

AUTOMATION IN DOCUMENTATION

1. UNION CATALOGUE PROCESSING BY DIGITAL COMPUTER

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Describes the compilation and the production problems associated with Union Catalogue. Builds up the background for the computer. Enumerates the probable uses to which the computer can be advantageously put in Insdoc.

I GENESIS

The essence of documentation lies in the accurate and speedy dissemination of information about knowledge to society. Considerable thought has been devoted to make documentation realise this goal. Viewed from this point, the theories and practices of classification and cataloguing, bibliographies, indexing and abstracting reduce to mere instruments for realising this aim. An entirely new field is being cultivated in the Western countries to attain this very purpose. This field is called "Mechanical Methods or Automation in Documentation". Sizeable amount of literature exists on this new thought. Nearly every documentation centre in the West is contributing its share in developing this field. Insdoc, too, has entered this field with a view to keep abreast with the developments and to contribute its own share in the cultivation of this field.

1.1 The Experimental Cell

There exists a cell in Insdoc which is charged with the responsibility of experimenting with the various mechanical methods available for documentation and to develop few methods which could efficiently be used under Indian conditions. This cell recently conducted an experiment on digital computer in non-arithmetical data processing.

2 INTRODUCTION

In this paper an attempt is made to describe the experiment as fully as possible

without using too much jargon either of the computer field or of the field of documentation. An attempt is also made not to sacrifice precision for the sake of simplicity and as such wherever a jargon had to be used it has been defined as lucidly as possible before its use. Very little knowledge in either fields is assumed on the part of the reader.

The experiment if being referred to as "Union Catalogue Processing by the Computer". This experiment has been conducted at the Computer Centre of Indian Institute of Technology, Kanpur, during the third week of October 1964.

2.1 Scope

Nothing new is claimed in this experiment except that it is the first of its kind in India. The programmes used are claimed to be neither original nor the most efficient. However the experiment is unique in the sense that as far as possible the thoughts and the details of the original records have not been allowed to be much influenced or conditioned by the computer.

2.2 Object

The experiment was conducted with a view to ascertain the following

- 1 Elements of speeds and accuracy with which the non-arithmetical data can be processed on a digital computer;

- 2 Practical problems that are met with in processing the non arithmetical data;

- 3 The possibility of using a digital computer efficiently in the other routines of Insdoc; and

- 4 The extent to which the computer can be used in the processing of the Union Catalogue of Scientific periodicals available in India.

3 THE UNION CATALOGUE

The union catalogue is a complex and very important concept in the field of documentation. Basically it is the list of periodicals indicating their availability in a limited geographical region. Insdoc became interested in the compilation of the Union Catalogue of scientific and technical periodicals available in India. The work on this project was started in 1959. About 375 technical and scientific libraries reported their holdings. These holdings reported about 12,000 different titles of periodicals.

3.1 Physical Form

The union catalogue exists on card form in Insdoc. The physical appearance of the union catalogue at the moment is only a catalogue cabinet holding 5 x 3 cards. A single card or a set of cards represents an entry in this catalogue. Such a form imposes a heavy restriction in the use. An extensive use of the catalogue can only be made if this catalogue is printed. The use of conventionally available methods in the processing and the preparation of the press copy will take so much of time that the printed catalogue will have very little up-to-date information. The increased man-power in order to cut this essential time is most likely to result in questionable accuracy and reliability.

3.2 Structure of the Entry

An union catalogue entry consists of a number of items of information. Each item of information is technically called a section. Thus an entry consists of number of sections. A detailed account of the structure of an entry can be obtained in any standard book or catalogue code. (Entries in this union catalogue have been constructed according to the Classified catalogue code ed 4., which gives a very rigorous treatment). In other words, a standard union catalogue entry comprises of the following important sections:

- 1 Call Number section;
- 2 Heading or title section;
- 3 History section; and
- 4 Holding section.

CALL NUMBER SECTION is the first section of the entry. It contains the class number of the periodical and a serial number by which the periodical can be identified. The class

numbers have been assigned according to CC (= Colon Classification ed 5).

HEADING SECTION is the second section of the entry. It contains the name of the periodical as found on the title page of the periodicals.

HISTORY SECTION is the third section of the entry. It contains the date of the first volume of the periodicals and other historical details which might be of interest.

HOLDING SECTION is the last section of entry. It contains the list of the libraries along with their holdings of the periodical.

3.3 Illustration

A sample union catalogue entry is given below:

Fm55, N28 3653
CHEMISCHE fabrik. (=Zeitschrift des vereins Deutscher Chemiker Teil B).
1;1928C

From 15;1942 continued as CHEMISCHE technik.

From 19;1947 continued as ANGEW ANDTE chemie. Ausgabe & Technischwirtschaftlicher teil.

From 21;1949 continued as CHEMIE-Ingenieur-Technik.

P1A3	24C	Q1BF	7C
P1KF	31C	Q1PE	21C(21-22)
P1MF	23C	Q2BhF	1C(33)
P1MF4	31C	R1DF	24C
P3BA	1C(13-28)	R5DJ	8C(12, 13-20)
P3MF	24C	R6L3	21C
P5HA	28C	S2CA2	21-22
P5W3	?	S2KF	1955C

In this entry the first line is the call number section. Fm55, N28 is the class number of the periodical according to CC and 3653 is the serial number of the entry in the Union Catalogue. The next two lines starting with "Chemische" and ending with the "Teil B)" is the title of the periodical. The historical section is 1;1928C which means that the first volume of the periodical was published in 1928 and the periodical has not ceased publication. The next three sections relate to the change of name of this periodical. The last section is holding section. This section gives that only 16 libraries in India are having this periodical. The first part P1A3 is the code number for the

library, and the second part i. e. 24C is its holding. 24C indicates that the library is having this periodical from volume number 24 and is still subscribing to the current issues. Similarly the second library has the periodical from volume 31 and is still subscribing to it. It will be clear that the size of the entry will depend on the nature of the periodical and the amount of information that has to be incorporated into it.

3.4 Basic Data

The basic data for the experiment comprised of about 100 such union catalogue entries. These entries were selected at random from the card file of the Union Catalogue at Indoc.

4 CONVERSION

The unit of basic data is the union catalogue entry described in sec 3. This entry contains information coded in natural language in a form which can be easily read by human beings knowing English. This basic data as such is not intelligible to non English speaking persons. In order to give him the information, the entry has to be converted into a language known and understood by him. Similarly, these entries of basic data had to be converted into a language which a machine can understand or can be made to understand. Such a language exists and is technically called machine language. In this language everything rather every bit of information has to

be converted into the presence and/or absence of a physical state.

4.1 Machine Readable Language

A simple language understood and read by a wide variety of machines is built on the presence and the absence of a hole cut either on a card or on a paper tape. The combination of holes in different positions of a column gives the code for conversion of a natural language data into a machine readable data.

4.2 Source Data

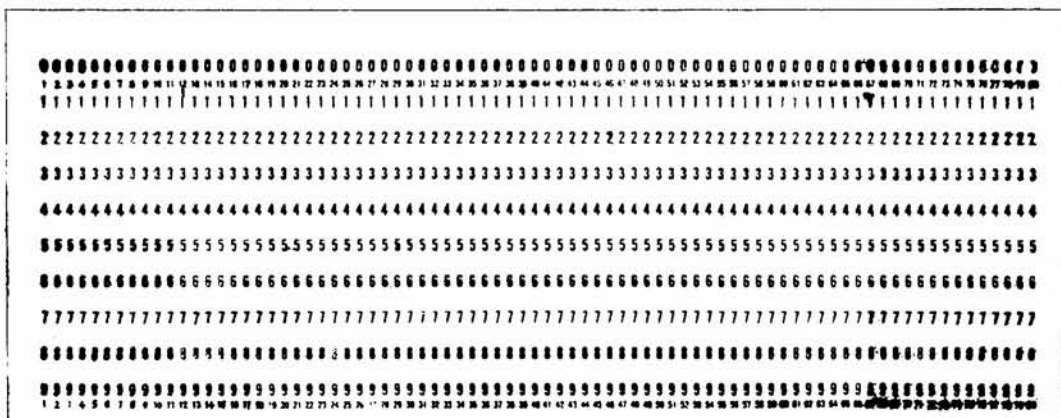
The basic data converted into machine readable form by the suitable code and on a suitable medium is called the 'Source Data'. Thus the source data for the experiment consisted of about 2,500 80 columns IBM punched cards. This source data is readable by machine, and can be fed as such to the computer.

4.3 Source Data Preparation

The source data was prepared from the basic data of 100 union catalogue entries by punching the information in each entry on to 80 column IBM general purpose punched card.

4.31 Punched Card

IBM 80 column punched card is a body-punched card. It is clear from the diagram, given below, that there are 80 columns and ten rows. For special uses, the number of rows can be increased to twelve.



4.32 Punching

It is clear that all the information given in an entry or unit of basic Data cannot be accommodated in one single 80 column card

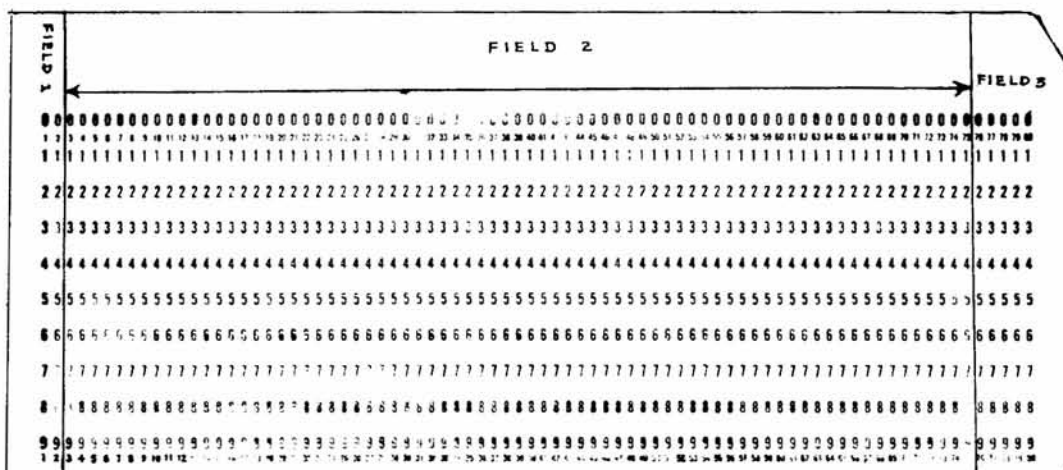
without further coding. This is mainly because one character in an unit of Basic Data is represented by one column on punched card. Space in between words is considered as a character.

4.51 Field

figure 2.

- 1 Continuation Card Field;
- 2 Information Field; and
- 3 Serial Field

The 80 column punched card was divided into the following fields as indicated in the



Field 1 or Continuation Card Field contains the continuation number of the card in column 1 and 2. There were two series of continuation numbers viz - 1) pure Indo-Arabic numerals and 2) mixed numbers of Roman capitals and Indo-Arabic numerals. The first type was used for numbering all the continuation cards upto History section of the entry in the basic data. The second type was used for numbering the continuation cards of the holding section of the entry in basic data. Every library was punched on a fresh card. The numbering was done in the following way

A1, A2, ..., A8, A9, ..., B1, ..., Z9

Field 2 or Information Field contains the items of information from an entry in basic data between 4 columns 3 to 75 both inclusive.

Field 3 or Serial Field contains the serial number of an entry in the Union Catalogue in column numbers 76-80.

4.52 Instruction

The following punching instructions were given for the preparation of the source data:

- 1 Punch the continuation card number on each card in columns 1 and 2 in a fixed field punching mode starting from 01 for the first card;
- 2 Punch a fresh card for each section of an entry in basic data from column number 3

to column number 75. The first card of each section is to be punched from column number 5 and not from column number 3;

- 3 All the continuation cards of the same section are to be punched from column number 3;
- 4 Put a \$ mark to indicate a section;
- 5 Follow composition rules while punching the cards;
- 6 Punch the serial number of an entry in columns 76-80 in a fixed field punching mode on each and every card punched for the entry.
- 7 Punch library holdings, given in the holding section of an entry in basic data, on separate cards for every library. Punch the library symbol between col 3 to 12. Punch the holding from column 17. Punch the serial number in col 76-80. Punch the continuation card numbers A1 in Col 1 & 2 for the first library A2 for second library and so on.
- 8 Verify all the cards thus punched, by the entry in the basic data.

4.6 The Source Data

With these instructions, the basic data of 100 entries from Union Catalogue was

converted into source data on punched cards. The basic data was replcaed in the Union Catalogue cabinets. For further experimentation the source data alone was used. It consisted of about 2,500 punched cards corresponding to 100 basic data entries.

4.61 Entry

An entry in the source data consisted of a string of punched cards; connected together by the serial numbers and separated by the continuation card number. Thus the basic data entry given in sec 3.3 appeared like the string of cards given in Figure 5

[illegible]

02 CHROMIUM PLATE 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000-1001-1002-1003-1004-1005-1006-1007-1008-1009-1010-1011-1012-1013-1014-1015-1016-1017-1018-1019-1020-1021-1022-1023-1024-1025-1026-1027-1028-1029-1030-1031-1032-1033-1034-1035-1036-1037-1038-10

[illegible]

00653

[illegible]

000000

[illegible]

03650

[illegible]

03653

[illegible]

24C

03653

[illegible]

235

03653

[illegible]

2000

61

This figure is self explanatory as whatever is punched is printed on the top of the card. Thus Card 1 is call number card, Card 2 is title card and so on.

5 THE COMPUTER

A computer, in very simple terms, is a device or machine which works with and on numbers. A computer, as the name suggests, counts and manipulates numbers. Transistors have revolutionised the entire computer technology. Consequently very compact and fairly cheap and commercially economic computers are available now. There are, functionally speaking, two types of computers viz Analogue and Digital computer. Analogue computer simulates a physical phenomenon. Slide rule, clocks, and a thermometer can in a restricted sense be called examples of analogue computer.

5.1 Digital Computer

Next logical question is 'what is a digital computer?' A modern digital computer is an electronic machine. A very simple example, in a highly restricted sense, of a digital computer is an Abacus. Electronic digital computers are complex machines of intricate circuitry transistors and valves. These are built primarily for counting, manipulating and producing either numerical or alphanumerical data. Very simple operations alone can be done by this circuitry.

5.2 Structure of a Digital Computer

Schematically, a digital computer may be represented as in figure 6.

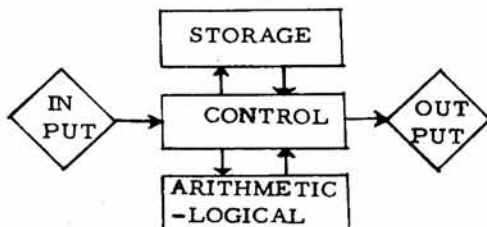


Figure 6

INPUT UNIT of a digital computer accepts Indo-Arabic numerals (numbers), Roman alphabets (letters), and Symbols (punctuation or other marks). These can be entered in the computer through this unit usually through punched cards, punched paper tape or through the key board of a typewriter provided on the computer controls.

CONTROL UNIT is the important unit which controls and regulates the entire operations of the computer. The control unit can be operated by suitable programmes

STORAGE UNIT stores the data entered in the computer through input unit by electro-mechanical, magnetic, or electronic devices until required. The information stored by a computer can be original input data, intermediate results, or instructions. The store can be imagined to be a number of cells arranged linearly, each cell being called a storage location. The storage location can be identified by a separate location number. The location number is called an Address.

A memory can be imagined in terms of a room full of card cabinets. Each file drawer can be rapidly located as it has its own number and all the drawers have equal capacity. Every memory or storage cell is analogous to one of the file drawers.

ARITHMETIC - LOGICAL UNIT is the part of the computer which can add, subtract multiply, divide and compare numbers at very great speeds. It can take certain logical decisions. It can discern positive, zero, and negative values and transfer the information to other units of the computer.

OUTPUT UNIT can produce the results in many forms, e.g. punch a tape, punch a card, make a magnetic tape, or print in a report form.

5.3 Characteristics of a Digital Computer

A digital computer, speaking very elementarily, accepts numbers, and/or letters; works with and manipulates numbers; and gives numbers as the results. Computer operations are done with a very high speed and with equally high degree of precision. The results are usually very reliable. The computer communicates with the external world by means of electrical signals. It is capable of taking simple logical decisions. It can use a large storage area on a very compact data storage media. It has high speed of selection and retrieval of the stored information. The computer is able to adapt to a wide variety of conditions effecting the source data, accumulation of data, transmission of data and processing of data. Such versatility, speed, and accuracy make a digital computer a powerful tool with great potentiality in the field of documentation. Figure 7 gives the flow of information inside and outside the computer.

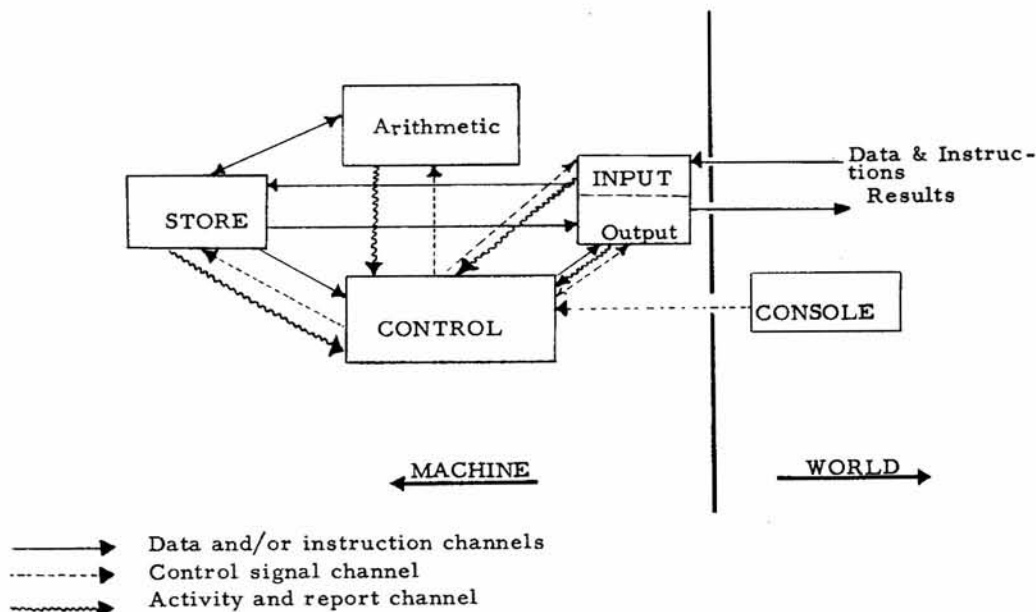


Figure 7

5.4 Making Computer Work

Very frequently a question is asked 'What can a computer do for us?' The answer is equally simple and glib 'Whatever you want it do.' This question and the answer lead one to another important and closely related field called 'Programming'. Programming is an art and science of making a computer do a set of sequential operations to achieve a desired goal or result. This is simple and not a rigorous definition. However, it indicates the importance and amount of intellectual efforts necessary to solve a problem on computer. In fact, programming tries to simulate the intellectual procedure needed to solve a problem and design suitable set of instructions to the computer to solve the problem, accurately and speedily. This requires the proper formulation of the problem desired to be solved on the computer.

5.41 What Programming Is

In Programming, that is in writing the programme, an attempt is made to translate the details of a problem into a language, the machine can understand and work with. The programming work consists of the following steps

1 Formulating the Problem - Mostly problems are stated in terms of mathematical

equations and problem numbers. Sometimes, a problem cannot be easily translated into a set of equations. In such cases other methods are used.

2 Analysing the Problem - the formulated problem and the equation are arranged in such a way that the desired results are achieved.

3 Planning - the actual 'mechanics' of the programming operation in which a detailed step-by-step plan of the operations is drawn up. At this stage the programme is carefully checked for errors.

4 Execution - the punching and feeding the programme in the machine.

5.42 Programme

The programme is only a set of permissible instructions grouped in such a way so as to solve a problem efficiently. Thus programme enables a computer to solve the complicated and involved problems by simple instructions alone.

5.43 Instruction Format

All information - instructions, problem numbers data etc - is in the same form i.e. group of digits. Each group or digit irrespective of what it represent is called

a computer word. There are two types of computer words: instruction words and not instruction words. An instruction word has the following format called instruction format.

OP Code No. Operation data address		
OPERATION	P ADDRESS	Q Address

Operation code number - represents the command that the computer will follow.

Operation data address gives the memory address of the number word to be used during the operation.

P & Q Address specifies the core location in the memory from where the operands are to be taken.

5.44 Illustration

The dump out programme when written in machine language and on instruction format will read as follows:

OPERATION		INSTRUCTION		
S. N.		OPERATION CODE	P ADDRESS	Q ADDRESS
0	Number of digits	2	5	5
1	Rewind tape 0	34	00000	02004
2	Read the tape 0 in location 08001	37	08001	02000
3	Write from 08001 in memory on the console typewriter	39	08001	00100
4	Branch back to 00012 in the memory for the next instruction	49	00012	00000

For reading facility the operation code has been translated into the natural language. Normally the programme for the dump out world appear like

```
340000002004 37 08001 020003908001
00100490001200000
```

6 EXPERIMENTAL WORK

This much for the background of the union catalogue and the computer. The experimental work conducted at Kanpur consisted of the following jobs:

- 1 Master File on magnetic tape
- 2 Checking the Master File
- 3 Manipulating the Master

6.1 Master File

The source data was transferred on to the magnetic tape. The source data on the magnetic tape was referred to as the master file. After the transference of the data the source data was not used. Further manipulation was done only with the Master File.

6.11 Input Programme

The programme used for building the

master file is given in Appendix 1. The problem that was solved by this input programme was to put all the cards in the source data corresponding to an entry in the basic data together on the magnetic tape without any interrecord gap and to put an interrecord gap between the last card of this entry and the first card of the next entry. An interrecord gap is the empty tape space put automatically between two succes-

sive writing operations. This was achieved by using SPS (= Symbolic Programming Systems) language for programming.

6.12 Flow Diagram

Figure 8 gives the flow diagram. It was thought necessary to check the first and second card of every basic entry in the source data cards before transcribing to the magnetic tape.

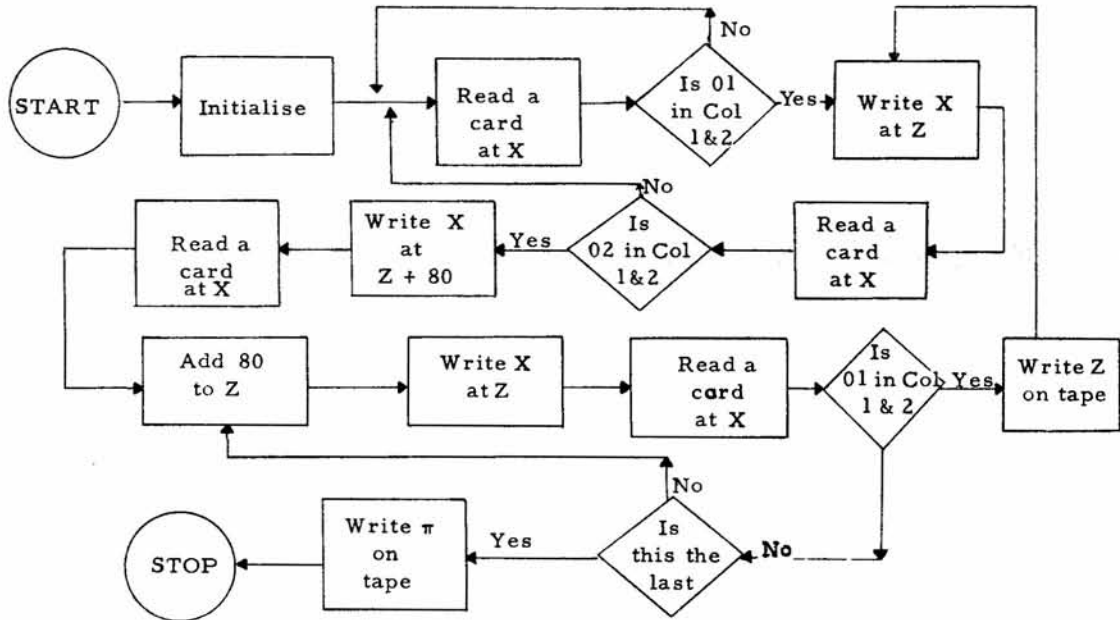


Figure 8

6.2 Checking the Master File

It was necessary to check the master file in order to ascertain whether or not the source data was being transcribed in the desired manner. The method used for doing this was to have a dump from the master file.

6.21 Dump-out Programme

The dump out programme was very simple and was written in machine language. In the natural language the programme consisted of the following steps

- 1 Rewind the Master tape file.
- 2 Read from Master file at X in Computer
- 3 Type out on Console type writer from X in the computer
- 4 Go to step 2

6.22 The Dump Out

The result of this programme were obtained on the console typewriter. A sample of the dump out has been given in the Appendix 2. It will be seen that this dump resembles the printed page of the union catalogue in some respects. There is no order or sequence in the master file.

6.3 Master File Manipulation

The master file was manipulated to give an alphabetic, geographical and chronological indexes. The results obtained were extremely accurate and very quick as compared to Manual handling. Out of these manipulations only the details of alphabetisation will be given.

6.31 Alphabetisation Programme

With this programme the information contained in the Master file was alphabetised. The programme designed has been given in Appendix 3. The programme contained about 265 machine instructions and nearly the entire memory was used up for this purpose. The language used for this programme was S. P. S.

6.32 Programme Execution

For the execution of the programme three tape units were used. The titles of the periodicals were copied on another tape from the master file. In principle, the entire title of the periodicals was read and compared with another and the lower one was transferred to another tape. This operation was repeated 96 times to obtain a complete alphabetised list.

6.33 Results

The results were available on either of the two intermediate tapes used for alphabetisation. The results have been given in Appendix 4. These results were obtained from the tape by an output programme.

6.34 Output Programme

The programme for taking out the results from the tape was written in machine language. In natural language the programme consisted of the following steps

- 1 Rewind the tape
- 2 Read a record from the tape at
X in the memory
- 3 Punch X from the memory
- 4 Go to step 2 if the next record is
not a record mark else stop.

6.35 Alphabetical Index

The cards punched by the computer were the alphabetic index to the master file. These were printed by the IBM 407 accounting machine. The printed copy was the hard copy which could be used for many purposes.

6.4 Problems

Although the experiment with its limitations can be pronounced as a success, yet the entire job was neither so simple nor so easy as it appears. Mentioned below are some of the problems that were faced during the experimentation.

6.41 Classification

Colon Classification has been used for classifying Union Catalogue entries. No doubt, it is a very powerful and is the most modern classificatory thought developed so far, but the computer in its present state of development is not able to work with it. This is mainly because the scheme uses mixed notations in one and the same array. On a punched card an array of order n is represented in the $(n+1)$ th column if the (BC) is represented on column 1. This difficulty is further accentuated by the lack of facilities available with IBM 1620 Data Processing System for lower case Roman alphabets and five connecting symbols used in the scheme.

The hierarchy of digits in CC is:

, ; : . ' a, b, --- y, z, 1, 2, --- 8, 9, A, B, --- Y, Z. Whereas on computer it is b.) + \$ * - /, (@A, B, ---, Y, Z, 0, 1, --- 8, 9.

It will be seen that the opposite hierarchy scales of digits poses a problem on computer and makes the use of Roman capitals, and Indo-Arabic numerals in the same way entirely unhelpful. Another effect is that on the computer IAN appear later than the Roman Capital -- sequence just opposite to that demanded by CC. Moreover ; (semicolon) and : (colon) are not available on the computer. It is conjectured that the powerful concepts of 'Optional facets', 'Telescoping of arrays', and 'Telescoping of facets' are likely to create and complicate the problem. In this experiment these problems have not arisen.

6.42 Programming

The difficulties pertaining to programming were not many. Most of these were on account of lack of availability of a suitable compiler and a suitable language.

6.5 Solution

These problems did not hold up the progress of the experiment. The experimentation continued in spite of these problems. However, many ad hoc solutions were arrived at and were frequently used. Some of these are given below.

6.51 Classificatory

Classificatory problem is not at all serious so long as no sorting and sequencing

is desired by any part of the class number and the work is confined to the 02 card. But it became thwarting when an attempt at geographical and chronological sorting was made. This problem was overcome by the judicious use of 'delimiters' and fixing the facet field on the 01 cards of the source data. The sequencing problem according to space facet was avoided rather than solved on account of shortage of time. Although notational difficulties of CC were not experienced for the same reasons, it was felt that proper field fixation of facets would yield a temporary solution. A more permanent solution to the information processing problems would be to write a suitable compiler but it could not be done due to paucity of both experience and time.

6.52 Programming

The difficulties arising out of the absence of suitable language and a compiler were solved by using a more fundamental language i.e. SPS or Symbolic Programming System. Most of the deeper difficulties were solved by the able guidance of Prof. Rabino-witz and minor problems were solved by discussions with Prof. P. Purushottam - a class fellow.

7 OBSERVATION

7.1 Speed

Conversion of basic data into source data is essentially a manual operation. The speed of operation is slightly higher than that of typing an index card. The other operations are performed very fast by the computer except tape rewinding which happens to be much too slow from computer standards. However, from the manual standards these operations are very fast. The master file building took 3 1/2 minutes approximately. The alphabetisation took approximately 5 minutes computer time. The printing of results took little less than a minute. This gives some rough ideas about the speeds with which the computer can process non-arithmetical or natural language data.

7.2 Reliability

The reliability of results is entirely dependent on the source data. Any mistake at the source data stage is likely to be faithfully continued during and after operation. In other words, the computed operations are

extremely reliable - as reliable as the source data for natural language data processing.

7.3 Accuracy

The accuracy of the results depends on the accuracy of the source data. If the source data is cent per cent accurate the results are also cent per cent accurate. Computers with high degree of precision are available. The one used for the experiment has a high degree of accuracy.

7.4 Versatility

The experiment demonstrated the versatility of the digital computer in one of the important aspects of documentation. It proved the value of computer in processing the Union Catalogue data efficiently and speedily. The computer can advantageously be used in preparing either a press copy or master copy for printing the Union Catalogue.

8 FUTURE

It has been rightly remarked that the computers have initiated a new movement a second industrial revolution. Computers are becoming more and more available not only for research purposes but in other walks of life. Computer has been used in the field of documentation in other countries. If India is not to be taken by surprise in this field, the time for work has arrived. The information storage and retrieval is a very fertile field where the computer can be effectively and advantageously used even in India where manpower is not so acute a problem as in west. The high speeds of operation with a high degree of precision and reliability; the capacity to communicate with the external world by electrical signals; the capability of taking simple logical decisions; the capacity of using large storage area on a very compact data storage media, the high speed selection and retrieval of stored information; and the adaptability to a wide variety of conditions influencing the source data, accumulation of data, the transmission of data and the processing of data for many purposes are likely to make computers a very useful and very efficient tool not only in the field of documentation but also in the other fields of data processing.

8.1 Insdoc's Role

The task for Insdoc should be to continue the experimentation in different problems of

documentation. The project team should test, evolve and develop suitable methods that will solve many immediate problems with high speed and high degree of precision. In doing so it should not try to change everything to suit computer. Instead an effort should be made to make computer do the desired thing in the desired way. This points to the fact that instead of working with already tested systems, experiment must commence from the very beginning. There is a pressing need for proper formulation of the problem of Information Retrieval. A reasonable inference from the published literature is that the information retrieval problem has been frequently solved but never formulated. The nature of the fundamental problems that arise in information retrieval has to be thoroughly investigated.

8.2 Immediate Work

Efforts should also be made to design a translator which will suit the information storage and retrieval problems in a neat, elegant and speedy way.

The present programmes have to be refined and better sorting sequencing methods have to be developed.

8.3 Future Potentiality

This experiment has shown the way for the future work. The master file could be efficiently used for speedy and accurate preparation of the following indexes to the Union Catalogue

- 1 Alphabetical index to the periodical included in the Union Catalogue;
- 2 Alphabetical list of participating libraries;
- 3 Classified list of the participating libraries;
- 4 Classified list of Union Catalogue

5 Alphabetical subject index to the Union Catalogue

6 Geographical list of periodicals included in the Union Catalogue;

7 Language list of periodicals included in the Union Catalogue; and

8 Preparation of regional and or city catalogues from the Union Catalogue etc.

In other words by using a computer it should be possible to publish Union Catalogue with these indexes in a short time with minimum of editorial and other time consuming works.

8.4 Application to Procurement Work

If additional information regarding the standard abbreviation of a periodical is added to the Union Catalogue entry, it will be possible to link up the document procurement work of Insdoc. In a suitably designed system, it will be possible to use master file either on tape or on magnetic disc for increasing the efficiency, accuracy of this service. Some rethinking is necessary before an experiment can be launched.

9 ACKNOWLEDGEMENT

Shri B.S. KESAVAN, Director, Insdoc; Dr. H.K. KESAVAN, Head Computer Centre; Prof. RABINOWITZ; and Shri P. PURUSHOTHAM of Guindy are the names of some of the important persons whose patronage, helping attitude and wise counsel have been a great solace during moments of despair. To thank them most gratefully and respectfully is deemed to be a great privilege. Prof. Rabinowitz who gave an insight into the computer and the necessary software is beyond all thanks. One is only filled with awe mixed with profound respect for his erudite learning and his charming exposition of the complicated subject like software or programming or algorithms.

Appendix 1

DORG800	
X DAS 81	
Z DSS 16000,8000	
Y DAC 1,1	
ORIGINK ,02004	
START RACDX	
TF X+160,Y	
SF X-1	
CM X+2,07071,8	
BNE START	
HERE TR Z,X-1	
RACDX	
SF X-1	
TFM ALPHA+6,Z+160	
CM X+2,07072,8	
BNE START	
ALPHA TR Z+160,X-1,Z	
AM ALPHA+6,00160,9	
RACDX	
CM X+2,07071,8	
BNE LCT	
WATOZ+1	
B HERE	
LCT BNLCALPHA	
K ,02005	
K ,02005	
H	
DENDORIGIN	
36000720050036002010050040001200276260005900274250001100000260009000269	0000
26000950026431000000020026001140027420000000001149000120000	1
DORG800	2
0000000800	90003
X DAS 81	4
0000000801 00081	90005
Z DSS 16000,8000	6
0000008000 16000	90007
Y DAC 1,1	8
0000000963 00001	90009
00000002	060096200964 0001
ORIGINK ,02004	00011
00000009643400000020042	J10096400976 R0012
START RACDX	00013
0000000976370080100500Z	J10097600988 R0014
TF X+160,Y	00015
0000000988260096100963Z	J10098801000 R0016
SF X-1	00017
0000001000320080000000Z	J10100001012 R0018
CM X+2,07071,8	00019
000000101214008030P071Z	J10101201024 R002
BNE START	00021
0000001024470097601200Z	J10102401036 R0022
HERE TR Z,X-1	00023
0000001036310800000800Z	J10103601048 R0024
RACDX	00025
0000001048370080100500Z	J10104801060 R0026
SF X-1	00027
0000001060320080000000Z	J10106001072 R0028

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IIT. KANPUR 26/10/64

TFM ALPHA+6,Z+160
0000001072160111408160Z
CM X+2,07072,8
000000108414008030P072Z
BNE START
0000001096470097601200Z
ALPHA TR Z+160,X-1,2
0000001108310816000800Z
AM ALPHA+6,00160,9
0000001120110111400J60Z
RACDX
0000001132370080100500Z

000000114 140 0 0 07*7
BNE LCT
0000001156470119201200Z
WAT0Z+1
0000001168390800102000Z
B HERE
0000001180490103600000Z
LCT BNLCALPHA
0000001192470110800900Z
K ,02005
0000001204340000002005Z
K ,02005
0000001216340000002005Z
H
0000001228480000000000Z
DENDORIGIN

0000000964
00000 L600000005004900000Z
360010000500360017200500360024400500360031600500360000000500
000000000000102030400020406080003060902100408021610050015102006021814200Z
704112820080614223009081726300000000005060708090012141618151811242720242Z
822363520353045403632484455324946536048465462754453627100123456789123456Z
7890234567890J34567890JK4567890JKL567890JKLM67890JKLMN7890JKLMNO890JKLMNZ
M8000000000049009640P90JKLMNOQZ L10038800019M90000000000M90003600000 00065

00029
J10107201084 R003
00031
J10108401096 R0032
00033
J10109601108 R0034
00035
J10110801120 R0036
00037
J10112001132 R0038
00039
J10113201144 R004
00041
J10114401156 R0042
00043
J10115601168 R0044
00045
J10116801180 R0046
00047
J10118001192 R0048
00049
J10119201204 R005
00051
J10120401216 R0052
00053
J10121601228 R0054
00055
J10122801240 R0056
00057
90058
080009600115 00059
0006
00061
00062
00063
00064
00065

Appendix 2

01=J	*55 ,N5 +	05879
02	ABHANDLUNGEN, DEUTSCHEN AKADEMIE DER WISSENSCHAFTEN, BERLIN. KLASSE FUR	05879
03	ANDWIRTSCHAFTLICHE WISSENSCHAFTEN. \$	05879
04	1=1950CS	05879
A1P1KOB	1C	05879
A201BC	1956C	05879
01=H2	*73 ,M +	05268
02	TRANSACTIONS, AMERICAN INSTITUTE OF MINING ENGINEERS. \$	05268
03	FROM 59=1918 CONTINUED AS TRANSACTIONS, AMERICAN INSTITUTE OF MINING AND	05268
04	METALLURGICAL ENGINEERS. /FROM 1928 ISSUED AS TRANSACTIONS OF VARIOUS SEC	05268
05	TIONS/\$	05268
A1P3BA	122, 124, 133, 176, 180, 184-85, 187-88, 191, 193, 197	05268
A201BA1	1932-45	05268
A301BF2	1-177, 179-182, 184, 185, 187, 192, 194/1-137, 139-177, 179-182, 184-184, 187	05268
A4-192, 194C		05268
A501PD	187-89	05268
A6R5DF1	204C	05268
A7R6B3	31-76, 139, 146, 151, 153, 163-98, 208C	05268
A8R7DH	5-75, 138, 141, 161, 165, 179-83, 190-92, 196.	05268
A9R7JF1	1C	05268
B1R7JEF	184-87, 190, 205, 211C	05268
B2S1RF	1960C	05268

RAIZADA

Appendix 3

00406	00005	* ALPH	ABET	IC SORTING	INSDOC	2
00411	00005	SWITCH	DC	5,00001		4
00416	00005	ILC	DC	5,00001		7
00419	12000	OLC	DC	5,00001		1
24419	00180	X	DAS	12000		13
24782	00005	TEMP	DAS	180		15
24787	00005	TAPE0	DC	5,02000		17
24792	00005	TAPE1	DC	5,02100		2
24795	00001	TAPE2	DC	5,02200		23
24800	00005	RECDM	DAC	1,1		26
30000		FLC	DC	5,00002		29
30000	34 00000 02004	DORG		30000		32
30012	34 00000 02104	PROGA	K	00000,02004		34
30024	34 00000 02204		K	00000,02104		36
30036	37 00419 02000		K	00000,02204		38
30048	26 24802 24795	READA	RATO	X		4
30060	37 00819 02000		TF	FLC+2,RECDM		42
30072	26 00739 24795	READB	RATO	X+400		44
30084	26 01139 24795		TF	X+320,RECDM		46
30096	32 00578 00000		TF	X+720,RECDM		48
30108	32 00978 00000		SF	X+159		5
30120	11 00411 0001		SF	X+559		52
30132	24 00727 01127		AM	ILC,00001		54
30144	46 30204 01100		C	X+308,X 708		56
30156	46 30240 01200		BH	HIGH		58
30168	39 00579 02100		BE	EQUAL		6
30180	31 24418 00978	LOW	WAT1	X+160		62
30192	49 30276 00000		TR	TEMP-1,X+559		64
30204	39 00979 02100		B	LOOPI		66
30216	31 24418 00578	HIGH	WAT1	X+560		68
30228	49 30276 00000		TR	TEMP-1,X+159		7
30240	39 00579 02100		B	LOOPI		72
30252	31 24418 00978	EQUAL	WAT1	X+160		74
30264	49 30276 00000		TR	TEMP-1,X+559		76
30276	11 00411 0001		B	LOOPI		78
30288	37 00419 02000	LOOPI	AM	ILC,00001		8
30300	32 00578 00000	READC	RATO	X		82
30312	26 00739 24795		SF	X+159		84
30324	24 24567 00727		TF	X+320,RECDM		86
30336	46 30396 01100		C	TEMP+148,X+308		88
30348	46 30420 01200		BH	HHIGH		9
30360	39 24419 02100		BE	EEQUAL		92
30372	31 24418 00578	LLOW	WAT1	TEMP		94
30384	49 30456 00000		TR	TEMP-1,X+159		96
30396	39 00579 02100		B	TESTI		98
30408	49 30456 00000	HHIGH	WAT1	X+160		01
30420	39 24419 02100		B	TESTI		01 2
30432	31 24418 00578	EEQUAL	WAT1	TEMP		01 4
30444	49 30456 00000		TR	TEMP-1,X+159		01 6
30456	14 00411 0090		B	TESTI		01 8
30468	47 30276 01300	TESTI	CM	ILC,00090		011
30480	34 00000 02104		BL	LOOPI		0112
30492	34 00000 02204	PROGB	K	00000,02104		0114
			K	00000,02204		0116
		RRRA	RAT1	X		0118

AUTOMATION IN DOCUMENTATION

30504	37	00419	02100						
30516	37	00819	02100	RRRB	RAT1	X+400			012
30528	26	00579	24795		TF	X+160,RECDM			0122
30540	26	00979	24795		TF	X+560,RECDM			0124
30552	32	00418	00000		SF	X-1			0126
30564	32	00818	00000		SF	X+399			0128
30576	11	00416	0001		AM	OLC,00001			013
30588	24	00567	00967		C	X+148,X 548			0132
30600	46	30660	01100		BH	OHIGH			0134
30612	46	30696	01200		BE	OEQUAL			0136
30624	39	00419	02200	OLOW	WAT2	X			0138
30636	31	24418	00818		TR	TEMP-1,X+399			014
30648	49	30732	00000		B	LOOPO			0142
30660	39	00819	02200	OHIGH	WAT2	X+400			0144
30672	31	24418	00418		TR	TEMP-1,X-1			0146
30684	49	30732	00000		B	LOOPO			0148
30696	39	00419	02200	OEQUAL	WAT2	X			015
30708	31	24418	00818		TR	TEMP-1,X+399			0152
30720	49	30732	00000		B	LOOPO			0154
30732	11	00416	0001	LOOPO	AM	OLC,00001			0156
30744	37	00419	02100	RRRC	RAT1	X			0158
30756	32	00418	00000		SF	X-1			016
30768	26	00579	24795		TF	X+160,RECDM			0162
30780	24	24567	00567		C	TEMP+148,X+148			0164
30792	46	30852	01100		BH	HIGHO			0166
30804	46	30876	01200		BE	EQUALO			0168
30816	39	24419	02200	LOWO	WAT2	TEMP			017
30828	31	24418	00418		TR	TEMP-1,X-1			0172
30840	49	30912	00000		B	TESTO			0174
30852	39	00419	02200	HIGHO	WAT2	X			0176
30864	49	30912	00000		B	TESTO			0178
30876	39	24419	02200	EQUALO	WAT2	TEMP			018
30888	31	24418	00418		TR	TEMP-1,X-1			0182
30900	49	30912	00000		B	TESTO			0184
30912	14	00416	0090	TESTO	CM	OLC,00090			0186
30924	47	30732	01300		BL	LOOPO			0188
30936	14	24800	0090	ALPHA	DATA	FLC,00090			019
30948	47	30972	01300		BL	BAN			0192
30960	48	00000	00000		H				0194
30972	14	00406	0002	BAN	CM	SWITCH,00002			0196
30984	47	31008	01300		BL	CHANGE			0198
30996	46	31176	01200		BE	ALTER			02
31008	26	30515	24792	CHANGE	TF	RRRA+11,TAPE2			02 2
31020	26	30527	24792		TF	RRRB+11,TAPE2			02 4
31032	26	30755	24792		TF	RRRC+11,TAPE2			02 6
31044	26	30635	24787		TF	OLOW+11,TAPE1			02 8
31056	26	30671	24787		TF	OHIGH+11,TAPE1			021
31068	26	30707	24787		TF	OEQUAL+11,TAPE1			0212
31080	26	30827	24787		TF	LOWO+11,TAPE1			0214
31092	26	30863	24787		TF	HIGHO+11,TAPE1			0216
31104	26	30887	24787		TF	EQUALO+11,TAPE1			0218
31116	11	00406	0001		AM	SWITCH,00001			022
31128	11	24800	0001		AM	FLC,00001			0222
31140	36	24796	00100		RNTY	F.C-4			0224
31152	16	00416	0001		TFM	OLC,00001			0226
					B	PROGB			0228

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31164	49	30480	00000				
31176	26	30515	24787	ALTER	TF	RRRA+11,TAPE1	023
31188	26	30527	24787		TF	RRRB+11,TAPE1	0232
31200	26	30755	24787		TF	RRRC+11,TAPE1	0234
31212	26	30635	24792		TF	LOW+11,TAPE2	0236
31224	26	30671	24792		TF	OHIGH+11,TAPE2	0238
31236	26	30707	24792		TF	CEQUAL+11,TAPE2	024
31248	26	30827	24792		TF	LOWO+11,TAPE2	0242
31260	26	30887	24792		TF	EQUALO+11,TAPE2	0244
31272	26	30863	24792		TF	HIGHO+11,TAPE2	0246
31284	12	00406	0001		SM	SWITCH,00001	0248
31296	11	24800	0001		AM	FLC,00001	025
31308	16	00416	0001		TFM	OLC,00001	0252
31320	49	30480	00000		B	PROGB	0254
30000					DEND	PROGA	0256

00406	*SWITCH	00411	ILC	00416	OLC	00419	X	24419	TEMP
24782	TAPE0	24787	TAPE1	24792	TAPE2	24795	RECDM	24800	FLC
30000	PROGA	30036	READA	30060	READB	30168	LOW	30204	HIGH
30240	EQUAL	30276	LOOP1	30288	READC	30360	LLOW	30396	HHIGH
30420	*EEQUAL	30456	TEST1	30480	PROGB	30504	RRRA	30516	RRRB
30624	LOW	30660	OHIGH	30696	*OEQUAL	30732	LOOP0	30744	RRRC
30816	LOWO	30852	HIGHO	30876	*EQUALO	30912	TESTO	30972	BAN
31008	*CHANGE	31176	ALTER		Z				

Appendix 4

02	ABHANDLUNGEN, DEUTSCHEN AKADEMIE DER WISSENSCHAFTEN, BERLIN. KLASSE FÜR	05879
02	ABSTRACTS OF PUBLISHED PAPERS AND LIST OF TRANSLATIONS. (COMMONWEALTH	31
02	AERONAUTICAL JOURNAL. (AERONAUTICAL SOCIETY OF GREAT BRITAIN).\$	02566
02	ANNALEN DER PHYSIK.\$	01615
02	ANNALES DE PHYSIQUE.\$	016 6
02	ANNALES DES SCIENCES NATURELLES. ZOOLOGIE ET BIOLOGIE ANIMALE.\$	07022
02	ANNALI, SOCIETA AGRARIA DI TORINO.\$	05823
02	ARCHIVES ROUMAINES DE PATHOLOGIE EXPERIMENTALE ET MICROBIOLOGIE. (BUCHA	08189
02	ARCHIVES, INSTITUT PASTEUR D'INDOCHINE. (INSTITUT PASTEUR DE SAIGON AND	0853
02	BACTERIOLOGICAL REVIEWS. (SOCIETY OF AMERICAN BACTERIOLOGIST).\$	04785
02	BELL SYSTEM TECHNICAL JOURNAL. (BELL TELEPHONE LABORATORIES).\$	03218
02	BERICHT, SENCKENBERGISCHE NATURFORSCHENDE GESELLSCHAFT IN FRANKFURT ON	04446
02	BIMONTHLY BULLETIN, AMERICAN INSTITUTE OF MINING ENGINEERS.\$	05269
02	BIOCHEMISCHES CENTRALBLATT.\$	03585
02	BRITISH JOURNAL OF OPHTHALMOLOGY.\$	0864
02	BULLETIN, CENTRAL BUILDING RESEARCH INSTITUTE.\$	02162
02	BULLETIN, SOCIETE CHIMIQUE DE PARIS.\$	03343
02	BULLETIN, SOCIETE MATHEMATIQUE DE FRANCE.\$	00731
02	CHALMERS TEKNISKA HOGSKOLAN HANDLINGAR. (=TRANSACTIONS, CHALMERS UNIVER	01934
02	CHEMICAL REVIEWS. (AMERICAN CHEMICAL SOCIETY).\$	03419
02	CHEMISCHE FABRIK. (=ZEITSCHRIFT DES VEREINS DEUTSCHER CHEMIKER TEIL B).\$	03653
02	COMMENTARIUM MATHEMATICI HELVETICI.\$	00814
02	DESIGN AND WORK.\$	02645
02	DOKLADY, ROSSISKAIA AKADEMIYA NAUK (AKADEMIYA NAUK SSSR.), LENINGRAD.\$	00375
02	ENGINEERING. LONDON.\$	019 9
02	HELVETICA CHIMICA ACTA. (SCHWEIZERISCHE CHEMISCHE GESELLSCHAFT).\$	034 6
02	INDIAN FOREST RECORDS.\$	06855
02	INDIAN JOURNAL OF CHILD HEALTH. (ASSOCIATION OF PEDIATRICIANS OF INDIA)	08875
02	INDIAN JOURNAL OF DAIRY SCIENCE. (INDIAN DAIRY SCIENCE ASSOCIATION).\$	09496
02	INDIAN JOURNAL OF OCCUPATIONAL HEALTH. (SOCIETY FOR STUDY OF INDUSTRIAL	090 6
02	INDIAN JOURNAL OF PHYSIOLOGY AND PHARMACOLOGY. (ASSOCIATION OF PHYSIOLO	09069
02	INDIAN JOURNAL OF PSYCHOLOGY (INDIAN PSYCHOLOGICAL ASSOCIATION)\$	09676
02	IZVESTIYA, AKADEMIYA NAUK SSSR. 6TDELENIYA MATEMATICHESKIKH I ESTESTVENNO	04913
02	IZVESTIYA, BIOLOGICHESKOGO NAUCHNO-ISSLEDOVATELSKOGO INSTITUTA I BIOLOGIC	04513
02	IZVESTIYA, PETROVSKAYA ZEMEL'CHESKAYA AKADEMIYA.\$	05929
02	JOURNAL OF COMPARATIVE NEUROLOGY.\$	088 8
02	JOURNAL OF GENERAL MICROBIOLOGY. (SOCIETY FOR GENERAL MICROBIOLOGY).\$	04774
02	JOURNAL OF PHOTOGRAPHIC SCIENCE. (ROYAL PHOTOGRAPHIC SOCIETY OF GREAT	09398
02	JOURNAL OF PHYSIQUE THEORIQUE ET APPLIQUEE. (SOCIETE FRANCAISE DE PHYSIQ	016 7
02	JOURNAL, PHYSICAL SOCIETY OF JAPAN.\$	01589
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