



## Data Processing Techniques

### Flowcharting Techniques

Adherence to standard techniques for the preparation of flowcharts of data processing systems and procedures greatly increases effectiveness of communication between the programmer analyst and the many groups with whom he deals. The manual describes in detail the preparation of system and program flowcharts. The symbols used are those provided by the new IBM Flowcharting Template (X20-8020), which contains cutouts for all flowchart symbols. The template envelope gives uses for the symbols. The Flowchart Worksheet (X20-8021) is a means of standardizing documentation. It provides space for drawing program flowcharts and contains an area for identification of the job, including application, procedure, date and pagination.

## CONTENTS

Introduction . . . . .	1
Summary of New Symbols and Changed Meanings . . . . .	2
Composite Symbols . . . . .	4
Other Improvements and Features . . . . .	4
Symbols in Three Groups . . . . .	4
Checklist Summary of Changes . . . . .	5
Flowcharting Template . . . . .	7
System and Program Flowcharts . . . . .	8
Basic Symbols . . . . .	9
Situation 1: Symbols Other Than the Basic Symbols . . . . .	13
Situation 2: Depicting Selected Portions of a Processing Run . . . . .	14
Situation 3: Flowcharting to Document the Devices Used . . . . .	16
Situation 4: Specific Punched Card Equipment Symbols in a System Flowchart . . . . .	18
Situation 5: Program Flowchart Depicting Elementary Decision Logic with Alternative Processing Paths . . . . .	20
Situation 6: Communication Link and Other Specific Symbols . . . . .	22
Situation 7: Recommendations for Flowcharting with Communication Links . . . . .	23
Situation 8: Magnetic Tape Symbol . . . . .	24
Situation 9: Program Flowcharting . . . . .	24
Situation 10: Depicting Decision Techniques, Test Settings, and Parallel Mode . . . . .	27
Situation 11: Striping Convention . . . . .	29
Situation 12: Flowcharting and the Source Program . . . . .	32
System/360 Flowchart . . . . .	35
Flowcharting Pointers . . . . .	35

Major Revision (Reprinted March 1970)

This edition, C20-8152-1, is a major revision of, and obsoletes C20-8152-0.

Copies of this and other IBM publications can be obtained through IBM branch offices. Address comments concerning the contents of this publication to:  
IBM, Technical Publications Department, 112 East Post Road, White Plains, N. Y. 10601

## INTRODUCTION

The use of data processing equipment has focused attention upon the necessity for an orderly representation of information flow. The sequence in which operations are to be executed should be precisely stated. The data and the sequence of operations to be performed upon the data together constitute the information flow.

A flowchart is a diagram that shows the operations performed in an information processing system and the sequence in which the operations are performed. Flowchart symbols are used to represent the operations and sequence of operations.

While flowcharts are widely used in the field of information processing, they are occasionally misinterpreted because of a lack of uniformity in the meaning and use of specific symbols. To reduce these misunderstandings, the flowchart symbols used comply with the requirements of the International Organization for Standardization (ISO) Recommendation on Flowchart Symbols for Information Processing.

As a preliminary section to this major revision of Flowcharting Techniques (C20-8152), a "Summary of New Symbols and Changed Meanings" is given below. This provides an option whereby the reader may, by reading the summary only, determine to what degree his present usage conforms to the ISO Recommendation and the changes required. Alternatively, the beginning student of data processing may skip this section and proceed to study the text, which uses examples.

## Summary of New Symbols and Changed Meanings

Figure 1 shows the template envelope which illustrates the new symbols. Most of the familiar shapes used in recent years remain, but some of their meanings have changed. Note particularly that input/output and "clerical" operation have traded symbols: the parallelogram is now I/O, and the trapezoid (flowerpot) means manual operation. The old "predefined process" six-sided figure is now entitled "preparation"; there is a new vertical-striped rectangle for predefined process. Both the name and the symbol for "program modification" are eliminated, but the function is shown by the "preparation" symbol.

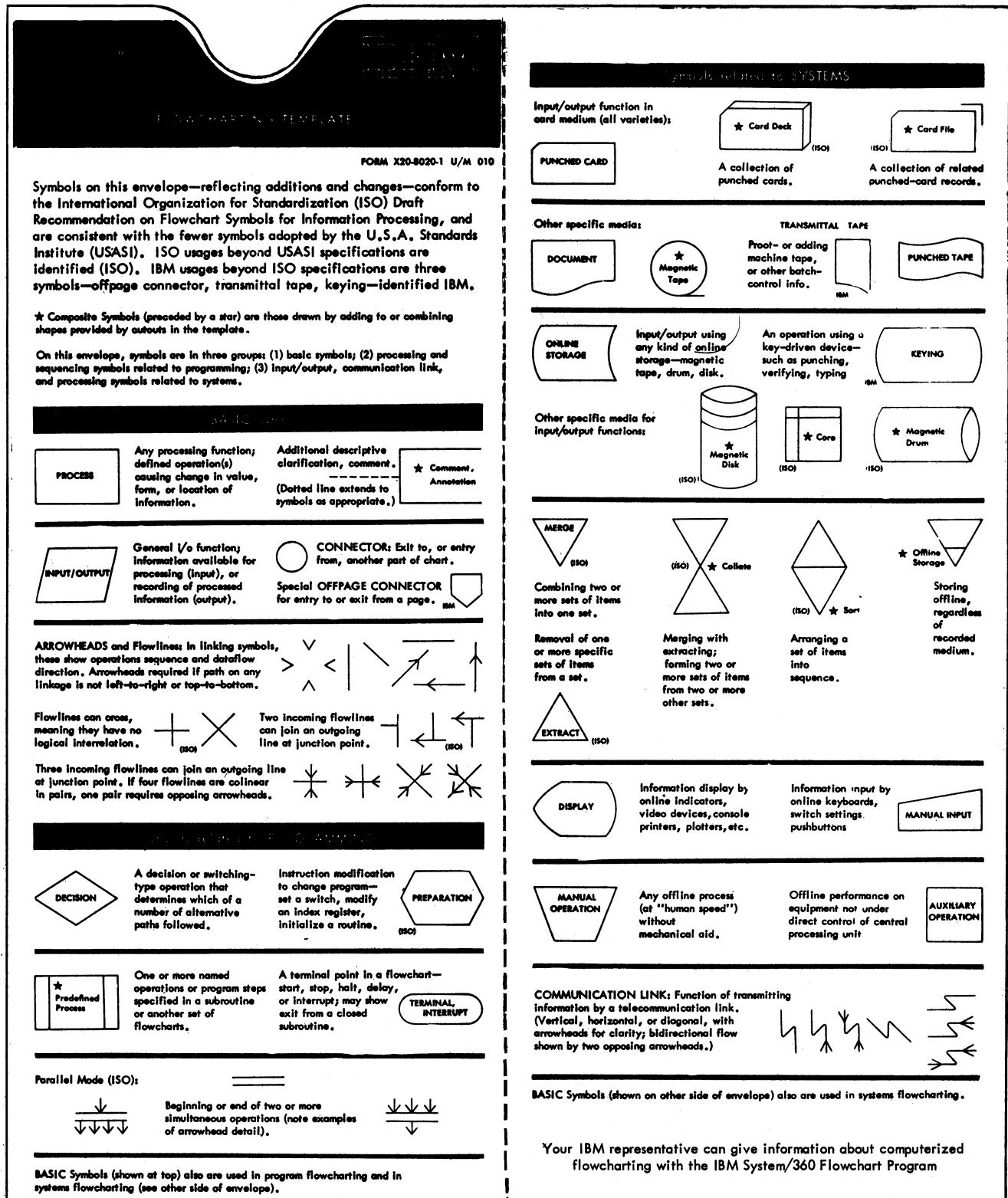


Figure 1. Flowcharting template envelope

Some additional symbols use equilateral triangles in different facings and combinations for such systems details as merge, extract, sort, and collate. The larger circle is the nucleus shape for drawing "magnetic tape" (unchanged). The circle has no other meaning except in the smaller size as a connector.

Note, too, among other changes, (1) the old "perforated tape" symbol is now inverted and its title changed to "punched tape", (2) the "comment, annotation" symbol now is three-sided, with a dotted line to the described area, (3) "offline storage" continues as an inverted triangle but is now equilateral, with a horizontal stripe — the stripe is simply to distinguish it from the new symbol for merge, (4) the keying cutout is slightly wider to accommodate more readily the curved stripes needed when the cut-out is positioned vertically to become the new graphic for magnetic disk. The wider shape also is the basis for drawing the new symbol for magnetic drum.

### **Composite Symbols**

Although more than 30 symbols have been adopted, about one-third fewer symbols are provided as cutouts in the template. The additional symbols are those drawn by adding to or combining shapes appearing as template cutouts; these composite symbols are identified underneath the cutouts, their names are preceded by a star, and the symbols themselves are shown on the envelope. For example, a triangle can be used to symbolize extract, merge, or offline storage. When the triangle is drawn so that a vertical flowline enters at the apex, it symbolizes extract. Rotating the triangle so that it rests on a point directed toward the page bottom converts it to the merge symbol. Adding a horizontal stripe near the bottom converts the merge triangle to the offline storage symbol.

Sort needs the addition of a horizontal line at its midpoint to conform to the International Organization for Standardization (ISO) Recommendation. That is why it is shown on the template as a starred composite symbol.

All ISO symbols beyond the USA Standards Institute (USASI) set are identified on the envelope. Three other symbols are identified by the letters IBM. All unidentified symbols belong both to the ISO set and to the present USASI set. What this amounts to is that IBM has accepted both the ISO and USASI sets, while preserving for optional use three extra symbols — keying, offpage connector, and transmittal tape.

### **Other Improvements and Features**

The new template is slightly larger than before — both to accommodate new features and symbols, and to provide more space between cutouts for greater strength. Cutouts along the right-hand edge provide one-inch and half-inch braces. A metric scale of 90 millimeters, making nine centimeters, is printed along the left-hand edge. For easier drawing, the angle in the communication link cutout has been softened to 45 degrees. Arrowhead cutouts are larger for easier use.

### **Symbols in Three Groups**

The practice of relating certain symbols to programming flowcharts, and other symbols to systems flowcharts, is continued. As shown on the envelope, symbols fall into three groups (although separation of programming and systems charts is not a "standards" requirement):

1. Basic symbols are used both in program and systems flowcharting.
2. Additional symbols are related to programming.
3. Other additional symbols are related to systems flowcharting — specifics, where needed, to relate functions to media.

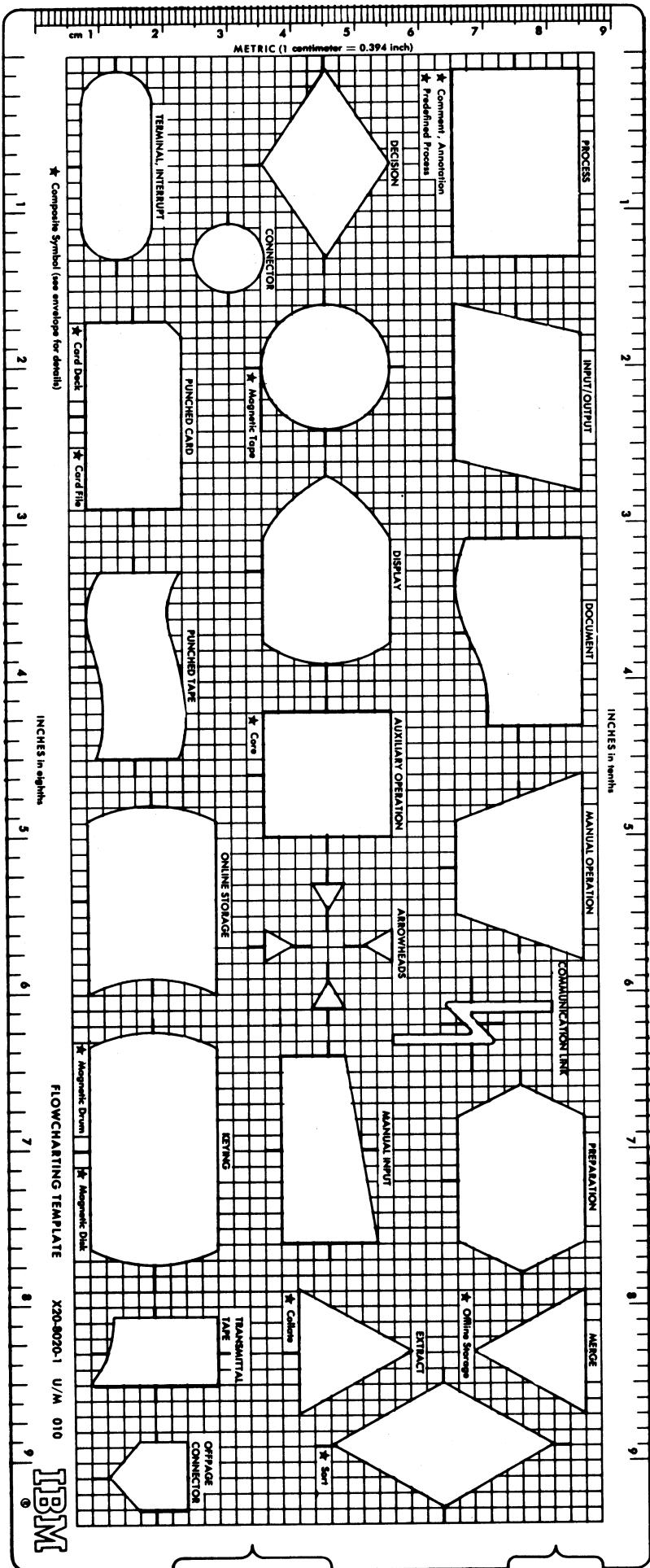
This grouping order is maintained in the accompanying table (Checklist Summary of Changes). In three alphabetized sections the table lists old and new (capitalized) function names, indicates whether the symbol remains the same or has been changed/modified, and briefly describes changes under "Remarks". Further details appear in the envelope illustration (Figure 1).

## CHECKLIST SUMMARY OF CHANGES

(New and modified names  
are in capitals below)

Function Name	S Y M B O L		Remarks
	Same	Changed	
<b>BASIC Symbols (for both programming and systems)</b>			
annotation		x	New composite symbol; now also "comment"
arrowhead	x		Now larger on template for easier use
COMMENT, ANNOTATION			New name; new symbol same as annotation
connector	x		Unchanged
flowline	x		See envelope for new ISO crossing and junction symbols listed under "Arrowheads and flowlines"
crossing of flowlines			
junction of flowlines			
input/output		x	Symbol is now parallelogram
offpage connector	x		Continued extra IBM symbol
PROCESS	x		New modified name
processing	x		Now called "process" (above)
<b>Additional PROGRAMMING-detail Symbols</b>			
decision	x		Additional name for terminal symbol
INTERRUPT			New ISO Symbol
PARALLEL MODE		x	Now vertical-striped rectangle
predefined process		x	Takes six-sided symbol
PREPARATION		x	Name dropped; use "preparation" symbol
program modification			Now also "interrupt"
terminal, interrupt	x		
<b>Additional SYSTEMS-detail Symbols</b>			
auxiliary operation	x		New composite symbol based on card symbol
DECK OF CARDS			New composite symbol based on card symbol
FILE OF CARDS			Name changed to "manual operation"
clerical operation		x	New composite symbol; name modified
COLLATE		x	Name modified to "collate" (above)
collating		x	Improved on template for easier use
communication link	x		New name and composite symbol
CORE		x	Now "magnetic disk", new composite symbol
disk		x	Unchanged
display	x		Unchanged
document	x		Now "magnetic drum"; new composite symbol
drum		x	New name and symbol
EXTRACT			Name modified (continued extra IBM symbol)
KEYING	x		Now called "keying" (above)
keying operation	x		New name and composite symbol
MAGNETIC DISK			New name and composite symbol
MAGNETIC DRUM			Remember to add line at bottom right of circle
magnetic tape	x		New name for "online keyboard"
MANUAL INPUT	x		

Function Name	SYMBOL		Remarks
	Same	Changed	
MANUAL OPERATION		x	New name for "clerical operation"; use trapezoid
MERGE		x	New name and symbol
OFFLINE STORAGE		x	Modified name; now striped triangle
offline storage file		x	Now "offline storage" (above)
online keyboard	x		Name changed to "manual input"
ONLINE STORAGE		x	New name; half-cylinder symbol
perforated tape		x	Renamed "punched tape"; symbol now inverted
punched card	x		Unchanged
PUNCHED TAPE		x	New name for "perforated tape"; symbol inverted
random access file		x	Name dropped; see "online storage"
SORT		x	New composite symbol; new modified name
sorting		x	Name modified to "sort"; new composite symbol
transmittal tape	x		Continued extra IBM symbol



## FLOWCHARTING TEMPLATE

To encourage standardization in the use of symbols and thereby simplify the problem of exchanging information, IBM has made available the flowcharting template (X20-8020) shown in Figure 2, which includes all the recommended symbols for drawing flowcharts.

The heavier grid indicates the center of each symbol. For those symbols which should be striped, appropriate grids can be selected for the stripe placement.

So that all symbols will be consistent, the template should be used face up. Although most manually drawn (as opposed to computer-generated) flowcharts are done with pencil or ball point pen, it is sometimes necessary to use an ink-flowing pen. To prevent blotting from an ink-flowing pen, small strips of masking tape can be attached to the solid areas on the reverse side of the template to raise it off the paper.

Figure 2. Flowcharting template (actual size)

## **SYSTEM AND PROGRAM FLOWCHARTS**

A system flowchart describes the flow of data through all parts of a system. A program flowchart describes what takes place in a program; it displays specific operations and decisions, and their sequences within the program run or phase.

A system flowchart represents an application in which data provided by source media is converted to final media. Therefore, emphasis is placed on the media involved and on the work stations through which they pass. The actual operations that must be performed are described briefly.

Symbols depicting these documents and operations are designed so that when used in a system flowchart they are meaningful without comment or text. When text is placed within the symbol, the flowchart takes on specific application meaning. To acquaint the reader with these symbols, they are illustrated in a representative series of flowcharts. Uses, techniques, and recommendations for flowcharting are demonstrated.

## BASIC SYMBOLS

The basic functions that can be depicted on flowcharts are processing, input/output (I/O), flow or sequence, connection, and annotation. A flowchart (system or program) may be drawn with only the basic symbols. Figures 3 and 4 are valid flowcharts that use only three such symbols.

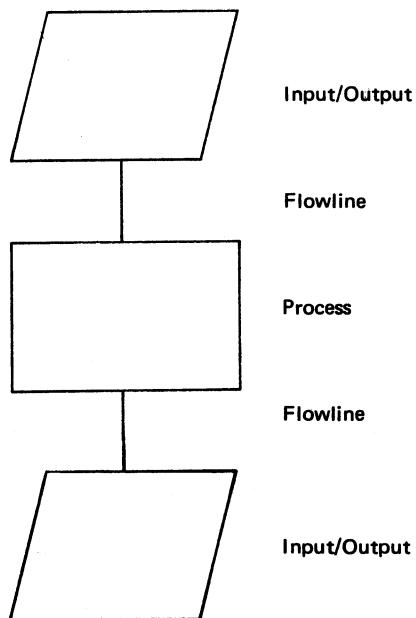


Figure 3. Flowchart using basic symbols

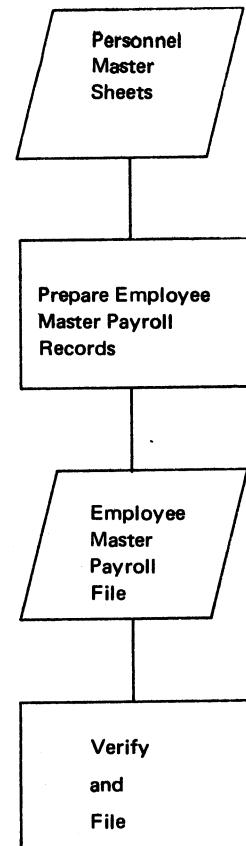
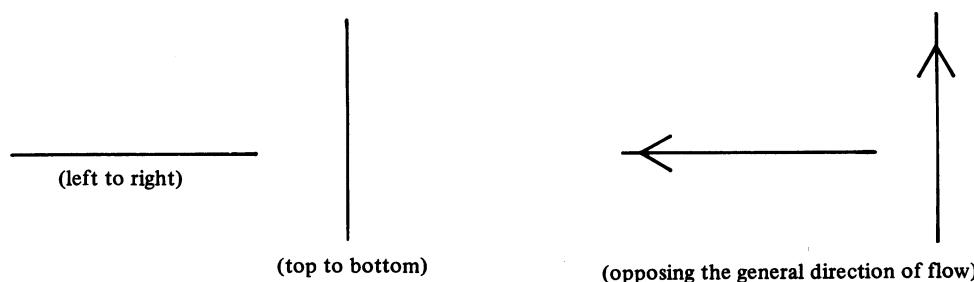


Figure 4. Flowchart using basic symbols with text

The input/output symbol represents an I/O function; that is, the making available of information for processing (input), or the recording of processed information (output). The symbol is useful where specification of medium is neither important nor desirable.

The process symbol represents any kind of processing function; for example, the process of executing a defined operation or group of operations resulting in a change of value, form, or location of information, or in the determination of which of several flow directions are to be followed.

The general direction of flow is from top to bottom, and from left to right. Where space limitations or considerations of appearance necessitate a flow opposed to the general direction, this must be indicated with arrowheads.



Flowlines are used singly or are joined end-to-end to change direction, in which case they form angles to link symbols. If the direction of flow of any flowline of a linkage is not left to right or top to bottom, an arrowhead must be used on the linkage. One or more arrowheads may be used on linkage when increased clarity will result. In the example below

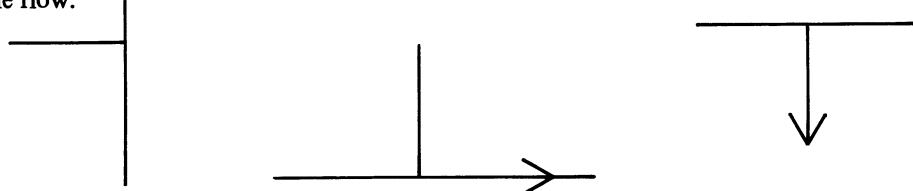


the flowlines connecting the symbols form a linkage part of which opposes the general direction of flow. Hence, an arrowhead is required. It could be placed anywhere on the linkage.

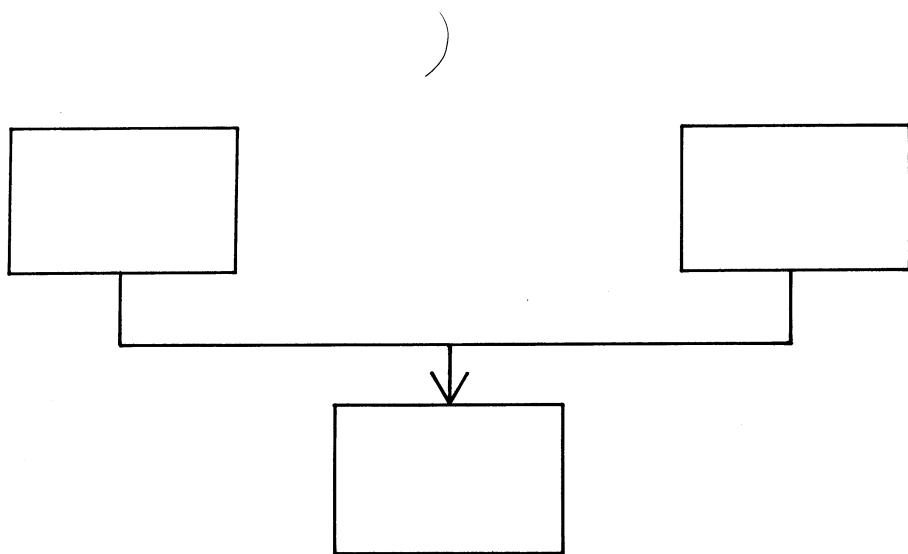
Flowlines may cross. If no arrowheads appear in the vicinity of the intersection, this means the flowlines have no logical interrelation.



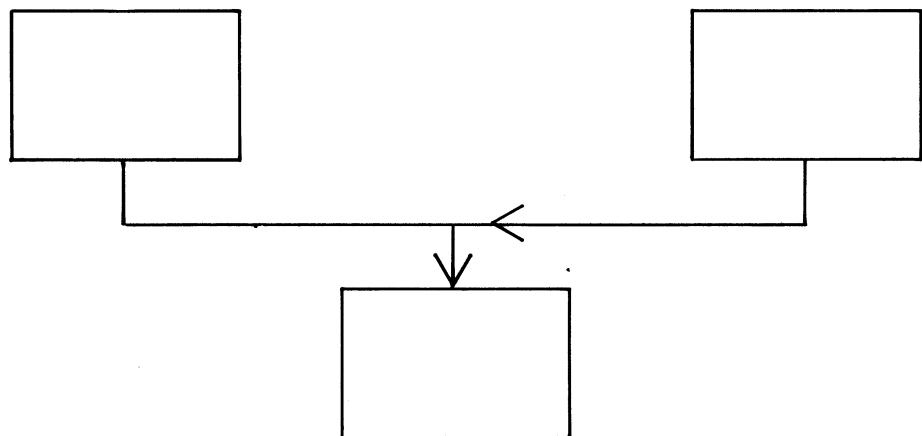
Where two incoming flowlines join with one outgoing flowline, a logical union (junction) occurs in the flow.



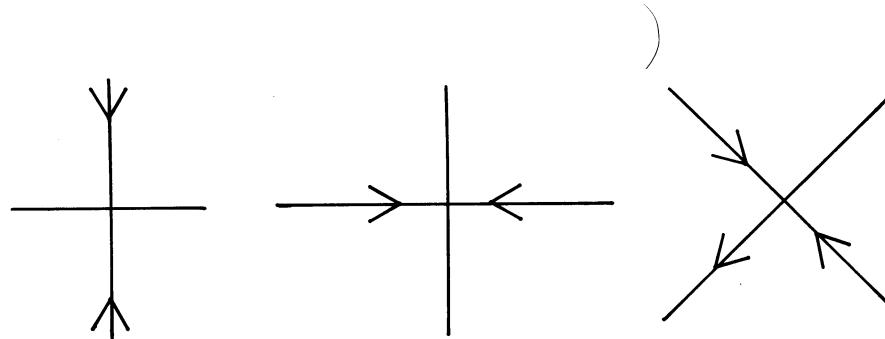
The example of junction on the right (above) would occur in the situation below.



The linkage between these three symbols contains a junction that is not itself a flowchart symbol. Only one arrowhead is required, but a second would be helpful, as in the modified example below.



Three incoming flowlines may join with one outgoing flowline at a junction point. The resulting four flowlines are referred to as "colinear" in pairs. The adjective "colinear" means in the same straight line. One colinear pair must have opposing arrowheads near the junction point.



With the insertion of text within the symbols, the flowchart in Figure 3 becomes more meaningful, as shown in Figure 4. In Figures 5, 6, 7, and 8, more detailed flowcharts introducing other symbols are shown, but it should be apparent, in each case, how these operations could be depicted using the basic symbols as the only ones in the flowcharts.

All text is read from left to right, top to bottom, regardless of the direction of flow. There are no requirements for the location of text. It may be inside a symbol, outside a symbol, or in conjunction with the annotation symbol.

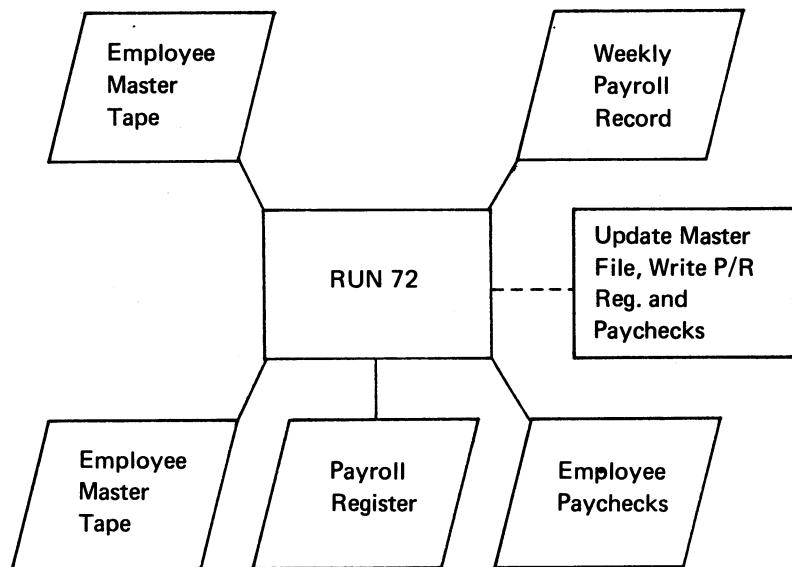


Figure 5. Use of comment, annotation symbol together with basic symbols

## Situation 1: Symbols Other Than The Basic Symbols

To make flowcharts more meaningful, special input/output and operation symbols may be used. Fourteen of these symbols are available. Figure 6 is a system flowchart of a basic procedure for creating cards for a file. The symbol name is placed alongside the symbol for identification purposes only. Alternative ways of depicting the keying operation are shown. The chart to the right employs the generalized auxiliary operation symbol. The chart to the left uses the more specific IBM keying operation symbol. The auxiliary operation symbol represents any offline operation performed on equipment not under direct control of the central processing unit.

The document symbol represents paper documents and reports of all varieties, including source documents and ledgers. Similarly, the punched card symbol represents all varieties of punched cards, including mark sense cards and stub cards.

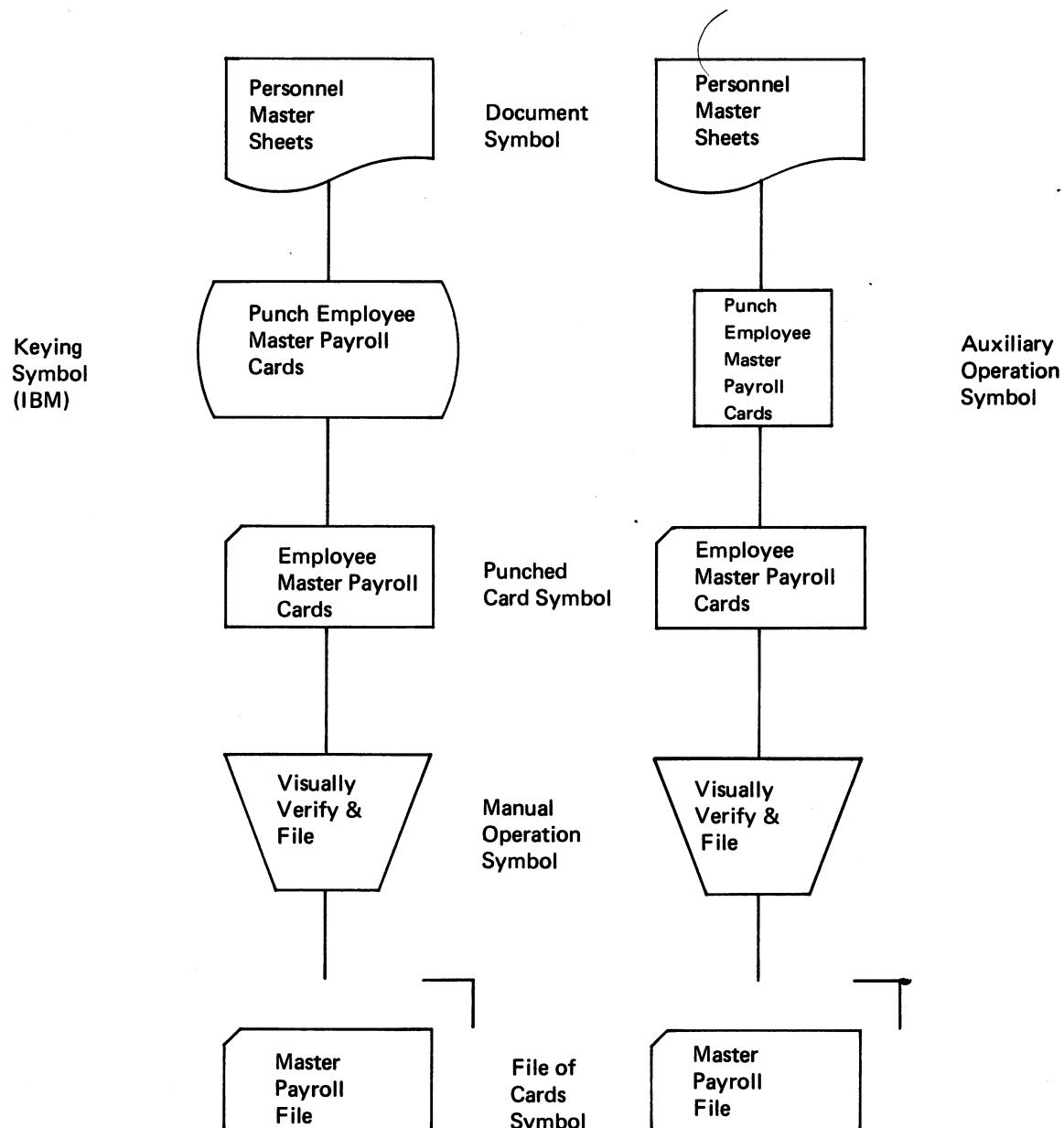


Figure 6. Flowchart of a basic procedure

## Situation 2: Depicting Selected Portions Of A Processing Run

The circular connector symbol represents an exit to, or entry from, another part of the flowchart. A set of two connector symbols is used to indicate a continued flow when the use of a linkage is precluded by the physical or esthetic limitations of the flowchart. Identical information should be placed within an associated set of connectors. Figure 14 will show the usefulness of circular connectors.

In addition to its special keying symbol, IBM has a special offpage connector and a transmittal tape symbol that have proved useful. The ISO Recommendation does not include these. The IBM offpage connector symbol is a special purpose connector that may be used instead of the connector symbol to designate entry to, or exit from, a page. The symbol should be so placed that its point indicates the direction of flow. As with the other connector, identical identification should be placed within associated connector symbols.

The predefined process symbol (simply the "process" symbol with two vertical stripes added) represents a named process consisting of one or more operations or program steps that are specified elsewhere. An example of such a process is a subroutine; "elsewhere" means not on this set of flowcharts.

In Figure 7, a checkpoint in a processing stream is shown. Each document is a transaction item from which the total is entered into an adding machine. Offpage connectors inform the reader that processing occurs before and after the processing depicted. Run #2 is an output report, one line of which shows the total arrived at by computer processing. This total is visually compared with the manually produced total on the transmittal tape.

# IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_

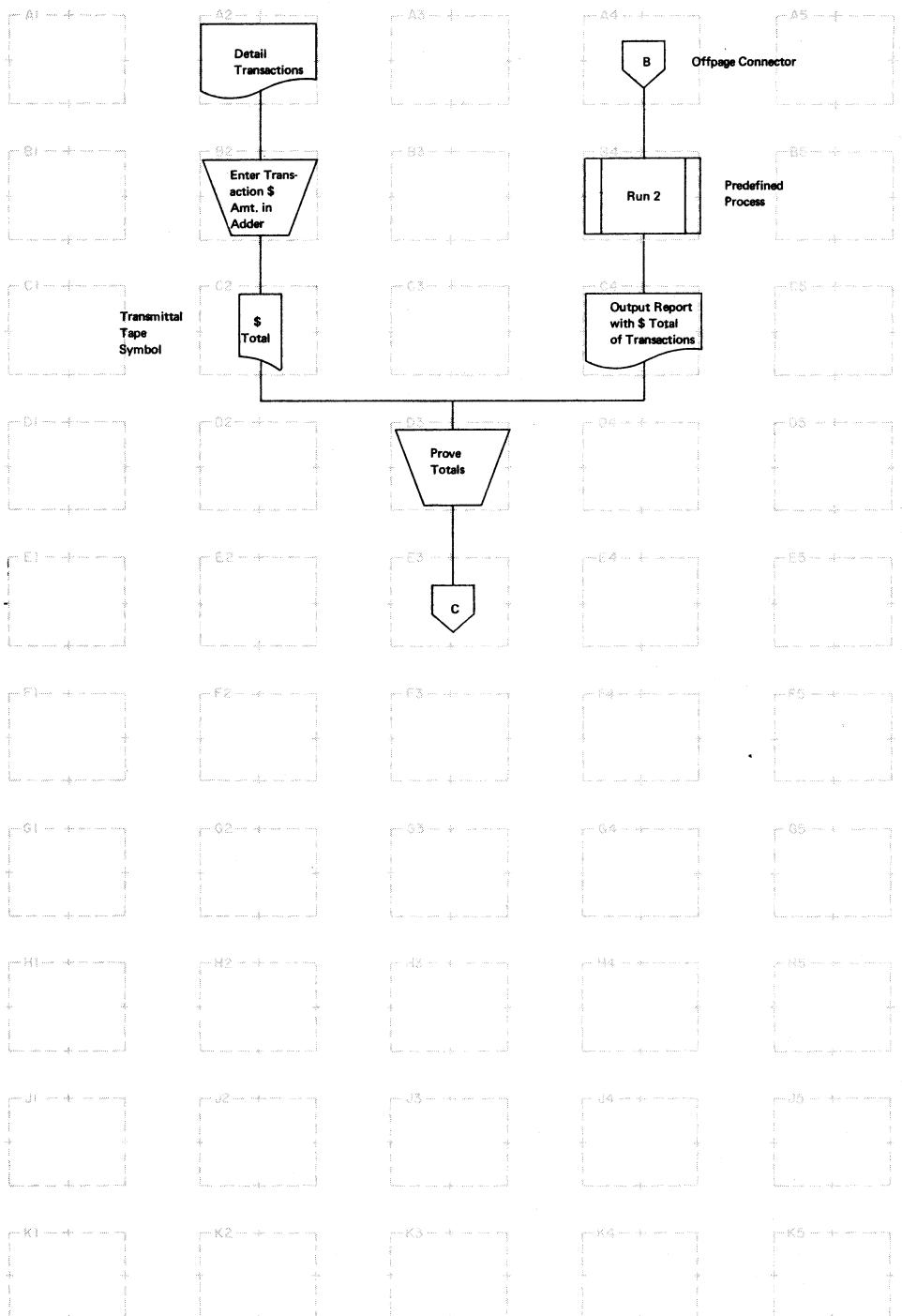


Figure 7. Offline clerical procedure at a processing checkpoint

### **Situation 3: Flowcharting to Document the Devices Used**

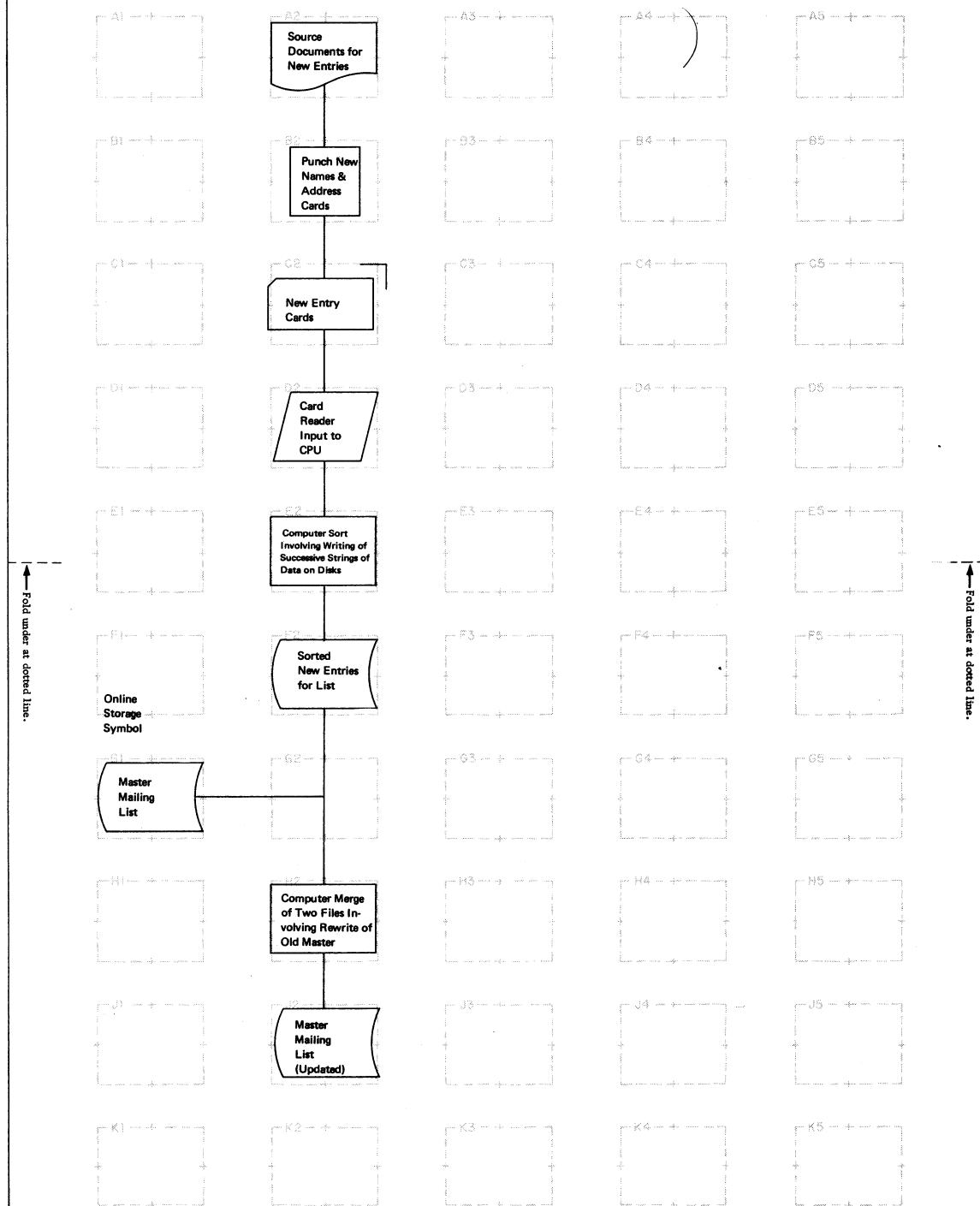
The only symbol introduced in Figure 8 is the one for online storage. The flowchart documents a method for incorporating new names and addresses in a mailing list. This flowchart provides some details about the devices (card punch, card reader, computer, online storage) used.

If less detail were desired, this processing might have been depicted in a system flowchart where a single predefined process block could be labeled "Master Mailing List Update".

## IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
 Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_



#### **Situation 4: Specific Punched Card Equipment Symbols in a System Flowchart**

In Figure 9, the sorting and merging operations are performed on punched card equipment, and the appropriate symbols for these specific operations are used. The extract symbol is, as shown, simply an inverted merge symbol.

Since the processing depicted does not involve computer runs, no distinction has been made between auxiliary processing and online processing. All operations are directly in the data flow path, and the process symbol is used. If the chart depicted computer processing, those offline operations performed on an accounting machine would be represented with the auxiliary operation symbol.

The offline storage symbol represents the function of storing information offline, regardless of the medium on which the information is recorded. This may include paper, cards, magnetic or punched tape, or any other medium.

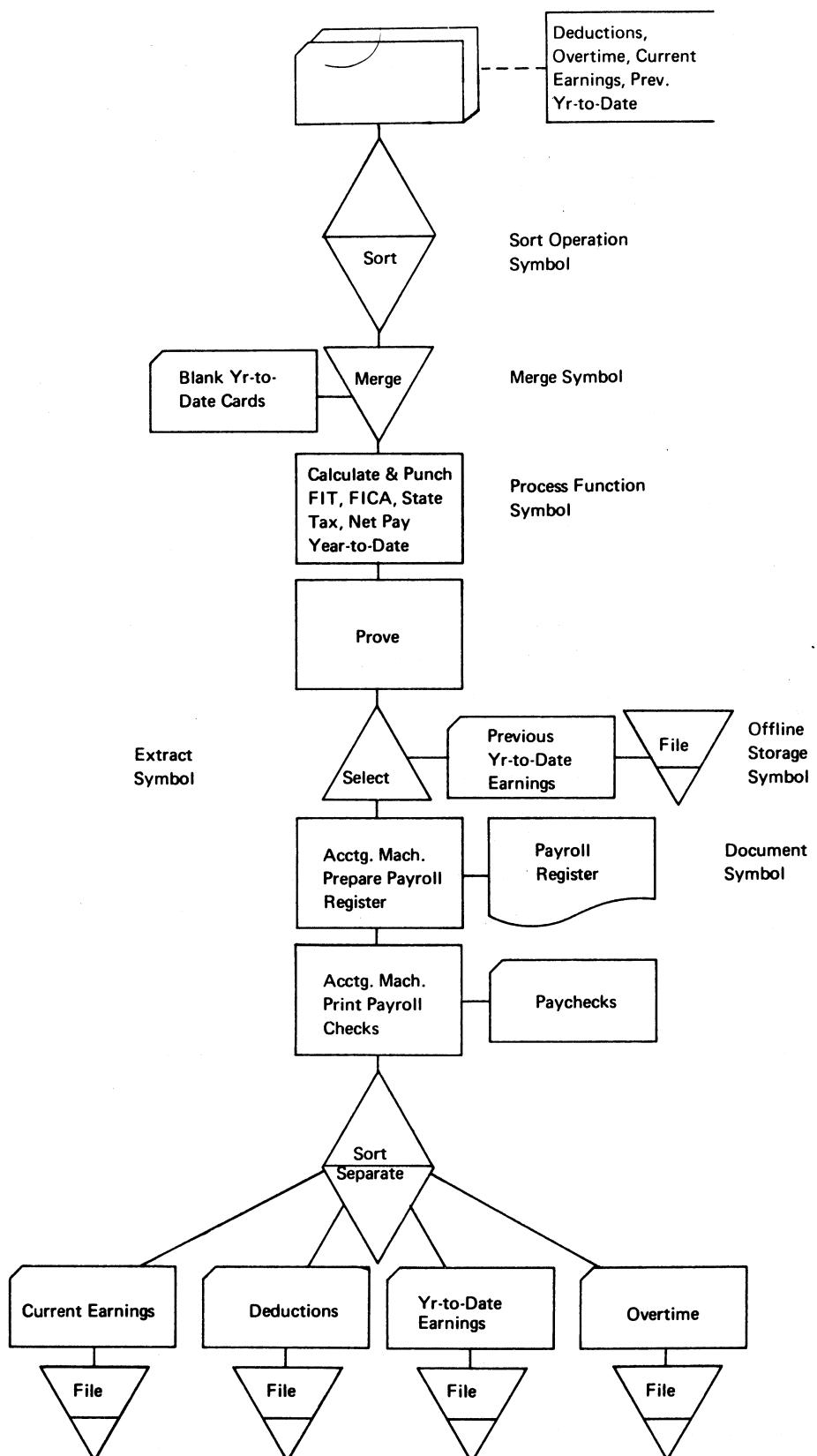


Figure 9. Flowchart introducing sort, merge, extract, and offline storage symbols

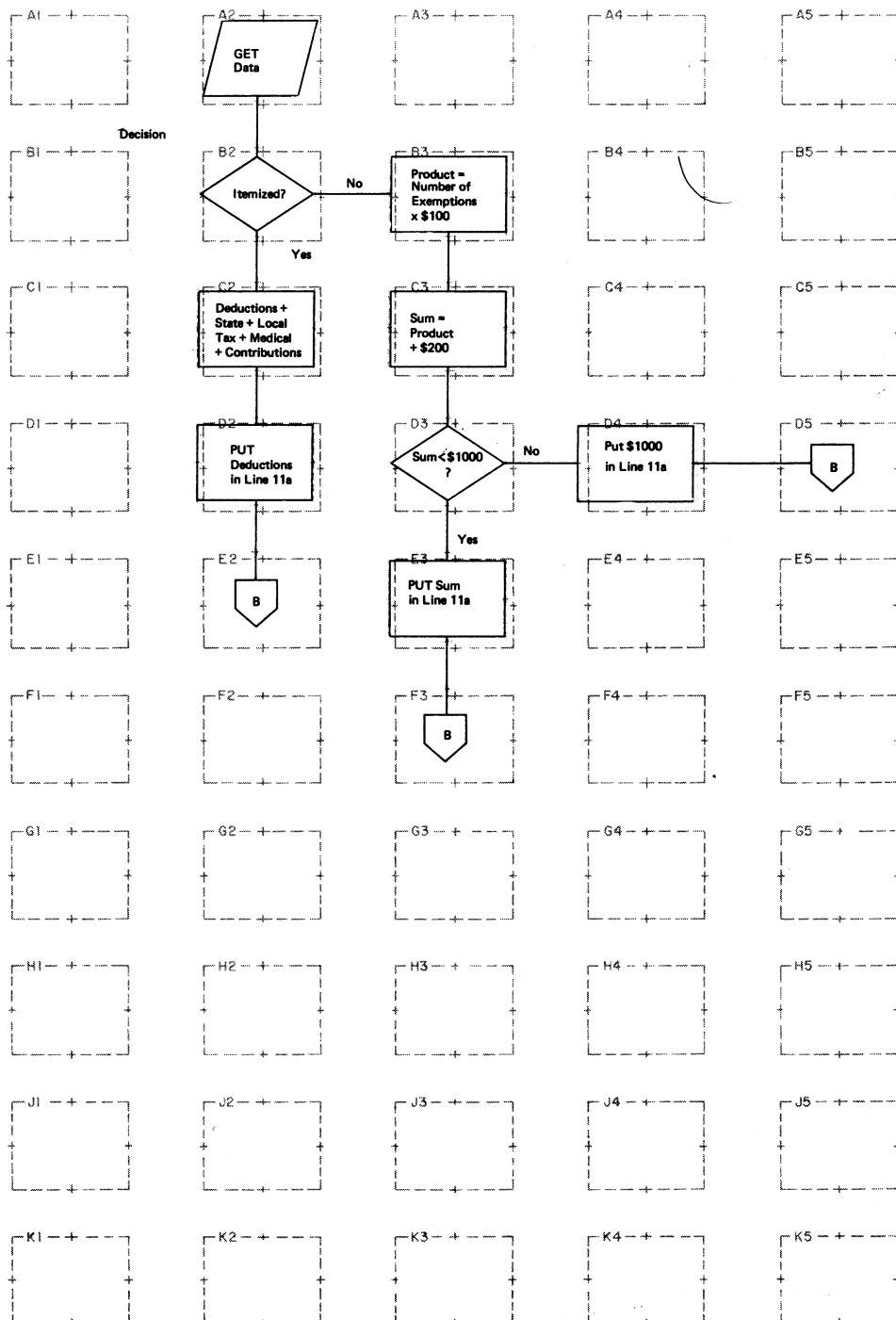
### Situation 5: Program Flowchart Depicting Elementary Decision Logic with Alternative Processing Paths

To see the elementary level at which processing can be depicted, consider a simple income tax computation: if deductions are itemized, enter on line 11a the total of medical, contributions, and tax decuctions, where tax = state + local. If deductions are not itemized, enter on line 11a \$200 + \$100 times the number of exemptions (but not more than \$1000). Figure 10 is a program flowchart in which the decision symbol is introduced and connectors are shown. The offpage connector labeled "B" is presumably repeated on another page where it becomes the entry point for the flowchart depicting the next step in the tax computation.

# **IBM** Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

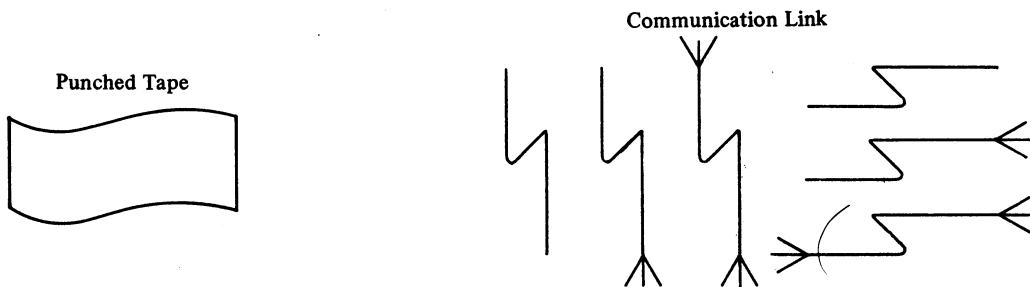
Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_



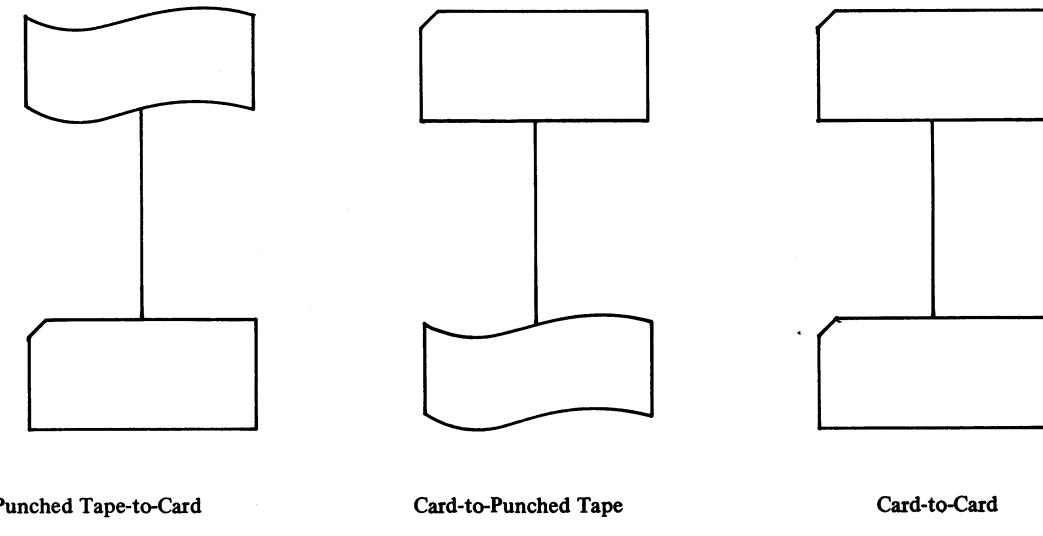
**Figure 10.** Elementary decision logic

## Situation 6: Communication Link and Other Specific Symbols

The punched tape symbol and the communication link symbol are shown below. The punched tape symbol represents punched tape, whether paper or plastic, chad or chadless, used as input or output on a system flowchart. The communication link symbol represents the transmission of information from one location to another via communication lines.



Operations such as the conversion of cards to magnetic or punched tape are shown simply by joining the symbol appropriate to each medium with a flowline. When two symbols for the same medium are connected, a device such as a data transceiver is usually implied, and the communication link symbol is used as the connection. Note that the arrowhead (above) in this symbol may indicate two-way (duplex) communication.



The manual input symbol represents an input function in which the information is entered manually at the time of processing by such means as online keyboards, switch settings, or pushbuttons.

The display symbol represents an I/O function in which the information is displayed for human use at the time of processing, by means of online indicators, video devices, console printers, plotters, etc.

The communication link, manual input, and display symbols are shown in Figure 11. The keyboard and printing device are located together but at a location remote from the computer.

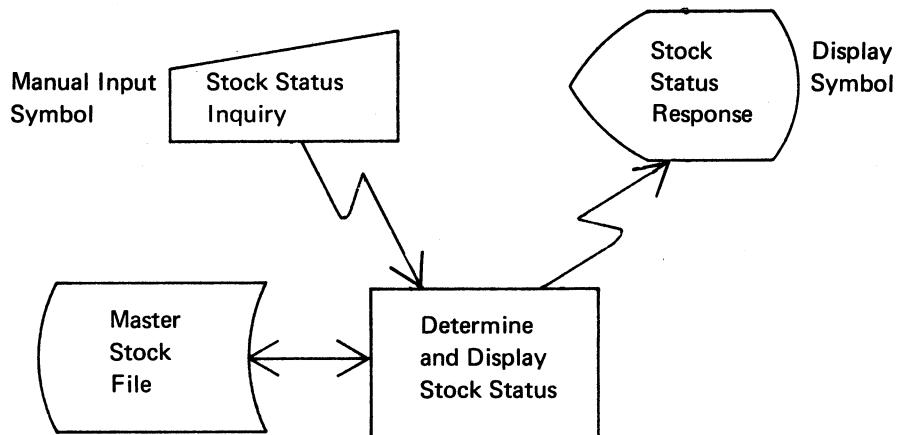


Figure 11. Communication link for a remote inquiry situation

#### Situation 7: Recommendations for Flowcharting with Communication Links

Some recommendations for flowcharting operations with communication links are shown in Figure 12. Figure 13 contains an example of bidirectional flow for a communication link.

When the input or output medium is known and it is the only such medium, the particular symbol is used. When I/O is a combination – that is, card, punched tape, manual entry, badge, etc. – the I/O symbol is used as shown.

As in this example, when it is important to stress that several stations are transmitting to a central location, the control unit is not included in the flowchart.

The auxiliary operation symbol is used here because the receiving unit is a card punch.

Situations 8 and 9 illustrate some further flowcharting recommendations.

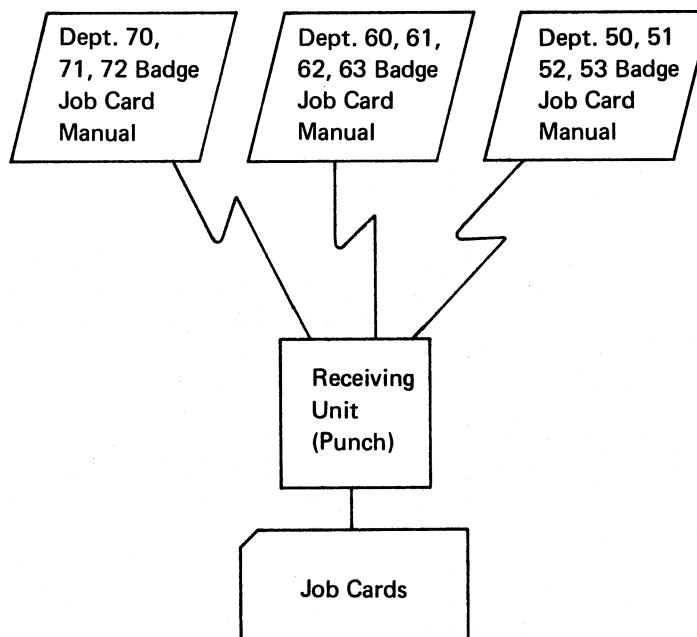


Figure 12. Flowchart of remote inputs to a central receiving unit

### Situation 8: Magnetic Tape Symbol

The magnetic tape symbol, of course, represents an I/O function in which the medium is magnetic tape. The symbol is a circle from the bottom of which a line is extended horizontally to the right. Figure 13 shows the use of this symbol where data is transmitted directly from one system to another via communication lines utilizing an appropriate data adapter unit. In such a case, only the process symbols are used.

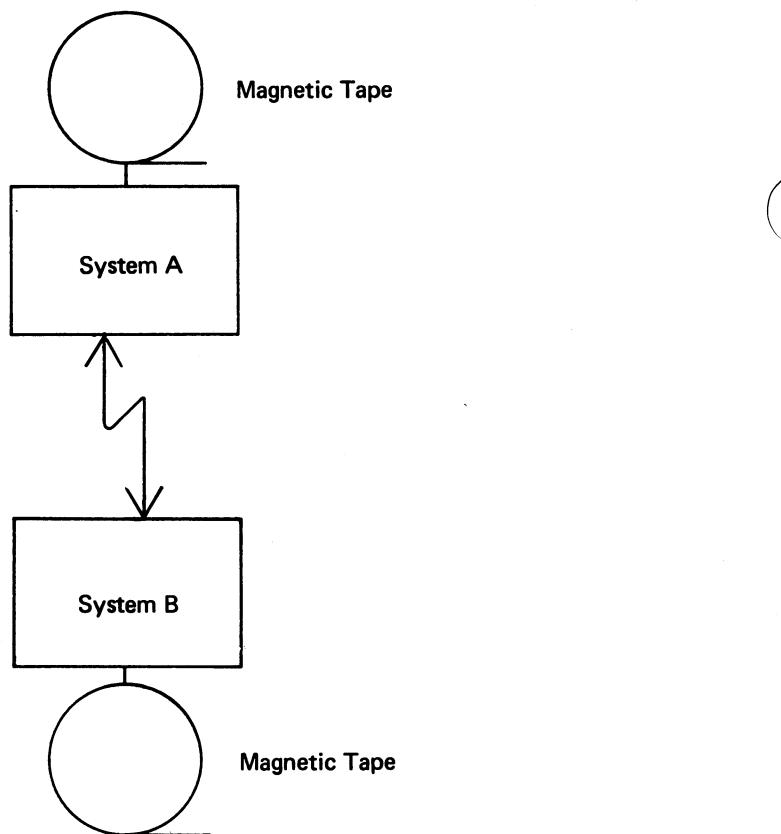


Figure 13. Processor-to-processor tape transmission

### Situation 9: Program Flowcharting

Program flowcharts were described earlier as descriptions of what takes place in a program. More specifically, a program flowchart is a diagram of operations and decisions, and the sequence in which they are performed by a computer. A program flowchart that clearly shows the functions of a program (or a routine) and the relationship of the functions to each other provides:

- A graphic picture of the problem solution
- A graphic presentation of program logic used for coding, desk checking, and debugging while testing
- Verification that all conditions possible have been considered
- Documentation of the program

An additional advantage of flowcharting is the ability to name and use a process in the overall planning of a procedure before the process is defined in detail.

The basic functions that can be depicted on flowcharts are (1) process, (2) input/output, (3) flow or sequence, (4) connection, and (5) annotation. One basic symbol is established for each basic function, except connection, for which two basic symbols are established. Like system flowcharts, program flowcharts may be drawn with only the basic symbols. However, special processing symbols are established to make a program flowchart more meaningful. There are six such symbols.

The decision symbol, shown earlier in Figure 10, represents a decision or switching type operation that determines which of a number of alternative paths is to be followed.

The "terminal, interrupt" symbol represents a terminal point in a flowchart: for example — start, stop, halt, delay, or interrupt. It also represents a connection to one or more places, the location of which is not stated explicitly, such as an exit from a closed subroutine.

The preparation symbol represents modification of an instruction or a group of instructions, that changes the program itself — for example, set a switch, modify an index register, and initialize a routine.

Figure 14 illustrates some of these symbols. This simplified program flowchart is concerned with keeping group totals while writing detail records. Group headings and totals are included in the printout. The "last" record is not a valid record, but is a signal that all the valid records have been read.

# IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_

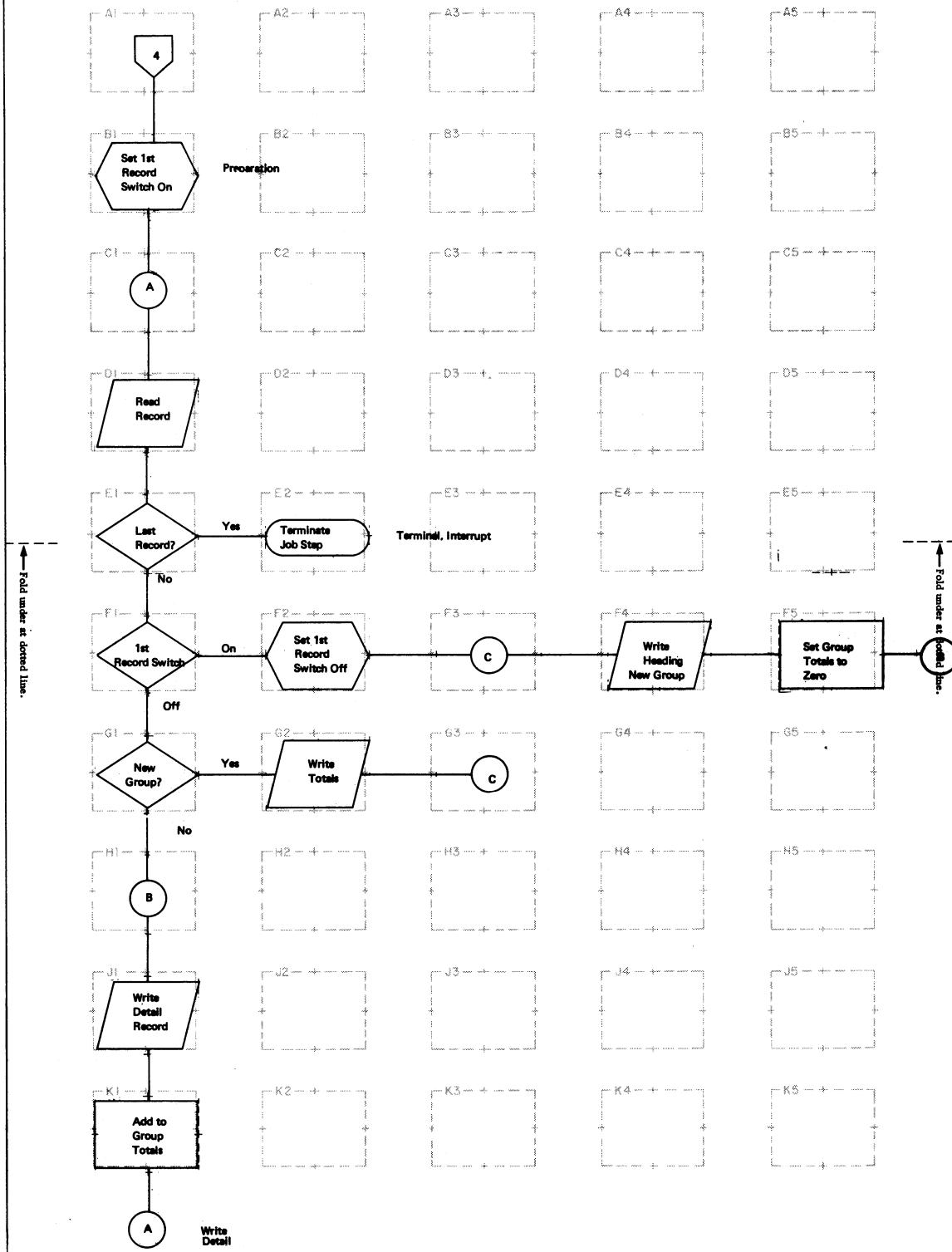
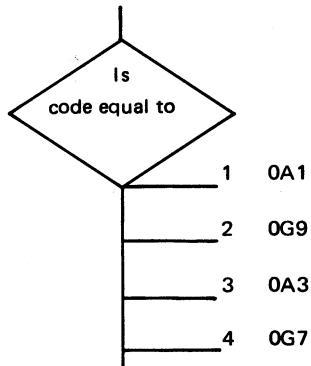


Figure 14. Simplified program flowchart

### Situation 10: Depicting Decision Techniques, Test Settings, and Parallel Mode

Multiple exits from a decision symbol may be shown by several lines running from the decision symbol to other symbols, or by a single line, which then branches into the appropriate number of lines from the decision symbol.

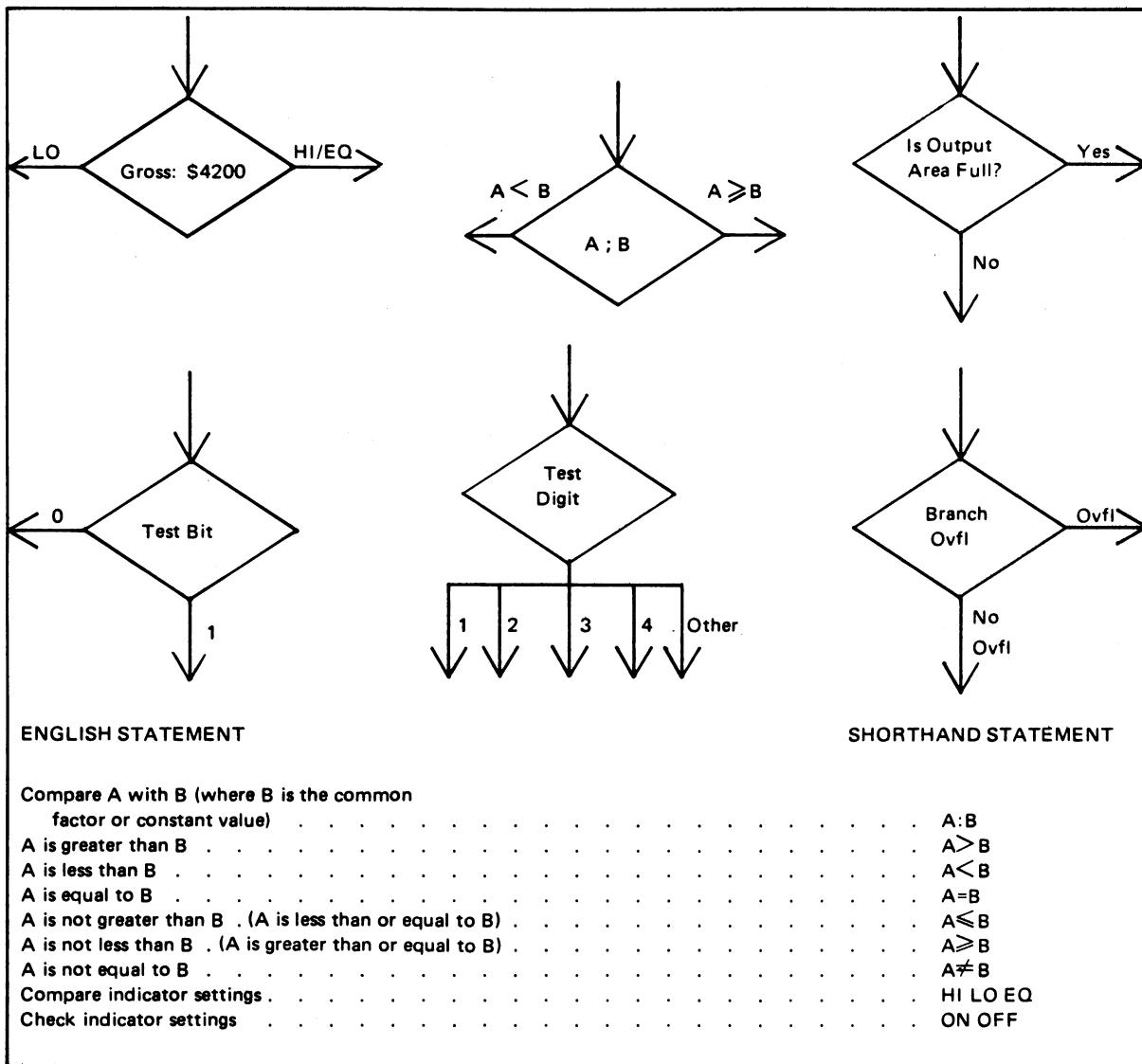


Where a decision occurs, the flowline may exit in any direction.

Figure 15 shows some examples of decision techniques. A list of commonly used shorthand notations for program conditions is also shown.

For depicting parallel mode, arrowheads are used as shown in the examples for the beginning (left) and end (right) of two or more simultaneous operations.





**Figure 15. Examples of decision techniques**

### **Situation 11: Striping Convention**

Striping a flowchart symbol is a convention that means that a more detailed representation of a function is to be found elsewhere in the same set of flowcharts. This differs from the predefined process symbol, since that function requires no detailed representation. A set of multilevel charts is produced when a precise picture of program logic at a high level of detail is required. This approach may be likened to map-drawing techniques – for example, starting with an all-inclusive map and exploding sections of it on succeeding maps, each map showing greater detail.

The technique of presenting a complete picture on each chart is called modular program flowcharting. The technique stresses the logic of a program, component routines, and subroutines. Any portion of the flowchart may be shown in more detail on a succeeding chart.

There are three parts to the striping convention:

1. A horizontal line is drawn within and near the top of the symbol.
2. The detailed representation starts and ends with a terminal symbol.
3. An identifier is placed above the stripe in the striped symbol. The identical identifier is placed in the entry terminal symbol of the detailed representation.

To illustrate the technique of modular flowcharting, two charts are shown. Figures 16 and 17 are explosions of higher-level charts. Figure 17 is an explosion of the area enclosed by the irregular line in Figure 16.

Figure 17 is the final level for this set of flowcharts. Since no further detail is required, no blocks on this flowchart are striped. The legs of this chart return to the symbol immediately following the striped symbol on the preceding level.

# IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_

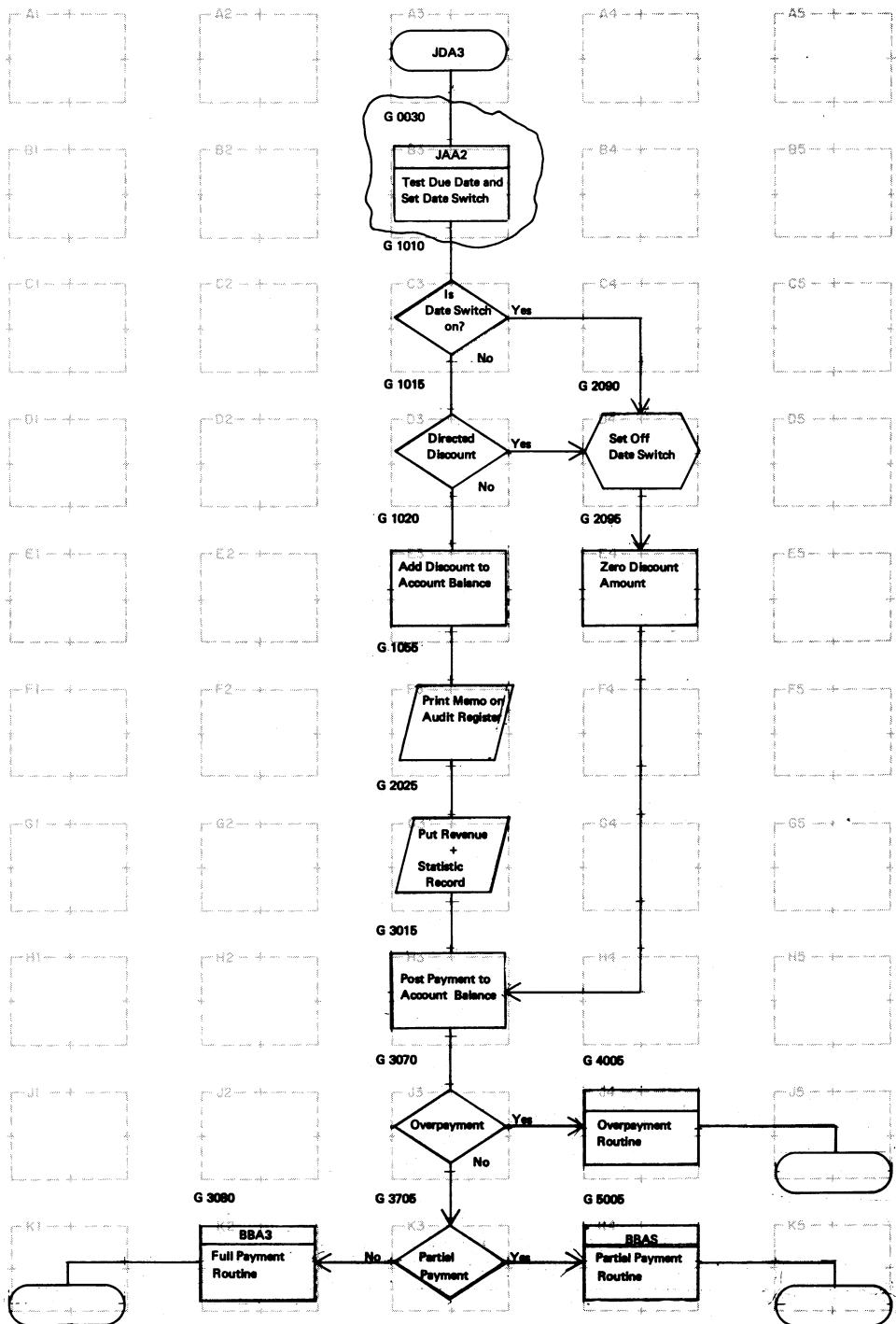


Figure 16. Modular flowcharting

## IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
 Chart ID: \_\_\_\_\_ Chart Name: Cash Payment Program Name: Customer Billing File Maintenance

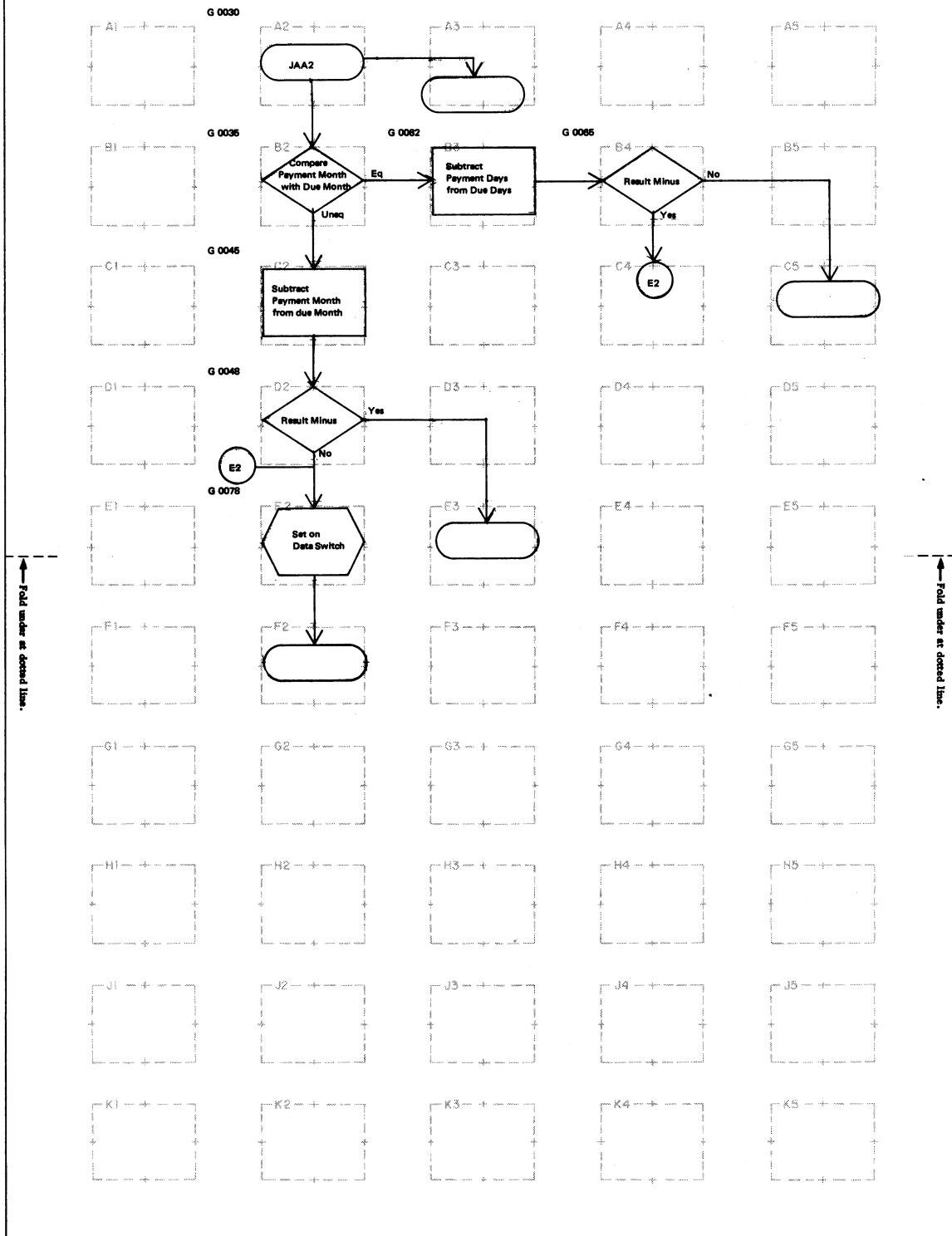


Figure 17. Explosion of processing block JAA2 from Figure 16 flowchart

## Situation 12: Flowcharting and the Source Program

To show the relationship of a program flowchart and a source program, a basic sort into ascending sequence is described. The flowchart and the PL/I statements complement each other to document the processing. With some knowledge of PL/I, these constitute a detailed program explanation. With no knowledge of PL/I, but with the aid of a few explanatory remarks, it is possible to grasp the rudiments of the program. Following this explanation of the source program, the source program itself is shown in Figure 18. Figure 19 is a flowchart of the processing.

Line 1 establishes the program as a PL/I procedure having the name SORT1.

Lines 2-3 name six areas in storage that are to contain 80-character strings.

Lines 4-5 specify the action to be taken when there are no more cards to be read: specifically, the printer is disconnected from the program, and control is transferred to the last statement in the program, which is named OVER.

Lines 6-7 cause five cards to be read into storage.

Lines 8-11 cause the cards just read in to be printed. This printout provides the SORT1 INPUT shown in Figure 20. Unnecessary in a realistic problem, the printout, its coding, and its representation on the flowchart are shown to add to the completeness of this demonstration problem.

Line 12 has the name SORT and is the first of a series of statements that do the actual sorting of five cards named CARD1, CARD2, CARD3, CARD4, and CARD5.

Line 13 causes a comparison (IF GREATER THAN) between the first three characters of CARD1 (beginning in position 1) and the same substring of characters in CARD2(SUBSTR(CARD2, 1, 3)).

Lines 14-15 specify what action is to be taken if the GREATER THAN comparison made in line 13 proves to be true. (If the substring in the first card is greater than the substring in the second card, then CARD1 and CARD2 trade locations in storage.)

Lines 16-24 perform comparisons on the other four cards in the group.

Line 25 returns control to line 12 until the cards are sorted (that is, until none of the THEN DO;K=1; statements are executed).

Lines 26-29 print the cards in sorted sequence. The keyword SKIP in line 29 causes the printer to advance a line before printing 80 characters from storage.

Line 30 returns control to line 6 to read five more cards. If no cards remain to be read, control goes to line 4 and thence to line 31, where the END causes the program named SORT1 to be terminated.

```
1  SORT1: PROCEDURE OPTIONS (MAIN);
2    DECLARE(CARD1,CARD2,CARD3,CARD4,CARD5,SAVE)
3      CHAR (80);
4      ON ENDFILE (SYSIN) BEGIN, CLOSE FILE (SYSPRINT);
5        GO TO OVER; END;
6      INPUT: GET EDIT(CARD1,CARD2,CARD3,CARD4,CARD5)
7          (A(80));
8      PUT SKIP (2) LIST ('SORT1 INPUT:');
9      PUT EDIT
10         (CARD1, CARD2, CARD3, CARD4, CARD5)
11         (SKIP, A(80));
12      SORT: K=0;
13      IF SUBSTR(CARD1,1,3)>SUBSTR(CARD2,1,3)
14        THEN DO;K=1;SAVE=CARD1;CARD1=CARD2;
15          CARD2=SAVE;END;
16      IF SUBSTR(CARD2,1,3)>SUBSTR(CARD3,1,3)
17        THEN DO;K=1;SAVE=CARD2;CARD2=CARD3;
18          CARD3=SAVE;END;
19      IF SUBSTR(CARD3,1,3)>SUBSTR(CARD4,1,3)
20        THEN DO;K=1;SAVE=CARD3;CARD3=CARD4;
21          CARD4=SAVE;END;
22      IF SUBSTR(CARD4,1,3)>SUBSTR(CARD5,1,3)
23        THEN DO;K=1;SAVE=CARD4;CARD4=CARD5;
24          CARD5=SAVE;END;
25      IF K=1 THEN GO TO SORT;
26      PUT SKIP (2) EDIT ('SORT1 RESULT:') (A);
27      PUT EDIT
28         (CARD1, CARD2, CARD3, CARD4, CARD5)
29         (SKIP, A(80));
30      GO TO INPUT;
OVER: END SORT1;
```

Figure 18. PL/I program for a demonstration of sorting

# IBM Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-2

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_ Page: \_\_\_\_\_  
Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_

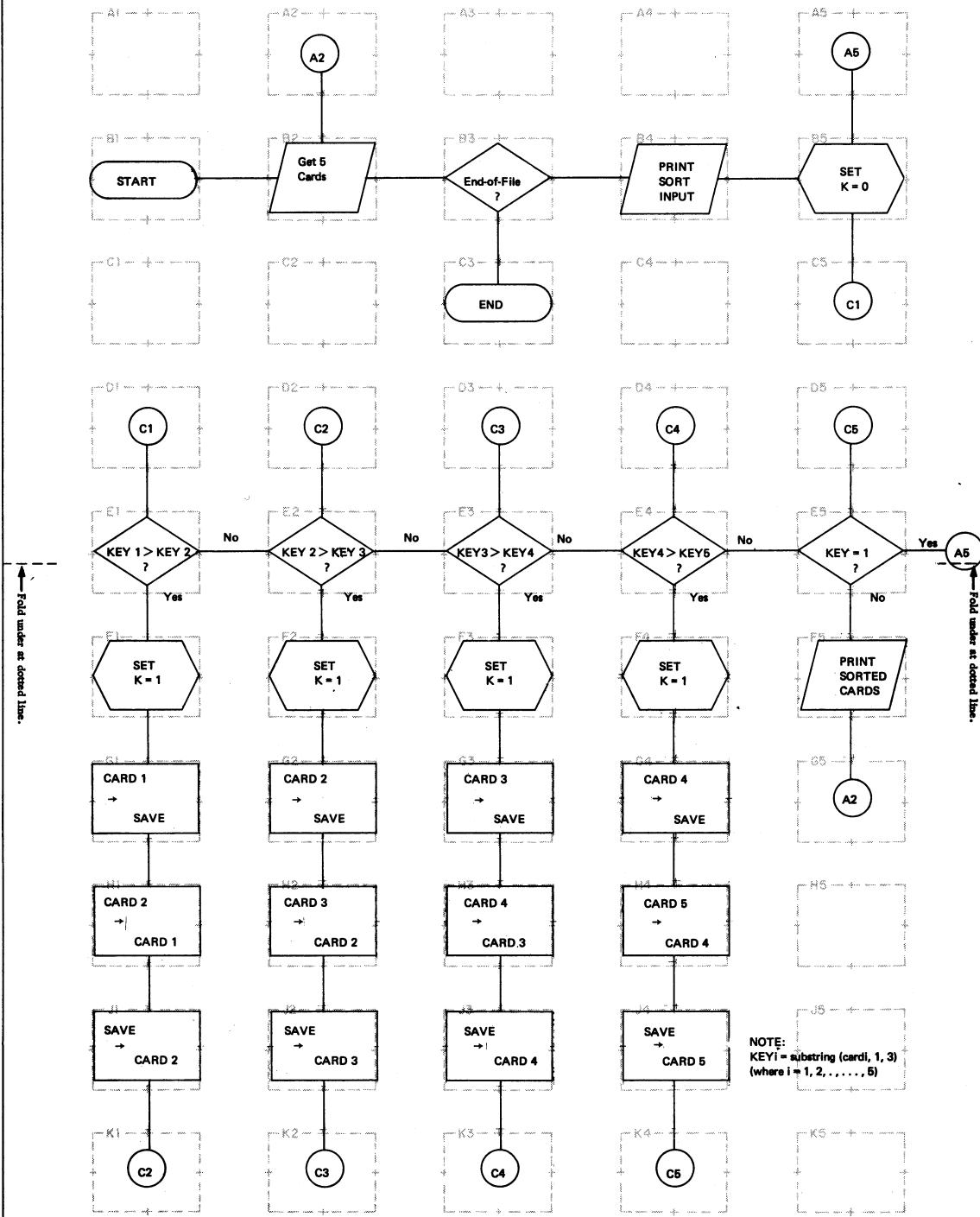


Figure 19. Flowchart of demonstration sort

SORT 1 INPUT:

Z71_FIFTH-----	5
A96_SECOND-----	2
A14_FIRST-----	1
W17_FOURTH-----	4
E02_THIRD-----	3

SORT1 RESULT:

A14_FIRST-----	1
A96_SECOND-----	2
E02_THIRD-----	3
W17_FOURTH-----	4
Z71_FIFTH-----	5

SORT 1 INPUT:

A14_FIRST-----	1
A96_SECOND-----	2
E02_THIRD-----	3
W17_FOURTH-----	4
Z71_FIFTH-----	5

SORT1 RESULT:

A14_FIRST-----	1
A96_SECOND-----	2
E02_THIRD-----	3
W17_FOURTH-----	4
Z71_FIFTH-----	5

SORT 1 INPUT:

W17_FOURTH-----	4
Z71_FIFTH-----	5
A96_SECOND-----	2
A14_FIRST-----	1
E02_THIRD-----	3

SORT 1 RESULT:

A14_FIRST-----	1
A96_SECOND-----	2
E02_THIRD-----	3
W17_FOURTH-----	4
Z71_FIFTH-----	5

(COLUMNS 41-80 OF THE 15 INPUT CARDS  
CONTAIN BLANKS)

Figure 20. Listing from SORT1

## **SYSTEM/360 FLOWCHART**

IBM System/360 Flowchart is a System/360 program designed to machine-generate flowcharts. This documentation aid is intended to minimize the planning and effort required to produce and maintain program documentation. The user writes statements in a specially designed input language that is easy to learn and simple to use. These statements are used to generate printed flowcharts.

With the use of System/360 Flowchart, flowcharts can be produced automatically and, once produced, can be changed or modified with a minimum of effort. The only prerequisite for reading the publications containing the specifications and detailed instructions for using the System/360 Flowchart program is a basic understanding of flowcharting. This manual is intended to provide that basic understanding.

## **FLOWCHARTING POINTERS**

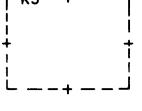
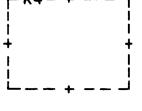
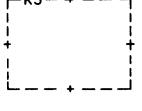
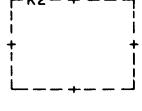
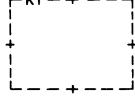
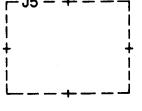
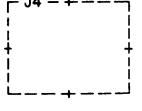
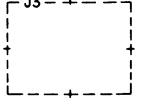
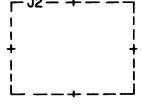
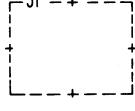
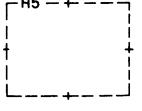
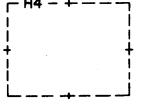
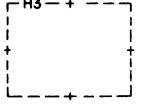
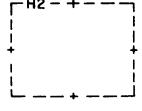
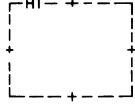
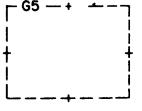
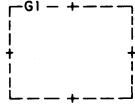
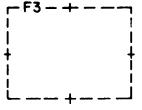
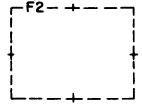
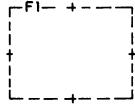
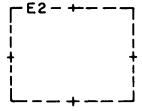
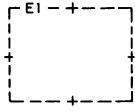
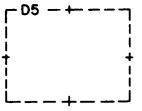
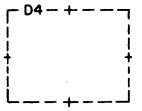
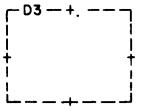
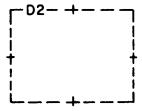
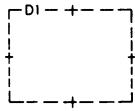
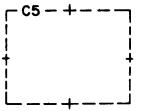
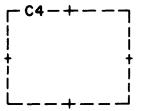
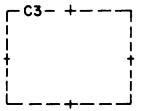
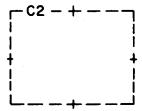
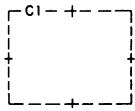
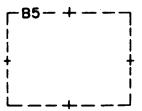
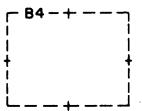
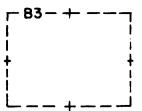
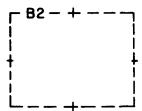
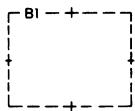
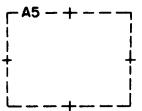
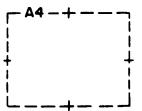
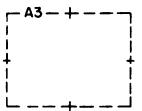
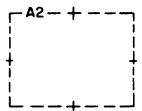
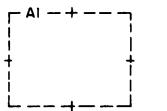
The following pointers may be of help in producing a good set of flowcharts:

- Use some form such as the IBM Flowcharting Worksheet (X20-8021), shown in Figure 21 and again, with symbols in Figure 22.
- Put yourself in the position of the reader.
- Try to anticipate the reader's problems in understanding your chart.
- Make the main line of each flowchart easily recognizable.
- Look for opportunities to tabulate information (decision tables).
- Do not chart every detail of the program.
- Cross-reference the flowchart to the source program, because the reader may need to refer to the source-language program.
- Leave a margin of one inch on all sides for binding of charts when the worksheet is not used.

# IBM® Flowcharting Worksheet

PRINTED IN U.S.A.  
X20-8021-1

Programmer: \_\_\_\_\_ Program No.: \_\_\_\_\_ Date: \_\_\_\_\_  
 Chart ID: \_\_\_\_\_ Chart Name: \_\_\_\_\_ Program Name: \_\_\_\_\_ Page: \_\_\_\_\_



Fold under at dotted line.

Fold under at dotted line.

Figure 21. Flowcharting worksheet

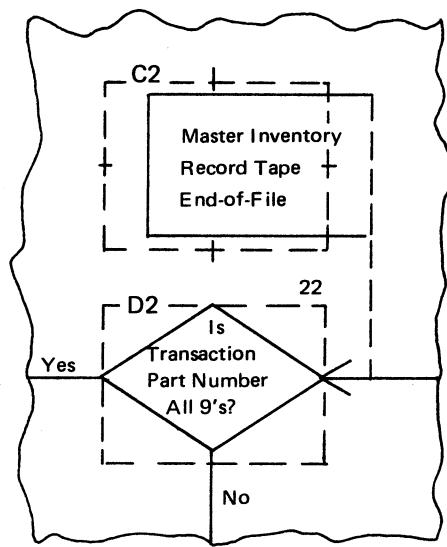


Figure 22. Section flowcharting worksheet showing symbols



International Business Machines Corporation  
Data Processing Division  
112 East Post Road, White Plains, N. Y. 10601  
(USA Only)

IBM World Trade Corporation  
821 United Nations Plaza, New York, New York 10017  
(International)