IBM

Reference Manual

IBM 545 Output Punch Models 1 and 2

Preface

This reference manual describes the capabilities, operating procedures, programming considerations, features and special features of the IBM 545 Output Punch. It also contains the information required by an operator or trainee to use the 545 efficiently. The reader is assumed to have at least an introductory knowledge of data processing.

The manual has two major sections: Keypunch Mode and Autopunch Mode. "Keypunch Mode" presents a complete description of the 545 as a manual card punch. The reader who is *not* familiar with IBM keypunch machines (e.g. the 24/26, 29, or 534/536) should read this section first. Those who have had experience with keypunch type machines may prefer to proceed to "Autopunch Mode," which presents a complete description of the 545 as an output punch for system use.

The user may or may not choose to use the power and signal resources of the 545 Output Punch. However, the functions and procedures described in this manual are based on the assumption that all power and signals necessary to output punch operation originate in the 545.

Second Edition (June, 1968)
This is a major revision of, and obsoletes, A19-0029-0. The manual has been entirely rewritten to reflect numerous additions and changes, and should be reviewed in its entirety. Changes are periodically made to the specifications herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

This manual has been prepared by the IBM Systems Development Division, Product Publications, Dept. B98, PO Box 390, Poughkeepsie, N.Y. 12602. Address comments concerning the contents of this publication to this address.

Contents

IBM 545 Output Punch

Basic to all IBM punched-card data processing is the IBM card punch. The IBM 545 Output Punch (Frontispiece) is the modern way to automatically prepare punched cards for accounting operations.

The 545 Output Punch is available in two models, the Model 1 is a nonprinting output punch, and the Model 2 is a printing output punch.

The IBM 545 offers two modes of operation: autopunch and keypunch. In autopunch mode, the 545 has the popular features of other IBM output punches that are required for producing punched card output of data from a data processing system or other unit and adds several new features.

In keypunch mode, the IBM 545 functions and operates similar to the IBM 29 Card Punch, with program and keyboard control by the operator. Either the 48- or 64-character keyboard arrangement is available.

FEATURES

- Output information received from the using system is punched into a card by the 545 Model 1 at the rate of 20 columns per second (cps). The Model 2 punches and prints the output at 18 cps.
- Autopunching may be interrupted and keypunching performed in autopunch mode under control of the program card and the system.
- Information may be duplicated from one card into the following card in a gangpunch operation under system or program card control.
- Card columns may be skipped at the rate of 80 cps, again under system or program card control.
- The using system may select either of two program levels for control and may shift back and forth between program levels during card punching.
- Card feeding, releasing, and spacing are also under control of the using system.
- Cards may be punched manually from the keyboard when the 545 is used as a standard keypunch.

SPECIAL FEATURES

- Duplication of information from an auxiliary drum card, or use of auxiliary drum card punching for control signals to the system.
- Identification of selected cards with a specified punch in column 81.
- Utilizing the 545 as a system's input card reader.
- Verifying while keypunching precoded numeric information called self-checking numbers.
- Automatic generation of self-checking code numbers.

Keypunch Mode

The IBM 545 Output Punch may be used as a standard keypunch by setting the autopunch/keypunch switch to keypunch. This places the 545 in keypunch mode, electrically isolated from an attached system (except the 48V power supply). The interface cable need not be disconnected.

Operation as a keypunch is dependent upon the operator and the program he selects.

Features

In keypunch mode, the 545 has the same features as other IBM card punches, plus the unlimited use of two program levels (except when the self-checking special feature is installed). The two independent programs provide greater flexibility in application and operation of the card punch.

PROGRAMS

One of the most important features is the simple means of setting up the 545 for automatic control of duplicating and skipping operations. Each setup or program is made by punching a card and mounting it on a program drum, which is inserted in the machine.

On the 545 Output Punch, with unlimited use of two program levels, each program card can contain two totally different, complete 80-column programs. Either program can be selected for card-to-card use by setting a program selection switch. If it is desired to use both program levels to control punching on a single card, alternations from program to program can be made by program selection keys on the keyboard. Programs can be alternated at will, during the punching of a single card, by use of these keys.

CARD PUNCHING

Eighty columns on the card can be punched.

Each column has 12 punching positions: one each for the digits 1 to 9, and one each for the zones 0, 11, and 12. The 11-zone punch is sometimes referred to as X. The digits are recorded by punching a single hole in the corresponding digit or zero position of the desired column.

A letter is a combination of one zone punch and one digit punch in the desired column. For example, A is a 12-zone and digit-1 punches, N is an 11-zone (X) and digit-5 punches, and Z is a 0-zone (zero) and digit-9 punches.

A special character is one, two, or three holes in the desired column as shown in Figure 1. Punching two or three holes in one column for a letter or special character is automatic when the corresponding key is pressed.

CARD DESIGN

The almost complete visibility of the cards in the card bed facilitates the design and punching of dual cards and the identification of prepunched cards into which more data must be punched. Direct access to all parts of the card bed also permits easy manual insertion and removal of cards when necessary.

Punched cards are usually designed so that each item (or field) of information recorded in the card can be readily identified. Figure 2 shows a card designed for use in a sales accounting application, and a typical invoice from which the card was punched.

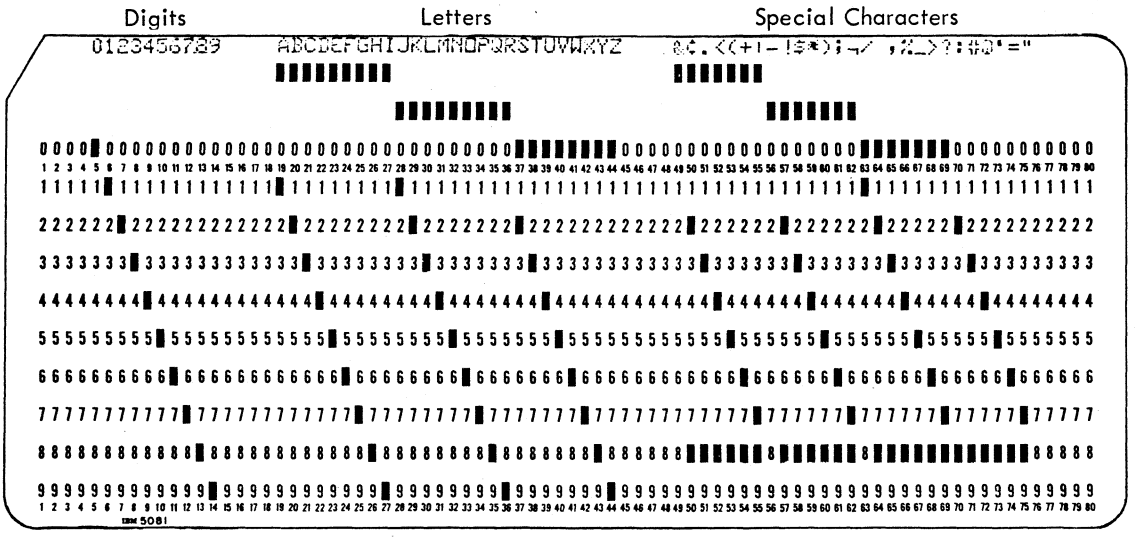


Figure 1. Card Codes and Graphics for 64-Character Set

GENERAL MANUFACTURING COMPANY

ENDICOTT, N. Y.

CUSTOMER'S ORDER NO. 311 INVOICE DATE 12-31 INVOICE NO. 12349

SOLD TO New Mexico Company
216 Wysor Building
Houston, Texas

CUSTOMER NO. 59751

SHIP TO Above

Make all checks payable to

SALESMAN Macy-67

GENERAL MANUFACTURING COMPANY
Endicott, N. Y

SHIPPED VIA Truck Prepaid

TERMS 2% 10 Days Net 30

QUANTITY	COMMODITY No.	DESCRIPTION	PRICE	AMOUNT
		Casters		
40	11202	Sq. Shank Swivel	.83	33.20
75	13102	Flat Top Rigid	.84	63.00
5	17203	Ext. Shank with Brk.	1.62	8.10
2	32105	Bolt and Nut Shank	2.64	5.28
4	44104	Rnd. Spr. Ring Stem	3.51	14.04
40	62110	Bolt and Nut Shank	7.25	290.00
		Freight		.78
				414.40

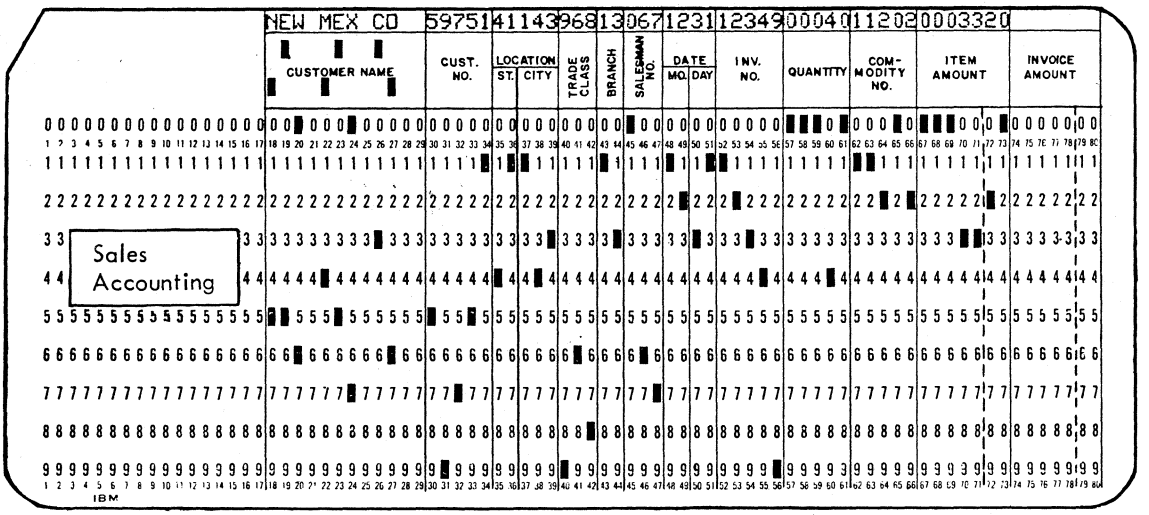


Figure 2. Document and Punched Card

The card contains, in punched-hole form, descriptive information such as customer name, customer number, and location printed in the heading of the invoice, and quantitative data for the first commodity printed in the body of the invoice. The fields on the card are in the same sequence as the corresponding items of information on the invoice. This simplifies the reading of the original document as the information is being punched.

The card form also illustrates other operations characteristic of many card-punching jobs. For example, columns 1-17 are always skipped; columns 18-56 are punched in the first card for an invoice, and duplicated into all other cards for that invoice; and columns 57-61, a five-column field in which the quantities are variable, are always keypunched. Columns 74-80 (invoice amount) can be punched in some cards and skipped in others.

DUPLICATION

The 545 duplicates common information from any card into the following card in a gangpunch operation. Duplication can be performed automatically (under program control) or manually (controlled from the keyboard). This method of duplicating reduces manual keying of repetitive data and consequently increases production. All characters of the 64-character set can be duplicated and printed.

The duplicating feature greatly facilitates error correction during punching. When an error is made, the operator need not repunch the whole card manually. Instead, without any card handling, the operator duplicates into the next card all correctly punched fields and rekeys only the field in error. The program control permits such duplication, field-by-field, without concern about column numbers.

Duplicating under program control proceeds at a rate of 20 columns per second on the Model 1, and 18 columns per second on the Model 2.

Note: Where two duplicating or punching speeds are indicated in this publication, the lower speed refers to the Model 2 and the higher speed refers to the Model 1.

SKIPPING

Card columns or fields that are not to be keypunched or duplicated may be skipped. Skipping can be performed automatically (under program control) or manually (controlled from the keyboard).

Skipping and card release proceed at a rate of 80 columns per second. Release is keyboard controlled only and causes the card to be "skipped out" past column 80. Programmed auto-duplicate fields are duplicated during release.

KEYBOARD

The combination keyboard (Figure 3) can be either a 48-character or 64-character arrangement, as described under "Operating Elements." The character arrangement chosen determines the special character graphic that prints for the various special-character punched-hole combinations.

The keyboard can be rotated on the desk (reading board) for the operator's greatest convenience and comfort. A group of the right-hand typewriter keys serves for punching digits as well as letters, with the shift from one function to the other normally made automatically by the program card. This permits the operator to punch an alphabetic field with both hands and then, without shifting from the *home* position, to punch a numeric field with the right hand only. Use of the right hand alone for numeric punching frees the left hand for document handling.

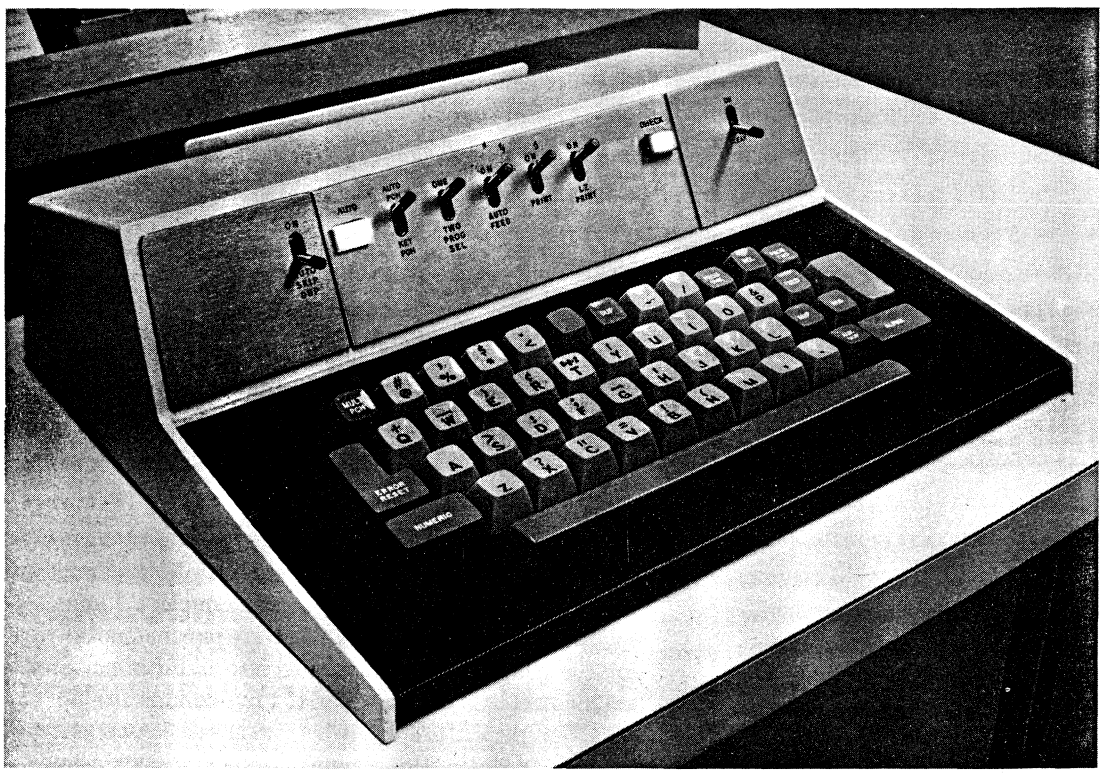


Figure 3. Combination Keyboard

MAIN LINE SWITCH

The main line switch is on the front right side of the cabinet under the keyboard. When the main line switch is turned on, the machine is ready for immediate use.

Press the release key before starting operation (keypunch mode) to ensure that the program card is at column 1.

READING BOARD DESK

The desk area provides ample work space for the source documents from which the cards are punched. The keyboard can be rotated on the desk to provide the greatest convenience and comfort for the operator.

CARD HOPPER

The card hopper, which holds approximately 500 cards, is on the upper right of the machine. The cards are placed in the hopper, in front of the sliding pressure plate, face forward, with the 9-edge down, and are fed front card first. The sliding pressure plate assures uniform feeding.

To feed a card down from the hopper to the card bed, press the feed key. The first two cards to be punched must be fed by the feed key, but all other cards in the hopper can be fed automatically under the control of the auto feed switch. (See "Functional Controls.")

PUNCH STATION

Punching is performed at the first of two stations in the card bed through which the cards pass from right to left. To start a punching operation, press the feed key twice, this feeds two cards into the card bed at the right of the punch station. As the second card is fed in, the first card is automatically registered for punching. The registering operation moves the card in position to punch column 1. While the first card is being punched, the second card remains at the right of the punch station, in the preregister position. The first card is transported to the read station as it is punched or released through column 80. When the third card is fed to the preregister position, the first and second cards are registered in the read and punch stations respectively, (Figure 4).

To place a single card in the card bed by hand and register it in punching position, press the register key.

The whole card is visible before it is registered at the punching position, and at least 71 columns are visible after punching has started. For example, when column 15 is to be punched (Figure 5), columns 1-12 and columns 22-80 are visible.

Cards with lower corner cuts (except lower-left corner cut C-3, 30-degree, 0.130-inch base measurement) cannot be fed. For registration and spacing, the card is gripped along its lower edge by two wheels. Lack of the two lower corners creates registration inaccuracies. Round corner cut cards are acceptable.

READ STATION

The read station, where the cards are read for duplicating, is slightly greater than one card length to the left of the punch station. Consequently, each card that has been punched passes through the read station as the next card is being punched. The two cards move in synchronism, column-by-column, and information to be duplicated is transferred from the first card to the second card. This principle of duplication is the same as gangpunching. Reading from one card to another can be controlled, field-by-field, so that only the desired information is duplicated.

This feature eliminates card handling when duplicating information from cards prepared during the punching operation. Card handling is necessary only when an operation requires duplication from prepunched master cards. In this case, insert the prepunched master card manually at the right of the read station before the next card to be punched is registered. Press the register key to register both the master card and the detail card at their respective stations.

The whole card is visible before it is registered at the read station, and at least 68 columns are visible after reading has started. For example, when column 15 is being read, columns 1-8 above the 7-row and columns 21-80 are visible.

CARD STACKER

The card stacker, with a capacity of approximately 500 cards, is on the upper left side of the machine on a level with the hopper. After each card passes the read station, it is fed into the stacker automatically, or by keying if the auto feed switch is off. The cards are stacked at an angle, 12-edge to the rear, face up, and are held in position by a card weight. When the cards are removed from the stacker, they are in their original sequence.

A full stacker operates a switch that interlocks the card feed. However, power is not turned off and the machine is immediately ready for operation as soon as the cards are removed from the stacker.

A scale is provided in the stacker so that an estimate can be made of the total number of cards processed before the cards are removed from the stacker.

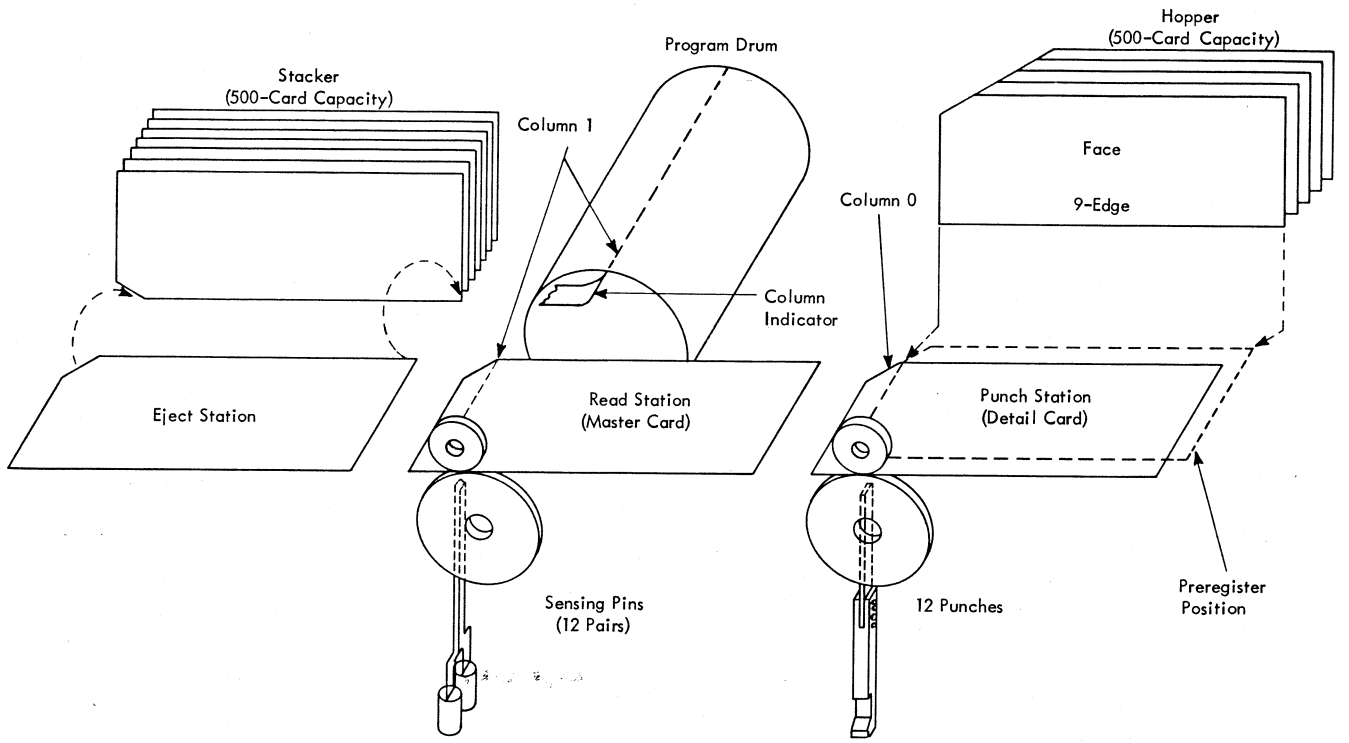


Figure 4. Card Path

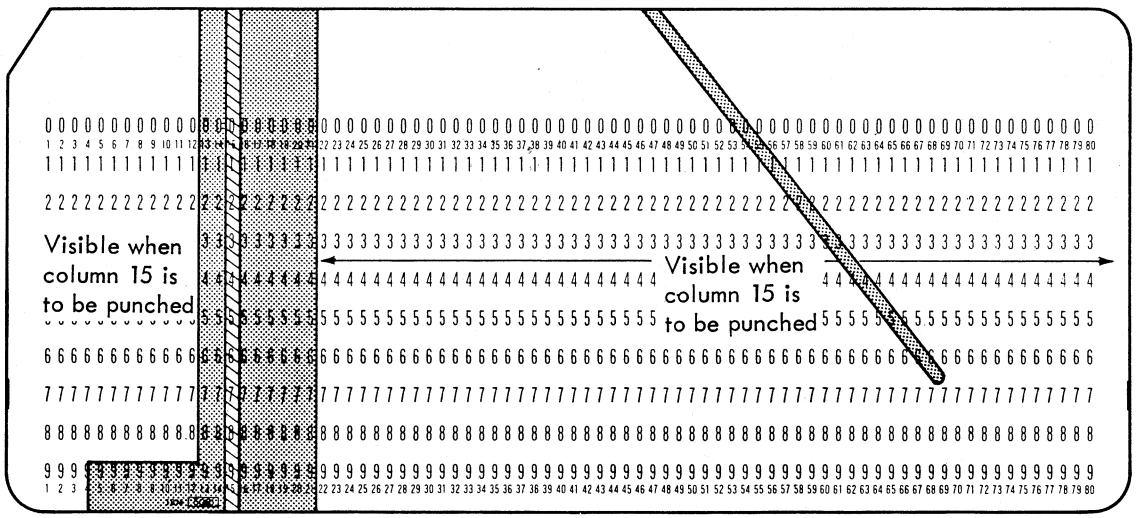


Figure 5. Card Visibility at the Punch Station

BACKSPACE KEY

The backspace key is below the card bed between the reading station and punching station. As long as the backspace key is held down, the cards at the punching and reading stations backspace continuously until column 1 is reached. At the same time, the program card, which controls skipping and duplicating, also backspaces.

Backspacing should not be attempted after a card has passed column 78 in the punching station unless the following card (in the preregister position) is removed from the

card bed. Because registration accuracy may be affected, cards should not be backspaced for more than 20 columns.

PROGRAM UNIT

The program unit (Figure 6) controls automatic skipping, automatic duplicating, and shifting back and forth between numeric and alphabetic punching. The unit is accessible to the operator from the front of the machine. Lift the middle portion of the top cover to remove the program drum for removal and installation of program cards.

Each of the operations performed under control of the program unit is designated by a specific code recorded in a program card. The program card is punched with the program card codes to fit the application desired. The program card is mounted on the program drum, which is placed on the program unit of the 545 Output Punch. The program drum revolves in synchronism with the movement of the cards past the punching and reading stations so that the program card codes control the operations, column-by column.

The program unit is equipped with two program levels, which give added flexibility to a program operation. Automatic skipping, duplicating, field definition, and alphabetic shift can be performed through both levels of program control.

Program Control Lever

The program control lever, below the program unit, controls operation of the program unit (Figure 6). Turn the control lever on (to the left) to lower the sensing mechanism.

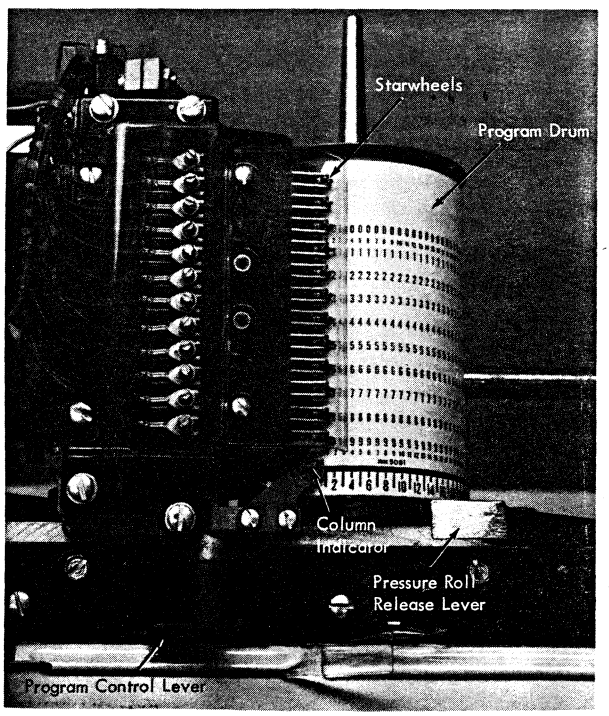


Figure 6. Program Unit

The sensing mechanism consists of 12 starwheels, which, when the mechanism is lowered, ride along the surface of the program card to sense the program control punches in the card. When a punched hole is sensed by a starwheel, a signal goes to the controlling circuits of the machine. This signal initiates the particular function designated by the code punch detected in the program card.

Turn the control lever off (to the right) to raise the sensing mechanism. This lifts the starwheels off the program card; the program control punches will not be sensed. The control lever must be turned to the off position to remove the program drum, and must be left in that position when no program drum is in the machine.

Column Indicator

The column indicator, at the base of the program drum holder (Figure 6), indicates the next column to be punched. Use this indicator as a guide for spacing or backspacing to a particular column.

PRESSURE-ROLL RELEASE LEVER

The pressure-roll release lever is next to the column indicator (Figure 6). This lever is accessible by raising the center cover over the program unit. Pressing this lever permits manual removal of a card from the punching or reading station. Normally, a card can be removed in one piece if it is pulled out with care. If torn pieces are caught at either station, push them out with another card or a smooth-edge metal blade while holding down the pressure-roll release lever. Do not use saw-edge metal blades.

CHIP BOX AND FUSES

The chip box is under the desk top below the keyboard. When the chip box is removed, the fuses for the machine are accessible. The chip box should be emptied daily.

KEYBOARD

The combination keyboard for the IBM 545 Output Punch is equipped with square keybuttons. The keyboard is so interlocked that no two character keys can be completely depressed at the same time, but it is not necessary to wait for one key to rise fully before pressing another.

The combination keyboard has the features of both a typewriter and a numeric keypunch. The letter keys are arranged for operation by the standard typewriter touch system, while the digit keys are placed so that a rapid three-finger touch system can be used. The usual numeric keys on a typewriter have been eliminated; instead, a group of dual-purpose keys at the right serves for digit punching as well as letter punching. This permits numeric punching with the right hand from the normal home position for alphabetic punching. The touch system for the ten numeric keys is: index finger for digits 1, 4 and 7; middle finger for digits 2,

5, and 8; and ring finger for digits 0, 3, 6, and 9. The punching of a digit or a letter with any of the combination keys depends on the shift of the keyboard. For example, pressing the 4-J key, punches a 4 when the keyboard is in numeric shift, but a J when in alphabetic shift. This shifting is similar to upper or lower case shifting on a standard typewriter and may be controlled automatically by the program unit or manually by key.

A 48- or a 64-character keyboard (and print code plate on Model 2) arrangement may be specified. Except for the shaded keys (Figures 8-19) and 12-8-4 (* or <), the 64-character and 48-character keyboards are the same. The 16 special characters shown on the shaded keys are not available on the 48-character keyboard. Pressing one of these keys while in numeric shift causes the keyboard to lock up; to unlock the keyboard, press the error reset key.

Figure 7 shows the functional switches and the American English key nomenclature. Figures 8-19 show the corresponding keyboard arrangements used in various countries outside of the United States.

The two indicators (auto and check) on the 545 are operative only in autopunch mode (see "Operations" in the autopunch section).

Functional Controls

The print and left-zero print switches are on the Model 2 only and are not discussed in this section. The functions of these switches are described under "Printing."

Autopunch/Keypunch

This switch selects the mode of operation. To operate the 545 as a system's output punch, the autopunch mode is used; for manual keypunch operation, the keypunch mode is used.

Program Selection (Prog Sel)

With a program card in place and the program control lever in the on position, the position of this switch determines whether program control starts in program one or program two. The switch setting selects the program level as a new card is registered for punching. The program level may be changed at will during punching by using the program selection *keys.* However, each time a card is registered, the switch setting selects the starting program level.

Auto Skip/Duplicate (Auto Skip/Dup)

This switch must be in the on position to obtain automatic skipping and duplicating, initiated by the program card 11 and 0 punches respectively. When the switch is in the off position, these functions can be started only by pressing the skip and dup keys.

Auto Feed

When the auto feed switch is turned on and column 80 of the card has passed the punch station, a new card is fed automatically. At the same time, the card in the left of the

Figure 7. The 64-Character Alphameric Keyboard–American English

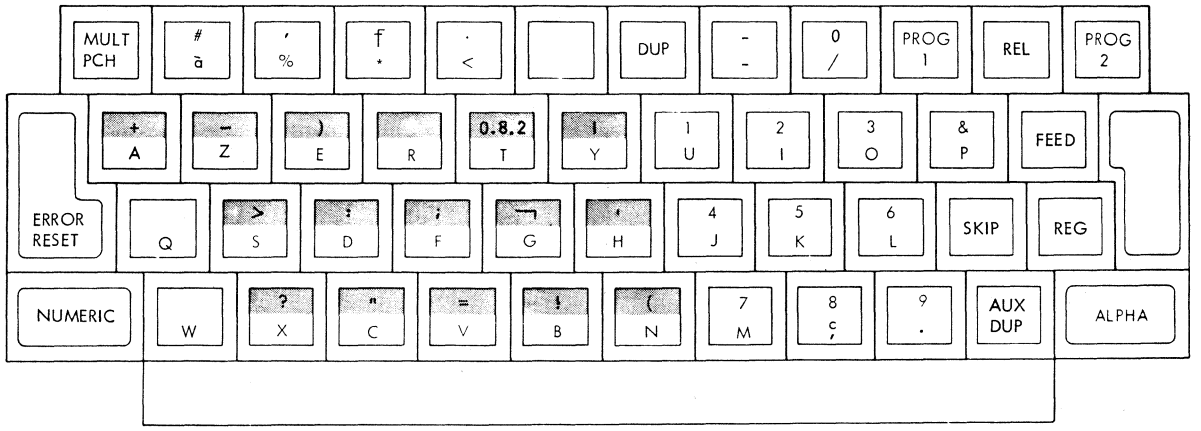


Figure 8. Belgian Keyboard

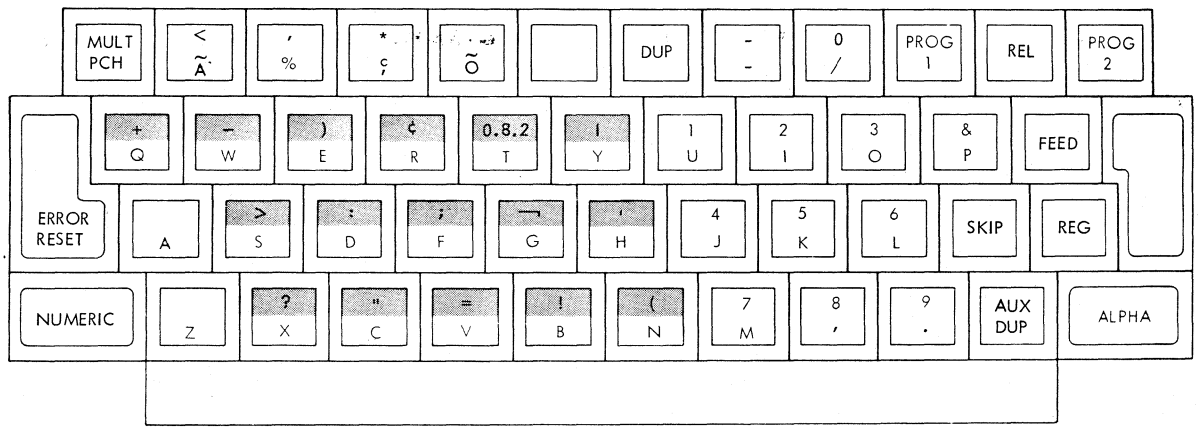


Figure 9. Brazilian Keyboard

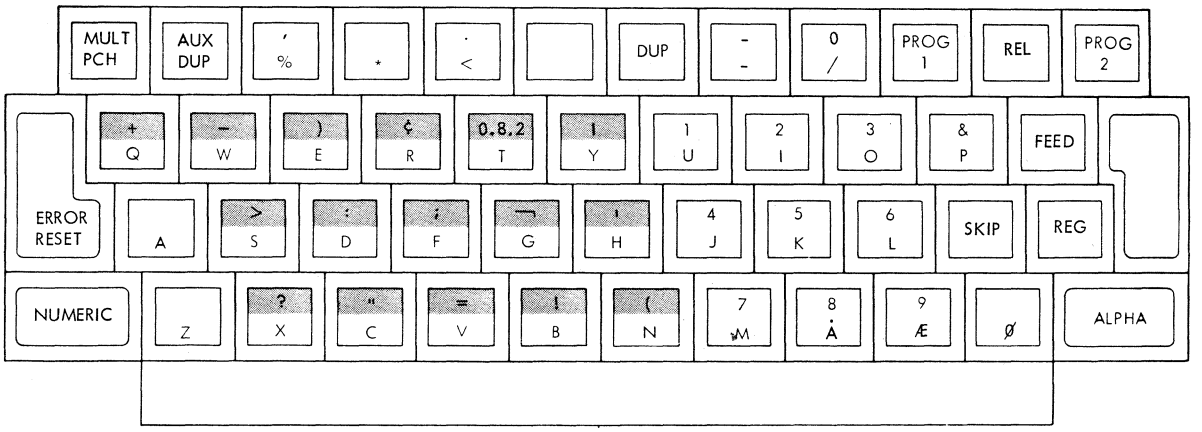


Figure 10. Danish Keyboard

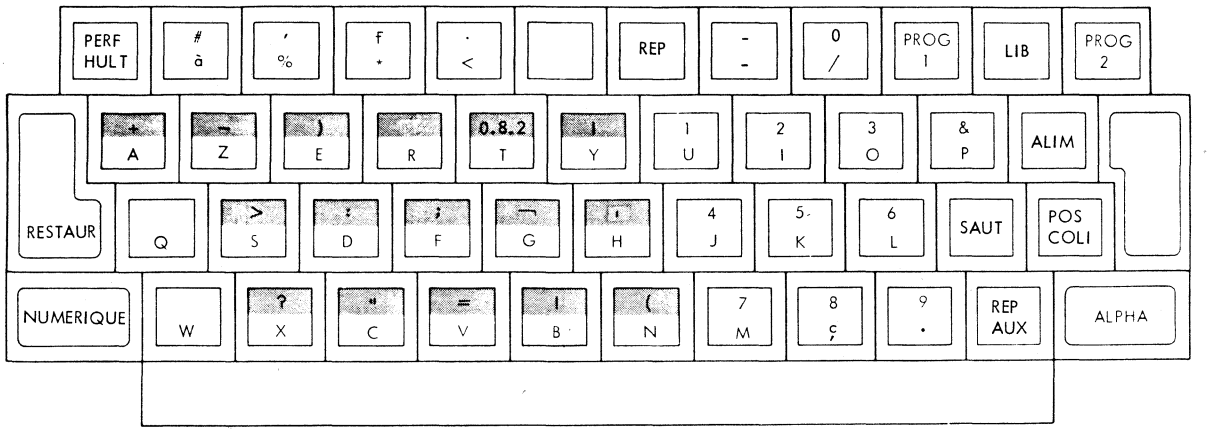


Figure 11. French Keyboard

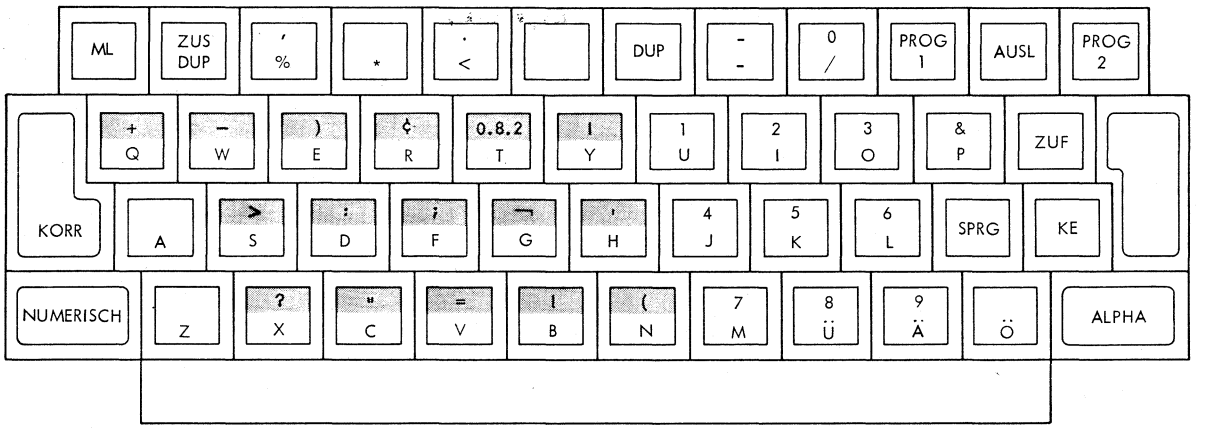


Figure 12. German Keyboard

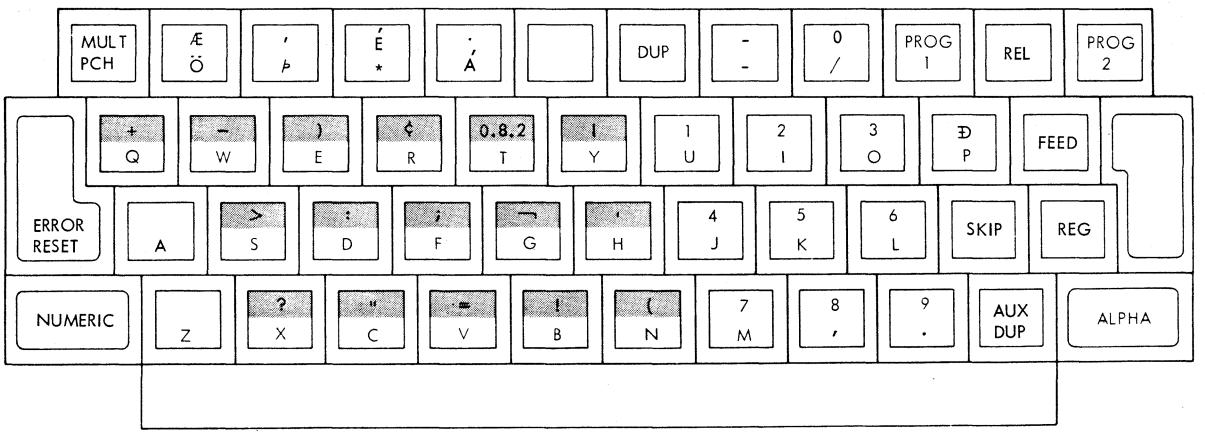


Figure 13. Icelandic Keyboard

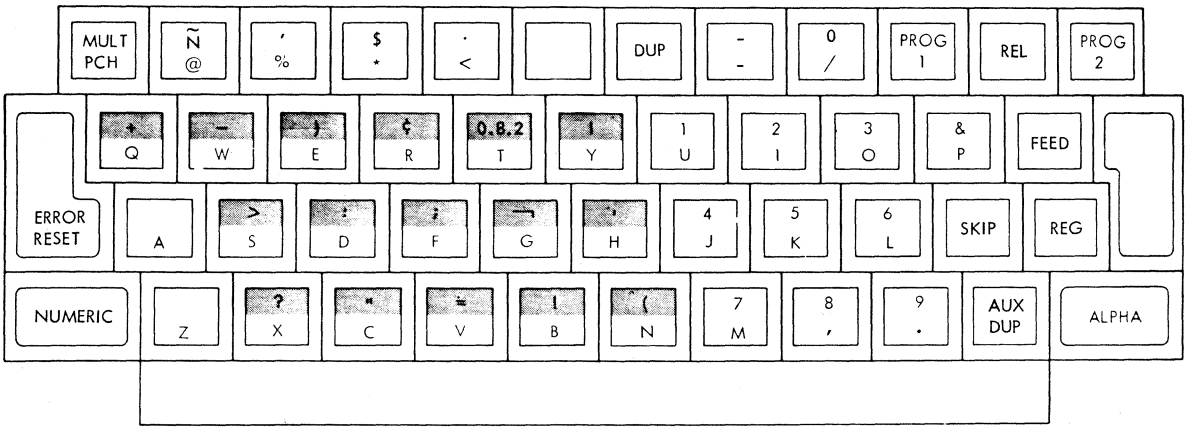


Figure 14. Latin American Keyboard

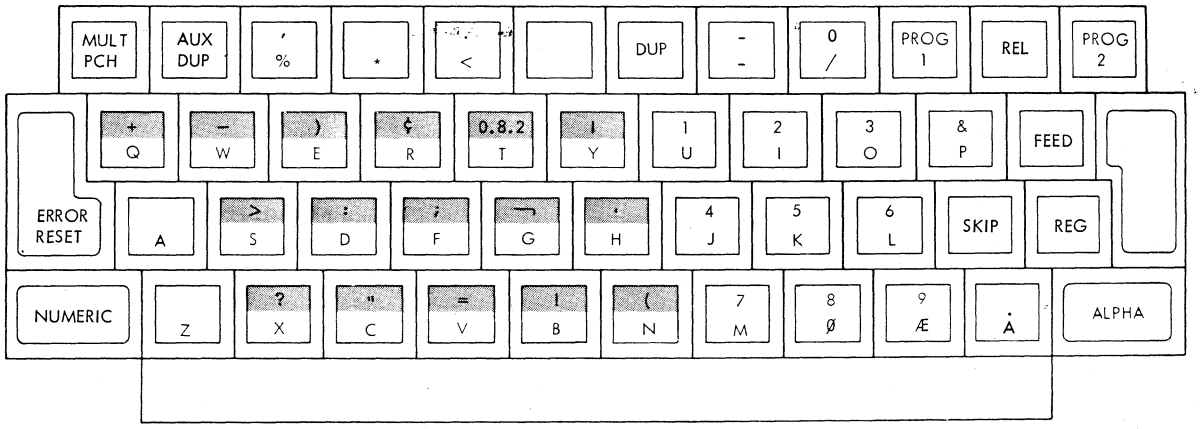


Figure 15. Norwegian Keyboard

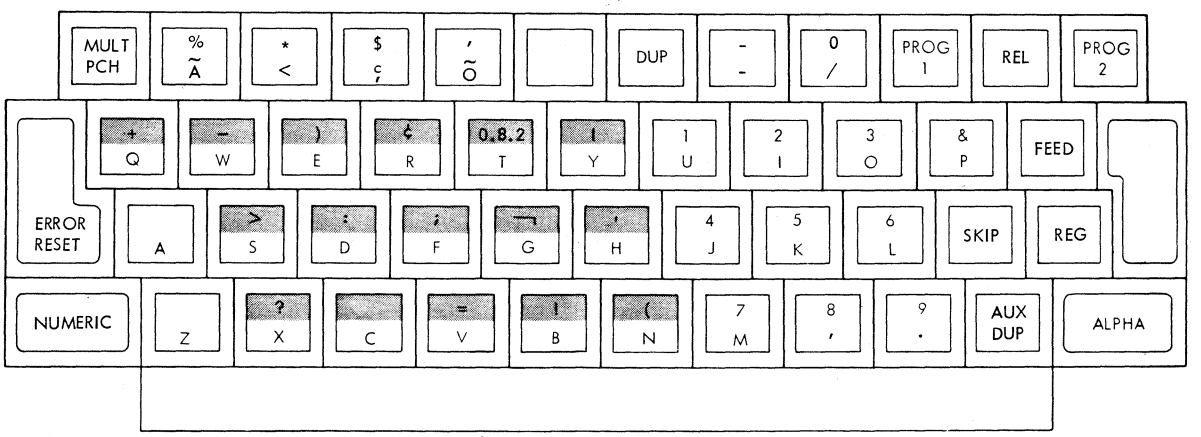


Figure 16. Portuguese Keyboard

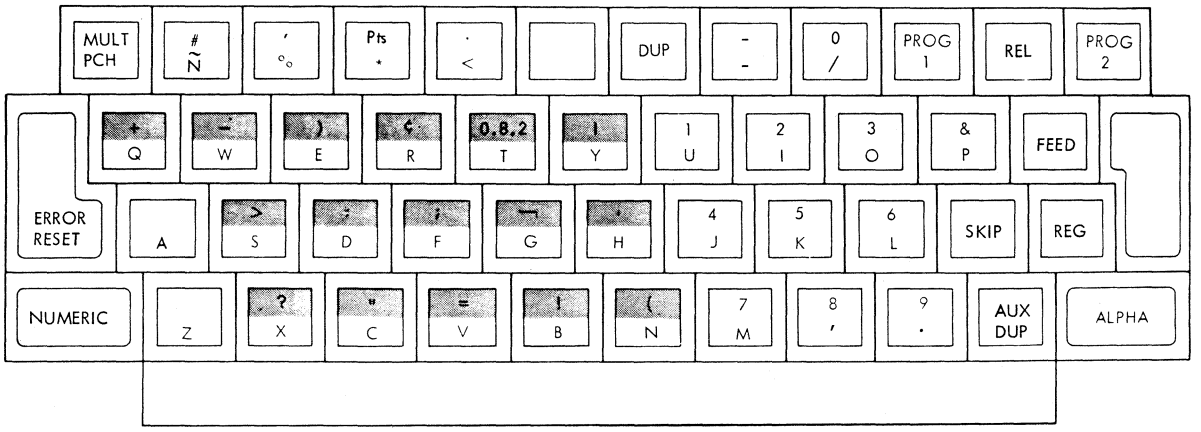


Figure 17. Spanish Keyboard

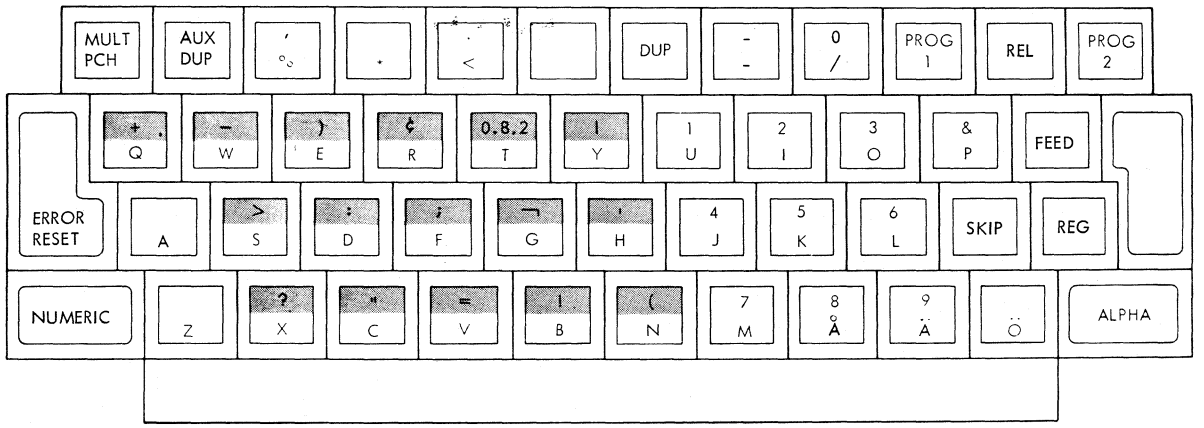


Figure 18. Swedish Keyboard

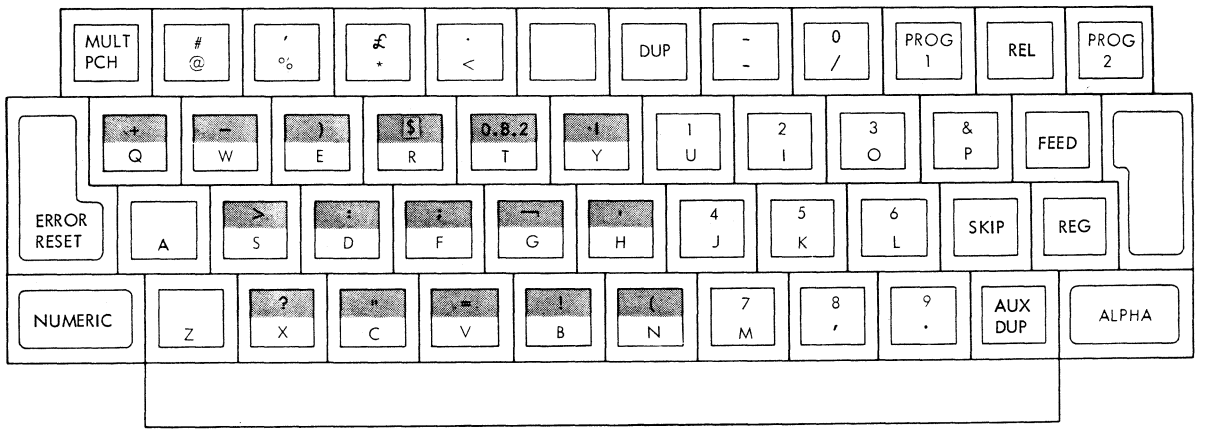


Figure 19. United Kingdom English Keyboard

card bed is stacked, the one in the center is registered at the read station, and the one at the right is registered at the punch station. This automatic feeding occurs after the card, completely processed, passes column 80.

When the switch is turned off, cards may be fed manually by pressing the feed key, program one key, or the program two key. (See "Combination Keyboard.")

Clear

The clear switch (a spring-loaded, self-restoring switch) is used to clear all cards from the feed bed, without feeding additional cards from the hopper. One operation of the switch initiates the multiple cycles necessary to complete the operation.

PROGRAM CARD

A program card, which is a basic part of the program unit, is prepared for each punching application and can be used repeatedly. Proper punching in the program card controls the automatic operations for the corresponding columns of the cards being punched. Each row in the program card governs a specific function. (See "Program Card Preparation.")

Figure 20 shows a typical program card using program one. For program two, the identical hole pattern would appear in punch rows 4-9, on the lower half of the card. For example, all the 12-punches would be 4-punches, all the 1-punches would be 7-punches, etc.

Figure 21 shows the program codes.

Program One	Function	Where Punched	Program Two
12	Field Definition	Each column of field, except first	4
11	Start Auto-Skip	First column of field only	5
0	Start Auto-Dup	First column of field only	6
1	Alphabetic Shift (Keypunch Mode Only)	Every column of alpha field	7
2	Not specified	Not specified	8
3	Not specified	Not specified	9

Figure 21. Program Codes

Field Definition (12, 4)

The 12-punch is the field definition punch for program one; the 4-punch is the field definition punch for program two. A field definition punch for the program level being used must appear in every column except the first (left-hand position) of every field to be automatically skipped, duplicated, or manually punched.

The field definition punch causes any skip or duplication operation started within a defined field to continue to the end of that field. Several consecutive fields to be automatically skipped or duplicated as one field can be programmed as a single field. Do not program a single column field with a field definition punch.

Field definition codes punched in the program card for manually punched fields permit occasional skipping or duplicating. This skipping or duplicating is started by keyboard control keys.

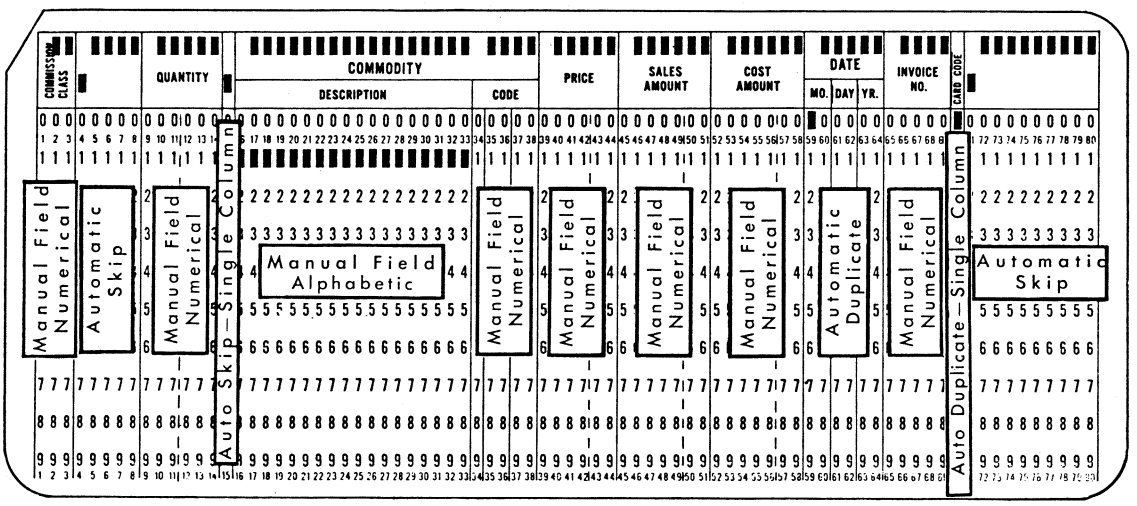


Figure 20. Program Card – Program One Level

Automatic Skip (11, 5)

The 11-punch is the start auto-skip code for program one; the 5-punch is the start auto-skip code for program two. In either program level, punching the start auto-skip code in the first column of the field to be skipped starts an automatic skip, which continues to the end of the field defined by the field definition punches.

This operation is also under control of the auto skip/dup switch on the keyboard. If this switch is off, the program card codes for start auto-skip are not effective.

Automatic Duplication (0, 6)

The 0-punch (zero) is the start-automatic-duplication code for program one; the 6-punch is the start-automatic-duplication code for program two. In either program level, punching the start-automatic-duplication code in the first column of the field to be duplicated starts automatic duplication, which continues to the end of the field defined by the field definition punches.

This operation is also under control of the auto skip/dup switch on the keyboard. If the switch is off, the program card codes for start automatic duplication are not effective.

Alphabetic Shift (1, 7)

The 1-punch is the alphabetic shift code for program one; the 7-punch is the alphabetic shift code for program two. Lowering the program sensing mechanism to place the card punch under program control sets the keyboard in the numeric shift or mode. Therefore, to punch any alphabetic characters or special characters that are part of the alphabetic shift, the keyboard function must be shifted to the alphabetic mode. The shifting is accomplished by an alphabetic shift code in the program card for the program level being used. Each column of the card to be punched alphabetic requires an alphabetic shift code in the corresponding program card column. *Field definition does not extend alphabetic shift.*

PROGRAM DRUM

The program drum (Figure 22) is the part of the program unit that holds the program card. The program drum can be removed by the operator so that the program card can be inserted to set up the program operation for a specific application.

Drum Removal

1. Raise the sensing mechanism by turning the program control lever to the right or off position.
2. Remove the program drum by pulling in a parallel direction to the sensing mechanism. The program card can then be removed from the drum.

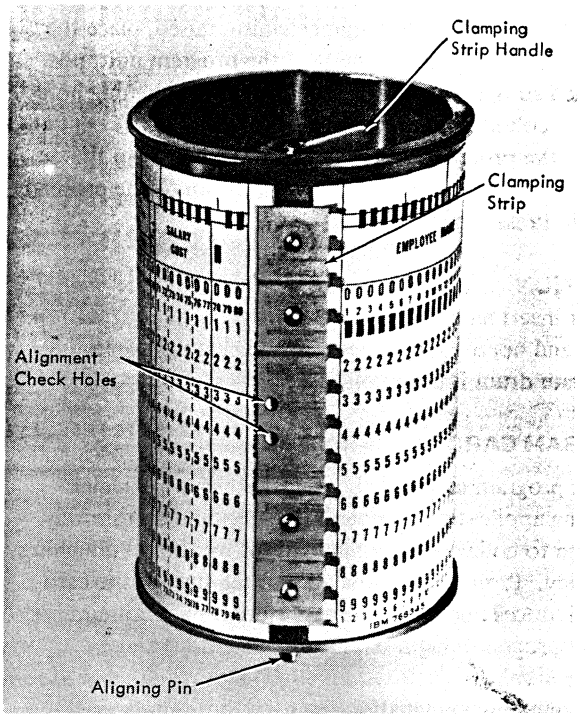


Figure 22. Program Drum

Card Removal

1. Turn the clamping strip handle to the center position and remove the column-1 end of the card from beneath the clamping strip.
2. Turn the handle fully counterclockwise and remove the card from the drum.

Card Insertion

1. With the clamping strip handle turned fully counterclockwise, insert the column-80 end of the card under the smooth edge of the clamping strip. Two alignment check holes in the clamping strip make it possible to see that the card is flush with the metal edge under the strip. The card should be positioned so that the 9-edge of the card is against the lower rim of the drum.
2. Turn the handle to the center position. This tightens the smooth edge of the clamping strip and loosens the toothed edge.
3. Wrap the card tightly around the drum and insert the column-1 edge under the toothed edge of the clamping strip.
4. Turn the handle clockwise as far as it will go. This fastens the toothed edge of the clamping strip. The drum is ready to be inserted in the machine.

Drum Insertion

1. With the program sensing mechanism raised, place the drum on the mounting shaft of the program unit, positioned so that the aligning pin falls in the aligning hole in the column indicator dial.
2. Turn the program control lever to the left or to the on position to lower the sensing mechanism to the program card. Press the release key.

CAUTION
Never insert an empty program drum in the program unit, and never lower the sensing mechanism when the program drum is not in place.

PROGRAM CARD PREPARATION

When a program card is to be prepared for a particular punching application, the card design should be carefully analyzed to code the program card for maximum punching efficiency. Proper use of the various features of the card punch reduces operator time and effort to a minimum. Greater programming flexibility is gained by using both program levels.

The following explanations mention both program levels; the second code in parenthesis is program two. Also, refer to Figure 21.

Programming

To prepare a program card, the following analysis must be made of the cards to be punched:

1. Field definition coding, which determines the length of each field. Punch a field definition 12(4) in each column except the first (left-hand) of every field regardless of the type of operation to be performed in that field. The 12(4)'s are used in skipped or duplicated fields to continue the skip or duplication across the field, once the operation is started. Field definition punches are also used in fields programmed for manual punching to make full use of the feature provided for the correction of errors made while punching. With all field-lengths defined, each *correct* field can be duplicated by a single depression of the dup key, and only the *field* containing the error must be rekeyed.
2. Automatic skipping for each field that is not to be punched at this time. If several successive fields are to be skipped on every card, program them as one large field with an 11(5) in the first column and 12(4)'s in all successive columns.
3. Automatic duplication of each field that is punched with the same data for a group of cards. If several successive fields are to be duplicated on every card, program them as one large field with the zero (or 6) in the first column and 12(4)'s in all successive columns.
4. Alphabetic coding to shift the keyboard when letters are to be keyed. If all or most of a field is to be alphabetically punched, code it with 1(7)'s and use the numeric shift key for occasional numeric punching. In the duplication or alphabetic punching, the 1(7)'s permit duplication of blank columns.

Program Two used for Alternate Programming

When it becomes necessary to alternate programs to handle two types of cards in one punching operation, all the preceding operations must be analyzed for the alternate program, and the proper codes (4-9) must be punched. Consideration must be given to the time within the card cycle that the change to the alternate program is to be made. The change can be made either at the beginning of the card or at any time within the card cycle when it is desirable for the alternate coding to become effective. Once the alternate program is selected, by pressing the program two selection *key,* the alternate program codes are read for the remainder of the card, or until the other program selection key is pressed to return to the original program. Programs can be alternated at will in this manner during punching of a card. However, when the following card is fed, the normal program coding, determined by the program selection *switch* setting, becomes effective.

If the first field of a card is to be controlled by the alternate program, the auto feed switch should be turned off before the preceding card reaches column 80. This suppresses the feed cycle and allows the operator to select the alternate program by pressing the program two key. Pressing the program two key also causes a feed cycle; the new card is registered in the punch position.

Multiple Functions

When alternate program functions are used in addition to the basic program functions, the program card may require several codes in a column (Figure 23). In this case, punch a master deck of cards for the preparation of the program card. This deck consists of a maximum of 12 cards, one for each punching row: one card punched with all the required 12-codes, a second card with all the required 11-codes, a third card with all the required 0-codes, etc. After the cards of the master deck are punched, duplicate each card, one at a time, into a single card, which then becomes the program card. This method of preparing a program card facilitates the preparation of slightly changed or duplicate program cards on the 545 Model 2, because multiple punches other than standard should not be duplicated. *Duplicating other than standard multiple punch combinations may cause print mechanism damage.* Program cards may be duplicated on the 545 Model 1 without restriction.

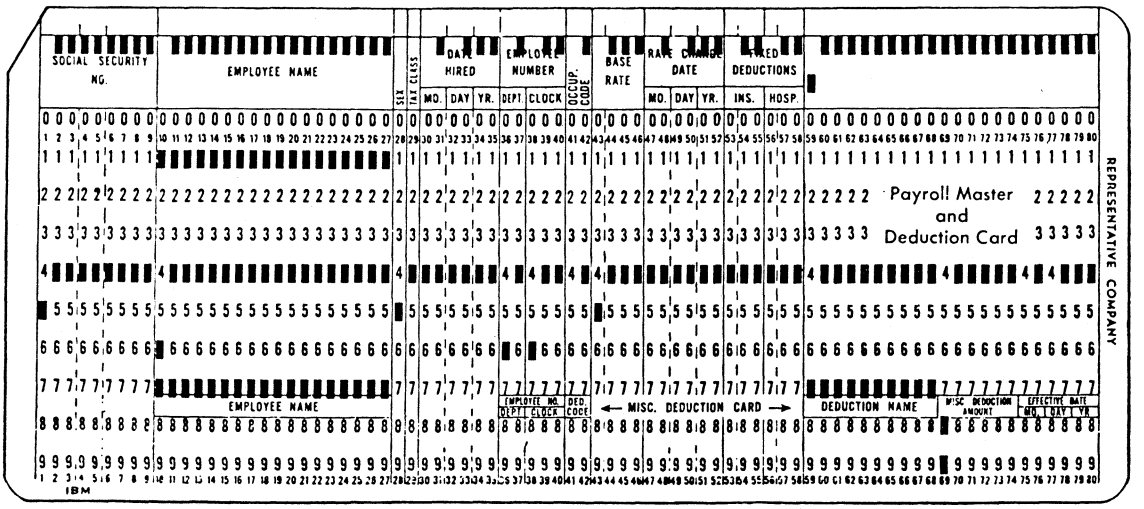


Figure 23. Program Card – Multiple Functions

Program Example

The functions listed on the card in Figure 25 constitute the program plan for the payroll master and deduction card shown in Figure 23. The field headings for the payroll master part of the card are at the top of the card; the headings for the deduction part are between the 7 and 8 punching rows. A payroll master card is prepared for each new employee and is punched under normal program (program one) coding. Miscellaneous deduction cards are punched for only those new employees who have deductions other than the fixed deductions, and are punched under alternate program (program two) coding. Whenever possible, common information is duplicated from the payroll master cards into the deduction cards. The cards are punched in groups by date hired, and the rate-change date for a new employee is the same as the date hired. The program card is planned and punched as shown in Figure 24.

Program Planning Card Form

A card form, usable as an aid in the preparation of program cards, is available on the reverse side of the installation supply form *Card Punching or Verifying Instructions,* Form X24-6299. As illustrated in Figure 25, this card is designed with 12 rows of column numbers, each row located in a punching position. The program codes, with the functions of each, are also listed for reference.

When analyzing the cards to be punched, mark the planning card for the functions to be performed in each column. For example, if columns 10-27 are to be punched with alphabetic characters under normal program control, draw a mark through columns 10-27 in the 1-row; if columns 59-80 are to be automatically skipped under normal program control, draw a mark through column 59 in the 11-row and columns 60-80 in the 12-row. Punch the program card, or the individual cards of the master deck, using the planning card as a reference. After the program card is punched, check it by laying it over the planning card. The markings on the planning card should be visible through the holes in the program card.

Columns	Field Heading	Normal Program	Alternate Program
1-9	Social Security No.	Manual punch	Automatic skip
10-27	Employee Name	Manual punch, alphabetic	Automatic duplicate, alphabetic
28	Sex	Manual punch	Automatic skip
29	Tax Class	Manual punch	
30-35	Date Hired	Manual punch	
36-40	Employee Number	Manual punch (Department and Clock coded as separate fields for error correction and zero suppression)*	Automatic duplicate (Department and Clock coded as separate fields for zero suppression)*
41-42	Occupation Code or Deduction Code	Manual punch	Manual punch
43-46	Base Rate	Manual punch	Automatic skip
47-52	Rate Change Date	Manual punch	
53-58	Fixed Deductions	Manual punch (Insurance and Hospitalization coded as separate fields for error correction and zero suppression)*	
59-68	Deduction Name	Automatic skip	Manual punch, alphabetic
69-74	Misc Ded Amount		Manual punch (left-zero insertion field)
75-80	Effective Date		Manual punch

Month and day in each date field are coded as separate fields for zero suppression*

*Left-zero print switch off

Figure 24. Table for Program Example

PROGRAM CODES FOR IBM CARD PUNCHES AND VERIFIERS

FOR 24-26-56	REGULAR		ALTERNATE	
OPERATION	1ST COL	REST OF FIELD	1ST COL	REST OF FIELD
KEY NUMERICAL-FIELD DEFINITION	SPACE	12	SPACE	4
KEY ALPHABETIC	1	12-1	7	4-7
DUPLICATE-VERIFY AUTOMATICALLY	0	12	6	4
SKIP AUTOMATICALLY	11	12	5	4
LEFT ZERO PRINT -26 11-12 ELIMINATION -56	2	12-2	8	4-8
SUPPRESS PRINTING -26 0-9 ELIMINATION -56	3	12-3	9	4-9

CAUTION: PROGRAM CARDS WITH MULTIPLE PUNCHES PER COLUMN MUST NOT BE DUPLICATED ON THE IBM 26, OR PRINTING MODELS OF THE IBM 29, AS PRINT UNIT DAMAGE MAY OCCUR

FOR 29-59	PROGRAM ONE		PROGRAM TWO	
OPERATION	1ST COL	REST OF FIELD	1ST COL	REST OF FIELD
KEY NUMERICAL-FIELD DEFINITION	SPACE	12	SPACE	4
KEY ALPHABETIC	1	12-1	7	4-7
DUPLICATE-VERIFY AUTOMATICALLY	0	12	6	4
HIGH SPEED VERIFY AUTOMATICALLY-59	0-3	12	6-9	4
SKIP AUTOMATICALLY	11	12	5	4
LEFT ZERO FILL-29				
8 POSITION FIELD	2	12	8	4
7 POSITION FIELD	3	12	9	4
6 POSITION FIELD	2-3	12	8-9	4
5 POSITION FIELD	1-2	12	7-8	4
4 POSITION FIELD	1-3	12	7-9	4
3 POSITION FIELD	1-2-3	12	7-8-9	4
LEFT ZERO VERIFY AUTOMATICALLY-59	2	12	8	4
LEFT ZERO VERIFY-CONTROL	--	*11-12	--	*4-5
11-12 ELIMINATION-59	3	12-3	9	4-9
0-9 ELIMINATION -59	1-3	12-1-3	7-9	4-7-9

* PUNCHED IN UNITS (LAST) COLUMN ONLY

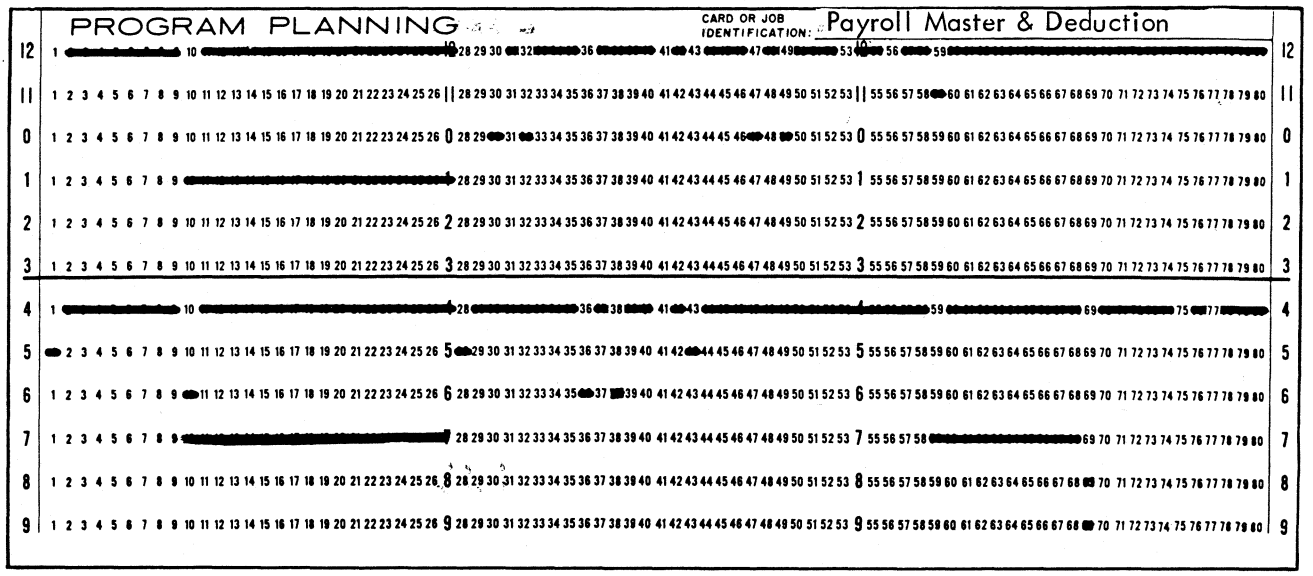


Figure 25. Program Planning Card

INSERTING CARDS MANUALLY

In certain instances it is desirable to insert cards manually, one at a time, as in the case of making over a damaged card or correcting an error found while verifying. Also, when an individual card accompanies each original document, manual insertion is necessary. A card can be manually inserted in the card bed to the right of either the punch station or the read station. A single card need not be inserted in the hopper.

CAUTION

Improper manual registration of a card at the read station may cause dropping of punches during an auto duplication or key duplication operation. Therefore, when manually inserting a card at the read station, *do not push the card in all the way to the stop.* Insert the card about 1 inch beyond the pressure roll so that the card will be *machine registered* by the pressure roll when the register key is depressed.

As shown in Figure 26, cards prepunched with part code are to be punched and printed with part name, which is written on an accompanying ticket. Program control is on; columns 1-25 are programmed as a manual alphabetic field, columns 26-80 are automatically skipped.

Procedure for Inserting Cards Manually

1. Set the keyboard auto skip/dup and print switches on, the auto feed switch off, the program selection switch to the appropriate program level, and the autopunch/keypunch switch to keypunch.
2. Place a card in the card bed at the right of the punch station, and press the register key.
3. Punch part name, starting in column 1; press the numeric shift key when necessary. After punching the part name, the card automatically skips out through column 80.
4. Insert the next card in the card bed at the right of the punch station and press the register key. This registers the first card at the read station and the new card at the punch station. After the second card is punched, insert the third card in the punch station. The first card at the left of the read station moves into the stacker when the third card is registered.

NUMERIC PUNCHING WITH PROGRAM CONTROL

Normally, in a punching operation, the cards are in the card hopper and are fed into the card bed automatically. Also, as the cards are punched, the program card controls the automatic functions such as skipping and duplicating.

Figure 27 is an example of a labor distribution card to be punched with numeric information according to the fields

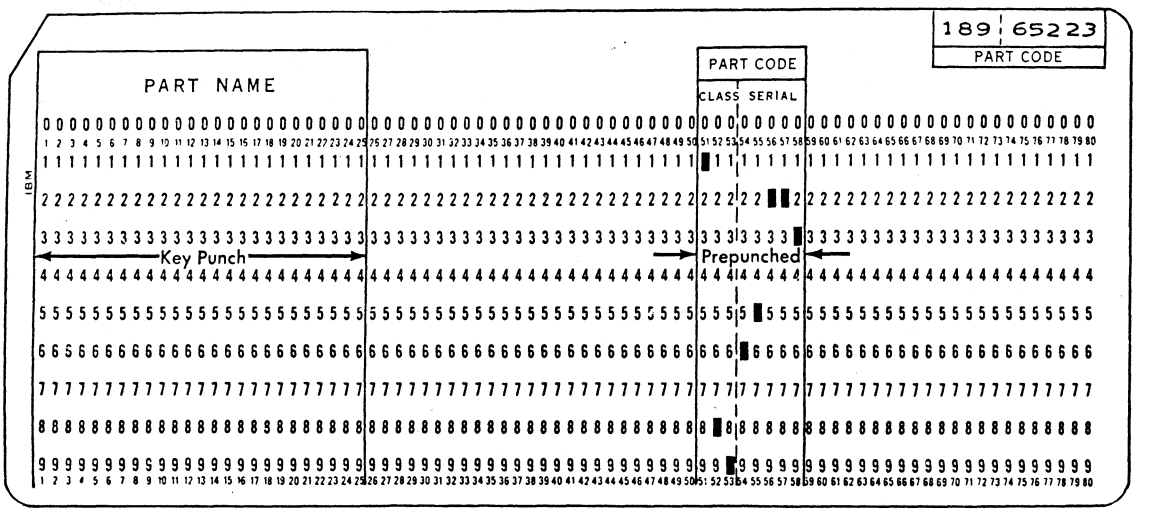


Figure 26. Inserting Cards Manually

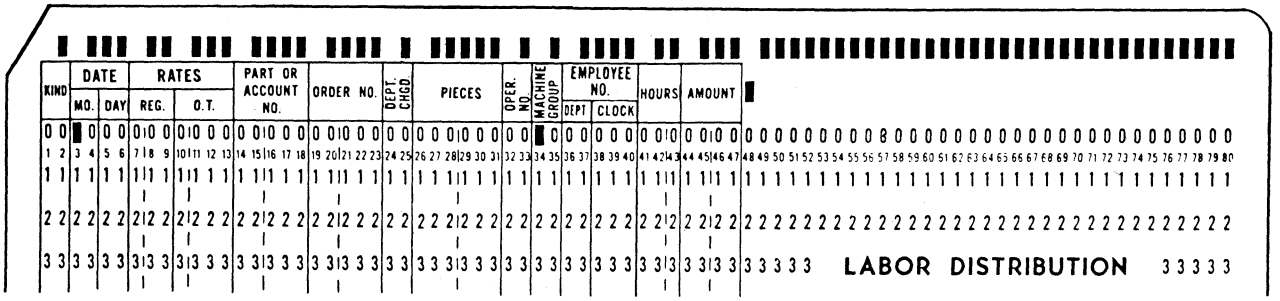


Figure 27. Numeric Punching

shown. The example shows how the card is punched to serve as a program card, indicating the type of operation to be performed in each field. Columns 3-6, 34 and 35 are to be automatically duplicated; columns 48-80 are to be automatically skipped; all other fields are to be punched.

If the auto feed switch is off and prog 1 or prog 2 key is depressed at the end of a completed card, a feed cycle is initiated; the next card registered at the punch station will be controlled by the corresponding program level.

In this example (Figure 27), the switch is set for program one.

Procedure for Numeric Punching with Program Control

Figure 27 shows an example of the program card for program one; program two is the identical hole pattern in punch rows 4-9.

1. Place unpunched cards in the card hopper.
2. Press the feed key twice to feed two cards. The first card registers automatically as the second card is fed.
3. Punch columns 1 and 2 (program card punched with a 12 in column 2).
4. Columns 3-6 are programmed for automatic duplication (program card punched with a 0 in column 3 and 12's in columns 4-6). Manually key the first card of each date group with the auto dup switch off. Then, set the switch to the on position and the date in each succeeding card is automatically duplicated from the preceding card. Thus, no card handling is necessary even for changes in information being automatically duplicated.
5. Punch columns 7-33 (program card punched with a 12 in each column except the first position of each field).
6. Columns 34 and 35 are programmed for automatic duplication (program card punched with a 0 in column 34, and a 12 in column 35). In the same manner as date in columns 3-6, manually key the machine group for the first card of each group so that it can be automatically duplicated into succeeding cards.
7. Punch columns 36-47 (program card punched with a 12 in each column except the first position of each field).
8. The card punch automatically skips columns 48-80 (program card punched with an 11 in column 48, and 12's in columns 49-80). The auto skip/dup switch must be on.
9. With the auto feed switch on, an automatic feed occurs after column 80 is skipped.

ALPHABETIC AND NUMERIC PUNCHING WITH PROGRAM CONTROL

Although the keyboard is normally in numeric shift when the program is turned on, alphabetic information can be punched by changing to alphabetic shift. This can be done either manually, by pressing the alphabetic shift key, or automatically, by coding in the program card.

Columns 6-26 of Figure 28 illustrate the coding for the automatic shift to alphabetic mode. Both program one (1's) and program two (7's) are shown. (For the sake of illustration, both programs on this example are the same; either could be used.) If a field is to be punched with both alphabetic and numeric characters, program it for whichever are more frequent; if there is about an equal number of each, program the field for alphabetic punching.

In punching alphabetic names or descriptions that vary in length, it is usually desirable to skip over that part of the field, at the right, which is not used. In this illustration, a portion of the name field should be skipped on most cards. Because the starting point of this skipping varies from card to card, it must be controlled manually by pressing the skip key.

Another type of skipping that must be considered is in the trading area field (columns 75-77). The trading area code is to be punched for some customers but not for others. This skip, also, is started by pressing the skip key.

When a field is to be punched with the same information in a few successive cards, only the first card must be manually punched; the field in the following cards can be punched by pressing a *single* key. In this illustration (Figure 28), salesman number in columns 78 and 79 may be the same for several consecutive cards and can be duplicated by key.

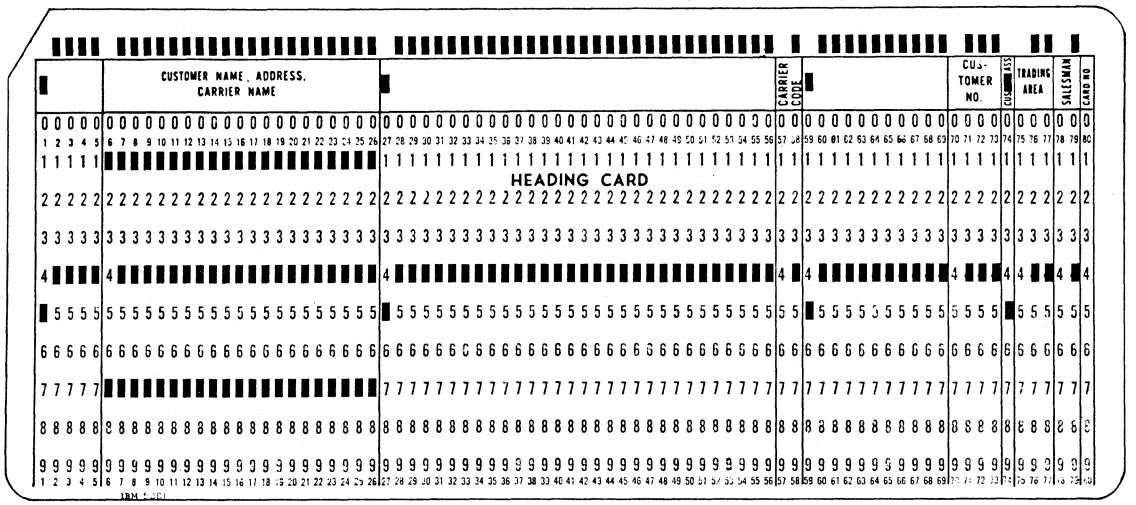


Figure 28. Alphabetic and Numeric Punching -- Program One and Program Two

Skip Key

Press this key to skip any field coded with 12's (or 4's) in the program card. Pressing the key starts the skip, and the 12's (or 4's) in succeeding columns of the field continue the skip for the rest of the field. This key is primarily for skipping the unused right-hand portion of an alphabetic field. (The card punch skips at the rate of 80 columns per second.)

Numeric fields skipped with this key are blank and cannot be duplicated later.

Duplicate Key

Press this key to duplicate any information manually punched in one card and common to one or more successive cards. Pressing this key at the beginning of a field starts duplication, and the 12's (or 4's) punched in the program card continue the duplication for the rest of the field.

With the machine under program control, one depression of the dup key starts the operation. Duplication continues at the rate of 18 (Model 2) or 20 (Model 1) columns per second, until the end of field definition.

Without program control, duplication occurs at the rate of 9 or 10 columns per second and occurs only as long as the key is held down. This allows the operator precise column control in a card correction or make-over application.

Encountering a space during duplication of numeric fields locks the keyboard. The error reset key unlocks the keyboard and permits keying of the space, substitute data, or release. The alpha shift key can also be used to get over the space without pressing the error reset key. For machines with the self-checking feature installed, the backspace key should be used instead of the error reset key.

Procedure for Alphabetic and Numeric Punching with Program Control

Figure 28 shows the program card for this procedure. The instructions that follow describe program one. They could apply to program two, also shown in Figure 28, by substituting codes 4-9 for the 12-3 used.

1. Place a deck of unpunched cards in the card hopper, and press the feed key twice to feed two cards from the hopper.
2. The card punch automatically skips columns 1-5 (program card punched with an 11 in column 1 and 12's in columns 2-5). The auto skip/dup switch must be on.
3. Punch columns 6-26 with customer name, address, or carrier name (program card punched with 1's in columns 6-26). The 1's automatically shift the keyboard from numeric to alphabetic punching. When figures are to be punched in this field, press the numeric shift key.
4. Press the skip key at the end of the alphabetic punching to skip over the rest of the field (program card punched with 12's in columns 7-26).
5. Columns 27-56 are skipped automatically (program card punched with an 11 in column 27 and 12's in columns 28-56).
6. Punch the carrier code in columns 57 and 58 (program card punched with a 12 in column 58).
7. Columns 59-69 are skipped automatically (program card punched with an 11 in column 59 and 12's in columns 60-69).
8. Punch the customer number in columns 70-73 (program card punched with 12's in columns 71-73).
9. Column 74 is skipped automatically (program card punched with an 11).
10. The trading area field in columns 75-77 is coded in the program card for manual numeric punching (blank in

column 75 and 12's in columns 76 and 77). Optional skipping of the field is controlled by pressing the skip key in column 75.

11. Punch columns 78 and 79. Salesman number is frequently the same for several successive cards. After punching the first card, duplicate the following ones by pressing the dup key in column 78.
12. Punch column 80, after which the next card feeds automatically. The auto feed switch must be on.

ERROR CORRECTION

Errors in punching are often noticed and corrected by the operator at the time they are made. Usually this involves rekeying a large portion of the card. This card punch reduces rekeying to a minimum, requires no concern about the precise column in which the error occurred, minimizes the possibility of making another error while correcting the first, and practically eliminates card handling. As an example, to correct an error in the order number field of the labor distribution card (Figure 29):

1. Press the release key immediately upon detecting the error. This advances the card without punching the fields coded for manual punching, but allows duplication of the fields programmed for automatic duplication beyond the point of release. Therefore, columns 34 and 35 are duplicated into the error card as it is being released. This retains the common information for duplication into the following cards. The three cards in the card bed advance to their proper stations and a new card is fed from the hopper.
2. Duplicate the kind field by pressing the dup key once. (Columns 3-6 are programmed to duplicate automatically, as shown in Figure 27.)
3. Press the dup key at the beginning of each field to manually duplicate the regular rate, overtime rate, and part account number fields. Duplication stops at the end of the part or account number field.
4. Rekey the order number field, and manually punch the remaining fields programmed for manual punching. Machine group is automatically duplicated, and columns 48-80 are automatically skipped.
5. Remove the error card from the stacker.

Partially Prepunched Cards

Partially prepunched cards may contain prepunched names or codes, or they may be serially numbered and punched. When an error is made in punching cards of this type and the correction ls to be made immediately, automatic feeding from the hopper must be interrupted and a blank card must be inserted manually in the card bed. Because each card that feeds from the hopper contains some prepunched data, it is not possible to duplicate into the following card as outlined in "Error Correction."

The commodity card in Figure 30 illustrates a partially prepunched card for which the punching is to be completed. The commission class, commodity description, commodity code, and price fields are prepunched; the remainder of the card is to be punched. The commodity code and description are interpreted for pulling from a file. If an error is made in the keying of column 14 (salesman field):

1. Operate the clear switch once. This advances the card in the read station, the error card in the punch station, and the card following in the preregister position until they are stacked in the stacker. The date in columns 70-75 is not duplicated as in a release-key release. Feeding does not take place; the card bed is clear.
2. Remove the bottom card from the stacker and hold aside.
3. Again, remove the bottom card from the stacker; this is the error card.
4. Manually insert the error card to the right of the read station.
5. Manually insert a blank card to the right of the punch station.

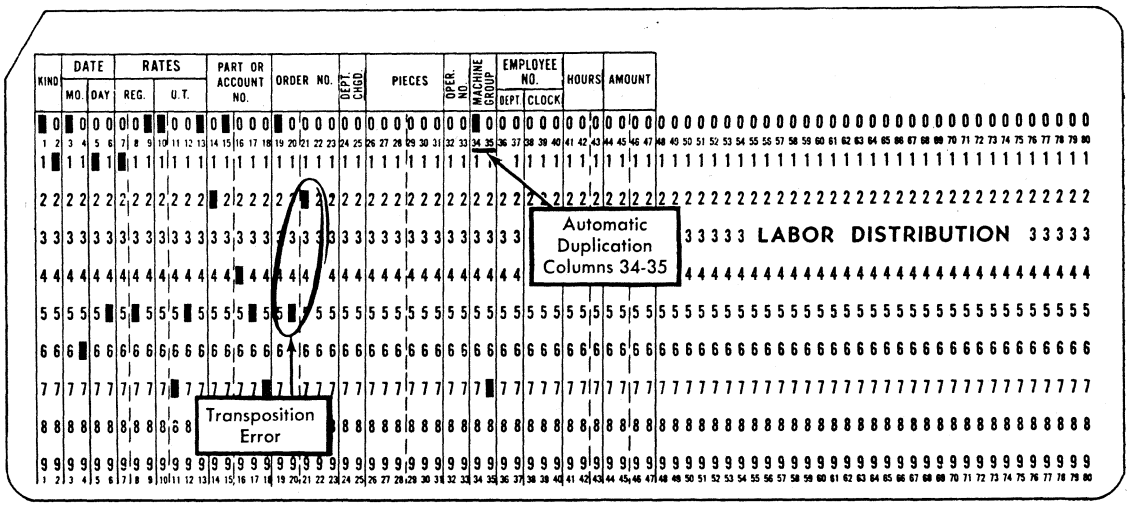


Figure 29. Error Correction

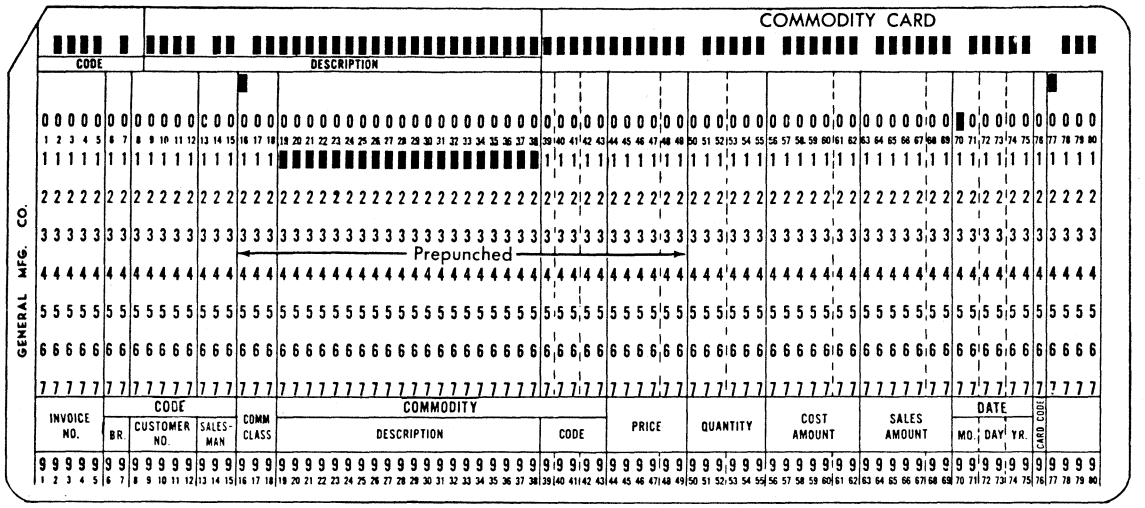


Figure 30. Error Correction – Partially Prepunched Cards

6. Turn off the auto feed switch. This prevents feed cycles (undesirable while manually inserting cards) until the auto feed switch is turned on again.
7. Turn off the auto skip/dup switch to prevent automatic skipping during the correction of the error card. The prepunched fields are programmed for automatic skipping, but when correcting an error, these fields must be manually duplicated into the blank card.
8. Press the register key to register the error card at the read station and the blank card at the punch station.
9. Press the dup key at the beginning of each field to manually duplicate the invoice number, branch, and customer number fields, which were punched correctly.
10. Rekey the salesman field.
11. Press the dup key in column 16 to manually duplicate the commission class, commodity description, commodity code, and price fields. These fields are programmed as one field for automatic skipping in the regular punching operation. The commodity description field is coded with 1's in the program card to permit automatic spacing over blank columns during the correction of errors made in the punching operation.
12. Turn on the auto skip/dup switch for automatic duplication of the date and automatic skipping of the last four columns.
13. Manually punch the remaining fields programmed for manual punching. The date is duplicated automatically and columns 77-80 are skipped automatically.
14. Replace in the right of the card bed, the card removed in step 2.
15. Turn on the auto feed switch.
16. Press the feed key to register the card replaced in step 14 at the punch station, and to feed the next card from the hopper to the preregister position. Continue the operation interrupted by the error. The error card, again, is the last card in the stacker; remove it for disposal. The repunched card is in its proper sequence in the card deck.

PREPUNCHED MASTER CARD INSERTION

In an operation in which certain fields are to be duplicated from prepunched master cards, it is necessary to insert each master card manually before duplicating the first card of the group. Master cards should be inserted in the card bed at the right of the read station.

1. Turn off the auto feed switch before completing the punching of the last card of a group.
2. Manually move the last card after it is released from the punch station, to the left into the read station.
3. Press the release key, while maintaining a slight leftward pressure on the card in the read station, to advance that card past the read station.
4. Place the master card in the read station card bed. Do not push the card in all the way to the stop. Insert the card beneath and about one inch beyond the registering pressure roll (Figure 31) so that the card can be machine registered by the pressure roll during the next card feed cycle.
5. Press the feed key to register the master card and the detail card that is at the right in the punch card bed, and to feed a new card from the hopper. Turn on the auto

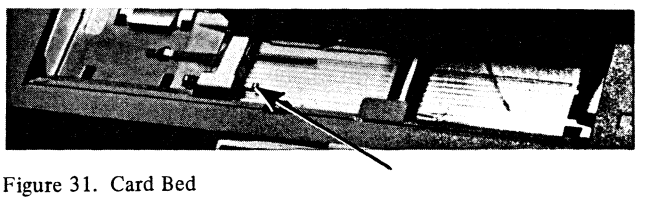


Figure 31. Card Bed

feed switch. Normal punching of the first card of the new group can then proceed, with automatic feeding of the following detail cards.

6. Remove the master card, if it is not to be stacked with the detail cards, immediately after completion of the punching of the first detail card.

   This type of operation normally precludes the possibility of automatic duplication of any common information (such as date) from one group of cards to the next, because the continuity of such duplication is interrupted by insertion of the prepunched master cards. Consequently, when common punching is required, the information must be manually punched in the first card of each new group. This keying can be avoided by using the auxiliary duplication feature. (See "Special Features.")

OPERATING SUGGESTIONS

Engaging the Program Reading Mechanism

Turning the program control lever to lower the starwheels may not fully engage the reading mechanism; therefore, it is also necessary to press the release key. For this reason, once the program is turned on, leave it on, and, whenever possible, any temporary changes or interruptions in the punching routine should be handled by the functional switches and keys. A method that can be used if only one program level is punched in the program card, is to press the program selection key for the program level not being used. Program control can again be restored by pressing the selection key for the program level being used.

Starting a Punching Operation

When a new job is started, the machine is ready for operation as soon as the main line switch is turned on (keypunch mode). Press the feed key twice, or hold depressed for two feed cycles to register the first card. If a prepunched master card is to be inserted, place it in the center of the card bed after the first feed cycle. On the second cycle, the master card and the first blank card are registered at their respective stations.

When master information for automatic duplication is to be keyed in the first card of the group, turn off the auto skip/dup switch before the first card is registered, and leave it off until the master information is keyed. On this first card, use the skip key to skip the fields programmed for automatic skipping.

Stopping a Punching Operation

When an operation is to be stopped and the main line switch is to be turned off before a batch of work is completed (as at a lunch hour), the card at the punch station should first be completely punched and released. Before the card is released, however, turn off the auto feed switch. This permits restarting the job without additional card handling.

When one batch of work is to be followed by another batch that is using the same master information and program control, a blank card should follow the last card of the batch through the punch station. The blank card can be released past the punch station as the last card is released past the read station. This causes the blank card to be automatically punched with the master information for duplication into the first card of the next batch, and thus eliminates the necessity of rekeying the master information. The auto feed switch should be off when the cards are released.

Clearing the Card Bed

When the card bed is to be completely cleared at the end of a punching operation without feeding more cards from the hopper, turn off the auto feed switch during the punching of the next-to-last card. The last card is registered for punching by pressing the register key. After the last card is punched and moved to the center of the card bed, it is moved on to the stacker by operating the clear switch.

If the auto feed switch is not turned off after the last card is punched, operating the clear switch causes two blank cards to be stacked behind the last punched card in the stacker.

The clear switch is used to completely clear the card bed. When operated, the switch causes all cards in transport between the feed hopper and the stacker unit to progress, with no further punching, to the stacker. No new cards are fed from the feed hopper during this operation.

Removing a Card from the Center of the Card Bed

To remove a card from the center of the card bed without affecting the following cards, manually move it into the read station and press the release key (auto feed switch off). This moves the card to the left of the card bed where it can be lifted out.

Removing a Card from the Left of the Card Bed

When a card has been released from the read station but not stacked, it is in the left of the card bed. For easy manual removal, move the card to the extreme left by pressing down on the arm that extends from the read station.

Removing a Card from the Punch or Read Station

If for any reason a card must be removed manually from the punch or read station, hold down the pressure roll release lever while pulling out the card. If a card at the punch station does not move easily, press all the numeric keys; then, while holding down the lever, pull out the card without tearing it.

Spacing Over Columns

Without program control, the dup key may be used to space over columns if the same columns are unpunched in the preceding card at the read station or if there is no card at the

read station. This operation is faster than using the space bar.

Multiple Punched Columns

Punch two or more digits in one column by holding down the multiple punch key while pressing the digit keys one at a time. The keyboard is automatically shifted to numeric operation when the multiple punch key is pressed.

Corner Cuts

Cards can have a normal upper-left or upper-right corner cut. Cards with lower corner cuts (except lower-left corner cut C-3, 30-degree, 0.130-inch base measurement) cannot be fed. Round corner cut cards are acceptable.

Single Card Feeding

When the cards are to be fed manually, one at a time, place them directly in the card bed, to the right for punching or in the center for reading. Do not insert single cards in the card hopper. When placing a card in the center of the card bed, position it so that the column-1 edge is between the feed rolls at the right of the read station. If the card is pushed in too far, improper feeding and duplicating may result.

Keyboard Locking

The keyboard locks under any of the following conditions:

1. The main line switch is turned off and then on while a card is registered at the punch station. The clear switch should be operated to move the card to the stacker; however, the card at the punch station need not be removed. One depression of the feed key brings a second card down without advancing the first card, and restores the machine to operating condition.
2. On the combination keyboard, when either the A or the Z key is pressed in a column programmed for numeric punching. Press the error reset key to unlock the keyboard.
3. A blank column is duplicated in a field programmed for numeric punching. This serves as a blank-column detection device to ensure that a digit is punched in every column of a numeric field that is being duplicated. To unlock the keyboard, press the error reset key or the alphabetic shift key on the combination keyboard. On a machine with the self-checking feature installed, press the backspace key.
4. A card is not registered at the punch station. It is impossible to do any punching or spacing unless a card is registered at the punch station. To move a card into punching position, press the register, the feed, or (with the auto feed switch on) the release key.
5. The register key or the feed key is pressed when a card is already registered at the punch station. Press the error reset key to unlock the keyboard.

Suspending Automatic Duplication on First Card

Master information in the first card of each new group must be keyed. Automatic duplication must be suspended for that card by turning off the auto skip/dup switch. Because this requires the manual setting of the auto skip/dup switch each time master information changes, consideration should be given to proper card design as an aid to most efficient operation.

Whenever possible, program the first field in a card for manual operation. This gives the operator a chance to turn the auto skip/dup switch off before starting to punch the first card of a new group.

Several recommended procedures for punching the first card of each group are (the procedures vary depending on conditions brought about by differences in card design):

1. Turn the auto skip/dup switch off when the first card of a new group is registered at column 1.
2. Punch the complete card.
3. Turn the auto skip/dup switch on when the second card of the group is registered at column 1. (The switch could have been returned on after the master information was punched.)

Automatic duplication should not immediately follow an automatic skip.

1. Punch the first field.
2. Automatically skip the second field (auto skip/dup switch on).
3. Turn off the auto skip/dup switch; punch the third field.
4. Punch the fourth field; turn on the auto skip/dup switch.

Sometimes other factors in the use of the cards make it necessary for automatic duplication to follow an automatic skip. In such a case, study the two possible procedures and follow the best one:

1. Long-skip field
   a. Punch the first field.
   b. Automatically skip the second field. During the skip, turn off the auto skip/dup switch to prevent automatic duplication in the following field. (This can be done if the skip is fairly long.)
   c. Punch the third field and turn on the auto skip/dup switch.
2. Short-skip field
   a. Turn off the auto skip/dup switch when the card is registered at column 1.
   b. Punch the first field.
   c. Press the skip key to skip the second field.
   d. Punch the third field and turn on the auto skip/dup switch.

When automatic duplication is immediately followed by an automatic skip, punch the first card as follows:

1. Turn off the auto skip/dup switch when the card is registered at column 1.
2. Punch the first field.
3. Punch the second field. (Either during, or at the end of

this field, turn on the auto skip/dup switch, so that the following field can be automatically skipped.)

4. Automatically skip the third field.

If an automatic skip must come first in a card immediately followed by automatic duplication, the procedure for handling the punching is:

1. Long-skip field
   a. Automatically skip the first field. During the skip, turn off the auto skip/dup switch to prevent automatic duplication in the second field. (This can be done if the skip is fairly long.)
   b. Punch the second field and turn on the auto skip/dup switch.
   c. Punch the third field.
2. Short-skip field
   a. Turn off the auto skip/dup switch before the last card of a group is punched in column 80.
   b. Press the skip key to skip the first field of the first card in the following group.
   c. Punch the second field and turn on the auto skip/dup switch.
   d. Punch the third field.

When an automatic skip field comes between two fields programmed for automatic duplication, punch the first card as follows:

1. Turn off the auto skip/dup switch when the card is registered in column 1.
2. Punch the first and second fields.
3. Press the skip key to skip the third field.
4. Punch the fourth field and turn on the auto skip/dup switch.

The special features described in this section provide additional flexibility for keypunch applications that require special handling on the IBM 545.

AUXILIARY DUPLICATION

This feature enables duplicating information from a master card on an auxiliary drum rather than from the card at the read station. The auxiliary drum is similar to and located just behind the conventional program drum.

The information duplicated from the auxiliary duplicating unit is punched in a master card, which is mounted on a drum, exactly as a program card is mounted, and the drum installed on the spindle of the auxiliary unit. The auxiliary duplicate key manually controls this duplication. Pressing this key starts auxiliary duplication, which continues to the end of the field defined by field definition punches in the program card. The information in the master card must be in the same columns that are defined in the program card.

This type of duplication is advantageous when common information is required for certain cards but not for others, for example, when prepunched master cards are inserted.

When prepunched master cards are used, any information common to all cards (such as date) is dropped when a new master card is inserted. In this case, with the auxiliary duplication feature, the master information can readily be punched in the first detail card of each group by pressing the aux dup key and without reference to a source document.

SELF-CHECKING

The self-checking number feature provides for verifying numeric information at the same time it is punched. To do this, the numeric information must be precoded. The immediate verification of precoded data eliminates the need of any further verifying of this information. Thus, only the variable data, such as quantities and amounts, need be verified by a second operation, if desired.

Self-checking is controlled by a keyboard toggle switch and by special punching in the program card. The self-checking number feature is available in two models: Modulus 10 and Modulus 11. Modulus 10 is designed primarily to detect the most common type of errors, the incorrect keying of a single digit, and a single transposition. Modulus 11 is designed to detect single digit mispunches, single transpositions, and double transpositions. The operation and programming of each type is discussed later.

Operating Procedure

The use of the self-checking number feature requires that a check digit be developed for each basic code number to be self-checked. Once the check digit for the basic code number has been determined, it is added to the basic code number as the units or last position. This, then, becomes the self-check number, one digit longer than the original basic number. (These check digits can be developed by computer calculations, by manual arithmetic, or by using the self-checking number generator. See "Self-Checking Number Generator.") More than one self-checking field may be checked per card. Adjacent self-checking fields must be separated by at least one card column.

No special knowledge is required by code clerks who record these numbers on the original document, or by operators who punch the numbers in cards.

The operator keys and punches the number, through the check-digit position, as it appears on the source document. Internal calculations verify the accuracy of the keying or validity of the self-check number. When the number on the source document is correct and the number has been keyed correctly, the punching operation is not interrupted.

If no errors are detected throughout the punching of all the self-check fields in the card, an 11-hole is automatically punched in column 81.

When more than one self-check field is programmed, successful keying of any one field can produce an "X" in column 81, even if the other fields are skipped. The appearance of an 81X signifies that all self-check fields punched in the card are correct, whether keyed or duplicated. Skipping or bypassing an entire self-check field is a valid operation.

If the number is recorded on the source document incorrectly, or if the number is punched incorrectly, the error is indicated by the self-check light on the keyboard after the last digit of the self-check field is punched. A 12-hole is automatically punched in the units (check digit) column, and the keyboard locks up. Whenever an error occurs, the automatic 11-punch in column 81 is suppressed. Pressing the error reset key turns off the self-check light, unlocks the keyboard, and releases the error card. (The standard release key is inoperative while the keyboard is locked.)

To duplicate the correctly punched fields of the error card into a new card up to the self-check field in error, manually press the dup key. The self-check field is then repunched. If it is punched as recorded on the source document, and the keyboard locks again, it means that an incorrect number appears on the source document.

Operating Suggestions

When the first column of a self-check field is reached, the following operations can be performed:

1. The field can be manually keyed; the validity of the number is checked by the arithmetic circuits.
2. The entire field can be skipped without validity check by using the skip key.

3. The entire field can be duplicated and checked by using the dup key. Duplication *must* start in the high-order (first) column of the field.
4. The first part of the field can be programmed for auto duplication. This is advantageous when punching a batch of cards that contain codes in which the first few digits remain unchanged while the remainder vary from card to card.

Duplicating the first part of the self-check field can also be initiated by pressing the dup key, if either the start automatic-duplication code is not used, or the auto skip/dup switch is off. Both methods of partial field duplication *must* start in the first column of the field. If the dup key method is used, it must be used in conjunction with program (field definition punches) control. Under no circumstances should manual duplication by dup key alone, without program control, be attempted. Programming examples of partial field duplication are shown in Figures 32 and 34.

Duplication

Duplication of a self-check field that has one or more columns programmed alphabetic is possible if the columns so designated contain letters rather than spaces.

Do not attempt to duplicate a self-check field if the number contains one or more spaces; this locks the keyboard. Under these conditions, the release key is inoperative and the error reset key cannot unlock the keyboard. Pressing the alpha shift key permits the operator to get past the blank columns, however, the check digit calculations are incorrect. The card should be made over, manually keying the self-check number that contains spaces.

In the auto dup portion of a self-check field, certain extraneous punches can check out correctly. Cards should be examined periodically for double punching.

Manual Operations

Self-checking cannot be applied to left-aligned (left-base) numbers (i.e., numbers aligned on the high-order digit). Self-checking numbers can include letters and spaces, but only the numbers (0-9) and the digit portion of the letters (1-9) will be checked. Special characters cannot be checked. Letters, spaces, and zero-punched columns can be processed only if they were considered part of the basic code number when the check digit was established.

Once processing of the self-check field has started, the dup and skip keys are inoperative. The release key is not affected unless a checking error has been indicated; it can be used if the operator has miskeyed and wishes to make over the card.

If the remainder of the card is to be skipped, anywhere after a self-checking field, skipping must be initiated by program control or the skip key. If the release key is used for this skipping, the 11-punch in column 81 is not punched, even though the self-checking field is correct.

In a self-check field, operating the backspace key creates an error condition. Such an invalid operation should be avoided.

Although a field to be self-checked may be of any length (up to 79 columns plus the check digit), once the predetermined field length has been programmed for self-checking, all numbers to be self-checked must contain the same number of digits as the programmed self-checking field. The check digit must always occupy the units position of the self-checking number field.

Modulus 10

Modulus 10 is designed to detect either incorrect keying of a single digit or a single transposition. The following arithmetic process is used to generate the check digit, regardless of the method of generation employed (i.e., generator, computer, or manual):

1. The units position and every alternate position of the basic code number is multiplied by 2.
2. The digits in the product and the digits in the basic code number that are not multiplied by 2 are crossfooted.
3. The crossfooted total is subtracted from the next higher number ending in zero.
4. The difference is the check digit.

Example:

Basic code number	6 1 2 4 8	
Units and every alternate position of basic code number	6 2 8	
Multiply by 2	x2	
Product	1 2 5 6	
Digits not multiplied by 2	1 4	
Cross add	1+2+1+5+4+6	=19
Next higher number ending in zero		20
Subtract crossfooted total		−19
Check digit		1
Self-checking number	6 1 2 4 8 1	

Other Examples:

	Self-Checking Number	
Basic Code Number	*Basic Code*	*Check Digit*
45626	45626	9
30759	30759	5
73074	73074	7

In Modulus 10 self-checking, the space and zero have the same numeric value; therefore, spaces can be substituted for nonsignificant leading zeros. The use of spaces is valid only *when they are keyed.* Any attempted duplication of blank spaces in a self-checking field causes a machine stop and keyboard lockup.

Note: When duplicating *any* numeric field, the keyboard locks when encountering a blank column. On a 545 equipped with Modulus 10 self-checking, the backspace key or the alphabetic shift key can be used to overcome the locked condition.

Compatibility

Modulus 10 self-checking is compatible with auxiliary duplication, but is not compatible with Modulus 11 self-checking or program level 2.

Program Card

To prepare a program card for Modulus 10 self-checking, fields must be defined exactly the same as in any other application; 12-punches in all columns except the high-order column of the field. In addition, the following coding pattern must be used:

Even number of columns

Col	1	2	3	4	5	6	7	8*
		4		4		4		4
	5		5		5		5	5

Odd number of columns

1	2	3	4	5	6	7*
4		4		4		4
	5		5		5	5

* Check-digit position

The preceding example shows fields for 6-digit and 7-digit basic numbers which, with the check digits added, become 7-digit and 8-digit self-check numbers. Any size basic number up to a 79-column maximum is handled the same way. With the check digit included, if the self-check field contains an odd number of digits, the starting code is 4; with an even number of digits, it is 5. The check digit position must be programmed with both the 4 and 5 codes.

Figure 32 shows a program card for two 10-position Modulus 10 self-check fields. Note that the second example is for a partial duplication (first four columns) self-check field.

Self-Checking Number Generator

This feature is standard with Modulus 10 and optional with Modulus 11. A switch is provided on the keyboard to select between check and punch modes.

With the switch in the check position, numbers that have the check digits assigned can be processed.

With the switch in the punch position, the machine calculates the check digit during keying and punches it into the units position automatically. Thus, self-checking numbers are generated from basic numbers.

The field size must take into account the check digit. For example, a basic 7-digit number without a check digit must have eight columns assigned on the detail card. The program card is also coded for an 8-place field.

Program codes are identical to those used with the basic feature.

Modulus 11

Modulus 11 is designed to detect single digit mispunches, single transpositions, and double transpositions. The main feature of this system, distinguishing it from other self-checking number systems, is that it is based on a weighted checking factor for each digit in the basic number being tested. Regardless of how the self-check digit is generated, the following arithmetic process is used:

1. Each digit position of any basic number is assigned a weight (checking factor). These factors are: 2,3,4,5,6, 7,2,3,4,5. . . starting with the units position of the number and progressing toward the high-order digit.
2. In the example shown in Figure 33, write the number as illustrated, leaving space between the digits.

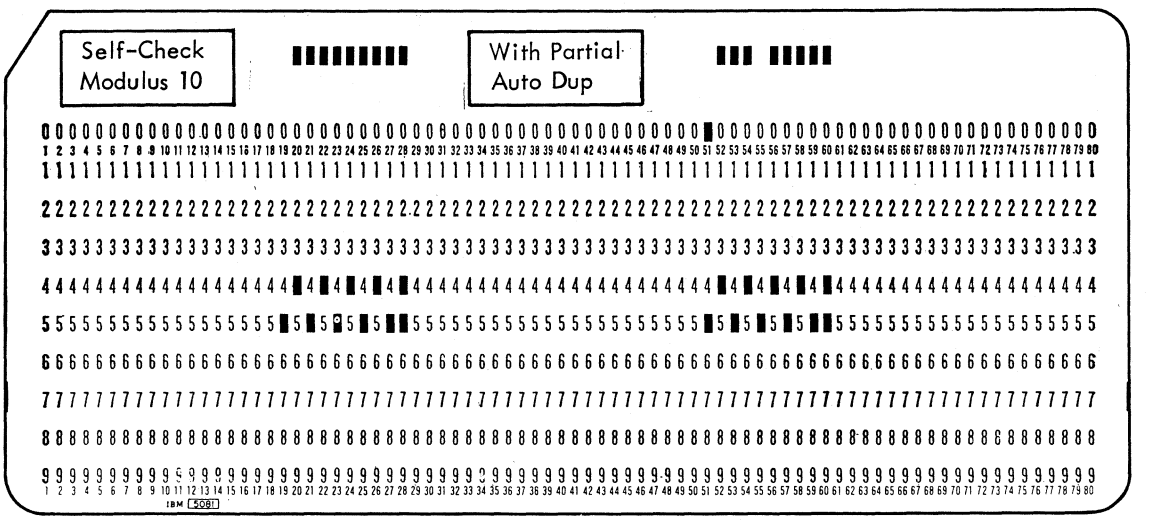


Figure 32. Self-Check Modulus 10 Program Card

Basic number: 943457842									
Write digits of basic number:	9	4	3	4	5	7	8	4	2
From right to left, write checking factors:	4	3	2	7	6	5	4	3	2
Add the products:	36 +	12 +	6 +	28 +	30 +	35 +	32 +	12 +	4 =
					Total 195				
Divide: 195 divided by 11 = 17 plus a remainder of 8									
Subtract: 8 subtracted from 11 = 3 (the check digit)									
The new self-checking number is: 9434578423									

Figure 33. Self-Check Modulus 11 – Manual Method of Developing a Check Digit

3. Below each digit, starting at the right and working left, place the corresponding checking (weighting) factor.
4. Multiply each digit by its checking factor and add the products.
5. Because this is a Modulus 11 operation, divide the sum of the products by 11, and subtract the remainder from 11. The result is the check digit.

In Modulus 11 operation, basic numbers that require a check digit of 10 cannot be used as self-checking numbers. The accounting system must be adjusted to eliminate such numbers from codes that are to be self-checked. If an operator is generating check digits and punches a basic number requiring a check digit of 10, the machine indicates an error condition. It punches a 12 in the check digit column, the self-check light goes on, and the keyboard locks. The operator must release the card and substitute another basic number.

When the calculations on the basic number result in a check digit of 11, the digit 0 can be substituted and appended to the basic number to make a valid self-checking number. Eleven and zero have the same value in this part of the calculation.

Compatibility

Modulus 11 self-checking is compatible with auxiliary duplication, but is not compatible with Modulus 10 self-checking or program level 2.

Program Card

Preparation of the program card for Modulus 11 self-checking is similar to that for Modulus 10. Fields must be defined with 12-punches in all columns *except* the high-order column of the field. In addition, the following coding pattern must be used.

Column	1	2	3	4	5	6	7	8	9
									4
	8	9	4	5	6	7	8	9	9

Note: Column 9 is check-digit position

Any size self-checking field is handled in the same manner. Start by punching a 12, 4 and 9 in the units position (check-digit column) of the self-check field. Proceeding to the left, the next column is punched 12,9; successive columns to the left are punched 12,8; 12,7; 12,6; 12,5; 12,4. If additional positions require coding, the sequence is started with 12,9 again until the high-order position of the field is reached. A 12 is not punched in the high-order column. See Figure 34.

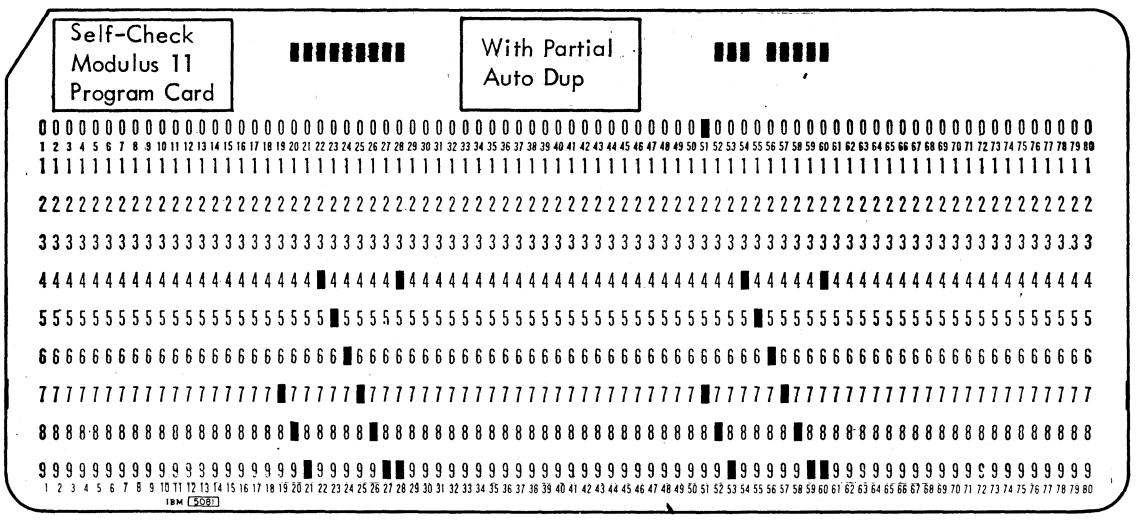


Figure 34. Self-Check Modulus 11 Program Card

The IBM 545 Output Punch is designed primarily for use in the autopunch mode to produce punched card output for a data processing system or other unit. Off-line use as a manual keypunch is provided in the keypunch mode (see "Keypunch Mode").

The 545 is placed in autopunch mode by setting the autopunch/keypunch switch (Figure 7) to autopunch. The 545 is then under control of impulses from the program unit and the using system. The switches on the keyboard (Figure 7) are set to control all desired automatic operations, however, all keyboard keys are inoperative unless specifically programmed to be active for keypunching in the autopunch mode. (The feed, register, release, program 1, and program 2 keys become inoperative after the third card is fed and all card levers are set.)

The 545 Model 1 is designed to operate at 20 columns per second (cps) and the Model 2 (printing output punch) at 18 cps, with the output punch supplying the timed impulses. If this is not desired, the using system must provide 13-20 millisecond, 48 volt pulses at 100 millisecond intervals. Operating speed, however, would be reduced to 10 cps. *The descriptions in this section presume the 545 to be the source of all impulses used by the system.*

FUNCTIONS

Autopunching, skipping, duplicating, keypunching, and printing (Model 2) may be performed by the 545 in autopunch mode. These functions are initiated and controlled by the system and the program card. The program card may be punched in the upper half, lower half, or both. Program level 1 is punched in the upper half of the program card (rows 12-3), and program level 2 is punched in the lower half (rows 4-9). Rows 12, 11, and 0 in program 1 and rows 4, 5, and 6 in program 2 initiate and maintain the automatic skipping and duplication functions. (See "Programming" in the autopunch mode section.) The other rows have no assigned function. They may be utilized by the using system for control purposes, column identification, counting, etc. A maximum of three holes per column, for each program level, is allowed.*

Note: All further references to the program in this manual will show program level 2 in parentheses.

Autopunching

Autopunch operation usually commences with the start signal from the using system. The start signal is issued before sending information to be punched on the 545. Original information from the using system is fed to the 545 output punch as pulses to the punch interposers. Each punching position, 12-9, in the card has its corresponding interposer. No numeric or alphabetic shift is needed because any combination of holes (maximum of three holes*) may be punched by simultaneously impulsing the proper punch interposer lines (Hubs K-Y, Figure 35). Figure 35 shows the 545-to-system interface through which all control and data signals must pass.

After each column is punched, the card automatically moves (escapes) to the next column. A column may be punched from the system, from the master card as in automatic duplication, from the auxiliary drum card as in auxiliary duplication (see "Special Features"), or from the keyboard when using keyboard control. Card columns may be spaced over by impulsing the space interposer instead of a punch interposer, or several columns may be skipped (see "Skipping").

Column 81 may be punched with an identifying punch if punch-81 indication special feature is installed (see "Special Features.").

Escapement of the card from column 80(81) into the master station preregister position, is normally followed by an auto feed cycle (auto feed switch on). When the first card is stacked, the second and third cards are registered at the read and punch stations, and the fourth card is fed from the hopper into the preregister position preparatory to receiving the next start signal from the system. Feeding a card automatically or manually by pressing the feed key is signaled to the system by an impulse on the functional interlock line (Hub BS, Figure 35). Skip, release, keyboard control, and self-check (special feature) also activate the functional interlock. The using system must not signal the 545 to perform any function during functional interlock time.

Autopunching requires no program control, however, all card fields to be autopunched should be defined with 12(4)-punches in all columns except the high-order column of each autopunch field in the program card. This provides for optional skipping or auto duplication of these fields by impulse from the system. (See "Programming" in the autopunch mode section.)

Note: The start signal from the system to the 545 causes the generation of 545 punch pulses (P-pulses). P-pulses are directed by the system to the 545 punch interposers to cause the punching of output data (i.e., autopunching). The skip and duplication functions are initiated by the program, with or without system control. Skipping requires no P-pulses and duplication generates its own P-pulses. Card processing, therefore, can begin without the start signal if the first card field processed is skipped or duplicated. Furthermore, because P-pulses are generated during duplication, autopunching can immediately follow duplicating without

* This limitation may not apply if the using system provides the power and signal source.

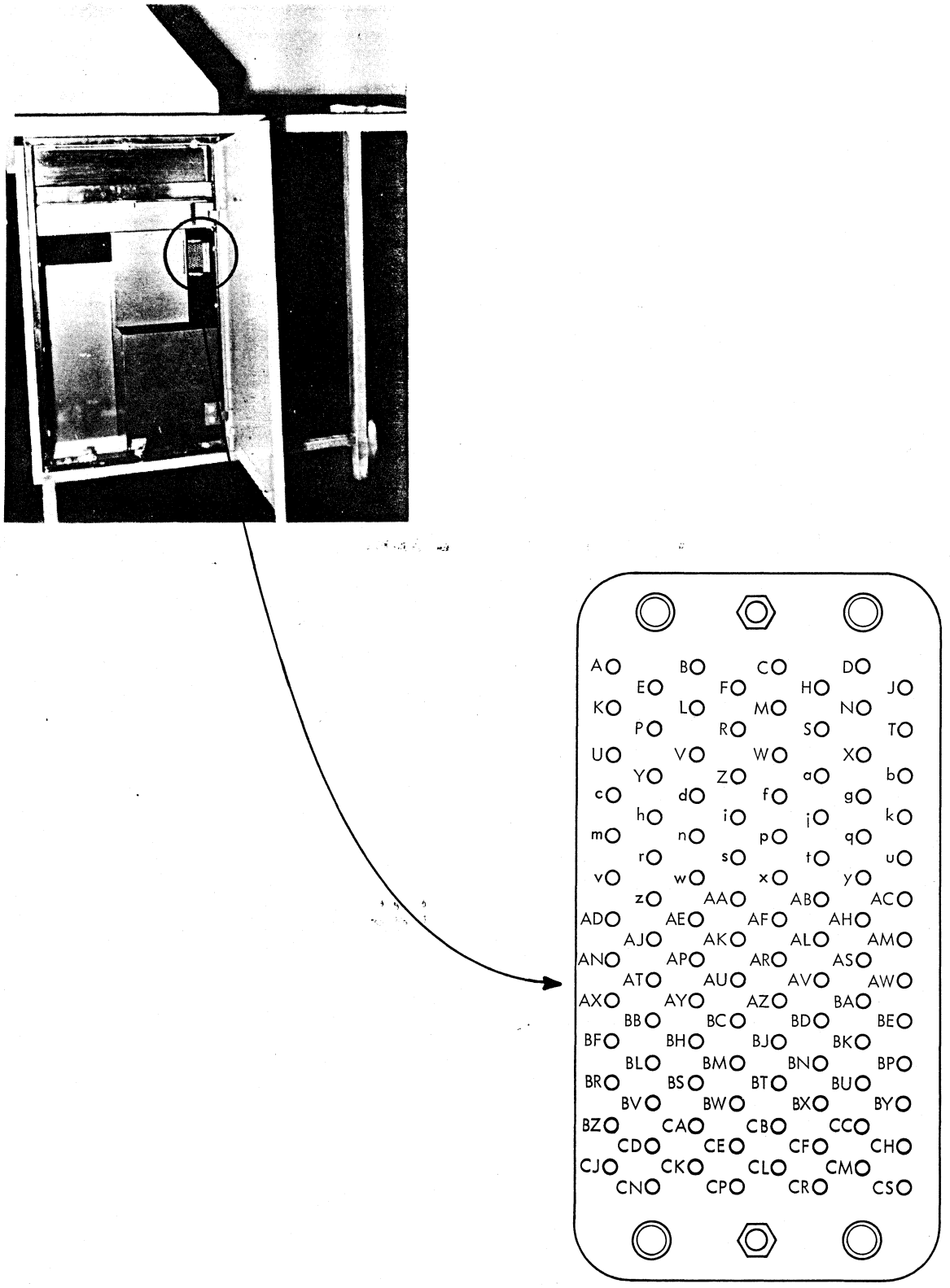


Figure 35. IBM 545 Interface Connector

first issuing the start signal. But, autopunching that follows a skip must be started with a start signal from the system.

Duplication

Information read from the card at the master card station is duplicated into the detail card at the punch station. The dup operation, in the autopunch mode, is permitted when the auto skip/dup switch is in the on position. Duplication may be initiated by a 0(6)-punch in the program card, or by an equivalent impulse from the using system. The operation continues in either case, under the control of program field definition 12(4)-punches, to the end of the field. (See "Programming" in the autopunch mode section.) Information is duplicated at the rate of 20 cps.

Skipping

The rapid skipping of card columns without punching is permitted when the auto skip/dup switch is in the on position. Skipping may be initiated by an 11(5)-punch in the program card or by an equivalent impulse from the using system. The operation continues in either case, under the control of program field definition 12(4)-punches, to the end of the field. Card columns are skipped at the rate of 80 cps.

The duplication of an 11-punch does not cause skipping.

Keyboard Control

Information may be keypunched in autopunch mode in the fields defined in the program for keyboard control. Keyboard control unlocks the keyboard and allows the operator to perform all operations usually associated with manual keypunching. (See "Keypunch Mode.") In autopunch mode, the keyboard is normally locked.

Either the system or the program may initiate and maintain the keyboard control function. The 2(8)-, 3(9)- and 12(4)-punches are available in the program for this use. For example, the system may be *designed* to allow the program 2(8)-punch to initiate keyboard control with field definition provided by 12(4)-punches. However, any one of the above mentioned punches may be used to initiate (except 12 or 4) or define keyboard control fields, depending on the design of an individual system.

Error Correction

If an operator makes a keying error in a keyboard control field, the autopunch/keypunch switch should be set to keypunch, the error corrected, and the keypunch field completed. Return the switch to autopunch to continue operation in autopunch mode.

Program Control

The processing of a card starts in column 1 under the control of either program 1 or program 2. The setting of the program selection switch (Figure 7) determines which program level will be in control in column 1. With an impulse to program 1 or program 2 (Hub AA, AB, Figure 35), the system may, in any card column, transfer control to the alternate program level. The program level may be changed as often as desired, however, the change cannot be made during an automatic skip or dup operation.

When operating with the auto feed switch off, the system may select the initial program level for the next card by impulsing program 1 or program 2, following the escapement of a card from column 80(81). The program selecting impulse also causes a card feed cycle, and the punching operation resumes with the next start pulse from the system.

Note: Operation with the auto feed switch off causes an error interlock signal at the end of each card, and turns on the check light. The error condition is alleviated by impulsing card feed, program 1, or program 2.

Feed/Release/Space

Proper operation in autopunch mode includes feeding the cards automatically, that is, the auto feed switch is on. This permits a stacker-full condition to be brought to the attention of the system by preventing auto feeding. Failure to automatically feed the next card allows *improper* card positioning for continued autopunch operation, which is indicated by the check light and an error signal to the system.

The system may override this condition by impulsing card feed (Hub z, Figure 35), but proper procedure calls for emptying the stacker and pressing the feed key to allow normal operation to continue.

Operation in autopunch mode with the auto feed switch off is possible; however, an error indication occurs at the end of each card. The system ignores and overrides the indication by impulsing card feed, program 1, or program 2 to feed the next card for continued operation.

CAUTION

The system may cause card feed cycles as long as no card is registered at either or both the master and punch card stations. Therefore, the system must not impulse "card feed" in autopunch mode until after the manual card run-in procedure is used. See "Start-Procedure."

The processing of any card may be discontinued in any card column by a system impulse to "release" (Hub L, Figure 35). The master and detail cards are moved out of the master and punch stations, past column 80, at the rate of 80 cps. After a release, if the auto feed switch is off, cards will be positioned in the prestack, master preregister, and punch preregister positions. If the auto feed switch is on, the master card is stacked, the detail card is registered at the master station, the punch preregister card is registered at the punch station, and the next card in the hopper is fed to the preregister position.

Release cannot be initiated by the program card or by the release key. However, auto duplication is performed

wherever called for by the program, unless inhibited by the using system. Thus, common information is not lost.

Spacing over single columns or repetitive spacing over multiple columns is also allowed. Each impulse to the space interposer (Hub K, Figure 35) spaces the card one column. Spacing is completely controlled by the system. When blank columns are spaced (not skipped), no start signal is required to resume autopunching.

Error Conditions

When errors are detected by the using system, the check light on the 545 turns on. The error card is automatically released, auto feeding is prevented, and the error interlock signal is issued to the system. Operation is resumed when the system issues the drop error signal to turn off the check light, and the next card is fed on signal from the system or by the operation of the feed key.

If the punch-81 indication special feature is installed, all error-released cards are identified by the lack of a punch in column 81. See "Punch-81 Indication."

The check light may also turn on to indicate a 545 malfunction or improper condition. In this case, the card is not released, but the system does receive the error interlock signal. The cause may be a stacker-full condition that prevents an automatic card feed. Any improper card motion, jamming, or failure to feed a card may also cause the check indication. Because the program must be on for proper autopunch operation, raising the starwheels (turning off the program) in autopunch mode also turns on the check light. To turn off the check light, remove the error condition and feed the next card. No reset (drop error signal) is needed.

SPECIAL FEATURES

Increased flexibility may be gained for the IBM 545 Output Punch by installing one or more of three available special features: punch-81 indication, auxiliary-drum, and read-in.

Punch-81 Indication

This special feature allows the system to identify the cards that meet desired criteria by punching an identifying punch in the blank space following column 80 (column 81). The particular punch used, 12-9, is optional. The desired punch may be specified to the customer engineer at time of installation. (A 12- and 11-punch cannot be specified if the self-checking number feature is installed.)

The criteria are specified and tested by the system. An affirmative test is signaled to the 545 by impulsing "yes" (Hub AE, Figure 35) in any column prior to column 80. The yes signal is "remembered" until column 81 where the identifying punch is made.

The system may cancel a "yes" by impulsing "no" (Hub AF, Figure 35). Yes and no signals may be issued aternately, column-by-column, as often as required prior to column 80. The last signal issued rules: a "yes" causes column 81 to be punched, a "no" (or lack of "yes") prevents punching in column 81.

Punch-81 indication is not turned on or off. It functions in autopunch mode only and complete control is exercised by the "yes" and "no" lines from the system. These lines may or may not be active during the punching of each card. If column 81 is not punched, the card-to-card skip follows column 80.

Auxiliary Drum

The auxiliary drum feature is, in some respects, similar to auxiliary duplication in the keypunch mode. An additional drum, similar to and located behind the standard program drum, is used as an auxiliary drum. The information punched in the card mounted on the auxiliary drum can be duplicated into the card at the punch station. This is auxiliary duplication, and is used to punch common information into the appropriate cards.

The holes in the auxiliary drum card may not represent data, however. They may serve instead to issue controlling impulses to the system. This is auxiliary control. In either case, a maximum of three holes per column is allowed in the auxiliary drum card. (This limitation may not apply if the using system provides the power and signal source.)

To perform auxiliary duplication, the system must impulse the auxiliary drum (Hub BR, Figure 35). One column of information punched in the auxiliary drum card is duplicated in the corresponding column of the detail card. An entire card may be duplicated this way, the auxiliary drum line being impulsed for each column duplicated. No program card control is used. See also "Auxiliary Duplication" in the keypunch mode section.

To use the control function of the auxiliary drum, both the auxiliary control (Hub BP, Figure 35) and auxiliary drum lines must be impulsed by the system. One pair of impulses per column read is required. The holes in the card column on the auxiliary drum are sent to the system as impulses. Effectively, the auxiliary drum card is read out to the system.

Complete control of the auxiliary drum resides in the system. When the auxiliary drum is impulsed, the information from the auxiliary drum card is sent to the punch interposers for duplication. When both auxiliary control and auxiliary drum are impulsed, the auxiliary control information is sent to the system via the interface (Hubs BA-BN, Figure 35). No program card control is used.

Normally, auxiliary dup fields are intermixed with autopunch, and auto dup fields. In such cases, the controls already mentioned suffice. If auxiliary duplication or auxiliary control is to start in column 1, or immediately following a skip, the start signal must precede the impulse to the auxiliary drum.

Auxiliary control can be used in any and all columns, even concurrently with keyboard control, autopunching, or auto duplication, but not auto skipping or release.

Programming Auxiliary Drum

No program control is used for either auxiliary duplication or auxiliary control. The program card can therefore be left blank in such fields. It is advisable though, to punch field definition 12(4)-punches in all but the high-order column of an auxiliary dup field to permit optional skipping of these fields on impulse from the system.

Read-In

When desired, the 545 may be used as an input card reader, provided the read-in special feature is installed. Fields of a card or the entire card may be read as the card passes through the master station. The information read from the card is placed on the interface lines to the system (Hubs AK-AX, Figure 35). A maximum of three holes per column is permitted. (This limitation may not apply if the using system provides the power and signal source.)

The read-in operation, similar to the autopunch operation, requires a start signal from the system. Reading and card movement begin when the system impulses "start read-in" (Hub AH, Figure 35). Reading continues until stopped in any column by impulsing "stop read-in" (Hub AJ, Figure 35) in that column. The card stops in the next column, if desired, but more likely, begins a programmed skip to the next read-in field. The start and start read-in signals must be issued again in the first column of the next field to be read; likewise, the stop read-in signal must be issued in the last column of the field. At least one start read-in and one stop read-in is required for each card. Blank columns may be read instead of skipped, but skipping long fields saves time.

The read-in feature may also be used with autopunching as a means of checking the punched output. While fields are autopunched at the punch station, corresponding fields may be read at the read station. The system can, thereby, determine if a card has been punched in error. If so, the system may issue the error signal (Hub BV, Figure 35) to alert the operator and stop card processing (see "Error Conditions"). Processing is resumed after the system issues the drop error signal and the next card is fed by impulse from the system or by the operator pressing the feed key.

Programming Read-In

Normally, only card reading and skipping are performed during a read-in operation; but read-in fields can be intermixed with other fields in an autopunch operation, as for example when read-in is used for checking purposes (see "Programming" in the autopunch mode section). Fields to be read do not require punching in the program card. However, read-in fields may be punched with 12(4)'s to allow optional skipping of such fields on impulse from the system.

Where read-in is used concurrently with autopunching, the program card is punched for the autopunch operation. Fields to be skipped should be punched with an 11(5) in the high-order column of the field and 12(4)'s in the remaining columns of the field (see Figure 36).

Note: If skipping is to start in column 1, the system must issue the start signal in the first column to be read and prior to the start read-in signal.

Self-Checking Number

The self-checking number modulus 10, self-checking modulus 11, and self-checking number generator features may be used in autopunch mode. The self-checking features function the same in autopunch and keyboard control fields as they do in manual (keypunch mode) fields. The programming is also the same. See "Self-Checking" in the keypunch mode section.

PROGRAMMING

The program preparation required for each autopunch function is described with the function. Autopunch program card preparation is similar to keypunch program card preparation. See "Programming" in the keypunch mode section. Figure 36 summarizes the program card punching used by the 545 Output Punch in autopunch mode. It is not intended to be a representation of a program card for any single application, although it would function properly if used.

OPERATIONS

All controls for operating the 545 are located on the keyboard (Figure 7). Except for the slight variations in function presented here, the keyboard switches function the same in both keypunch and autopunch mode. See "Functional Controls" in the keypunch mode section.

Indicators

The IBM 545 has two indicators on the keyboard:

Auto (White)

This indicator is on when the 545 is in the autopunch mode.

Check (Red)

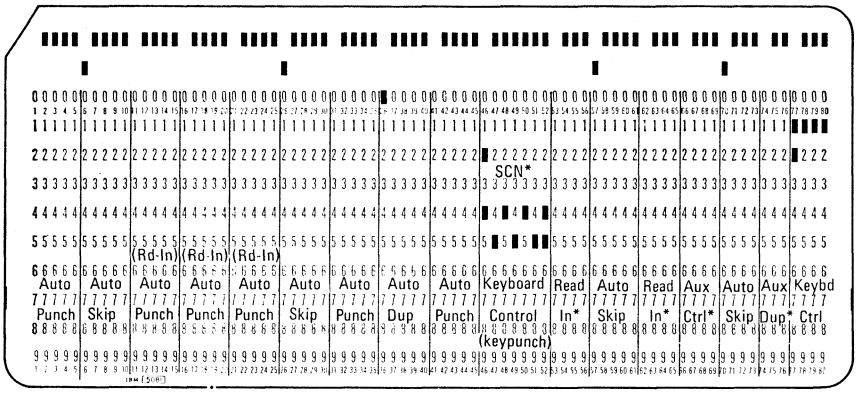
This indicator, operative in the autopunch mode, indicates:

1. Card jam or card levers not closed (improper card movement).
2. Program drum lever in off position (starwheels raised).
3. Stacker full condition, which prevents an auto feed cycle.
4. An error condition signal from the using system.

The check indication caused by an error signal from the system is relieved by a signal from the system. The check indication caused by a 545 condition is relieved by the operator.

When the stacker is full, the operator empties the stacker and presses the feed key.

If a card fails to feed from the hopper, the operator adjusts the cards in the hopper and presses the feed key to feed the next card.



*Special Feature

Column	Punch	Function	Comments
1	Blank	None	Start signal from system required.
2-5	12 (4)	Define autopunch field	Permits optional skip of field on signal from system.
6	11 (5)	Start auto skip	
7-10	12 (4)	Define skip field	No P-pulses generated during a skip.
11	Blank	None	Start and start read-in signals from system required.
11-15 16-20 21-25		Same as columns 1-5	These fields autopunched at punch station; also read at the read station if read-in special feature installed. May be skipped individually on signal from system.
25		Stop read-in	Stop read-in signal from system required.
26-30		Skip	Same as columns 6-10.
31	Blank	None	Start signal from system required.
31-35		Autopunch	Same as columns 1-5.
36	0 (6)	Start auto duplication	This field autopunched in first card of each group;
37-40	12 (4)	Define dup field	system cancels program 0 signal to dup.
41-45		Same as columns 1-5	No start signal in column 41.
46	2 (8)	Start keypunching	System design may choose the 2 (8), or 3 (9)-
47-52	12 (4)	Define keypunch field	punch to initiate keyboard control. See Note
46-52	4, 5	Self-checking	A keypunched (or autopunched) field may also be self-checked if self-checking number feature is installed. See "Special Features" under "Keypunch Mode."
53	Blank	None	Start read-in signal from system required; no start signal required.
54-56	12 (4)	Define read-in field	Permits optional skipping of field.
56		Stop read-in	Stop read-in signal from system required.
57-61		Skip	Same as columns 6-10.
62		Start read-in	Start read-in and start signals from system required.
62-65		Read-in	Same as columns 53-56.
65		Stop read-in	Stop read-in signal from system required.
66	Blank	None	Aux drum and aux ctrl signals from system (each column)
67-69	12 (4)	Define auxiliary control field (used only to permit optional skip of field).	are required to read this field from auxiliary drum card, assuming auxiliary drum special feature is installed. (Cards at punch and read stations would be spaced*.)
70-73		Skip	Same as columns 6-10.
74	Blank	None	Start signal and aux drum signals from system required.
75-76	12 (4)	Define auxiliary dup field (Used only to permit optional skip of field)	Aux drum signal from system (each column) to duplicate field from the aux drum card, assuming auxiliary drum special feature is installed.
77	2 (8)	Start keypunching, alpha shift	Same as columns 46-52, but in the alpha shift for punching alphabetic characters without self-checking.
78-80	12 (4) 1 (7)	Define keypunch field Alpha shift	

*Auxiliary control requires no program control; it may be active concurrently with autopunching, auto duplication, or reading.

Note: Except for self-checking fields, all fields can be punched in the program 2 level as indicated by numbers in parentheses. Self-checking is not compatible with program level 2.

Figure 36. Program Card–Autopunch Mode

If cards jam at the read or punch station, removal of the jammed cards and feeding in new cards will allow resumption of autopunch operation.

Switches

Auto Skip/Dup

When this switch is off, skip and dup may be impulsed from the system only.

Prog Sel

The program selected by the program selection switch may be changed by a system impulse to program 1 or program 2.

Auto Feed

The auto feed switch is on during proper autopunch operation. If procedure calls for this switch to be off, the feed, register, release, program 1, and program 2 keys become active following the escapement of the card from column 80 (81). To resume autopunch operation press the feed, program 1, or program 2 key to feed the next card. The using system may also impulse card feed, program 1, or program 2 to cause a single card feed cycle.

Autopunch operation with the auto feed switch off causes a continual simulation of the stacker-full condition, whether or not the stacker is actually full. The check light is turned on and an error interlock signal (non-ready condition) is sent to the system after each card. A card is fed (and the check light turned off) by impulse from the system to card feed, program 1, or program 2; or one of the corresponding keys on the keyboard may be pressed to obtain the same result.

Clear

The clear switch is normally not effective when operating in the autopunch mode. If, however, the auto feed switch is off, the clear switch becomes active between cards. It is therefore possible to clear cards from the feed bed after escaping from column 80(81) and before feeding the next card manually.

Start Procedure

To prepare the 545 for autopunch operation:

1. Set autopunch/keypunch switch to *keypunch.*
2. Turn on main line switch.
3. Install a program drum with appropriate program card mounted and lower the starwheels.
4. Set appropriate switches on the keyboard to control desired automatic operations during autopunch operation.
5. Feed three cards:
   a. With the auto feed switch on, press the feed key twice and the release key once.
   b. With the auto feed switch off, press the feed key twice, then the release key, and then the feed key once again.

   (This places one card at the master station, one at the punch station, and one at the preregister position.)
6. Set autopunch/keypunch switch to *autopunch.* The 545 is now ready for operation under direction of the using system

PRINTING

The Model 2 prints as it punches. Each character prints at the top edge of the card, above the punches in the column (Figure 37), thus providing for full interpretation of the card. Printing is controlled by the print switch on the keyboard. The print switch must be set on to print. When in the off position, all printing is suppressed.

Further control is provided by a second switch, the left-zero print switch. This switch, in conjunction with the print switch mentioned previously, allows or suppresses printing of left zeros. (Left zeros are the zeros to the left of the first significant digit in any defined numeric field.) Control by the left-zero print switch is immediate when it is turned on in the middle of a field; when turned off in the middle of a field, control is delayed until the end of the defined field.

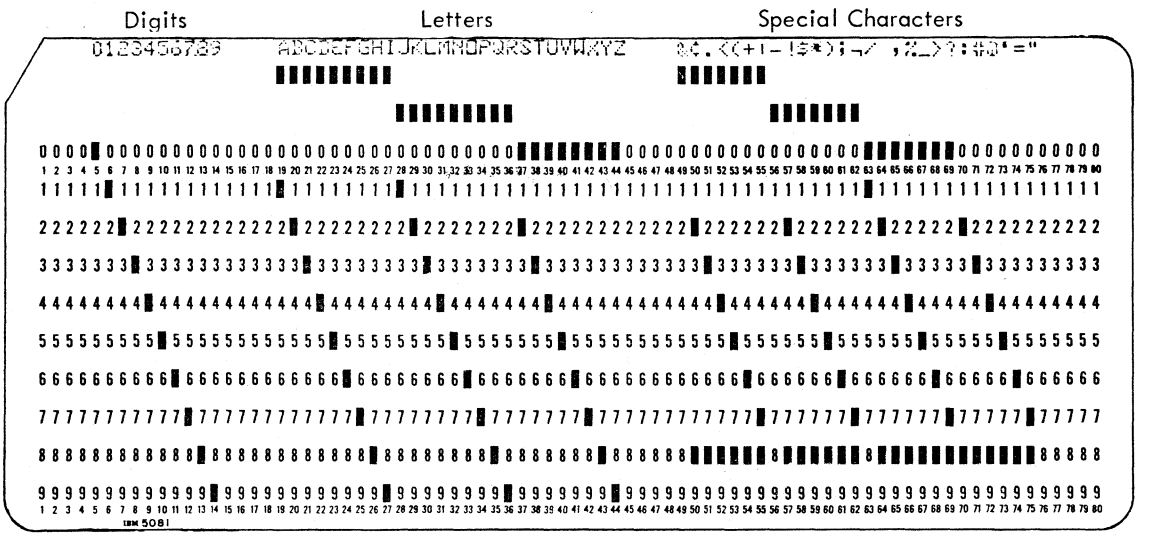


Figure 37. Card Codes and Graphics for 64-Character Set

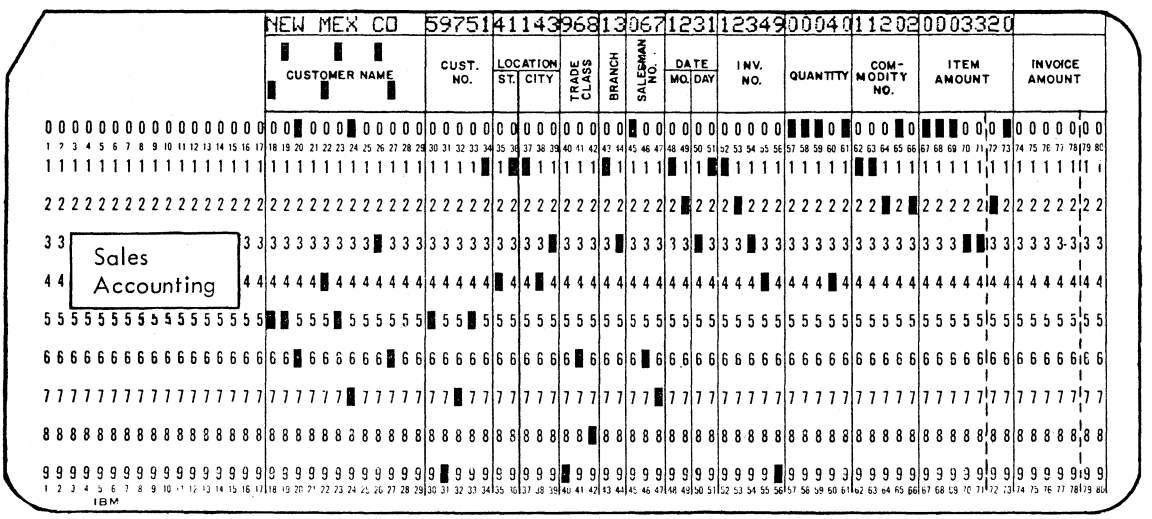


Figure 38. Punched Card

As an example, Figure 38 shows the printing of several numeric fields. Left-zeros are present and printed in three of the fields: salesman number (columns 45-47), quantity (columns 57-61), and item amount (columns 67-73). Printed as shown, both switches were on. If the left-zero print switch had been off, the salesman number field printing would be 67 the quantity field printing would be 40, and the item amount field printing would be 3320.

Character Arrangments

On the IBM 545 Output Punch Model 2, the characters that print are determined by the type of keyboard attached. Machines with a 64-character keyboard print 64 characters; machines with a 48-character keyboard print only 48 characters.

A 64-character (arrangement EL) keyboard includes 26 letters, 10 numerals, and special characters (shown in Figure 39 under EL).

A 48-character keyboard (arrangement A) includes 26 letters, 10 numerals, and 11 special characters. The special characters associated with arrangement A are shown in Figure 39. Any attempt to print, by duplicating, one of the 16 punched-hole combinations shown below the dotted line on Figure 39 causes a solid square printed warning mark. This indicates that characters not associated with a 48-character keyboard have been used.

Keyboard Switches

The two switches that control printing (Figure 7) are:

Print: This switch must be on to permit printing of characters as they are punched.

LZ Print: This switch must be on (print switch must also be on) to permit printing of high-order zeros in defined numeric fields. The printing of high-order zeros is suppressed when the LZ Print switch is in the off position.

Zero Print and Suppression

When printing, in addition to the analyses described under "Program Card Preparation," the cards should be analyzed for zero printing.

With the print switch on, zeros, dashes, and ampersands to the left of the first significant digit in a field are automatically suppressed unless the left-zero print switch is on. This suppression depends on the field definition 12(4)'s in every column except the first. Therefore, if several successive fields are to be programmed for automatic duplication but zero suppression is desired, program each field independently for automatic duplication rather than as one large field as described previously.

A zero always prints in the units position of a field that does not have a significant digit (field with all zeros).

If zeros (dashes and ampersands) are desired to the left in a field, such as social security number, the left-zero print switch and the print switch must both be on.

Card Code	Graphic	
	EL	A
12	&	&
11	-	-
0-1	/	/
12-8-3	.	.
11-8-3	$	$
0-8-3	,	,
8-3	#	#
12-8-4	<	¤
11-8-4	*	*
0-8-4	%	%
8-4	@	@
12-8-2	¢	
11-8-2	!	
0-8-2	(No Graphic Assigned)	
8-2	:	
12-8-5	(	
11-8-5	)	
0-8-5	_	
8-5	'	
12-8-6	+	
11-8-6	;	
0-8-6	>	
8-6	=	
12-8-7	|	
11-8-7	¬	
0-8-7	?	
8-7	"	

&	Ampersand
-	Minus or Hyphen (Dash)
/	Slash
.	Period
$	Dollar Sign
,	Comma
#	Number Sign
<	Less Than Sign
*	Asterisk
%	Percent Sign
@	At Sign
¤	Lozenge
¢	Cent Sign
!	Exclamation Point
:	Colon
(	Left Parenthesis
)	Right Parenthesis
_	Underscore
'	Prime or Apostrophe
+	Plus Sign
;	Semicolon
>	Greater Than Sign
=	Equal Sign
|	Vertical Bar, Logical OR
¬	Logical NOT
?	Question Mark
"	Quotation Mark

Figure 39. Special Characters

Ribbon Replacement

The ribbon on printing models of the IBM 545 Output Punch is fed between two spools, through ribbon guides, and under the punch die (Figure 40). The old ribbon is removed and a new one is inserted as follows:

1. Turn off the main line switch.
2. Remove the ribbon-spool retaining clamp.
3. Cut or break the old ribbon.
4. Remove both spools from their spindles and pull out the two pieces of ribbon. Empty one of the spools.
5. Place the spool of new ribbon on the right-hand spindle, positioning it so that the ribbon is fed from the top of the spool toward the front of the machine. Lift the right end of the ribbon-reversing arm, if it is not already up, and unroll 1-1/2 feet of ribbon; then push down the right end of the ribbon-reversing arm to hold the spool steady.
6. Feed the metal leading end of the ribbon between the punch die and the card bed, sliding it through the groove in in the center of the card bed (between the 3- and 4-punching position). The groove permits the extra thickness of the metal end and the reversing eyelet to pass between the punch die and the card bed. Be sure to keep the ribbon straight, with the *top* side up at all times.
7. Hook the metal leading end of the ribbon in the slot in the center of the empty spool and wind the ribbon onto the spool until the reversing eyelet is on the spool.

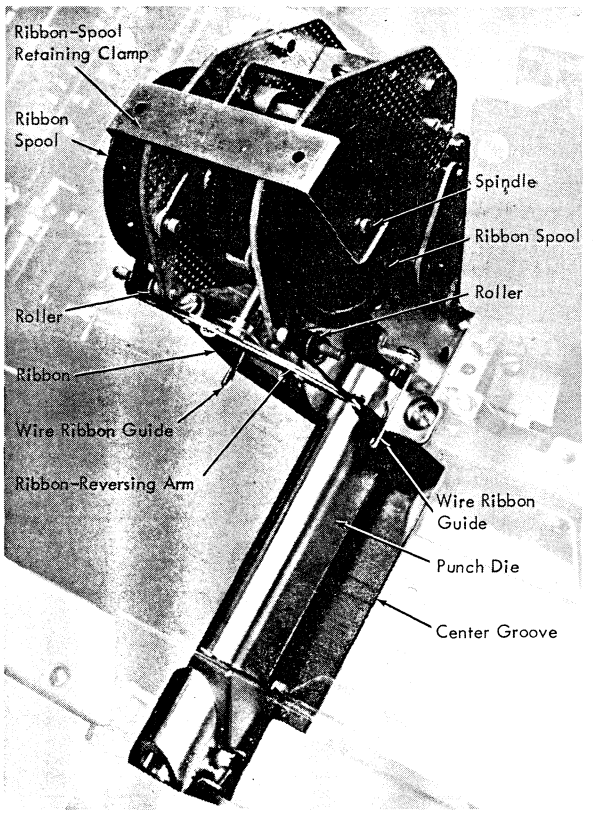


Figure 40. Ribbon Replacement

8. Place the spool on the left spindle, positioning it so that the ribbon is fed onto the spool over the top. Be sure that the ribbon is not twisted and that the *top* side of the ribbon is still up.
9. Hook the ribbon around the right and left wire ribbon guides, and slide it through the right and left ends of the reversing arm and over the rollers in front of the ribbon spools.
10. Slide the ribbon up under the punch die so that it is in the upper groove provided for it in card-printing position (above the 12-punching position), and take up the slack.
11. Replace the ribbon-spool retaining clamp.

COMBINATION KEYBOARD

A 545 Output Punch can have either a 48-character keyboard or an expanded 64-character keyboard.

48-Character Keyboard

The 48-character keyboard is designated as arrangement A. In addition to the 26 letters, and numerals 0-9, special characters in various combinations can be punched by a single key depression. Examples of the special characters available in arrangement A are shown in Figure 39.

64-Character Keyboard

The expanded 64-character (arrangement EL) keyboard is System/360 compatible. The 64 characters include all the letters and numerals contained on the 48-character keyboard, plus all the special characters shown under arrangement EL in Figure 39.

In Figure 41, each key is numbered for purposes of description in the following summary.

Punching Keys

Keys 1-29, 33, and 40-43 are, except for key 7(A) and key 13 (Z), dual character keys that may be pressed when the keyboard is in either numeric or alphabetic shift. (Keys 7 and 13 should be pressed only when the keyboard is in alphabetic shift; in numeric shift they cause the keyboard to lock up.) The resulting punched-hole combinations represent numerals, letters, and special characters. See Figure 42 for the keytop graphics and punched-hole codes associated with each key on the expanded 64-character keyboard.

Note that in numeric shift, key 5 punches a combination of the zero, two, and eight holes in the card. A graphic has not been assigned to this combination, hence the punched-hole code punched by the key is shown on the keytop instead.

Space Bar

The space bar can be pressed at any time in a manual field to cause spacing over one column of the card.

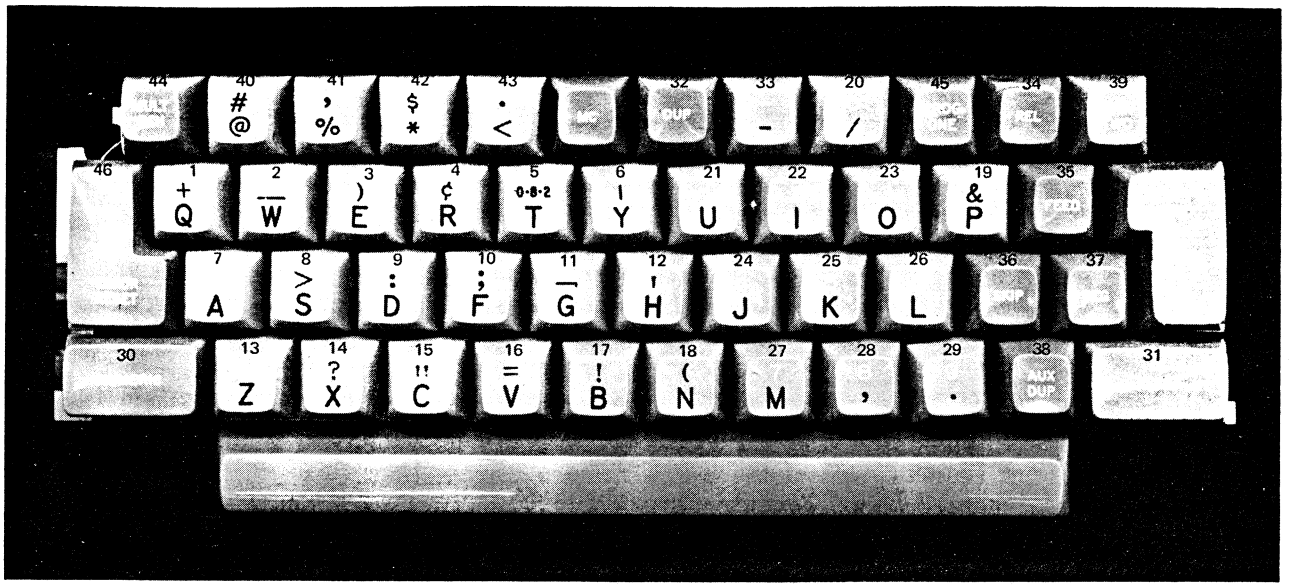


Figure 41. Keys–Combination Keyboard

Key Number	ALPHABETIC		NUMERIC	
	Card Code	Graphic	Card Code	Graphic
1	11-8	Q	12-8-6	+
2	0-6	W	0-8-5	¯
3	12-5	E	11-8-5	)
4	11-9	R	12-8-2	¢
5	0-3	T	0-8-2	0-8-2
6	0-8	Y	12-8-7	|
7	12-1	A	none	none
8	0-2	S	0-8-6	>
9	12-4	D	8-2	:
10	12-6	F	11-8-6	;
11	12-7	G	11-8-7	¬
12	12-8	H	8-5	'
13	0-9	Z	none	none
14	0-7	X	0-8-7	?
15	12-3	C	8-7	"
16	0-5	V	8-6	=
17	12-2	B	11-8-2	!
18	11-5	N	12-8-5	(
19	11-7	P	12	&
20	0-1	/	0	0
21	0-4	U	1	1
22	12-9	I	2	2
23	11-6	O	3	3
24	11-1	J	4	4
25	11-2	K	5	5
26	11-3	L	6	6
27	11-4	M	7	7
28	0-8-3	,	8	8
29	12-8-3	.	9	9
33	11	-	11	-
40	8-4	@	8-3	#
41	0-8-4	%	0-8-3	,
42	11-8-4	*	11-8-3	$
43	12-8-4	<	12-8-3	.

Figure 42. Key Graphics and Punched-Hole Codes

Functional Keys

The remaining keys, numbers 30-32, 34-39, and 44-46 control the various functions of the card punch.

30. Numeric (Numeric Shift): This key shifts the combination keyboard into numeric shift or mode as long as it is held down. It is normally used to punch numbers in an otherwise alphabetic field.

31. Alpha (Alphabetic Shift): This key shifts the combination keyboard into alphabetic shift or mode as long as it is held down. It is normally used to punch letters in an otherwise numeric field. When duplication is being performed in numeric shift, pressing this key permits automatic spacing over blank columns.

32. Dup (Duplicate): When a manual field contains identical information for two or more cards, this field can be duplicated at 18 or 20 columns per second on the cards that follow. With the machine under program control, one depression of the dup key initiates the operation. Duplication continues until the end of field definition.

Without program control, duplication occurs at the rate of 9 or 10 columns per second and occurs only as long as the key is held down. This allows the operator precise column control in a card correction or make-over application.

Encountering a space during duplication of numeric fields locks the keyboard. The error reset key unlocks the keyboard and permits keying of the space, substitute data, or release. The alpha shift key can also be used to get over the

space without pressing the error reset key. Use the backspace key on machines with the self-checking feature installed.

34. Rel (Release): This key is used to advance the card in the read or punch station through column 80. If the machine is under program control and the release operation encounters an auto dup field, the auto dup information is punched before the release operation can continue. Thus, when a card is released because of a keying error, the common information is not lost.

Multiple release and register cycles are not required to clear the card transport area of cards. Use the clear switch for this operation.

35. Feed (Card Feed): The feed key, if held depressed, moves two cards from the hopper into the punch station and preregister station. It is inoperative when a card is registered at the punch station.

36. Skip: A skip can be initiated manually by operating the skip key. Skipping occurs at 80 columns per second and continues to the end of field definition under program control, or in the absence of field definition, each key operation results in a single space.

37. Reg (Card Register): When a single card is fed from the hopper, or when a card is manually inserted at either the punch or read station, operating the register key locates the card in the proper position for reading or punching column one. This key does not cause an additional card to be fed from the hopper.

38. Aux Dup (Auxiliary Duplicate): This key is operable only when the machine has the auxiliary duplication feature installed. When pressed, it causes duplication from the master card on the auxiliary duplicating drum. Under program control, pressing the key once duplicates the entire field.

39. Prog Two (Program Two): With the machine under program control, card format may be changed by operating the program two key to place the operation under the control of program two. The shift between program level 1 and 2 can be made any number of times during the punching of a card.

When depressed in column 1 (auto feed switch off), this key also causes a card feed cycle, and sets the corresponding program level regardless of the setting of the program selection switch.

In a one-program application, if the second level is not punched in the program card, using the program 2 key suspends programming. This makes it unnecessary to lift the starwheels for program suspension.

44. Mult Pch (Multiple Punch): This key places the keyboard in numeric shift and suppresses spacing while individual codes are keyed and punched.

45. Prog One (Program One): This key causes the machine program control to transfer immediately to program one, assuming it had been in program two. (This key's function is similar to that of Prog Two. See key 39.)

46. Error Reset: This key unlocks an interlocked keyboard. The backspace key does not have to be used for this purpose. The error reset key also resets an error condition encountered during the use of the self-checking number feature. See "Self-Checking."

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