mention. Fatigue strength here is ultrasonically determined. No mention of 'repeated stresses' or 'thermal

QUESTION 26. Non-relevant documents (Continued)

51A/1726 Comments (Continued)

gradients! The document is retrieved because the search programme will accept 'fatigue' alone and also because of the exhaustive indexing.

Reasons for retrieval (a) Searching. Insufficient co-ordination.
(b) Exhaustive indexing.

292M/1930 Indexing col. 8 Aluminium
A.B. cols. 10 Copper
 cols. 83/86 KAL Deformation (DAFL 1006)
 Temperature (RAHT 1004)

Comments The document contains nothing on 'repeated stresses' or 'fatigue cracks', but is retrieved because the search programme will accept above terms at the 4th level containing the codes D-FL and R-HT.

Reason for retrieval (a) Searching. Insufficient co-ordination.
(b) Exhaustive indexing.

250Q/1064 Indexing col. 2 7340 Weld metal
A.B. col. 16 Hot cracking
 cols. 37/38 KUP. KAP Freezing cycle
 col. 44 Ductility
 No mention of fatigue.

Comments The document contains nothing about fatigue cracks but is retrieved by the search programme C-RT 1002 Cyclic, cycle.

Reason for retrieval (a) Searching. Insufficient co-ordination.
(b) Exhaustive indexing.

480Q/1025 Indexing cols. 2/20 (Various copper alloys)
A. cols. 31/46 KUP. KAP Several properties including
 col. 44 Fatigue strength

Comments The document is not studying the effect of 'thermal gradients' nor 'repeated stresses on fatigue cracks', but it is recalled because the search programme asks for 'fatigue' alone, without further limitation.

Reason for retrieval Searching. Insufficient co-ordination.

799Q/1279 Indexing col. 22 Tension loading
 cols. 25/26 KAH Cyclic
 cols. 35/36 KAH Fatigue
 cols. 55/58 KUP. KAP Crack propagation/fatigue.

Comments This document considers the effect of 'fatigue cracking on embrittlement' and does not discuss the effect of 'repeated stresses on thermal gradients' or 'fatigue cracks'. It is brought out by the broad search programme which will accept 'fatigue' alone or 'cyclic' alone.

Reason for retrieval (a) Searching. Insufficient co-ordination.
(b) Exhaustive indexing.

QUESTION 28 What alloys are likely to have the best tensile and impact properties in the range of temperature -100°C to -200°C ?

Search programme
$$\left[\left[\left[A + \left[B + C \right]^2 + D + E + F + G + \left[H + I \right]^2 + \left[J \right]^2 \right] \left[K + L \right]^4 \right]^2 \right]^5$$

- | | |
|--|---|
| A. BATT 1007 Impact | G. P-PR 1048 Tension |
| B. B-TT 1007. P-PR Charpy impact
charpy value | H. D-FL 1006. 4593 Ultimate stress |
| C. B-TT 1007 NULL Charpy testing
impact testing | I. D-FL 1006. D-FL 1016 Yield
strain. Yield stress |
| D. P-SH 1002 Pull | J. LAMN. P PR 1019 Ultimate yield
stress. Elastic constant |
| E. P-PR 1010 Brittle, brittleness | K. RAPR 1111 Low |
| F. P-PR 1045 Strength | L. RAHT 1004 Temperature |

Non-relevant documents

<u>164F/1975</u>	<u>Indexing</u>	col. 12 Forgings
B.C2.		col. 14 Press forging (1st Phrase)
		cols. 16/18 KAH Low temperatures
		col. 28 Testing (4th Phrase)
		cols. 31/36 KAH Low/high temperatures (5th Phrase)
		cols. 41/42 KUP. KAP Yield stress (6th Phrase)

Comments The low temperatures mentioned in the document are not related to 'yield stress'. This false drop could not be avoided by role indicators in the search programme, although the 5th level could be used with success. Interfixing would be another way of avoiding the false drop. Also temperature would only be included with very exhaustive indexing. The term seems of small significance.

Reason for retrieval (a) Level 5 required in search programme
(b) Interfixing required.
(c) Exhaustive indexing

<u>388K/1571</u>	<u>Indexing</u>	col. 2 Plate
		cols. 6 Hy-80 Steel
		cols. 154 Cracking (5th Phrase)
		cols. 156/157 KAJ Low temperature (5th Phrase)
		cols. 165/168 KUP. KAP Impact strength (6th Phrase)

Comments The low temperature mentioned in the document does not apply to impact properties but to cracking. Role indicators could not prevent this false drop, although the 5th level in the search programme would, as 'low temperature' and 'impact strength' are in different phrases. Interfixing in the abstract would be another way of avoiding the false drop.

Reasons for retrieval (a) 5th level required in the search programme
(b) interfixing required.
(c) Exhaustive indexing.

QUESTION 28. Non-relevant documents (Continued)

799Q/1279	<u>Indexing</u>	col. 6 Copper
A. B.		col. 8 Zinc
		col. 10 Coated
		cols. 19/20 KQJ Hg
		cols. 22/24 Tension loading
		cols. 27/32 KAH Low temperature (-70 + 120°F)

Comments The document is concerned with 'mercury coated metal' and not alloys, and the low temperature range does not correspond with that in the question. The document was retrieved because the broad search programme requires only 'tension' with 'low temperatures', and does not specify 'alloys' or range of temperature. 'Low temperatures' in this document would only be included where the indexing was very detailed.

<u>Reasons for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Exhaustive indexing.

QUESTION 37 To what extent do stress concentrations affect the structural tensile strength of aircraft and space vehicles ?

Search programme $[[[A+B+C], [{}^2{}_1D] + [{}^2{}_1E]]] {}^6_4F$

- A. S-RR Aircraft
- B. S-TR Celestial bodies
- C. S-SP Space
- D. P-PR, P-SH 1002 Tensile testing
- E. PAPR 1048 3646 Tensile yield strength

Non-relevant documents

<u>358G/1429</u>	<u>Indexing</u>	col. 2 Alloy (1st phrase)
<u>B. C2.</u>		cols. 6/28 Various metals and alloys
		col. 34 Explosive metalworking (2nd phrase)
		col. 84 Plastic deformation
		cols. 101/104 KWJ Rocket nozzle (3rd phrase)
		col. 128 Tensile strength (4th phrase)

Comments This document is a two page account of explosive metalworking of various metals and includes among other examples the use of the technique to manufacture rocket nozzles. In a later paragraph having no connection with the rocket nozzles, it is mentioned that explosively formed 7075 al had a tensile strength of a certain value. The 'rocket' and the 'tensile strength' are quite unrelated in this document. Including role indicators in the search programme would not prevent recall although use of 5th level would, with risk of loss of data. Interfixing in the abstract a surer method.

Reason for retrieval

- (a) Interfixing required.
- (b) Exhaustive indexing.

QUESTION 41 What are the properties required by resins for the coatings of metals by thermoplastics ?

Search programme

Programme 1 . $\begin{matrix} 4 & 4 & 8 \\ \text{[R+]} & \text{B]} & \end{matrix}$

- A. KQJ By means of
- B. R-SN Plastics, resins

Programme 2. $\begin{matrix} 8 & 8 \\ \text{[A]} & \end{matrix}$

- A. RASN Plastics

Non-relevant documents

83F/1855 Indexing col. 4 Titanium
A. col. 10 Forming
col. 17/18 KQJ Teflon die

Comments The document contains nothing about the plastic coatings of metals, and is retrieved because the search programmes omit the concept "coatings" altogether, and the first search programme will accept R-SN, Resins, plastics with role indicators KQJ.

Reason for retrieval Searching. Omits concept in question.

212P/1631 Indexing col. 2 Jet engine
A. col. 30 Heat sink
col. 34/88 Various heat sink materials including
at col. 60 Plastic
No mention of coating.

Comments This document contains nothing on plastic coatings and is retrieved because of the broad second search programme which will accept just RASN 'Plastics', omitting 'coatings'.

Reason for retrieval Searching. Omits concept in question.

499Q/1484 Indexing col. 2/4 Aircraft structural material
A. col. 10/20 Various metals
col. 70 Plastic
No mention of coatings.

Comments This document makes no mention of 'plastic coatings' and is retrieved by the broad second search programme which will accept just RASN 'Plastics', omitting 'coatings'.

Reason for retrieval Searching. Omits concept in question.

QUESTION 46

What are the underlying principles and advantages of the fluidized bed furnace in the heating of metal components ?

Search programme

⁸⁵₅ ⁵₈
[[A]]

A. B-SS 1004 F-LD Fluid bed.

Non-relevant documents

51A/1726

Indexing

cols. 13/14 KEJ. KOV Ore

A. B.

col. 16 Iron

col. 18 Roasting

col. 19/20 KQJ Fluid bed kiln

Among 342 terms.

Comments This is a review article on metallurgical processes in Canada. The reference to 'fluid bed kiln' here is very brief and does not refer to heat treatment of metal components. A less broad search programme could have prevented retrieval, as would less detailed indexing.

Reasons for retrieval (a) Searching. Omits concept in question.
(b) exhaustive indexing

435L/2045

Indexing

col. 14 Fluid bed coatings

A. B.

Comments This article describes the new factory of the Superior Plating Co. and mentions in passing, (one line only) that 'fluidized bed coatings' are undertaken. In any case a narrower search programme specifying 'fluid bed furnaces' with 'heat treatment' would have eliminated.

Reason for retrieval (a) Searching. Omits concept in question.
(b) Exhaustive indexing

QUESTION 52

Is it possible to produce castings of the order of three tons by precision investment castings ?

Search programme

Programme 1.

⁸⁶₆ ⁶₈
[[A.B]]

A. RAPR 1131 Precision

B. C-NS 1025 Casting

Programme 2.

⁶₆
[A+B]

A. RAPR 1131 Precision

B. C-NS 1025 Casting

QUESTION 52. (Continued)

Non-relevant documents

<u>176A/1480</u>	<u>Indexing</u>	cols. 1/2 KEJ. KWJ Billet
A. B.		col. 4 Sheet
		cols. 6/20 Various metals and alloys
		cols. 24/46 Various properties
		cols. 58/86 Various processes including
		cols. 59/60 Arc casting (CUNS 1025 LQCR 1003 MWTL PASS 4001)

Comments This document contains nothing on 'precision casting' but is retrieved because the second search programme will accept any term encoded 'casting'.

<u>Reason for retrieval</u>	(a) Searching. Uses concept less specific than concepts in question.	(b) Exhaustive indexing.
-----------------------------	--	--------------------------

115D/1727 Indexing col. 26 Casting
A. B.

Comments Review article on ultrasonics in Russia. Casting is mentioned, but nowhere 'precision casting'. The document brought out by the second search programme which will accept 'casting' alone.

Reason for retrieval	(a) Searching.	Uses concept less specific than concept in question.	(b) Exhaustive indexing.

<u>210E/1240</u>	<u>Indexing</u>	col. 2 Gray iron
A.		col. 6 Casting
		No mention of precision casting.

Comments The document brought out by the second programme which will accept 'casting' alone.

<u>Reason for retrieval</u>	Searching.	Uses concept less specific than concept in question.
-----------------------------	------------	--

219E/1762	<u>Indexing</u>	col. 2 Gray cast iron
A.		col. 10 Casting
		No mention of precision casting.

Comments Document brought out by second search programme which will accept 'casting' alone.

<u>Reason for retrieval</u>	Searching. Uses concept less specific than concept in question.
-----------------------------	---

<u>82F/1855</u>	<u>Indexing</u>	col. 4 Titanium
A.B.D.		col. 6 PH 15-7 Stainless steel
		cols. 9/10 Forming (C-NS 1027)
		cols. 13/14 Trapped rubber forming (CUNS 1025 PQRS RQBB 1570)

Comments This document on 'forming' of ti. and 'stainless steel' contains nothing on 'precision casting'. It is retrieved because the term 'trapped rubber forming' contains, unexpectedly, the factor CUNS 1025 'casting' and is consequently recalled by the broad second search programme which will accept any term encoded C-NS 1025 'casting'.

<u>Reasons for retrieval</u>	(a) Searching. Uses concept less specific than concept
	(b) Semantic code. in question.
	(c) Exhaustive indexing.

QUESTION 52. Non-relevant documents (Continued)

164F/1975 Indexing col. 2 Casting
A. No mention of precision casting.

Comments Article on the press forging of stainless steel castings.
Brought out by second programme which will accept 'casting' alone.

Reason for retrieval Searching. Uses concept less specific than concept
in question.

267G/1491 Indexing cols. 2/8 Alloys
A. B. col. 12 Electric arc forming
col. 16 Explosive forming
cols. 39/40 KUP Microstructures
cols. 41/42 Precision
No mention of precision casting

Comments Document concerned with the shaping by high energy processes.
Retrieved because the second search programme will accept "precision" alone.

Reason for retrieval (a) Searching. Uses concept less specific than concept
(b) Exhaustive indexing. in question.

358G/1429 Indexing cols. 2/20 Various alloys
A. B. D. cols. 25/26 KEJ Powder metals
cols. 33/34 KAM Explosive forming
cols. 40/64 Various processes
cols. 109/143 KUP. KAP Various properties, including
cols. 123/124 KUP. KAP Green strength (CYNS 1025
MYCH, MWNR 1072 PAPR 1045. 4515)

Comments This document is not concerned with 'precision casting', but the
broad second search programme which will accept any term encoded 'casting'
C-NS 1025, recalls the paper because the code for green strength includes
'casting' in its wide generic base.

Reason for retrieval (a) Searching. Uses concept less specific than concept
(b) Semantic code in question.

54H/2041 Indexing (c) Exhaustive indexing
col. 16 Slip casting
No mention of precision casting

Comments The article about metal powder compacts, but retrieved because
the second search programme will accept 'casting' alone.

Reason for retrieval (a) Searching. Uses concepts less specific than concepts
(b) Exhaustive indexing. in question.

102J/1785 Indexing col. 2 Castings
A cols. 4 Steel
No mention of precision casting.

Comments Document retrieved because the second search programme will
accept 'castings' alone.

Reason for retrieval Searching. Uses concepts less specific than concepts
in question.

QUESTION 52. Non-relevant documents (Continued)

313K/1525 Indexing col. 2 Gray iron
A. B. col. 4 Cast iron
 col. 16 Castings
 No mention of precision casting or precision castings.

Comments Document retrieved because second search programme will accept 'castings' alone.

Reason for retrieval (a) Searching. Uses concepts less specific than concepts
(b) Exhaustive indexing in question.

316K/1228 Indexing cols. 2 Foil
A. B. cols. 4 Strip
 cols. 8 Stainless steel
 cols. 33/34 KWJ Honeycomb
 cols. 43/44 KUP Precision

Comments Document not concerned at all with 'precision' casting but is retrieved because the second search programme will accept 'precision' alone.

Reason for retrieval (a) Searching. Uses concepts less specific than concepts
A. B. (b) Exhaustive indexing. in question.

160L/1729 Indexing col. 2 Automobiles
 col. 6 Die castings
 No mention of precision casting or precision castings.

Comments Document retrieved because the second search programme will accept 'castings' alone.

Reason for retrieval (a) Searching. Uses concepts less specific than concepts
(b) Exhaustive indexing in question.

167L/1831 Indexing col. 8 Castings
A. B. Among 150 terms. No mention of precision casting.

Comments Document retrieved because second search programme will accept 'castings' alone. This is a review article on metal finishing and the mention here of castings could also be attributed to over-detailed indexing.

Reasons for retrieval (a) Searching. Uses concepts less specific than concepts
(b) Exhaustive indexing. in question.

268Q/1485 Indexing col. 6 Nickel brass
A. B. col. 9/10 KWV Cast
 col. 24 Electrodeposition
 No mention of precision casting.

Comments This article on the adhesion of electrodeposited coatings and contains nothing on precision casting, but is retrieved because the second search programme will accept 'cast' alone.

Reason for retrieval (a) Searching. Uses concepts less specific than concepts
(b) Exhaustive indexing. in question.

QUESTION 54 Are there any automatic installations producing laminations in the United Kingdom ?

Search programme
$$\begin{matrix} 5 & 2 & 2 & 5 \\ \left[\left[A \right] + B \right] \end{matrix}$$

- A. P-SS SWHT 1005 2001 Strip Coil
B. S-HT 1005 Laminated -ing, etc.

Non-relevant documents

143J/1477 Indexing cols. 2/4 steels (1st phrase)
A B. C1. cols. 5/4 gears
cols. 21/22 heat treatment (2nd phrase)
cols. 23/24 KQJ heating element
cols. 27/28 KQJ coil
cols. 35/36 KQJ KOV core
cols. 37/38 KWV Laminated

Comments The coil and the laminated core are a part of the heating element used for the heat treating of gears. There is nothing in the article on the manufacture of the laminated coil. Recall could have been prevented if the role indicator KWJ had been used before 'strip' in the search programme to indicate 'product'. The use of the 5th level in the search programme would not have avoided the false drop as both terms are in the same phrase. The addition of the word 'manufacture' to the search programme would also have excluded. Interfixing could not prevent recall in this case.

- Reasons for retrieval (a) Lack of role indicators
(b) Searching. Omitted concept in the question.
(c) Exhaustive indexing.

QUESTION 56 Is it possible to cut metal with a machine designed for welding ?

Search programme
$$\begin{matrix} 8 & 6 & 4 & 4 & 6 & 8 \\ \left[\left[\left[A.B. \right] c \right] \right] \end{matrix}$$

- A. KAM Process
B. C-TT Cutting
C. F-ST Welding

Non-relevant documents

316K/1228 Indexing col. 8 KAM Stainless steel (1st phrase)
B. C2. col. 12 KAM Resistance welding (2nd phrase)
col. 20 KAM Cutting (3rd phrase)

Comments The processes of welding and cutting are two unrelated processes in this document. Role indicators do not provide a means for avoiding this false drop. The use of the 5th level in the entire search programme would have been effective in preventing recall as the terms are in separate phrases in this document. Also interfixing of related terms, in the abstract, would have prevented the false drop.

- Reasons for retrieval (a) Lack of the 5th level in the search programme
(b) Lack of interfixing
(c) Exhaustive indexing

QUESTION 56. Non-relevant documents (Continued)

<u>388K/1471</u>	<u>Indexing</u>	cols. 71/72 KAM Arc welding (3rd phrase)
<u>B. C2</u>		cols. 114/116 KAM Arc gouging (4th phrase)

Comments The terms at cols. 72 and 116 above are quite unrelated. The false drop could not be avoided by role indicators in the search programme, but a requirement for "level 5" for the whole of the programme would exclude the document without necessarily excluding relevant documents as the terms are in different phrases. Interfixing in the abstract would also have eliminated the document.

<u>Reasons for retrieval</u>	(a) Lack of the 5th level in the search programme
	(b) Lack of interfiling.
	(c) Exhaustive indexing

QUESTION 59 If the oxide film is removed from steel strip by liquid fluxes is the flow of liquid tin over the surface more satisfactory ?

Search programme $\begin{matrix} 8 & 6 & 5 & 2 & 2 & 5 & 5 & 5 & 6 & 8 \\ [[[[A]]], [C.D]]] \end{matrix}$

- A. LALL RERN Steel
B. KEJ Material processed
C. F-ST Fastening
D. QSQN Tin

Non-relevant documents

458Q/1808	<u>Indexing</u>	cols. 3/4 KWV Solderability (1st phrase)
A. B. C1. C2.		cols. 33/34 KEJ Tin (1st phrase)
		cols. 43/44 KEJ Steel (1st phrase)

Comments The document contains nothing on'tinning of steel strip', but considers various metals as solders, among these'tin' and'steel'. The broad search programme picks up the document because it will accept KEJ with 'steel' with'tin' and'fastening'(F-ST), a semantic factor which also retrieves 'soldering solderability'. The search programme ignores altogether the term 'strip' in the question, and adds 'fastening' not in question. The false association between 'tin' and 'steel' could be avoided either by using the role indicator KQJ (By means of) with 'tin' to show it is used for'coating', or by introducing interfixing into the abstract. The use of the 5th level for all the terms in the programme would not prevent recall as the terms in the document are all in the same phrase.

Reasons for retrieval

- (a) Searching.
 - i. Omits concept in question
 - ii. Adds concepts not in the question
- (b) Lack of role indicators
- (c) Interfixing required
- (d) Exhaustive indexing

QUESTION 61 What are the requirements of a roll force measuring device and in what ways if any would these differ from those of a torque measuring device ?

Search programme ${}^6{}_2{}^2{}_6$
 $[[A]B]$

- A. MQCL M-TL P-SS Rolled, rolling, etc.
 B. MUSR Measurement

Non-relevant documents

54F/1859 Indexing col. .2 Stainless steel
 B. col. 6 Rolling
 col. 8 Measurement
 col. 34 Strip

Comments The document is very brief and is mainly about the filter system on a strip mill. There is only one line on 'beta ray thickness measurement of the strip'.

Reasons for retrieval Exhaustive indexing.

137P/1628 Indexing cols. 55/56 KWV Cold rolled (annealed bar)
 B. C1. col. 60 Measurement

Comments There is nothing in the document on measurement of rolling force. The article was retrieved because a role indicator was omitted from the search programme. If the role indicator KAM (process) had been inserted before 'rolling' this would have excluded the unwanted 'cold rolled' referring to the condition of the annealed bar, preceded in the abstract by KWV (property given for). Interfixing in the abstract would not have eliminated as the measurement does relate to the 'cold rolled bar'. The use of the 5th level in the entire search programme would have excluded the document as the terms are in different phrases, with the risk of excluding relevant documents also

Reason for retrieval a) Lack of role indicators in search programme.
 b) Exhaustive indexing

QUESTION 63 What recent work has been done on the resistance to corrosion of nickel electrolytic deposits ?

Search programme ${}^3{}_4{}^2{}_2{}^4{}_6{}^2{}_2{}^2{}_6{}^8$
Programme 1. $[A[[B[[C+D]E]]+[[[C+D]E][F+G]]]]$

- A. D-TR Deterioration
 B. KQJ By means of
 C. MATL Metal
 D. LALL Alloy
 E. QNQi Nickel
 F. C-CR L-CT Electroplating
 G. C-CR L-TL Electrodeposited coatings

QUESTION 63. Search programme (Continued)

Programme 2. ^{8 6}[[²A/B/C+²D+E+F+G+H+I+J+K+L].^{2 2}[^{2 6 2}M.N][^{2 2}[^{2 6 8}O.P].^{2 6 8}Q+R+S+T]]]

- | | |
|--|--|
| A. D-TR 1001 Corroded, etc. | K. D-TR L-TL Corrosion cell |
| B. D-TR 1004 Attack | L. D-TR M-TR Stringer corrosion |
| C. D-TR 1008 Pinhole corrosion | M. MATL Metal |
| D. D-TR NULL Deterioration testing | N. QNQi Nickel |
| E. D-TR R-RN Rust | O. MATL Metal |
| F. D-TR S-HT Scaling | P. QNQi Nickel |
| G. D-TR CYMN 1009 Fretting corrosion | Q. C-CR L-CT Electroplating, etc. |
| H. D-TR DYFL 1006 Stress corrosion | R. C-CR L-TI Electrodeposited coatings, etc. |
| I. D-TR GANT V.C.1, | S. C-CR M-TL Chromizing, galvanizing, etc. |
| J. D-TR PAPR 1036 Corrosion resistance | T. C-CR S-HT Film, skin panel etc. |

Non-relevant documents

<u>115D/1727</u>	<u>Indexing</u>	col. 232 Alloy steel
A. B. C1. C2.		cols. 233/234 KIJ Nickel
		cols. 241/242 KAM Heat treating
		cols. 255/256 KAL Ultrasonic vibration
		cols. 259/260 KEJ. KOV Steel
		cols. 261/266 KWV Zn Cd Plated
		cols. 71/72 KAM Electroplating
		cols. 285/286 KAL Ultrasonic vibration

Comments This document reviews applications of ultrasonics in the U.S.S.R. Originally there was punctuation for "6th level partitioning" between the many distinct uses mentioned, but this was struck out. Consequently the second search programme, which will accept 'nickel' with 'electroplating' retrieves the paper even though the nickel and electroplating occur in different 'themes'. The one, 'nickel', is a minor component in 'steel' receiving 'heat treatment', and the other, 'electroplating', relates to coating 'steel' with 'cadmium' and 'zinc' and not with 'nickel'. The false drop could have been avoided if the second search programme had included the role indicator KQJ (By means of) before 'nickel', but retention of the original partitioning would have been just as effective. Also if the second search programme had also required 'corrosion' with 'nickel' and 'electroplating' the document would have been excluded.

Reasons for retrieval

- (a) Searching. Insufficient co-ordination
- (b) Partitioning required in abstract
- (c) Lack of role indicators.
- (d) Exhaustive indexing

QUESTION 63. Non-relevant documents (Continued)

313K/1525 Indexing col. 2 Gray iron (1st phrase)
A.B.C2. cols. 19/29 KAM Addition (2nd phrase)
 cols. 25/26 KQJ Ni
 cols. 68/70 KUP. KAP Corrosion (3rd phrase)

Comments This document is not about the corrosion of nickel coatings. The 'nickel' here is an addition to improve the quality of 'Gray iron', and the corrosion refers to the iron and not to the 'nickel'. The false drop would have been avoided if the search had co-ordinated concepts 'coatings' with 'nickel' and 'corrosion'. In this instance the use of the role indicator KQJ did not prevent a false drop. Since 'corrosion' and 'nickel' are in different phrases, use of the 5th level in the search programme would have prevented recall but at the risk of losing relevant documents. Interfixing would have prevented recall also.

Reasons for retrieval (a) Searching. Insufficient co-ordination
 (b) Interfixing required
 (c) Exhaustive indexing

268Q/1830 Indexing col. 2 Cast iron
A.B. col. 4 Brass
 col. 6 Nickel brass
 col. 24 Electrodeposition
 col. 58 Nickel
 cols. 67/68 KAL Coatings thickness

Comments The main interest of the document is the adhesion of electro-deposited coatings. There is no mention of 'corrosion', but the document is retrieved because the search programme will accept 'nickel' with 'electroplated or electrodeposited coatings'. Co-ordination with 'corrosion' would have excluded document.

Reason for retrieval Searching. Insufficient co-ordination

290R/1492 Indexing col. 30 Coatings
B. cols. 37/38 KUJ Nickel
 col. 44 Corrosion

Comments The article is about the 'forming' and 'welding' of 'automobile bodies'. In passing, notes that nickel coated bodies are corrosion resistant until the coatings are broken. Only for very detailed indexing would this paragraph be thought worth including.

Reason for retrieval Exhaustive indexing.

QUESTION 65 What types of austenitic stainless steels are suitable for use in nuclear reactors when in contact with reactor slurries ?

Search programme 8 6 2 2 2 2 6 8
 [[[A]. [B+C]]]

- A. LALL RERN CQR Steel, Cr
- B. MACH NQCL 2003 Nuclear reactors
- C. MACH NQCL 2007 Atomic reactor

QUESTION 65. (Continued)

Non-relevant documents

264K/1396 Indexing col. 6 308 Steel
A col. 20 Nuclear reactors
No mention of reactor slurries

Comments The document is about the 'arc welding' of 'steels' for 'reactor cores'. No mention of compatability of the steels with reactor slurries. The document recalled because the search programme will accept "steel" with 'chromium' with 'nuclear reactors', omitting "slurries altogether".

Reason for retrieval Searching. Omits concept in question

QUESTION 69 What work has been reported on the electrochemical corrosion of iron and aluminium alloys by A.C. currents ?

Search programme
$$\begin{matrix} 865 & 2 & & 25 & 5 & & 2568 \\ [[[A [B+C] [D+E]]] , [F [G+H]]]] \end{matrix}$$

- | | |
|---------------------------|-----------------------|
| A. KEJ Material processed | E. QAQL Aluminium |
| B. LALL Alloy | F. D-TR Deterioration |
| C. MATL Metal | G. L-CT Electricity |
| D. QFQE Iron | H. L-TL Electrolysis |

Non-relevant documents

290R/1492 Indexing cols. 2/28 KEJ Steels (1st phrase)
A.B. col. 66 Corrosion
col. 74 Electrode (LYCT MACH 011) (8th phrase)

Comments The document contains nothing on corrosion by A.C. currents, but is retrieved because the search programme accepts 'iron' with terms in the 5th level coded D-TR (such as 'corrosion') and L-CT (such as 'electrode'). It looks as though it was intended to give the level 2 indicator for D-TR L-CT, but one of the indices is missing. Level 2 would have restricted retrieval to one word containing D-TR L-CT.

Reason for retrieval (a) Searching. Searches concepts less specific than
(b) Exhaustive indexing the question.

339R/1610 Indexing cols. 1/2 KEJ Aluminium (1st phrase)
col. 16 Corrosion (3rd phrase)
cols. 20/22 Cathodic protection (LQTL PUTT 001)

Comments There is nothing on corrosion by A.C. currents in this document, but it is retrieved because the broad search programme will accept 'aluminium' with 'deterioration' D-TR (retrieving corrosion) and 'electrolysis' L-TL (retrieving cathodic protection). It looks as though a level 2 indicator was omitted before D-TR, L-TL in the search programme, without which the search programme is broader than was intended.

Reason for retrieval (a) Searching. Searches concepts less specific than question.

QUESTION 69. Non-relevant documents (Continued)

<u>391R/1106</u>	<u>Indexing</u>	col. 6 Concrete (1st phrase)
A.B.		cols. 7/8 Steel
		cols. 65/66 KUP. KAP Corrosion (4th phrase)
		cols. 78/80 Resistivity, electrical (4th phrase)

Comments The document does not touch on the corrosion of reinforced concrete structure by A.C. currents. It is brought out by the search programme which accepts 'iron' with D-TR (bringing out 'corrosion') and L-CT (retrieving 'resistivity, electrical') in the 5th level. It looks as though it was intended to restrict D-TR L-CT to one word, but the 2nd level indices in the search programme are not completed.

<u>Reason for retrieval</u>	(a) Searching. Searches concepts less specific than question.
	(b) Exhaustive indexing

<u>413R/1690</u>	<u>Indexing</u>	col. 2 Iron (1st phrase)
		cols. 46/48 Corrosion resistance (4th phrase)
		cols. 55/56 KAL Current (4th phrase)

Comments The document contains nothing on corrosion by A. C. currents but is concerned with the anodic behaviour of stainless steels and their susceptibility to stress corrosion cracking. The document brought out because the search programme accepts 'iron' with D-TR (retrieving corrosion resistance) and L-CT (bringing out "current"). It looks as though it was intended to restrict D-TR L CT to one word, but the 2nd level indices in the search programme are not complete.

<u>Reason for retrieval</u>	
(a) Searching.	Searches concepts less specific than question.
(b) Exhaustive indexing	

QUESTION 71 What is the effect of hydrogen on steel tubing in use at high temperatures (up to 800°F) and at pressures up to 930 p.s.i. ?

Search programme

Programme 1.

865 2 2 5 2 2 6 8
[][A][B] . [C]]]

- A. T-TB Tubes, pipes
B. LALL RERN Steel
C. GASS QH Hydrogen

Programme 2.

$$\begin{matrix} 8 & 2 & 2 & 2 & 2 & 8 \\ \square & [A] & . & [B] & \square \end{matrix}$$

- A. LALL RERN Steel
B. GASS QH Hydrogen

Non-relevant documents

<u>280K/1047</u>	<u>Indexing</u>	col. 8 304 Stainless steel
A.		col. 12 Brazing
		col. 26 Hydrogen
		col. 28 Atmosphere
		No mention of tubes or pipes.

QUESTION 71. Non-relevant documents (Continued)

280K/1047 (Continued)

Comments The document retrieved because the second search programme does not specify 'tubes'.

Reason for retrieval Searching. Omits concept in question.

388K/1571 Indexing col. 6 HY-80 Steel (1st phrase)
A. B. C1. C2. col. 72 Arc welding (3rd phrase)
col. 76 Electrode
cols. 83/84 KIJ. KOV Coatings
cols. 85/86 KIJ Metal powder
cols. 89/90 KIJ Moisture
cols. 91/92 KIJ Hydrogen
No mention of pipes

Comments The document retrieved because the second search programme omits the concept 'tubes'. In this case there is also a false drop, as the hydrogen is in no way related to the steel, but is indexed in connection with the arc welding electrode. The inclusion of 'hydrogen' at all in the abstract is due to the very detailed indexing. False drop could have been prevented by use of role indicator KOJ "by means of", or by use of 5th level, as 'steel' and 'hydrogen' are in different phrases. Interfixing would also have been successful.

Reasons for retrieval (a) Searching. Omits concept in question.
(b) Exhaustive indexing.
(c) Role indicator lacking (d) Interfixing required.

167L/1831 Indexing col. 18 Stainless steel
A. B. col. 116 Embrittlement
cols. 117/118 KAL Hydrogen
No mention of tubing.

Comments This is a review article on metal finishing. The metals considered include several others besides 'stainless steel'. 'Embrittlement by hydrogen' is mentioned in passing. The document is also retrieved because 'tubing' is not included in the second search programme.

Reasons for retrieval (a) Searching. Omits concept in question
(b) Exhaustive indexing.

QUESTION 73

How is the flow pattern in a U-fired soaking pit dependent on ingot placement and port and burner design ?

Search programme

Programme 1.

$${}^8 2 \ 2 \quad 2 \ 2 \ 8$$

$$[[A] + [B]]$$

- A. MWTL. PASS. RQHT 3022 Soaking
B. LACN. MWTL. PUSS. RQHT 4002 Soaking pit

Programme 2.

$$822 \quad 8$$

$$[[A], B]$$

- A. M-TL P-SS. R-HT Heat treating, etc.
B. MATN 1008 Flow

Non-relevant documents

192K/1519

Indexing

col. 2 Titanium

A. B. D.

col. 40 Fusion welding (FUST 1008. MWTL
PQSS. 1007 RQHT 4002)

cols. 17/18 KUP. KAP Flow

Comments This document on welding titanium has nothing on the flow pattern in furnaces. The document is retrieved because the wide second search programme omits 'soaking pit' and adds the concept 'heat treating' (M-TL P-SS R-HT). This retrieves the term 'fusion welding'. If the generic basis of the code for "fusion welding" had not been quite so wide the document would not have been recalled, as this is the only term in the abstract encoded 'heat treating'.

Reasons for retrieval

(a) Searching.	(b) Omits concept in question.	(c) Adds concept not in question.
(b) Semantic code.		
(c) Exhaustive indexing		

167N/1196

Indexing

cols. 13/14 KWV Vacuum annealed (1st phrase)

cols. 62/64 Plastic flow (3rd phrase)

Comments In this document the flow is not 'heat flow' but 'plastic flow' but the second search programme retrieves it because it will accept 'flow' MATN 1008 with terms coded M-TL P-SS R-HT which includes 'vacuum annealed'. The use of the role indicator KAM (process) before 'heat/metal/process' in the search programme would have prevented recall of 'vacuum annealed' preceded by KWV (property given for). The 5th level could have been used for the entire search programme but this would have excluded this document and possibly most of the relevant ones. Interfixing would not necessarily prevent retrieval of this document.

Reasons for retrieval

(a)	a) Searching.
	b) Omits concept in question
	c) Adds concept not in question
(b)	Lack of role indicators
(c)	Exhaustive indexing

QUESTION 73. Non-relevant documents (Continued)

475Q/1952	<u>Indexing</u>	col. 4 Brass
A. B. C1.		cols. 7/8 KWV Annealed
		cols. 79/80 KUP. KAP. KAL Yield point
		cols. 83/84 KAL Flow

Comments This document contains nothing about heat flow patterns. The reason for recall and methods of preventing it are as for the previous document 167N/1196.

Reasons for retrieval

- (a) Searching
 - (i) Omits concept in question
 - (ii) Adds concept not in question
- (b) Lack of role indicators
- (c) Exhaustive indexing.

798Q/1275 Indexing col. 14 KWV Annealed
A. B. C1. cols. 62/64 Plstic flow

Comments The reason for retrieval are the same as those for document 167N analysed above.

Reasons for retrieval

- (a) Searching
 - (i) Omits concept in question
 - (ii) Adds concept not in question
- (b) Lack of role indicators
- (c) Exhaustive indexing

QUESTION 76 How can stainless steel tube be expanded by explosive forming ?

Search programmes

Programme 1.

$${}^8{}_6{}^5{}_2{}^2{}_5{}^6{}_8$$

$$[[[A[B]C]]]$$

- A. T-TB Tubes, pipes
B. LALL RERN CQR Cr.
C. P-LS Explosive

Programme 2.

$$[[[{}^8{}_6[A]_TB].C]]^6_8$$

- A. LALL RERN QFQE CQR Steel, Fe, Cr.
B. T-TB Tubes, pipes
C. P-LS Explosive

Non-relevant documents

<u>358G/1429</u>	<u>Indexing</u>	col. 18 Stainless steel
A. B.		col. 120 Explosive forming
		No mention of tubes

Comments Two page article on explosive metalworking of a number of different metals, including the forming of various components not including tubes. The document brought out by the second search programme which will accept 'Fe/Cr Steel alloys' alone with 'explosive'.

<u>Reason for retrieval</u>	(a) Searching. Accepts concepts less specific than question.
	(b) Exhaustive indexing

QUESTION 78

How does the presence of up to 3% Mo affect the ductility of 18/8 austenitic stainless steels at low temperature (from ambient down to -200°C) ?

Search programme

^{8 6 2 2}
[[⁴[A],⁴[B+C],^{6 8}D[E.F]]]

- A. LALL. RERN. CQR Steel, chromium
- B. QMQO Molybdenum
- C. MQO Molybdenum
- D. P-PR 1017 Ductility
- E. R-PR 1111 Low
- F. RAHT 1004 Temperature

Non-relevant documents

617Q/1375 Indexing
B. C1. C2.

cols. 2/36 (steels, al. and ti. alloys by proprietary names. The stainless steels mentioned do not have mo. in their coding although mo. is in the coding of other alloys, e.g. col. 2 SAE 4340 Col. 8 H11). (1st phrase).
cols. 71/72 Ductility (5th phrase)
cols. 56/60 Low temperatures (6th phrase)

Comments The search programme asks for 'chromium steel', 'molybdenum', 'ductility' and 'low temperatures'. These terms are included in the document, but they are not related in the way required by the question. 'Molybdenum' is not a constituent of 'stainless steel' and 'low temperatures' are not associated with ductility. The use of the role indicator KAL (influencing) before 'mo.' would have prevented recall, as would the use of the 5th level for the terms 'ductility' and 'low temperatures'. Interfixing in the abstract would also have avoided the false drop.

Reasons for retrieval (a) Lack of role indicators
(b) Lack of 5th level
(c) Lack of interfixing
(d) Exhaustive indexing.

20922/2008 Indexing
A. B. C1. C2.

cols. 1/2 KEJ. KOV Stainless steel (1st phrase)
cols. 7/8 KIJ Chromium (1st phrase)
cols. 17/18 KIJ Molybdenum (1st phrase)
cols. 33/34 KWV Ductility (2nd phrase)
cols. 82/84 Low temperature (6th phrase)

Comments This patent does not mention '18/8 stainless steel' so that a more specific search programme would have excluded. Although the 'mo. content of stainless steel' is indexed the affect of the 'molybdenum' is not discussed. The addition of KAL before 'molybedenum' would also have excluded this document.

Also the use of the 5th level for the terms ductility and low temperatures would have prevented recall, as the terms are in different phrases. Interfixing in the abstract would also have prevented recall.

Reasons for retrieval (a) Searching. Not specific enough.
(b) Lack of role indicators in the search programme
(c) Lack of 5th level in search programme
(d) Lack of interfixing in the abstract.
(e) Exhaustive indexing

QUESTION 80

What type of equipment can be used for testing the mechanical properties of metals and temperatures down to -423°F ?

Search programme

⁸⁴
⁴⁸
[[A.B]]

- A. RAPR 1111 Low
- B. RAHT 1004 Temperature

Non-relevant documents

164F/1975

Indexing

A.B.

col. 14 Press forging
cols. 16/18 Low temperatures (-100°F)
col. 28 Testing
col. 30 Deforming
cols. 32/36 Low/High temperatures ($\text{RT}-860^{\circ}\text{F}$)
No mention of equipment for testing mechanical properties.

Comments The document retrieved because the search programmes will accept 'low temperatures' only and does not specify testing equipment for mechanical properties. Also the inclusion of the temperature range in the abstract looks like over-detailed indexing.

Reason for retrieval

- (a) Searching. Omits concept in question
- (b) Exhaustive indexing

388K/1571

Indexing

A.B.

col. 142 Weldment
cols. 145/146 KUJ. HY-80 Steel
col. 150 Test
col. 154 Cracking
cols. 57/60 Low temperatures (-125°F)

Comments The article contains nothing on the equipment for testing mechanical properties, and even the low temperatures mentioned are not in the range required. The document retrieved because the search programme will accept 'low temperatures' only. Also in this case the inclusion of the temperature condition could be regarded as over-detailed indexing.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Exhaustive indexing

202M/1947

Indexing

A.B.

col. 18 Heat treatment
col. 20 Low
col. 22 High
col. 26 Temperature (-197°C 1200°C)

Comments The document is not concerned with testing of mechanical properties, and in any case the low temperatures mentioned are not in the required range. Recall due to the search programme which will accept 'low temperatures' alone. The inclusion of the temperature condition looks like over-detailed indexing.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Exhaustive indexing

QUESTION 80. Non-relevant documents (Continued)

<u>313M/1302</u>	<u>Indexing</u>	col. 4 Ni3Al
A. B.		col. 32 Creep
		col. 34 Tensile
		col. 36 Testing
		col. 46 Quenching
		cols. 48/52 Low temperature

Comments There is no mention in this document of the equipment for testing mechanical properties at low temperatures. The 'low temperature' in cols. 48/52 refers to quenching. The document retrieved partly because the search programme is so broad that it requires 'low temperature' alone, and partly because of the very detailed indexing which includes low temperatures in the abstract although in this case it can be of only minor importance.

<u>Reasons for retrieval</u>	(a) Searching. Omits concept in question
	(b) Exhaustive indexing

<u>167N/1831</u>	<u>Indexing</u>	cols. 20/21	Tensile testing
<u>B.</u>		cols. 24/26	High/low temperatures (77 < 415°K)

Comments Main interest of the document, the strain aging of silver base alloys. There is a brief mention of the equipment used in the tensile testing of the specimen, but insufficient to be of interest in answer to the question.

Reason for retrieval Exhaustive indexing.

<u>511Q/1350</u>	<u>Indexing</u>	col. 42 Testing
A.B.		col. 44 Temperature
		col. 46 Low (163°C to 1°C)
		No mention of mechanical properties

Comments The temperature range is not sufficiently low for the question and the document contains no reference to the testing of mechanical properties. The inclusion of the temperature range of the testing in the abstract appears to be unnecessarily detailed indexing.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Exhaustive indexing.

<u>542Q/1820</u>	<u>Indexing</u>	col. 16	Testing
<u>B</u>		col. 18	Low
		col. 20	High (-51° to 172°F)
		col. 34	Charpy V notch impact
		col. 38	Ductile brittle transition

Comments The temperature range is not sufficiently low to answer the question. In this case the inclusion of the temperature range of the testing in the document gives unnecessarily detailed indexing.

Reason for retrieval Exhaustive indexing.

QUESTION 80. Non-relevant documents (Continued)

617Q/1375	<u>Indexing</u>	cols. 53/54 KAM Testing
B		cols. 55/56 Low (cryogenic)
		cols. 64/82 Strength, ductility, fracture, toughness

Comments The document discusses materials for pressure vessels, mentioning behaviour at temperatures as low as -420°C but gives no detailed description of test methods and equipment. The inclusion of the temperature range of testing could usefully have been omitted from the abstract.

Reason for retrieval	Exhaustive indexing.
----------------------	----------------------

746Q/1635	Indexing	col. 16 KAM Testing
B		cols. 17/18 KAH Tension
		cols. 20/22 KAH Low temperatures (4.2° - 77°K)
		col. 40 KUP. KAP. KAL Shear modulus

Comments The main interest of the document, the X-ray analysis of dislocation density in crystals. The testing does not apply to the mechanical properties indexed, and the temperature range is not within the one required. The inclusion of the temperature range of the testing could usefully have been omitted from the abstract and so prevented the recall of this document.

Reason for retrieval Exhaustive indexing.

799Q/1279	<u>Indexing</u>	cols. 22/24 Tension loading
A.B.		cols. 28/32 Low/high temperature (-70° to +120°F). No mention of mechanical properties or testing.

Comments The document contains nothing on the testing of mechanical properties and even the temperature range mentioned is not within that required by the question. The document is retrieved because the search programme will accept 'low temperatures' alone. Also the document need not have been recalled if the detailed indexing had not included the temperature range which is likely to be of minor interest.

<u>Reasons for retrieval</u>	(a) Searching. Omits concept in question
	(b) Exhaustive indexing.

QUESTION 81 Do stainless steels have any advantage over Al and Ti alloys as structural materials for rockets using liquid oxygen and hydrogen propellants ?

Search programme $\begin{matrix} 8 & 6 & 2 & 2 & 2 & & 2 & & 5 & 2 & 2 & 5 & 6 & 8 \\ \left[\left[\left[A \right] + \left[\left[B+C \right] \cdot \left[D+E \right] \right] \cdot \left[F+G+H + \left[\left[J+K \right] \right] \right] \right] \right] \end{matrix}$

- | | |
|-----------------------------|--------------------------|
| A. LALL RERN. CQR Steel Cr. | G. S-TR Celestial bodies |
| B. LALL Alloy | H. S-RR Aircraft |
| C. MATL Metal | I. F-LD Fluid/liquid |
| D. QAQL Aluminium | J. GASS QO Oxygen |
| E. QTQI Titanium | K. GASS QH Hydrogen |
| F. S-SP Space | |

QUESTION 81 (Continued)

Non-relevant documents

<u>358G/1529</u>	<u>Indexing</u>	col. 6 Aluminium
B		col. 8 Titanium
		col. 18 Stainless steel
		col. 34 Explosive forming
		cols. 89/90 KWJ Missile nose cone

Comments The article discusses 'explosive forming' of several metals and powder metals. Among the applications mentioned are 'missile nose cones' and 'rocket nozzles'. With less detailed indexing these applications would not have been mentioned and the document not recalled.

Reason for retrieval Exhaustive indexing.

<u>216K/1446</u>	<u>Indexing</u>	col. 6 Pressure vessel
A		col. 8 321 Stainless steel
		col. 10 Fabrication
		cols. 28/30 Liquid oxygen
		col. 32 Storage

Comments The document does not mention the application of the pressure vessels in missiles and rockets, but the document is retrieved because the search programme will accept 'stainless steel' with 'liquid oxygen'.

Reason for retrieval Searching. Insufficient concept co-ordination

<u>168N/1204</u>	<u>Indexing</u>	col. 2 Binary systems
A. B. C2.		col. 4 Alloy
		cols. 6/36 KUJ. KIJ Various metals
		col. 46 Resistance heating
		col. 48 Vacuum
		cols. 49/50 KIJ Hydrogen atmosphere
		cols. 69/74 Liquid/Solid transformation

Comments This document contains nothing on stainless steel, Ti or Al as structural materials for rockets. 'Aluminium' is mentioned as an element in a binary system and the 'liquid' (cols. 69/74) is not related to the 'hydrogen' (col. 50). The search programme broadly requests 'aluminium' with 'liquid' and 'hydrogen'. The false association between 'liquid' and 'hydrogen' could not be prevented by role indicators, although "level 4" might have been used. "Level 5" in the search programme would not have prevented recall. A more certain method of avoiding the false drop would be interfixing in the abstract.

Reason for retrieval (a) Searching. Insufficient concept co-ordination
 (b) Lack of level 4 in search programme
 (c) Interfixing required.

QUESTION 81. Non-relevant documents (Continued)

212P/1631 Indexing col. 2 Jet engine
A. B. col. 30 Heat sink
 col. 38 Aluminium
 col. 40 Titanium

Comments Document concerned with metals suitable for heat sinks in jet engines, and would not have been recalled if the search programme had not been broadened to include 'aircraft' as well as space vehicles.

Reason for retrieval Searching. Adds concept not in question

QUESTION 83 What means can be used to reduce warpage in the austempering of alloy steel parts of complex shapes ?

Search programme

Programme 1. $\begin{matrix} 8 & 6 & 2 & 2 & 2 & 2 & 6 & 8 \\ \llbracket \llbracket [A], \llbracket [B]+C \rrbracket \rrbracket \rrbracket \end{matrix}$

- A. LALL RERN Steel
- B. MWTL P-SS RQHT 3016 Austempering
- C. D-FL 1015 Warping, warped.

Programme 2. $\begin{matrix} 8 & 6 & 2 & 2 & 2 & 2 & 6 & 8 \\ \llbracket \llbracket [A], \llbracket [B]+C \rrbracket \rrbracket \rrbracket \end{matrix}$

- A. LALL RERN Steel
- B. M-TL P-SS RQHT 301 - Heat treating, etc.
- C. D-FL 10-- Deflection, etc.

Non-relevant documents

358G/1584 Indexing col. 18 Stainless steel
A. B. col. 84 Plastic deformation

Comments This article is on the explosive forming of certain alloys and contains nothing on austempering. It is recalled because the second search programme will accept 'steel' (retrieving stainless steel) alone with 'deflection' (retrieving plastic deformation).

Reason for retrieval Searching. Used concepts less specific than the question

66J/1722 Indexing col. 2 Steel
A. col. 12 Steel
 col. 42 Quenching

Comments The document is quite irrelevant containing nothing on 'warpage' nor on 'austempering', but is retrieved by the second search programme which will accept alone terms encoded 'steel' with terms encoded 'heat treatment' (see terms at cols. 2, 12 and 42 above).

Reason for retrieval Searching. Used concepts less specific than the question

QUESTION 83. Non-relevant documents (Continued)

79J/1447 Indexing col. 2 Gears
A col. 4 Nitralloy N. steel
 col. 12 Heat treatment
 col. 20 Tempering
 col. 46 Distortion
 col. 48 Shrinkage

Comments The document does not mention 'austempering', although it does discuss 'shrinkage' in connection with 'tempering'. The document was excluded by the narrow first search programme but retrieved by the second which will accept 'steel' with 'heat treatment'.

Reason for retrieval Searching. Used concepts less specific than question

97J/1522 Indexing col. 4 Steel
A. B. col. 6 Welded
 col. 8 Resistance heating
 col. 10 Stress relief

Comments The document contains nothing on 'austempering' or 'warpage', but is retrieved by the second search programme which will accept 'heat treatment etc.' (as in col. 10 above) alone with 'steel' (as in col. 4 Steel).

Reason for retrieval (a) Searching. Used concepts less specific than question
 (b) Exhaustive indexing

102J/1785 Indexing col. 2 Castings
A. col. 4 Steel
 col. 14 Heat treatment
 col. 16 Tempering

Comments The document contains nothing on 'austempering' or 'warpage' but is brought out by second search programme which accepts 'heat treatment' and 'steel' alone (see cols. 2 and 14).

Reason for retrieval Searching. Used concepts less specific than question

116J/1526 Indexing col. 6 Alloy steel
A. col. 16 Preheating
 col. 24 Stress relieving

Comments The broad search programme retrieves this article which has reference neither to 'austempering' nor to 'warpage'. The programme will accept 'heat treatment' alone with 'steel' and so picks up the document by the terms indexed at cols. 6 and 24.

Reason for retrieval Searching. Used concepts less specific than question.

388K/1571 Indexing col. 6 HY 80 Steel
A. col. 28 Quenched, tempered
 col. 54/56 Quenching, tempering

Comments The document is not concerned with 'autempering' nor with 'warpage', but it is retrieved by the second search programme which will accept as sufficient for retrieval the terms indexed at cols. 6 and 28 or 54.

Reason for retrieval Searching. Used concepts less specific than question

QUESTION 83. Non-relevant documents (Continued)

129N/2019 Indexing col. 2 Steel
A col. 26 Heat treatment
 col. 38 Austenitizing
 col. 44 Quenching
 col. 84 Tempering

Comments The second programme which asks for any term with code 'heat treatment' with any term with code 'steel' retrieves this document, although the article does not consider 'warpage' nor 'austempering'.

Reason for retrieval Searching. Used concepts less specific than question

507Q/1256 Indexing cols. 28/38 Ferrous alloys
A. B. col. 60 Heat treatment
 col. 94 Deformation

Comments The broad search programme is responsible for the recall of this non-relevant document. It will accept 'steel' with terms containing either the factors for 'heat treatment' or 'deflection'.

Reason for retrieval (a) Searching. Used concepts less specific than question
 (b) Exhaustive indexing

542Q/1820 Indexing col. 10 Normalizing
A col. 4 Steel

Comments This document contains nothing on 'warpage' nor on 'austempering' but is retrieved by the second search programme which accepts the terms at cols. 10 and 4 alone in combination.

Reason for retrieval Searching. Used concepts less specific than question

QUESTION 85 What kind of pretreatment should be applied to a steel base which is to receive a heavy vinyl plastisol coating ?

Search programme $\begin{matrix} 8 & 6 & 2 & 2 & 5 & 5 & 6 & 8 \\ [& [& [A] & . & [B.C] &] &] &] \end{matrix}$

- A. LALL. RERN Steel
- B. C-CR Cover, coating
- C. R-SN Plastic

Non-relevant documents

291R/1486 Indexing col. 4 PH-15-7-MO Steel
A. col. 26 Coatings
 col. 44 Epoxy
 col. 48 Teflon

Comments The document discusses 'plastic coatings' among other types of coatings to protect materials from flight heat, but contains no information on pretreatment for vinyl plastisol coating. If the search programme had specified the exact type of plastic coating the document would not have been recalled.

Reason for retrieval Searching. Used concepts less specific than question.

QUESTION 85. Non-relevant documents (Continued)

<u>339R/1610</u>	<u>Indexing</u>	col. 10	Stainless steel
<u>A</u>		col. 24	Coating
		col. 26	Epoxy

Comments This article reviews 'corrosion in breweries' and mentions protection by 'plastic coating'. Does not refer to 'vinyl plastisol coating pretreatment', and is recalled because the search programme does not specify the type of plastic coating nor pretreatment.

Reason for retrieval Searching. Used concepts less specific than question

QUESTION 86 What type of copper alloy possesses the best machinability and why ?

Search programme $\left[\left[\left[A+B \right] C \right] D \right]$

- A. LALL Alloy
B. MATL Metal
C. QCQU Copper
D. CUNS 1028 Machining, machined

Non-relevant documents

313K/1525	<u>Indexing</u>	col. 4 Cast iron (1st phrase)
B. C2.		col. 12 Machinability
		col. 132 Arc welding (6th phrase)
		cols. 133/134 KQJ Electrode
		cols. 139/140 KUJ Tin bronze

Comments In this document the 'machinability' (col. 12 above) applies to the 'cast iron' (col. 4) and not to the 'tin bronze', which refers to the composition of the arc welding electrode. There is a case that the 'electrode metal' is of very slight importance and could have been omitted, preventing this false drop. Role indicators would not be useful in preventing the false drop although interfixing in the abstract would. The use of the 5th level would prevent recall as tin bronze and machinability are not in the same phrase (but this risks loss of data). Reasons for retrieval (a) Exhaustive indexing

(b) Interfixing required

<u>268Q/1830</u>	<u>Indexing</u>	col. 4 Brass
<u>B</u>		col. 24 Electrodeposition
		col. 26 Machining
		col. 40 Adhesion

Comments. The main theme of this paper is the adhesion of electrodeposited coatings. The inclusion of the term 'machining' is a good example of the way in which detailed indexing of concepts of small importance leads to the recall of non-relevant document.

Reason for retrieval Exhaustive indexing.

QUESTION 88 What is the effect of pressure on the solubility of nitrogen in molten Fe-Mn alloys ?

Search programme. ⁸⁶⁵²
[[[[[A+B],C],²],²][A+B],²⁵²²⁶⁸][E]]]

- A. LALL Alloy
- B. MATL Metal
- C. QFQE Fe
- D. QMQN Manganese
- E. GASS QN Nitrogen

Non-relevant documents

<u>593Q/1110</u>	<u>Indexing</u>	col. 4 Killed steel
A.B.C2.		cols. 9/10 KIJ Nitrogen
		cols. 11/12 KIJ Mangonese
		cols. 32/34 Alloy/Ferrite
		cols. 37/38 KUJ Iron

Comments This is a false drop as there is no 'Fe. Mn' alloy mentioned in the document. 'Mangonese' is a component of the killed steel as is the 'Nitrogen' and 'Iron' is a constituent of a ferrite alloy. The false drop could have been prevented by a search programme specifying also the term 'solubility'. Role indicators would not, and 5th level did not, prevent recall, although interfixing would.

Reason for retrieval (a) Searching. Omits concept in question
(b) Interfixing required

QUESTION 90 What are the values of thermal conductivity and specific heat of Armco iron at 1000°C. ?

Search programme ⁸⁶⁴
[[[[[A+B][C+D],E],²⁴],²²²²⁴²²⁶⁸][F]+[G]+[H[I]²]]]]]

- | | |
|---------------------------|----------------------------------|
| A. KEJ Material processed | F. PAPR. RYHT 2030 Specific heat |
| B. KUJ Component | G. RWHT. PAPR. TYRN 1002-3001 |
| C. LALL Alloy | Thermal conductivity |
| D. MATL Metal | H. R-HT Heat |
| E. QFQE Iron | I. PAPR. TYRN 1002. 2001 |
| | conductivity. |

Non-relevant documents

<u>102J/1785</u>	<u>Indexing</u>	col. 2 Castings
A.B.		col. 4 Steel
		cols. 128/130 Surface finish
		cols. 138/140 KAL Heat conductivity

Comments The document surveys technical control of steel foundries in America - welding, heat treatment, etc. No mention of 'Armco iron'. 'Heat conductivity' is included in the index as influencing 'surface finish'. A more detailed search programme mentioning 'Armco iron' would have excluded this article.

Reason for retrieval (a) Searching. Used concepts less specific than question
(b) Exhaustive indexing

QUESTION 91

What are the phases that precipitate at grain boundaries in austenitic alloys ?

Search Programme

$$[[[A]^{22}, [B+C]^{22} + [D.E]^{44}], [F]^{68}]^{8622}$$

- A. LALL RERN Steel
- B. S-PR 1019 Precipitation
- C. CWRS LYLL PAPR 3001 Grain boundaries
- D. C-RS 1008 Grains
- E. T-RM 1010 Boundary

Non-relevant documents

164F/1975

Indexing

col.2 Castings
cols. 4/10 Steels
col. 4 18-8 Stainless
col. 10 17-7-PH Stainless steel
col. 68 Precipitation

Comments This article discusses the increase of strength of stainless steel forgings, and is not concerned with phases in grain boundary precipitation. If the search programme had specified 'precipitation' and 'grain boundaries', instead of or the document would not have been recalled.

Reason for retrieval

- (a) Searching. Insufficient concept co-ordination
- (b) Exhaustive indexing

358G/1429

Indexing

col. 18 Stainless steel
col. 136 Grain boundary

Comments The document is about the explosive metalworking of several alloys including stainless steel. Grain boundary is listed as one of the properties determined, but would probably not have been included except by over-detailed indexing. The search programme could have asked for "steel" with "grain boundaries" and instead of or "precipitation" and so prevented recall.

Reasons for retrieval

- (a) Insufficient concept co-ordination
- (b) Exhaustive indexing

54H/2041

Indexing

col. 2 Powder metal
col. 4 Copper
col. 6 316 Stainless steel
cols. 17/18 KAM Sintering
col. 50 KUP. KAP. KAL Grain boundary

Comments The article concerned with the 'porosity of metal powders' including '316 stainless steel (austenitic)'. Discusses the total porosity of loose powders which delays grain boundary movement. No mention of phases that precipitate at grain boundaries. Document retrieved because the search programme will accept either 'grain boundaries' or 'precipitation' with 'steel'.

Reason for retrieval

- (a) Searching. Insufficient concept co-ordination
- (b) Exhaustive indexing

QUESTION 91. Non-relevant documents (Continued)

<u>526Q/1836</u>	<u>Indexing</u>	col. 2 Stainless steel AM 355
A. B.		col. 6 Semi austenitic
		cols. 7/8 KVV Precipitation

Comments No mention of 'grain boundaries'. Brief article on precipitation hardening of semi-austenitic stainless steel. Brought out by the search programme which will accept either 'grain boundaries' or 'precipitation' with 'steel'.

<u>Reason for retrieval</u>	(a) Searching. Insufficient concept co-ordination
	(b) Exhaustive indexing

593Q/1110	<u>Indexing</u>	col. 4 Killed steel
A. B.		cols. 161/162 Grain boundary

Comments No mention of 'austenitic alloys' or 'precipitation'. Brought out by the search programme which will accept any 'steel' with 'precipitation' or 'grain boundaries'.

<u>Reason for retrieval</u>	(a) Searching. Insufficient concept co-ordination
	(b) Exhaustive indexing

<u>628Q/1713</u>	<u>Indexing</u>	col. 2 Austenitic (1st phrase)
		col. 6 Stainless steel (2nd phrase)
		cols. 169/170 KUP. KAP. KAL Precipitation (3rd phrase)

Comments The document discusses a number of metals and their compatibility with graphite. The 'precipitation' does not refer to the 'austenitic stainless steel'. This false drop is partly the fault of the broad search programme which will accept 'steel' with 'precipitation'. Over-detailed indexing is also partly to blame for the importance of the concept 'precipitation' in the document is slight. Role indicators would not be effective in preventing the false drop and the use of the 5th level although it would exclude this document would also exclude relevant data. Interfixing in the abstract is a surer method of preventing the false drop.

Reasons for retrieval

- (a) Searching. Insufficient concept co-ordination
- (b) Exhaustive indexing
- (c) Interfixing required

<u>20922/2008</u>	<u>Indexing</u>	col. 2 Stainless steel
<u>A. B.</u>		col. 124 Precipitation

Comments The document is concerned with various stainless steels, transformable from austenitic to martensitic with hardness and other mechanical properties. 'Precipitation' is mentioned as one of the properties determined. The document brought out because the broad search programme will accept 'steel' with 'precipitation' or 'grain boundaries'.

<u>Reason for failure</u>	(a) Searching. Insufficient concept co-ordination (b) Exhaustive indexing
---------------------------	--

QUESTION 95 What are the tensile properties of Ag-Al alloys (Al 1-6%) and does the alloy exhibit yield point behaviour ?

Search programme $^{652} \left[\left[\left[A+B \right] C \right] \right] ^{22} \left[\left[A+B \right] D \right] \right] ^{258}$

- A. MATL Metal
- B. LALL Alloy
- C. QAQG Silver
- D. QAQL Aluminium

Non-relevant documents

15A/1365 Indexing cols. 2/4 Mineral industry (1st phrase)
A. B. C1. C2. col. 6 China
 cols. 26/45 Several metals including (4th phrase)
 cols. 25/26 KEJ Aluminium
 cols. 43/44 KEJ Silver

Comments 'Aluminium' and 'silver' are not here related. False drops would have been avoided if other concepts in the question 'yield point' and 'tensile properties', had not been omitted from the search programme. The use of role indicators KUJ Silver, KIJ Aluminium would have prevented recall. Use of 5th level does not prevent recall, but interfixing would.

Reasons for retrieval (a) Searching. Omits concepts in question
 (b) Lack of role indicators
 (c) Lack of interfixing
 (d) Exhaustive indexing

167L/1831 Indexing col. 2 Magnesium (1st phrase)
A. B. C1. C2. cols. 3/4 KEJ Aluminium (1st phrase)
 cols. 5/6 Strip
 col. 8 Castings
 cols. 17/18 KUJ. KEJ Stainless steel
 cols. 21/22 KUJ Silver (1st phrase)

Comments 'Aluminium' and 'silver' indexed here are not elements in the one alloy. This false drop would have been avoided if the search programme had not omitted concepts in the question, for example, 'tensile properties'. The use of role indicator KIJ with Al would have prevented recall where 5th level did not. Interfixing would prevent recall.

Reasons for retrieval (a) Searching. Omits concepts in the question
 (b) Lack of role indicators
 (c) Lack of interfixing
 (d) Exhaustive indexing

293M/1936 Indexing col. 8 Alloy (1st phrase)
A. C1. C2. cols. 9/10 KUJ Aluminium (1st phrase)
 cols. 11/12 KIJ Silver (1st phrase)

Comments The alloy in this document is an Al-Ag alloy and not the Ag-Al alloy required. In any case the document does not consider tensile properties. Recall due to the broad search programme which does not specify the properties required for the alloys in question. The use of the role indicators KUJ Ag and KIJ Al would also have prevented retrieval, where use of 5th level did not. Interfixing would also prevent recall.

Reasons for retrieval (a) Searching. Omits concepts in the question.
 (b) Lack of role indicators
 (c) Lack of interfixing

QUESTION 95. Non-relevant documents (Continued)

310M/1272	<u>Indexing</u>	col. 2 Single crystal
A. C1. C2.		cols. 5/6 KUJ. KEJ Aluminium (1st phrase)
		cols. 13/14 KUJ. KEJ Silver (2nd phrase)

Comments The document is concerned with single crystals of a number of elements including Al and Ag. This false drop could have been avoided if the search programme had included the concepts 'tensile properties' or 'yield point'. The use of the role indicator KIJ with aluminium in the search programme would also have avoided this recall where the use of 5th level did not. Interfixing would also prevent recall.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators
- (c) Lack of interfiling

<u>276P/2064</u>	<u>Indexing</u>	col. 2 Binary alloy (1st phrase)
<u>A. B. C1. C2.</u>		cols. 5/6 K U J. K I J Copper
		cols. 15/16 K I J Silver (1st phrase)
		cols. 17/18 K I J. K U J Zinc
		cols. 19/20 K U J. K I J Aluminium (1st phrase)

Comments This document contains nothing on Ag-Al alloys. 'Silver' indexed at col. 16 is a component of the copper alloys and 'Aluminium' at col. 20 is not an element in the same alloy. This false drop could have been avoided if the search programme had also demanded the properties of the alloy. The use of the role indicator KUJ with Ag in the search programme would have prevented recall, where the use of 5th level did not.

Reasons for retrieval

- (a) Searching. Omits concepts in question.
- (b) Lack of role indicators
- (c) Lack of interfiling
- (d) Exhaustive indexing

<u>275Q/1411</u>	<u>Indexing</u>	col. 26 Powder
B. C1. C2.		cols. 175/176 KEJ Silver
		cols. 179/180 KEJ Aluminium

Comments There is no mention of a Ag-Al alloy in this document. 'Aluminium' at col. 176 and 'Silver' col.180 indexed almost at the end of the long abstract are quite unrelated. Role indicators in the search programme would have prevented this false drop (KUJ/Al and KIJ Ag), where use of 5th level failed. Interfixing would prevent recall. The inclusion of the terms yield point or tensile properties would not have excluded this document as both these terms occur in the abstract.

Reasons for retrieval

- (a) Lack of role indicators
- (b) Lack of interfiling
- (c) Exhaustive indexing

QUESTION 95. Non-relevant documents (Continued)

<u>458Q/1808</u>	<u>Indexing</u>	cols. 19/20 KEJ Aluminium (1st phrase)
B. C1. C2.		cols. 45/46 KEJ Silver (1st phrase)
		cols. 55/56 KEJ. KOV Solders
		cols. 61/62 Tensile strength

Comments Aluminium and silver here are separately considered solders. There is no mention of a Ag-Al alloy. Role indicators in the search programme would have prevented recall, where use of 5th level failed. Interfixing would prevent recall. (KUJ Ag and KIJ Al). The inclusion of 'tensile properties' in the search programme would not have excluded the document as this term is in the abstract.

Reasons for retrieval

- (a) Lack of role indicators
- (b) Lack of interfixing
- (c) Exhaustive indexing

QUESTION 96 Does the presence of vacancies in the grain boundaries of cu-al solid solution affect grain boundary relaxation ?

Search programme
$$\begin{matrix} 8 & 5 & 2 & 2 & 2 & 5 & 8 \\ [& [& [A.B] & . & [A.C] &] &] \end{matrix}$$

A. MATL	Metal
B. QAQL	Aluminium
C. MATL	Metal
D. QCQU	Copper

Non-relevant documents

<u>15A/1365</u>	<u>Indexing</u>	cols. 2/4 Mineral industry (1st phrase)
A. B. C1. C2.		col. 6 China
		cols. 25/26 KEJ Aluminium
		cols. 3/34 KEJ Copper

Comments This article discusses the minerals available in China, and 'aluminium' and 'copper' are mentioned as separate alloys. There is no mention of vacancies or grain boundaries in the abstract so the inclusion of these in the search programme would have prevented this false drop, as would the use of the role indicators KUJ with Cu and KIJ with Al. in the search programme. The 5th level in the search programme did not prevent recall, but interfixing in the abstract would.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators
- (c) Lack of interfixing
- (d) Exhaustive indexing

QUESTION 96. Non-relevant documents (Continued)

<u>115D/1727</u>	<u>Indexing</u>	cols. 111/112 KEJ. KOV Castings
A. B. C1. C2.		cols. 113/114 KUJ Aluminium
		cols. 119/120 KIJ Copper (5.3%)

Comments This section of an article on ultrasonics in Russia deals with the effect of ultrasonics on properties of 'aluminium castings'. For a short article (5 pages), the indexing is very detailed (326 terms). With less exhaustive indexing the Al and Cu components of the castings would not have been included. The use of the role indicators KIJ with Al and KUJ with Cu in the search programme would have prevented retrieval, as would the narrowing of the search programme by including the other concepts in the question 'vacancies' and 'grain boundaries'. The 5th level in the search programme did not prevent recall, but interfiling could.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators
- (c) Exhaustive indexing
- (d) Lack of interfiling

<u>324G/1406</u>	<u>Indexing</u>	cols. 1/2 KEJ Aluminium (1st phrase)
		cols. 3/4 KEJ Copper (1st phrase)
		col. 40 Explosive forming

Comments This document is about the explosive forming of various metals, but there is no mention of a cu-al alloy, the aluminium and copper at cols.2 and 4 are separately considered. This false drop could have been avoided if the search programme had not ignored the other elements in the question, 'vacancies' and 'grain boundaries'. Also the use of role indicators in the search programme would have prevented recall (i.e. KUJ Copper, KIJ Aluminium). The use of the 5th level in the search programme did not prevent recall, but interfingering could have prevented.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators
- (c) Lack of interfixing

<u>358G/1429</u>	<u>Indexing</u>	cols. 1/2 KEJ Alloy
		cols. 5/6 KUJ Aluminium
		cols. 15/16 KUJ Copper

Comments This document is about the explosive forming of various metals and alloys. Although Al and Cu are mentioned as alloy components they are not related in the same alloy. This false drop could have been avoided if the role indicator KIJ (minor component) had been used with Al in the search programme. A narrower search programme requiring also 'vacancies' and/or 'grain boundaries' would also have eliminated the document. The use of 5th level in the search programme could not prevent recall, unlike interfiling.

Reasons for retrieval

- (a) Lack of role indicators
- (b) Searching. Omits concepts in question
- (c) Lack of interfiling
- (d) Exhaustive indexing

QUESTION 96. Non-relevant documents (Continued)

<u>167L/1831</u>	<u>Indexing</u>	col. 2 Magnesium
<u>A.B.C1.C2.</u>		cols. 3/4 KEJ Aluminium (1st phrase)
		cols. 5/6 Strip
		col. 8 Castings
		cols. 9/10 KEJ Alloy
		cols. 14/15 KIJ. KUJ Copper (1st phrase)

Comments 'Aluminium' and 'copper' mentioned in this document are not components of the same alloy. This false drop could have been avoided if the search programme had not ignored the other concepts in the question, i.e. 'vacancies' and 'grain boundaries'. The use of the role indicator KIJ (minor component) with 'Aluminium' in the search programme would also have prevented recall. The 5th level in the search programme useless in preventing recall, unlike interfixing.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators
- (c) Lack of interfixing
- (d) Exhaustive indexing

<u>292M/1920</u>	<u>Indexing</u>	cols. 1/2 KEJ. KOV Single crystal (1st phrase)
		cols. 7/8 KUJ. KEJ Aluminium (1st phrase)
		cols. 9/10 KUJ. KEJ Copper (1st phrase)
		cols. 12/14 Plastic straining

Comments There is no mention in this article of 'vacancies' or 'grain boundaries' in Cu-Al solid solutions. The metals indexed at cols. 8 and 10 are not related, but are single crystals considered separately. If the search programme had not ignored vital terms in the question and had included the role indicator KIJ (minor component) with Al the document would not have been recalled. The use of the 5th level in the search programme did not prevent recall unlike interfixing.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators
- (c) Lack of interfixing

<u>310M/1272</u>	<u>Indexing</u>	cols. 1/2 KEJ. KOV Single crystal (1st phrase)
		cols. 3/4 KEJ. KOV Specimen
		cols. 5/6 KUJ. KEJ Aluminium
		cols. 7/8 KUJ. KEJ Copper

Comments 'Aluminium' and 'Copper' here are separately considered metals crystals and do not occur in a Cu. Al. alloy. This false drop could have been avoided by the use of role indicators KIJ (minor component) with Al. in the search programme. The search programme ignores the concepts 'grain boundaries' and 'vacancies' in the question. If these had been included the document would not have been recalled. The 5th level in the search programme is useless in preventing recall, unlike interfixing.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators in search programme
- (c) Interfixing required.

QUESTION 96. Non-relevant documents (Continued)

212P/1631 Indexing cols. 29/30 KAD Heat sink
A. C1. C2. cols. 37/38 KUJ. KOV Aluminium (1st phrase)
 cols. 43/44 KUJ. KOV Copper (1st phrase)

Comments This article considers materials for heat sinks for jet aircraft. Al and Cu are materials considered, but separately, not in the same alloy. The use of the role indicator KIJ with aluminium would have prevented the false drop. The article also would not have been recalled if the search programme had included all the concepts in the question. The 5th level in the search programme is useless in preventing recall, unlike interfixing.

Reasons for retrieval (a) Searching. Omits concepts in question
 (b) Lack of role indicators in search programme
 (c) Interfixing required.

628Q/1713 Indexing col. 8 Superalloy
A. B. C1. C2. cols. 25/26 KUJ. KIJ. KEJ Nickel
 cols. 35/36 KIJ Copper
 cols. 37/38 KIJ Aluminium

Comments This document contains nothing on Cu-al alloys or vacancies in grain boundaries. 'Aluminium' and 'copper' are minor components, do not occur the same alloy. This false drop could have been avoided if the role indicator KUJ had been used with Cu in the search programme. The search programme, which omitted two of the important concepts in the question, was also the cause of recall. The 5th level in the search programme was useless in preventing recall, unlike interfixing.

Reasons for retrieval (a) Searching. Omits concepts in question
 (b) Lack of role indicators in search programme
 (c) Interfixing required
 (d) Exhaustive indexing

QUESTION 97 What are the creep rupture strengths of Cu-Al 203 at 850° ?

Search programme

Programme 1. $\begin{matrix} 8 & 6 & 2 & & 2 & 2 & & 2 & 6 & 8 \\ [[[A.B]. [C.D]]] \end{matrix}$

- A. MATL Metal
- B. QCQU Copper
- C. QAQL QO-- Aluminium oxide

Programme 2. $\begin{matrix} 8 & 6 & 2 & & 2 & & 2 & 6 & 8 \\ [[[[A+B] C]. [D.C]]] \end{matrix}$

- A. LALL Alloy
- B. MATL Metal
- C. QCQU Copper
- D. QAQL QO-- Aluminium oxide

QUESTION 97 (Continued)

Non-relevant documents

<u>15A/1365</u>	<u>Indexing</u>	cols. 2/4 Mineral industry
A. B. C.		col. 6 China
		cols. 25/26 KEJ Aluminium (2nd phrase)
		cols. 33/34 KEJ Copper (2nd phrase)
		col. 54 Aluminium (2nd phrase)

Comments The metals and alloys indexed here are not related as required by the question. They are individual items considered separately. This false drop could have been avoided if the search programme had included the concept 'creep rupture'. The use of the role indicator KIJ with Alumina in the search programme would also have excluded. The use of the 5th level for the entire programme would not have prevented recall, as the terms are in the same phrase, although interfixing would have.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Lack of role indicators
- (c) Interfixing required
- (d) Exhaustive indexing

51A/1726	<u>Indexing</u>	cols. 310 M257 Aluminium (3rd phrase)
A. B. C2.		cols. 311/312 KIJ Al 203 (3rd phrase)
		cols. 323/324 KEJ. KOV Copper alloy (8th phrase)

Comments The document has nothing on 'creep rupture', and would have been excluded if the search programme had demanded this term. Also the 'copper' and the 'alumina' are not related in the document. The use of role indicators in the search programme would not have prevented the false drop (KIJ before alumina for instance). The 5th level could have prevented recall, if it had been used for the entire programme, either in programme 1 or 2. Interfixing in the abstract would have been effective also.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) 5th level required in search programme
- (c) Interfixing required in the abstract
- (d) Exhaustive indexing

143J/1477 Indexing
A. C1. C2. D.

cols. 1/4 KIJ Steels (1st phrase)
cols. 5/6 KEJ Gear
cols. 21/22 KAM Heat treatment (2nd phrase)
cols. 24/26 KQJ Heating element
cols. 27/28 KQJ Coil
cols. 29/30 KIJ Copper (MATL 1009. QCQU)
cols. 31/32 KIJ. KOV Iron
cols. 33/34 KIJ Mica (MANRO 1025 QH 3KOMQG
QAQL QSQI QO 43)

Comments This document contains nothing on Cu Al 203, but it is recalled by the broad search programme which does not require the concept 'creep rupture' (not indexed in the document). It will accept alone alumina with copper. The copper in the document is a component of the coil and is not related to the alumina at all. This is in the coding of Mica (col. 34) which is broadly based. The role indicator KIJ used before 'alumina' in the search programme would have prevented the false drop, but not the use of the 5th level. Interfixing would have prevented recall.

Reasons for retrieval

- (a) Searching. Omits concepts in question
- (b) Interfixing required
- (c) Semantic code
- (d) Lack of role indicators
- (e) Exhaustive indexing

QUESTION 97. Non-relevant documents (Continued)

212P/1631 Indexing cols. 43/44 KUJ. KOV Copper (1st phrase)
A.B.C1.C2. cols. 51/52 KEJ. KOV Alumina (1st phrase)

Comments This article considers materials for heat sinks in jet engines. The materials indexed at cols. 44 and 52 are quite unrelated. The article contains nothing on Cu Al 203 or on 'creep rupture'. This false drop could have been avoided if KIJ had been used with 'Alumina' in the search programme. Also if the search programme had included the important concept 'creep rupture', the document would not have been recalled. The use of the 5th level for the entire search programme would not have prevented recall as the terms are in the same phrase, but interfiling would have excluded the document.

Reasons for retrieval (a) Searching. Omits concept in question
 (b) Lack of role indicators
 (c) Interfiling required
 (d) Exhaustive indexing

651Q/2069 Indexing cols. 1/2 KEJ. KOV Aluminium (1st phrase)
A.B.C1.C2. cols. 3/4 KEJ Copper (1st phrase)
 col. 28 Fatigue (6th phrase)
 col. 42 KAM Extrusion (7th phrase)
 cols. 43/44 KWJ Al 203 (8th phrase)

Comments This article discusses fatigue deformation caused by cyclic stresses and surface effects on high purity Al. There is no connection between the 'Copper' and the 'Alumina' included in the indexing. The false drop could have been avoided if the role indicator KIJ had been used with 'Alumina'. Also if the search programme had included the concept creep rupture, the document would not have been recalled. The use of 5th level would have prevented recall as would interfiling.

Reasons for retrieval (a) Searching. Omits concept in question
 (b) Lack of role indicators
 (c) Lack of 5th level in search programme
 (d) Interfiling required
 (e) Exhaustive indexing

QUESTION 98 Is there a structural transition in Bainite and does it depend on the composition of the steel ?

Search programme $\begin{matrix} 8 & 2 & 2 & 8 \\ [& [A] &] \end{matrix}$

A. L-LL 1002 RYNG 1013 RYRN 3002 Bainite

Non-relevant documents

41M/1796 Indexing cols. 2/8 Steels
B cols. 15/16 KIJ Bainite
 col. 20 Case hardening

Comments In the document three types of carburized surfaces are examined, normal, over-carburized, and de-carburized. 'Bainite' is mentioned only as the structure of the case in a normalizing carburized microstructure. The term would probably not be included except in extremely exhaustive indexing.

Reasons for retrieval Exhaustive indexing.

QUESTION 99. What optical methods can be used in determining the orientation of metal single crystals ?

Search programme

8 6 5 5 6 8
[[[A.B]C]]

- A. CARS 1009 Single crystals
- B. MATL Metal
- C. R-NG 1009 Orientation

Non-relevant documents

292M/1930 Indexing cols. 1/2 KEJ. KUJ Single crystal
B cols. 36 X-ray diffraction
 cols. 67/68 KUP. KAP Orientation

Comments Document concerns the easy glide of lead single crystals - effect of composition, size, etc. Stress-strain curves were recorded for various orientations, but optical methods not mentioned in relation to orientation. If the programme had included 'determination' the document would still have been retrieved as a false drop. It is doubtful whether the indexing of the term 'orientation' added a concept of significance. It would not have appeared in the abstract except in a case of detailed indexing. If the term had not been included, the document would not have been recalled.

Reason for retrieval Exhaustive indexing.

167N/1196 Indexing cols. 11/12 KVV Orientation (1st phrase)
B. C1. col. 72 X-ray Back reflection (4th phrase)

Comments The theme of this paper is the yield and strain ageing of crystals. There is a short paragraph on 'orientation determination' which would only be included where indexing is very detailed. The use of the role indicator KUP with 'orientation' would have eliminated the document. Interfixing could not prevent this false drop, and the use of the 5th level could not exclude the document without the risk of excluding the relevant documents.

Reasons for retrieval (a) Exhaustive indexing
 (b) Lack of role indicators in the search programme.

694Q/1996 Indexing col. 6 Single crystal
B col. 30 Laue back reflection metallurgic examination
 cols. 65/66 KUP. KAP. KAL Orientation

Comments The document concerns the strength of zone-hardened Al Zn crystals. The orientation of the tensile specimen is determined by the Laue technique, but no information is given about the method. The value of including the term 'orientation' at all in the abstract is questionable.

Reason for retrieval Exhaustive indexing.

QUESTION 102 What are the damping characteristics of SAP ?

Search programme $[[[A+B]C]^2][D+E]^5]$

- | | |
|-------------------|------------------------|
| A. MATL Metal | D. C-NS 1034 Sintering |
| B. LALL Alloy | E. M-PR 1075 Powder |
| C. QAQL Aluminium | |

Non-relevant documents

<u>358G/1429</u>	<u>Indexing</u>	col. 2 Alloy (1st phrase)
A. B. C2		cols. 5/6 KUJ Aluminium
		cols. 25/26 KEJ Powder metal
		cols. 34 Explosive forming (2nd phrase)

Comments This article is about the explosive forming of a series of alloys. In the case of the Al and powder metals indexed these are quite unrelated. The false drop could have been avoided if the search programme had included the important concept in the question, i. e. "damping". The use of role indicator KUJ in the search programme before Al would not have prevented recall, nor did the 5th level. Interfixing in the abstract the only method of avoiding the false drop.

Reasons for retrieval (a) Searching. Omits concepts in the question
(b) Intefixing required.
(c) Exhaustive indexing

QUESTION 104 Is the heating effect of an electron beam sufficient to cause dislocation re-arrangement in the thin metal foils examined by the electron microscope ?

Search programme $[[[A[B+[C]]]^5][D]^2][E]^2][F+[G]^2][H]^2]^6]$

- | | |
|-----------------------------------|---|
| A. PAPH 1006 Electron | E. P-PH 1006 PYTC Electron optical |
| B. BAMB Beam | F. MYPR 1124 Thin |
| C. M-CH N-LL 1024 2008 Microscope | G. METL SAHT 2001 Foil |
| D. BAMB P-PH 1006 Electron beam | H. C-RS H-LL 1009 PAPR 3001 Dislocation |

Non-relevant document

<u>51A/1726</u>	<u>Indexing</u>	cols. 289/290 Foil
B		cols. 291/292 Dislocation
		cols. 293/294 KAM Observation
		cols. 295/296 KQJ Transmission
		col. 298 Electron microscope

Comments The document reviews metallurgical progress in Canada. On page 154 there is a brief mention of dislocation in thin metal foils studied with a transmission electron microscope, but no further information is given. The document would not have been recalled if the indexing had been less detailed.

Reason for retrieval Exhaustive indexing.

QUESTION 105 What is the temperature range for the mechanical working of beryllium ?

Search programme ^{8 6 2} ^{2 4} ^{4 6 8}
[[[A+B]]][D][E+F]]]]

- | | |
|-------------------|---------------------|
| A. MATL Metal | D. KAM Process |
| B. LALL Alloy | E. C-NG Alteration |
| C. QBQE Beryllium | F. C-NS Fabrication |

Non-relevant documents

617Q/1375 Indexing cols. 27/28 KEJ. KOV Beryllium alloy (1st phrase)
C2. cols. 47/48 KAM Fabrication (3rd phrase)

Comments The article contains a paragraph on Be alloys for space pressure vessels; strength and other properties are mentioned in connection with beryllium, but the fabrication indexed at col. 48 does not apply to the beryllium, but to other metals in the document. This is an example where role indicators cannot be added to prevent a false drop. Interfixing would be a remedy. Also the 5th level could be used in the search programme to prevent recall, but it would also eliminate relevant documents.

Reasons for retrieval (a) Interfixing required.

QUESTION 107 What are the effects of increasing the Mo. content of carburising steels ?

Search programme ^{8 6 2} ^{2 2} ^{2 6 8}
[[[A].[B.C]]]]

- A. LALL RERN Steel
B. MATL QMQO Metal. Molybdenum

Non-relevant documents

115D/1727 Indexing cols. 24, 40, 48 Steels
B. C1. C2. col. 44 Carburising
 cols. 189/190 KEJ. KOV Alloy
 cols. 195/196 KIJ Molybdenum
 cols. 197/198 KIJ Steel

Comments This document reviews the use of ultrasonics in Russia. It contains nothing on the Mo content of carburising steels. 'Steel and 'Molybdenum' in the indexing are not related. This false drop could not have been avoided by narrowing the search programme by the addition of the term carburising, as this term is present in the document although in connection with Armco iron. The use of role indicators KAL with Mo in the search programme would have prevented the false drop. The original "partitioning" in this document (later deleted) would have enabled the 6th level in the search programme to prevent recall as 'steel' and 'Mo' were in different "levels".

Reasons for retrieval (a) Interfixing
 (b) Role indicators lacking in search programme
 (c) Exhaustive indexing

QUESTION 107. Non-relevant documents (Continued)

388K/1571	<u>Indexing</u>	cols. 5/6 KUJ. KOV HY-80 Steel (1st phrase)
A. B. C1.		cols. 23/24 KIJ Molybdenum (1st phrase)

Comments This document discusses the welding and fabrication of Hy-80 steel (0.23 - 0.60 Mo). It does not discuss the effect of the Mo content. The article is retrieved because the search programme omits the concept 'carburising'. The use of the role indicator KAL (influencing) with Mo would have prevented retrieval. The use of the 5th level for the entire search programme would not have eliminated the false drop, as both terms are in the same phrase. Interfixing would not prevent recall.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators
- (c) Exhaustive indexing

628Q/1713	<u>Indexing</u>	cols. 5/6 KEJ. KOV Stainless steel (1st phrase)
A. C1. C2.		cols. Refractory metal (1st phrase)
		cols. 41/42 KUJ. KEJ. KIJ Molybdenum (1st phrase)

Comments The document examines the compatibility of various metals and alloys, with graphite. The 'stainless steel' and the 'molybdenum' in the abstract at cols. 6 and 42 are quite independently considered. 'Molybdenum' is not part of the 'stainless steel'. This false drop could have been avoided if the role indicator KAL (influencing) had been used with Mo in the search programme. Also the addition of 'carburising' to the search programme would have eliminated the document. The use of the 5th level in the entire search programme would not have prevented recall as the terms are in the same phrase, but on the other hand interfiling would have prevented recall.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators in search programme
- (c) Interfixing required

291R/1486 Indexing cols. 3/4 KEJ. KOV Steel
A.B. C1.C2. cols. 15/16 KUJ Molybdenum

Comments There is no relationship between 'steel' and 'molybdenum'
This false drop could have been avoided if the role indicators
KIJ KAL had been used with Mo in the search programme. Also the addition of
the term 'carburising' to the search programme would have prevented retrieval.
The use of the 5th level for the entire programme cannot prevent recall, as both
terms are in the same phrase, but interfixing would have prevented recall.

Reasons for retrieval

- (a) Interfiling required
- (b) Searching. Omits concept in question
- (c) Lack of role indicators in search programme
- (d) Exhaustive indexing

QUESTION 107. Non-relevant documents (Continued)

20922/2008	<u>Indexing</u>	col. 2 Stainless steel (1st phrase)
A.B C1.		cols. 17/18 KIJ Mo (0-7%) (1st phrase)

Comments The document mentions 'stainless steels' with Mo content, among others. Does not discuss the influence of the Mo content. The use of the role indicator KAL (influencing) with Mo would have prevented recall as would the addition of 'carburising' to search programme. The use of the 5th level for the entire search programme would not prevent recall, as the terms are in the same phrase. Interfixing would not prevent recall.

<u>Reasons for failure</u>	(a) Searching. Omits concepts in question
	(b) Lack of role indicators in search programme.
	(c) Exhaustive indexing

QUESTION 109 What is the mechanism of the Cr.17 C.3 Cr.23 C.6 transformation in alloy steels and how does niobium affect this reaction ?

Search programme $\begin{matrix} 8 & 6 & 2 & 2 & 2 \\ \left[\left[\left[A \right] \cdot \left[B \left[C + D \right] \right] \right] \right] \end{matrix}$

- A. LALL RERN Steel
B. MATL Metal
C. QNQB Niobium
D. QCQB Columbium

Non-relevant documents

628Q/1713	<u>Indexing</u>	col. 6 Stainless steel (1st phrase)
B. C1. C2.		cols. 39/40 KEJ. KOV Refractory metal (1st phrase)
		cols. 43/44 KUJ. KEJ. KIJ Niobium (1st phrase)
		cols. 171/174 KUP. KAP. KAL Phase transformation

Comments Although the indexing includes three of the concepts required by the question, the retrieval of this document is a false drop as the concepts are not related to each other in the way required. The use of the role indicator KAL (influencing) with niobium would have prevented recall. Also 'phase transformation' would not have been included except in very detailed indexing. The use of the 5th level for the entire search programme would not have prevented recall as the terms are in the same phrase. Interfixing would also have prevented recall.

<u>Reasons for retrieval</u>	(a) Lack of role indicators
	(b) Exhaustive indexing
	(c) Interfixing required.

QUESTION 109. Non-relevant documents (Continued)

291R/1486 Indexing cols. 3/4 KEJ. KOV Steel (1st phrase)
A. B. C1. C2. cols. 19/20 KIJ Columbium (1st phrase)

Comments This document was recalled by false drop. The 'columbium' is a constituent of a Mo alloy and is not of the steel at col. 4. The false drop would have been avoided if the search programme had included the concept 'transformation'. Also the use of the role indicator KAL in the search programme with Cb would have prevented retrieval. The use of the indicator KIJ (minor component) would not have been effective in this case. The use of the 5th level for the entire programme would not have prevented recall, as the terms are in the same phrase. Interfixing would have been effective in preventing recall.

Reasons for retrieval

- (a) Searching. Omits concept in question
- (b) Lack of role indicators
- (c) Interfixing required
- (d) Exhaustive indexing

QUESTION 114 Is there any apparent difference in the nucleation rates of precipitation formed at sub-boundaries and main boundaries in titanium and titanium rich alloys ?

Search programme

Programme 1. $\left[\left[\left[A+B \right] \cdot C \right] \cdot \left[D + \left[E \right] \right] \right]$

- A. LALD Alloy
B. MATL Metal
C. QTQI Titanium
D. S-PR 1019 Precipitation
E. C-NS CWRS 2005 Nucleation

Programme 2. $[[[{}^8{}_6{}_4[A+B].{}^2[C+D]E]{}^2{}_4{}_6{}_8F]]$

- | | |
|---------------------------|-----------------------|
| A. KEJ Material processed | D. MATL Metal |
| B. KUJ Component | E. QTQI Titanium |
| C. LALL Alloy | F. S-PR Precipitation |

Non-relevant documents

<u>569Q/1331</u>	<u>Indexing</u>	cols. 21/22	KIJ Titanium (1st phrase)
B. C1.		cols. 63/64	KUP. KAP. KAL Precipitation (3rd phrase)
		cols. 67/68	KUP. KAP. KAL Nucleation

Comments The 'titanium' in this document is a minor alloying element (0.05%). The document would have been excluded if the first programme had included the role indicators KEJ or KUJ. The use of the 5th level in searching would have excluded, with risk of losing relevant documents. Interfixing could not be used to prevent recall.

Reason for retrieval a) Lack of role indicators.
b) Exhaustive indexing

QUESTION 115. What is the cross-sectional shape of extrusions formed on the surface of aluminium alloys subjected to fatigue ?

Search programme
$$\left[\left[\left[\left[A+B \right] C \right]^2, \left[D+E \right] \right]^4 F \right]^8$$

- | | |
|-------------------|---------------------------|
| A. LALL Alloy | D. KEJ Material processed |
| B. MATL Metal | E. KUJ Component |
| C. QAQL Aluminium | F. P-PR 1091 Fatigue |

Non-relevant documents

<u>569Q/1331</u>	<u>Indexing</u>	cols. 5/6 KUJ Aluminium
A.B.		cols. 71/72 KUP. KAP Fatigue

Comments The theme of the document is effect of addition of silver on the properties of Al-ZN-Mg alloys. Mechanical properties 'stress corrosion' and 'fatigue strength' included but no mention of 'surface extrusions'. If the search programme had specified 'extrusions', the document would have been excluded. It could be argued that the 'fatigue strength' is of minor importance in this document and that it need not have been included at all in the abstract.

Reasons for retrieval (a) Searching. Omits concept in question.
(b) Exhaustive indexing

QUESTION 119. To what extent are the mechanical properties of Al-Zn-Mg alloys improved by the addition of silver ?

Search programme
$$\left[\left[\left[\left[A+B \right] \left[C+D \right] \right]^5, \left[E+F \right] \right]^6 G \right]^8$$

- | | |
|-------------------|-------------------|
| A. AQL Aluminium | E. MQG Magnesium |
| B. QAQL Aluminium | F. QMQG Magnesium |
| C. ZQN Zinc | G. QAQG Silver |
| D. QZQN Zinc | |

Non-relevant document

<u>458Q/1808</u>	<u>Indexing</u>	cols. 15/16 KEJ Magnesium (1st phrase)
B. C1. C2.		cols. 19/20 KEJ Aluminium (1st phrase)
		cols. 21/22 KEJ Zinc (1st phrase)
		cols. 45/46 KEJ Silver (1st phrase)
		cols. 61/64 KWV Tensile strength

Comments The metals indexed are not constituents of one alloy, but are individual metals, considered for their properties as solders. This false drop could have been prevented if the role indicators KUJ had been used with Al and KIJ with Mg, Zn and Ag, and KAL with Ag. Use of 5th level in search programme useless in preventing recall, interfiling would have been effective.

Reasons for retrieval (a) Lack of role indicators
(b) Interfiling required.
(c) Exhaustive indexing.

QUESTION 122. How many pieces of graphite can be joined so that the joint has a high temperature strength equal to that of the parent parts ?

Search programme

Programme 1.

$$[[[[A+B].C]. [D.E]]]$$

- A. KEJ Material processed
- B. KUJ Component
- C. CARB 1010 Graphite
- D. KAM Process
- E. FLST Fastening

Programme 2.

$$[[[A+B+C], D]]$$

- A. KEJ Material processed
B. KUJ Component
C. KQJ By means of
D. CARB 1010 Graphite

Non-relevant documents

5A/1726

Indexing

cols. 2/4 Mineral industry
col. 6 China
cols. 119/120 KEJ Graphite

Comments This document discusses the minerals featuring in China's mineral industry. There is no mention made of the 'joining' of 'graphite'. This document is recalled by the second search programme which will accept graphite with any of three role indicators without the presence of other terms in the question, for example, 'joining'.

Reason for retrieval

- (a) Searching. Omits concepts in question
(b) Exhaustive indexing

313K/1525

Indexing

A. B. C2.

col. 4 Cast iron
cols. 9/10 KUJ. KAL Graphite
cols. 11/12 KWV. KAP Machinability
cols. 37/38 KUP. KAP Graphite (4th phrase)
cols. 107/108 KWJ. KOV. KEJ Weldment (5th phrase)
col. 122 Tig welding (6th phrase)

Comments 'Graphite' in this document is the composition of the 'cast iron', and the 'welding' refers to the 'cast iron' and not to 'graphite'. The document is brought out by the first search programme. Role indicators could not prevent this false drop although interfiling in the abstract could. The use of the 5th level in the search programme would also prevent retrieval at the risk of excluding relevant documents. Also if the search programme had included 'high temperature', the document would not have been recalled.

Reasons for retrieval

- (a) Searching. Omits concept in question.
- (b) Interfixing required.
- (c) Exhaustive indexing

QUESTION 122. Non-relevant documents (Continued)

628Q/1713	<u>Indexing</u>	cols. 99/100 KQJ Graphite
A		cols. 127/128 KUP. KAP. KAL Graphite Compatability

Comments This article concerned with 'graphite compatability' with a number of metals and alloys, and contains no mention of 'graphite joining'. The article recalled because the second search programme is so wide that it will accept graphite with role indicators KEJ, KUJ or KQJ without the term 'joining'.

Reason for retrieval Searching. Omits concepts in question

291R/1486	<u>Indexing</u>	cols. 11/12 KEJ. KOV Graphite
A. B.		cols. 21/22 KWV Coated
		cols. 25/26 KEJ. KOV Coatings
		cols. 33/34 KUJ Graphite

Comments This document is concerned with 'coatings' for 'graphite' and 'graphite coatings', but contains nothing on the 'joining' of 'graphite'. The article was recalled because the second search programme omits the term 'joining'.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question
	(b) Exhaustive indexing

<u>57T/1397</u>	<u>Indexing</u>	col. 2 KEJ Graphite
<u>A</u>		col. 28 Machining

Comments The document describes the production of 'lead bricks' and a special purpose machine for machining 'graphite'. It does not cover 'graphite joining'. The article is retrieved because the second search programme omits the concept 'joining'.

Reason for retrieval Searching. Omits concepts in question.

QUESTION 124. How may cooling water in an atomic energy power plant be treated to decrease the corrosion of Al. Ni alloy sheaths which contain fuel elements ?

Search programme

- A. N-CL Nuclear energy
B. MATL QAQL Metal Aluminium
C. MATL QNQL Nickel

Non-relevant documents

<u>628Q/1713</u>	<u>Indexing</u>	cols. 9/14 KEJ. KOV Heat resistant alloy
<u>A.B.</u>		cols. 15/26 KUJ. KIJ Nickel
		cols. 37/38 KIJ Aluminium
		cols. 83/90 KWV Thermal neutron cross section
		col. 136 Fuel element
		col. 138 Cladding

Comments This article discusses the compatibility of a number of metals and alloys with 'graphite'. There is no mention of 'corrosion' of 'nickel-aluminium cans' by 'cooling water'. The document is retrieved because the search programme omits the term 'corrosion'.

Reason for retrieval (a) Searching. Omits concepts in question
(b) Exhaustive indexing.

QUESTION 126. What alloys of nickel-chromium-cobalt have useful high temperature strength at 1700° F (927° C) but contain no strategic columbium ?

Search programme $\overset{8}{[}\overset{5}{[}\overset{2}{[}\overset{2}{[}\overset{2}{[}\overset{2}{[}\overset{2}{[}\overset{2}{[}\overset{5}{[}\overset{8}{]}$

- A. MATL QNQI Metal Nickel
- B. MATL QCQR Metal Chromium
- C. MATL QCQO Metal Cobalt

Non-relevant documents

<u>361G/1811</u>	<u>Indexing</u>	col. 4 Steel
<u>C1. C2.</u>		cols. 89/90 KUJ Tool steel (3rd phrase)
		cols. 93/94 KIJ Chromium (3rd phrase)
		cols. 95/96 KIJ Cobalt (3rd phrase)
		cols. 97/98 KIJ W (3rd phrase)
		cols. 99/100 KIJ Nickel

Comments This document has information on 'Nickel chromium steels' and 'cobalt nickel steel' but not on 'nickel chromium cobalt alloys'. From studying the telegraphic abstract alone it is not possible to tell which of the minor elements listed after 'tool steel' occur together in which alloy. Interfixing could show this relationship. The false drop could have been avoided if role indicators had been used in the search programme as follows: KEJ.KUJ/Ni, KIJ/Co, KIJ/Cr. It would not have prevented retrieval to include 'high temperature strength' in the search programme as these terms also occur in the abstract. The use of the 5th level in the search programme does not prevent recall but interfixing would.

Reasons for retrieval (a) Lack of role indicators
(b) Interfixing required

QUESTION 127. What is the plastic behaviour of copper subjected to fatigue stressing ?

Search programme $\overset{8}{[}\overset{6}{[}\overset{4}{[}\overset{2}{[}\overset{2}{[}\overset{4}{[}\overset{2}{[}\overset{4}{[}\overset{6}{[}\overset{8}{]}$

- | | |
|---------------------------|----------------------|
| A. KEJ Material processed | E. QCQU Copper |
| B. KUJ Component | F. P-PR 1091 Fatigue |
| C. LALL Alloy | G. PAPR 1236 Plastic |
| D. MATL Metal | |

Non-relevant documents

<u>292M/1930</u>	<u>Indexing</u>	cols. 9/10 Copper
<u>A</u>		cols. 11/12 KAM Plastic straining

Comments This paper discusses 'dislocation density' in 'deformed copper' and 'aluminium single crystals'. It has nothing on copper fatigue. The document is retrieved because the search programme will accept 'plastic' or 'fatigue' with 'copper' and not 'plastic' and 'fatigue' with 'copper'.

Reason for retrieval Searching. Insufficient concept co-ordination.

QUESTION 127. Non-relevant documents (Continued)

<u>649Q/2074</u>	<u>Indexing</u>	cols. 1/2 KEJ Rod
<u>B.C2.</u>		cols. 3/4 KUJ Gold
		cols. 7/10 KAM Cyclic stressing (2nd phrase)
		cols. 53/56 KUP. KAP Fatigue damage (5th phrase)
		cols. 97/98 KEJ Rod (6th phrase)
		cols. 99/100 KUJ Steel
		cols. 101/102 KUJ Copper

Comments This is a false drop. The document is concerned with the effect of annealing on fatigue damage in gold. The 'fatigue' indexed at cols. 53/56 refers to the 'gold' at cols. 3/4 and not to the 'copper rod', cols. 98 and 102. The inclusion of the 'copper' appears to be a case of indexing relatively minor elements in the document. If the copper had not been indexed the document would not have been retrieved. The role indicators could not prevent the false drop, although interfixing could, also 5th level in the search programme (with risks of loss of relevant material).

<u>Reasons for retrieval</u>	(a) Exhaustive indexing
	(b) Interfiling required

QUESTION 128. What range of alloy composition of malleable nickel will produce flake graphite in the microstructure and what particular condition of this graphite will reduce galling to a minimum ?

Search programme

Programme 1 . $[[A[A+B].[C+D]E]]].[F+G/H]$

A. KEJ Material processed	E. QNQL Nickel
B. KUJ Component	F. CARB 1010 Graphite
C. LALL Alloy	G. D-DD 1015 Galling
D. MATL Metal	H. D-DD 1016 Pollution

Programme 2. $\overset{8}{[}\overset{6}{[}\overset{5}{[}\overset{4}{[}A\overset{2}{[}A+B\overset{2}{[}C+D\overset{4}{[}E\overset{5}{[}F\overset{6}{[}G\overset{8}{]}$

A. KEJ Material processed
B. KUJ Component
C. LALL Alloy
D. MATL Metal
E. QNQL Nickel
F. CARB 1010 Graphite

Non-relevant documents

15A/1726	<u>Indexing</u>	cols. 2/4 Mineral industry (1st phrase)
A.B. C1. C2.		col. 6 China (1st phrase)
		cols. 41/42 KEJ Nickel (3rd phrase)
		cols. 119/120 KEJ Graphite (7th phrase)

Comments This document contains nothing on 'flake graphite in nickel'. The 'nickel' and 'graphite' indexed are discussed as individual minerals occurring in the Chinese mineral industry. This false drop could have been avoided if the role indicators KIJ, KUJ and KAL had been included before 'graphite' in the search programme. Also the search programmes should have co-ordinated 'galling' or 'pollution' with 'Nickel' and 'graphite'. The use of the 5th level for the entire search programme would have prevented recall, as the terms are in different phrases, but there would be too great a risk of excluding relevant documents. Interfixing would also prevent recall.

Reasons for retrieval

- (a) Lack of role indicators
- (b) Searching. Insufficient concept co-ordination
- (c) Interfixing required.
- (d) Exhaustive indexing

QUESTION 128. Non-relevant documents (Continued)

313K/1525 Indexing col. 4 Cast iron (1st phrase)
cols. 9/10 KUJ. KAL Graphite
cols. 15/16 KEJ Castings
cols. 19/20 KAM Addition (2nd phrase)
cols. 17/18 Nickel resistant
cols. 25/26 KQJ Nickel
cols. 37/38 KUP. KAP Graphite (4th phrase)

Comments This document discusses the repair welding of cast iron and the effect of the Si, Ni and C content on weldability, etc. The 'graphite' indexed at cols. 10, 26 and 38 are constituents of the 'cast iron' and not of the 'nickel'. The false drop would have been avoided if the search programmes had co-ordinated 'galling' or 'pollution' and 'nickel' and 'graphite'. The use of the role indicator KIJ (minor component) or 5th level in the search programme with graphite would have excluded, although in this case the use of the indicators KUJ, KAL (influence by) would have not. Omitting the role indicator KUJ from the search programme would also have prevented retrieval, but as it would certainly have also excluded relevant articles, it would not be advisable to do so. Interfixing the only other possibility of preventing recall.

Reasons for retrieval (a) Searching. Insufficient concept co-ordination
(b) Interfixing required
(c) Exhaustive indexing

628Q/1713 Indexing cols. 25/26 KUJ. KIJ. KEJ Nickel (1st phrase)
cols. 125/130 KUP. KAP, KAL Metal/graphite
compatibility (3rd phrase)

Comments This document discusses the compatibility of graphite with various metals. The graphite structure of nickel is not dealt with. This false drop would have been avoided if the search programme had co-ordinated 'galling' or 'pollution' with 'nickel' and 'graphite'. In this case the use of the role indicators KUJ/KIJ with 'graphite' would have excluded, although the use of KAL would still have allowed retrieval. The 5th level in the search programme would have prevented recall but at the risk of loss of relevant material. Interfixing in the abstract the only sure method.

Reasons for retrieval (a) Searching. Insufficient concept co-ordination
(b) Lack of role indicators
(c) Interfixing required in the abstract

291R/1486 Indexing cols. 7/8 KEJ. KOV Rene 41 (nickel in coding)
A.B. C1. C2. cols. 11/12 KEJ. KOV Graphite
cols. 25/26 KEJ. KOV Coatings (2nd phrase)
cols. 33/34 KUJ. Graphite

Comments This article is about coatings to protect metals and graphite from flight heat. It contains nothing on the graphite structure of nickel. The graphite and nickel in cols. 7/8 and 11/12 are not related. This false drop could have been avoided if the search programme had co-ordinated the terms 'galling' or 'pollution' as well as 'nickel' and 'graphite'. Also the use of the role indicators KIJ and KAL before the term 'graphite' in the search programme would have excluded although the use of KUJ, although reasonable, would not have excluded. Since 'graphite' and 'nickel' occur in the same phrase the use of level 5 in the search programme would also not have prevented recall. Interfixing the only sure method.

Reasons for retrieval (a) Searching. Insufficient concept co-ordination
(b) Lack of role indicators
(c) Interfixing required.
(d) Exhaustive indexing

QUESTION 130. Which type of soft solder is most suitable for joining copper alloys if the risk of intercrystalline penetration of the copper by the molten solder is to be minimised ?

Search programme

$$[[[A+B][C+D]E][F+G]]$$

- | | |
|---------------------------|------------------------|
| A. KEJ Material processed | E. QCQU Copper |
| B. KUJ Component | F. L-LL 1003 Solder |
| C. LALL Alloy | G. F-ST 1026 Soldering |
| D. MATL Metal | |

Non-relevant documents

<u>298R/1249</u>	<u>Indexing</u>	cols. 2/6 Chemical plant equipment
		cols. 9/10 KIJ Copper
		col. 68 Soldering

Comments The article deals with corrosion in chemical plant, and is mainly concerned with the mechanical, electrical and corrosion resistance of metals in water acids alkali salts, etc. 'Soldering' is mentioned in passing and hardly merits a place in the abstract. The document would not have been recalled if this term had not been indexed.

Reason for retrieval Exhaustive indexing.

QUESTION 134. How may the value for the toughness of a fracture be obtained ?

Search programme

8 8
[F]

- A. Tough, toughness

Non-relevant documents

51A/1726	<u>Indexing</u>	col. 70 Alloy steel
A.B.		cols. 85/86 KUP Toughness

Comments This is a review article on metallurgical progress in Canada (7 pages) indexed in very great detail, and partitioned in the abstract. It is arguable that the inclusion of 'toughness' in relation to the alloy steel was due to over-detailed indexing. A better search programme including the term "fracture" would also have excluded.

<u>Reasons for retrieval</u>	(a) Searching. Omits concepts in question
	(b) Exhaustive indexing

<u>216K/1446</u>	<u>Indexing</u>	cols. 6 Pressure vessel
A.B.		cols. 8 Stainless steel
		cols. 23/24 KUP Toughness

Comments The article gives no information of 'fracture toughness testing'. Retrieved because the search programme will accept 'toughness' alone, without the terms 'fracture' or 'testing'.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Exhaustive indexing.

QUESTION 137. What conditions of fluxing and temperature are necessary to separate efficiently low melting point metals, lead, tin and zinc from the higher melting metals aluminium, copper and iron ?

Search programme

Programme 1. $\overset{862}{[[[A],[B],[C],[D],[E],[F]]]}$

A. MATL QPQB Metal Lead
B. MATL QSQN Metal Tin
C. MATL QZQN Metal Zinc

D. MATL QAQL Metal Al.
E. MATL QCQU Metal Copper
F. MATL QFQE Metal Iron

Programme 2. $\overset{862}{[[[A+B],[C+D+E]]}.\overset{2}{[[A+B],[F+G+H]]}\overset{2}{]]}\overset{6}{]]}\overset{8}{]]]}$

A. LALL Alloy
B. MATL Metal
C. QPQB Lead
D. QSQN Tin

E. QZQN Zinc
F. QAQL Aluminium
G. QCQU Copper
H. QFQE Iron

Non-relevant documents

15A/1365
A.B.C2.

Indexing

cols. 2/4 Mineral industry (1st phrase)
col. 6 China
cols. 25/26 KEJ Aluminium (3rd phrase)
cols. 33/34 KEJ Copper
cols. 37/38 KEJ Lead
cols. 45/46 KEJ Zinc

Comments The document contains nothing on the separation of the metals required in the programme. The metals indexed are individual metals featuring in the Chinese mineral industry. The main cause of retrieval is the second search programme which does not ask for 'separation' or 'melting', and will accept a document indexing one metal from each of the two groups of metals in the question. Roles and levels in the search programme would not have prevented retrieval, although interfixing in the abstract could have done.

Reasons for retrieval

(a) Searching. Omits concepts in question
(b) Interfixing required
(c) Exhaustive indexing

51A/1726
A.B.C2.

Indexing

cols. 97/98 KOV Aluminium alloy
cols. 101/102 KIJ Zinc

Comments Nothing in this section of a review article on metallurgical progress in Canada on the separation of the metals indexed. The document retrieved by the second search programme which will accept any of the metals Pb, Sn or Zn with any of the metals in the group Al, Fe, Cu omitting concepts in the question 'separation' or 'melting'. Neither roles, levels, nor interfixing could prevent the false drop.

Reason for retrieval

(a) Searching. Omits concepts in question
(b) Exhaustive indexing

QUESTION 137. Non-relevant documents (Continued)

178E/1139 Indexing cols. 21/22 KEJ Alloy (2nd phrase)
 cols. 23/24 KUJ Copper
 cols. 33/34 KIJ Zinc
 cols. 35/36 KIJ Silicon
 col. 40 Casting (3rd phrase)
 col. 42 Heating (4th phrase)
 col. 86 Precipitation hardening

Comments Document contains nothing on the separation of the metals in the question. The article is retrieved because the second search programme will accept any one metal from each group of metals in the question omitting the concepts in the question 'melting' or 'separation'. The use of interfixes in the abstract would prevent the false association of the metals, but levels or roles would not.

Reasons for retrieval (a) Searching. Omits concepts in question.

(b) Interfixes required

(c) Exhaustive indexing

267G/1491 Indexing cols. 1/2 KEJ 30321 Steels (Code includes Fe)
 cols. 3/4 KEJ 5086 Al alloy (Code includes Al)
 cols. 5/6 KEJ AM 355 steel
 cols. 7/8 KEJ 6 Al-Hy-Ti alloy (Code includes Al)
 cols. 11/12 Electric arc
 cols. 29/30 KQJ Die
 cols. 31/32 KUJ Kirksite (LALL QZQN CQU AGL MQG)

Comments This paper contains nothing on the separation of the metals listed in the question. It is retrieved because the broad second search programme will accept together any one metal from each of the two groups of metals (i.e. Al with Zn or Fe with Zn). These metals occur in the coding of 30321 steels (Fe) and 5086 Al alloy (Al) and Kirksite (Zn, Cu and Al). Interfixing in the abstract could prevent the false relationship between 'Kirksite' and the metals at cols. 1, 2, 4 and 8 but could not prevent the retrieval of 'Kirksite' which has the necessary elements in its own composition. Only a less exhaustive search programme could avoid recall. Roles useless in preventing recall. 5th level would prevent recall only with risk to relevant documents.

Reason for retrieval (a) Searching. Omits concepts in question.

(b) Exhaustive indexing

324G/1406 Indexing cols. 1/2 KEJ Aluminium (1st phrase)
 A.B.C2. cols. 3/4 KEJ Copper
 col. 40 Explosive forming (2nd phrase)

Comments This document discusses the explosive forming of a number of metals and alloys, considered separately. There is no relationship between the Al and Cu indexed at cols 2 and 4. The document was retrieved because the second search programme omits the terms 'separation' or 'melting' in the question, and will accept any one of the metals from each of the group of metals in the question. Role indicators or levels could not eliminate the false association of the metals, although interfixing in the abstract could.

Reasons for retrieval (a) Searching. Omits concepts in question.

(b) Interfixing required in the abstract

(c) Exhaustive indexing.

QUESTION 137. Non-relevant documents (Continued)

358G/1429 Indexing cols. 1/2 KEJ Alloy (1st phrase)
cols. 5/6 KUJ Aluminium
cols. 13/14 KUJ Steel
cols. 15/16 KUJ Copper
cols. 19/21 KUJ 7075 Al alloy (Coded Al, Zn, Mg, Cu, Cr.)
col. 34 Explosive forming (2nd phrase)

Comments This article considers the explosive forming of a number of individual metals and alloys. There is no connection between the metals listed in cols. 6, 14, 16 and 21 except that they can all be explosive formed. The document is retrieved because the second search programme will accept one from each of the groups of metals in the question omitting the concepts 'separation' or 'melting'. Role indicators or levels in the search programme could not eliminate false drops, although interfixing in the abstract could.

Reasons for retrieval (a) Searching. Omits concepts in question.
(b) Interfixing required in abstract.
(c) Exhaustive indexing

160L/1729 Indexing cols. 5/6 Die castings (1st phrase)
A.C2. cols. 9/10 KUJ Copper
cols. 13/14 KUJ Zinc

Comments The document contains nothing on the separation of the metals indexed. They are the individual and unrelated metals of automobile die castings for electroplating. The document is retrieved because the second search programme will accept any one of the metals from each of the groups in the question, without the addition of terms such as 'separation' or 'melting'. The use of interfixing in the abstract rather than role indicators or levels in the search programme would eliminate recall due to false association between metals in the document.

Reasons for retrieval (a) Searching. Omits concepts in question
(b) Interfixing required

167L/1831 Indexing cols. 3/4 KEJ Aluminium (1st phrase)
A.C2. cols. 9/10 Alloy
cols. 13/14 KIJ. KUJ Copper
cols 17/18 KUJ. KEJ Stainless steel
cols. 23/24 KUJ Zinc
cols. 25/26 KUJ. KIJ Silicon

Comments Review article on finishing development. No mention of the separation of the unrelated metals indexed, in cols. 4, 14, 24 and 26. The document retrieved because the second search programme will accept any one of the metals from each of the groups in the question without the further limitation of the other concepts in the question, such as 'separation'. The use of interfixing in the abstract would have avoided the false association between the metals, not possible with roles or levels in the search programme.

Reasons for retrieval (a) Searching. Omits concepts in question
(b) Interfixing required

QUESTION 137. Non-relevant documents (Continued)

279L/2063 Indexing Zinc and Copper, but as the metals used
in electrodeposited coatings. (In same phrase).

Comments No mention of separation of the two metals indexed. The document recalled because the second search programme omits the concepts 'separation' or 'melting' and will accept any one of the metals from each of the groups mentioned in the question. The use of interfixing in the abstract would have avoided the false relation between the metals, not possible to avoid with roles or levels.

Reasons for retrieval

- (a) Searching. Omits concepts in question.
- (b) Interfixing required
- (c) Exhaustive indexing

<u>310M/1272</u>	<u>Indexing</u>	cols. 1/2 KEJ. KOV Single crystal
A.C2.		cols. 5/6 KUJ. KEJ Aluminium (1st phrase)
		cols. 7/8 KUJ. KEJ Copper (1st phrase)
		cols. 17/18 KUJ. KEJ Brass (Cu. Zn)
		cols. 39/40 KUP. KAP. KAL Stacking fault energy

Comments The document is concerned with the metals indexed above as individual crystals in the study of stacking fault energy. There is nothing in the document on the separation of the metals as required by the question. The document is retrieved by the second search programme which omits the term 'separation' and will accept any one of the metals in each of the groups of metals in the question. Neither roles, levels nor interfixing could prevent recall.

Reason for retrieval Searching. Omits concepts in question.

268Q/1830	<u>Indexing</u>	cols. 2/4 KEJ. KOV Brass (Cu. Zn)
A. B. C2.		col. 24 Electrodeposition

Comments This document on the adhesion of electrodeposited coatings has nothing on the separation of the metals listed in the question. The document is retrieved because the second search programme will accept any one of the metals from each of the groups of metals mentioned in the question without the addition of the other terms in the question, for instance 'separation'. Neither roles, levels, nor interfiling could prevent the false drop.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Exhaustive indexing

<u>475Q/1952</u>	<u>Indexing</u>	cols. 1/2 Specimen
<u>A. C2.</u>		cols. 3/4 Brass (Cu. Zn)
		col. 12 Wetting
		cols. 14/16 Liquid Hg
		cols. 30/34 Ductile brittle transition

Comments This document contains nothing on the separation of the metals required by the question, but is retrieved because the second search programme omits the concept 'separation' and will accept any one of the metals from each of the groups mentioned in the question. Roles, levels and interfixing ineffective in preventing the false association between the metals.

Reason for retrieval Searching. Omits concepts in question.

QUESTION 137. Non-relevant documents (Continued)

480Q/1025	<u>Indexing</u>	cols. 1/2 KEJ	Al Bronze (Coded Al. Cu. Sn)
A. B. C2.		cols. 5/6 KEJ	70/30 Brass (Coded Cu. Zn)

Comments This document discusses the low temperature properties of copper alloys and contains nothing on the separation of the metals required. The document is retrieved because the second search programme omits the concept 'separation' and will accept any one of the metals in each of the two groups of metals in the question. Roles, levels and interfiling ineffective in preventing the false association between the metals.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Exhaustive indexing

<u>799Q/1279</u>	<u>Indexing</u>	cols. 1/2 KEJ. KOV Specimen (1st phrase)
<u>A. C2.</u>		cols. 3/4 KEJ. KOV Single crystals
		cols. 5/6 KUJ. KEJ Copper
		cols. 7/8 KUJ. KEJ Zinc

Comments The theme of the document is the fracturing of zinc and copper. The document contains nothing on the separation of the metals. Recall is due to the second search programme, which omits the concepts 'melting' or 'separation' and allows recall if one from each of the groups of metals in the question is present in the document. The use of interfixing in the abstract would have prevented the false association of the unrelated metals in the document, where roles and levels could not.

<u>Reasons for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Interfixing required in abstract

61R/1749	<u>Indexing</u>	col. 2 Heat exchanger
A.B. C2.		col. 4 Tube
		cols. 9/10 KUJ Stainless steel
		cols. 11/12 KUJ Admiralty brass (Cu. Zn)

Comments This article is on the stress corrosion and cracking of heat exchanger tubes. No mention is made of the separation of the metals. The document is retired because the second search programme will accept any one from each of the two groups of metals in the question, (hence brass Cu. Zn) without requiring the presence in the abstract of 'separation' or 'melting'. Neither roles, levels nor interfixing could prevent recall.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question
	(b) Exhaustive indexing

<u>298R/1249</u>	<u>Indexing</u>	cols. 1/6 KEJ Chemical plant equipment
		cols. 9/10 KUJ Copper
		cols. 15/16 KUJ Zinc
		cols. 19/20 KIJ Silicon
		cols. 21/22 KIJ Aluminium
		cols. 23/24 KUJ Lead
		cols. 27/28 KIJ Steel (1st phrase)

Comments This document is concerned with the corrosion of copper alloys in chemical plant and has nothing about the separation of the metals indexed. The document is retrieved by the first search programme which requires that all the metals in the question should be present in the abstract but does not demand also the terms 'separation' or 'melting'. Neither roles, levels, nor interfixing could prevent recall.

<u>Reason for retrieval</u>	(a) Searching. Omits concepts in question.
	(b) Exhaustive indexing.

APPENDIX 4C

ANALYSIS OF FAILURES BY CRANFIELD TO RETRIEVE RELEVANT DOCUMENTS

These analyses have been done in a similar manner to those in Appendix 4A, and again the indexing has not been shown in full, but is only given for the concepts which were involved in the particular question. The search programme is set out in the following example

<u>Concepts</u>	<u>Searches</u>
(A) Hot forming Vh	1. A : B : C, A : C : B
(B) Titanium or Titanium alloys Nti or Nti.d	B : A : C, B : C : A
(C) Sheet Kwf	C : A : B, C : B : A
(D) Stress relieving Vms	2. B : C : D, B : D : C
	C : B : D, C : D : B
	D : B : C, D : C : B
	3. A : B, B : A
	4. B : D, D : B

The various concepts used in the complete search programme are shown with the facet notation following. The letters in brackets refer to the second column which lists the separate searches. In the above case A : B : C indicates that the search was for Vh Nti Kwf or Vh Nti.d Kwf. The various permutations which were tried are also listed.

In the Cranfield work, a separate search in a card catalogue can consist of a number of sub-searches, but in such a case all the same concepts must be used. A new search results when any concept is changed, added or left out. In the example given, we consider there were four separate searches.

Q.6 (1240), Q.7 (1840), Q.13 (1228), Q.21 (1713,
1912), Q.26 (2069), Q.28 (1025), Q.37 (1376),
Q.42 (2063), Q.54 (1403), Q.55 (1035) Q.59 (1354 1859)
Q.71 (1576), Q.80 (1025), Q.81 (1047, 1062, 1092,
1376, 1375, 1450, 1493, 1622, 1630), Q.86 (1665),
Q.96 (1733), Q.99 (1161, 1278), Q.108 (1619,
Q.111 (1279), Q.126 (1456).

Question

Q. 23 (1183)

Searching

- (A) Omits concepts in question Q. 37 (1376, 1450), Q. 70 (1094, 1116, 1119, 1124, 1749)
- (B) Omits concepts implied in question Q. 8 (1061, 1558), Q. 19 (1749, 2020), Q. 26 (1311), Q. 37 (1042, 1142, 1259, 1376, 1450, 1566, 1975), Q. 41 (1486, 1610, 1624, 1625, 1991, 1999), Q. 63 (2031), Q. 81 (1484, 1493, 1855), Q. 93 (1851), Q. 96 (1332), Q. 107 (1632, 1740), Q. 132 (1494).
- (C) Used concepts more specific than question Q. 37 (1374)
- (D) Did not use concepts less specific than question Q. 6 (1240), Q. 7 (1242), Q. 27 (1761), Q. 74 (1749), Q. 111 (1279), Q. 117 (1720), Q. 131 (1717), Q. 133 (1789).
- (E) Did not use concept more specific than question Q. 42 (2063)
- (F) Required co-ordination of too many concepts Q. 19 (2020, 1749), Q. 28 (1158), Q. 46 (1453, 1834, 1835, 1821), Q. 55 (1035), Q. 76 (1020, 1406, 1491, 1618), Q. 107 (1740), Q. 112 (1636), Q. 126 (1254).
- (G) Clerical errors Q. 95 (1161), Q. 117 (1196), Q. 126 (2018, 2065).
- (H) Lack of knowledge of indexing practice Q. 124 (1461).

Indexing Language

- (A) More than one place in schedules for a single subject. Q. 96 (1332), Q. 112 (1636).
- (B) Over specific. Provision in the schedules for subjects differing only finely. Q. 41 (1486, 1610, 1624, 1991, 1999). Q. 63 (2031).
- (C) Enumeration in the schedules where synthesis could have been used. Q. 31 (1625), Q. 41 (1625), Q. 133 (1638).
- (D) Synthesis in the schedules. Q. 111 (1279).
- (E) Inability to permute in parts of the schedules. Q. 82 (1452), Q. 95 (1161), Q. 96 (1166), Q. 117 (1196), Q. 126 (2018, 2065).

QUESTION 6 We are having a high incidence of porosity in iron castings. Chemical analysis gives satisfactory results. What might be the cause and the remedy.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A) Porosity	Pec	1. A : B, B : A
(B) Iron Castings	Nfec+	2. B : C, C : B
(C) Defects	Pn	

DOCUMENTS

Source 1240/210E	Practical observations on mould stability as a factor in controlling the soundness of grey iron castings. British Foundryman, Vol.54, Feb.1961, pp 45-53.			
<u>Indexing</u>	Grey cast iron	Nfecp	Sand casting	Vgb
	Castings	Vg	Defects	Pn
	Mould making	Vgs	Porosity	Pec
<u>Comments</u>	Omitted to combine Nfecp with Pec or Pn. The searcher could have used further programmes, e.g. Pec : Vg or Vg : Pn, both of which would have been successful.			
<u>Reasons for failure</u>	(a) Indexing D. (b) Searching D			

QUESTION 7. What are effects of size and geometry of weld defects, and specifically the effect of damage to heat affected zone due to plastic strain.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A) Welds	Kyw	1. A : B, B : A
(B) Plastic deformation	Pgc	2. A : C, C : A
(C) Deformation	Pg+	3. A : D, D : A
(D) Fracture	Pj	4. A : E, E : A
(E) Defects	Pn	5. A : F, F : A
(F) Stresses	Pp+	6. A : G, G : A
(G) Fatigue	Pk	

DOCUMENTS

Relevance 3 1242/433Q	Residual stress distribution in and around spot welds. British Welding Journal, Vol.8, Feb. pp 57-60.		
* <u>Indexing</u>	Spot welds	Kywn	
	Stresses, residual	Ppq	
<u>Comments</u>	Should have broadened search to all types of welds and stresses (Kyw + and Pp+)		
<u>Reason for failure</u>	Searching D.		

QUESTION 7 - DOCUMENTS (Continued)

Relevance 3 1840/246G Pressure-forming ups reliability of welded rocket cases. Space Aeronautics, Feb.1961, pp 83-96.

Indexing Welds Kyw Pressure forming
 Bending stresses Ppg Rocket cases

Comments Omitted to combine Kyw and Ppg, which would have retrieved on 5th search.

Reasons for failure Indexing D.

QUESTION 8. What processes can be used to repair castings. Factors affecting choice of method.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Castings Vg	1. A : B, B : A
(B)	Repair Xce	2. B : C, C : B
(C)	Cast iron Nfec+	

DOCUMENTS

Relevance 2 1061/159L Hard surfacing of blast furnace bells and hoppers.
 Welding Journal, Vol.401, Jan.1961, pp 18-24.

Indexing Hardfacing Vwt
 Blast furnace components Zrb
 Hoppers Kcx

Comments Omitted concepts 'submerged arc welding'(Vsf) and 'castings'(Vg). The document was relevant, although the concept 'repair' was not obvious to an indexer of the document. 'Hardfacing' in the document is dealt with as a wear resisting protective process; the term 'repair' is not mentioned. This could be an example of relevancy where there is no correlation between words of the question and the relevant document. Searcher tried only 'castings: repair' 'cast-iron: repair'. Might have widened search to 'repair by welding' or 'welding: castings'. The latter programme would have retrieved document if 'castings' and 'submerged arc welding' had been indexed.

Reasons for failure (a) Indexing A
 (b) Searching, B

Relevance 3 1558/322K Tungsten arc welding saves trucking firm \$3000.
 Welding Journal, Vol.40, March 1961, pp 249.

* Indexing Trucks Elf Repair by Tungsten arc welding Xce Vse
 Aluminium parts

Comments Search should have been extended to cover 'Repair by welding', or even 'Repair'.

Reason for failure Searching, B.

QUESTION 9. How can stove-pipe welding be used in erection of storage tanks.
Specify electrodes and welding preparation procedures.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Storage tanks Kcs	1. A : B, B : A
(B)	Welding Vs	

DOCUMENTS

Relevance 3 1446/216K Welding and heat treating a 60 ton cryogenic vessel.
Metal Progress, Vol.79, Feb.1961, pp 88-90.

<u>Indexing</u>	Pressure vessels Kct Tanks (not translated) Welding Vs
<u>Comments</u>	Did not translate concept indexing of "storage tanks" into notation Kcs.
<u>Reason for failure</u>	Indexing C.

QUESTION 13. Is it possible to weld stainless steel up to 3 in. dia. into a large structure by automatic controls, and what economic savings result.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Stainless steel Ns.j	1. A : B, B : A
(B)	Automatic welding Vs Xg	2. C : B, B : C
(C)	Steel Ns	3. A : D, D : A
(D)	Welding Vs+	

DOCUMENTS

Relevance 3 1062/148K Inert gas spot welding in the aircraft and missile industry.
Welding Journal, Vol.40, Jan.1961, pp 25-33.

<u>Indexing</u>	Spot welding Vsn Inert gas-shielded arc welding Vse High tensile steel Ns.p
<u>Comments</u>	Omitted to index 'stainless steel'.
<u>Reason for failure</u>	Indexing A.

Relevance 3 1228/316K A new way to make honeycomb.
American Machinist, Vol.105, Feb.1961, pp 100-101.

<u>Indexing</u>	Stainless steel Ns.j Honeycomb panel Kwmh Automatic welding Vs Xg
<u>Comments</u>	'Stainless steel' and 'Automatic welding' not combined.
<u>Reason for failure</u>	Indexing D.

QUESTION 15. Can high-strength titanium alloy sheet be stretch formed.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Stretch forming Vhs	1. A : B
(B) Titanium or Titanium alloys Nti or Nti.d	2. B : C
(C) Sheet metalworking Vh+	

DOCUMENTS

Relevance 2 1520/265G The development of production processes for use with titanium sheet. Welding and Metal Fabrication, Vol. 29, Feb. 1961, pp 50-56.

<u>Indexing</u>	Titanium Nti Stretch-forming (not translated)
<u>Comments</u>	Did not translate concept indexing of "stretch-forming" into Vhs.
<u>Reason for failure</u>	Indexing C.

QUESTION 16. What temperatures should be used for the hot forming and subsequent stress relief of pure titanium sheet.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Hot forming Vh	1. A : B : C, A : C : B
(B) Titanium or Titanium alloys Nti or Nti.d	B : A : C, B : C : A
(C) Sheet Kwf	C : A : B, C : B : A
(D) Stress relieving Vms	2. B : C : D, B : D : C
	C : B : D, C : D : B
	D : B : C, D : C : B
	3. A : B, B : A
	4. B : D, D : B

DOCUMENTS

Relevance 3 1520/265G The development of production processes for use with titanium sheet. Welding and Metal Fabrication, Vol. 29, Feb. 1961, pp 50-56.

<u>Indexing</u>	Titanium Nti Hot forming (not translated)
<u>Comments</u>	Did not translate concept indexing of "hot forming" into notation Vh.
<u>Reason for failure</u>	Indexing C.

QUESTION 19. What considerations will decide the choice of steels for superheater tubes for boilers.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Boilers Bbz+	1. A : B : C, A : C : B
(B)	Tubes Kkh	B : A : C, B : C : A
(C)	Steel Ns+	C : A : B, C : B : A
		2. A : C, C : A
		3. A : B, B : A

DOCUMENTS

Relevance 3 2020/141M Microstructural causes of heat-affected zone cracking in heavy section 18-12-Nb austenitic stainless steel welded joints.
Journal Iron and Steel Inst., Vol. 197, Jan. 1961, pp 29-39.

<u>Indexing</u>	Austenitic stainless steel Ns.1	Cracking Pj
	Steam pipes Kkh agb	Embrittlement Pbt
	Steam turbines Db	

Comments Could have tried the implied concept 'Steam pipes' (Kkh agb) co-ordinated with 'steel' (Nst), or 'Tubes' (Kkh) and 'steel', dropping out 'boilers' from first search programme.

Reasons for failure Searching B and F.

Relevance 3 1749/61R Bimetallic heat exchangers tube solve dual corrosion problem. Metal Progress, Vol. 78, Dec. 1960, pp. 115-117.

<u>Indexing</u>	Heat exchangers Dv	Stainless steel Nsij
	Tubes Kkh	Copper Ncu
	Chemical corrosion Opq	Stress corrosion Pps

Comments Could have tried 'heat exchangers' (Dv) with 'tubes' (Kkh) 'Heat exchanger' is not in question, but is closely related to subject. Alternatively have tried 'steel' (Ns) with 'tubes'.

Reasons for failure Searching B and F.

QUESTION 21. What are the best temperature/strength properties available in present alloys of molybdenum. Are they amenable to casting and shaping processes.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Molybdenum/Molybdenum alloys Nmo/Nmo.d+	1. A : B, B : A 2. A : C
(B)	High temperature mechanical properties Pb Prb	3. A : D 4. A : E
(C)	Mechanical properties Pb+	5. A : F
(D)	Casting Vg	
(E)	Forming Vh	
(F)	Pressing Vj	

DOCUMENTS

Relevance 3 1713/628Q Graphite metal compatability at elevated temperatures.
Jnl. of Nuclear Materials, Vol.3, Jan.1961, pp 89-100.

<u>Indexing</u>	Graphite Nc Compatability Fuel elements Jg Cans Kkh	Molybdenum Nmo Embrittlement Pbt Thermal stress Prpb
<u>Comments</u>	'Molybdenum' and 'embrittlement' not brought together in indexing.	
<u>Reason for failure</u>	Indexing D.	

Relevance 3 1912/325K Electron beam welds molybdenum sheets. Steel.
March 27th, 1961, pp. 166-7.

<u>Indexing</u>	Electron beam welding Vsh Molybdenum titanium alloy Nmoti Tensile properties Pbb Embrittlement Pbk	
<u>Comments</u>	Would have been retrieved if 'Molybdenum-titanium alloys' and either 'Tensile properties' or 'Embrittlement' had been brought together in indexing.	
<u>Reason for failure</u>	Indexing D.	

QUESTION 23. What methods can be used to identify the microconstituents in alloy steels.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Microscopic analysis: trace analysis Xj.m	1. A : B, B : A
(B)	Steel alloys Ns.g+	2. C : B, B : C
(C)	Microscopic metallography Xulm+	3. D : E, E : D
(D)	Metallography Xul+	4. F : E, E : F
(E)	Steel Ns+	5. G : E, E : G
(F)	Analysis Xj+	6. H : E, E : H
(G)	Impurities Odl	
(H)	Microstructure Od/e	

DOCUMENTS

Source	1183/163N	Intergranular precipitation of intermetallic components in austenitic alloys. AIME Metallurgical Soc. Trans., Vol. 221, Feb. 1961, pp 28-34.
<u>Indexing</u>		Austenitic alloys Ns.1 Intergranular precipitation Odj Ageing Pgcb Phases Oev Microstructure (not translated)
<u>Comments</u>		The question is too specific for the document, since it only has one paragraph on methods of investigation. The 6th search would have retrieved the document if 'micro-structure' had been translated into the class number Od/e.
<u>Reasons for failure</u>	(a) Question (b) Indexing C.	

QUESTION 24. What equipment and procedure can be used to determine the complete orientation of an uniaxial crystal.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Orientation, Crystals Oer	1. A
(B)	Metallography Xul+	2. AB : BA

DOCUMENTS

Relevance	3 1161/205M	Xray small angle scattering from Guinier Preston Zones in deformed aluminium silver. Acta Metallurgica, Vol. 9, Jan. 1961, pp 59-61.
<u>Indexing</u>		Dislocation Oed Deformation Oeb X-ray determination Xulmh

QUESTION 24. DOCUMENTS (Continued)

Comments Concept indexing omitted 'orientation' and 'orientation determination'.

Reason for failure Indexing A.

Relevance 3 1332/231M Structural ageing characteristics of Al or Mg alloy with copper. Institute of Metals Jnl. Feb.1961, pp 205-209.

Indexing Age hardening Pgcb

Comments Concept indexing omitted 'orientation'.

Reason for failure Indexing A.

Relevance 3 1928/746Q Easy glide of lead single crystals. Acta Metallurgica, Vol.9, March 1961, pp 184-190.

Indexing Glide Oef Creep Ph
Impurities Od1 Tensile properties Pbb

Comments Omitted concept 'orientation' in indexing.

Reason for failure Indexing A.

Relevance 3 2022/693Q Twinning in iron-aluminium alloys. Acta Metallurgica, Vol.9, Feb.1961, pp 138-148.

Indexing Twinning Oej
X-ray diffraction Xxx

Comments Omitted concept 'orientation' in indexing.

Reason for failure Indexing A.

QUESTION 26. Do repeated stresses due to varying thermal gradients cause fatigue cracks.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A) Fatigue	Pk	1. A : B : C, B : A : C
(B) Cracking	Pj	C : A : B, C : B : A
(C) Thermal stress	Pprb	2. B : D, D : B
(D) Thermal fatigue	Pkrb	3. D
		4. A : B, B : A

DOCUMENTS

Relevance 3 1311/809Q On the rule of strain hardening in the plastic range fatigue.

Indexing Low alloy steel Ns.h
Fatigue Pk
Strain hardening Pgcb
Fatigue testing Pk Xh

QUESTION 26. DOCUMENTS (Continued)

Comments Could have extended search to 'fatigue testing'.

Reason for failure Searching B.

Relevance 3 2069/651Q A study of fatigue deformation by reflection electron microscopy. Jnl. Inst. of Metals, March 1961, pp 253-254.

Indexing Fatigue Pk Cracking Pj

Comments If 'fatigue' and 'cracking' had been permuted, the last search would have retrieved the document.

Reason for failure Indexing D.

QUESTION 27. Are there any new processes to improve the soundness of castings of grey-iron.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Grey iron Nfecp	1. A : B
(B)	Castings Vg+	2. A : C
(C)	Furnaces Zr+	3. A : D
(D)	Mechanical properties Pb+	

DOCUMENTS

Relevance 3 1525/313K Repair welding cast iron. Welding and Metal Fabrication, Vol.29, March 1961, pp 104-110.

Indexing Grey cast iron Nfecp
Welding Vs
Repair Kce

Comments The effect of 'Silicon', 'Nickel' and 'Carbon' on the mechanical properties of cast iron was omitted from the indexing. This would have retrieved document at 3rd search.

Reason for failure Indexing A.

Relevance 3 1761/221E Innoculation and casting expansion. B.C.I.R.A. Journal, Vol.9, Jan.1961, pp 103-116.

Indexing Grey cast iron Nfecp Nucleation
Inoculation Vgy Expansion Pgh

Comments 'Grey cast iron' (Nfecp) was incorrectly translated as Nfec 'cast iron'. The search should have been extended to 'Cast iron: strength of materials' Nfec Pg+, where the document would have been found at Pgh Nfec "Elongation/Expansion: cast iron".

QUESTION 28. What alloys are likely to have the best tensile and impact properties in the range of temperature - 100 to 200°C.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Impact properties PbcP	1. A : B, B : A
(B)	Low temperatures Prd	2. C : B, B : C
(C)	Tensile properties Pbb	3. D : B
(D)	Mechanical properties Pb	4. A

DOCUMENTS

Relevance 2 1025/480Q Can copper alloys hold the line at ultra low temperatures. Iron Age, Vol.187, 9th March 1961, pp 92-94.

Indexing Copper Ncu
Low temperature mechanical properties Pb Prd
Tensile properties Pbb

Comments The concept 'low temperature' in 'low temperature mechanical properties' was not brought to the front in permuting. The concept tensile properties was not translated into the class number.

Reasons for failure Indexing C and D.

Relevance 3 1158/198N Strain-hardening and crystalline fracture of polycrystalline iron. Acta Metallurgica, Vol.9, Jan.1961, pp 32-39.

Indexing Fracture Pj
Low temperature effects Prd

Comments Indexing should have included 'low temperature mechanical properties'. Searcher could have reduced the co-ordination required and searched Prd 'Low temperature affects' only.

Reasons for failure (a) Indexing A.
(b) Searching F.

Relevance 3 1181/416Q Effect of structure and purity on the mechanical properties of columbium. AIME Metallurgical Soc. Trans. Vol.221, Feb.1961, pp 19-24.

Indexing Mechanical properties Pb Cold working Vh ajm
High temperature properties PbPrb

Comments The indexing omitted 'low temperature properties'

Reasons for failure Indexing A.

QUESTION 31. How effective can a sprayed plastic coating be for the protection of metals from corrosion in service.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Plastic coating Vwkp	1. A : C
(B) Plastic coatings Ldkp	2. B : C
(C) Corrosion Op+	3. A
	4. B

DOCUMENTS

Relevance 3 1625/421L Range of dip-coated plastics extended. Corrosion Prevention and Control, March 1961, pp 50-51.

Indexing Dip coatings Lds Plastics Mp

Comments 'Plastic coatings' Ldkp was not indexed. In the schedules, 'plastic coatings' is enumerated under types of coatings; if it could have been synthesised from Ld 'Coatings' and Mp 'Plastic' and Mp Ld had been the notation used for plastic coatings, the search would have retrieved the document.

Reasons for failure (a) Indexing A.
(b) Index language.

Relevance 3 2045/435L Superior plating shows the way.
Metal Finishing, April 1961, pp. 45-48.

Indexing Plastic coatings (not translated)

Comments The concept 'plastic coatings' was not translated into the notation Ldkp.

Reasons for failure Indexing C.

QUESTION 34. How does the composition of a hypoeutectic cast iron affect its shrinkage unsoundness.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Cast iron Nfec	1. A : B : C, A : C : B, B : A : C
(B) Shrinkage Pgg	B : C : A, C : A : B, C : B : A
(C) Hypoeutectic Oev.xd	2. A : B, B : A
(D) Defects Oeb	3. A : C, C : A
(E) Castings Vg	4. A : D, D : A
	5. E : B, B : E
	6. E : D, D : E

QUESTION 34. (Continued)

DOCUMENTS

Relevance 3 1126/65E Riserling a malleable iron. Foundry, Vol.89,
Jan. 1961, p.82.

<u>Indexing</u>	Malleable iron Nfect	Gating Vgsv
	Riserling Vgsw	Shrinkage (not translated)
<u>Comments</u>	Concept 'shrinkage' not translated into class number.	
<u>Reason for failure</u>	Indexing C.	

QUESTION 37. To what extent do stress concentrations affect the structural tensile strength of aircraft and space vehicles.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Aircraft structures Eb Fc	1. B : A : C, C : B : A
(B) Stress concentrations Px	B : C:A, A : B : C
(C) Tensile properties Pbb	C : A : B, A : C : B
	2. B : A
	3. A : C, C : A
	4. B : C, C : B

DOCUMENTS

Source 1376/618Q Structural significance of ductility.
Journal of Metals, Vol.13, March 1961, pp 201-203.

<u>Indexing</u>	Missiles, rockets Ed	Space vehicles Eg
	Pressure vessels Kct	Stress concentration Px

Comments The concepts 'tensile strength' (Pbb), 'Aircraft' (Eb) and 'Aircraft structures' (Eb Fc) were all in the document but not indexed. Permutations between concepts indexed 'stress concentrations' (Px) and both 'missiles' (Ed) and 'space vehicles' (Eg) were not made. The search should have been extended to concepts in the question or implied in the question 'stress concentrations' with 'missiles' and 'space vehicles', although this would not have retrieved the document because of lack of permutation. The search could have been broadened to 'stress concentrations' (Px) alone, but the rules for searching prohibited this.

Reasons for failure Searching. A and B

Relevance 2 1042/106J For stronger missile cases - decarburize. Metal
Progress Vol. 79, March 1961, pp. 78-80.

<u>Indexing</u>	Missiles Ed	Notches (not translated)
<u>Comments</u>	Concept 'notches' not translated into class number (Px - 'notches, stress concentrations'). Search did not try the concept missiles - implied in question.	
<u>Reasons for failure</u>	(a) Indexing. C (b) Searching. B	

QUESTION 37. DOCUMENTS (Continued)

Relevance 2 1450/776Q Selection of metals for use at cryogenic temperatures.
Metal Progress, Vol. 79, April, 1961, pp 65-72.

<u>Indexing</u>	Missiles, rockets	Ed	Hardness testing	Xtbp
	Low temperatures	Pb Prd	Notch testing	Xtbb.n
	Tensile testing	Xtbb	Aluminium alloys	Nal.d
	Fatigue testing	Pk Xh	Other alloys	
	Impact testing	Xtbn		

Comments Omitted to search for 'space vehicles' or related concepts
'missiles' and 'rockets' (Ed). Search not extended to
'tensile testing' (Xtbb).

Reason for failure Searching A and B

Relevance 3 1142/97T Stress relieved alloy plate for aircraft.
Metallurgia, Vol. 63, Feb. 1961, p. 55.

<u>Indexing</u>	Aircraft structures	Eb Fc
	Tensile testing	Xtbb

Comments Search not extended to 'aircraft structures: tensile testing',
where the document would have been found.

Reason for failure Searching B

Relevance 3 1259/826Q Review of current developments in the metallurgy of
high strength steels. DMIC Memo 100 (OTS PB 161250).

<u>Indexing</u>	Missiles, Rockets	Ed	Stress raisers	Px
-----------------	-------------------	----	----------------	----

Comments Search not extended to 'missiles/rockets: stress raisers'.

Reason for failure Searching B.

Relevance 3 1374/616Q Evaluating fracture toughness. (Pressure vessels for space,
aerospace and hydrospace: a symposium).
Journal of Metals, Vol. 13, March 1961, pp 195-197.

<u>Indexing</u>	Aircraft	Eb	Tensile properties	Pbb
-----------------	----------	----	--------------------	-----

Comments Search not extended to 'Aircraft: tensile properties'.

Reason for failure Searching C.

Relevance 3 1566/584Q Use of the center notch-tensile test to evaluate rocket
chamber materials. Welding Journal Vol. 40,
March 1961, pp 130s-134s.

<u>Indexing</u>	Missiles, Rockets	Ed	Notch tensile testing	Xtbb.n
	Mechanical properties	Pb		

Comments Search could have been extended to 'Missiles/rockets:
mechanical properties' (Ed Pb), or 'missiles/rockets:
tensile testing' (Ed Xtbb)

Reason for failure Searching B.

QUESTION 37. DOCUMENTS (Continued)

Relevance 3 1975/164F Strength of castings multiplied by forging.
Missiles and Rockets, 20 March 1961, p.30.

<u>Indexing</u>	Rockets Ed	Mechanical properties Pb
<u>Comments</u>	Concept 'tensile properties' (Pbb) not indexed. Search could have been extended to 'missiles/rockets: mechanical properties' (Ed Pb)	
<u>Reasons for failure</u>	(a) Indexing A. (b) Searching B.	

QUESTION 41. What are the properties required by resins for the coating of metals by thermoplastics.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Coating, plastic Vwkp	1. A : B : C
(B)	Resins Mp	2. A : B, B : A
(C)	Metals N	3. A : C, C : A
		4. A

DOCUMENTS

Relevance 3 2083/388L Refrigerated dip tank solves finishing problem.
Products Finishing, Vol.25, March 1961, pp 49-50.

<u>Indexing</u>	Dip coatings Lds	Epoxy resins Mry
	Primers Lel	
<u>Comments</u>	Concepts 'plastic coating' (Vwkp) and 'plastic coatings' (Ldkp) omitted from the indexing.	
<u>Reason for failure</u>	Indexing A.	

Relevance 3 1625/421L Range of dip-coated plastics extended. Corrosion Prevention and Control, March 1961, pp 50-51.

<u>Indexing</u>	Dip coatings Lds	Plastics Mp
<u>Comments</u>	The concept 'plastic coatings' not indexed. The search should have been extended to 'plastic coatings' (Ld kp). This raises the question whether 'plastic coatings' should be enumerated Ldkp under types of coatings, as it is, or whether it should be synthesised from Ld 'coatings' and Mp+ 'plastics'. If Mp+ Ld+ had been the notation for 'plastic coatings', this document would have been found, provided the searcher had used the Ld rather than Vw number for 'coatings'.	
<u>Reasons for failure</u>	(a) Indexing A. (b) Searching B. (c) Index language C.	

QUESTION 41. DOCUMENTS (Continued)

Relevance 3 1999/285R Developments in the protection of magnesium.
Light Metals, Feb.1961, pp 38-39.

Indexing Magnesium alloys Nmg.d
Epoxide coatings Mrg Ldkp
Protective coatings Ldkp

Comments Both 'plastic coatings' (Ldkp) and 'plastic coating' (Vwkp) should have been searched, although in this case Ldkp was the most likely one. The question is whether the difference between 'coating' and 'coatings' is so fine as to require searching for both every time.

Reasons for failure (a) Searching B
(b) Index language B.

The following four documents have the same Indexing, Comments and Reasons for failure as 1999/285R above.

Relevance 3 1991/415R The corrosion protection of magnesium in electronic equipment. Metal Finishing, March 1961, pp 40-45.

Relevance 3 1486/291R Coatings protect materials from flight heat.
SAE Journal, March 1961, pp 78-79.

Relevance 3 1610/339R Corrosion in breweries. Corrosion Prevention and Control. Jan.1961, pp 32-33.

Relevance 3 1624/419L Plastic coated metal sheet. Corrosion Prevention and Control. March 1961, pp 47-49.

QUESTION 42. What methods are available for determining the adhesion of electro-deposits.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Electro-deposited coatings Ldl	1. A : B, B : A
(B)	Adhesion Peq	

DOCUMENTS

Relevance 2 2063/279L Evaluation of electro-deposited coatings.
Metal Finishing Vol. 59, 1961, pp 38-44.

<u>Indexing</u>	Electro-deposited coatings Ldl Electro-plated coatings Ldm Adhesion Peq
<u>Comments</u>	Permutations made between 'adhesion' (Peq) and 'electro-plated coatings' (Ldm) but not between 'adhesion' (Peq) and 'electro-deposited coatings' (Ldl). Omitted to search more specifically at 'electro-deposited coatings: adhesion' (Ldm Peq). Fault in index language that the inclusion of Ldm as Ldl is not apparent from the notation.

Reasons for failure (a) Indexing D. (b) Searching E.

QUESTION 46. What are the underlying principles and advantages of the fluidized bed furnace in the heat treating of metal components.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Fluid bed furnaces Zrw	1. A : B, B : A
(B)	Heat treatment Vm	

DOCUMENTS

Relevance 2 1453/138J Principles of the fluid bed. Metal Progress, Vol. 79, April 1961, pp 78-81.

<u>Indexing</u>	Fluid bed furnaces Zrw Heat transfer
<u>Comments</u>	Search not broadened to 'fluid bed furnaces' generally.
<u>Reason for failure</u>	Searching.

The following documents were all indexed 'Fluid bed furnaces' and have the same comments and reasons for failure as 1453/138J.

Relevance 3 1834/169L Developments in fluid bed coatings. Metal Finishing, Vol. 59, Jan. 1961, pp. 42-44.

Relevance 3 1385/276D Methods of reducing iron ores. Journal of Metals, Vol. 13, April 1961, pp. 305-307.

Relevance 3 1821/49B Fluid bed roasting of nickel sulphide. Canadian Mining and Metallurgical Bulletin Feb. 1961, pp. 152-156.

QUESTION 51. In the final inspection of castings, how great a part in testing is played by non-destructive methods.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Casting Vg	1. A : B, B : A
(B)	Non-destructive testing Xu/z+	2. A : C, C : A
(C)	Testing Xh	3. A : D, D : A
(D)	Inspection Wkk	

DOCUMENTS

Relevance 3 2013/225G Oldsmobile turn to aluminium. Machinery, Feb.1961, pp 98-103.

<u>Indexing</u>	Aluminium Nal	Machining Vk
	Engines Defi	Milling Vkg
	Cylinders Jf	

Comments The concept 'casting' omitted. 'Leak testing' noted in the concepts, but not translated into class number. The search could have been broadened to 'non-destructive testing' generally, but this would not have retrieved the document as the concept 'leak testing' was not translated.

Reasons for failure (a) Indexing A and C.
(b) Searching F.

QUESTION 54. Are there any automatic installations producing laminations in the United Kingdom.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Laminations Mail	1. A
(B)	Laminating Vhz	2. B

DOCUMENTS

Source 1403/247G Quality production of laminations for transformer cores. Machinery, Vol.98, 1 Feb.1961, pp 250-252.

<u>Indexing</u>	Transformers He	Electric steel	Ns.hv
	Cones Hw	Strip	Kwh
	Laminations Mail	Presswork	Vj

Comments 'Laminations' (Mail) not brought to the front in any permuted entry.

Reason for failure Indexing D.

QUESTION 55. Does the injection of gas into the blast furnace produce any significant increase in iron production, or saving in coke consumption.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Blast furnace Zrb	1. A : B : C, A : C : B
(B) Gas Mnl	2. A : D, D : A
(C) Fuel injectors Jgf	3. A : E : B, A : B : E
(D) Coke Mme	E : A : B
(E) Iron Nfe	4. B : C, C : B

DOCUMENTS

Relevance 3 1035/171D Blast furnace injectors. Journal of Metals, Vol. 13, Jan. 1961, pp 31-36.

<u>Indexing</u>	Blast furnaces Zrb Fuel injection Jgf	Gases Mahe Natural gases Mnl Combustion On
<u>Comments</u>	A search under "blast furnaces: gas" (Zrb Mnl) or "blast furnaces: fuel injectors" (Zrb Jhf) would have found the document. Alternatively, additional permutation would have brought about retrieval.	

Reasons for failure (a) Indexing D. (b) Searching F.

QUESTION 59. If the oxide film is removed from steel strip by liquid fluxes, is the flow of liquid tin over the surface more satisfactory.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Tin plated Ldm Nsn	1. A : D : C : E, D : C : A : E
(B) Tin plating Vwm Nsn	E : D : C : A, B : D : C : E
(C) Steel Ns	D : C : B : E, E : D : C : B
(D) Strip Kwh	2. E : D : C, E : C : D
(E) Cleaning Vv+	D : E : C, D : C : E
	3. D : C : A, D : A : C
	A : D : C, A : C : D
	D : C : B, D : B : C
	B : D : C, B : C : D
	4. D : A, A : D
	D : B, B : D
	5. D : E, E : D

DOCUMENTS

Source 1354/427L The spread of molten tin on mild steel reduced in hydrogen or treated with molten fluxes. Iron and Steel Institute J., Vol. 197, March 1961, pp. 233-239.

<u>Indexing</u>	Mild steel Ns.d Turning Vty	Cleaning Vv Strip Kwh
-----------------	--------------------------------	--------------------------

QUESTION 59. DOCUMENTS (Continued)

Comments The concept 'tinplating' and not 'tinning/soldering' should have been used. If permutations had been made between 'strip' (Kwh), 'mild steel' (Ns.d) and 'cleaning' (Vv) and between 'strip' (Kwh) and 'cleaning' (Vv), the document would have been retrieved at the second or fifth search.

Reasons for failure Indexing A and D.

Relevance 3 1859/54F Filter system upgrades ultrathin steel strip. Steel: The metalworking weekly, Vol.148, 9th Jan.1961, pp 76

Indexing Strip Kwh Cleaning Vv
Steel Ns

Comments The three concepts 'strip' (Kwh), 'cleaning' (Vv) and 'steel' (Ns) not brought together by permutation.

Reason for failure Indexing D.

QUESTION 63. What recent work has been done on the resistance to corrosion of nickel electrolytic deposits.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Nickel plated Ldm Nni	1. A : B, B : A
(B)	Corrosion resistance Opy	2. A : C, C : A
(C)	Corrosion Op+	

DOCUMENTS

Relevance 3 2031/283L Science for electroplaters. 63 Nickel plating. Metal Finishing, Vol.59, Feb.1961, pp 61-64.

Indexing Nickel plating Vwm Nui Solutions Mahl
Watts bath Vwm Mahl Corrosion-resistance (not translated)

Comments The concept 'nickel plated' (Ldm Nni - the coating rather than the process) was not indexed. This raises the question whether there needs to be a distinction between 'coatings' (Ld) and 'coating' (Vw). The concept 'corrosion resistance' (Opy) was not translated into the class number.

Reasons for failure (a) Indexing A and C.
(b) Searching B
(c) Index language B.

QUESTION 70. What is the mechanism of the corrosion of the steel in a re-inforced concrete structure exposed to the action of sea water.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Reinforced concrete Mckv	1. A : B, B : A
(B)	Seawater corrosion Opms	2. B : C, C : B
(C)	Concrete Mck	3. A : D
(D)	Corrosion Op	

DOCUMENTS

Relevance 3 1116/438R Aluminium, aluminized steel, galvanized steel in severe coastal environment.
Corrosion, Vol.17, April 1961, pp 101-104.

Indexing Seawater corrosion Opms
Steel Ns

Comments The search omitted the concept 'steel' altogether. If a search had been made for 'steel: seawater corrosion' (Ns Opms), the document would have been found.

Reason for failure Searching A.

The following four documents have the same Indexing, Comments and Reason for failure as for 1116/438R above.

Relevance 3 1094/308R Effects of flow rate on the galvanic corrosion of low-carbon steels in sea water. Corrosion, Vol.17, Feb.1961, p 89.

Relevance 3 1119/441R Investigation of mild steel corrosion rate in San Diego Harbour. Corrosion, Vol.17, April 1961, pp 112-114.

Relevance 3 1124/376L Structural and marine steel protection systems. Gelled primers prevent slag. Corrosion Prevention and Control Engineer, Vol.8, Feb.1961, p.49.

Relevance 3 1749/61R Bimetallic heat exchangers tube solve dual corrosion problem. Metal Progress, Vol.78, Dec.1960, pp 115-117.

QUESTION 71. What is the effect of hydrogen on steel tubing in use at high temperatures (up to 800^o F) and at pressures up to 950 p.s.i.

SEARCH PROGRAMME

<u>Concepts</u>			<u>Searches</u>
(A)	Hydrogen	Nh	1. A : B : C : D, A : B : D : C
(B)	Embrittlement	Pbt	B : A : C : D, B : C : D : A
(C)	Tubes	Kkh	B : D : C : A, C : B : A : D
(D)	Steel	Nst	C : A : B : D, C : D : A : B
(E)	Thermal stresses	Pprb	2. C : D : E, C : E : D
(F)	Absorption	Oq	E : D : C, E : C : D
(G)	Diffusion	Or	3. C : A : B, C : B : A
(H)	Compression	Ppj	A : C : B, A : B : C
			B : C : A, B : A : C
			C : A : F, C : F : A
			A : C : F, A : F : C
			F : C : A, F : A : C
			C : A : G, C : G : A
			A : C : G, A : G : C
			G : C : A, G : A : C
			4. C : E, E : C
			5. A : B : D, B : D : A
			A : F : D, F : D : A
			A : G : D, G : D : A
			6. C : H

DOCUMENTS

Relevance 3 1576/385K The role of hydrogen in arc welding with coated electrodes. Welding Journal, Vol.40, April 1961, pp 145s.

Indexing Steel Ns Embrittlement Pbt
Hydrogen Nh

Comments If the concepts 'steel' (Ns), 'hydrogen' (Nh) and 'embrittlement' (Pbt) had been brought together by permutation, the document would have been retrieved at the fifth search.

Reason for failure Indexing D.

QUESTION 74. What is the effect of high-pressure steam on the stress-corrosion behaviour of austenitic stainless steels.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Austenitic stainless steel Ns.1	1. A : B : C, A : C : B B : A : C, B : C : A C : B : A, C : A : B
(B) Stress corrosion Pps	2. A : B, B : A
(C) Steam corrosion Opr	3. A : C, C : A 4. B : C, C : B

DOCUMENTS

Relevance 3 1749/61R Bimetallic heat exchanger tubes solve dual corrosion problem. Metal Progress, Vol.78, Dec.1960, pp 115-117.

<u>Indexing</u>	Stainless steel Ns.j	Stress corrosion Pps
<u>Comments</u>	Search should have been broadened to 'stainless steel' (Ns.j) with 'stress corrosion' (Pps).	
<u>Reason for failure</u>	Searching D.	

QUESTION 76. How can stainless steel tube be expanded by explosive forming.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Tube Kkh	1. A : B : C
(B) Stainless steel Ns.j	2. A : C
(C) Explosive forming Vj ajg	

DOCUMENTS

Relevance 3 1618/323G Spark forming works on stainless. American Machinist, Vol.105, 6th March 1961, p.80.

<u>Indexing</u>	Stainless steel Ns.j	Explosive forming Vj ajg
<u>Comments</u>	The searcher should have broadened the programme by dropping the concept 'Tubes'.	
<u>Reason for failure</u>	Searching F.	

Relevance 3 1020/174E Electrosark forming: new way to shape hard to form metals. Iron Age, Vol.187, 23 Feb.1961, pp 98-99.

<u>Indexing</u>	)	
<u>Comments</u>	)	As 1618/323G above.
<u>Reason for failure</u>	)	

QUESTION 76. DOCUMENTS (Continued)

Relevance 3 1491/287G High-energy methods shape space-age.
SAE Journal, March 1961, pp 44-45.

<u>Indexing</u>	Explosive forming Vj ajg
<u>Comments</u>	The concepts omitted the metals processed, including 'stainless steel' (Ns.j). If the search had been broadened to 'stainless steel: explosive forming' (Ns.j Vj ajg), it still would not have been found, because of the concept indexing. Extension of search to 'explosive forming' alone (Vj ajg) would have found the document (together with irrelevant ones).
<u>Reasons for failure</u>	(a) Indexing A. (b) Searching F.

Relevance 3 1406/324G Explosive forming of missile components.
Machinery, Vol.98, 1 March 1961, pp 486-490.

<u>Indexing</u>	)	
<u>Comments</u>	)	As 1491/287G above.
<u>Reasons for failure</u>	)	

QUESTION 80. What type of equipment can be used for testing the mechanical properties of metals at temperatures down to -423° F.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Low temperature mechanical properties Pb Prd	1. A : B, B : A 2. A
(B) Testing Xh+	

DOCUMENTS

Relevance 3 1025/480Q Can copper alloys hold the line at ultra-low temperatures.
Iron Age, Vol.187, 9 March, 1961, pp 92-94.

<u>Indexing</u>	Copper Ncu Copper alloys Ncu.d	Low temperature mechanical properties Pb Prd
<u>Comments</u>	'Low temperature mechanical properties' not brought to the front of a class number in permutation.	
<u>Reason for failure</u>	Indexing D.	

Relevance 3 1156/483Q Low temperature elastic constants of magnesium alloys.
Acta Metallurgica, Vol.9, Jan.1961, pp 14-22.

<u>Indexing</u>	Magnesium single crystals Nmg.d	Elastic constants Pbg
<u>Comments</u>	The concepts of 'low temperatures' and 'measurement' were omitted from the indexing.	
<u>Reason for failure</u>	Indexing A.	

QUESTION 80. DOCUMENTS (Continued)

Relevance 3 1181/416Q Effect of structure and purity on the mechanical properties of columbium. AIME Metallurgical Soc. Trans., Vol. 221, Feb. 1961, pp 19-24.

Indexing High temperature mechanical properties Pb Prb
Columbium Nnb

Comments The concept 'low temperature properties' to cover the temperature range -196 to 1093 °C omitted by the indexer.

Reason for failure Indexing A.

Relevance 3 1215/170N The anomaly in the rate of strain hardening of zinc single crystals. AIME Metallurgical Soc. Trans. Vol. 221, Feb. 1961, pp 204-205.

Indexing Strain hardening Pgcb
Zinc Nzn
Single crystals Oc

Comments The concepts 'low temperature mechanical properties' and 'testing' were omitted by the indexer.

Reason for failure Indexing A.

Relevance 3 1273/797Q Effect of hydrogen on the tensile properties of iodide vanadium. AIME Metallurgical Soc. Trans. Vol. 221, April 1961, pp 238-241.

Indexing Tensile properties Pbb
Iodide vanadium Nv
Hydrogen embrittlement Nh Pbt

Comments The concepts 'low temperature' and 'measurement' were omitted by the indexer.

Reason for failure Indexing A.

QUESTION 81. Do stainless steels have any advantage over Al and Ti alloys as structural materials for rockets using liquid oxygen and hydrogen as propellants.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Liquid fuel rocket engines Djt	1. A : B, B : A
(B) Stainless steel Ns.j+	2. A : C, C : A
(C) Aluminium alloys Nal.d	3. A : D, D : A
(D) Titanium alloys Nti.d	4. A : E
(E) Metals N	5. F : B, B : F
(F) Rocket engines Djh/t	6. F
(G) Missiles Ed	7. G : B, B : G
	8. G : C, C : G
	9. G : D, D : G
	10. G : E

QUESTION 81. (Continued)

DOCUMENTS

Source 1450/776Q Selection of metals for use at cryogenic temperatures.
Metal Progress, Vol. 79, April 1961, pp 65-72.

Indexing Missiles, rockets Ed
Low temperature mechanical properties Pb Prd
Low temperature metals N.tb
Liquid fuel Lkf
Titanium alloys Nti.d
Aluminium alloys Nal.d
Nickel alloys Nni.d
Cobalt alloys Ncp.d
Austenitic stainless steel Ns.1

Comments The concept 'liquid fuel rocket engines' (Djt) was omitted,
This could have retrieved the document at the sixth search.
If permutations had been made between 'missiles' and the
metals listed, the document would have been retrieved at
the seventh to tenth searches.

Reasons for failure Indexing A and D.

Relevance 2 1092/306R Corrosion effects of liquid fluorine and liquid oxygen
on materials of construction. Corrosion, Vol.17,
Feb.1961, pp 80-82.

Indexing Missiles, rockets Ed
Metals N

Comments These concepts not brought together by permutation.

Reason for failure Indexing D.

Relevance 3 1047/280K Brazing missile and electronic components in dry hydrogen.
Metal Progress, Vol. 79, March 1961, pp 93-96.

Indexing Missiles, rockets Ed
Stainless steel Ns.j

Comments These concepts not brought together by permutation.

Reason for failure Indexing D.

Relevance 3 1062/148K Inert gas spot welding in the aircraft and missile industry.
Welding Journal. Vol.40, Jan.1961, pp 25-33.

Indexing Missiles Ed Metals N

Comments These concepts not brought together by permutation.

Reason for failure Indexing D.

Relevance 3 1228/316K A new way to make honeycomb. American Machinist,
Vol.105, 20 Feb.1961, pp 100-101.

Indexing Stainless steel Ns.j Welding Vs
Honeycomb structures Kwmh

Comments The concept 'missiles' (Ed) was omitted by the indexer

Reason for failure Indexing A.

QUESTION 81. DOCUMENTS (Continued)

Relevance 3 1375/779Q Materials for space pressure vessels.
Journal of Metals, Vol.13, March 1961, pp 198.

Indexing Stainless Steel Ns.j
Missiles, rockets Ed
Aluminium Nal

Comments These concepts were not permuted

Reason for failure Indexing D.

Relevance 3 1376/618Q Structural significance of ductility.
Journal of Metals, Vol.13, March 1961, pp 201-203.

Indexing Missiles Ed
Titanium Nti

Comments These concepts were not permuted

Reason for failure Indexing D.

Relevance 3 1406/324G Explosive forming of missile components.
Machinery, Vol.98, 1 March, 1961, pp 486-490.

Indexing Missiles Ed
Explosive forming

Comments The metals involved were not indexed.

Reason for failure Indexing A.

Relevance 3 1484/499Q Materials-metallic and non-metallic.
Royal Aero.Soc.Jnl., Vol.65, Feb.1961, p. 83

Indexing Supersonic aircraft Eb Qct Aluminium Nal
Titanium Nti
Materials, Metals N Stainless steel Ns.j

Comments The concept 'missiles, rockets' (Ed) was omitted. The search could have included 'supersonic aircraft' as well as 'missiles, rockets'.

Reasons for failure (a) Indexing A.
 (b) Searching

Relevance 3 1491/267G High-energy methods shape space-age.
SAE Journal, March, 1961, pp 44-45.

Indexing Missiles, rockets Ed
Explosive forming Vj ajg

Comments The metals involved were not indexed

Reason for failure Indexing A.

QUESTION 81. DOCUMENTS (Continued)

Relevance 3 1493/543Q B70 Spurs wide use of sandwich design.
Space Aeronautics, March 1961, pp 46-79.

Indexing Space vehicles Eg
 Supersonic aircraft Eb Qct
 Titanium Nti

Comments These concepts were not brought together by permutation.
The search could have extended to 'space vehicles' as
being a reasonable possibility, but lack of permutation
between Eg and Nti would have ensured failure.

Reason for failure (a) Indexing D.
 (b) Searching B.

Relevance 3 1622/356K Tooling up a stainless balloon.
American Machinist, Vol.105, 9 Jan.1961, pp 63-65.

Indexing Missiles Ed
 Metals N

Comments These concepts not brought together by permutation

Reason for failure Indexing D.

Relevance 3 1630/75T Aerospace fasteners use new materials.
Materials in Design Engineering, Vol.53, March 1961,
pp 110-113.

Indexing Missiles Ed
 Metals N

Comments These concepts not brought together by permutation

Reason for failure Indexing D.

Relevance 3 1842/401Q Mobile Mauler launcher made of high strength
aluminium. Space Aeronautics, Feb.1961,
pp 65-66, 68, 72, 74, 78.

Indexing Missiles (not translated)
 Aluminium alloys Nal.d

Comments Concept "missiles" not translated into class number.

Reason for failure Indexing C.

Relevance 3 1855/82F Teflon insert die tames toughies. Steel Metal-
Working Weekly, Vol.148, 16 Jan.1961, p.87.

Indexing Forming, Pressing Vj Titanium Nti
 Stainless steel Ns.j

Comments The concepts 'aircraft' and 'space vehicles' were omitted.
The search could have extended to 'space vehicles' to retrieve
the document, if it had been included in the indexing.

Reasons for failure (a) Indexing A. (b) Searching B.

QUESTION 85. What kind of pre-treatment should be applied to a steel base which is to receive a heavy vinyl plastisol coating (as a replacement for vitreous enamel).

SEARCH PROGRAMME

<u>Concepts</u>			<u>Searches</u>
(A)	Plastic coatings	Ldkp	1. A : C : D, A : D : C
(B)	Plastic coating	Vwkp	D : A : C, D : C : A
(C)	Steel	Ns+	B : C : D, B : D : C
(D)	Cleaning	Vv+	D : B : C, D : C : B
(E)	Plastisol		2. E
(F)	Vitreous enamel coatings	Ldk	3. A : C, B : C
(G)	Vitreous enamel coating	Vwk	4. C : D, D : C
			5. A : D, D : A
			B : D, D : B
			6. F : C, G : C
			7. A, B

DOCUMENTS

Source 1457/468L No. 7 in a series on better finishing 1: Phosphating in cold solutions. Metal Progress, Vol. 79, April, 1961, pp 100-102.

<u>Indexing</u>	Posphating	Vwec	Spray coating	Vvw
	Steel	Ns	Cleaning	(not translated)

Comments The concepts 'paints' and 'plastic coatings' were omitted. The concept 'cleaning' was not translated into the class number Vv. If this had been done, and a permutation with 'steel' made, the document would have been found at the sixth search.

Reasons for failure Indexing A and C.

QUESTION 86. Which type of copper alloy possesses the best machinability, and why.

SEARCH PROGRAMME

<u>Concepts</u>			<u>Searches</u>
(A)	Copper	Ncu	1. A : C, C : A
(B)	Copper alloys	Ncu.d	B : C, C : B
(C)	Machinability	Pdm	2. A : D, D : A
(D)	Machining	Vk	B : D, D : B
(E)	Mechanical properties	Pb+	3. A : E, B : E

DOCUMENTS

Relevance 3 1665/255E Effects of metal/mould reaction and section thickness on the properties of gunmetal castings. British Foundryman, Vol. 54, March 1961, pp 137-145.

QUESTION 86. DOCUMENTS (Continued)

Indexing Castings Vg Copper tin alloys Ncun
Tin bronze Ncun Mechanical properties Pb

Comments 'Copper tin alloys' and 'mechanical properties'
not permuted.

Reason for failure Indexing D

Relevance 3 2026/227G Die sinker generates forms without a model.
Machinery, Feb.1961, pp 122-125.

Indexing Precision investment casting Vgg
Die making Zvbm V
Pantograph die making machine Vgg Zvbm Z

Comments Concepts 'machining', 'aluminium bronze' and 'brass'
omitted by the indexer.

Reason for failure Indexing A.

QUESTION 93. What is the value of the activation energy of diffusion of copper
in molten copper in the temperature range 1400-1550°C.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Copper Ncu	1. A : C : B, B : A : C
(B)	Diffusion Oq	B : C : A, C : A : B
(C)	Activation energy Oke	C : B : A
		2. A : B, B : A

DOCUMENTS

Relevance 3 1851/178K Diffusion method bonds copper perfectly.
Steel: The Metalworking Weekly, Vol.148,
23 June, 1961, p.55.

Indexing Diffusion bonding Vsun
Copper Ncu

Comments The search could have extended to 'copper:diffusion
bonding' where the document would have been found.

Reason for failure Searching B.

QUESTION 95. What are the tensile properties of Ag-Al alloys (Al, 1-6%) and does the alloy exhibit yield point behaviour.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Silver aluminium alloys Nagal	1. A : B, B : A
(B)	Tensile properties Pbb+	2. A : C, C : A
(C)	Yield point Pbbe	3. D : B, B : D
(D)	Silver Nag	E : B, B : E
(E)	Silver alloys Nag.d	

DOCUMENTS

Relevance 3 1161/205M Xray small angle scattering from Guinier Preston Zones in deformed aluminium silver.
ACTA Metallurgica, Vol.9, Jan.1961, pp 59-61.

<u>Indexing</u>	Aluminium silver alloys Nalag
	Deformation Oeb
	Dislocation Oed

Comments 'Tensile properties' not indexed. The searcher omitted to use the index to the schedules to locate 'silver aluminium alloys' where silver is the minor element. If this had been done, there would have been the possibility of locating the document presuming 'tensile properties' had been indexed. Permutation within the class number of the alloy would have avoided this failure (i.e. if both Nagal and Nalag, 'silver aluminium' and 'aluminium silver' alloys were in the class sequence).

Reasons for failure (a) Indexing A.
(b) Searching G.
(c) Index language E.

QUESTION 96. Does the presence of vacancies in the grain boundaries of Cu-Al solid solution affect grain boundary relaxation.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Copper aluminium alloys NcuAl	1. A : B, B : A
(B)	Vacancies Odn	2. C : B, B : C
(C)	Aluminium copper alloys NalCu	3. C : D, D : C
(D)	Solid solution Oes	4. B : E, E : B
(E)	Relaxation Pgcc	5. E : F, F : E
(F)	Grain boundaries Odj	6. F : G, G : F
(G)	Lattice deformation Oeb	F : H, H : F
(H)	Lattice dislocation Oed	7. B : G, G : B
		B : H, H : B

DOCUMENTS

Relevance 3 1166/207M Some results obtained from the microscopic examination of fracture surfaces of cast aluminium silicon copper alloy.
ACTA Metallurgica, Vol.9, Jan.1961, pp 73-75.

QUESTION 96. DOCUMENTS (Continued)

<u>Indexing</u>	Aluminium silicon copper alloys	Nalsicu
	Fracture	Pj
	Intercrystalline fracture	Oeb

Comments No entry was made in the alphabetical index under 'copper' as a minor document in the alloy 'aluminium silicon copper', so the searcher could not locate this particular alloy. This is partly a fault of the index language, since if a permuted entry had been made under 'copper-aluminium-silicon-alloys', the document could have been traced.

Reasons for failure Index language E.

Relevance 3 1332/231M Structural ageing characteristics of Al or Mg alloy with copper. Institute of Metals Jnl. Feb.1961, pp 205-209.

Indexing Aluminium copper magnesium alloys Nalcumg
Age hardening Pgcgb

Comments The concepts 'deformation' (Oeb) and 'dislocation' (Oed) were omitted. The search could have extended to 'aluminium copper alloys' - 'dislocation' or 'crystal deformation' (Nalcu Oed or Nalcu Oeb), where the document would have been found if the concepts Oeb and Oed had been indexed, or to the strength of materials number for 'deformation' (Pg+), where the document would have been found at Pgcb Nalcumg. This raises the point whether there should be two places for 'deformation', one at Oeb/Oed 'crystallography' and one at Pg+ 'strength of materials'.

Reasons for failure

- (a) Indexing A.
- (b) Searching B.
- (c) Index language

Relevance 3 1733/848Q Some results of the examination of aluminium alloy fracture surfaces. Metallurgia, Vol.63, March 1961, pp 117-124.

<u>Indexing</u>	Vacancies	Odn
	Dislocations	Oed

<u>Comments</u>	If these concepts had been brought together by the permutation, the seventh search would have retrieved the document.
-----------------	---

Reason for failure Indexing D.

QUESTION 98. Is there a structural transition in Bainite and does it depend on the composition of the steel.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Bainite transformation Oev.n	1. A : B
(B)	Steel Ns+	

DOCUMENTS

Relevance 3 1355/259N The effect of up-quenching on the kinetics of bainitic formation. Iron and Steel Institute Jnl. Vol.196, March 1961, p.241.

Indexing Carbon steel N.c. Austenite phase Oev.1
Bainitic formation Oev.n Quenching effects Vmk

Comments The concept 'carbon steel' (Ns.c) was translated into N.c in error.

Reason for failure Indexing C.

QUESTION 99. What optical methods can be used in determining the orientation of metal single crystals.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Orientation Oer	1. A : B, B : A
(B)	Microscopic metallography Xulm+	2. A : C, C : A
(C)	Diffraction analysis Xxx	3. A
(D)	Microstructure Od/e	4. B : D, D : B
		5. C : D, D : C

DOCUMENTS

Relevance 3 1161/205M Xray small angle scattering from Guinier Preston Zones in deformed aluminium silver. ACTA Metallurgica, Vol.9, Jan.1961, pp 59-61.

Indexing Deformation Oeb X-ray examination Xulmh
Dislocation Oed

Comments Oeb Xulmh and Oed Xulmh not brought together by the permutation. The concept 'orientation' (Oer) was omitted by the indexer.

Reasons for failure Indexing A and D.

QUESTION 99. DOCUMENTS (Continued)

Relevance 3 1278/480R The rates of formation and structure of oxide films formed on a single crystal of iron. AIME Metallurgical Soc. Trans., Vol. 221, April 1961, pp 257-261.

Indexing X-ray examination Xulmh
 Crystal structure Oc/e

Comments The concept 'orientation' (Oer) was omitted.

Reasons for failure Indexing A and D.

Relevance 3 1332/231M Structural ageing characteristics of Al or Mg alloy with copper. Institute of Metals Jnl. Feb. 1961, pp 205-209.

Indexing Age hardening

Comments The concept 'orientation determination' was omitted.

Reason for failure Indexing A.

QUESTION 107. What are the effects of increasing the molybdenum content of carburising steels.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Steel Nst	1. B : A : C, B : C : A
(B)	Carburised Oev.t	C : A : B, C : B : A
(C)	Molybdenum Nmo	2. B : A
(D)	Carburising Vmpe	3. C : A : D, C : D : A
		D : A : C, D : C : A
		4. A : D, D : A

DOCUMENTS

Relevance 3 1632/672Q Three stainless steels retain hot hardness better than standard AISI grade 440 C. Materials in Design Engineering, Vol. 53, March 1961, p. 19.

Indexing Stainless steels Ns.j Molybdenum Nmo
 Hardness Pcb

Comments The document would have been found if the search had included the implied concept 'hardness', with 'steel' and 'molybdenum'.

Reason for failure Searching B.

QUESTION 107. DOCUMENTS (Continued)

Relevance 3 1740/6J Does silicon accelerate decarburization.
Metal Progress, Vol.78, Dec.1960, pp 78-81.

<u>Indexing</u>	Hardness	Pcb	Molybdenum	Nmo
	Decarburising	Vmq	Steels	Ns

Comments The document would have been found if the search had included the implied concept 'hardness', with 'steel' and 'molybdenum'.

Reason for failure Searching B and F.

QUESTION 108. What are the causes of the secondary hardening characteristics of high speed steels.

SEARCH PROGRAMME

	<u>Concepts</u>	
(A)	Hardness Pcb	1. A : B, B : A
(B)	High speed tool steels Ns.s	2. B : C, C : B
(C)	Hardening Vmj+	3. B : D
(D)	Heat treatment Vm+	4. B : E, E : B
(E)	Strength of materials Pg/z+	5. A : F, F : A
(F)	High strength steels Ns.p	A : G, G : A
(G)	Low alloy high strength steels Ns.hp	C : F, F : C
(H)	Wear Pel	C : G, G : C
		6. B : H, H : B

DOCUMENTS

Relevance 3 1619/729Q Heading with high vanadium dies.
American Machinist, Vol.105, 9 Jan.1961, pp 72-73.

<u>Indexing</u>	Tool steel	Ns.s	Wear	Pel
	Hardness	Pcb		

Comments The concept 'tool steel' was not permuted with 'wear' or 'hardness'. Permutation would have found the document at the first or sixth search.

Reason for failure Indexing D.

QUESTION 111. Is the ductile-brittle fracture transition of metals wetted by liquid metals caused by diffusion of the liquid metal, or is there any similarity to the transition occurring in body centred cubic metals as a function of temperature.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Ductile brittle transition Pbt	1. A : B : C, B : A : C
(B)	Liquid metals N Mahf	C : A : B, A : B : D
(C)	Diffusion Oq	B : A : C, D : A : B
(D)	Absorption Or	2. A : C, C : A
(E)	Brittle fracture Pjb	A : D, D : A
(F)	Liquids Mahf	3. B : E, E : B
(G)	Metals N+	4. C : E, E : C
		D : E, E : D
		5. A : F : G, F : G : A
		F : A : G
		6. A

DOCUMENTS

Relevance 3 1279/799Q A study of fracturing behaviour of copper and zinc coated mercury. AIME Metallurgical Soc. Trans., Vol. 221, April 1961, pp 261-285.

<u>Indexing</u>	Liquid mercury Nhg Mahf Brittle fracture Pjb
<u>Comments</u>	These two concepts not brought together in the permutation. The search for 'liquid metals' should be N+ Mahf, to find all types of liquid metals. The code for 'liquid metals' made up from 'metals' N and 'liquid' Mahf is not satisfactory as individual liquid metals are separated by the notation
<u>Reasons for failure</u>	(a) Indexing D. (b) Searching D. (c) Index language D.

QUESTION 112. Is there any direct evidence that preferential precipitation on non-coherent boundaries of annealing twins is due to the presence of dislocations.

SEARCH PROGRAMME

<u>Concepts</u>		
(A)	Twins Oevp or Oevv	1. A : B : C, A : C : B
(B)	Precipitation boundaries Odj	B : A : C, B : C : A
(C)	Dislocation Oed	2. A : D
(D)	Annealing Vme	3. A : B, B : A
(E)	Dislocations Oeb	4. A : C, C : A
		A : E, E : A
		5. C : D, D : C
		E : D, D : E
		6. B : D, D : B

QUESTION 112. (Continued)

DOCUMENTS

Source 1957/200M Electron-microscopic study of recrystallisation twins in copper. ACTA Metallurgica, Vol. 8, Dec. 1960, pp 874-877.

<u>Indexing</u>	Electron microscopy Xulme	Copper	Ncu
	Recrystallisation twins Oevp	Twinning	Oej
	Grain growth Oevv	Dislocations (not translated)	

Comments The concept 'dislocations' was not translated into the class number. The document could have been found by extending the search to 'twinning' Oevp alone, but this would have been contrary to the searching rule.

Reasons for failure Indexing C

Relevance 3 1636/747Q Effect of grain size and temperature on slip, twinning and fracture in 3% silica iron. ACTA Metallurgica, Vol. 9, March 1961, pp 191-204.

<u>Indexing</u>	Slip Oef	Twinning	Oej
	Brittle fracture Pjb	Grain size	Odh

Comments It was decided not to search "twinning" alone. If this had been done, the document would not have been found as the searcher was using the wrong number for "twinning"; of the three places in the schedules for "twinning", Oej, Oevp, and Oevv, Oej should have been used.

Reasons for failure (a) Searching F.
(b) Index language A.

QUESTION 115. What is the cross-sectional shape of extrusions formed on the surface of aluminium alloys subjected to fatigue.

SEARCH PROGRAMME

<u>Concepts</u>	<u>Searches</u>
(A) Aluminium Nal	1. A : C : D, A : D : C
(B) Aluminium alloy Nal.d+	C : A : D, D : A : C
(C) Fatigue Pk	D : C : A, B : C : D
(D) Stress raisers Px	B : D : C, C : B : D
(E) Surface properties Pej	D : B : C, D : C : B
	2. A : C, C : A
	B : C, C : B
	3. A : D, D : A
	B : D, D : B
	4. C : D
	5. C : E, E : C

QUESTION 115. (Continued)

DOCUMENTS

Source 2069/651Q A study of fatigue deformation by reflection electron microscopy. Inst. of Metals Jnl., Vol. 59, March 1961, pp 253-254.

Indexing Fatigue Pk Microstructure Od/e
Electron microscopy Xulme Surface properties (not translated)
Deformation Pg

Comments The concept 'surface properties' was not translated into the class number, and concepts 'extrusions' (stress raisers) and 'aluminium' in the document were omitted altogether.

Reasons for failure Indexing A and C.

Relevance 3 1733/ Some results of the examination of aluminium alloy fracture surfaces. Metallurgica, Vol. 63, March 1961 pp.117-124.

Indexing Aluminium alloys (not translated) Fatigue Pk

Comments The concept "aluminium alloys" was not translated into the class number.

Reason for failure Indexing C.

QUESTION 117. How does the dislocation density of aluminium change when an annealed sample is subjected to shear strains of the order of 10^{-2} .

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Aluminium Nal	1. A : C : B : D
(B)	Dislocation Oed	B : D : A : C
(C)	Annealing Vme	2. A : C : B, B : A : C
(D)	Density Teb	3. A : B, B : A

DOCUMENTS

Relevance 3 1196/167N Strain ageing in silver base Al alloys. AIME Metallurgical Soc. Trans., Vol. 221, Feb. 1961, pp 103-107.

Indexing Silver aluminium alloys Nagal
Dislocations Oed

Comments The searcher did not search the index to the schedules, which would have revealed aluminium alloys where aluminium was not the first mentioned element, e.g. 'aluminium: Silver aluminium alloy' (Nagal). The system would assist the searcher to find the document if it allowed for permutation of the alloy elements in the class sequence, e.g. 'Aluminium silver alloy' (Nalag) and 'silver aluminium alloy' (Nagal).

Reasons for failure (a) Searching G
(b) Index language E.

QUESTION 117. DOCUMENTS (Continued)

Relevance 3 1270/796Q Effect of temperature on the creep of polycrystalline aluminium by the cross-slip mechanism.
AIME Metallurgical Soc. Trans. Vol.221, April 1961, pp 229-232.

<u>Indexing</u>	Aluminium Nal Creep Ph Dislocation Oeb
<u>Comments</u>	The concept 'dislocation' was incorrectly translated into Oeb and not Oed. The search could have extended to more generic 'aluminium crystal deformation'
<u>Reasons for failure</u>	(a) Indexing C. (b) Searching D.

QUESTION 124. How may cooling waters in an Atomic Energy power plant be treated to decrease the corrosion of aluminium-nickel alloy sheaths, which contain fuel elements.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Aluminium nickel alloys Nalni	1. A : B : C, C : A : B
(B)	Corrosion, water Opm	2. D : E : B
(C)	Sheaths Kce	3. D : E : C
(D)	Reactors Dk	4. E : C
(E)	Fuel elements Jg	5. E : A
		6. A : B

DOCUMENTS

Relevance 3 1461/138P Metallurgy in nuclear power technology: 5 Fuel element canning materials pt.3.
Metal Treatment, Vol.28, Jan.1961, pp 21-30.

<u>Indexing</u>	Nuclear reactors Dk Fuel elements Jg Aluminium alloys Nal.d Corrosion Op Cans Kcm
<u>Comments</u>	The searcher was unfamiliar with the system, and did not know that 'cans' (Kcm) is used for reactor fuel element cans and sheaths. Knowing this, the third search should have been Dk Jg Kcm and not Dk Jg Kce and would have retrieved the document.
<u>Reason for failure</u>	Searching H.

QUESTION 126. What alloys of nickel-chromium-cobalt have useful high temperature strength at 1700°F (927°C) but contain no strategic columbium.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Nickel chromium cobalt alloys Nnicrco	1. A : B, B : A
(B)	High temperature mechanical properties Pb Prb	2. A
(C)	Nickel cobalt alloys Nnico	3. C : B, B : C
(D)	Nickel chromium alloys Nnicr	4. D : B, B : D
(E)	Columbium Nnb	5. C
		6. E : D, D : E

DOCUMENTS

Relevance 2 1456/777Q A new cast alloy for use at 1900°F.
Metal Progress, Vol. 79, April, 1961, pp 97-99.

Indexing Nickel chromium cobalt alloys Nnicrco
Turbine blades Je

Comments The alloy was not brought to the front in permutation;
although of obvious importance.

Reason for failure Indexing D

Relevance 2 2065/156A A new high temperature alloy. Metal Treatment,
Vol. 28, March 1961, pp 123-124.

Indexing Nickel chromium molybdenum cobalt tungsten alloy
Nnicrmocow
Index entries were made under "Nickel chromium
molybdenum cobalt tungsten alloys'(Nnicrmocow) and for each
of the alloys, e.g. 'chromium, nickel chromium molybdenum
cobalt tungsten alloy'(Nnicrmocow).

Comments The subject index was not checked under any of the elements
of the alloy, any of which would have given a lead to Nnicrmocow.
Permutation within the class number of an alloy is not allowed, in
the system, but partial permutation in this instance would have been
helpful to the searcher, e.g. Nicrcomow in the class sequence would
have retrieved the document.

Reasons for failure (a) Searching G.
(b) Index language E.

Relevance 3 1254/439Q The evaluation of nickel-base precipitation-
hardening superalloys. DMIC Memo 84.

Indexing Nickel chromium alloys Nnicr

Comments The concept 'nickel cobalt alloys' was omitted. The search
could have broadened to 'nickel chromium alloys' (Nnicr) alone
to retrieve the document.

Reasons for failure (a) Indexing A.
(b) Searching F.

QUESTION 126. DOCUMENTS (Continued)

Relevance 3 2018/22561 Manufacture of point bearings in instruments.
U.S. Patent 2,973,291.

<u>Indexing</u>	Cobalt chromium nickel alloys	Ncocrni
<u>Comments</u>	The searcher did not check the index to the schedules under 'nickel', 'chromium' or 'cobalt' where a lead would have been found to 'cobalt chromium nickel alloys'(Ncocrni). Permutation of the elements of the alloy in the class sequence might have retrieved the document.	
<u>Reasons for failure</u>	(a) Searching G (b) Index language E.	

QUESTION 130. Which type of soft solder is most suitable for joining copper alloys if the risk of intercrystalline penetration of the copper by the molten solder is to be minimised.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Solder, ing Vty	1. A : B, B : A
(B)	Copper Ncu	A : C, C : A
(C)	Copper alloys Ncu.d	2. B : D, D : B
(D)	Soldered joints Kyv	C : D, D : C
		3. D
		4. A

DOCUMENTS

Relevance 3 1025/480Q Can copper alloys hold the line at ultralow temperatures. Iron Age, Vol.187, 9 March 1961, pp 92-94.

<u>Indexing</u>	Copper Ncu	Soldering (not translated)
<u>Comments</u>	The concept 'soldering' was not translated into the class number Vty.	
<u>Reason for failure</u>	Indexing C.	

QUESTION 131. Is the crystal orientation of uranium affected by the previous history of the metal, and what effect does orientation have on properties.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Orientation Oer	1. A : B, B : A
(B)	Uranium Nu	A : C, C : A
(C)	Uranium alloys Nu.d	

QUESTION 131. (Continued)

DOCUMENTS

Source 1717/240N The recrystallisation of uranium during cold or hot forging. Jnl. of Nuclear Materials, Vol. 3, Jan. 1961, pp 115-119.

<u>Indexing</u>	Uranium	Nu
	Recrystallisation	Oevp
	Forging	Vhc

<u>Comments</u>	The searcher abandoned the search after the first programme 'orientation: uranium'. The search could have extended to 'Uranium, or Uranium alloys: microstructure (Od/e+)' to retrieve the document.
-----------------	--

Reason for failure Searching D.

QUESTION 132. What mineral sources of Columbium are available and how may low grade ores be concentrated.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Columbium Nnb	1. A : B, B : A
(B)	Mineral deposits OAq	2. A : C, C : A
(C)	Ores N.w	3. A : D, D : A
(D)	Minerals Mac	

DOCUMENTS

Relevance 3 1494/24117 Columbium and tantalum separation.
U.S. Patent 2,962,372

<u>Indexing</u>	Columbium	Nub	Extraction	Vc
	Source material (not translated)			

Comments The concept 'source material' was not translated into N.w "ores". The search did not try "extraction", (Vc+), a concept not in the wording of the question, but closely related.

<u>Reasons for failure</u>	(a) Indexing C.
	(b) Searching B.

QUESTION 133. How may defects in the enamelling of ferrous articles due to combustion gases and process vapours be avoided.

SEARCH PROGRAMME

	<u>Concepts</u>	<u>Searches</u>
(A)	Vitreous enamel coatings Ldk	1. A : B, B : A
(B)	Corrosion, high temperature gas Opr	2. A : C, C : A
(C)	Oxidation Om	3. A : D, D : A
(D)	Defects (not translated)	4. E : D, D : E
(E)	Vitreous enamel coating Vwk	5. A : F, F : A
(F)	Corrosion Op	6. E : F, E : G
(G)	Oxidation Om	F : E, G : E

DOCUMENTS

Relevance 3 1638/22946 Effect of moisture in furnace atmosphere during ground coat firing. American Ceramic Soc. Jnl. Vol. 44, Jan. 1961, pp 1-6.

Indexing Vitreous enamels Lg

Comments The concept 'coatings' was omitted, 'Vitreous enamels' was translated Lg, and not 'vitreous enamel coatings' Ldk. This raises the point of whether "enamel coatings" should be made up of 'enamel' (Lg) and 'coatings' (Ld) or enumerated (Ldk). If the notation for 'enamel coatings' had been Lg Ld, the document would have been found. The concept 'defects' was not translated into the class number.

Reason for failure (a) Indexing A and C.
(b) Index language C.

Relevance 3 1789/230L Institute of Vitreous Enamellers Annual Conference. Metal Finishing Journal, Vol. 7, Jan. 1961, pp 26-32.

Indexing Vitreous enamel coatings Ldk
Strength of materials Pg/z

Comments The search could have extended to 'Vitreous enamel coatings' with the less specific term 'strength of materials'.

Reason for failure Searching E.

QUESTION 134. How may the value for the toughness of a fracture be obtained.

SEARCH PROGRAMME

<u>Concepts</u>		<u>Searches</u>
(A)	Impact testing Xtbm	1. A : B, A : C
(B)	Fracture Pj	2. A
(C)	Brittle fracture Pjb	3. B : D, C : D
(D)	Testing Xh+	

DOCUMENTS

Relevance 2 1257/699Q Review of recent developments in the evaluation of special metal properties. DMIC Memo 94.

Indexing Fracture toughness Pj

Comments The important concept 'fracture testing' was omitted.

Reason for failure Indexing A.

Relevance 2 1326/566Q The properties of some metals in alloys at low temperatures. Institute of Metals Jnl. Jan.1961, pp 145-161.

Indexing Low temperature properties Pb Prd

Comments The concept 'fracture toughness evaluation' was omitted.

Reason for failure Indexing A.

APPENDIX 5A

Comments on Test Procedure

Apart from the actual test on the W.R.U. index, this work has also been an interesting experiment in the technique of testing index systems. This technique was a by-product of the first Aslib-Cranfield test, and it was, in fact, only the second occasion in which an attempt had been made to carry out such a test. It has resulted in a considerable advance in the procedures, and we hope the validity of the technique will be shown in the report, which outlines the methods which were used. This appendix considers a few of the practical matters.

It has to be realised that there were complications involved in this test due to the distance between Cranfield and Cleveland. It was also most unfortunate that it was not possible for the second author to have the extended discussions which were intended to be held after the Cleveland conference in April, 1962. The result of both factors was that the work took considerably longer than might otherwise have been the case.

The starting date of the test may be taken as May 1961, when W.R.U. sent to Cranfield the first lists of documents to be included in the test. By July the first set of questions had been received at Cleveland, but the delay in the receipt by W.R.U. of their new computer held up the searches until September. From then until early March 1962, further searches were made and the results sent to Cranfield.

The indexing of the documents at Cranfield commenced in September 1961 and was done on a part-time basis by the first author, being completed in February 1962. The clerical tasks of preparing the physical index proceeded concurrently, and the testing at Cranfield was completed during March 1962.

After the Cleveland Conference, work at Cranfield was concerned with analysis of the test results, and it was at this stage that the major fault in the planning of the test became clear. The clerical work in the earlier stages of the test had been skimped and in particular had failed to make certain exactly which documents were in the W.R.U. file. It was some months after analysis had started that it was realised that there must be serious discrepancies between the list of documents which we had thought were included in the W.R.U. file, and the documents which actually were included. The receipt from W.R.U. in October 1962 of a print-out of the document numbers enabled this matter to be straightened out, but a considerable amount of time had been wasted in fruitless analysis.

This analysis was also far more detailed than had been originally intended, and as a result it was necessary for the first author to become very closely acquainted with the W.R.U. index language. This is not a simple task, and a considerable amount of correspondence was necessary to clear up many of the doubtful points, in particular with regard to the interpretation of the search programmes.

The first author, who worked exclusively on this test, put in 1690 hours work between September 1961 and July 1963; the second author, who was mainly concerned with the general organisation of the test, contributed approximately 500 hours. In addition about 500 hours were spent on the test by clerical staff.

Most of the technical points concerned with this method of testing are discussed in the main report, but to summarise these, it is considered that this test has shown the possibility of ascertaining, within reasonably precise limits, the operating efficiency of an indexing system. This can be obtained by testing a relatively small sample of the collection; certainly the number of documents and questions used in the main test was sufficient, but equally so the number used in the test of patents (see Chapter 6) was too small to give any valid results. The next test to be carried out will reduce the size of the document collection, but have approximately the same number of questions.

This test has also shown that the analysis which can be done is sufficient to show why the system is operating at a particular level and thereby to show how it can be operated more efficiently or more economically.



DSPACE

<https://dspace.org/>

Aslib Cranfield research project - A report on a test of the index of metallurgical literature of Western Reserve University

Aitchison, Jean; Cleverdon, Cyril W.

1963-10

<http://hdl.handle.net/1826/860>