IBM

Reference Manual

101 Electronic Statistical Machine

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101 Electronic Statistical Machine

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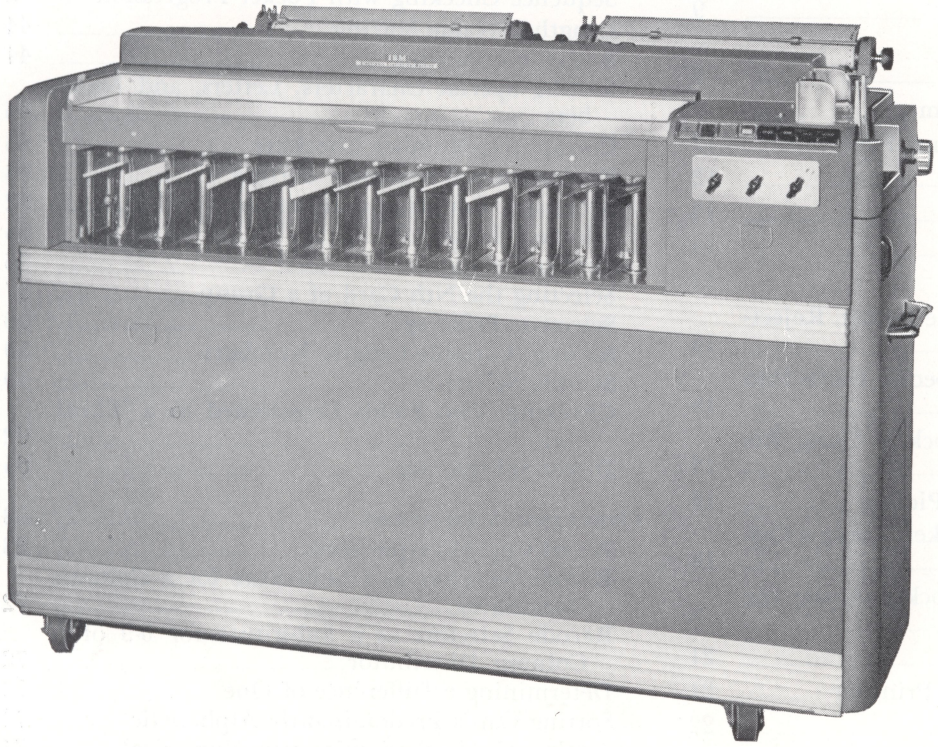

IBM 101 Electronic Statistical Machine

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Statistics may be defined as the science that deals with the collection and tabulation of numerical data. In our modern-day economy, statistics embrace practically every phase of human activity. They play a major role not only in the conduct of governmental affairs, but also in the conduct of business, industry, and institutions of every description.

By its very nature, the job of compiling statistics is concerned with the following:

1. Gathering of facts.
2. Coding of facts to facilitate mass handling of statistical data.
3. Editing of facts to insure accuracy and consistency.
4. Arranging and re-arranging of facts to permit cross-analysis of statistical data.
5. Counting of facts.
6. Preparation of statistical tables.

In many cases, statistical data are already recorded in IBM cards as part of regular accounting procedures. In those cases, only the last four of the above operations are needed to produce statistical reports. The 101 Electronic Statistical Machine combines in one unit the functions of sorting, counting, accumulating, balancing, editing, and printing of summaries of facts recorded in IBM cards.

The following operations may be performed at the rate of 450 cards a minute:

1. Sort IBM cards in numerical or alphabetic sequence.
2. Arrange cards into any desired pattern.
3. Check cards for consistency of coded information.
4. Check the accuracy of sorting.
5. Search files of cards for specific facts or combination of facts.
6. Count cards for as many as 60 different classifications in one run.
7. Add two 5-digit amounts punched in IBM cards to accumulate two 8-position totals; or add one 9-digit amount to accumulate one 12-position total.
8. Print results in final form on one or two reports of convenient size.
9. Print group identifications.
10. Print a check symbol on each line of the report to indicate that the totals printed on the line cross-check.
11. Summary punch totals in IBM cards when one or two summary punches are connected to the 101.

The 101 is available in two models to meet varying statistical requirements. Model 1 is a full-capacity machine with two printing units and sixty unit counters. Model 2 is a smaller capacity machine with one printing unit and fifteen unit counters.

The basic functions of the 101 Electronic Statistical Machine are described below.

Input

Source information is fed into the 101 in the form of punched cards. Input consists of feeding the cards into the machine, reading the information from the cards, and instructing the machine what to do with this information. This is the first of the basic functions of the 101.

Edit Testing

The machine is capable of editing (approving) facts before the facts are sorted or counted. Such a check not only points to errors in control panel wiring but also recognizes missing or wrong punches in a card. If errors are detected, the card is sorted to the reject pocket for manual inspection and correction. This 101 operation is widely used to check input data and programs of data-processing systems.

Classification

The machine operator knows what significant classifications he wants the machine to recognize. The machine is instructed by means of switch settings and control panel wiring to place the cards of different categories in pockets of the machine, according to their classifications.

Arithmetic

The 101 can count, accumulate, and crossfoot and balance according to the instructions given the machine by control panel wiring and switch settings.

Output

The machine is capable of two forms of output. It can print totals, group indications, card counts, or crossfoot checks, resulting from the arithmetic functions. It can also transmit signals to an auxiliary machine (524 Duplicating Summary Punch) which will result in summary punching the results of the arithmetic functions into IBM cards. When classification and arithmetic functions are performed simultaneously, the cards classified into any or all pockets can be counted and the counts can be printed, verified, and summary punched.

A complete description of the operating features and methods of operation is contained in the following pages. The manual is divided into five sections as follows:

Section I	Operating Features
Section II	Principles of Operation
	A. Normal Sorting
	B. Edit Testing
	C. Selective Sorting
	D. Counting, Accumulating and Printing
	E. Summary Punching
Section III	Typical Applications
Section IV	Operating Suggestions
Section V	Control Panel Summary
Section VI	Timing Chart

Operating features of the Electronic Statistical Machine (Frontispiece and Figure 1) are described below:

Main Line Switch and Power Light

When the main line switch on the right end of the machine is turned on, a signal light (power) goes on, indicating that the machine is ready to operate. Because the machine is electronically controlled, approximately one minute is required for the electronic tubes to heat before the light turns on.

Hopper

Cards are placed in the hopper face down, 9's edge toward the throat of the machine. The hopper holds approximately 800 cards. Cards feed from the hopper at the rate of 450 a minute. The machine stops when the last card reaches its pocket.

Start Key

Card feeding is started by depressing the start key, and feeding continues until the card hopper is empty, until a pocket becomes filled, or until other conditions recognized within the machine or through control panel wiring cause the machine to stop. If the start key had previously been depressed without cards in the hopper, it is necessary to press the restore key before the start key will operate.

Stop Key

Card feeding can be stopped at any time by depressing the stop key.

Card Feed Stop

Located in the bottom of the hopper is a card feed stop device to stop card feeding. It consists of arms which lift cards above the feed knives when the stop key is depressed, when a sort pocket becomes filled, or when reject-stop has been wired on the control panel.

Printing Carriages

The machine may have one or two carriages for printing reports: the left for printing a total of punched amounts, a group indication, and the counts from

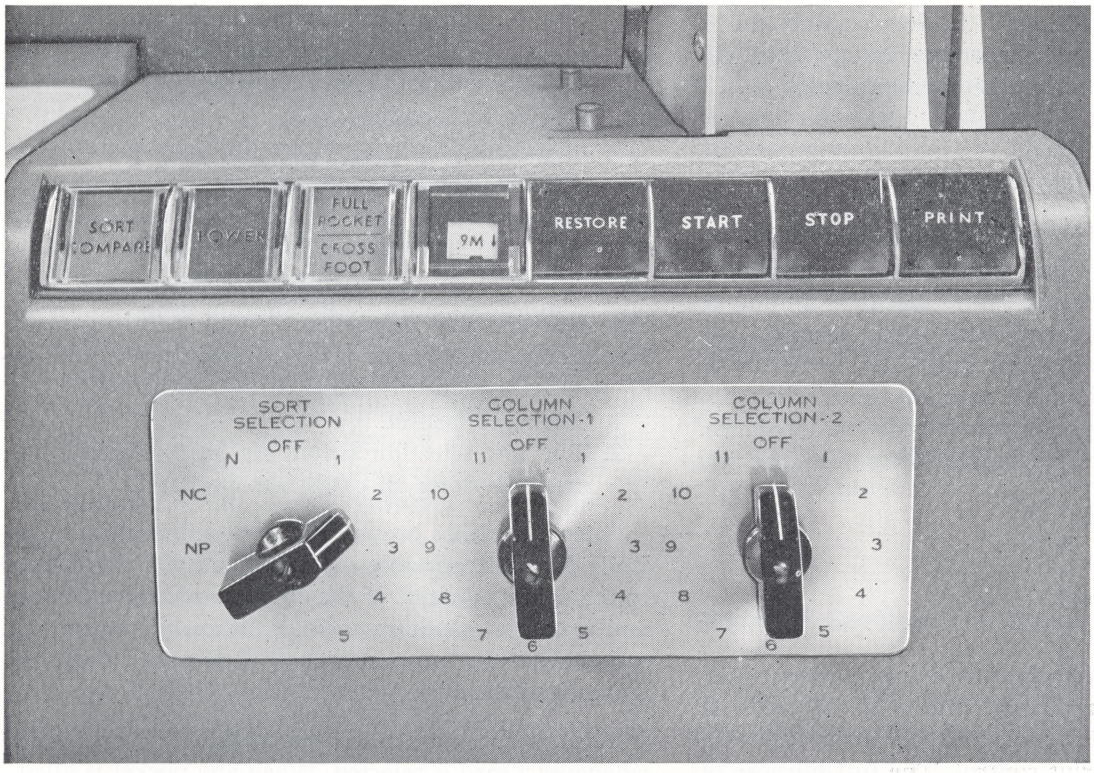


Figure 1. Lights, Keys, and Switches

counters 1 to 30; the right for printing another total amount, the same group indication, and the counts from counters 31 to 60. Preprinted or blank forms are inserted in each carriage in the same way that they would be inserted in a typewriter.

The carriages may be equipped with pin-feed platens for feeding marginally punched paper so that alignment of forms in the proper position is automatic. Single sheet forms can be used, in which case alignment can be made by placing the first column in printing position. For each carriage, there are four type bars which do all the printing. The carriages skip like a typewriter carriage as the totals are printed across the form. The margin stops behind the carriages can be set for 8 or 12 positions of total amount, or for normal or extra columns of group indication. These marginal stops must be set alike on both carriages. The control panel may be wired to stop printing at any column on each form. The carriages can be moved by hand, but they must be restored to the extreme right to start card feeding or printing.

Sort Compare Light

The sort compare light turns on and the machine stops if a card does not enter the correct pocket. The card is marked on the back to identify it in case it should reach a sort pocket. Ordinarily, two cards follow a marked card. The cards in the machine can be run out by depressing the start key, but feeding will not restart until the restore key is depressed.

Full Pocket-Crossfoot Light

This light turns on when any pocket becomes filled during a sorting operation. The machine cannot be restarted by the start key until cards are removed from the filled pocket. This light also turns on if, in a printing operation, the machine stops when distributed counts do not crossfoot to a zero balance. The restore key must be depressed before the machine can be restarted.

9M Switch

The 9M (Master) switch is set to its UP position when master cards are being sorted into a file of cards. It is set to its DOWN position when master cards are being used for automatic print control. The full purpose of this switch is described under "Master Card Control."

Print Key

Totals can be printed manually by depressing the print key. As total counts are printed, the machine checks their accuracy by crossfooting to obtain a zero balance. The result of crossfooting is indicated by a zero or the difference printed in the column to the right of the last count on each report.

Restore Key

The restore key must be depressed before the machine can be restarted after the sort-compare or crossfoot signal turns on.

Column Selection Switches

These switches are used to select the column on which cards are to be sorted. By means of control panel wiring, any 22 columns of the card can be sorted successively. The two switches can be used independently for selecting columns and control impulses during specific runs of the cards.

Sort Selection Switch

This switch can be set to one of eight positions to control the following operations:

NP—(Non-print) Eliminate printing and summary punching of totals
NC—Normal sorting and counting
N—Normal sorting
1-4—Selective sorting; four different patterns
5—Sorting all cards into pocket 11

Sort Pockets

The machine has 13 pockets — 12 for sorting cards into groups and one for rejects. Cards are directed to all pockets by control panel wiring except for:

1. The reject pocket.
2. The sort selection switch set on 5, which automatically sorts all cards into pocket 11.

After a card has been read, a test is made automatically for all acceptable combinations of information in the columns wired. If the edit test proves punching and machine operation to be satisfactory, the card is sorted into the proper pocket. Otherwise, the card moves into the reject pocket.

The control panel can be wired to stop the machine whenever a card is rejected. When any pocket is filled, the machine stops automatically.

Principles of Operation

This section describes the fundamental principles of operation for the following:

1. Normal Sorting
2. Edit Testing
3. Selective Sorting
4. Counting, Accumulating, and Printing
5. Summary Punching

The control panel (Figure 2) contains 64 columns of hubs numbered from 1 to 64 and 40 rows of hubs lettered *A* to *AN*. The location of a single hub can be identified by use of these coordinates. For example, sort hub 4 is located at coordinates *K*, 32.

The full-capacity machine (Model 1) has all the features shown on the control panel except the sample selector which is a special device. The smaller capacity machine (Model 2) has all the features that are not shaded.

The machine operates from electrical impulses which result from sensing the holes in a card. An impulse originates when a contact is made between a brush and a metal roll. Such a contact is possible when there is a hole in a card which is passing between the brush and the roll. The impulse travels by internal connections to the control panel, and, by means of external wires, it can be directed to perform the required operation.

There are two types of hubs on the control panel—exits and entries. An exit is one which emits an impulse. Some exits are under the control of the hole in the card, and others result from some function previously performed or are automatic for every card. An entry hub is one which can accept an impulse wired to it. A connection must always be made from an exit to an entry, by placing one end of a wire in the exit hub and the other end in the entry hub. Which exits and entries are used will depend entirely upon the job the machine is called upon to do. The control panel wiring may be changed to prepare each new report, thereby giving to one machine the flexibility to produce different reports for many different applications. Two or more hubs connected by lines are common, that is, two or more exits or entries serve the same purpose. Such an arrangement reduces the need for split wires (wires with more than two ends) since these hubs are actually connected together and serve the same purpose as split wires. An arrow between two hubs identifies them as a switch which is turned on by connecting the two hubs.

Distributing Units

The great flexibility of this machine is based upon the fact that information read at card reading 1 can be used to control three basic types of distributing units through which a sort or count impulse can pass. These distributing units are:

Column Distributors — 6 units
Recode Selectors — 60 units
Two-Column Distributor — 1 unit

The use of these distributing units will be explained singly or in combination in the examples to follow.

Path of Cards through the Machine

Cards are fed (Figure 3) from the hopper to card reading 1. At this station cards are normally read to control sorting and counting operations. After the card passes this station, the machine emits an edit-test impulse and then a sort and count impulse. The sort and count impulses are usually wired through distributing units. Counting takes place immediately but sorting is delayed until the card passes card reading 2.

Cards then pass card reading 2. At this station cards are normally read for group indication and accumulation. The sort impulse remembered from card reading 1 then directs the card to a sorting pocket.

Any card which is directed to a pocket by a sort impulse must go to that pocket. Otherwise, it is a missorted card and will be marked with a line on the back by a card marker.

Normal Sorting

Cards may be sorted normally, i. e., 9 cards into the 9 pocket, 8 cards into the 8 pocket, and so on. Blank cards will reject.

Normal Sorting on One Column

Normal numerical sorting is illustrated in Figure 4. For simplicity, only one column is used. The machine features required are: the sort selection switch, card reading 1, column distributor 1, and the sort hubs.

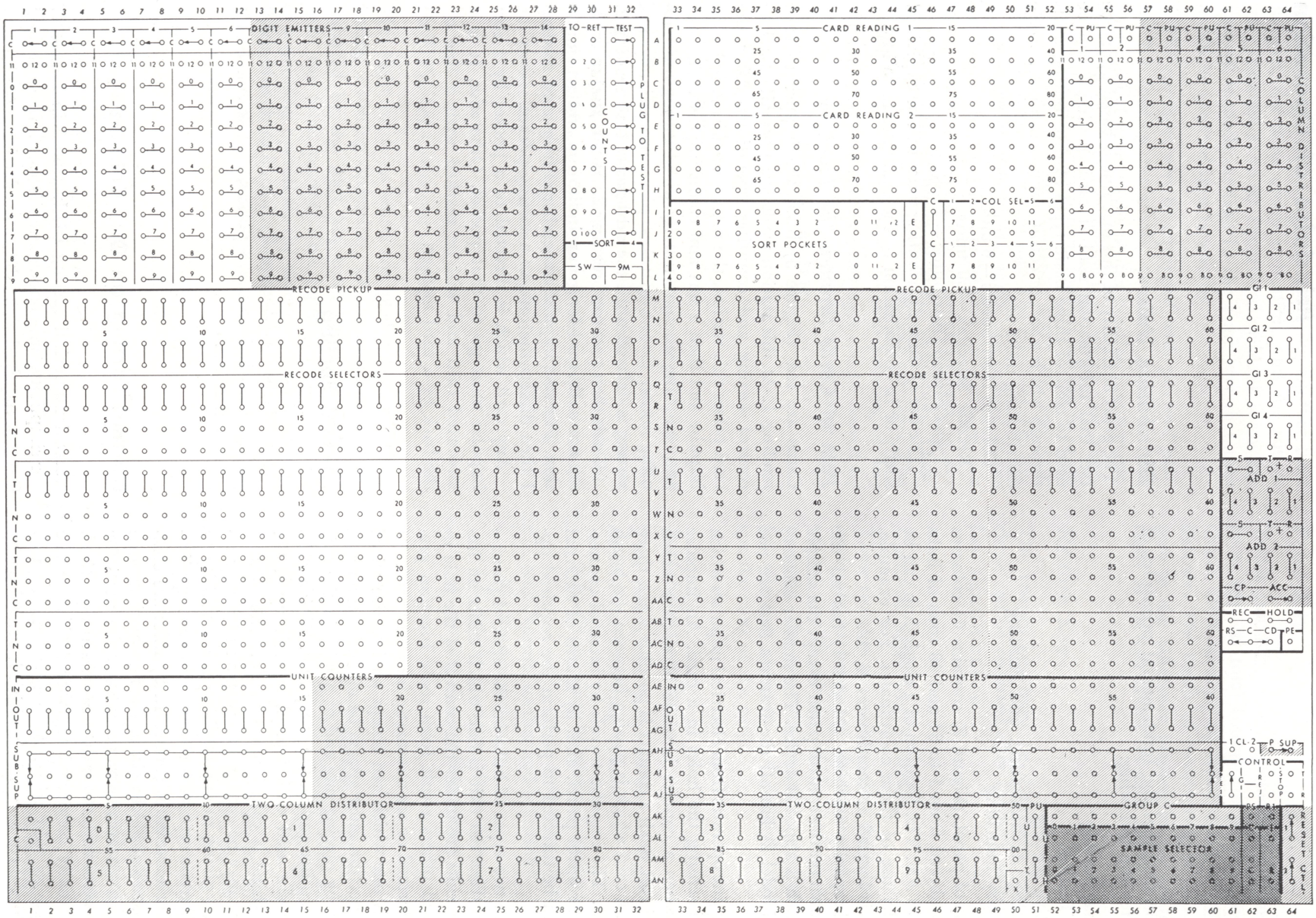


Figure 2. Control Panel

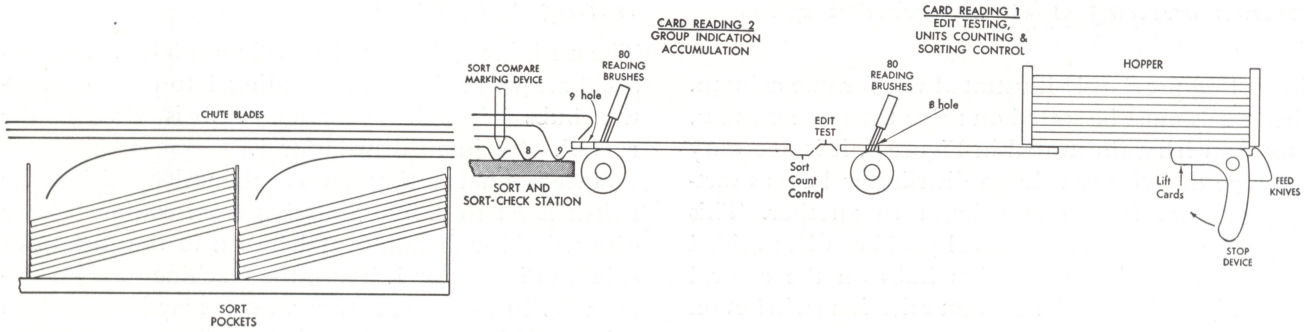


Figure 3. Path of Cards through the Machine

Since more than one pattern of sorting can be wired on one control panel, a sort selection switch is provided so that the operator can select the particular pattern desired for a given operation. To perform normal sorting, this switch must be set at N (normal sorting). Other settings of the switch will be described later.

Card Reading 1 (A-D, 33-52). These hubs are exits. They emit impulses corresponding to the information punched in each column of the card as it passes the first reading station. They are usually wired to the pickup hubs of column distributors, recode selectors, or the two-column distributor. For normal sorting, they are wired to column distributor 1 PU.

Column Distributor 1 (A-L, 53-54). When the sort selection switch is set on N (normal sorting) or NC (normal sorting and counting) an internal path is set up between digit exit hubs (9-12) in column distributor 1 and the corresponding pockets. For example, exit 0 is internally connected to pocket 0, exit 1 is internally connected to pocket 1, etc. Therefore, for normal sorting, all that is required is an impulse to the PU of column distributor 1 from the column to be sorted, and a sort impulse to the C hub of the same column distributor. It must be remembered that when column distributor 1 is used for normal sorting, the exit hubs on the control panel are inactive because the connections from exit hubs to the sort pockets are made internally.

Sort (K, 29-32). The four sort hubs supply sort impulses. Usually they are wired through distributing units. For normal sorting (sort selection switch on N) any of these hubs may be used.

Wiring (Figure 4)

1. The sort selection switch is set on N (normal).
2. The column to be sorted is wired to the PU hub of column distributor 1.
3. A sort impulse is wired to the C hub of the column distributor.

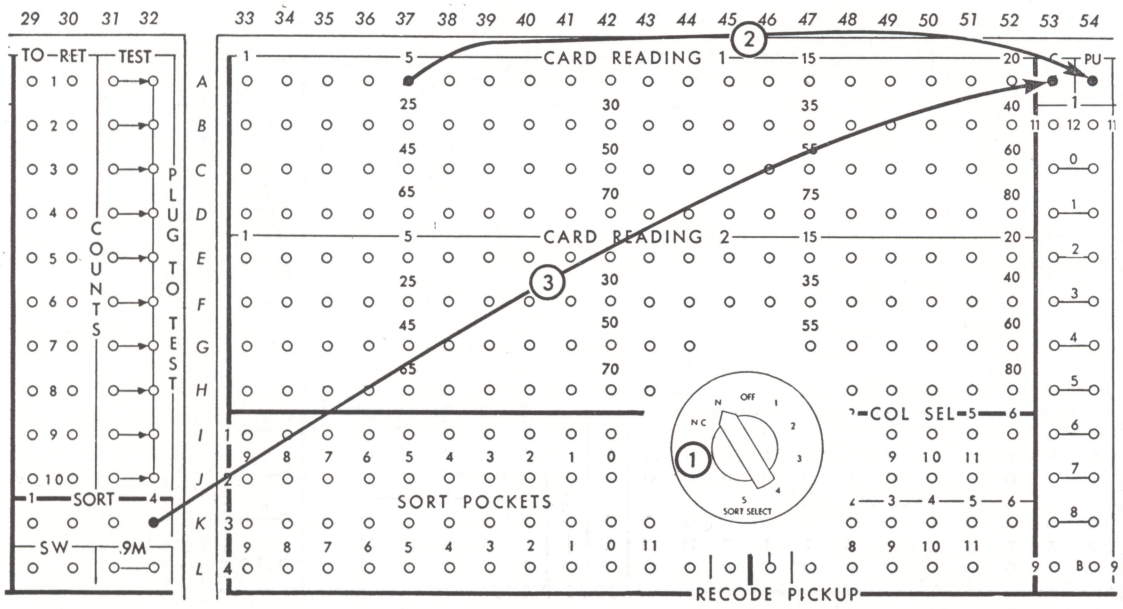
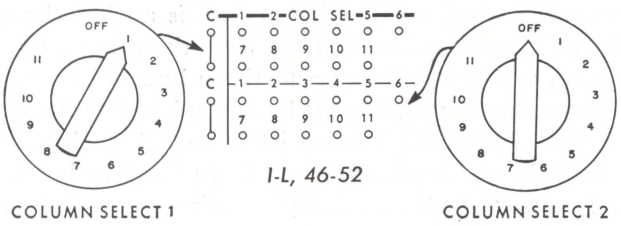


Figure 4. Normal Sorting on One Column

Normal Sorting a Three-Column Field

The sorting previously illustrated was for one column. When cards must be sorted on more than one column, using the wiring illustrated in Figure 4, it is necessary to change the wire to column distributor 1 PU as sorting progresses from one column to another. This changing of wires on the control panel can be avoided by use of the column selection hubs on the control panel (Figure 5) and the column selection switches on the machine.



Column Selection Switches (I-L, 46-52). The two column selection switches are manually operated selection devices. The left switch controls the top group of hubs on the control panel; the right switch controls the bottom group of hubs. These switches are set by the operator to select the column to be sorted. When a switch is set on a number, the corresponding control panel hub is connected to the C (common) hub for that switch. Only one hub is connected to C at any one time. If the switch is off, none of the hubs (1-11) is connected to C.

Impulses from card reading, emitter, control panel switches, etc., may be selected through these switches.

Wiring (Figure 5)

The cards are to be sorted on columns 36-38. Columns 36-38 are wired from card reading 1 to column selection hubs 1-3, and the common hub is wired to the PU hub of column distributor 1.

Since normal sorting starts at the units position, the switch is set to 3. The impulses from column 38 are directed through hub 3 and hub C to the pickup of column distributor 1. Thus, the machine sorts on column 38. In the same manner, cards may be sorted on column 37 by setting the switch on 2, and on column 36 by setting the switch on 1. Figure 5 shows that 11 columns may be wired using one column selection switch; 22 columns may be wired if both column selection switches are used. When both switches are to be used, connect the common hub of one switch to the common hub of the other and then wire one of them to the PU of the column distributor. When one switch is set on a number, the other must be set to the OFF position.

General Rule for Sorting

Depending upon the ingenuity used in wiring the control panel and the number of distributing units available to set up conditions, many unusual sorting and selecting operations can be performed. The following rule, however, must be kept in mind.

A card may be selected by information in the card itself or any card previous to it, but it cannot be selected by information in any card after it.

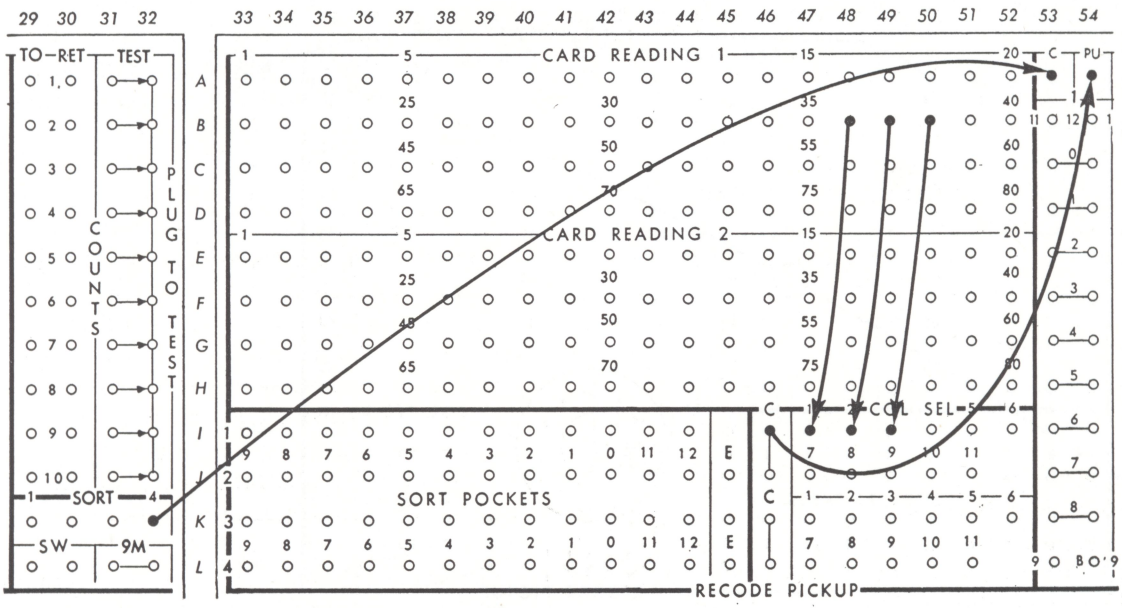


Figure 5. Normal Sorting a Three-Column Field

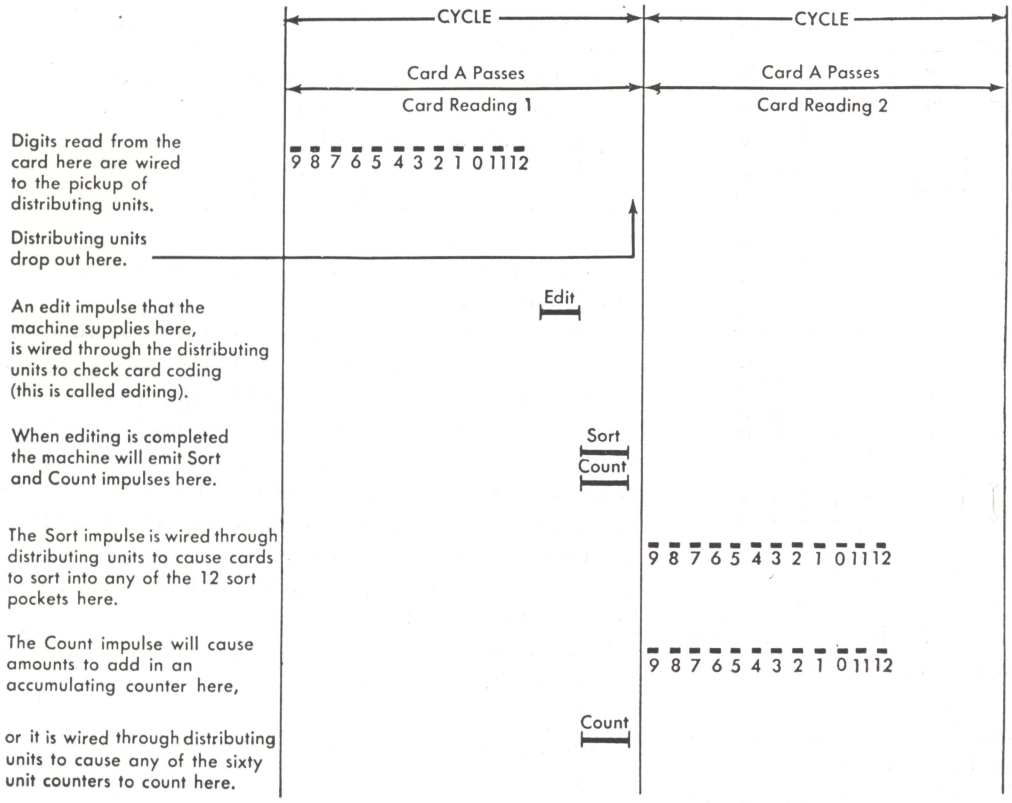


Figure 6. Schematic of Machine Operation

Edit Testing

Editing is a term borrowed from the publishing industry. Editors review, check and approve material before it is published. In much the same way, the 101 reviews, checks and approves any statistical fact (recognized by control panel wiring) before the fact is sorted or counted. This function of the 101 is known as "edit testing," and plays a major role in every operation performed. For normal sorting only, edit testing is automatic. For selective sorting or counting operations, edit testing must be wired on the control panel. Its purpose is to tell the machine that the set-up has been reviewed and found satisfactory and, therefore, to proceed with the operation of sorting. If the edit test discloses any errors or inconsistencies, either in punching or in control panel wiring, that card rejects for possible manual inspection and correction.

The edit test impulse starts slightly after the 12th row of the card has passed card reading 1. Edit testing is completed whenever the edit impulse reaches a PLUG TO TEST hub. It passes through the same network as the sort and count impulses. If the edit test impulse is completed satisfactorily through the network, and reaches PLUG TO TEST, editing is correct. The sort and count impulses start immediately thereafter and complete the operation. In other words, the test impulse first checks the path and if the path is satisfactory, it is cleared for the sort or count impulse. If the test impulse does not find a completed path through the network, the sort and count impulses do not occur. Consequently, the card is rejected without counting.

Edit Test Impulse

The edit test impulse may originate at either the SORT hubs, or at COUNTS TO hub 1 (A-J, 29-30; Figure 7), depending upon the setting of the sort selection switch. When the sort switch is set on N, NC, 2, 3, or 4, edit test impulses originate at all four of the sort hubs. When the sort selection switch is set on 1, the edit test impulse originates at the number 4 sort hub only; this is explained under "Pre-editing Multiple Sorts." When the sort switch is set on 5, the edit test impulse originates at COUNTS TO hub 1. This impulse passes through distributing units, counters, and sort pockets to check codes before cards are either sorted or counted.

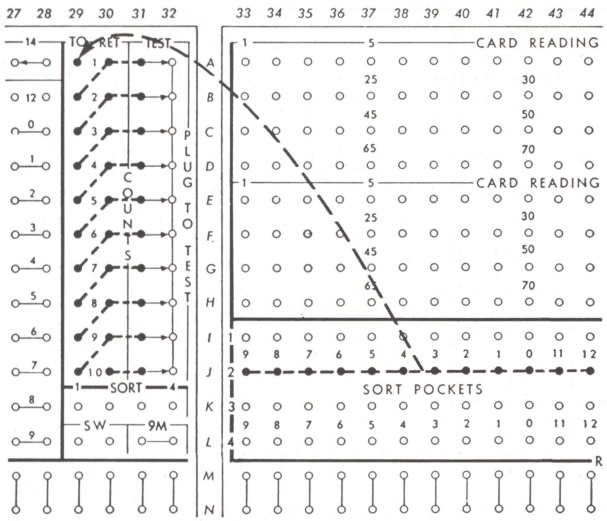


Figure 7

When wired for normal sorting, edit testing is automatically completed whenever the column being sorted is punched 9-12.

When the sort selection switch is set on 1, 2, 3, or 4, an edit impulse reaching a sort pocket row corresponding to the switch setting will be internally directed to COUNTS TO hub 1. Notice that if an edit impulse reaches a sort pocket row it means that sorting has been correctly edited. Therefore the edit impulse is continued to COUNTS TO hub 1 so that counting may be edited before either sorting or counting occurs. In selective sorting operations, editing is concluded at this point by wiring COUNTS TO hub 1 to PLUG TO TEST. In combined sorting and counting operations, editing is continued for the count wiring.

When the sort switch is set at NC, the edit impulse reaches the C hub of column distributor 1 and comes out of COUNTS TO hub 1 if the column being sorted is punched 9-12.

To count cards without sorting, the sort selection switch is set at 5 which sorts all edited cards into the 11 pocket. Since all edited cards sort into the 11 pocket, the sort hubs are inactive. Therefore, the edit impulse originates at COUNTS TO hub 1. The COUNTS TO, RETURN, TEST, and PLUG TO TEST hubs are used to edit counting. COUNTS TO hub 1 emits an edit test impulse whenever the sort selection switch is set on 5; it also emits when the switch is set on NC, 1, 2, 3, or 4, provided sorting was edited correctly. This hub does not emit an edit impulse when the sort switch is on N.

The internal connections shown by dotted lines (Figure 7, sort selection switch on 2) are made until editing is completed.

The edit impulse from the first COUNTS TO hub is wired to counter IN. It comes out of the counter OUT hub and reaches return. The edit impulse is then available out of the TEST hub and the next COUNTS TO hub. Editing may be completed at this point by wiring TEST TO PLUG TO TEST, or may be continued for the next count by using the next COUNTS TO hub. Editing may be continued for all ten count classifications, or may be ended after any of them.

Neither the COUNTS TO nor the SORT hubs emit count or sort impulses unless editing has been completed; thus, *until editing is completed, cards can neither sort nor count.*

Once editing is completed, all ten COUNTS TO hubs emit count impulses. The internal connections shown are broken, and the RETURN hubs are a path to the fuse, so that a count impulse passing through a unit counter can reach the fuse to cause counting. This is the reason that a *counts-to hub cannot be wired directly to a return hub* — it would be the same as a short circuit and blow a fuse.

Once editing is completed, the sort hubs emit sort impulses as follows:

Sort selection switch on N, NC, 2, 3, or 4 — Sort hubs 1-4 emit.

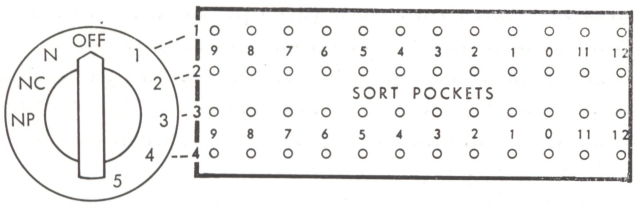
Sort selection switch on 1 — Sort hubs 1 and 4 emit. Sort hubs 2 and 3 may emit, provided a sort impulse is wired to the next higher-numbered sort row.

Selective Sorting

Selective sorting directs cards to one or more pockets desired, by the conditions wired on the control panel. For example, cards with a 9 punch can be sorted to pocket 4, cards punched 2689 can be sorted to pocket 1 and so on, on a single pass through the machine. In the previous examples, normal sorting was accomplished by use of column distributor 1, which is internally arranged to sort the cards in their corresponding pockets. For normal sorting, the sort selection switch must be set on N; for normal sorting and counting, the sort selection switch must be set on NC. For selective sorting, the switch is set on 1, 2, 3, or 4 and sorting must be controlled by control panel wiring.

Sorting Cards into One Pocket

If the sort impulse is wired directly to sort pocket 4, row 2, as in Figure 9, all cards will sort into the 4th pocket when the sort selection switch is set on 2. This operation would normally be used in conjunction with counting.



Sort Pockets (I-L, 33-44). When the sort selection switch is set on 1, 2, 3, or 4, the corresponding sort pocket rows are active as shown in the previous diagram. When a row is active, a sort impulse wired to a hub in that row causes the card to sort into the corresponding pocket. When the sort selection switch is set on N, NC, or 5, none of the sort pocket rows is active.

Sort pocket hubs provide four different pocket entries under control of the sort selection switch. This allows the operator to change sorting arrangements with a maximum of four different patterns. Since the impulses from the sort hubs differ for the various sort selection switch settings, refer to the chart in Figure 8.

Figure 8 shows which hubs are active or receptive for different sort selection switch settings.

Sort Selection Switch Setting	Sort Pocket Receptive Row	Sort Hubs Active	Group Indicate Hubs Active
1	1	1 & 4*	None
2	2	1 to 4	1
3	3	1 to 4	2
4	4	1 to 4	3
5	11 Pocket	None	4
N	None	1 to 4	None
NC	None	1 to 4	None
NP	None	1 to 4**	None

* Only the 4 hub is active for edit; 1 and 4 hubs are active for sorting.
** These hubs are active but not useful on this setting.

Figure 8. Sort Selection Switch Table

Wiring (Figure 9)

1. A sort hub is wired to pocket 4, row 2. Because row 2 is used, the sort selection switch must be set on 2 in order to make hubs in that row receptive.

2. Editing is concluded at this point by wiring COUNTS TO hub 1 TO PLUG TO TEST.

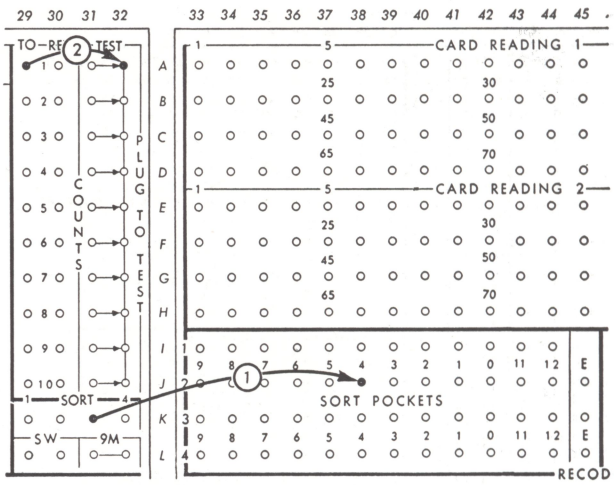


Figure 9. Sorting All Cards into One Pocket

Sorting Punched Cards into One Pocket, Rejecting Unpunched Cards

Usually, the sort impulse is wired through distributing units of one kind or another so that cards of any code or combination of codes may be sorted into any of the 12 pockets. For example, cards punched in column 25 may be directed to sort in pocket 6, as illustrated in Figure 10. Cards blank in column 25 are rejected. The distributing unit used in this example is a recode selector.

Recode Selectors (M-AD, 1-60). Recode selectors are similar in purpose to selectors on other IBM machines. In the 101 machine, recode selectors are normally used to select sort or count impulses. Each recode selector has two pickups and four sets of common, normal and transfer hubs. When both the upper and lower pickup hubs are impulsed at the same time, a recode selector transfers one card punching position later and remains transferred up to 342° of that cycle. For example, a selector picked up at 9 time is transferred by 8 time. Therefore, the same impulse that picks up a recode selector is able to pass through the selector's normal side, but cannot pass through its transferred side. When a recode selector is transferred, C and T are internally connected so that a sort or count impulse entering C is available out of T. When a recode selector is not transferred, C and N are internally connected so that a sort or count impulse entering C is available out of N. An impulse should not be routed through more than 75 selector points.

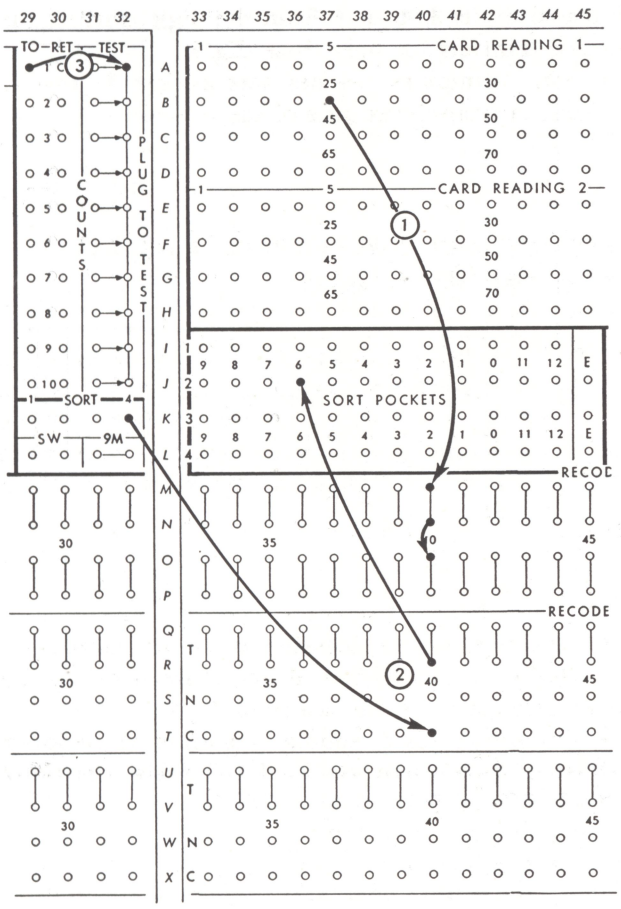


Figure 10. Sorting Punched Cards into One Pocket, Rejecting Unpunched Cards

Wiring (Figure 10)

1. Column 25 (card reading 1) is wired to both the upper and lower pickups of recode selector 40. Therefore, the selector transfers whenever column 25 is punched, because the same impulse reaches both pickups at the same time. The selector remains normal when column 25 is blank.

2. Sort hub 4 reaches hub 6, row 2, through the transferred side of the selector. Therefore, all cards punched in column 25 sort in pocket 6; all cards blank in column 25 sort in the reject pocket. Because row 2 is used, the sort selection switch must be set on 2.

3. Editing is concluded at this point.

Sorting Cards Punched with Specific Digits into One Pocket

Cards punched with specific digits may be selected, using the digit emitters. The digit emitters may be used as either digit emitters, or as digit selectors. Figures 11 and 12 show how cards punched 3, 4, or 5 in column 30 can be selected into pocket 1.

Digit Emitters (A-L, 1-28). Digit emitters are similar to digit selectors on other IBM machines. Each emitter has a common entry hub (C) and 12 exit hubs (9-12). When used as digit selectors, the C hub is wired from a card reading hub; when used as digit emitters, the C hub is jackplugged from the hub on the right. This hub emits impulses from 9-12 for each card, and is similar to a digit impulse hub on other IBM machines. The purpose of a digit emitter is to separate multiple

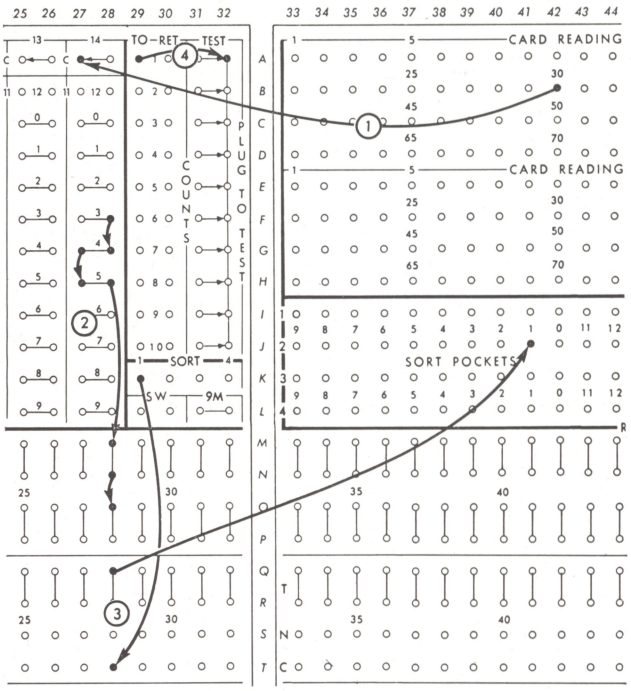


Figure 11. Digit Selector Method

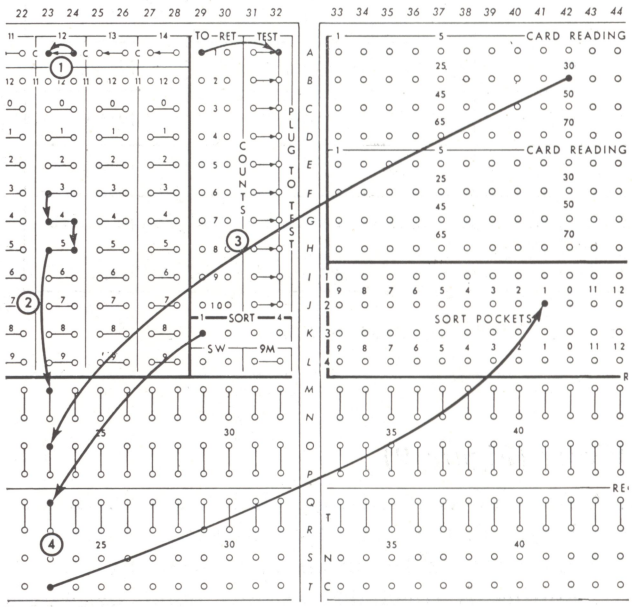


Figure 12. Digit Emitter Method

digit impulses, whether from a card column or from the DI hub, in order that specific digits may be used to perform different functions.

Wiring (Figure 11)

1. The C hub of digit emitter 14 is wired from column 30, card reading 1.

2. Digits 3, 4, and 5 are wired to the upper and lower pickup hubs of recode selector 28. Only cards punched 3, 4, or 5 transfer the selector.

3. Sort 1 impulse reaches sort pocket 1, row 2, through the transferred side of the selector.

4. Editing is concluded at this point.

Wiring (Figure 12)

1. DI is wired to the C hub of digit emitter 12. Exits 9-12 emit impulses for every card.

2. Digits 3, 4, and 5 are wired to the upper pickup of recode selector 23.

3. Card column 30 is wired to the lower pickup of recode selector 23. Because digits 3, 4, or 5 in column 30 match digits 3, 4, or 5 from the digit emitter, the selector transfers for only these digits.

4. Sort 1 impulse reaches sort pocket 1, row 2, through the transferred side of the selector.

Sorting Cards into Various Pockets Using Recode Selectors

In Figure 13, cards punched 12, 11, 0, 7, 8, and 9 in column 15 sort into the corresponding pockets. Cards punched 1, 2, 3, 4, 5, or 6 sort into pocket 5. Cards blank in column 15 sort into pocket 3. The same operation can be done using one column distributor as shown in Figure 15.

Wiring (Figure 13)

1. The digit emitter is wired as a digit emitter.

2. Digits 12, 11, 0, 1-6, 7, 8, and 9 are wired to the upper pickups of recode selectors 21-27.

3. Column 15 (card reading 1) is wired to the lower pickups of recode selectors 21-27. The selectors trans

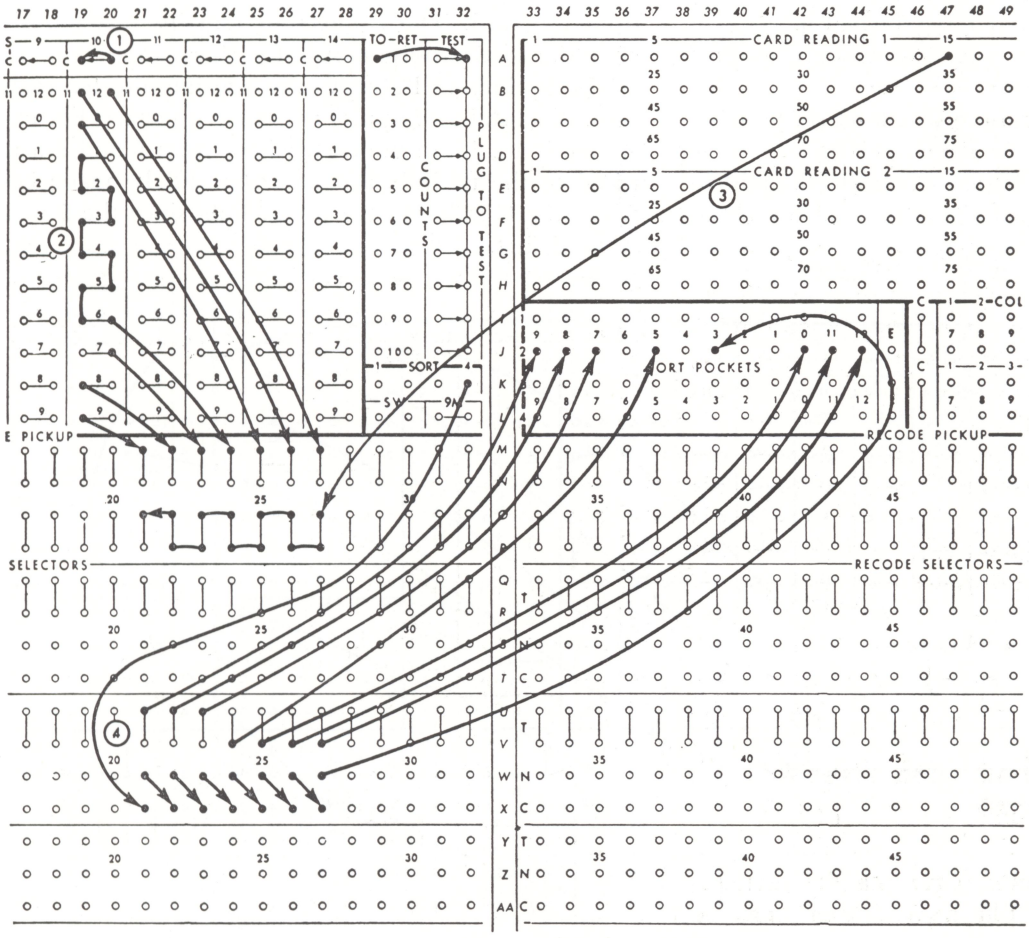


Figure 13. Sorting Cards into Various Pockets Using Recode Selectors

fer when a digit read from column 15 matches an emitted digit.

4. If recode selector 21 transfers, the card is punched 9 in column 15. Sort 4 passes through the transferred side of the selector and reaches sort pocket 9, row 2. If recode selector 22 transfers, the card is punched 8 in column 15. Sort 4 then passes through the normal side of selector 21 and the transferred side of selector 22 and reaches sort pocket 8, row 2. If all recode selectors are normal, the card is blank in column 15, and sort 4 passes through the normal side of all the selectors and reaches sort pocket 3, row 2. If this wire were omitted, blank cards would reject.

Summary of Recode Selector Pickup

Figure 14 summarizes the various methods of transferring recode selectors.

1. Recode selector 5 transfers whenever column 9 is punched. The selector is normal if column 9 is blank.

2. Recode selector 9 transfers whenever column 7 is punched 6. The selector is normal for all other digits.

3. Alternate method (dotted wiring) for transferring a selector when column 7 is punched 6.

4. Recode selector 15 transfers whenever column 5 is punched 12, 1, 4, 7, or 8.

5. Recode selector 20 transfers whenever the punches in columns 21 and 45 of the same card agree.

6. Recode selector 25 transfers whenever the punching in column 70 of one card agrees with the punching in column 70 of the preceding card.

Sorting Cards into Various Pockets Using a Column Distributor

As previously explained, only column distributor 1 is internally arranged to permit normal sorting without any control panel wiring from exits to sort pockets. For operations other than normal sorting, all column distributors in the machine may be used as distributing units by control panel wiring.

Column Distributor (A-L, 53-64). Each column distributor has a pickup hub (PU), a common entry hub (C), and 13 exit hubs (9-12 and blank). The PU hub is usually wired from card reading 1. The common entry hub is wired from either a sort or a count hub. The exit hubs are usually wired to sort pockets or counters.

When column distributor PU is impulsed by a digit 9-12, the C hub is internally connected to the correspondingly-numbered exit hub. If the PU hub is not impulsed, the C hub is internally connected to the blank hub (B). For example, if a 5 impulse from card reading 1 is wired to the PU hub of a column distributor, the 5 exit and the C hub are internally connected so that a sort impulse wired into the C hub will come out of the 5 exit hub. The connection between C and 5 is made after the 5 is read, but before a 4 is read from the card. The connection remains made until after the sort impulse occurs for that card.

The PU hub will accept only one impulse for each card. A second PU impulse will have no effect. For example, if a column punched with both a 5 and a 3 is wired to the PU hub, a connection will be made between the C hub and the 5 exit hub, since the 5 will be read first.

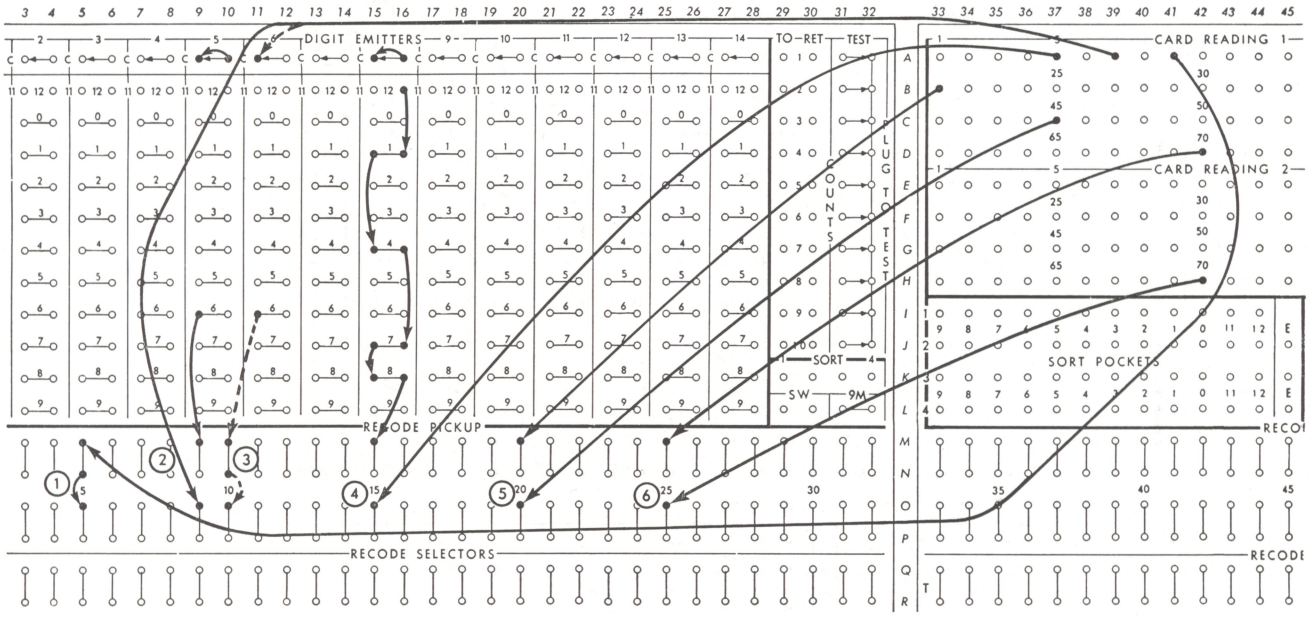


Figure 14. Recode Selector Pickup

Wiring (Figure 15)

1. Column distributor PU is wired from column 15.
2. Sort hub 2 is wired to the C hub.
3. Exit hubs 12, 11, 0, 7, 8, and 9 are wired to the corresponding pockets. Exit hubs 1, 2, 3, 4, 5, and 6 are wired together and to pocket 5. The B hub is wired to pocket 3. The sort impulse wired into the C hub will come out the exit hub corresponding to the pickup. For example, if the PU hub is impulsed by a 7, the sort impulse will come out of the 7 exit hub and cause the card to sort into pocket 7.
4. Sort selection switch is set on 4.

Sorting Cards into Various Pockets Using the Two-Column Distributor

The two-column distributor is used to analyze any two columns of the card for control of either sorting or counting. It consists of a common entry hub, two pickup hubs, and 111 exit hubs.

The two-column distributor is used in Figure 16 to control sorting by age groups. Age is punched in columns 59 and 60 as follows:

X	Age unknown
00	Less than one year
01	One year
02	Two years
etc.	
99	Ninety-nine years

The following sorting is desired:

X	Pocket 11
00	Pocket 9
01-04	Pocket 7
05-12	Pocket 5
13-19	Pocket 3
20-39	Pocket 1
40-49	Pocket 0
Over 49	Reject

Two-Column Distributor (AK-AN, 1-51; AK, 52-61)

C (Common). This entry hub usually is wired from either a sort or a count hub. An impulse received at the C hub will be emitted from one or more exits hubs (00-99, X, and group C 0-9), depending upon the impulses received by the UNITS and TENS pickup hubs.

Units and Tens Pickups. These hubs are wired from card reading 1. The units pickup hub will accept digits 9-0. The tens pickup hub will accept digits 9-0 and X impulses. The pickup hubs will accept only one impulse for each card; a second impulse will have no effect.

When both the units and tens pickup hubs are impulsed, a sort or count impulse wired into the common entry hub will come out of the exit hub (00-99) corresponding to the pickup impulses.

Exit Hubs, 01-99 & 00. These hubs emit the impulse received by the common entry hub, provided both the units and tens pickup hubs have been impulsed.

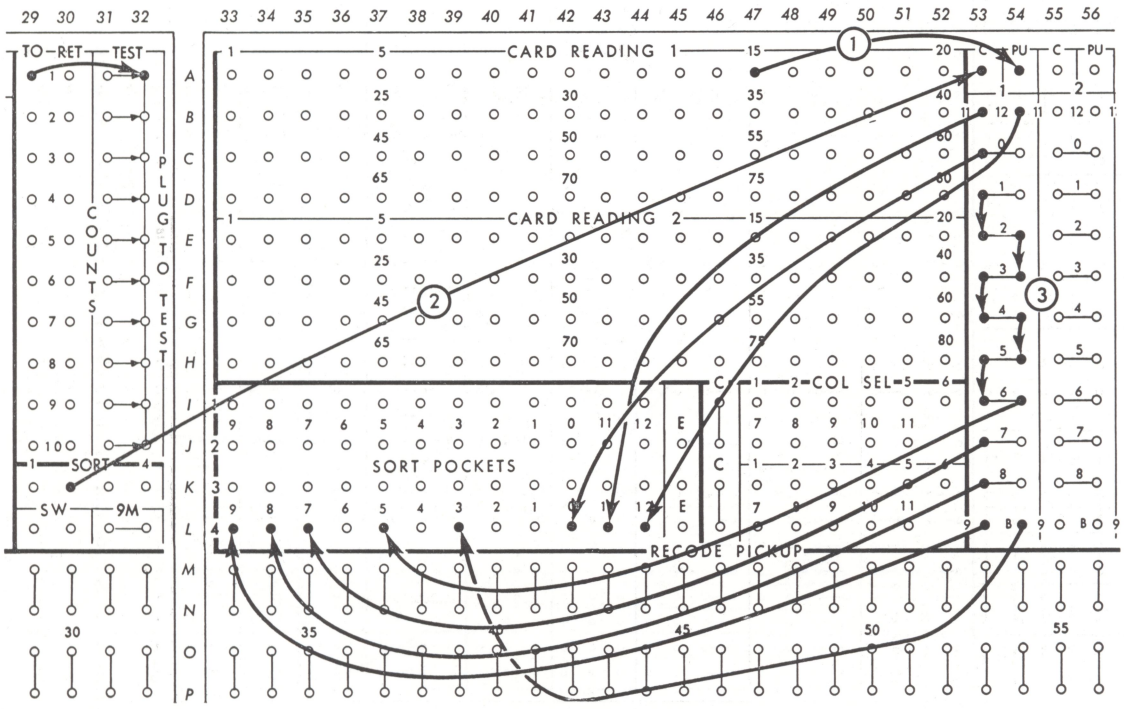


Figure 15. Sorting Cards into Various Pockets Using a Column Distributor

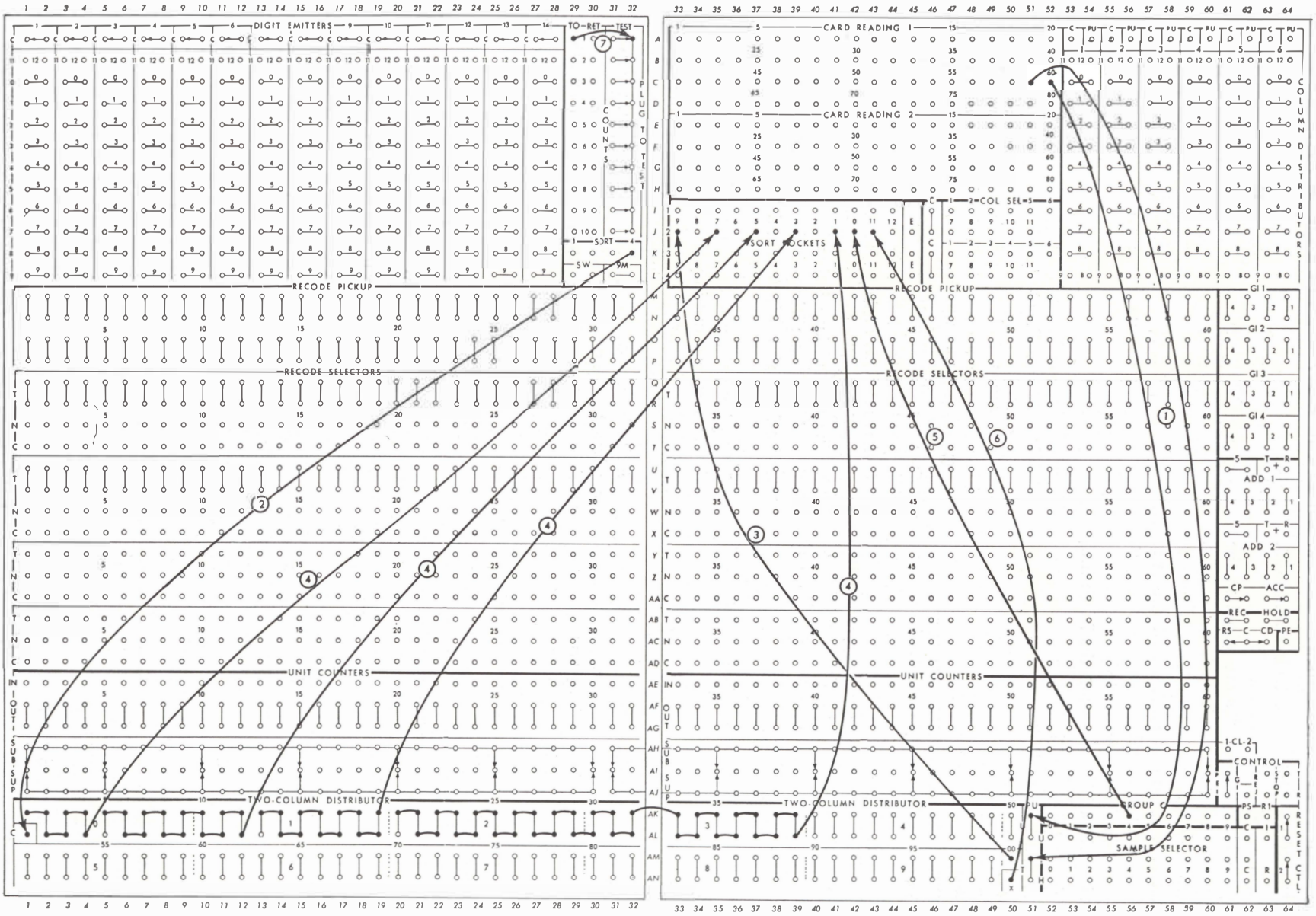


Figure 16. Sorting Cards into Various Pockets Using the Two-Column Distributor

Which exit hub emits is controlled by the units and tens pickup. For example, if the units pickup is impulsed by a 5 and the tens pickup is impulsed by a 2, exit hub 25 will be internally connected to the C hub and will, therefore, emit the impulse wired into the C hub.

Group C, 0-9. Whenever the tens pickup hub receives an impulse from the 0-9, the corresponding group C hub is connected to the common entry hub. Therefore, the group C hub corresponding to the tens pickup will emit the impulse wired into the common entry hub. For example, if the tens pickup receives a 7 impulse, a sort or count impulse wired into the common entry hub will come out of the 7 group C hub.

X. The X hub is connected to the common entry hub whenever the tens pickup hub receives an X impulse. This hub is usually used to control either sorting or counting when a field is X-skipped.

The basic principles of the two-column distributor are described above. Because of the flexibility of this feature, the more advanced principles are described under "Operating Suggestions."

Wiring (Figure 16)

1. The units and tens position of age (columns 59-60) are wired to the units and tens pickup hubs of the two-column distributor.

2. Sort hub 4 is wired to the common entry hub.

3. If columns 59 and 60 are punched 00, the sort impulse wired into common entry will come out of the 00 hub and cause the cards to sort into pocket 9.

4. If columns 59 and 60 are punched 01-04, the sort impulse wired into the common entry hub will come out of one of the exit hubs 01-04. Because these exit hubs are wired together and to the 7 pocket, any card punched 01-04 will sort into pocket 7. Cards are sorted into pocket 5, 3, or 1 in a similar manner.

5. Group C hub 4 is connected to the common entry hub if the tens pickup hub receives a 4 impulse. Therefore, group C hub 4 will emit a sort impulse for all cards punched 4 in column 59. Cards punched 40-49 will sort into pocket 0.

6. If column 59 is X punched, the card sorts into pocket 11.

7. Editing is concluded at this point.

Sort Comparing

The 101 is equipped with a sort comparing feature. The purpose of this feature is to check that cards sort into the proper pockets, as directed by control panel wiring. This is necessary because sight checking is not possible while selective sorting, because any card or any combination of cards may be directed into any pocket. If a card missorts the machine stops, the sort comparing light turns on, and the missorted card is marked on the back with a vertical line. The machine is restarted by depressing the restore key and then the start key.

Because the machine does not stop immediately, the missorted card may be in a sort pocket, or may be in the chute blades waiting to go into a sort pocket.

Counting, Accumulating and Printing

Because accumulated amounts, group indications, and unit counts always print in fixed positions on a report form, the column arrangement in designing a report form is quite standard. The only difference between one design and another, therefore, is the width of the form and column headings.

Figure 17 illustrates the standard column arrangement of any report form. The first column is used to print 8- or 12-position totals from accumulating

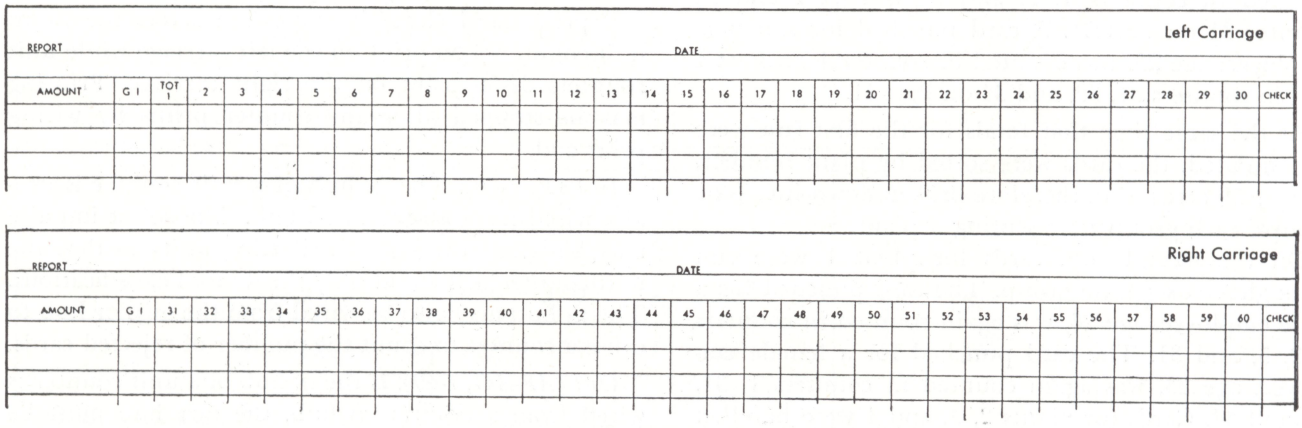


Figure 17. Standard Report Form

counters. The second column is used to print numerical group indications. The third column is used to print a total card count from unit counter 1. The rest of the counter columns (2-30) are used to print totals from counters 2-30. The last column is used to print a zero check signal or a difference, indicating that the totals printed on that line either crossfoot-check or do not balance. When less than 30 unit counters are used, the zero check symbol prints in the column after the last unit counter used. This arrangement applies to any form prepared on the left carriage.

The same column arrangement applies to the right carriage, except that the 30 unit counts print from unit counters 31-60 instead of from 1-30. A pluggable switch (AH, 63-64) can be used to suppress printing on the right carriage.

The 60 unit counter machines are equipped with two printing carriages. Printing in each column is done by one set of four type bars for the left carriage and another set of four type bars for the right carriage. As totals are printed from left to right, both carriages move together from one column of the report to the next. Thus, unit counter 1 and unit counter 31 print at the same time, but on two different forms.

On the smaller 15 counter machine, only the right carriage is supplied.

Figure 18 illustrates a two-part statistical report. Part I was prepared on the left carriage, and Part II was prepared on the right carriage.

The report was prepared by running 8,359 payroll earnings cards. Each card contained earnings, sex, plant, and age.

It was necessary to run the cards through the machine twice. On the first run, earnings for males were accumulated in the first accumulating counter and printed on Part I; earnings for females were accumulated in the second accumulating counter and printed on Part II. Each card was counted in four counters. For example, a card for a male employee, age 26, was counted in counters 1, 2, and 5 on Part I and in counter 31 on Part II. A card punched for a female employee, age 23, was counted in counter 1 on Part I and in counters 31, 32, and 34 on Part II.

At the same time that totals for the first run were accumulated, the cards were sorted by plant number. The 8,359 cards were therefore broken down into four groups, each group representing a plant.

On the second run, cards for plant 1 were run through as a separate group. The card punched for a male employee, age 26, was again counted in counters 1, 2, 5, and 31. The card punched for a female employee, age 23, was again counted in counters 1, 31, 32, and 34. Cards for plants 2, 3, and 4 were handled in a similar manner.

If further breakdowns were desired by other classifications, for example by marital status, the cards would be sorted into marital status groups during the second run. A third run would then be necessary to count each group by marital status.

NP—Sort Selection Switch

Before starting any counting operation, it is normal procedure to take a print cycle to clear the counters. This is necessary to make sure that no totals were left in the machine from a previous operation. All counters must be wired from the TO to the IN hubs, and from the OUT hubs to RETURN. Setting the sort selection switch to NP suppresses printing and depressing the print key clears the counters.

Counting All Cards

The number of cards in a file may be counted, using the wiring shown in Figure 19. The sort selection switch is set on 5 so that all the cards will sort into pocket 11.

Unit Counters

Each unit counter can add 1 as each card feeds, and is internally wired to print a 4-position total. Counter 1 is equipped with a count-limiting feature that forces a total print cycle whenever it reaches 9992. Thus, all other counters can be prevented from exceeding their capacities by wiring this counter to the highest count expected, usually a total card count. For reliability, no more than 15 counters should add on any one card cycle, and no more than five unit counters should be coupled for the return connection to the test hubs when they add on one card cycle.

When the print key is depressed, each unit counter will print (and clear) in succession across the form; unit counters 1-30 print on the left carriage while unit counters 31-60 print on the right carriage. Printing may be stopped after any counter prints by wiring print end.

In (AE, 1-60). The IN hub of a unit counter is usually wired from a COUNTS TO hub. The count impulse may be wired through distributing units so that the unit counter will count only the desired classifications. The IN hub may also be wired from the REJECT hub to cause a counter to count the number of rejected cards.

Out (AF-AG, 1-60). If the IN hub of a unit counter is wired from a COUNTS TO hub, the OUT hub must be wired to the corresponding RETURN hub, either directly

or through the common hubs of other counter OUT positions. If the IN hub is wired from the T REJ hub, the OUT hub is wired to the R REJECT hub.

Counts To (A-J, 29). These hubs may be used to cause counting when the sort selection switch is set on NC, 1, 2, 3, 4, or 5. They do not operate when the sort selection switch is set on N. They are wired to the IN hubs of unit counters, either directly to count all cards or through distributing units to count only certain classifications. The hubs must be used in sequence, starting with number 1. A different COUNTS TO hub is used for each major classification (or breakdown) being counted. In Figure 18, for example, the COUNTS TO hubs would be used as follows: COUNTS TO hub 1 would be wired to cause counting in both counters 1 and 31; COUNTS TO hub 2 would be wired through recode selectors so that it would count males in counter 2 or females in counter 32; COUNTS TO hub 3 would be wired first through age-group distributors and then through male-female recode selectors to count males in one of

General Mfg. Corp. Endicott, N. Y. — Part I — Left Carriage

Report — Employees By Plant and Age Group — Male

Total Earnings — Male	Plant No.	Total Male and Female	Total Male	Male Age Groups 15-19	20-24	25-29	30-39	40-49	50-59	60-64	65 And Over	0 Check
		1	2	3	4	5	6	7	8	9	10	11
44511497		8359	6182	160	875	902	1184	1881	895	283	2	0
← Accm. Counter →	Group Indic.	←				Unit Counters						→
21811143	1	4096	3029	78	429	442	580	922	438	139	1	0
10682519	2	2006	1484	38	210	216	286	451	215	68		0
9792301	3	1839	1360	35	192	199	261	414	197	62		0
2225534	4	418	309	9	44	45	57	94	45	14	1	0

General Mfg. Corp. Endicott, N. Y — Part II — Right Carriage

Report — Employees By Plant and Age Group — Female

Total Earnings — Female	Plant No.	Total Male and Female	Total Female	Female Age Groups 15-19	20-24	25-29	30-39	40-49	50-59	60-64	65 and Over	0 Check
		31	32	33	34	35	36	37	38	39	40	41
14803614		8359	2177	26	372	281	298	711	460	29		0
← Accm. Counter →	Group Indic.	←				Unit Counters						→
7456771	1	4096	1067	13	182	138	146	348	225	15		0
3649070	2	2006	522	6	89	67	72	171	111	6		0
3586451	3	1839	479	6	82	62	65	157	101	6		0
111322	4	418	109	1	19	14	15	35	23	2		0

Figure 18. A Two-Part Statistical Report

the counters 3-10, or females in one of the counters 33-40.

Counts Return (A-J, 30). The RETURN hubs are wired from the unit counter OUT hubs. Usually, a COUNTS TO hub is selected so that it will count in any one of several counters. The OUT hubs of all these counters are connected together and are wired back to the RETURN hub corresponding to the COUNTS TO hub. COUNTS TO *hubs should not be wired directly to* RETURN *as this will blow a fuse.*

A counter will count, print, and clear only when its OUT hub is wired to RETURN. The wire from a COUNTER OUT TO RETURN should not be selected, since the various distributing units on this machine normally do not remain operative during printing.

Test; Plug to Test (A-J, 31-32). COUNTS TO and COUNTS RETURN hubs are not active unless TEST is wired to PLUG TO TEST. Only one TEST hub is wired to one PLUG TO TEST for any one control panel. Normally, the connection is made in the row of hubs corresponding to the last COUNTS TO and RETURN hubs used. For example, if COUNTS TO and RETURN 1 to 5 are used, the plug to test connection is made in row 5. This puts counts 1 to 5 under control of an internal test. For a given card all five counts must be active in order for the card to be sorted and counted. If any one of the five counts fails, either because of elimination through the distributing units or because of machine failure, all five counts are inactive and the card is rejected. COUNT TO and RETURN hubs below the TEST position wired may be used, but they are not included in the test. Additional information is given in the section on "Operating Suggestions."

Wiring (Figure 19)

1. COUNTS TO hub 1 is wired to the IN hub of unit counter 1. The OUT hub of unit counter 1 is wired to RETURN.

2. Test is wired to PLUG TO TEST for the last COUNTS TO and RETURN hubs used.

Counting by Two Classifications

Figure 20 shows the control panel wiring for a report in which total population, the number of males, and the number of females are counted. The sort selection switch is set on 2 and the cards are sorted into pocket 6.

Wiring (Figure 20)

1. All the cards will sort into pocket 6, provided they also count.

2. The total population is counted in unit counter 1.

3. Recode selector 20 picks up when there is a 1 code (male) in column 5. Recode selector 22 picks up when there is a 2 code (female) in column 5.

4. COUNTS TO hub 2 is wired through the transferred side of selector 22 and counts the number of females in unit counter 5. It is wired through the normal side of selector 22 and through the transferred side of selector 20 to count the number of males in unit counter 3. The OUT hubs of unit counters 3 and 5 are wired back to RETURN.

5. TEST is wired to PLUG TO TEST for the last COUNTS TO and RETURN hubs used.

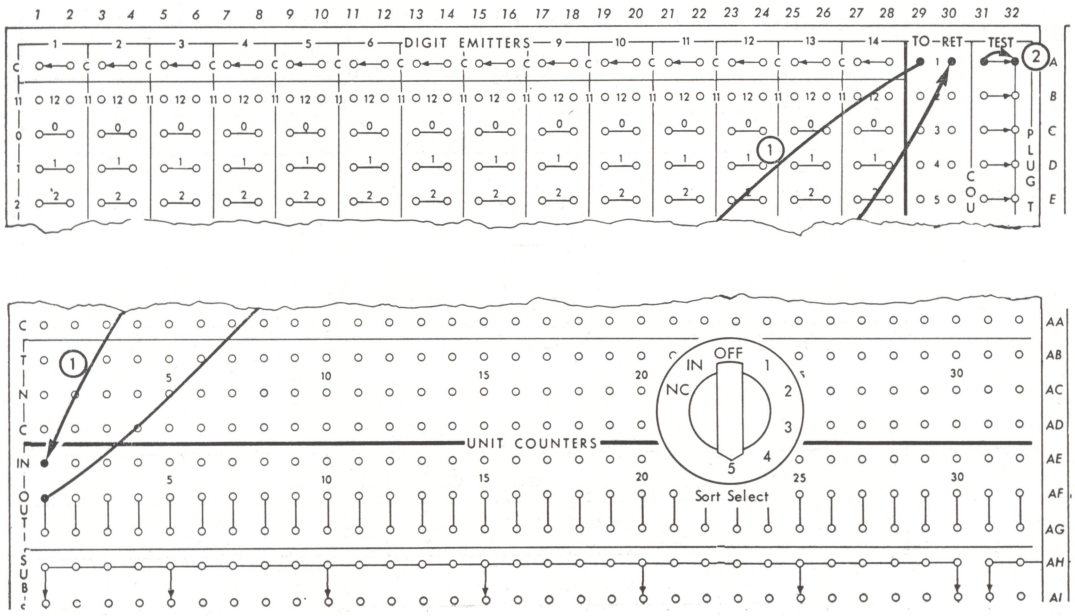


Figure 19. Counting All Cards

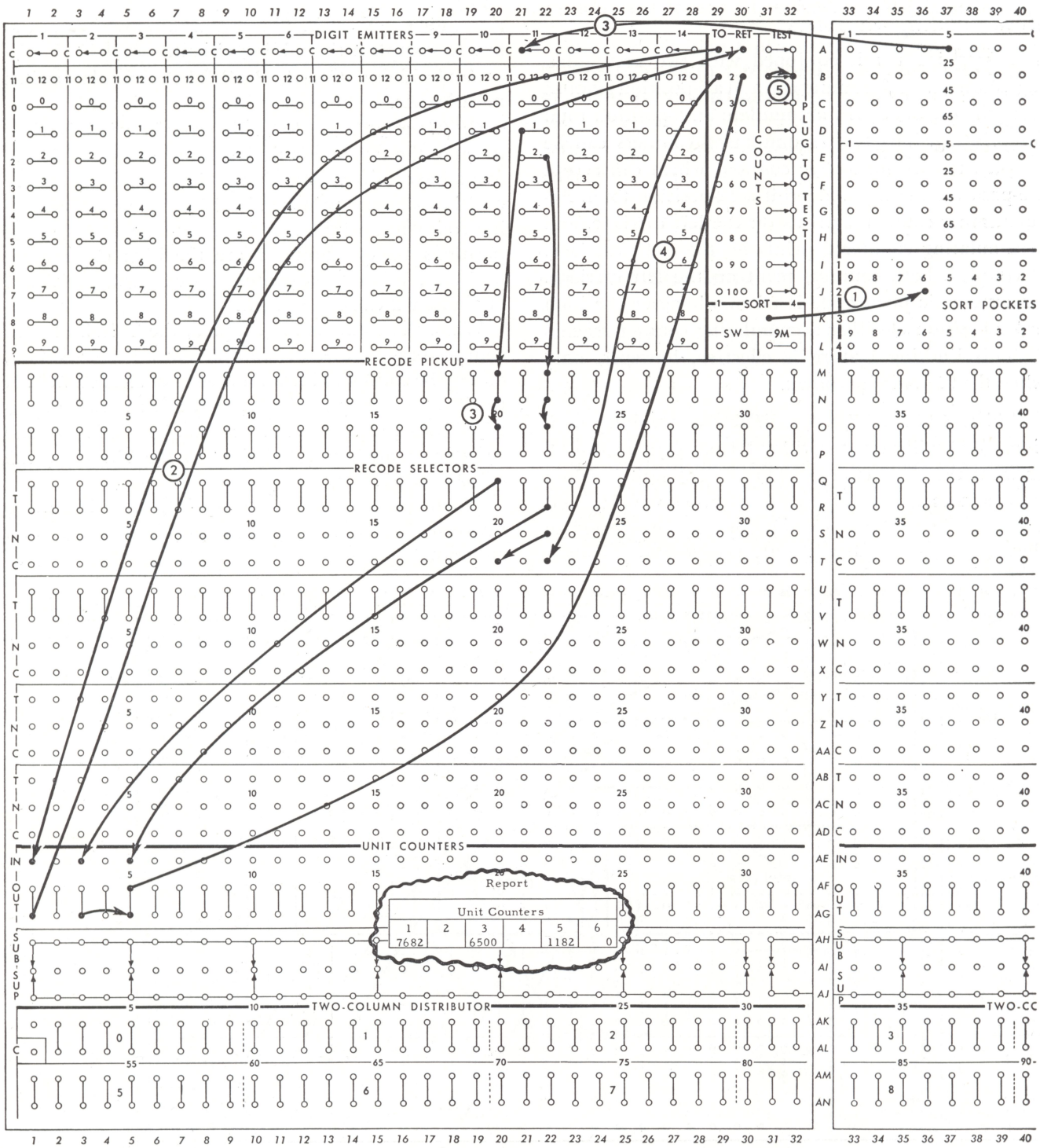


Figure 20. Counting Males and Females

Accumulating an Eight-Position Total

In Figure 21, accumulating counter 1 is used to add 5-position amounts and print an 8-position total. The sort selection switch is set on 5, so all the cards will sort into pocket 11.

Card Reading 2 (E-H, 33-52). These hubs are exits. They emit impulses corresponding to the information punched in each column of the card as it passes the second reading station. They are normally wired to the add hubs of accumulating counters for accumulation and to the group indicating units to identify totals.

Accumulating Counters

The Model 1 101 is equipped with two accumulating counters. Each counter can add a 5-position amount from the card and will accumulate an 8-position total for printing. The two accumulating counters can be coupled to form one large counter, which can accept a 9-position amount and print a 12-position total. Accumulating counter 1 prints on the left carriage, and accumulating counter 2 prints on the right carriage. If coupled, both counters print on the left carriage. An automatic print cycle is taken whenever the high order position of either accumulating counter reaches 9. This limiting feature is effective, however, only when the 9M switch is DOWN.

Add 1, Add 2 (U-Z, 61-64). The counter entry positions (1-5) will accept digits 9-1 from card reading 2 or from the digit emitter. The T (TO) hub is wired from a COUNTS TO hub to cause the counter to add amounts. The COUNTS TO impulse may be selected so that the counter will add only the desired classifications, such as X cards. The R (RETURN) hub is wired to RET to complete the adding circuit.

Acc (Accumulate)(AA, 63-64). The accumulate switch must be wired whenever either counter is used.

CP (Couple) (AA, 61-62). The couple switch is wired to cause the two accumulating counters to function as one large counter, with nine positions of entry and 12 positions of total printing. Positions 1-4 of accumulating counter 2 are the low order entry positions, while positions 1-5 of counter 1 are the high order entry positions. When the counters are coupled, position 5 of counter 2 cannot be used.

When the counters are coupled, the T hub of each counter may be wired from different COUNTS TO hubs, or may be split-wired from the same COUNTS TO hub. If the T hubs are split-wired, the R hubs must be split-wired back to the same RETURN hub. *The R hub of one counter should never be wired to the T hub of the other counter.*

When the coupled counters print, there is a space between the eighth and ninth positions of the total amount.

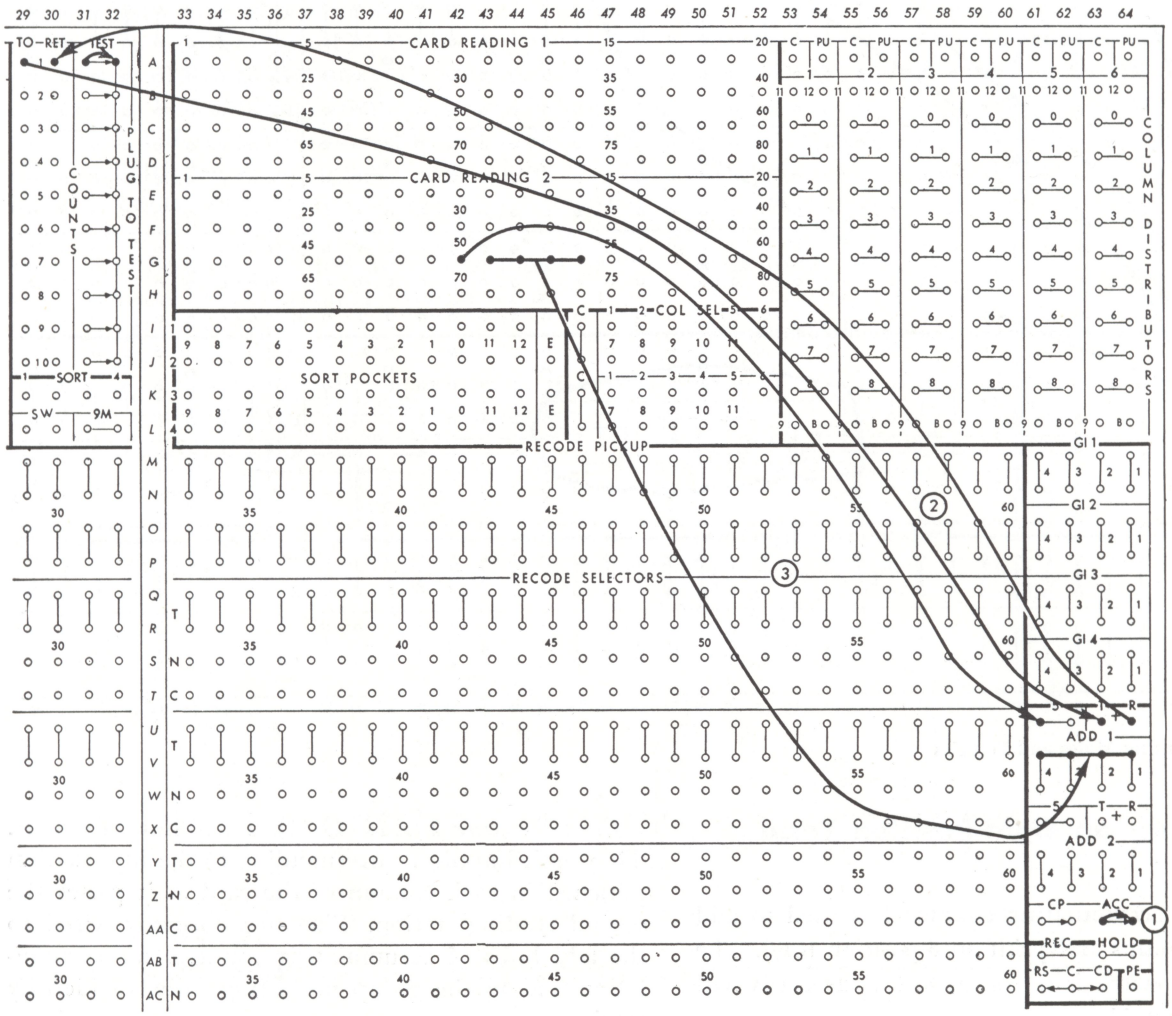


Figure 21. Accumulating an Eight-Position Total

Wiring (Figure 21)

1. The accumulate switch is wired so that the counters will operate.

2. COUNTS TO hub 1 is wired to the counter T hub. The counter R hub is wired back to RETURN.

3. Amounts are read from card reading 2 and are wired to counter entry. The left-margin stop in both carriages is set on 8. At least one unit counter must be wired to subtract, as explained under "Crossfoot Checking."

Accumulating a Twelve-Position Total

Figure 22 shows the counters coupled to add 9-position amounts and print a 12-position total.

1. Both the couple and accumulate switches are wired.

2. The 9-position amount is wired to the counter entry. Columns 50-54 are wired to positions 5-1 of counter 1; columns 55-58 are wired to positions 4-1 of counter 2; position 5 of counter 2 cannot be used.

3. COUNTS TO hub 1 is split-wired to the T hub of both counters. The R hubs of both counters are split-wired to RETURN.

The margin stops for both carriages must be set on 12.

Crossfoot Checking

Crossfoot checking is a feature of the 101 that is used during printing to balance to zero the total of all the printed counts for a line. To obtain a zero balance, counting must be arranged so that the sum of the counts added equals the sum of the counts subtracted.

If the result of the crossfooting balances to zero, a zero will print in the crossfoot check column as proof that the counts for that line balance. If the result of the crossfooting does not balance to zero, the machine will stop and the crossfoot check light will turn on.

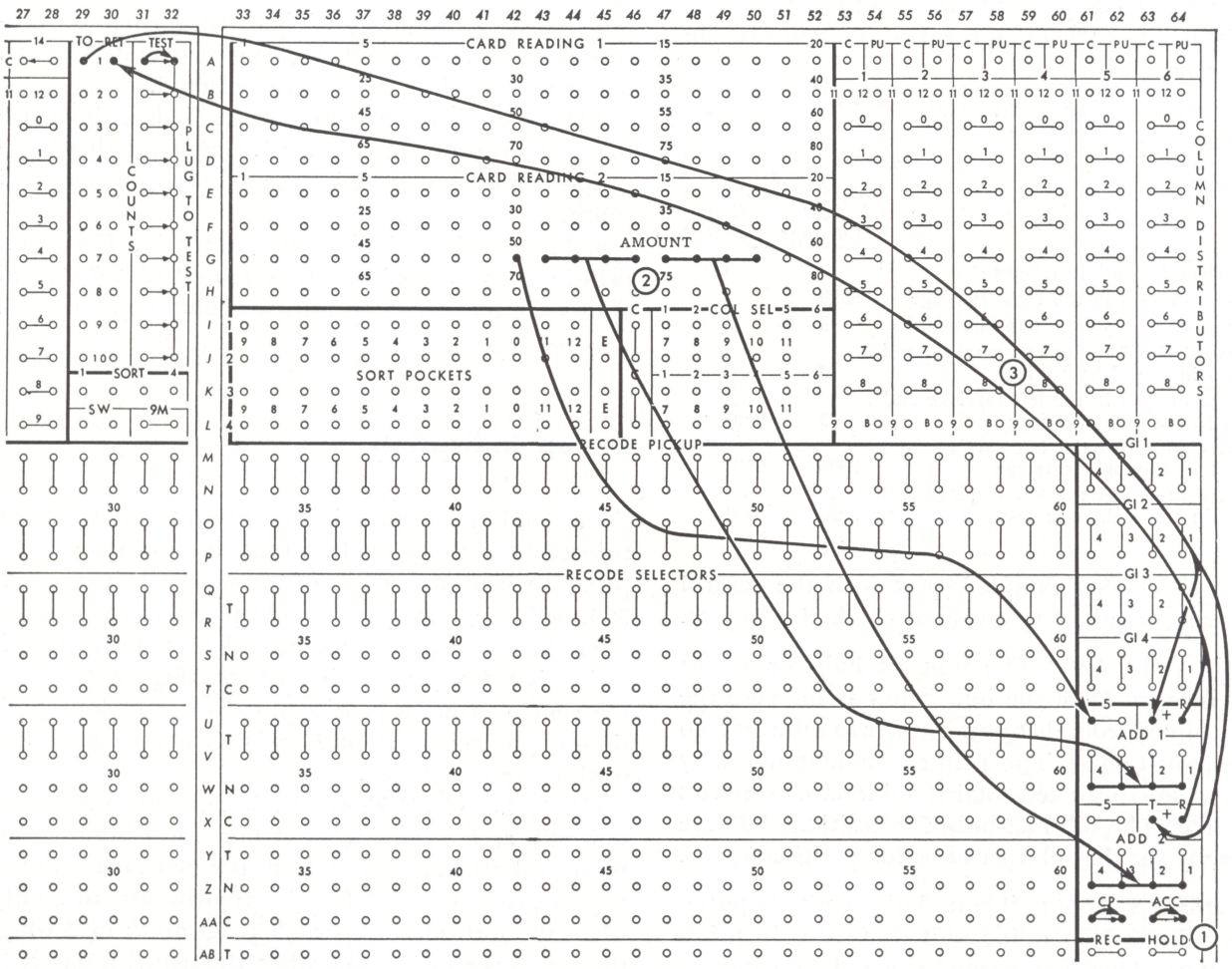


Figure 22. Accumulating a Twelve-Position Total

The error in the left carriage will print on the left carriage, and the total error for both the left and right carriages will print on the right carriage. Before the machine can be started again, the crossfoot check light must be turned off by pressing the restore key.

In actual operation, the accumulating counters (which clear after they print) are used for crossfooting. As each unit counter prints, the count is normally added into the accumulating counter for that carriage. The control panel may be wired so that the count will either subtract into the accumulating counter, or be suppressed so it will neither add nor subtract.

When the zero-check column is reached, the crossfooted count in accumulating counter 1 is read out and added to the crossfooted count in accumulating counter 2. The result in accumulating counter 2 is then tested by the machine to determine whether or not it is zero. If the result is zero, a zero will print in the crossfoot check column of both carriages. If the result is not zero, the difference in accumulating counter 1 will print on the left carriage and the sum of the differences in accumulating counters 1 and 2 will print on the right carriage. Negative differences will print as 9's complements. A zero in the left carriage will print as 9999 if there is a difference in the right carriage.

Zero-check printing is illustrated by the following examples:

Example	*Zero Check Column*	
	Left Carriage	*Right Carriage*
1. Correct in both carriages	0	0
2. Error of + 3 in the right carriage	9999	3
3. Error of + 3 in the left carriage	3	3
4. Error of + 3 in the left carriage and + 5 in the right carriage	3	8
5. Error of + 3 in the left carriage and − 5 in the right carriage	3	9997
6. Error of − 3 in the left carriage and + 1 in the right carriage	9996	9997
7. Error of − 3 in the left carriage and − 5 in the right carriage.	9996	9991

Figure 23 shows a sample report with the control panel wiring required to crossfoot check that report.

Subtract (AH, 1-60). The subtract hub for a unit counter is wired from the hub below it to cause the amount printed from that unit counter to subtract into the crossfooted total. The printed amount normally adds into the crossfooted total if subtract or suppress is not wired. The subtract hubs for positions 1-30 are common, as are the subtract hubs for positions 31-60.

Unlabeled (AI, 1-60). These hubs emit impulses whenever the corresponding unit counter is in printing position. They are normally wired to subtract, suppress, or print end.

Suppress (AJ, 1-60). Each suppress hub may be wired from the hub above it to prevent adding the amount from that unit counter into the crossfooted total. The suppress hubs for counters 1-30 are common, as are the suppress hubs for counters 31-60. *To suppress all crossfooting, the counters used must be wired to suppress and an unused unit counter before print end must be wired to subtract.*

PE (Print End) (AC, 64). Print end is wired from any one of the unlabeled hubs to stop printing from unit counters on both carriages. The crossfoot check (zero or difference) will print in the column after print end is wired, and then the carriages will return to the left margin stop. On early machines, print end is not wired but is set by a lever in back of the right carriage.

Wiring (Figure 23)

1. The total male count (unit counter 2) is subtracted into the crossfooted total. This will balance the distributed age group counts for males (counters 3-12), which will add into the crossfooted total.

2. The total female count (counter 31) is subtracted into the crossfooted total. This will balance the distributed age group counts for females (counters 32-41), which will add into the crossfooted total.

3. Counter 42 is wired to subtract. This will balance the all total count in counter 1. Counter 1 should be suppressed if counter 42 is not used to repeat the total count.

4. Print end is wired from counter 12. This stops printing from the unit counters beyond 12 and 42, and allows the zero check to print in columns 13 and 43.

Group Indication

Four positions of numerical group indication may be printed to identify totals. Group indications may be printed whenever the sort selection switch is set on 2, 3, 4, or 5. The group indication prints in the column after the accumulated amount. The same group indication is printed on both carriages. Figure 24 shows the control panel wiring required to print four positions of group indication. For simplicity, counting and sorting are not shown.

GI, 1, 2, 3, 4 (M-T, 61-64). Each group indication unit will accept four digits of numerical information from card reading 2, only from the first card counted after a print cycle. GI 1 will accept information only when the sort selection switch is set on 2; GI 2 when the switch is set on 3; GI 3 when the switch is set on 4; and GI 4 when the switch is set on 5.

Right Carriage

REPORT Employees by State and Age Group -- Female

	STATE	FEMALE-AGE GROUPS															
		TOT	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64		CHK			
AMOUNT	G I	31	32	33	34	35	36	37	38	39	40	41	42	43		60	CHECK
	29	533	73	306	106	18	14	12	1		1	2	2408	0			
	31	742	126	318	215	31	22	15	8	4	2	1	1706	0			
	34	363	62	132	127	40		1	1				865	0			
	37	3033	240	512	717	943	350	106	84	61	20		9992	0			
	37	97	9	20	18	35	14	1					145	0			
(Crossfoot check each line)		(-)	+	+	+	+	+	+	+	+	+	+	(-)				

Left Carriage

REPORT Employees by State and Age Group -- Male

	STATE	ALL	MALE-AGE GROUPS														
		TOT	TOT	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	CHK			
AMOUNT	G I	1	2	3	4	5	6	7	8	9	10	11	12	13		30	CHECK
10 12987808	29	2408	1875	33	195	220	240	220	273	296	188	98	112	0			
7 37213780	31	1706	964	16	102	106	135	118	147	134	85	74	47	0			
3 89341690	34	865	502		48	66	73	135	102	54		18	6	0			
43 97569128	37	9992	6959	200	512	582	1140	1516	774	790	623	516	306	0			
55013625	37	145	48		1	6	22	10	4	3	2			0			
(Crossfoot Check Each Line)		+	(-)	+	+	+	+	+	+	+	+	+	+				

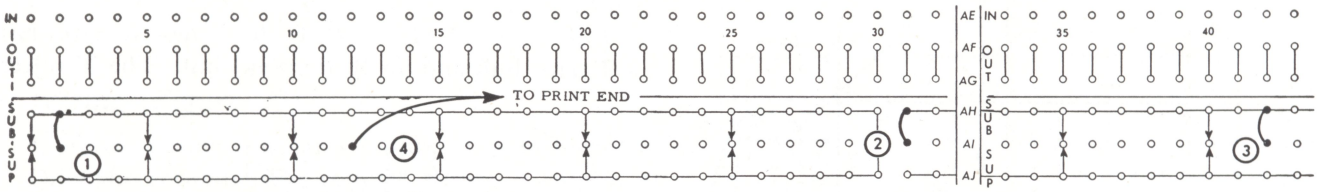
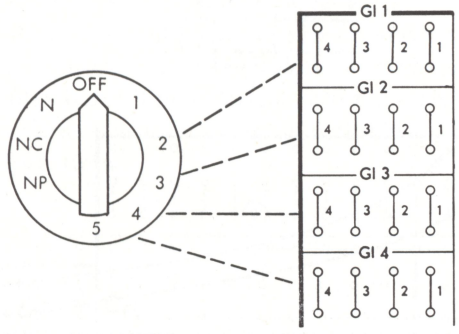


Figure 23. Crossfoot Checking



Wiring (Figure 24)

The indicative information in columns 33-36 is wired to the GI hubs. The sort selection switch is set on 2.

Figure 24. Group Indication

Extra Group Indication

Four extra positions of group indication may be printed using the accumulating counters. The extra group indications print to the left of the normal group indication, in the columns usually used for accumulated amounts. The same extra group indication may be printed on both carriages by using both accumulating counters. A fifth position of extra group indication can be printed from the fifth position of the accumulating counters if summary cards are not being punched.

Figure 25 shows the control panel wiring to group indicate an eight-digit part number. The four positions on the left are printed from an accumulating counter; the four positions on the right are group indicated normally.

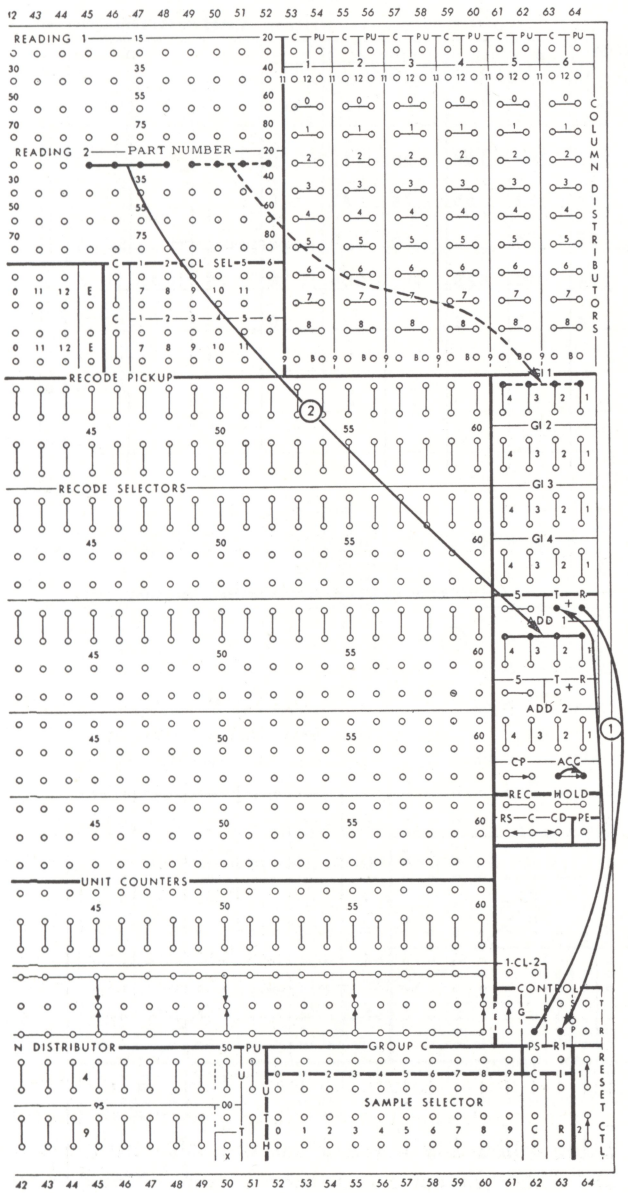


Figure 25. Extra Group Indication

GI (A-J, 62). This hub emits a count impulse for the first card counted after printing. It emits only when the sort selection switch is set on 2, 3, 4, or 5. It is used to control an accumulating counter so that the counter adds for the first card of each group, thus adding the group indication into the counter only once.

Wiring (Figure 25)

1. The accumulate switch must be jackplugged to make the counter operate. The GI hub is wired to the accumulating counter T hub. The accumulating counter R hub is wired back to the lower reject hub or to a count return hub (after the plug to test) to complete the circuit for adding. The accumulating counter will add from the first card that is counted after a print cycle.

2. The four high-order positions of part number are wired to the counter entry hubs from card reading 2.

Stopping the Machine or Counting Rejected Cards

In Figure 26, *A* shows the control panel wired to stop the machine whenever a card rejects, and *B* shows the control panel wired to count the number of rejected cards.

Rej; Stop (AI-AJ, 63-64). Each of these features has a T (TO) hub and an R (RETURN) hub. The T reject

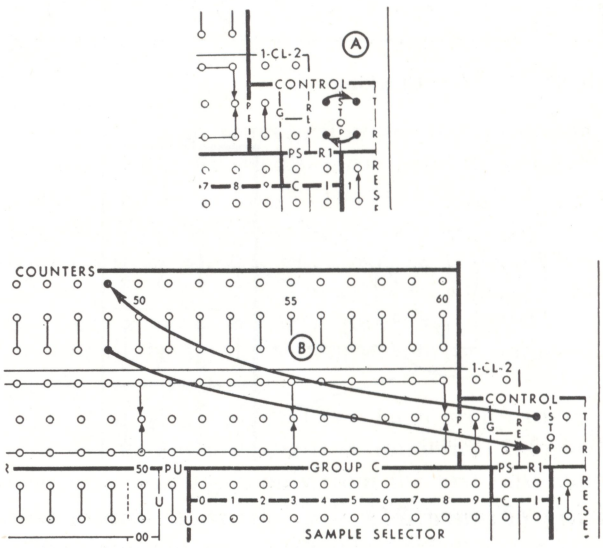


Figure 26. Stopping the Machine or Counting Rejected Cards

hub emits a count impulse whenever a card rejects. To stop the machine for rejected cards, the T reject hub is wired to the R reject hub through the T and R stop hubs as illustrated in wiring A, Figure 26. To count rejects, the T reject hub is wired to a counter IN hub, and counter OUT is wired to R reject, as illustrated in wiring B. *T reject should never be wired directly to R reject, as this will blow a fuse.* The impulse emitted by T reject must always pass through unit counter IN and OUT hubs, through T and R hubs of an accumulating counter, or through T and R stop hubs. Card feeding may be stopped for any specific condition by wiring a selected count or sort impulse through T and R stop hubs to the R reject hub.

Counting in an Accumulating Counter

The accumulating counters, when not used to add amounts, may be used as unit counters to count card classifications. When they are used for counting (Figure 27) the count in the accumulating counters must be included in the crossfoot check.

Reset Ctl (AK-AN, 64). Normally, accumulating counters reset as totals are printed. However, when reset control is wired, accumulating counters do not reset until the zero check column is reached. Therefore, the totals in these counters are included in the crossfoot check on a plus basis. This feature permits their use as additional unit counters. Each accumulating counter has its own reset control switch.

Wiring (Figure 27)

1. Accumulating counter 1 is wired to add normally. Only the accumulating counter wiring is shown, although in practice unit counters would also be wired.
2. A digit emitted "1" is wired to counter entry. The counter will add 1 for each card.
3. Reset control is wired. The count in the accumulating counter will be included in the crossfoot check on a plus basis. Therefore, to zero balance, distributed unit counts must be subtracted during the crossfooting operation.

Recode Hold

The 101 is arranged so that certain selectors or column distributors which are picked up for one card may remain transferred for the next card.

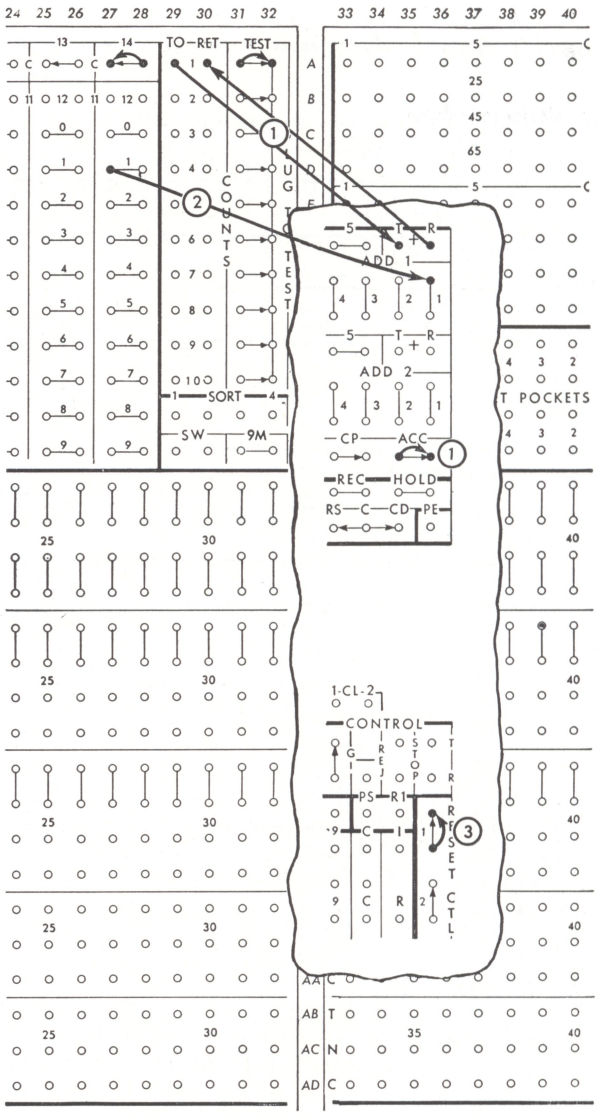


Figure 27. Counting in an Accumulating Counter

The control panel may be wired so that the special hold will apply to the last ten recode selectors installed (51-60 on a full-capacity machine); to all the column distributors; or to both the last ten recode selectors and to all the column distributors.

The recode hold operation is analyzed in Figure 28.

Rec Hold (AB, 61-64). These entry hubs will accept digits 8-12 and edit impulses. The REC and HOLD hubs must receive matching impulses before the extra-cycle-hold operation will function. These hubs may be wired from card reading, emitted digits, and so on.

RS, C, CD (AC, 61-63). These hubs must be wired if the REC-HOLD feature is used. When C is wired to RS, the recode selectors are under the control of recode hold. When C is wired to CD, the column distributors are under the control of recode hold. C may be split-wired to both RS and CD if desired.

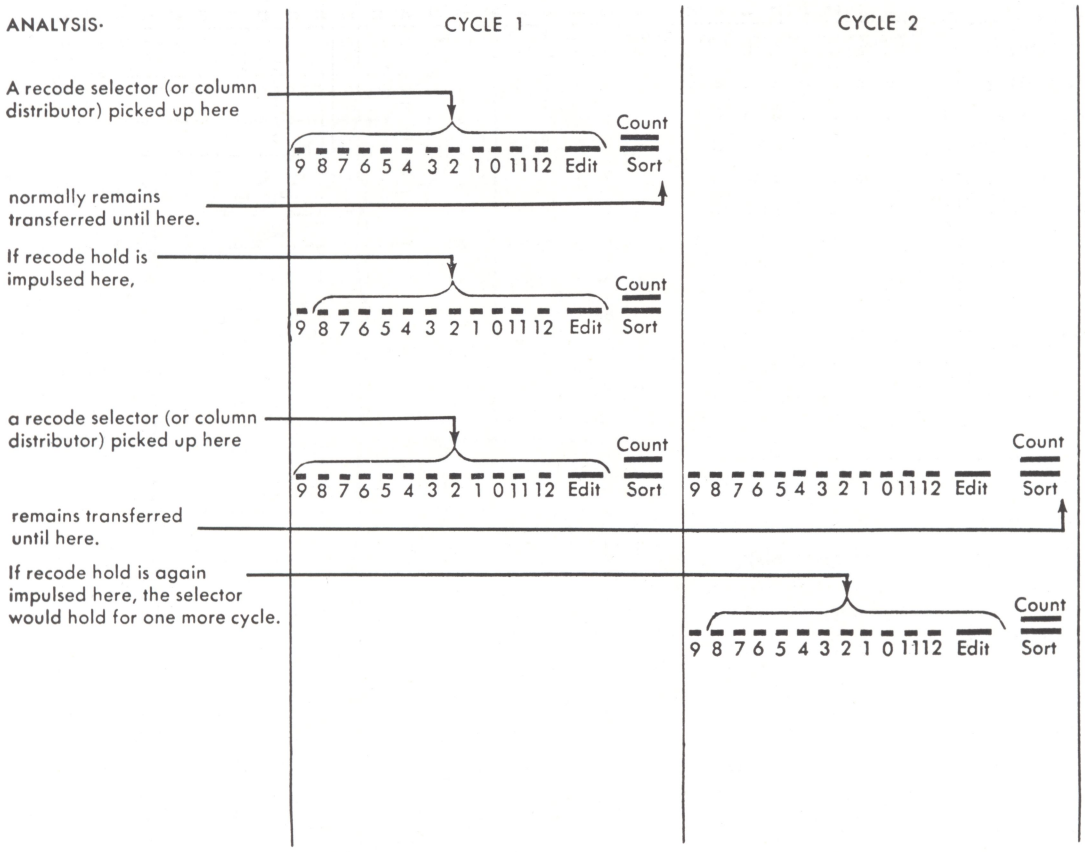


Figure 28. Recode Hold Schematic

Wiring (Figure 29)

The control panel is wired so that X cards and the card following an X card will sort into the 11 pocket. The remaining cards will sort into pocket 2.

1. Selector 51 is picked up for cards X-punched in column 5.
2. The X impulse from column 5 is also wired to both sets of REC-HOLD hubs. Since C is wired to RS, recode selector 51 will transfer for an X card and the card following the X card.
3. Sort 4 is wired through selector 51. X cards and the card following an X card sort into pocket 11. The remaining cards sort into pocket 2.

Master Card Control

As previously described, print cycles occur when the print key is depressed at the end of each group of cards counted. Print cycles may also be taken automatically by inserting master cards punched with a 9 in some column behind each group. The detail cards must not contain a 9 punch in the same column.

The master cards can be hand filed, or they may be machine sorted behind each group if the master cards are punched with the same sorting classification as the detail cards.

For easier handling and recognition of master cards, it may be desirable to have a color or corner cut different from the detail cards.

The automatic print cycle is under control of the 9M hub *(L, 31-32)* and the 9M switch (Figure 1). The 9M hub will accept a 9 impulse wired from card reading 1 to initiate the print cycle. With the 9M switch in the upper position, master cards which contain sorting classifications may be machine sorted behind the corresponding detail group. The switch should never be up except when sorting in master cards, or when the 9M hub is not wired, and the sw hubs *(L, 29-30)* are being used to control wiring. Also, the 9M switch in the upper position eliminates automatic counter overflow total.

When the switch is down, sensing of a 9 master at the 9M hubs causes an automatic print cycle. If one or more 9-master card follows another, only the first 9-master will cause a print cycle, except when the sort selection switch is set on 1. With the sort selection switch set on 1, an automatic print cycle is taken for every 9M master card.

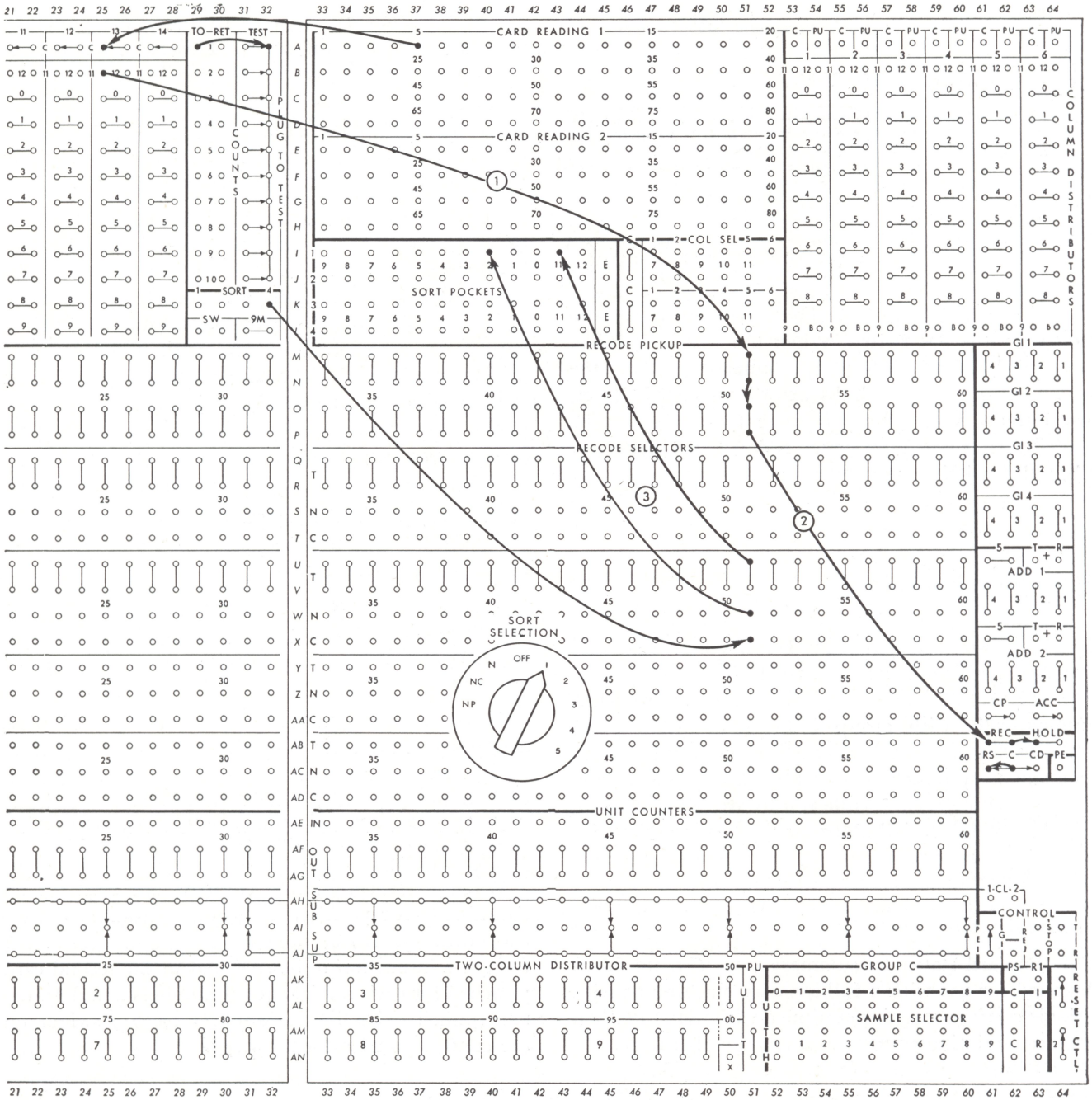


Figure 29. Recode Hold Wiring

With the sort selection switch set on 2, 3, 4, and all the cards run into the reject pocket, the machine does not recognize a 9M master card. Therefore, an automatic print cycle does not occur. If reject stop is wired with the 9M switch down, the machine will stop for detail cards but not for master cards.

When machine-sorted groups are run for automatic printing of group totals, cards which are not punched with a count classification are rejected.

If the master cards should contain the same count control punching as the details, they will follow the details.

Note that the sorting classification also has already been proved identical. Any master would have been rejected on the sort run if this was not true. Refer to Figure 30 for the combinations which will cause the master card to be rejected, or allow masters to follow the group cards.

If Master Card Contains	Master Card
9 Punch - Same Sorting and Count Control	Follows Detail
9 Punch - Different Sorting and Same Count Control	Rejects
9 Punch - Same Sorting and Different Count Control	Rejects
9 Punch Only (Manually Inserted)	Rejects

Figure 30. Rejecting Master Cards

SW (Switch) (L, 29-30). These two hubs are controlled by the 9M switch. When the switch is down, the two hubs are internally connected. When the switch is up, the two hubs are disconnected. Thus, any impulse wired through these two hubs can be made effective when the switch is down and ineffective when the switch is up.

Summary Punching

One or two optional 524 Duplicating Summary Punches may be attached to a 101 for summary punching (Figure 31). Summary cards can be punched automatically with group indications, accumulated amounts, and the count for each of the unit counters. One summary punch is used for each carriage. Summary punching occurs while results are being printed, and does not materially increase the time required for preparing a report.

Summary Card Design

The standard statistical summary card (Figure 32) is designed for use with a full-capacity machine or with a single carriage machine equipped with not more than one accumulating counter as an optional feature.

The summary card has 15 fields for the punching of four-position count totals. This means that four cards are required for the 60 possible count totals, two for the 30 counters which print on the left carriage and two for the 30 counters which print on the right carriage. The fields are numbered to indicate the counters from which the counts are punched.

At the left of the counts is a column (20) for card code. The summary punch associated with the left-hand carriage punches a 1 in the card for counters 1-15 and a 2 in the card for counters 16-30. Similarly, cards are punched by the second summary punch with 3 for counters 31-45 and with 4 for counters 46-60. Consequently, the counts contained in each card are identified by card number. Notice that the arrow under each card number shows the unit counters punched for that card.

Group indication is punched in columns 16-19. The same group indication is punched in all four cards and, with the card number, provides a means for sorting or merging the cards.

Eight-position totals can be punched in columns 8-15 from accumulating counter 1 into card 1, and from accumulating counter 2 into card 3. These eight columns are X-skipped on cards 2 and 4.

When the two accumulating counters are coupled, a 12-position total will be punched in columns 4-15 of card 1. In this case columns 4-15 in card 3 (the second summary punch) will be punched automatically with 12 zeros. These columns will be X-skipped on cards 2 and 4.

When the accumulating counters are used for an additional four positions of group indication, the extra indication will be punched in columns 12-15. For the extra indication to be repeated in the second card punched for each carriage (card numbers 2 and 4), the PEI (punch extra indication) *(AI-AJ, 61)* switch on the control panel must be wired.

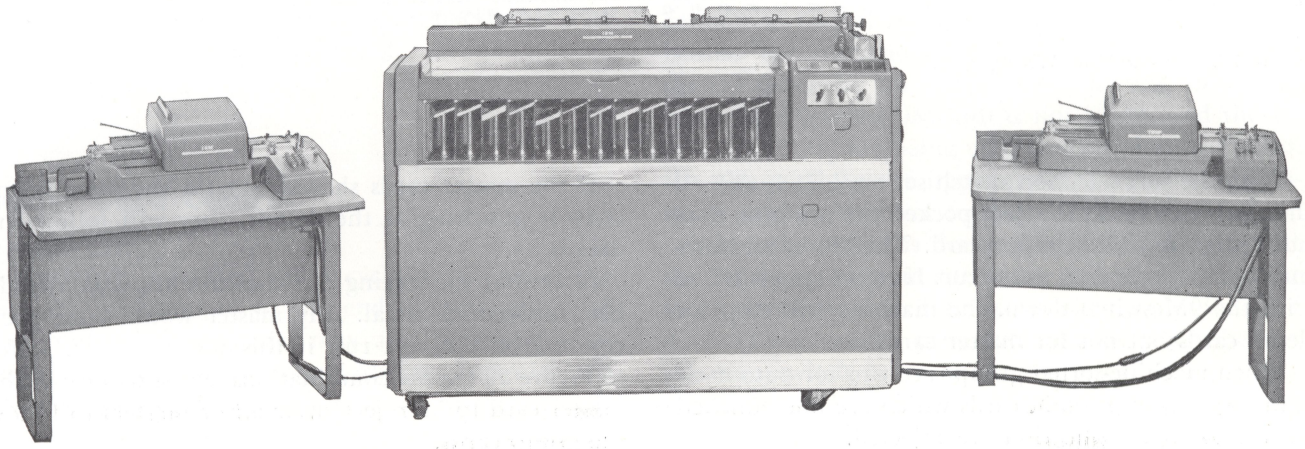


Figure 31. 101 and Two 524 Summary Punches

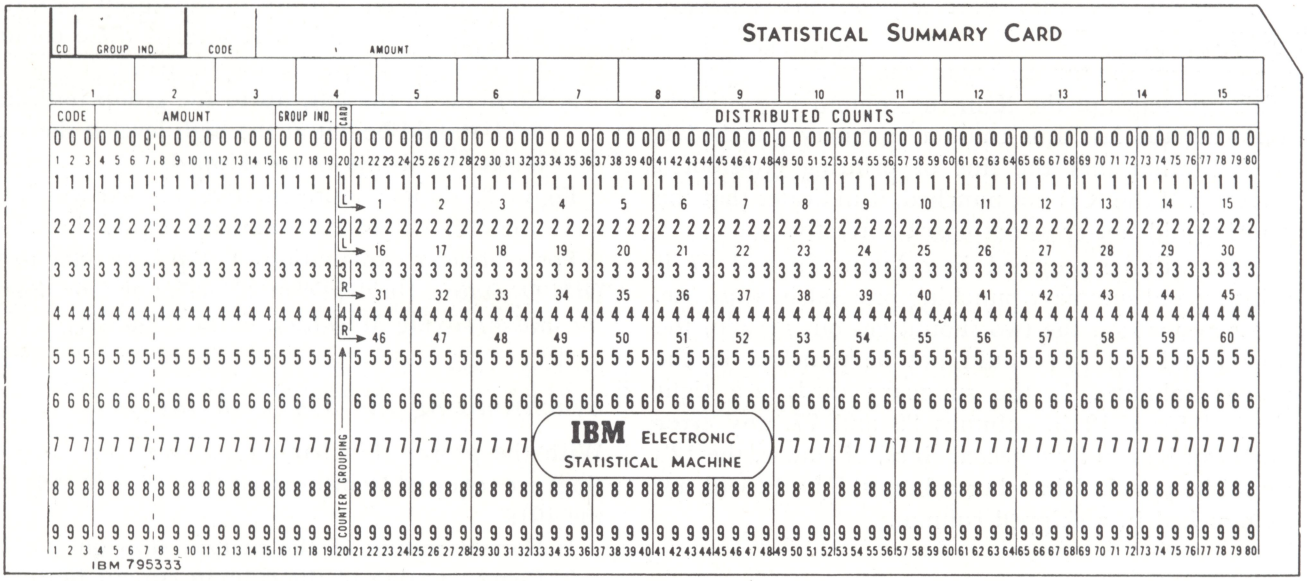


Figure 32. Standard Statistical Summary Card

When a single carriage machine is equipped with two accumulating counters as an optional feature, group indications will punch in columns 17-20, and totals from the accumulating counters will punch as follows:

Single counters (two 8-position totals)
  Counter 1 — Columns 1-8
  Counter 2 — Columns 9-16
Coupled counters (one 12-position total)
  Columns 5-16

The card number field is not needed for a Model 2 machine because there is only one summary card for each line of printing. Any unused columns on the right end of the card will be X-skipped after the last unit counter prints and summary punches.

Summary Punch Operation

The 101 machine has two receptacles for summary punch cables. A summary punch connected to the right receptacle will receive summary punch information from accumulating counter 1 and unit counters 1-30. A summary punch connected to the left receptacle will receive information from accumulating counter 2 and unit counters 31-60. In addition to the summary punch cable, each has its own power cord which must be plugged into power outlets on the rear of the 101. *They should never be connected to independent power outlets.*

When summary punches are to be connected to the 101, use the following procedure:

1. Connect the summary punch cables.
2. Plug the power cords of the summary punches into the power outlets in the 101.
3. Insert skip bars in each summary punch.
4. Set the duplicating column cut-out buttons on both machines for the last column to be duplicated.
5. Turn the summary punch switches on for each 524.
6. Turn the power switches on for both the 101 and the 524's.
7. Place cards in the 524 hoppers face up, column 1 end toward the throat.
8. Depress the release key on the summary punch (not necessary for any summary card punched with 15 unit counts).
9. Lower the reject-stop levers on both machines.
10. Press the auto start key for each 524.
11. The 101 is now ready for operation.

The summary punches and the 101 operate together as long as both are supplied with cards. As each item prints on the report, it is summary punched. Printing and summary punching proceed together until after the 15th (or 45th) unit counter summary punches. The 101 then pauses momentarily while the summary punch feeds another summary card. Printing and summary punching then resume and continue until print end is impulsed.

After the last unit counter prints, a summary card punched with less than 15 unit counts is automatically X-skipped to column 80 and stacked. A new summary card is fed into punching position. If, however, the crossfoot-check light comes on, the summary card does not skip out to column 80 and both machines stop. Operation is resumed as follows:

1. Depress the release key on the summary punch (not necessary for any summary card punched with 15 unit counts).

2. Depress the auto start key on the summary punch.

3. Depress the restore key on the 101.

The presence of the X in the column immediately following the last unit counter summary punched is an indication that the line of printing crossfooted correctly. If the X is not punched, it indicates that the printing did not crossfoot check correctly.

A 12 will be punched in columns 29 and 77 if printing and summary punching proceed in sequence. If for any reason the two should get out of step, the counts and the 12's would not be punched in the proper columns. If the summary cards are sight checked for a 12 in columns 29 and 77, any error cards can be readily detected since, of course, the 12's would be punched in other columns. The 12 will not be punched in a skipped column.

Skip Bar Design

The skip bars inserted in the 524 Summary Punch to control card movement should be designed as follows:

1. The first column to be punched from accumulating counters should be cut to the lowest level.
2. The first GI (group indication) column should also be low cut.
3. The remaining summary punch columns should be cut to the intermediate, X, level.
4. Columns to the left, up to the group indication field, should be cut to X level if these columns are to be X skipped or duplicated.
5. Columns to the left, up to the group indication field, should be left at the high level if these columns are always to be skipped.

Figure 33 shows a representative skip bar which will serve the majority of 101 summary applications.

For a broader explanation of skip bars refer to the *IBM Operators Guide,* Form 224-8485; or *Card Punching and Verifying Machines,* Form 222-3176.

Synchronizing the 524 with the 101

With the proper skip bar already insterted, two settings are required to insure that the 524 is in step with the 101:

1. Correct setting of the margin stop on the 101.
2. Correct setting of the column cut-out button on the 524.

First, the capacity of the particular 101 must be known. Next, the desired number of positions in the accumulated total must be known. Figure 34 is a summary of all the combinations for the settings.

The margin stop is set on the number of columns desired for the accumulated total. The column cut-out button is set on the last column to be duplicated. The indicator will be pointing to the column in which the summary punching (accumulated total) will begin.

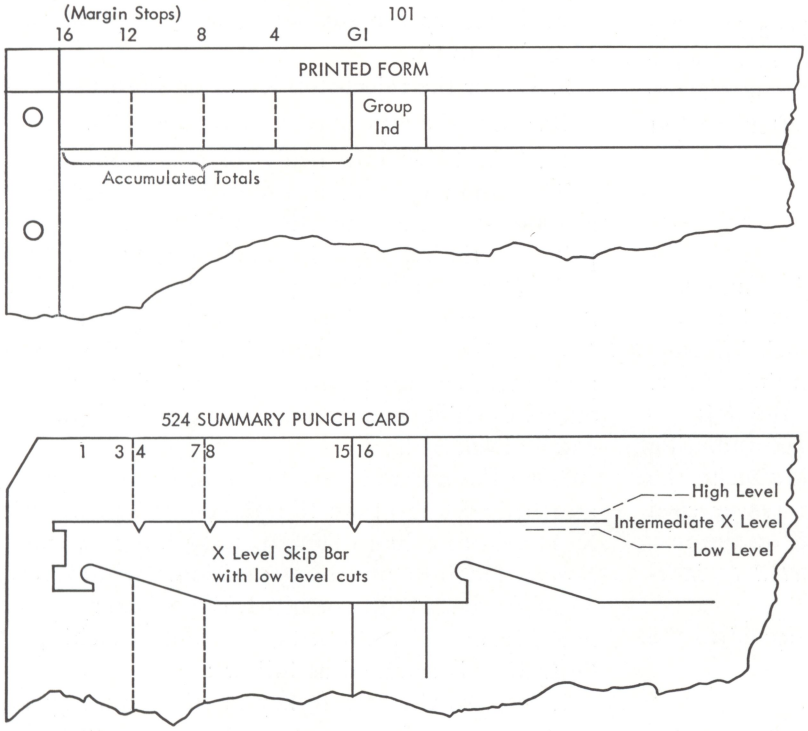


Figure 33. Margin Stop and Skip Bar

Margin Stop - 101	16	12	8	4	GI	No of Columns to be summary punched
Column Cut Out Button - 524	Note*	3	7	11	15	No. of Columns to be duplicated
Indicator -524	1	4	8	12	16	Column in which summary punching begins

Figure 34

* NOTE: If a 16-position accumulated total is desired, the summary punch must have an optional Punch Column 1 Switch. When the switch is on, the column cut-out action starts at column 1. The cut-out button cannot be set far enough to the left to start the cut-out action at column 1. (This means duplication is cut out for all columns and summary punching will begin at column 1.)

Manual Key Punching

The 524 can be used as a numerical card punch. The power switch must be on and the summary punch-manual switch set to MANUAL. The summary punch cables may remain connected to the 101, or may be disconnected.

The punch has all the features of the 16 Duplicating Punch. However, depressing the space key will not restore a projected skip lifter as it does on the 16 or 31 Punch. For this reason, cards to be used for manual key punching on the 524 should be designed so that a digit 0-9 or a 12 punch will always follow an X-skipped field.

Typical Applications

This section of the manual contains typical applications which exemplify the flexibility of the 101.

Sorting by Unpunched Classifications

The 101 may be used to combine groups of cards into new classifications, even though the new classifications are not punched in the cards. For example, cards which are punched with state codes are sorted into nine regional groups even though the regional group codes are not punched in the cards (Figures 35 and 36).

If the cards were in state-code sequence before starting the regional sort, the cards for each region will be in numerical sequence as shown in Figure 35.

Region	States		Region	States	
1	*New England*		5	*So. Atlantic*	
	06	Connecticut		07	Delaware
	18	Maine		08	District of Columbia
	20	Massachusetts		09	Florida
	28	New Hampshire		10	Georgia
	38	Rhode Island		19	Maryland
	44	Vermont		32	North Carolina
				39	South Carolina
				45	Virginia
				47	West Virginia
2	*Middle Atlantic*		6	*E. S. Central*	
	29	New Jersey		01	Alabama
	31	New York		16	Kentucky
	37	Pennsylvania		23	Mississippi
				41	Tennessee
3	*E. N. Central*		7	*W. S. Central*	
	12	Illinois		03	Arkansas
	13	Indiana		17	Louisiana
	21	Michigan		35	Oklahoma
	34	Ohio		42	Texas
	48	Wisconsin			
4	*W. N. Central*		8	*Mountain*	
	14	Iowa		02	Arizona
	15	Kansas		05	Colorado
	22	Minnesota		11	Idaho
	24	Missouri		25	Montana
	26	Nebraska		27	Nevada
	33	North Dakota		30	New Mexico
	40	South Dakota		43	Utah
				49	Wyoming
			9	*Pacific*	
				04	California
				36	Oregon
				46	Washington

Figure 35. States Arranged Alphabetically within Region

Wiring (Figure 36)

1. State code is wired to the units and tens pickup hubs of the two-column distributor.

2. Sort hub 4 is wired to the common hub of the two-column distributor.

3. The exit hubs for the states in the first region (06, 18, 20, 28, 38, 44) are wired together and to sort pocket 1. Therefore, all the cards for region 1 are sorted into pocket 1. Similarly, the state codes for each region are wired together and to the sort pocket for that region. For simplicity, control panel wiring is shown for regions 1, 2, and 9 only.

4. Editing is concluded at this point.

Double-Punch and Blank-Column Detection

The 101 can check cards for double-punched columns, blank columns, or both. Double-punch and blank-column detection can be done as a separate operation (Figure 37) or in conjunction with another operation.

Wiring (Figure 37)

1. Columns 77-80 are wired to the pickup hubs of selectors 49-52. Each selector will transfer if the corresponding column is punched.

2. Columns 77-80 are also wired through the transferred side of selectors 49-52 to the pickup hubs of selector 55. Therefore, selector 55 will transfer if any one of the columns 77-80 is double-punched.

3. Sort 4 is wired to pocket 11 through the normal side of selector 55 and through the transferred side of selectors 49-52. Cards which do not have double-punched or blank columns will sort into pocket 11. The remaining cards will reject.

4. The dotted wires may be added to stop the machine for double-punched cards.

5. Editing is concluded at this point.

Sequence Checking

Data in the same field of two successive cards can be read simultaneously to check the sequence of a file of cards. Two recode selectors are required for each numerical column to be checked; four recode selectors are required for each alphabetic column to be checked.

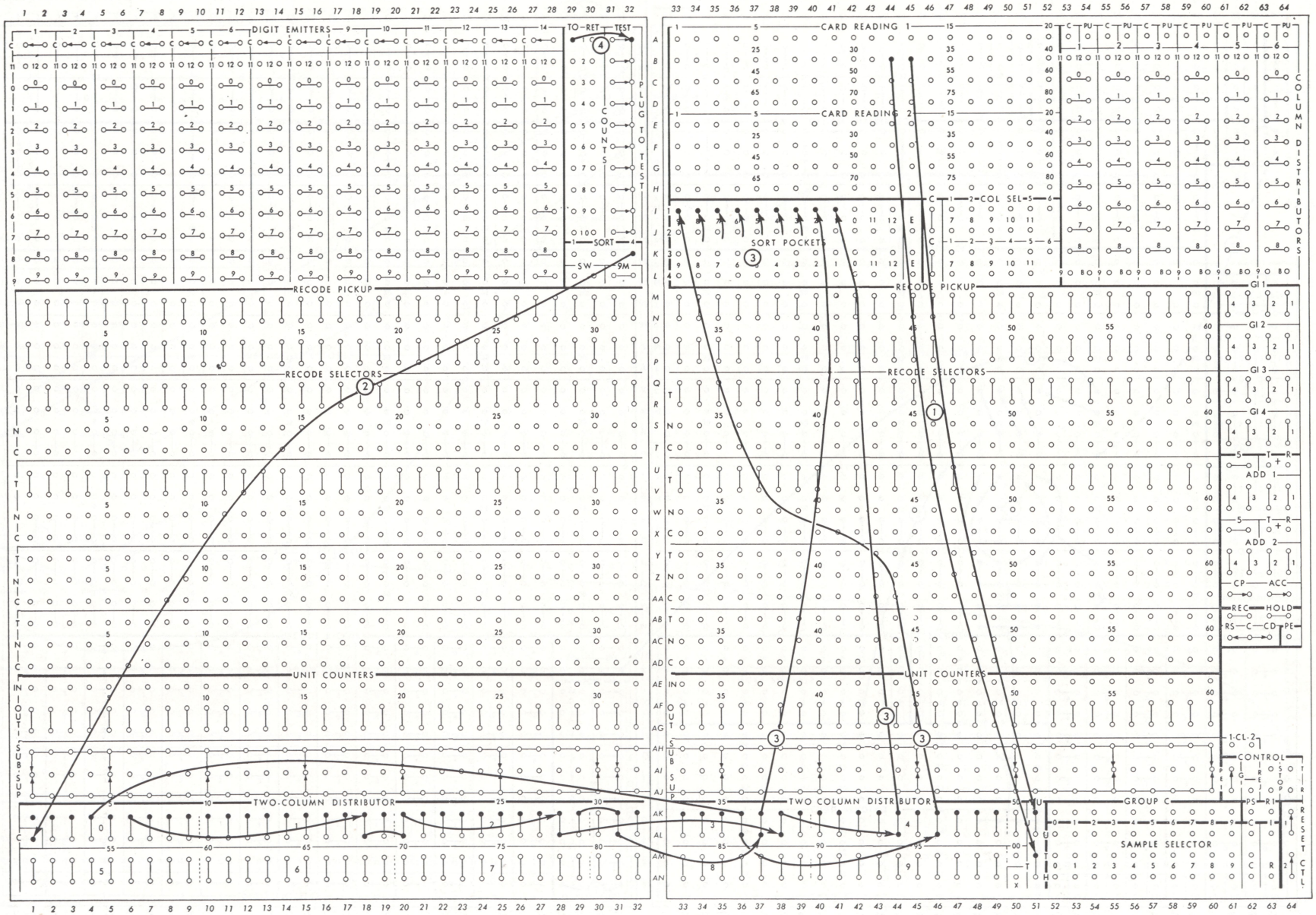


Figure 36. States Sorted into Regional Groups

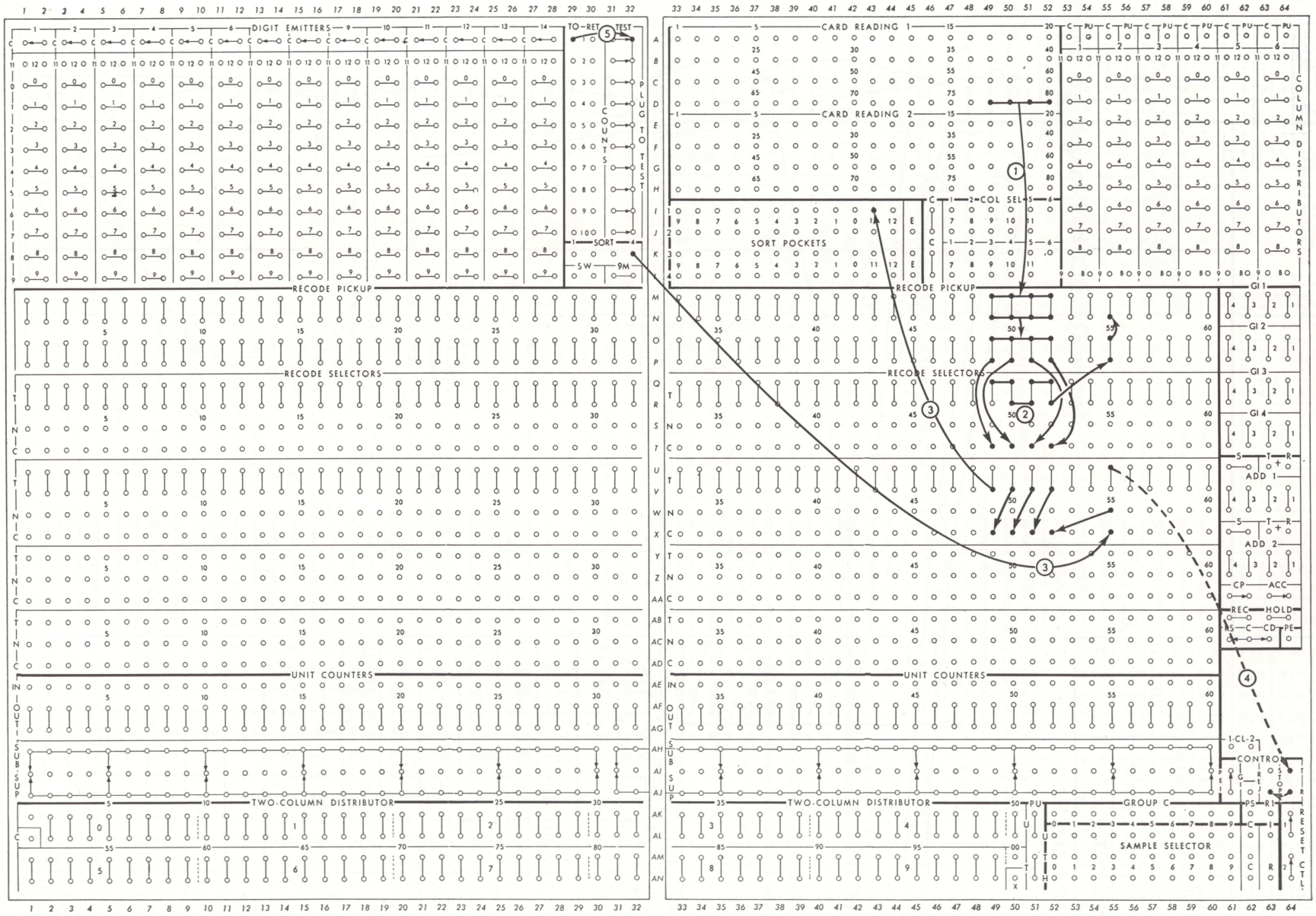


Figure 37. Double-Punch and Blank-Column Detection

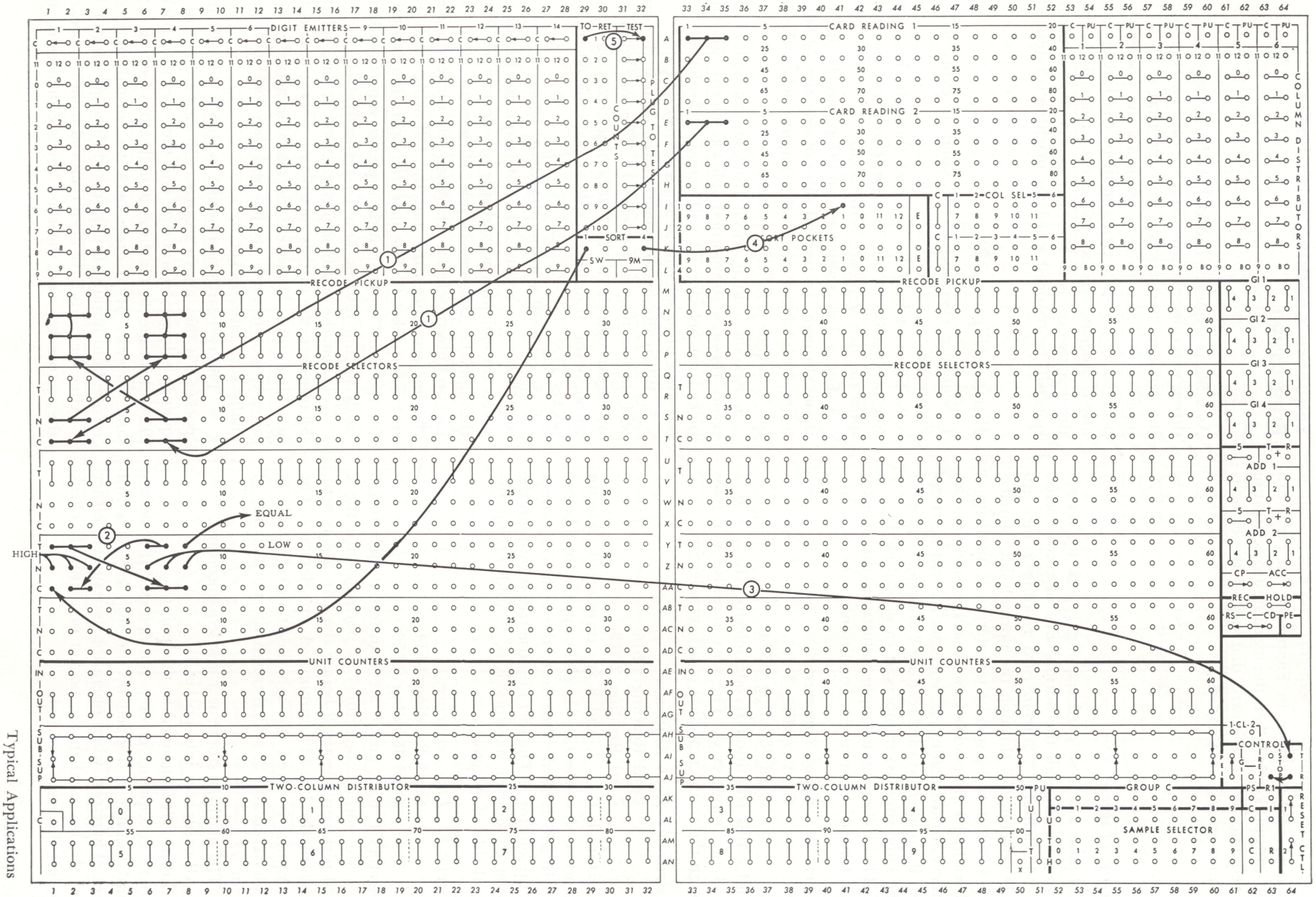


Figure 38. Sequence Checking

The wiring required to sequence check a 3-column numerical field is shown in Figure 38. All cards are sorted into pocket 1. When the machine stops because of a sequence error, the card that caused the error is the third card from the top.

Wiring (Figure 38)

1. Columns 1-3 from card reading 1 pick up recode selectors 6-8 through the normal side of recode selectors 1-3. Columns 1-3 from card reading 2 pick up recode selectors 1-3 through the normal side of selectors 6-8. Selectors 6-8 will be transferred if numbers at card reading 1 are read before (or at the same time as) numbers at card reading 2. Selectors 1-3 will be transferred if numbers at card reading 2 are read before (or at the same time as) numbers at card reading 1.

2. The following examples illustrate the selector action for various sequence conditions:

EXAMPLE 1: *Equal Sequence*
Card reading 1-514
Card Reading 2-514

Under this condition recode selectors 1, 2, 3, 6, 7 and 8 are transferred. The sort impulse will pass through the transferred side of all six selectors.

EXAMPLE 2: *High Sequence*
Card Reading 1-514
Card Reading 2-513

Selectors 1, 6, 2, 7, and 8 are transferred. Selector 3 is normal since the 4 in 514 picks up selector 8 before the 3 in 513 is read. Therefore, the 3 in 513 cannot pick up selector 3. The sort impulse passes through the transferred side of selectors 1, 6, 2, and 7, and the normal side of selector 3.

EXAMPLE 3: *Low Sequence*
Card Reading 1-514
Card Reading 2-520

Selectors 1, 6, 2, and 8 are transferred. Selectors 3 and 7 are normal. Selector 7 is normal since the 2 in 520 picks up selector 2 before the 1 in 514 is read. Therefore, the 1 in 514 cannot pick up selector 7. The sort impulse is wired through the transferred side of selectors 1, 6, and 2, and through the normal side of selector 7.

3. The machine stops for a low sequence card.
4. All cards sort into pocket 1.
5. Editing is concluded at this point.

NOTE: A sequence error is not detected if it occurs as card feeding is stopped by the stop key or a full pocket. Therefore, when operation is resumed, either refeed the last card in the pocket or manually check it against the next card fed.

Sequence Checking with Pocket Progression

As a file is sequence checked, each low sequence condition will cause the low sequence card and the following cards to start sorting into the next pocket. The machine is wired to stop when all the pockets have been used. Sequence errors must be checked by manually comparing the last two cards in one pocket with the first two cards in the next pocket. Pocket progression will be resumed when the machine is restarted.

Wiring (Figure 39)

1. Sequence checking is the same as explained for Figure 32.

2. The sort impulse is wired through the normal side of selectors 51-60. The cards sort into pocket 12 until the first sequence error occurs.

3. For a low sequence condition, an 11 impulse passes through the normal sides of selectors 51-60. Selector 60 is picked up by this impulse when the first low sequence condition occurs.

4. Recode hold is wired from an emitted 11 that passes through the normal side of selector 51. Once picked up, selector 60 will remain transferred until one cycle after selector 51 is picked up.

5. When the first sequence error occurs, the cards will start sorting into pocket 11. The sort impulse is wired through the normal sides of selectors 51-59, and through the transferred side of selector 60, to sort pocket 11.

6. Selector 59 will be picked up when the second sequence error occurs. The low sequence impulse is wired through the normal side of selectors 51-59 and through the transferred side of selector 60 to the pickup hubs of selector 59. When selector 59 transfers, the low sequence card and the following cards will sort into pocket 0. The machine operation is similar for the third to the ninth sequence errors, with the cards sorting into pockets 1-7 respectively.

7. When the tenth sequence error occurs, selector 51 transfers, the card is sorted into pocket 8, and the machine stops. However, the machine actually stops after two more cards are fed and they too would normally sort into pocket 8.

8. The two cards mentioned in step 7 will sort into pocket 8 if they are in sequence. If they are not in sequence, selector 50 transfers and they sort into pocket 9. At this time the machine actually stops feeding cards and selectors 51-60 drop back to normal since the recode hold impulse is eliminated through selector 51.

After the cards have been removed from the pockets, the restore key and the start key are depressed, and

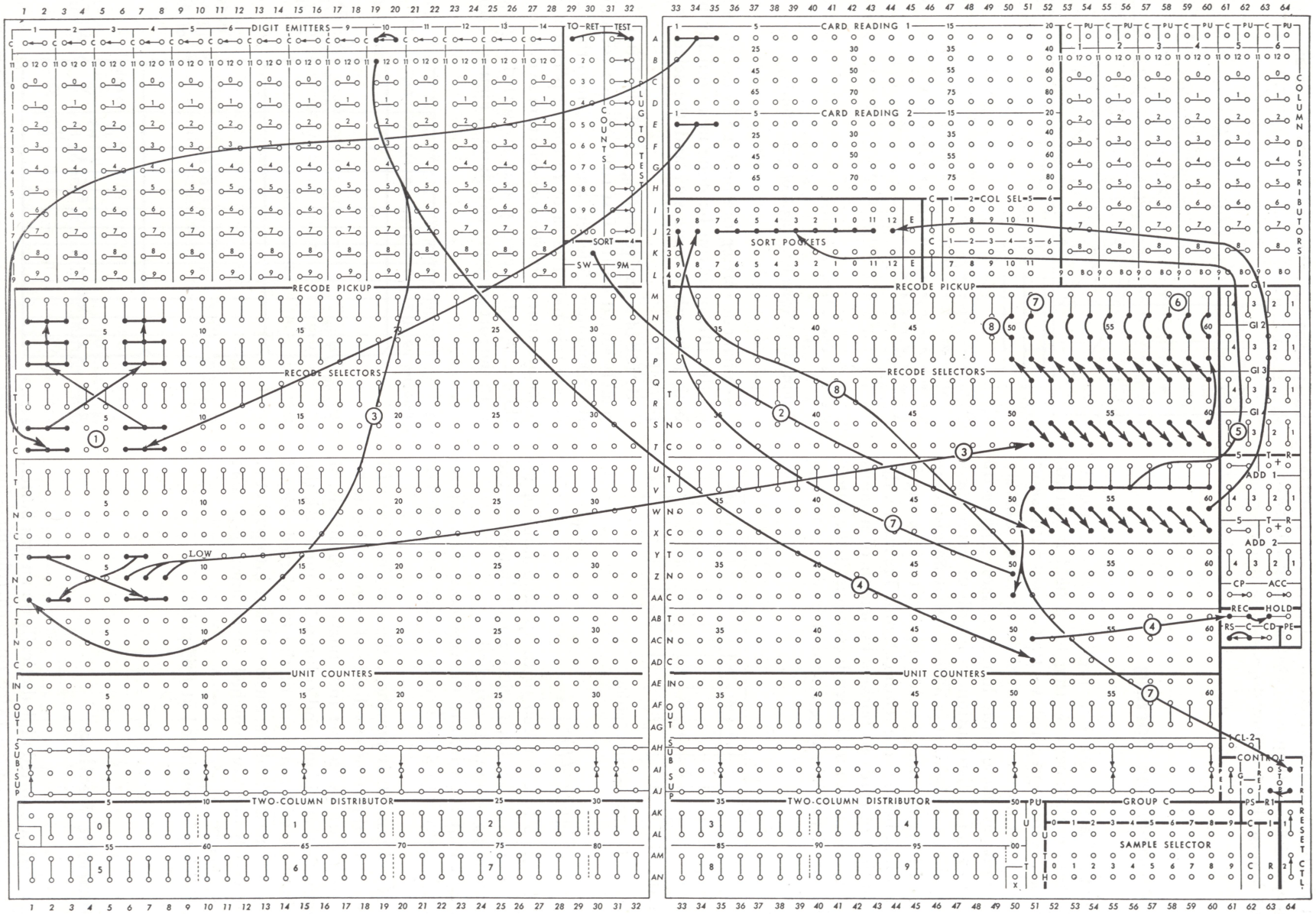


Figure 39. Sequence Checking with Pocket Progression

then the operation is resumed. With pocket progression, operators are frequently able to locate and correct errors before the machine stops.

Length-of-Name Sorting

A length-of-name sort is a preliminary sort usually made before alphabetic sorting for a field is started. The cards are segregated so that those with short names do not have to be sorted on the same number of columns as those with longer names. Figure 40 shows a possible distribution by length of name for a 15-column name field. It is assumed that no cards are punched in fewer than 4 columns, and that sorting is not required beyond the tenth column. Therefore, the distribution of cards to pockets by length of name is made for the fourth to the tenth columns of the name. The control panel wiring required is shown in Figure 41.

Pockets	9	8	7	6	5	4	3	2	1	0	11	12	Rej
Number of letters in the name			4	5	6	7	8	9	10 or more				

Figure 40. Length-of-Name Sorting

Wiring (Figure 41)

1. Columns 5-10 are wired to the pickup hubs of recode selectors 25-30. Each selector will transfer if the corresponding column is punched.

2. Sort hub 4 is wired to the common of recode selector 30. Sort hub 4 is used since the sort switch is set on 1.

3. If column 10 is punched, the sort impulse will come out of the transferred side of recode selector 30 to cause the cards to sort into pocket 1. Similarly, if columns 6-10 are blank and column 5 is punched, the sort impulse will come out of the transferred side of recode selector 25 and the cards will sort into pocket 6. Cards which are not punched in columns 5-10 sort into pocket 7.

4. Editing is concluded at this point.

Alphabetic Sorting

When cards are sorted alphabetically on an IBM Sorter, they are usually sorted twice on each column — first numerically and then by zone.

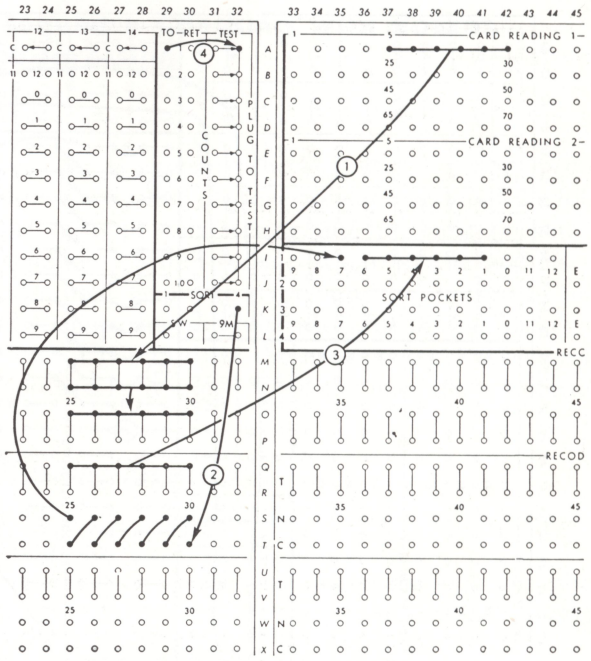


Figure 41. Wiring for Length-of-Name Sorting

Alphabetic sorting can be done in the same manner on the 101, or it can be done more quickly by using both a length-of-name sort and the selective sorting principle.

By use of selective sorting, 11 of the letters are completely sorted on the first run for each column, while the remaining 15 letters are sorted into the 12 pocket or are rejected. The cards in the 12 pocket are sorted a second time with the sort selection switch on 3; then the cards in the reject pocket are sorted a second time with the sort selection switch on 4. Figure 42 illustrates

Pockets	9	8	7	6	5	4	3	2	1	0	11	12	Rej	
Run 2B	Z	W	T	Q									Blank	Cards from Reject Pocket of Run 1
Run 2A	Y	V	S	P	N	L	J	H	F	D	B			Cards from 12 Pocket of Run 1
Run 1	X	U	R	O	M	K	I	G	E	C	A	Y JV HS FP DN BL	Blank Z W T Q	All Cards
												2A	2B	

Figure 42. Alphabetic Sorting

this procedure and Figure 43 shows the control panel wiring required.

E (Exit, Sort Rows) (J-L, 45). The E hub of a sort row is common to all the hubs (9-12) in that row, provided the sort selection switch is *not* set on that row. For example, if the sort selection switch were set on 2, E hub 3 would be common to the 9-12 hubs in row 3, E hub 4 would be common to the 9-12 hubs of row 4, and E hub 2 would be inactive.

Wiring (Figure 43)

Since 26 letters must be recognized in alphabetic sorting, the sort impulse must be distributed through 26 different paths. These paths may be set up with three recode selectors to recognize zone punching and three column distributors to recognize numerical punching.

1. The columns to be sorted are wired to column selection switch 1. The common hub of the column selection switch is wired to the pickups of both recode selectors (1, 2, and 3) and the column distributors (1, 2, and 3). If the column selection switch is set on 10, column 10 will be read.

2. The upper pickup hubs of recode selectors 1-3 are wired from digit emitter 12, 11, and 0 respectively. Selector 1 will transfer if the column being sorted is punched 12; selector 2 if the column being sorted is punched 11; and selector 3 if the column being sorted is punched 0.

3. Sort 1 is wired through selectors 1-3. The transferred sides of selectors 1-3 are wired to the C hubs of column distributors 1-3, respectively. Column distributor 1 distributes the sort impulse for letters A-I; column distributor 2 for letters J-R; and column distributor 3 for letters S-Z.

4. The sort pockets of sort rows 2, 3, and 4 are wired from the exit hubs of column distributors 1-3, as indicated by the letters. On the first sort, the sort selection switch is set on 2 and all cards will be run. On the second sort the switch is set on 3, and only cards from the 12 pocket of run 1 are used. The switch is then set on 4 and only cards from the reject pocket of run 1 are used.

5. When the sort selection switch is set on 2, only those letters wired to sort row 2 sort alphabetically. All other letters are either rejected or sorted into pocket 12. The letters that fall into the 12 pocket are later sorted alphabetically on run 2A. The letters that fall in the reject pocket are later sorted alphabetically on run 2B.

NOTE: The wiring in Figure 41 may be combined with that in Figure 43, so both the length-of-name sort and the alphabetic sort can be done using one control panel.

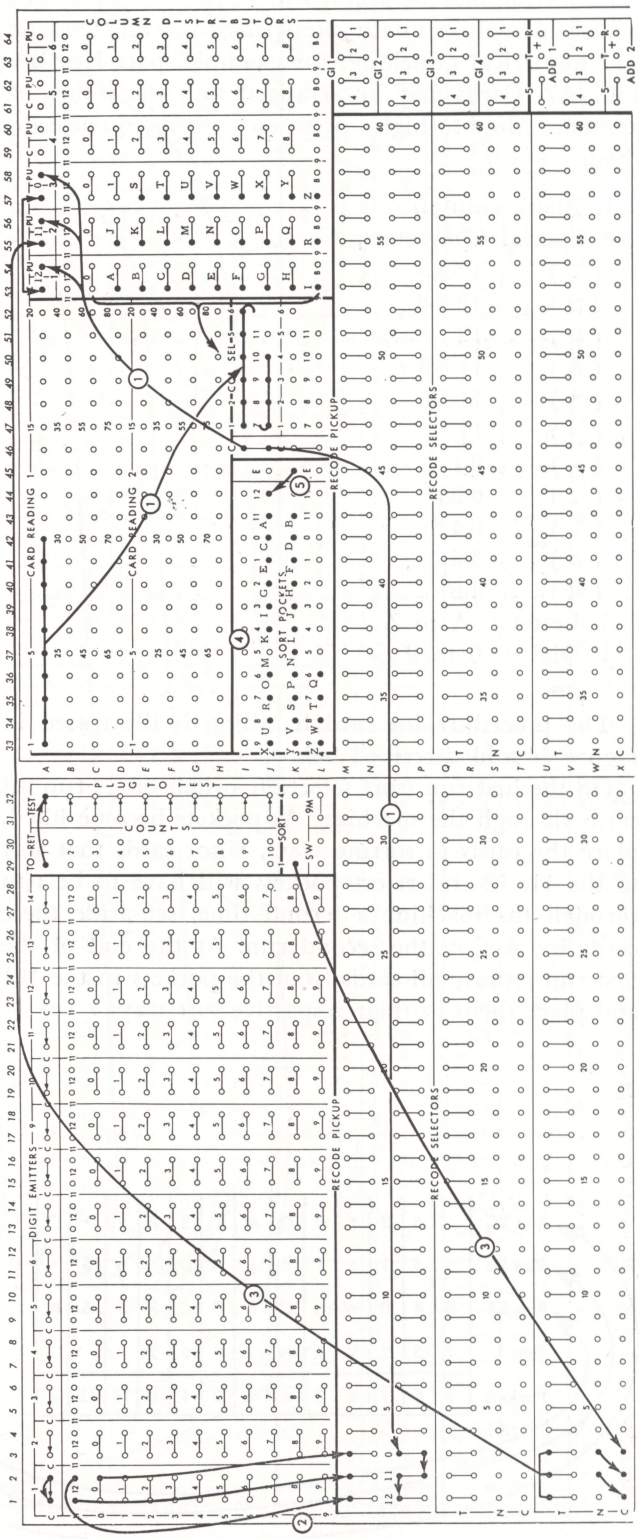


Figure 43. Wiring for Alphabetic Sorting

Sorting Special Characters, Letters and Numbers

Selective sorting principles used in Figure 44 for alphabetic sorting may be applied to sorting on alphabetic fields which also contain interspersed special character and numerical punching; for example, part No. BA-1357/AZ. Cards may be arranged into the following sequence (low to high), or to any other sequence desired.

1. Blank column
2. Special Characters:

(.)	12-3-8
(□)	12-4-8
(&)	12
($)	11-3-8
(*)	11-4-8
(–)	11
(/)	0-1
(,)	0-3-8
(%)	0-4-8
(#)	3-8
(@)	4-8

3. Letters: A to Z
4. Digits: 0 to 9

The procedure for card handling is illustrated in Figure 44 and described below.

On the first run (sort selection switch on 1) run all cards through the machine. As pockets become filled, place the cards in sorting trays. Since cards that sort in the 11, 12 and reject pockets will have to be run through the machine a second time, set aside these cards for use on the second run. At the end of the first run remove all cards from the pockets in the 101 and place them in their respective sort trays.

Run 2 will consist of three groups of cards (A, B, C), each group run separately. On run 2A (sort selection switch on 2) use the cards which were in the 11 pocket on run 1. After the run is completed, place the cards in the sort trays.

On run 2B (sort selection switch on 3) use the cards which were in the 12 pocket on run 1. After the run is completed, place the cards in the sort trays.

On run 2 C (sort selection switch on 4) use the cards which were in the reject pocket on run 1. After the run is completed, place the cards in the sort trays. Notice that the cards are now in sequence, and are ready to be sorted on the next column.

The wiring diagram for this operation (columns 13-15) is shown in Figure 45. The wiring is not explained since the principles used are similar to those used in Figure 43, "Alphabetic Sorting."

Consecutive-Number Checking

A file of cards may be checked to determine that each number is one higher than the preceding number (Figure 46). Consecutive-number checking may start with any number, and proceeds at 450 cards per minute. The machine is stopped whenever a non-consecutive card appears in the file.

The rule for checking consecutive numbers is:

1. Compare both numbers.
2. Starting from the left, the first unequal position must have a difference of one with the second card having the higher number.
3. All positions to the right must be 9's in the first card and 0's in the second card.

This is illustrated by the following four examples:

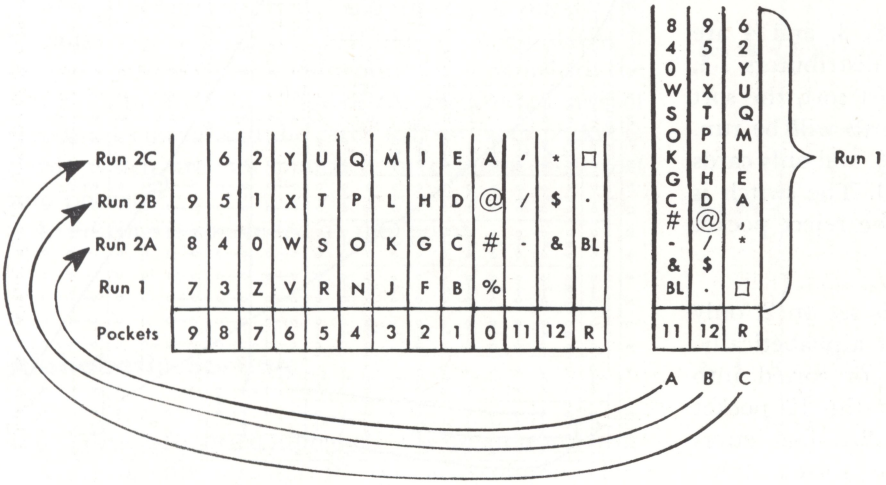


Figure 44. Sorting Special Characters, Letters, and Numbers

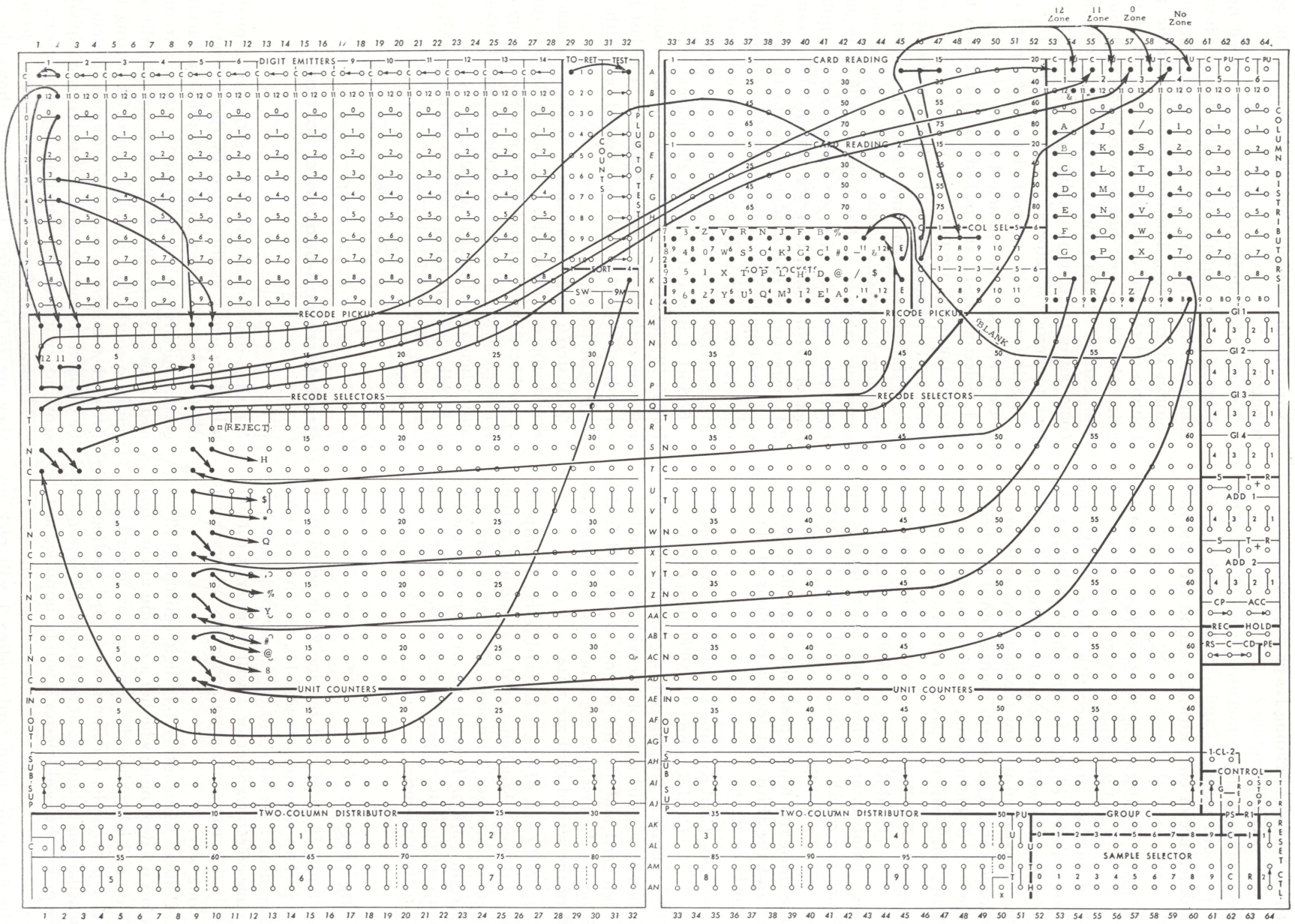


Figure 45. Wiring for the Sorting of Special Characters. Letters and Numbers

EXAMPLE 1: Card Reading 1 5675 (second card)
Card Reading 2 5674 (first card)

These numbers are consecutive, since (a) the first three positions are equal and (b) the fourth position has a difference of one, with the second card the high card.

EXAMPLE 2: Card Reading 1 5680 (second card)
Card Reading 2 5679 (first card)

These numbers are consecutive, since (a) the first two positions are equal, (b) the third position has a difference of one with the second card higher, and (c) the fourth position is 9 for the first card and zero for the second card. The fourth position must be checked for the 9 to 0 relationship, so that numbers such as 9683 and 9679 will not pass as consecutive numbers.

EXAMPLE 3: Card Reading 1 5700 (second card)
Card Reading 2 5699 (first card)

These numbers are consecutive, since (a) the first positions are equal, (b) the second positions have a difference of one with the second card higher, and (c) the third and fourth positions of the first card are nines and the third and fourth positions of the second card are zeros.

EXAMPLE 4: Card Reading 1 6000 (second card)
Card Reading 2 5999 (first card)

These numbers are consecutive, since (a) the first positions have a difference of one with the second card the high card and (b) the second, third, and fourth positions of the first card are nines and the same positions of the second card are zeros.

CL1, CL2 (AH, 61-62). CL (card lever) 1 emits impulses 9 through 12 when a card is at the first station. CL2 emits impulses 9 through 12 when a card is at the second station. These hubs are normally used to pick up selectors to suspend operations on the run-in and on the run-out.

Wiring (Figure 46)

1. Columns 65-68 of card reading 2 are wired to the lower pickup hubs of selectors 1-4. Columns 65-68 of card reading 1 are wired to the upper pickup hubs of the same selectors. Selector 1 will transfer if columns 65 at both stations are equal. Selectors 2-4 operate in the same way.

2. Column distributors 1-4, digit emitters 9-12 and selectors 6-9 determine whether a column at card reading 1 is one higher than the same column at card reading 2. For example, if column 68 at card reading 1 is punched 5 and column 68 at card reading 2 is punched 4, the pickup hubs of selector 9 will be impulsed as follows:

The 5 impulse from card reading 1 will pick up column distributor 4. Column 68 of card reading 2 is wired to the common hub of the same column distributor.

Because the column distributor was picked up by a 5 impulse, any impulse after 5 that is wired into the common hub will come out of the 5 exit hub of the column distributor. Therefore, the 4 impulse from column 68 of card reading 2 will come out of the 5 exit hub. The 5 exit hub is wired to the 4 hub of digit emitter 12. If a 4 impulse reaches this hub, it will come out of the common hub of the digit emitter and pick up recode selector 9.

3. Selectors 11-13 are picked up if columns 66-68 at card reading 1 are punched zeros.

4. Selectors 15-17 are picked up if columns 66-68 at card reading 2 are punched nines.

5. An 11 impulse from the digit emitter is wired to test the selectors. The impulse will come out of the transferred side of selector 9 for cards punched as shown in example 1. The impulse will come out of either the second, third, or fourth transfer hubs of selector 17 for cards that are punched like examples 2-4, respectively. If a card is equal to the preceding card, the impulse will come out of the transferred side of selector 4. Selector 20 transfers for consecutive numbers. Selector 19 transfers for duplicate numbers.

6. Sort 4 is wired through the normal sides of selectors 19 and 20 to stop the machine if a number is not consecutive and is not a duplicate. The last three cards in pocket 11 should be checked before the machine is restarted.

7. If step 6 were wired directly to stop, the machine would stop on the run-in, i. e., when the first card is at card reading 1. Therefore, it is wired through the transferred side of recode selector 40, which transfers only when a card is at card reading 2.

8. All duplicate cards sort into pocket 12. All other cards sort into pocket 11.

Predetermined-Sequence Sorting

Multiple digit numbers can be sorted to a predetermined sequence as illustrated by the sorting of two-digit state codes into regions, with the states arranged geographically within the region. Starting from the east, states are usually arranged geographically from north to south. The principles used for sorting these two-digit numbers into a predetermined sequence can be applied to sorting cards for states into alphabetic sequence by region or to sorting larger numbers.

The states are first listed in the sequence to which they are to be sorted. Figure 47A shows the states listed in their geographic arrangement within region.

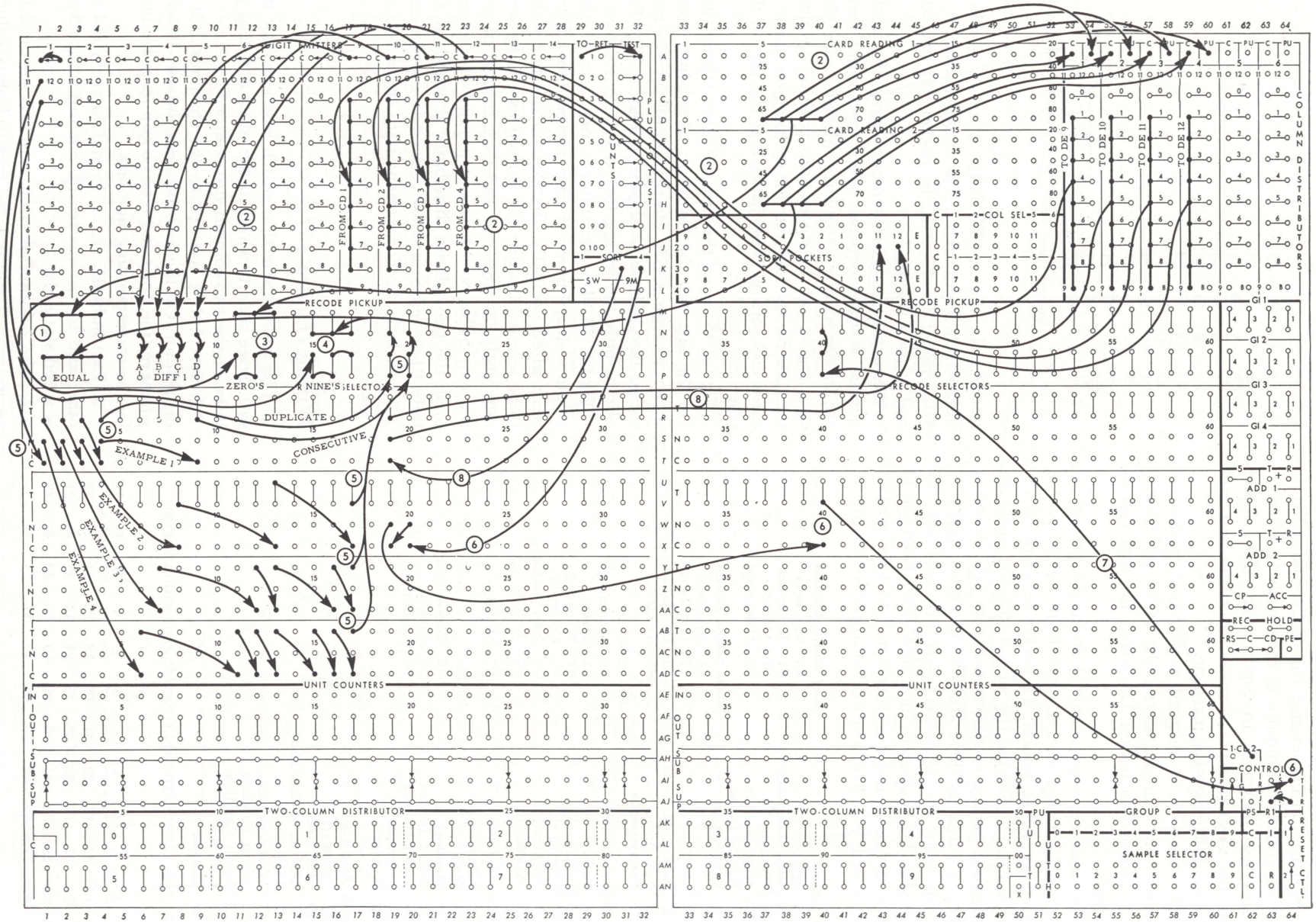


Figure 46. Consecutive Number Checking

In preparation for sorting, the predetermined state codes are listed horizontally in rows with 12 codes to the row, as illustrated in Figure 47B. This figure shows the arrangement of states after the first run of the cards through the machine.

Each state code is assigned to sort into pockets as indicated. For example, state codes 18, 21, 45, 35 and 04 are assigned to pocket 12 during the first run of the cards.

The cards are then removed from the pockets as for normal sorting; that is, cards from the 12 pocket in front of the 11 pocket, 11 pocket in front of the zero pocket, etc. During the second run, the cards are arranged in pockets as shown in Figure 47C. As many pockets are used as there are rows in Figure 47B.

Cards from the 12 pocket sort first and are distributed to five pockets as indicated; cards from the 11 pocket sort next and are distributed to four pockets as indicated; etc. Notice also that a horizontal row of numbers in Figure 47B is the same as a column of numbers in Figure 47C. The underscoring in Figure 47C (under 06, 37, etc., in pocket 12) indicates the end of each region.

When the cards are removed from the pockets in normal sorting sequence after the second sort, they are in the required sequence. Master cards (9M) for each region can be sorted into position by punching the code for the last state for each region in the master cards and sorting them in back of the file on the first run.

Figure 48 shows the control panel wiring required. On the first run the cards are sorted into pockets as shown in Figure 47B. On the second run the cards are sorted into pockets as shown in Figure 47C. For simplicity, only the wiring for pocket 12 is shown.

Figure 48 also illustrates a new use of the two-column distributor. If the two-column distributor were wired normally, the exit hubs 1-49 would have to be selected because the various exit hubs are wired differently on runs one and two. Instead of selecting the exit hubs (which would require 13 recode selectors), the two-column distributor is wired so (a) exit hubs 01-49 represent state codes 1-49 on run one, and (b) exit hubs 51-99 represent state codes 1-49 on run two.

New England
- 18 Maine
- 28 New Hampshire
- 44 Vermont
- 20 Massachusetts
- 38 Rhode Island
- 06 Connecticut

Middle Atlantic
- 31 New York
- 29 New Jersey
- 37 Pennsylvania

East North Central
- 34 Ohio
- 13 Indiana
- 12 Illinois
- 21 Michigan
- 48 Wisconsin

West North Central
- 22 Minnesota
- 14 Iowa
- 24 Missouri
- 33 North Dakota
- 40 South Dakota
- 26 Nebraska
- 15 Kansas

South Atlantic
- 07 Delaware
- 19 Maryland
- 08 District of Columbia
- 45 Virginia
- 47 West Virginia
- 32 North Carolina
- 39 South Carolina
- 10 Georgia
- 09 Florida

East South Central
- 16 Kentucky
- 41 Tennessee
- 01 Alabama
- 23 Mississippi

West South Central
- 03 Arkansas
- 17 Louisiana
- 35 Oklahoma
- 42 Texas

Mountain
- 25 Montana
- 11 Idaho
- 49 Wyoming
- 05 Colorado
- 30 New Mexico
- 02 Arizona
- 43 Utah
- 27 Nevada

Pacific
- 46 Washington
- 36 Oregon
- 04 California

Figure 47A. States Arranged Geographically within Region

9	8	7	6	5	4	3	2	1	0	11	12
12	13	34	37	29	31	06	38	20	44	28	18
08	19	07	15	26	40	33	24	14	22	48	21
17	03	23	01	41	16	09	10	39	32	47	45
36	46	27	43	02	30	05	49	11	25	42	35
											04

Figure 47B. First Run

2	1	0	11	12
04	35	45	21	18
	42	47	48	28
	25	32	22	44
	11	39	14	20
	49	10	24	38
	05	09	33	06
	30	16	40	31
	02	41	26	29
	43	01	15	37
	27	23	07	34
	46	03	19	13
	36	17	08	12

Figure 47C. Second Run

Wiring (Figure 48)

1. The column selection switch is set on 1 for the first sort. State code is wired to the units and tens pickup hubs of the two-column distributor.

2. Sort hub 4 is wired to the common hub of the distributor. On the first sort, exit hubs 01-49 will emit whenever the units and tens pickup hubs are impulsed by the corresponding numbers.

3. Exit hubs 04, 18, 21, 35 and 45 are wired to each other and to sort pocket 12. Sorting for pockets 11-9 is wired similarly.

4. The column selection switch is set on 2 for the second run. Therefore, the pickup hub of column distributor 1 is impulsed from column 79.

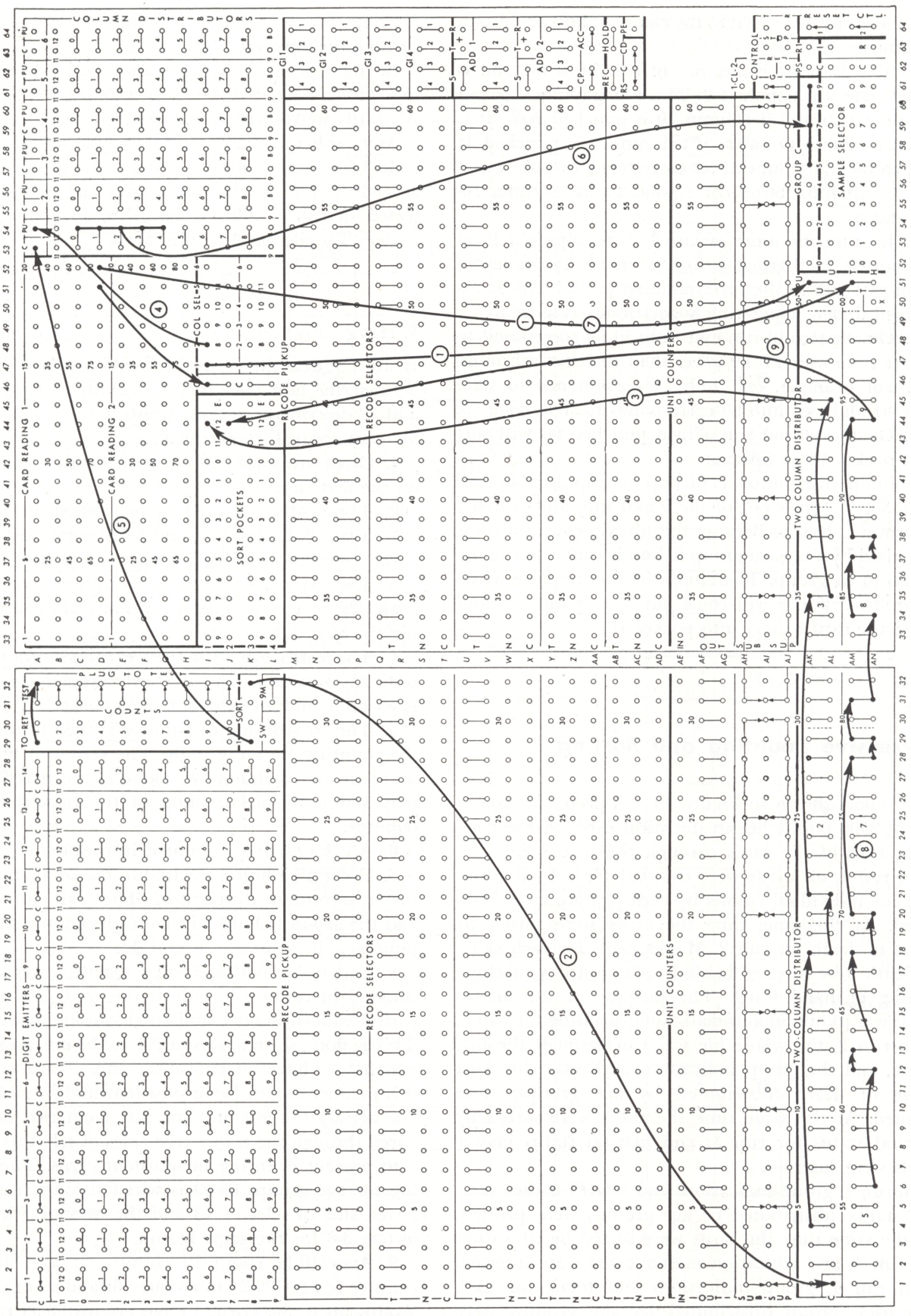


Figure 48. Wiring for Figure 47

5. Sort hub 1 is wired to the common hub of column distributor 1.

6. This impulse comes out of exit hubs 0-4 and is wired to group C hubs 5-9. The sort impulse is wired to group C hub 5 if column 79 is punched zero; it is wired to group C hub 6 if column 79 is punched 1; and so on. Exit hubs 51-59 correspond to state codes 01-09; exit hubs 60-69 correspond to states codes 10-19; and so on.

7. Because the units pickup hub is impulsed from column 80, each group C hub is internally connected to an exit hub in the corresponding group. This is explained under "Operating Suggestions" (Figure 67).

8. On the second run exit hubs 51-59 correspond to a state code which is 50 lower than the exit hub number. For example, exit hub 51 corresponds to state code 01 and exit hub 99 corresponds to state code 49.

9. On the second run a card punched 06 will sort into pocket 12 as follows:

Column distributor 1 pickup is impulsed by the zero. Sort 1 comes out of the 0 exit hub and is wired to group C hub 5. Because the units pickup hub was impulsed by a 6, each group C hub is connected to the 6 hub in its group. Therefore, the sort impulse wired to group C hub 5 will come out of exit hub 56, and cause the card to sort into pocket 12.

Successive Counting and Sorting

The report shown in Figure 49 was prepared from a file of 2500 public health statistical cards in five complete runs of the cards through the machine.

In run 1, all cards were counted for a total count and for individual counts by each age group as indicated. At the same time the cards were sorted by cause of death for run 2. Master cards for each cause of death were inserted behind each group by machine sorting or hand filing. The purpose of the master cards was to obtain automatic total printing for run 2.

In run 2, the whole file was run through the machine, and the group indications and totals for each cause of death (distributed by age groups) were printed. At the same time the cards were sorted by marital status for run 3, and marital status master cards were inserted.

In run 3, group indications and totals for each marital status (distributed by age groups) were printed. At the same time the cards were sorted by education for run 4, and education master cards were inserted.

In run 4, group indications and totals for each education group (distributed by age groups) were printed. At the same time the cards were sorted by earnings code for run 5, and master cards for each earnings group were inserted.

In run 5, group indications and totals for each earnings group (distributed by age groups) were printed. All cards were sorted into pocket 11.

Any cards punched with impossible codes (such as code 8 for marital status), or inconsistent codes (such as code 2 for marital status and age 0-4) were rejected in run 1. This is described in greater detail under "Pre-editing Multiple Sorts."

Wiring (Figure 50)

Items 1-4 describe how the cards are sorted. Items 5-9 describe how the cards are counted. Items 10, 11, and 12 describe print end, group indication, and master card control, respectively.

1. Cards are sorted by cause of death (column 52) on the first run.

2. The cards are sorted by marital status (column 66) on run 2. Codes 3, 4, and 5 are combined for the "other" classification shown on the report.

3. The cards are sorted by education groups (column 22) on run 3. The education code controls the pickup of recode selectors 1-8.

4. The cards are sorted by earnings groups (column 28) on run 4. On run 5 the sort selection switch is set on 5, and all cards sort into pocket 11.

5. The two-column distributor is used to distribute the counting by age groups. The tens and units columns of age (columns 76 and 77) are wired to the tens and units pickup hubs of the two-column distributor.

6. All the cards are counted in counter 1.

7. Counts to hub 2 is wired to the common hub of the two-column distributor. The exit hubs 00-99 and the group C hubs will emit, depending upon the punching in columns 76 and 77.

8. Exit hubs 00-04 are wired together. Ages 0-4 are counted in counter 2, only if the cards are punched with 0 education code and single marital status code. This is done since a person 0-4 could not possibly be married or have an education and a card coded in this manner would be inconsistent and should reject. For age 00-04 the count impulse from exit hub 4 is wired through the transferred sides of selectors 13 and 1 to prevent counting inconsistent cards. The counting for age groups 05-09 is wired through the transferred side of selector 13 and the normal sides of selectors 3-8 for the same reason.

9. Ages 10-14 count in counter 4; ages 15-19 in counter 5; ages 20-24 in counter 6; and so on, for age groups up to 80. Cards in age groups 80-99 count in counter 18.

Report - Totals by Age Group

Run No.	Count Classification	G. I.	Tot 1	Age Groups 0-4	5-9	10-14	15-19	80-99	0 Check
				2	3	4	5	18	19
1	All Cards		2500	150	200	175	225	4	0
2.	Cause of Death								
	Infectious	1	275	1	4	12	9		0
	Respiratory	2	26		1		2	4	0
	Accident	3	112	40	18	16	7		0
	Other	4	2087	109	177	147	207		0
3.	Marital Status								
	Single	1	502	150	200	175	200	1	0
	Married	2	1117	*	*		24	1	0
	Other (3-5)	3	881	*	*		1	2	0
4.	Education								
	0 years		238	150	75	3	10		0
	1-8 years	1	316	*	125	79	104	2	0
	9-10 years	2	285	*	*	6	69		0
5.	Earnings								
	0-999		175	46	32	29	41		0
	1000-1999	1	108	28	12	6	3	4	0
	2000-2999	2	82	21	9	5	3		0
	etc.								

Sort Classification

Cause of Death

Marital Status

Education

Earnings

11 Pocket

*Inconsistent Codes

Figure 49. Successive Counting and Sorting

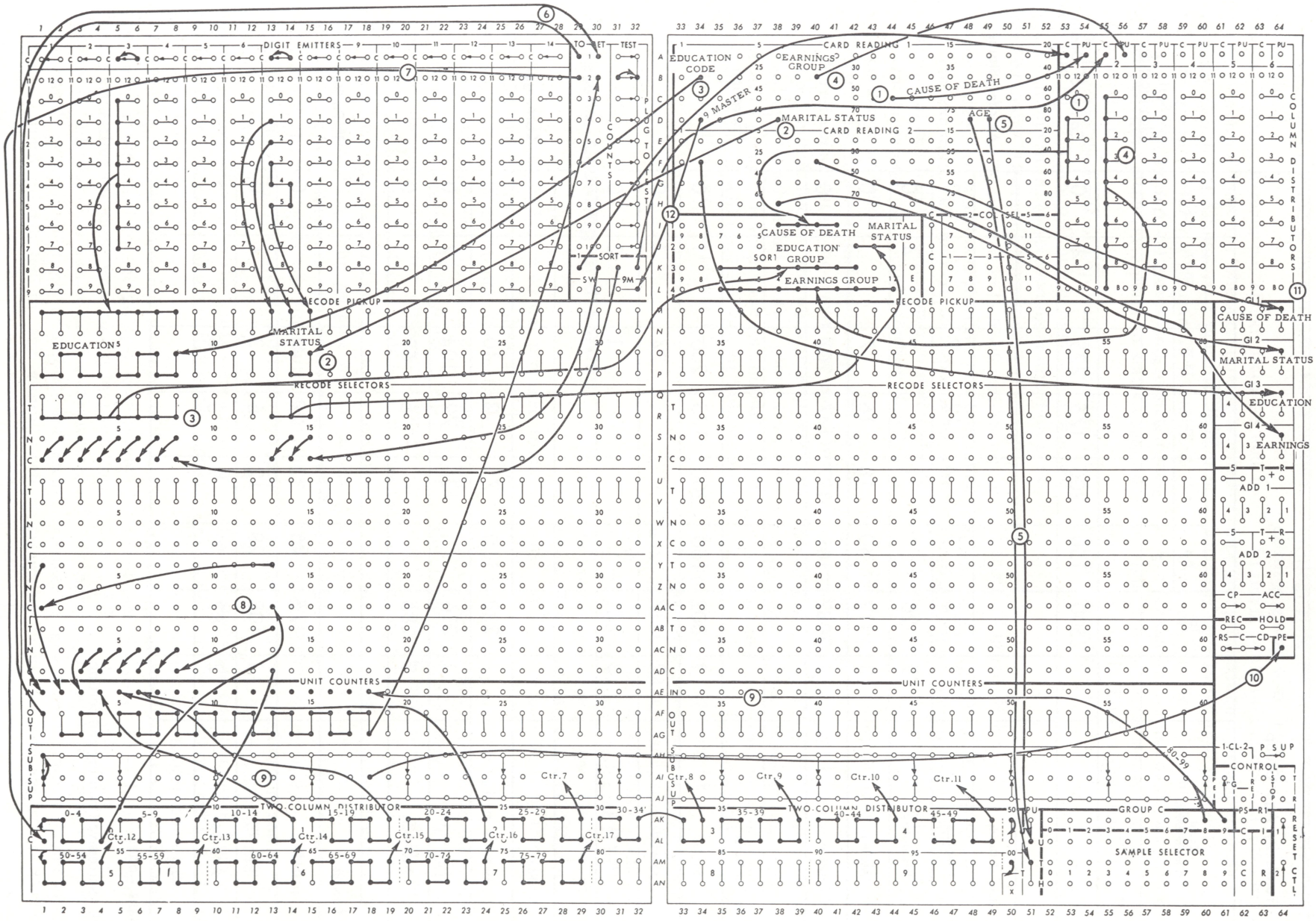


Figure 50. Wiring for Successive Counting and Sorting

10. Printing is stopped after counter 18. The zero check prints in column 19.

11. Group indications are wired for runs 2-5.

12. Master cards are punched 9 in column 62. Automatic total printing is obtained by wiring from card reading 1 to 9M. When the master cards are used for total printing, the 9-master switch is set to the DOWN position. When master cards are machine sorted, the 9-master switch is set to the UP position.

File Searching

A file of cards may be searched, selecting from the file all cards equal to a master card (Figure 51).

Wiring (Figure 51)

1. The six-column field in the master card is wired to the PU hubs of column distributors 1-6. These distributors hold up for the remainder of the run because recode-hold is impulsed whenever cards are at card reading 1. If the machine runs out of cards, the selectors drop and, therefore, the master card must be placed in front of the file when the run is restarted.

2. Emitted digits 9-0 are wired into the corresponding hubs of all the column distributors.

3. If a column distributor was picked up by a digit 3, a 3 will be emitted from the C hub of that distributor for every detail card. Thus, for every detail card, the lower pickup hubs of recode selectors 33-38 will be impulsed by a digit corresponding to the digit punched in the master card.

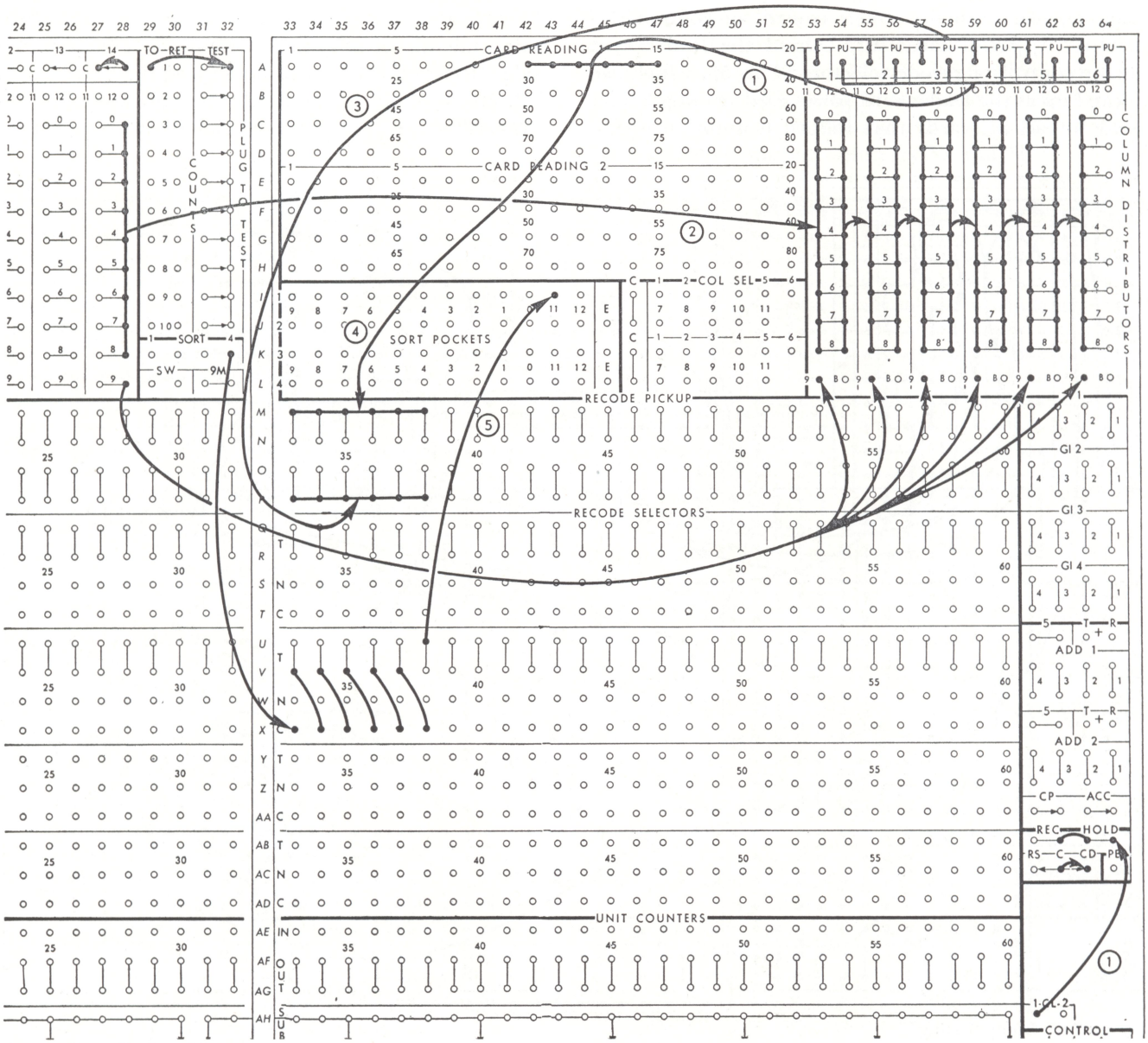


Figure 51. File Searching

4. The upper pickup hubs of recode selectors 33-38 are impulsed from each card. All the selectors will be transferred whenever the detail card is equal to the master card.

5. Detail cards that are equal to the master card sort into pocket 11. All other cards reject. The master card will also reject, since the column distributors are not operative until after the digits in the master card have been read.

Group Sorting

Groups of two or more cards may be sorted in accordance with the punching in "group-leader" cards, regardless of the punching in the detail cards behind each leader card. Figure 52 shows how group sorting may be accomplished. The principle used is that leader cards, identified by a distinguishing punch (X in column 1), sort normally under control of column distributor 1; detail cards sort behind the leader card under control of recode selectors 51 to 55, which are picked up as the leader card passes card reading 2, and held for all NX cards that follow. Column selection switches 1 and 2 are both set for the column being sorted.

Wiring (Figure 52)

1. Selector 34 transfers when an X-punched leader card passes card reading 1.

2. Column distributor 1 is picked up for each card. However, the column distributor is used only for leader cards since recode selector 34 selects the sort impulse for X-punched cards.

3. As the first detail card passes card reading 1, its leader card is at card reading 2. The leader card picks up recode selectors 51-55, which are held for all NX cards that follow. Recode selectors 51-55 are wired to operate like a column distributor, as illustrated in Figure 62. Since column distributor 1 is used for normal sorting of the leader cards, a second column distributor could not be used for sorting the detail cards. The reason is that column distributor 2 cannot be held independently of column distributor 1. Therefore, recode selectors must be used for sorting the detail cards.

4. Recode-hold is impulsed whenever there is a detail card at card reading 1 so that the reading set up

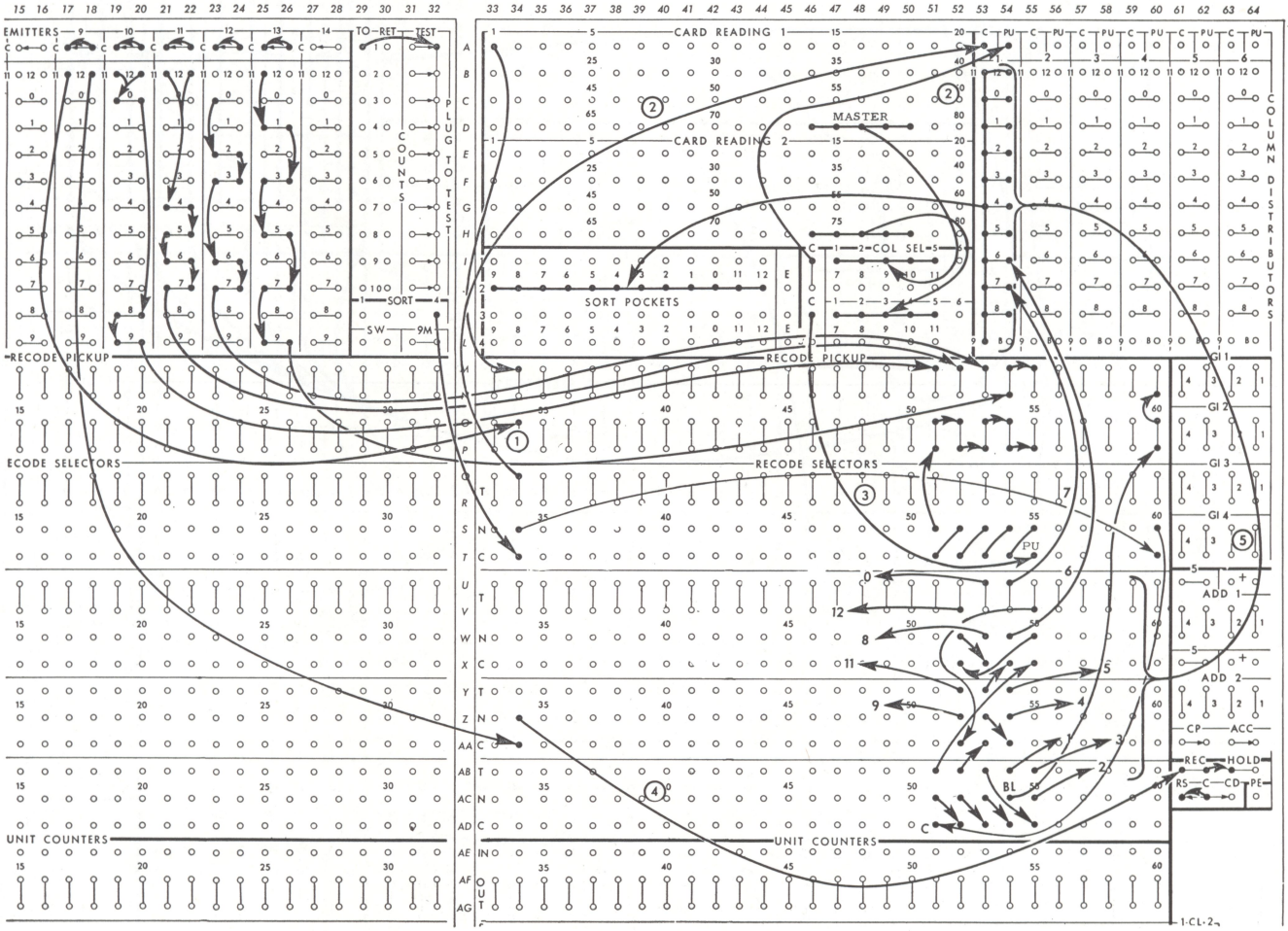


Figure 52. Group Sorting

by a leader card is held for every detail card that follows.

5. The sort impulse for detail cards is controlled through recode selectors 51-55. The numbered exits (12-9) are wired to sort pockets 12-9, respectively. Since these selectors are picked up by the leader card, each detail card will sort into the same pocket as the leader card. The presence of a blank (selector 54 normal) is used to prevent X leader cards which are blank in the X column from rejecting and missorting the detail cards.

Selecting the Nth Card of a Group

The example shown in Figure 53 selects the fifth card of each multiple card group into pocket 11. The remaining cards sort into pocket 12.

Wiring (Figure 53)

1. Recode selector 49 picks up, indicating a multiple card group.

2. A 12 impulse is wired through the transferred side of selector 49 to pick up selector 52 and recode-hold for the second card of a group.

3. In a similar manner, selector 53 is transferred for the third card, selector 54 for the fourth card, selector 55 for the fifth card, and selector 56 for all cards following the fifth. Recode selector 56 is necessary to prevent selecting all cards after the fifth.

4. Cards 1-4 are sorted into pocket 12 through the normal side of selector 55.

5. The fifth card is sorted into pocket 11 through the transferred side of selector 55 and the normal side of selector 56.

6. Cards after the fifth card are sorted into pocket 12 through the transferred side of selectors 55 and 56.

7. On each change of group, recode selector 49 is normal, but since recode hold was impulsed, selectors 52 through 55 remain transferred for one more cycle. In the event the *N*th card of a group is the last card, to prevent the first card of the next group from also sorting into pocket 11, a 12 impulse is wired through the normal side of selector 49 and picks up selector 56. If this condition arises, the sort impulse passes through the transferred sides of selectors 55 and 56.

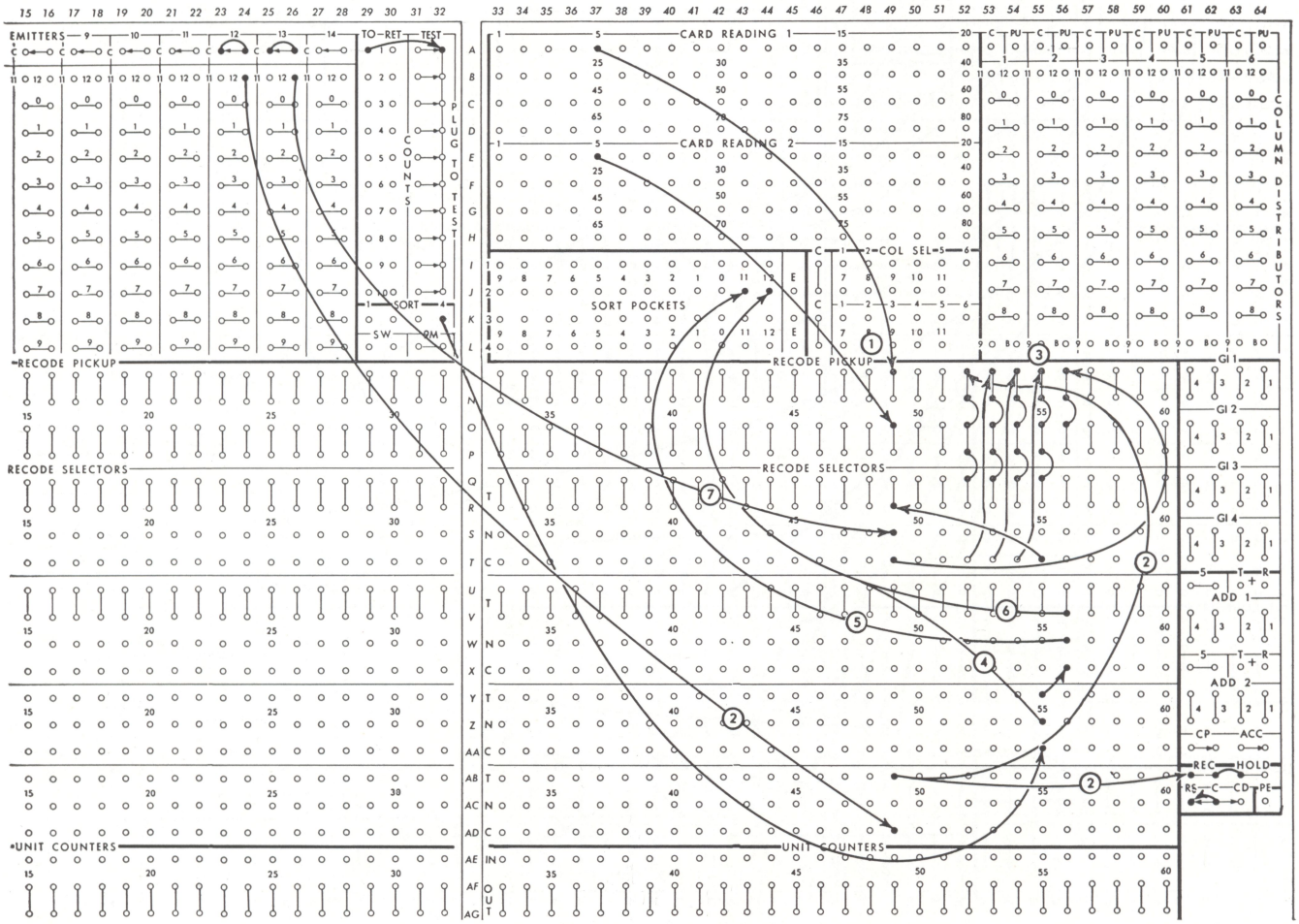


Figure 53. Selecting the Fifth Card of a Group

Selective Printing

Figure 54 shows the control panel wiring required to print the serial number of cards meeting specified conditions. Since sorting is not required, all cards drop in pocket 11 if the sort selection switch is set on 5.

In the example shown, the specified conditions are 258 in columns 23-25, which might mean a female (2), single (5), who speaks Spanish (8). Two methods are shown if two cards in succession meet the specified conditions. The first method prints the serial number for the first card but stops the machine for the second. The second method prints both serial numbers from two accumulating counters without stopping. If the stop method is used, the machine may be restarted by depressing the stop, restore, and start keys in that order.

Wiring (Figure 54)

1. The conditions read from the card are matched by specified conditions (2, 5, 8) from the digit emitter. Selectors 36-38 are transferred whenever the desired conditions are met.

2. The serial number field is wired to the accumulating counter entry.

3. Recode selector 51 transfers whenever a card meets the desired conditions. Recode selector 53 transfers one cycle later. Selectors 51 and 53 are both wired for recode-hold, and will remain transferred until a print cycle is completed.

4. The accumulating counter is wired to add for cards meeting the desired conditions. If several cards in succession meet the conditions, the accumulating counter will add the first, third, fifth, etc., cards.

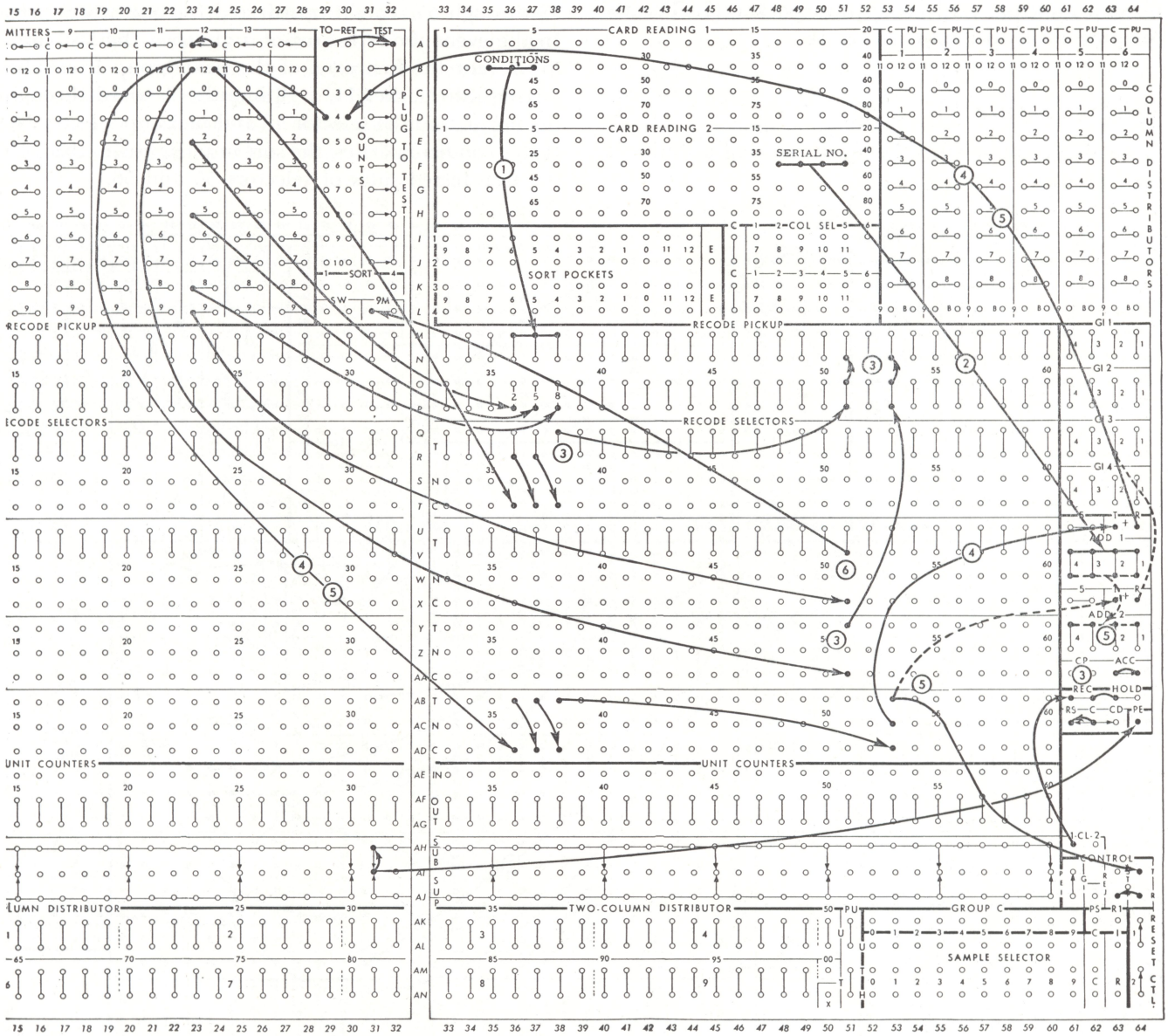


Figure 54. Printing the Serial Number of Cards with Conditions 2, 5, and 8

5. The machine stops whenever two cards in succession meet the desired conditions. If the alternate dotted wiring is used, the machine will not stop for the second, fourth, sixth, etc., cards, but will add the serial number in accumulating counter 2. Thus, when two cards in succession meet the specified conditions, both serial numbers will print on the same print cycle but from separate accumulating counters.

6. The print cycle is started by an emitted 9 wired to 9M through the transferred side of selector 51.

NOTE: In Figure 54, the conditions are set up from a digit emitter. By use of principles shown in Figure 51 *(File Searching),* the emitted digits may be controlled based on information punched in a master card.

Sorting Variable-Length Numbers

Normal procedure for punching code numbers is to line them up at a fixed right margin. For example, the units position of any number is always punched in the units position of the field, the tens position in the tens position of the field, etc. Fill-in zeros precede short numbers. In some applications, however, particularly when using part or order numbers supplied by other companies, the numbers are often punched at a fixed left margin and vary in length. Excess columns to the right of variable-length numbers are skipped. Thus, the punched digits do not line up as in normal punching procedure; yet, it is desired to sort them in the normal manner.

Figure 55 shows how variable-length numbers punched in a four-column field may be sorted. For the diagram shown, the sort selection switch is always set at 1; the column selection switch is set at 1 for the first sort, 2 for the second sort, 3 for the third sort, and 4 for the fourth sort.

Wiring (Figure 55)

1. The field to be sorted is punched in columns 1-4. These columns are wired to the pickup hubs of column distributors 1-4, and to the pickup hubs of recode selectors 42-45. Recode selectors 42-45 are used to deter-

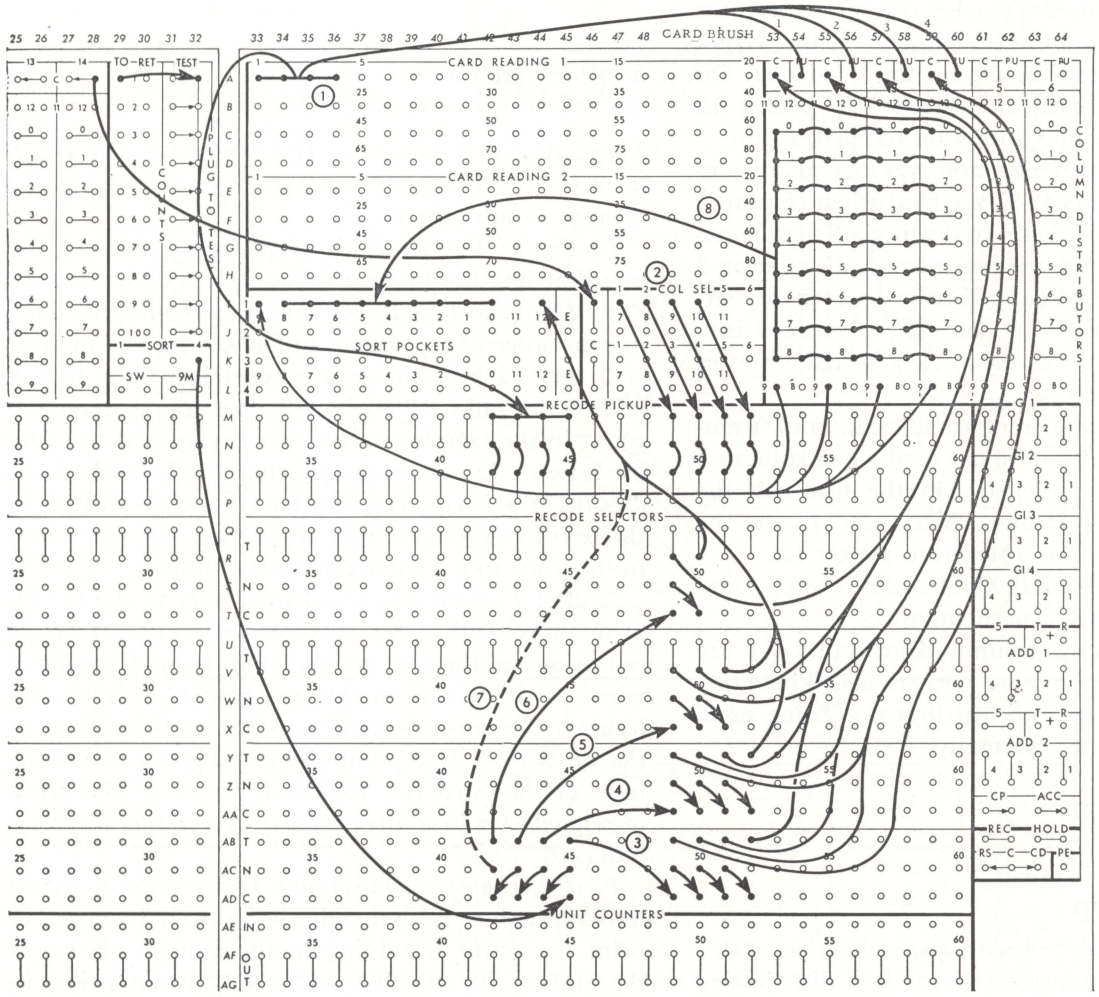


Figure 55. Sorting Variable-Length Numbers

mine the length of the number. Column distributors 1-4 are used for sorting, but only one of them will be used for any one card in any one run. The column distributor used will vary with the length of the number and the setting of the column selection switch.

2. Recode selectors 49-52 are used to control the sorting for each of the four different runs. The column selection switch is set on 1 for the first run, 2 for the second run, and so on. Therefore, recode selector 49 is picked up for the units sort, recode selector 50 for the tens sort, and so on.

3. If the fourth column is punched (indicating a 4-digit number) the sort impulse is distributed through the fourth set of common, normal and transferred hubs of recode selectors 49-52. Therefore, the sort impulse will reach the common hub of column distributor 4 on the first sort. In a similar manner, the sort impulse reaches the common hub of column distributor 3 on the second sort, 2 on the third sort, and 1 on the last sort.

4. The third set of common, normal, and transferred hubs of selectors 49-52 are used when column 3 is the last column punched (indicating a 3-digit number). The sort impulse reaches column distributor 3 on the first sort, column distributor 2 on the second sort, and column distributor 1 on the third sort. On the fourth sort the card is selected into pocket 12 because it was completely sorted on the first 3 runs.

5. The second set of common, normal and transferred hubs of selectors 49-51 are used when column 2 is the last column punched (indicating a 2-digit number). The sort impulse reaches column distributor 2 on the first sort and column distributor 1 on the second sort. On the third sort the card is selected into pocket 12 because it was completely sorted on runs 1 and 2.

6. The first set of common, normal, and transferred hubs of selectors 49-50 are used when column 1 is the only column punched. On the first run the sort impulse reaches column distributor 1. On the second run the cards are sorted into pocket 12.

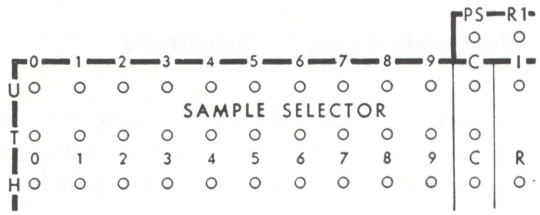
7. This wire is added if blank columns are interspersed in the variable-length numbers.

8. The exit hubs of column distributors 1-4 are connected and wired to sort pockets 0-9. Therefore, regardless of which column distributor is being used, the cards will be sorted normally.

Sample Selection

The 101 may be equipped with a sample selector as a special device. The sample selector is a distributing unit controlled by counting cards. It may be used to count any number of cards from 1 to 999 and to pick up recode selectors to control counting or sorting for any *N*th card; for example, every 4th, 50th, or 225th card, or every 4th, 50th, or 225th card of a special classification. By control panel wiring, the counter may be reset to zero or 1. It is reset to zero if the count used to make the selection is one less than the desired count; it is reset to 1 if the count used to make the selection is exactly the desired count. For example, if the desired count is 37 and 037 is used to make the selection, the counter must be reset to 1; if 036 is used to make the selection, the counter must be reset to zero.

Figure 56 shows the control panel wiring required to select the cards for every 37th female into pocket 2. All other cards sort into pocket 1.



Sample Selector
AK, 62-63; AL-AN, 52-63

I (In). A sort or count impulse is wired to the I hub (directly or through selectors) to cause the sample selector to advance 1.

R (Reset). The R hub is wired from a selected sort or count impulse to reset the sample selector to zero.

R1 (Reset to 1). The R1 hub is split-wired to the I hub in order to reset the counter to 1 instead of zero.

C, 0-9. Each C hub is connected internally to any one of the hubs 0-9 to its left, depending upon the count in the sample selector. For example, if the sample selector has counted 125, the C hub in the hundredths row is connected to its 1 hub; the C hub in the tens row is connected to its 2 hub; and the C hub in the units row is connected to its 5 hub.

A digit 4 impulse is wired internally to the C hub of the hundredths row. This impulse will be available out of one of the hundredths 0-9 hubs, and usually is wired to the C hub of the tens row. One of the 0-9 hubs in the tens row is then wired to the C hub of the units row. The 4 impulse coming out of the 0-9 hubs of the units row usually is wired to pick up a recode selector to control counting or sorting for every *N*th card.

PS (Print Sample). This hub is wired to the R (reset) hub through a column selection switch in order to print the count remaining in the sample selector at the end of the run. The remaining count prints in the group indication column of the report form.

Wiring (Figure 56)

1. Males and females are identified by recode selectors 21 and 22, respectively.

2. Sort 4 is wired through the transferred side of selector 21 to sort all male cards into pocket 1. The sort impulse is also wired through the transferred side of selector 22 and the normal side of selector 35 to sort all but every 37th female card into pocket 1.

3. A count impulse is wired through the transferred side of selector 22 and through the normal side of selector 35 to the I (IN) hub of the sample selector. The sample selector will advance one for all females, except for every 37th female.

4. Recode selector 35 is picked up for every 37th female. The selector is transferred by a digit 4 which comes from the sample selector internally.

5. When selector 35 transfers, the card sorts into pocket 2. Thus, every 37th female card is selected.

6. The counter is reset for every 37th female card.

7. The R1 hub is split-wired to the IN hub to cause the counter to reset to 1 instead of zero, since count 037 is used to transfer recode selector 35. If count 036 were used to transfer the selector, the split-wire to R1 would not be necessary.

8. PS (print sample) is wired to the R (reset) hub when column selection switch 2 is set on 1. This is used at the end of the run to print the remaining sample count in the group indication column of the report form.

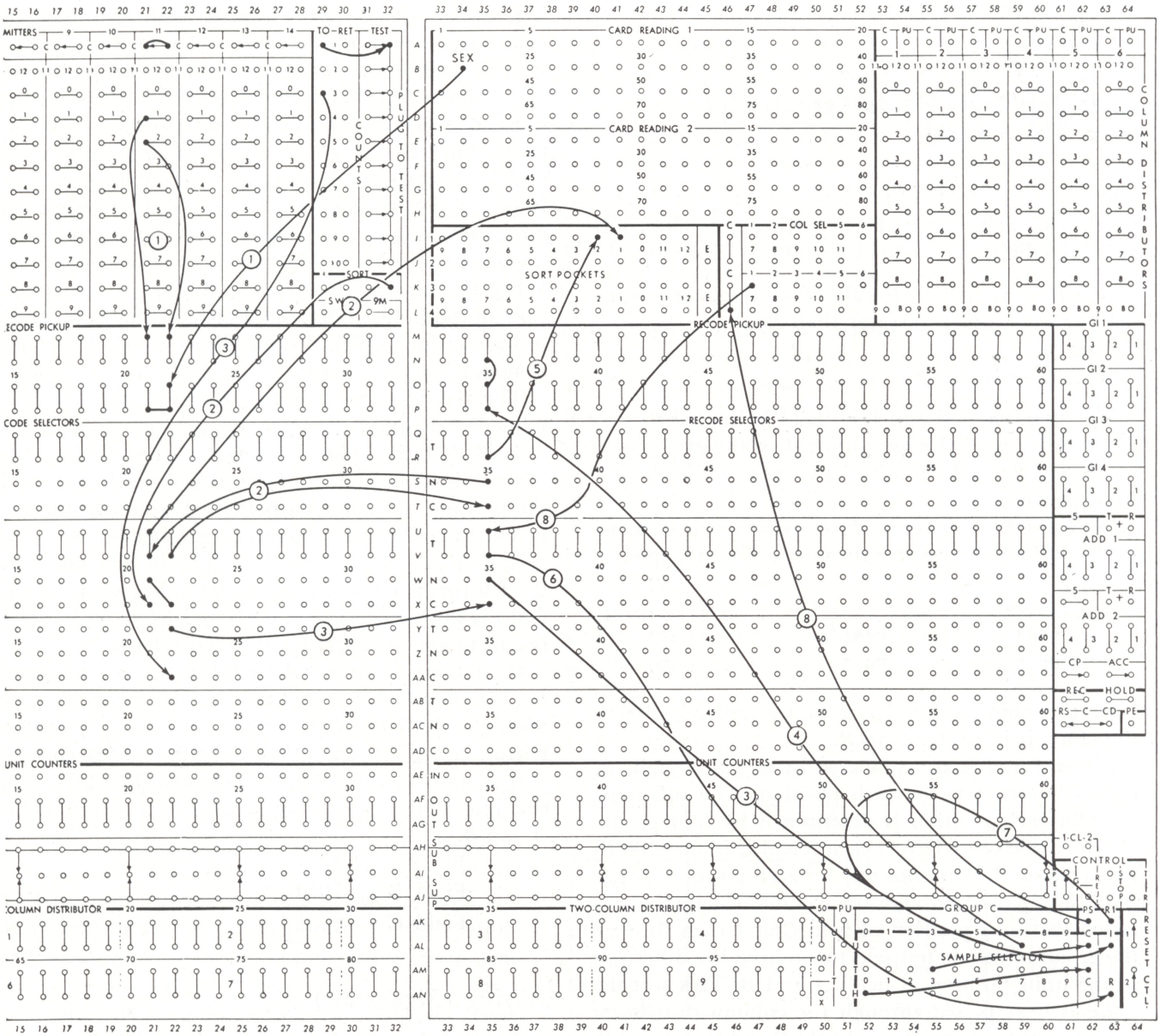


Figure 56. Sample Selection

Variations in Sample Selection

Multiple two-digit numbers, for example the 13th and 25th cards (8% sample), may be selected by split-wiring from the zero hub of the hundreds row to the C hubs of both the units and tens rows. The units number 3 (for 13) is wired to a pickup of a recode selector, and the tens number 1 (for 13) is wired to the other pickup of the same selector. The selector would thus transfer for 13. The same method would be used for the number 25; that is, the 5 is wired to a pickup and the 2 to the other pickup of the same selector. One selector is required for each two-digit number to be selected. Two selectors are required for each three-digit number to be selected. The recode selectors are used to control selection of the cards and the reset of the sample selector from the last number in the series.

Checking Two Fields Crossfooted to a Third Field

Two fields crossfooted to a third field may be checked on the 101 at the rate of 450 cards per minute, provided the digits in each field are positive. For example:

$A - B = C$ (where the absolute value of A is equal to or greater than B)

or

$B + C = A$

The maximum size of each field is limited to four digits. All three fields are punched in the card. Using recode selectors, the result of the equation is checked for correctness.

This check may be used on public utility meter readings, including meter turnovers. For example:

A	-	*B*	=	*C*
PRES. READING		PREV. READING		CONSUMPTION
8463		6431		2032
(1) 0025		9975		0050

In the above example, A is theoretically 10025; therefore, it is greater than B.

Fields A and B are compared by means of eight recode selectors, two for each position. The difference (0-9) in each position is determined by four groups of ten recode test selectors each. Field C is analyzed by four column distributors, one for each position. A sort impulse is passed through the column distributor analyzing the units position of field C and then through the group of recode test selectors testing the difference in the units position of fields A and B. This sort impulse is next passed through the column distributor analyzing the tens position of field C and then through the group of recode test selectors testing the difference in the tens position of fields A and B. If the selectors are properly set up (indicating correct crossfoot-checking), the sort impulse will reach the desired sort pocket. If the selectors do not allow the sort impulse to reach the sort pocket, the crossfoot-checking is incorrect and the card is rejected.

To assist in understanding the principles involved, the following specific example is used. Assuming that A is 8361 and B is 7940, the difference recognized by the selectors in each position is as follows:

Units	plus difference of 1
Tens	plus difference of 2
Hundreds	minus difference of 6
Thousands	plus difference of 1

In each group of recode test selectors a corresponding number of selectors transfer. Within a group of recode test selectors, plus differences are analyzed by the 0-9 row, and minus differences are analyzed by the 9-0 row (Figure 58). Which row is chosen depends on the status of the recode plus-minus selectors which recognize a high, low or equal condition in each position of field A compared against the corresponding position in field B. Depending on the status of the recode plus-minus selectors, a recode borrow selector in the next high-order position will be picked up or not picked up. When the plus-minus selectors recognize a low condition in field A, a borrow selector in the next high-order position is picked up, indicating that that position was borrowed from.

The recode selectors are wired and operate in the following manner.

A. If there is a plus difference in any position, the 0-9 row is chosen. Also, if the difference is plus and the position has not been borrowed from, an impulse is sent to and transfers another test selector.

B. If there is a minus difference in any position, the 9-0 row is chosen. Also, if the difference is minus and the position has been borrowed from, an impulse is sent to and transfers another test selector.

C. If there is an equal condition in any position, the borrow selector in that position designates the row through which the sort impulse will pass. When the borrow selector is transferred, the 9-0 row is chosen; if it is normal, the 0-9 row is chosen. The following example shows the actual difference between fields A and B.

Field A	8361
Field B	7940
Field C	0421

Wiring (Figure 58)

Individual 11 and 12 impulses from digit emitters 1, 2, 3, and 4 must be used.

Each digit of field *A* (8361) and field *B* (7940) and a digit impulse from digit emitter 1 transfers a compare recode selector.

1. The difference between the time of transfer of the recode compare selectors (46 and 47) for the units position allows digit impulses from digit emitter 1 to pass through the points of the recode compare selectors to transfer selectors 48 through 57 in the group. For the example used, selector 47 transfers at 1 time and selector 46 transfers at 0 time. As a result, a 0 time impulse is available. This impulse transfers selector 48 through its own normal side. The recode plus-minus selectors (58 and 59) for the units position recognize a plus difference and choose the 0-9 row. Because the units position has a plus difference and could never be borrowed from, the 12 impulse wired from digit emitter 4 passes through the transferred side of selector 58 and causes another test selector to transfer. Since selector 58 is transferred because of a plus difference, the 11 impulse from digit emitter 4 is blocked; therefore, the borrow selector in the tens position is not transferred.

2. Similarly the 6 and 4 in the tens position are compared by selectors 31 and 32. As a result digit impulses 5 and 4 are available and transfer selectors 33 and 34. The plus-minus selectors (43 and 44) for the tens position recognize a plus difference and choose the 0-9 row. Because the tens position has a plus difference, and is not borrowed from, the 12 impulse from digit emitter 3 passes through the normal side of selector 45 (borrow selector) and the transferred side of selector 43. It reaches and causes another test selector to transfer. Since selector 43 is transferred because of the plus difference, the 11 impulse from digit emitter 3 is blocked; therefore, the borrow selector in the hundreds position is not transferred.

3. The 3 and 9 in the hundreds position are compared by selectors 16 and 17. As a result, digit impulses 8 through 3 are available and transfer selectors 18, 19, 20, 21, 22, and 23. The plus-minus selectors recognize a minus difference and choose the 9-0 row. Because the hundreds position has a minus difference, and is not borrowed from, the 12 impulse from digit emitter 2 passes through the normal side of borrow selector 30, and is blocked at selector 28. Selector 28 is normal because of the minus difference. The minus difference and no borrow does not cause another test selector to be transferred. Since selector 28 is normal, the 11 impulse from digit emitter 2 is able to pass through and transfer borrow selector 15 in the thousands position.

4. The 8 and 7 in the thousands position are compared by selectors 1 and 2. As a result, digit impulse 7 is available and transfers selector 3. The plus-minus selectors recognize a plus difference and choose the 0-9 row. Because the thousands position has a plus difference and is borrowed from, the 12 impulse from digit emitter 1 cannot pass through the normal side of borrow selector 15 because this selector is transferred. Therefore, another test selector is not transferred. Figure 57 is a summary of the setup of the selectors by **position.**

5. When field *C* (0421) is read, each digit picks up a column distributor.

6. If zeros are always punched in the cards in fields *A* and *B*, then these fields are checked for blank columns. A sort impulse from sort hub 4 is wired through the transferred sides of the compare selectors in all four positions. All the compare selectors have to transfer between 0 through 9 time. If one does not, then a position in field *A* or *B* has a blank column and the card is rejected. The sort impulse, passing this check successfully, reaches the C hub of column distributor 4.

If zeros are not always punched in the cards in fields *A* and *B*, then the dotted wiring must be used in place of the wiring described above. Zero impulses from digit emitters 2 through 9 are wired to the common sides of the plus-minus recode selectors 13, 14, 28, 29, 43, 44, 58, and 59. The sort impulse is wired directly to the C hub of column distributor 4. At least one of the plus-minus selectors must transfer. If the columns are blank, the zero impulse transfers the plus-minus selectors.

7. The sort impulse is available from the 1 hub and reaches the 9-0 and 0-9 rows. In the units position the 0-9 row was chosen and two test selectors were transferred. The sort impulse passes through the transferred side of selector 49, comes out of the common, and is laced through the normal sides of the remaining test selectors. Since selector 58 is transferred because of the plus difference, the sort impulse is allowed to pass through and reaches the C hub of column distributor 3.

8. The sort impulse is available from the 2 hub and reaches the 9-0 and 0-9 rows. In the tens position the 0-9 row was chosen and three test selectors were transferred. The sort impulse reaches the transferred side of selector 35, comes out of the common, and is laced through the normal sides of the remaining test selectors. Since selector 43 is transferred and selector

Position	No. of Test Sel. Transferred	Condition	Row Chosen
Units	2	Plus	0-9
Tens	3	Plus	0-9
Hundreds	6	Minus	9-0
Thousands	1	Plus	0-9

Figure 57. Setup of Selectors by Position

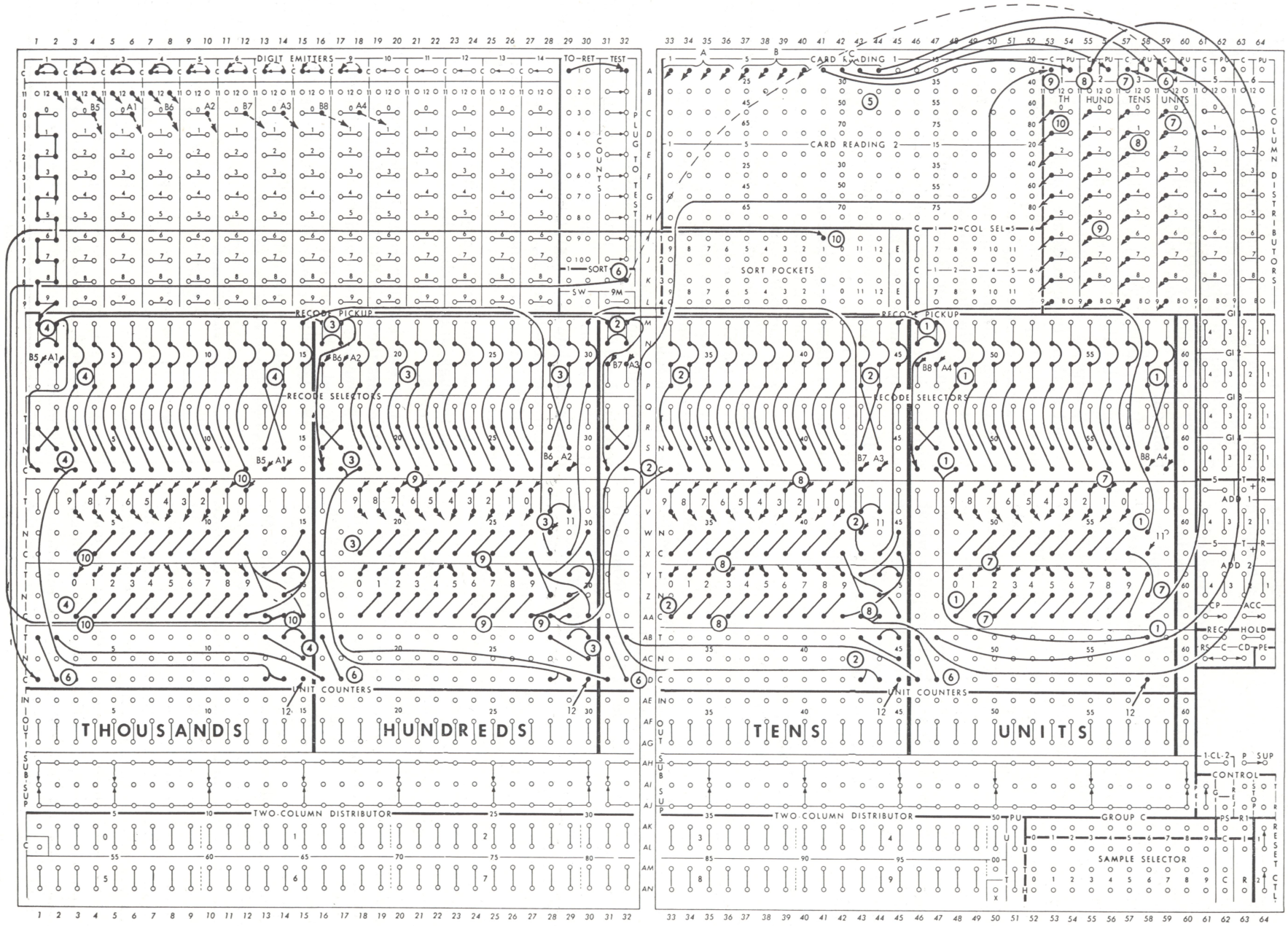


Figure 58. Checking Two Fields Crossfooted to a Third Field

44 is normal because of the plus difference, the sort impulse is allowed to pass through the normal side of selector 44, come out of the common hub, and then reach the C hub of column distributor 2.

9. The sort impulse is available from the 6 hub and reaches the 9-0 and 0-9 rows. In the hundreds position the 9-0 row was chosen and six test selectors were transferred. The sort impulse reaches the transferred side of selector 23, comes out of the common, and is laced through the normal sides of the remaining test selectors. Since selector 28 is normal and selector 29 is transferred because of the minus difference, the sort impulse is allowed to pass through the normal side of selector 28, come out of the common and reach the C hub of column distributor 1.

10. The sort impulse is available from the 0 hub and reaches the 9-0 and 0-9 rows. In the thousands position the 0-9 row was chosen and one test selector was transferred. The sort impulse reaches the transferred side of selector 3, comes out of the common, and is laced through the normal sides of the remaining test selectors. Since selector 13 is transferred and selector 14 is normal because of the plus difference, the sort impulse is allowed to pass through the normal side of selector 14, come out of the common, and reach sort pocket 1. If the sort impulse originating at sort hub 4 followed a path other than the one described, it could not have reached the sort pocket, and the card would be rejected, indicating an error.

Direct Subtraction

The 101 Electronic Statistical Machine can be used to perform direct subtraction operations.

A typical application is the accumulation of a net (or zero) balance from a file of cards containing debit and credit amounts. The amount field is located in columns 15-20, the credit X is overpunched in column 20, and the rate of accumulation is 450 cards per minute.

A "clean" eight-digit total is obtained by setting the left margin stop to allow only eight columns to print. (Nine digits are accurate, but vanishing "ones" will appear to the left in positions 10-12 if they are allowed to print.) Proper setting of the 9M switch will provide automatic totals for each zero-balanced group of 900 time and distribution cards.

However, because recode hold is used, two credit cards must not follow each other.

Another possible application is the simultaneous zero-balancing of two desired fields, such as hours and earnings, provided that the number of columns in each field does not exceed six.

Therefore, in direct subtraction, normal (no-X) cards will add into the coupled counters through wiring 6 on the control panel diagram. But cards with an X in column 20 will:

1. Transfer recode selectors 58-60 after X-time and hold them during the next card cycle (wiring 2 and 3 on diagram).
2. Retain column distributor settings for one cycle to permit conversion of amounts (wiring 1, 5, and 7).
3. Wiring 8 determines the number of zeros to the right of the last significant digit. This operation sets up other recode selectors with wiring 9 and 13. The digits of the amount to be subtracted are converted to their 9's or 10's complement as required, by wiring 10, 11, 12, 14.

Wiring (Figure 59A, B)

1. Pick up column distributors 1-5 from first read columns 16-20, which is the amount field. An X in column 20 signifies a credit.

2. Split-wire column 20 from first read to the upper pickups of recode selectors 58-60, and from there to one side of recode hold.

3. Wire an emitted X to the other side of recode hold, and from there to the lower pickups of recode selectors 58-60. This step permits selector pickup and hold only on a credit X-20 by neutralizing the effect of lower-hold punching on column 20. The recode selector, column distributor recode hold, couple, and accumulate are activated.

4. Split-wire plus hubs of counters 1 and 2 to count to and return.

5. Wire emitted 9 digits through transferred points of recode selectors 58-60 into the high-order positions of counter 1 entry to fill out 9's to the left of significant digits when "subtracting" complement figures.

6. To cause addition on normal no-X 20 cards, wire second read columns 16 to 20 through normal points of recode selectors 58-60, and out of the common to counter 2 low-order entry hubs; then wire commons from recode selectors 58 and 59 to the two low-order positions of counter 1.

7. Connect common hubs of column distributors 1-5 to transferred points of recode selectors 58-60, and from the common hubs to the five low-order coupled counter entries. This wiring enters the complement-converted amounts into the counters from credit cards.

8. Split-wire first read columns 17-20 to upper pickups of recode selectors 46-49. Connect the lower pickups to an emitted zero.

9. Wire progressively an emitted 12 through the

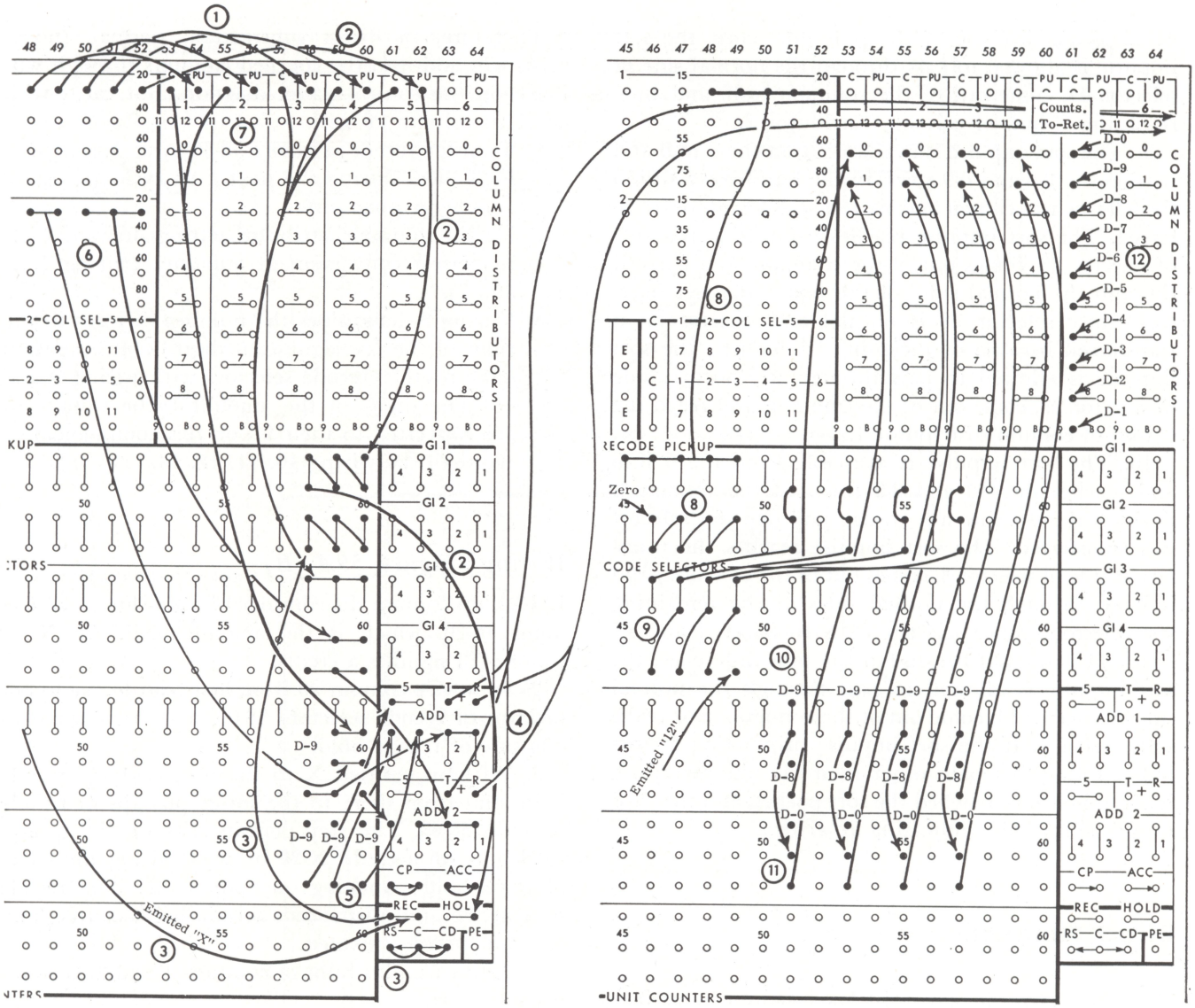


Figure 59A. Direct Subtraction

transferred points of recode selectors starting at 49, and progressing through 48, 47, and 46.

10. Wire 9's digit to the transferred row of recode selectors 51, 53, 55 and 57. Wire 8's digit to the normal row; wire the common hubs to the "1" positions of column distributors 1-4, respectively. This wiring converts a "one" to its 9's or 10's complement, depending upon the zero situation.

11. Similarly wire digits 0 and 9 through the other points of recode selectors 51, 53, 55, and 57 to the zero positions of column distributors 1-4, respectively. Note that positions 2-9 are wired somewhat similarly to those in paragraph 14.

12. Because the units position (column distributor 5) is always converted to a 10's complement, direct wiring from emitted digits is possible; *i.e.,* 0-0, 1-9, 2-8, and so on.

13. Split-wire an emitted 9 to the transferred points of recode selectors 51, 53, 55, and 57. Wire the commons to upper and lower pickup hubs of recode selectors 31-32, 35-36, 39-40, and 43-44, in that order. Note that this step, in effect, causes these recode selectors to act in synchronism with recode selectors 51, 53, 55, and 57 *after 9 time.*

14. Split-wire emitted digits 1-8 to the various transferred (and normal) hubs of recode selectors 31-32, 35-36, 39-40, and 43-44, as shown. Wire the various common hubs to positions 2-9 of column distributors 1-4. Recode selectors 31-32 supply the proper converted digits to column distributor 1 for the high-order position, while selectors 35-36 supply column distributor 2, selectors 39-40 supply column distributor 3, and selectors 43-44 supply column distributor 4. As noted in paragraph 12, the units position of all credit amounts is always converted to the 10's complements. Thus, column distributor 5 is wired directly to emitter.

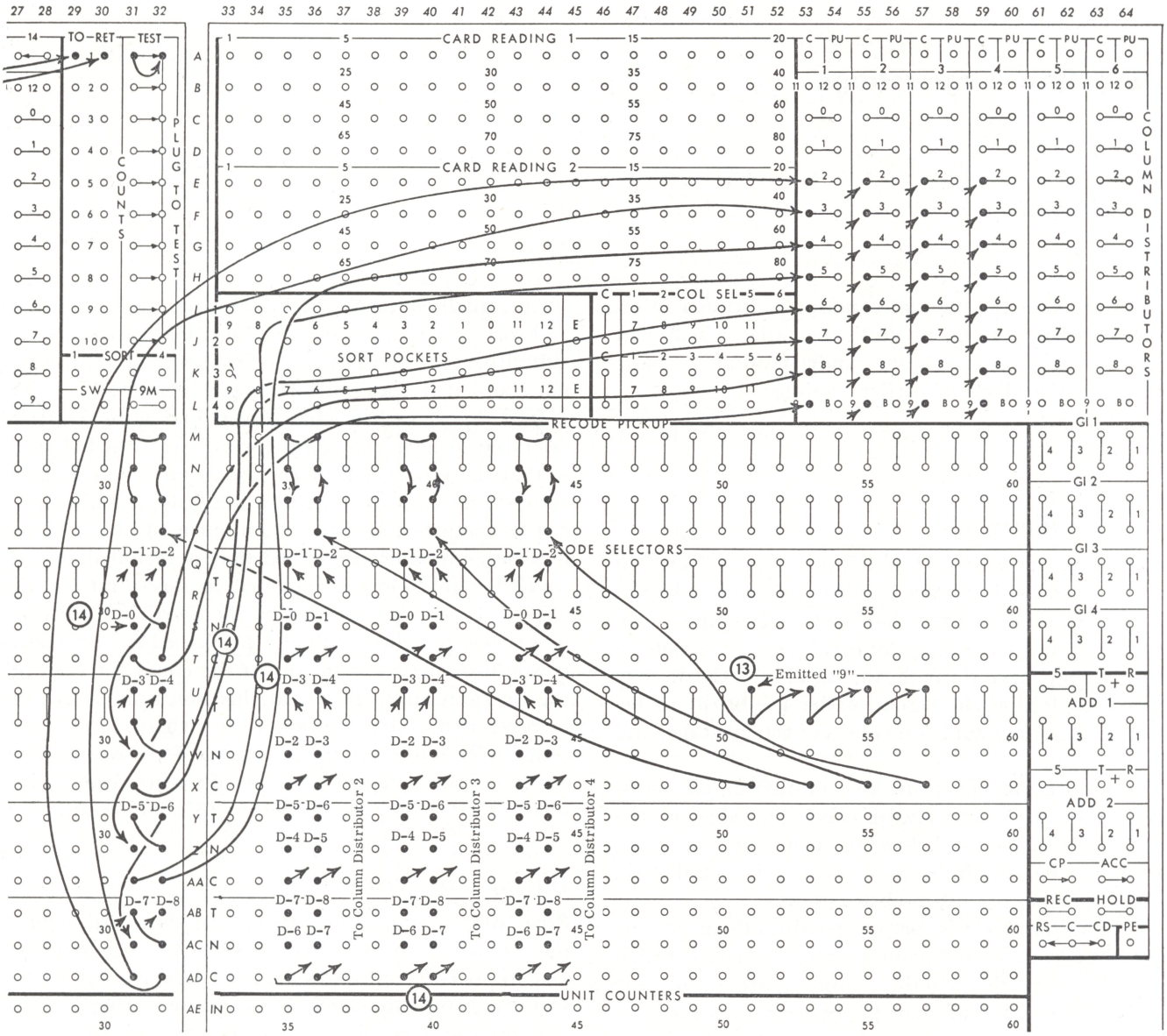


Figure 59B. Direct Subtraction (*Continued*)

Operating Suggestions

This section of the manual contains additional information, wiring diagrams and schematics which will assist in arriving at a better understanding of basic principles described in earlier sections.

Card Handling

Most of the difficulty that occurs in machine operation can be traced to improper handling of cards. Edges of the cards are sometimes damaged in joggling or in placing them in the feed hopper. This could cause a jam as they pass through the machine. Cards may wrinkle or fold at the throat, under the brush, or between the chute blades and rollers of the machine, and cause a jam.

To reduce this possibility to a minimum, an operator first of all should always check the edges of the cards to be sure none is bent or torn. Check the feed hopper to be certain it contains no dirt, card dust, pieces of paper, or other obstructions.

Always "fan" cards before putting them in the feed hopper. This will remove static electricity, which causes cards to stick together. Fanning also allows any foreign material that may be between the cards to drop out.

Pre-editing Multiple Sorts

Pre-editing of multiple sorts is done in almost all combined sorting and counting problems to insure accurate results.

Figure 60, which shows a death-analysis report prepared from a file of public health cards, illustrates pre-editing of multiple sorts. The cards are counted and sorted five times so that the number of deaths within each age group will be counted for (1) all cards, (2) each cause of death, (3) each marital status, (4) each education group, and (5) each earnings group. While the cards are being counted by one classification, they are being sorted by the next.

As explained under "Edit Testing," the counting and sorting for each run must be edited before a card will either sort or count. This insures that a card will not count if it does not sort, and vice versa.

In a report such as that shown in Figure 60, it is desirable to have the count for all five runs balance, so that the report will be consistent and the relations between cause of death, education groups, and so on, can be compared for the same number of cards. Thus, it is necessary to have a card that is included in the count for any one run included in the count for all runs. If a card were rejected on the fourth run because it was not punched with the proper education code, it would be necessary to correct the count for each of the previous runs. To avoid this, multiple sorts can be pre-edited so that all the cards which are incorrectly coded will reject on the first run. This means that errors can be detected and corrected in advance, instead of after they have affected printed results.

Wiring for Pre-editing

Pre-editing of multiple sorts can be done only when the sort selection switch is set on 1. All that is necessary to pre-edit multiple sorts is to use sort rows 1-4 in sequence, and wire sort hub 4 to cause sorting for the last sort row used. For the other sort rows used, wire the sort hub corresponding to that row to cause sorting for that row.

In Figure 60, sort rows 1-4 are used because there are four patterns of sorting. Sort hub 4 is wired through selectors to cause sorting according to earnings group on run 4, sort hub 3 to cause sorting according to education group on run 3, and so on.

Suppose there are only two patterns of sorting, but both patterns are to be pre-edited during the first run. In that case, sort hub 4 would be wired to sort row 2 to cause sorting according to the second pattern, while sort hub 1 would be wired to sort row 1 to cause sorting according to the first pattern.

To use sort row 1 by itself (or with other sort rows without pre-editing the other rows), sort hub 4 must be wired to cause sorting for row 1.

Principles of pre-editing multiple sorts are illustrated in Figure 61.

Report - Totals by Age Group

Run No.	Count Classification	G. I	Tot 1	Age Groups 0-4	5-9	10-14	15-19	80-99	0 Check
				2	3	4	5	18	19
1	All Cards		2500	150	200	175	225	4	0
2.	Cause of Death								
	Infectious	1	275	1	4	12	9		0
	Respiratory	2	26		1		2	4	0
	Accident	3	112	40	18	16	7		0
	Other	4	2087	109	177	147	207		0
3.	Marital Status								
	Single	1	502	150	200	175	200	1	0
	Married	2	1117	*	*		24	1	0
	Other (3-5)	3	881	*	*		1	2	0
4.	Education								
	0 years		238	150	75	3	10		0
	1-8 years	1	316	*	125	79	104	2	0
	9-10 years	2	285	*	*	6	69		0
5.	Earnings								
	0-999		175	46	32	29	41		0
	1000-1999	1	108	28	12	6	3	4	0
	2000-2999	2	82	21	9	5	3		0
	etc.								

Sort Classification

Cause of Death

Marital Status

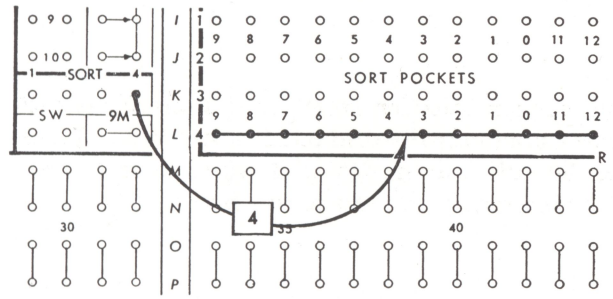
Education

Earnings

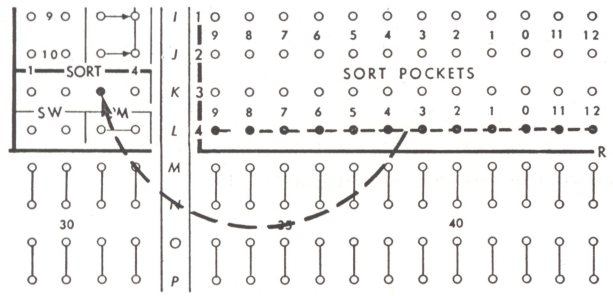
11 Pocket

*Inconsistent Codes

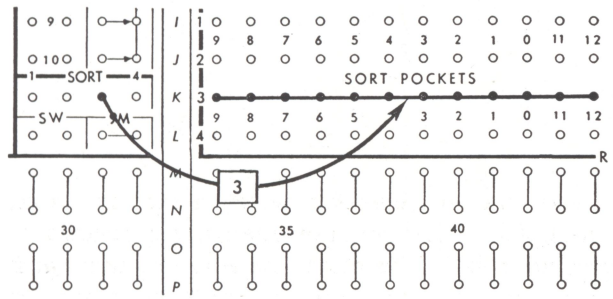
Figure 60. Successive Counting and Sorting



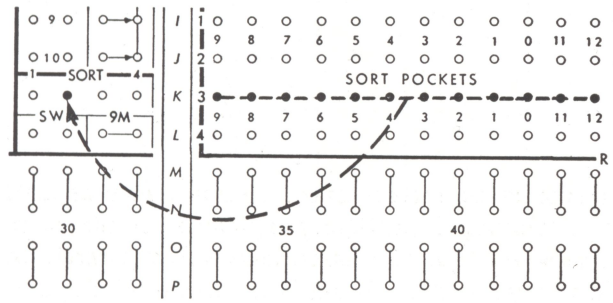
When the sort selection switch is on 1, the edit test impulse originates at sort hub 4 only. The edit impulse is wired through the distributing units for run 4 (represented by the box) to sort row 4.



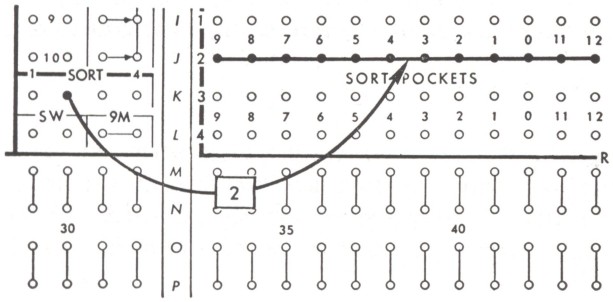
When the sort selection switch is on 1, all the hubs in row 4 are internally connected to sort hub 3. Therefore, the edit impulse wired to row 4 will be returned to sort hub 3, provided the distributors were properly controlled for sorting run 4.



The edit impulse, which is now available at sort hub 3, is wired through the distributing units for run 3 to sort row 3.

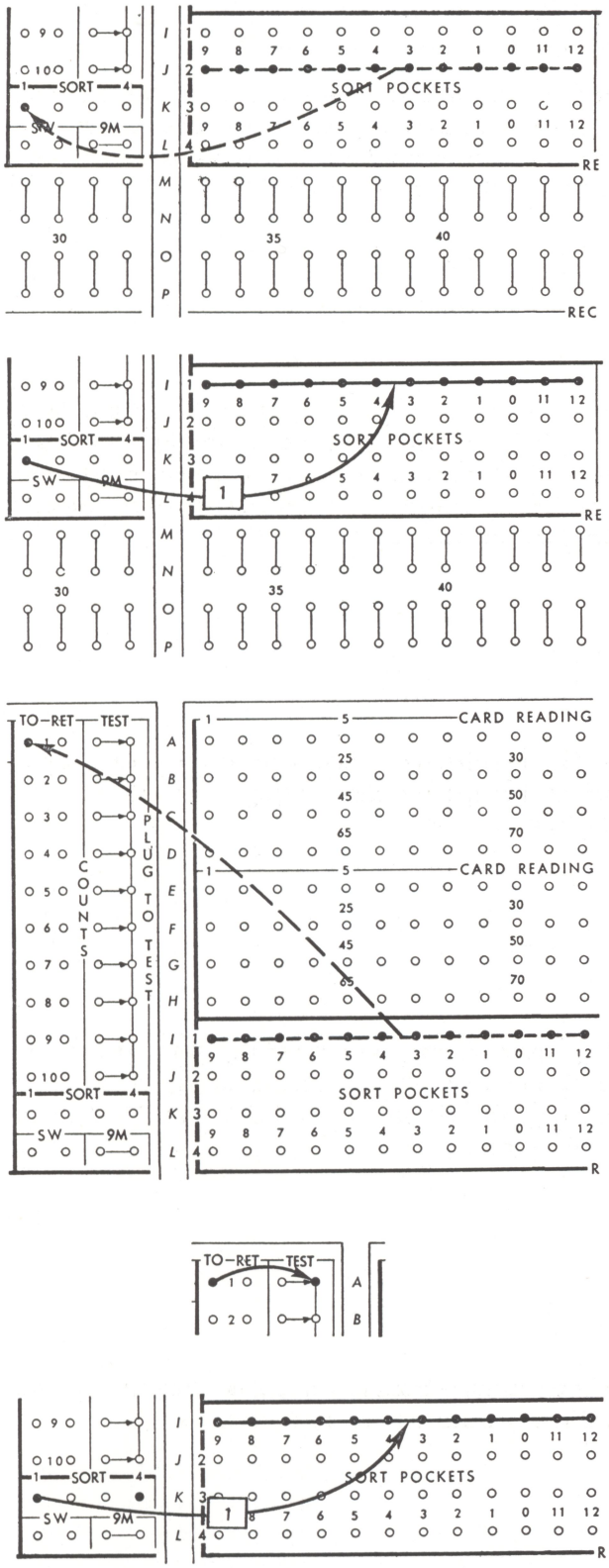


All the hubs in row 3 are internally connected to sort hub 2, whenever the sort selection switch is on 1. Therefore, the edit impulse wired to row 3 will be returned to sort hub 2.



The edit impulse from sort hub 2 is wired through the distributing units for run 2, to sort row 2.

Figure 61. Principle of Pre-editing



When the sort selection switch is on 1, all of the hubs in row 2 are internally connected to sort hub 1. Therefore, the edit impulse which is wired to sort row 2 will be internally returned to sort hub 1.

The edit impulse from sort hub 1 is wired to row 1 through the distributing units for run 1.

Whenever the sort selection switch is set for a row, all the hubs in that row are internally connected to COUNTS TO hub 1. Therefore, the edit impulse which reached row 1 is internally directed to COUNTS TO hub 1.

The edit impulse from COUNTS TO hub 1 may be used to edit counting as previously explained. In this example, however, the edit impulse is wired directly to PLUG TO TEST, so that editing is completed. Notice that the sorting distributions for sorts 4, 3, 2, and 1 were edited in that sequence before editing was completed.

Sort hubs 1 and 4 emit sort impulses when editing is completed with the sort selection switch set on 1. Since row 1 is receptive for sorting, the cards will be sorted according to the sort distributions for run 1.

Figure 61. Principle of Pre-editing

Recode Selectors as a Substitute for a Column Distributor

By using a combination of recode selectors as shown in Figure 62, five selectors may be wired to operate like a column distributor. The hubs that correspond to the common, pickup, and exit hubs of a column distributor are labeled.

Recode Selectors as a Substitute for 0-9 of a Column Distributor

By using a combination of recode selectors as shown in Figure 63, four selectors may be wired to operate like the 0-9 hubs of a column distributor. The hubs that correspond to the common, pickup, and exit hubs 0-9 of a column distributor are labeled.

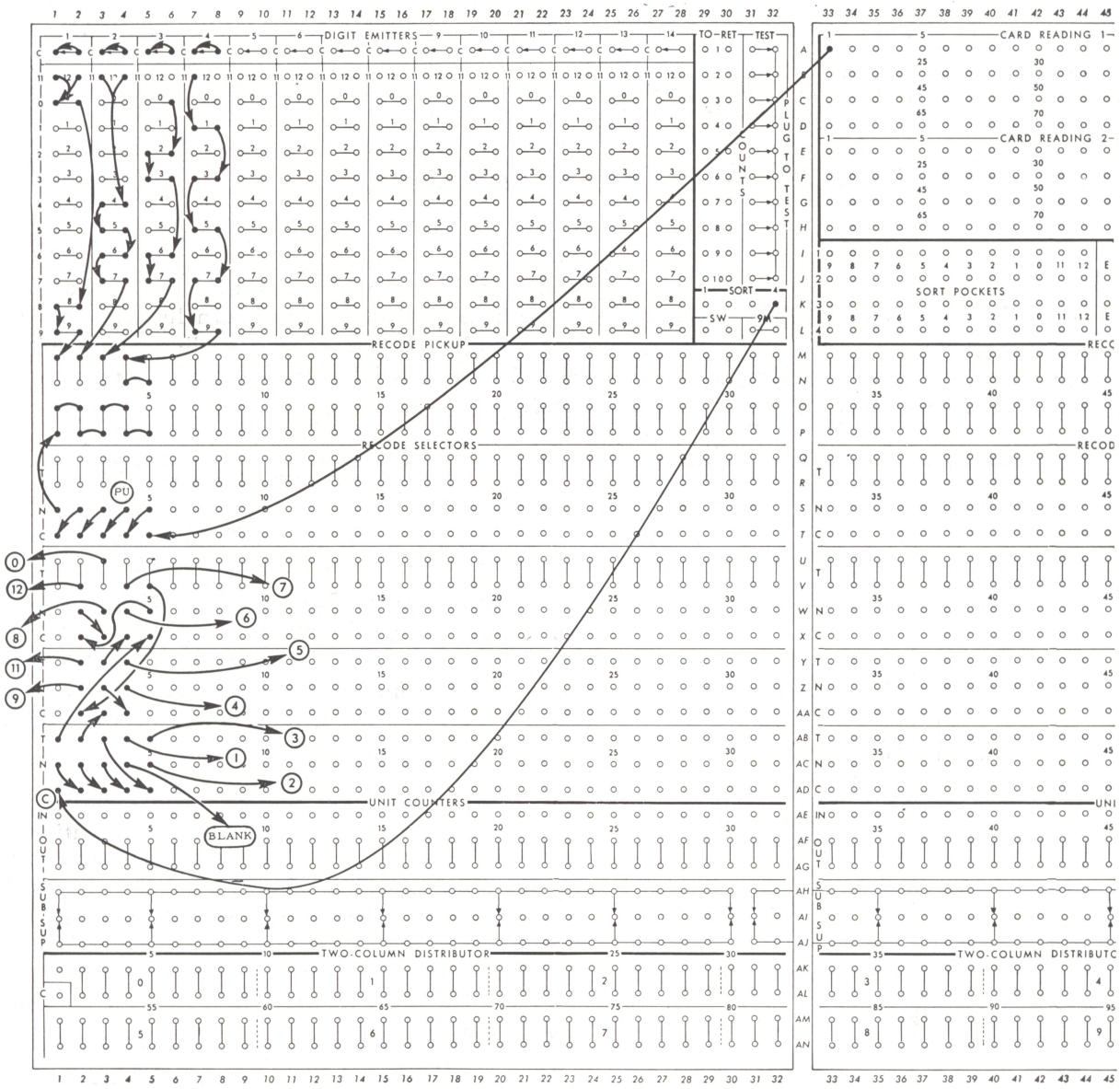


Figure 62. Five Recode Selectors as a Substitute for a Column Distributor

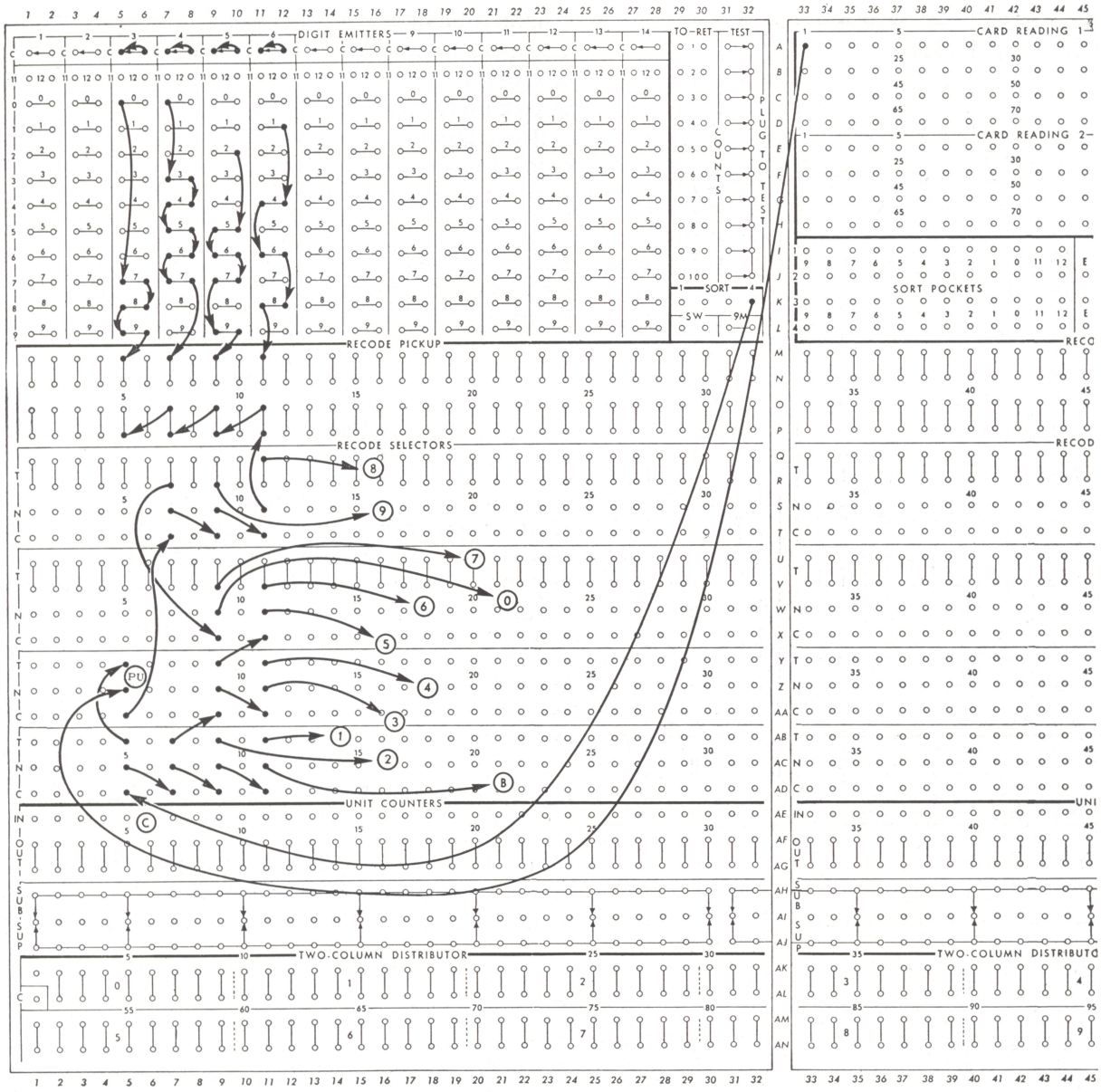


Figure 63. Four Recode Selectors as a Substitute for 0-9 of a Column Distributor

Determining a Difference of One

The rule for determining a difference of one was given in connection with "Consecutive-Number Checking." The wiring for the operation was illustrated in Figure 46, using combinations of digit selectors and column distributors for each column checked. Figure 64 shows the use of recode selectors as an alternative method for determining a difference of one. Selector 25 transfers when there is a difference of one between two single digits.

Wiring (Figure 64)

1. Selector 23 will be picked up when column 1 is read. If the column is punched with a 6, selector 23 will transfer immediately after 6 time and will be transferred before a 5 is read.

2. A digit impulse is wired through the transferred side of selector 23 to the pickup of selector 24. If selector 23 was picked up by a 6, an emitted 5 will impulse the pickup hubs of selector 24. Selector 24 will transfer after 5 time.

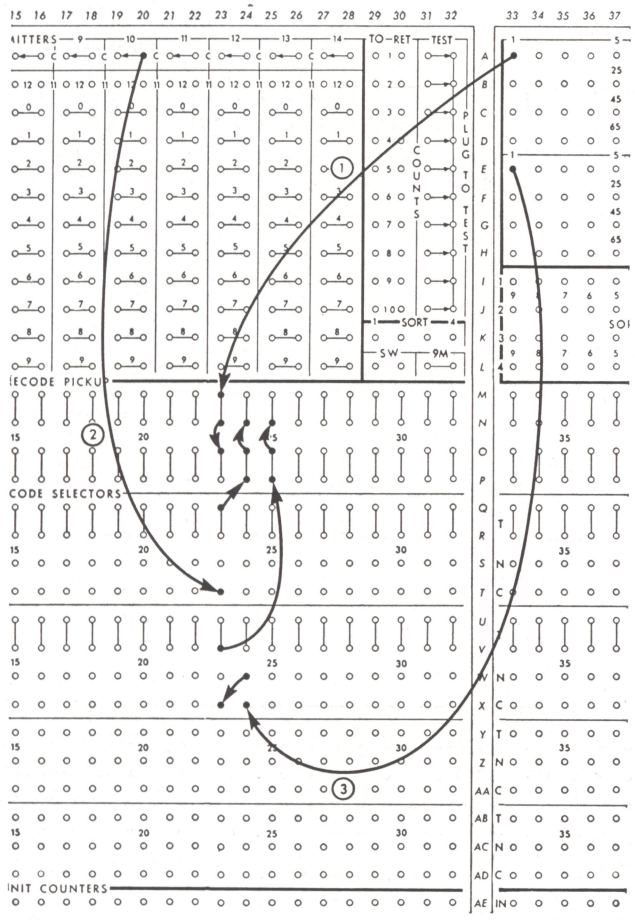


Figure 64. Determining a Difference of One

3. If column 1 at card reading 2 is punched with a 5, the 5 impulse will pass through the normal side of selector 24 and the transferred side of selector 23 to pick up selector 25.

If column 1 at card reading 2 is punched 9, 8, 7, or 6, selector 25 will not be picked up because selector 23 is not transferred until after 6 time in the example.

If column 1 at card reading 2 is punched 4, 3, 2, 1, or 0, selector 25 will not be picked up because, in the example, selector 24 is transferred after 5 time and before a 4 is read.

Sorting Cards Predominantly Alphabetic

Figure 65 shows a sorting procedure for sorting cards which are predominately alphabetic. All cards are used on the first run. After the first run, the cards are left in pockets 1-9, but the cards from pockets 12, 11, and 0 are removed and are placed in the hopper for the second run. After the second pass, the cards are removed from the pockets normally.

Sorting Cards Predominantly Numerical

Figure 66 shows an optimum sorting procedure when the cards are predominately numerical. After the first pass, the cards from pockets 0-9 are removed normally

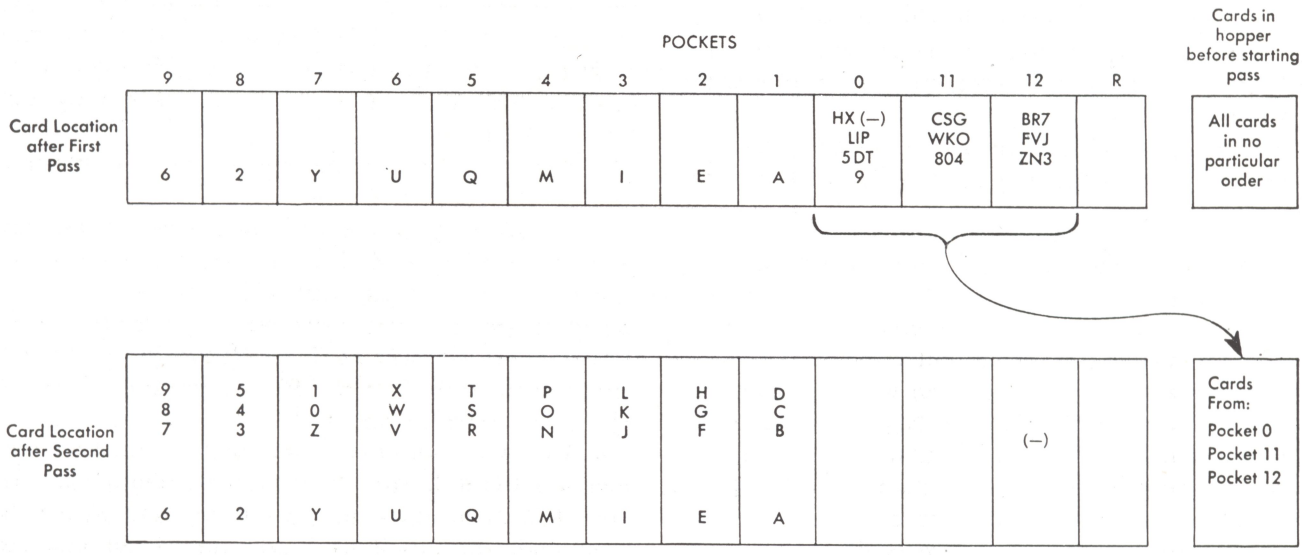


Figure 65. Sorting Cards Predominantly Alphabetic

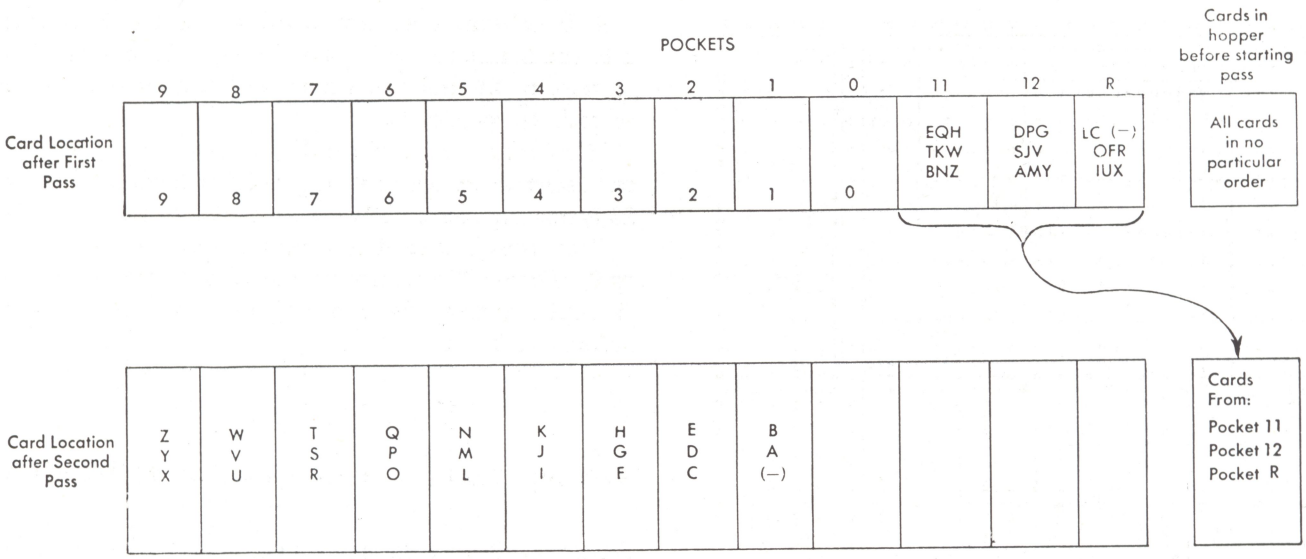


Figure 66. Sorting Cards Predominantly Numerical

and held aside; cards from the reject, 12, and 11 pockets are placed in the hopper for the second run. After the second run, the cards from pockets 1-9 are removed and placed in front of the cards that were in pockets 1-9 on run 1.

Two-Column Distributor for Alphabetic Codes

The two-column distributor can be used to control counting or sorting according to alphabetic codes as shown in Figure 67.

Although the two-column distributor has been discussed, additional information, which was previously omitted for simplicity, is presented in conjunction with this problem.

Each group C hub may be used as an entry hub for a specific group of the exit hubs 00-99, as shown below.

GROUP C HUB	CORRESPONDING EXIT HUBS
0	00-09
1	10-19
2	20-29
3	30-39
4	40-49
5	50-59
6	60-69
7	70-79
8	80-89
9	90-99

The connection between each group C hub and one of its corresponding exit hubs is controlled by the units pickup. For example, if the units pickup hub receives a 5 impulse, group C hub 0 is connected to the 05 exit hub, group C hub 1 is connected to the 15 exit hub, group C hub 2 is connected to the 25 exit hub, and so on.

When used in this manner the two-column distributor is similar to ten single-column distributors controlled by the same pickup impulse.

Wiring (Figure 67)

1. The column being sorted or counted is wired to the units pickup hub of the two-column distributor. The tens pickup hub is not impulsed. When the units pickup hub is impulsed with a specific digit, each group C hub is connected to the corresponding exit hub in its group.

2. Selectors 54-56 are transferred for zone punches 12, 11, or 0 respectively.

3. A SORT or COUNTS TO impulse is wired to the common hub of selector 54. This impulse is wired to group C hub 0 for cards punched with numbers 1-9. It is wired to group C hub 1 for zero zone cards (letters S-Z) and a numerical zero. It is wired to group C hub 2 for 11 zone cards (letters J-R) and to group C hub 3 for 12 zone cards (letters A-I).

4. Exit hubs 1-9 emit if the card is punched with numbers 1-9. Exit hub 10 emits if the card is punched zero. Exit hubs 12-19 emit for letters S-Z. Exit hubs 21-29 emit for letters J-R. Exit hubs 31-39 emit for letters A-I.

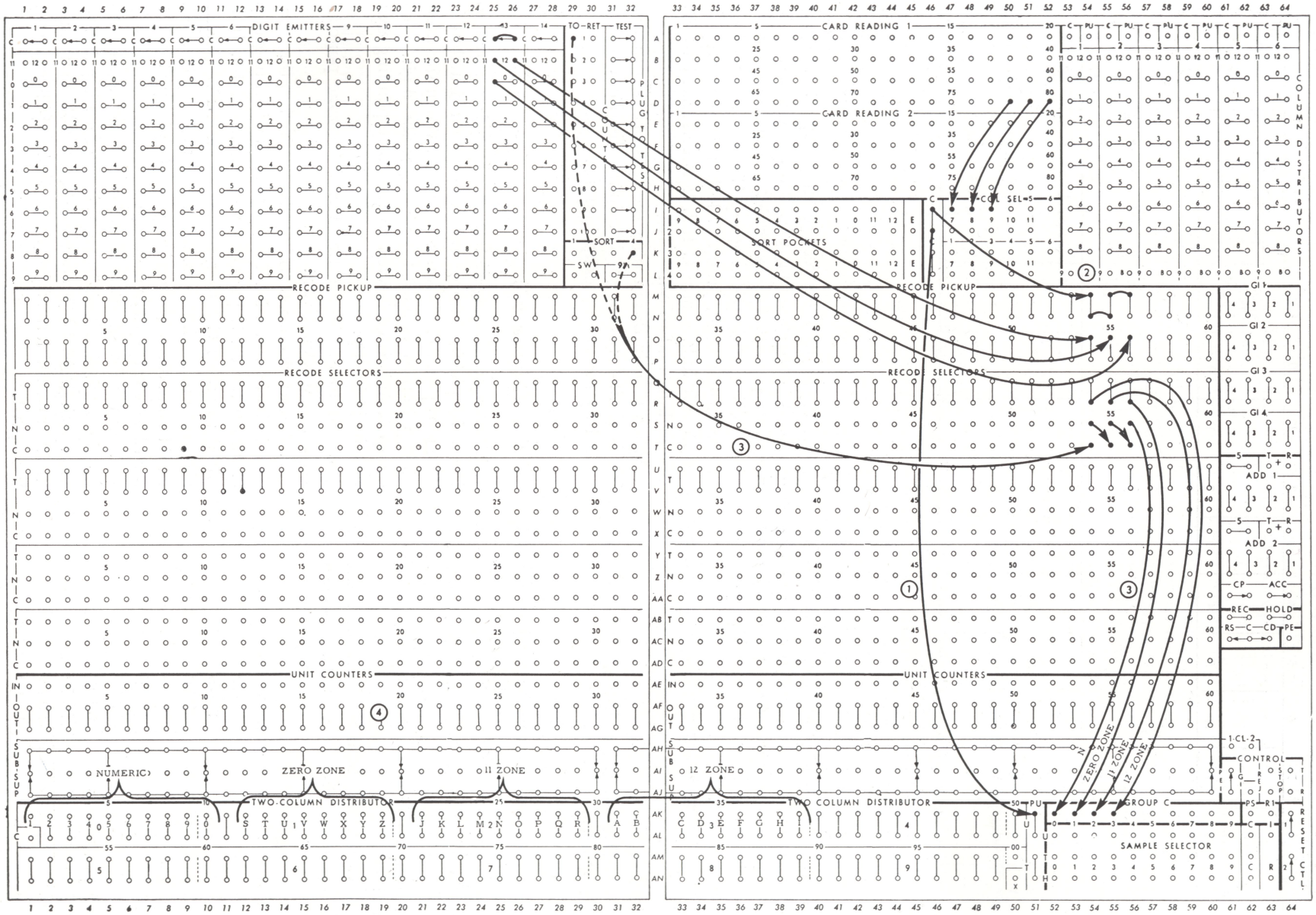


Figure 67. Two-Column Distributor for Alphabetic Codes

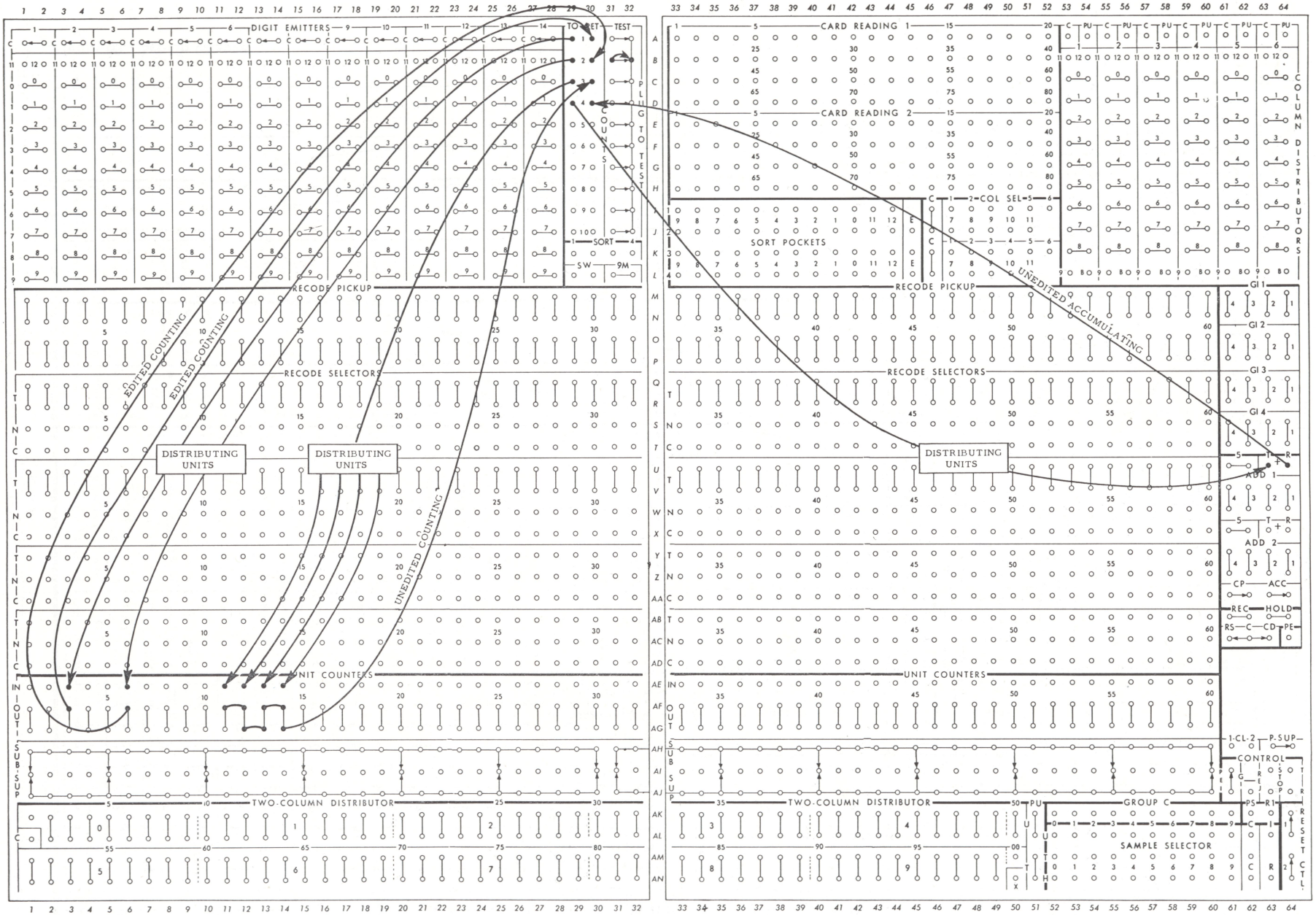


Figure 68. Counting Unedited Information

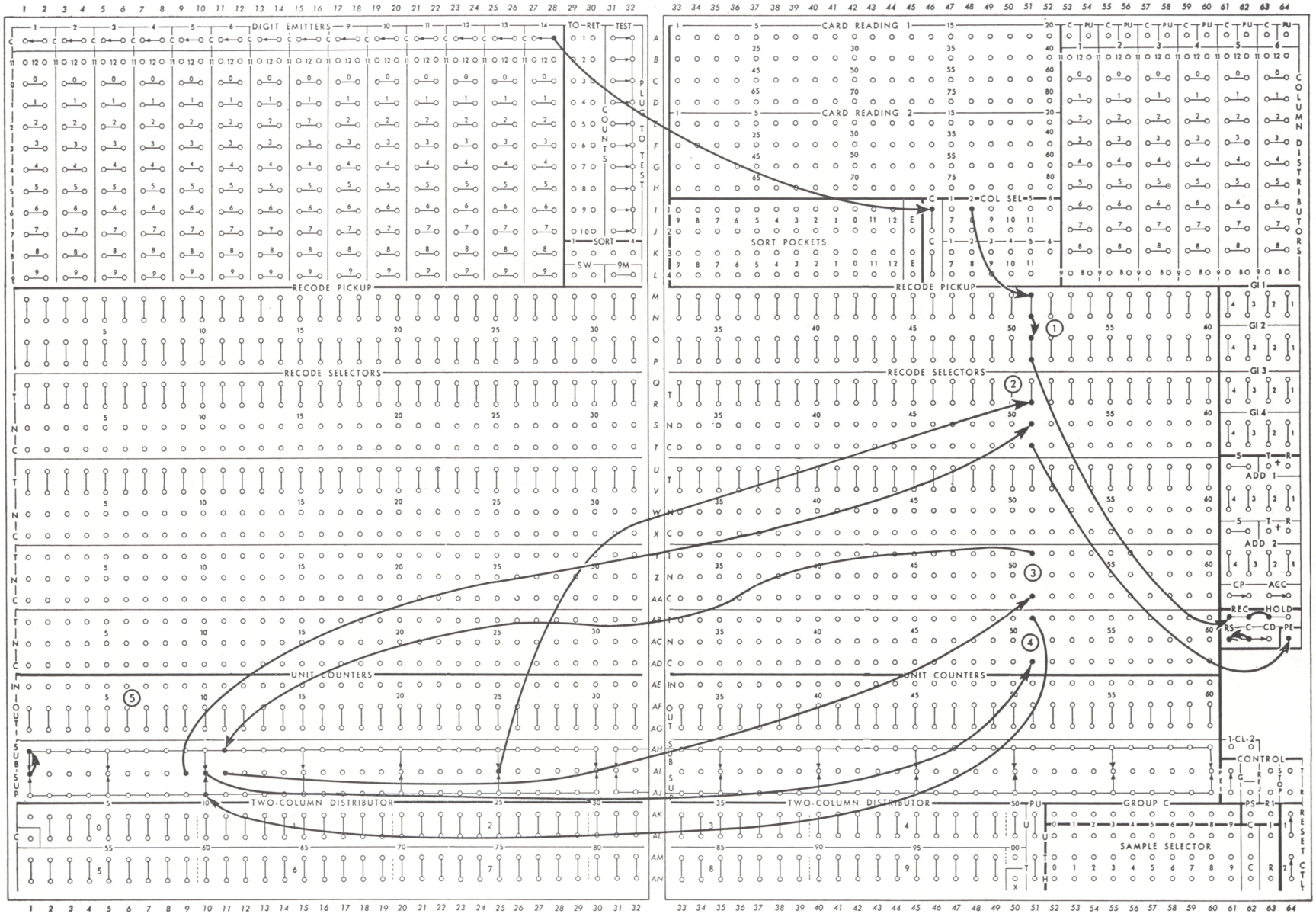


Figure 69. Set-Up Change

Counting Unedited Information

Normally, all COUNTS TO and RETURN hubs used are included in the edit test. To count or accumulate information not included in the edit test, a COUNTS TO and RETURN hub below edit test must be used.

Wiring (Figure 68)

COUNTS TO hubs 1 and 2 are wired normally. Editing is ended after COUNTS TO hub 2 by wiring TEST TO PLUG TO TEST for that position. The information that is to be counted without editing, is wired from the next COUNTS TO hubs (3 and 4). Since the edit impulse is completed at row 2, the information counted from counts 3 and 4 is not edited.

Setup Changes

When one control panel is wired to prepare two or more different reports, the control panel setup may be changed from one operation to another by use of column selection switches and recode selectors. Some of the items which may need to be selected are card reading, sort or count distributions, print end and counter subtract-suppress. Since print end and counter subtract-suppress functions occur during print cycles, the wiring for these functions must be controlled through recode selectors held up by recode hold. This is necessary because recode selectors not held up would transfer and drop several times during the print cycles.

Wiring (Figure 69)

Figure 69 shows the wiring for selecting print end and counter subtract-suppress for two different operations. Column selection switch 1 is used to make the set-up change.

1. When the column selection switch is set on 2, a digit impulse enters C and picks up and holds recode selector 51.

2. Print end is controlled through the transferred side of the selector from unit counter 25, and through the normal side from unit counter 9 when the column selection switch is not set on 2.

3. Unit counter 11 subtracts during the crossfooting operation when the column selection switch is set on 2. The counter adds normally when the column selection switch is not set on 2.

4. Unit counter 10 is suppressed during the crossfooting operation when the column selection switch is set on 2. The counter adds normally when the column selection switch is not set on 2.

Field Selection

Any information read from second reading, such as amounts to be accumulated, can be field selected on a card-for-card basis by use of recode selectors and recode hold. For example, amounts may be added in the accumulating counters from columns 21-24 of NX cards, or columns 31-34 of X cards. In this example, one recode selector would be picked up by the controlling X from first reading and held for the following cycle when the card is at second reading. Columns 31-34 would be wired through the transferred sides and columns 21-24 through the normal sides to counter entry.

Information read from first reading to control sorting or counting may be selected on a card-for-card basis, providing the controlling digit is read before the digits to be selected. For example, a controlling digit of 5 may be used to select digits 4, 3, 2, 1, 0, 11, 12. Nines cannot be selected on a card-for-card basis because none of the distributing units will transfer in time to select the 9 punch in the card. For an entire run, however, any column or field may be selected, regardless of punching by use of recode selectors and recode hold as described under "Setup Change."

False Crossfoot Errors

Before starting any counting operation, it is normal procedure to take a print cycle to clear the counters. This is necessary to make sure that no totals were left in the machine from a previous operation. During the print cycle, all used counters containing totals will print and clear. All unused counters before print end will print from any unit counter position standing at 9. However, any unused counters whose OUT hubs are not wired to RETURN will not clear, and therefore, will be included in every crossfooting operation, thus causing false crossfoot errors.

It is advisable, therefore, that the operator make sure that all counters (both used and unused) before print end are cleared before starting a counting operation. This can be done by wiring the OUT hubs of all unused counters to RETURN before taking the print cycle.

Mark-Sense Cards

Cards used in the 101 should not be designed for mark sensing on the back in areas occupied by fields to be read by the brushes of the 101. While the 101 is not designed to read mark-sensed cards, it is possible for a mark to short two adjacent brushes and cause them both to read the same hole. This would happen if the mark were made just above or below a punched hole being read by one of the brushes.

Summary of Models and Capacities

	MODEL 1	MODEL 2
Digit Emitters	14	6
Column Distributors	6	2
Recode Selectors	60	20
Unit Counters	60	15
Accumulating Counters	2	0
Two-Column Distributor	1	0

Each section of the panel (Figure 70) is assigned a number under which the hubs are briefly described.

1. *Card Reading 1.* Exits for columns read as the cards pass the first reading station. These hubs are normally wired to pickups of distributing units, directly or through column selection hubs, to set up various classifications for counting or sorting purposes.

2. *Card Reading 2.* Exits for columns read as the cards pass the second reading station. These hubs are normally wired to group indication units or accumulating counter entry. When wired to pickups of distributing units, counting or sorting may be controlled for the following card.

3. *Column Selection Switches.* These two groups of hubs are under the control of column selection dial switches on the front of the machine. Each group consists of 11 numbered hubs and a pair of C (common) hubs. The C hubs are internally connected to one of the numbered hubs at a time, depending upon the setting of the column selection switch. Thus, any one of 22 columns can be selected to control the pickups of distributing units.

4. *Sort.* Exits for edit and sort impulses. All four sort hubs emit edit impulses except when the sort selection switch is set on 1 or 5. With the switch on 1, only sort hub 4 emits an edit impulse. With the switch on 5, none of the sort hubs emit an edit impulse. If editing is completed, all four sort hubs emit sort impulses except when the sort selection switch is set on 1 or 5. When the sort selection switch is set on 1, only sort hubs 1 and 4 emit sort impulses; when it is set on 5, none of the sort hubs emit since cards automatically sort into the 11 pocket.

5. *Sort Pockets.* Four rows of entry hubs to 12 sort pockets. Each row accepts sort impulses when the sort selection switch is set at the number of that row, thus permitting four different patterns of selective sorting in a single control panel.

E (Exit). Rows 2 to 4 have E (exit) hubs which emit sort impulses wired to all other hubs in the same row whenever that row is wired for sorting but is not active. Normally, E hubs are wired to a sort pocket of another row.

6. *Counts.* Counting is controlled by count impulses which start at the TO hubs and pass through unit counters (IN and OUT) to a corresponding RETURN hub. All pairs of TO and RETURN hubs are used in sequence starting from number 1.

Test; Plug to Test. The test row, usually the one corresponding to the last pair of TO and RETURN hubs used, is jackplugged to complete a test for each card. This test, through all count wiring above the row wired for test, must be completed before a card will count or sort. A count impulse can be wired below the row wired for test in order to count classifications which cannot be tested for each card. All TO hubs are active only when a test is completed.

7. *Unit Counters.* The unit counters are assigned at will to count cards. Normally, unit counter 1 is used to count all cards; all other unit counters are used to count cards for specific classifications. For reliability no more than 15 counters should add on any one card cycle; no more than five unit counters should be coupled for the return connection to the test hubs when they add on one card cycle.

In, Out. A count impulse must pass through the IN and OUT hubs to make a unit counter add one. If a count impulse is selected and wired to the IN hubs of several unit counters in a group, the OUT hubs of all the unit counters in the group must be coupled together and wired to the corresponding count return. A count impulse can be split-wired to IN hubs; it cannot be wired from an OUT hub to another IN hub.

Sub (Subtract). Normally, all unit counters add during a crossfoot operation. To subtract a unit count while crossfooting, the subtract hub for that unit counter is jackplugged to the hub below.

Sup (Suppress). The suppress hub for a unit counter is jackplugged to the hub above to prevent the count in that counter from being included while crossfooting.

8. *Recode Selectors.* Distributing units for distributing sort or count impulses. Each recode selector has two pairs of common pickup hubs, both of which must receive like impulses to transfer the selector. Pickup hubs will receive digit impulses (9-12) and edit impulses. Each recode selector has four sets of common, normal and transfer hubs. An impulse should not be routed through more than 75 selector points.

9. *Digit Emitters.* Emitters are used to select specific digits from a card column or to emit digits on every machine cycle. The C hub is impulsed from a reading station if a specific digit is to be selected, or from the hub to the right of the C hub if the selector is to be used as an emitter.

10. *Column Distributors.* Distributing units for distributing sort or count impulses. The PU hub is wired from a card column and the C hub is wired from a sort or count hub. When the PU hub is impulsed by any digit (9-12), the C hub is internally connected to an exit hub corresponding to the digit. After the PU hubs are impulsed, they become inoperative for the rest of the card. If PU is not impulsed (blank column), C is internally connected to the B (blank) exit hub.

Figure 70. Control Panel Summary

The exit hubs of column distributor 1 are internally connected to correspondingly-numbered sort pockets when the sort selection switch is set on N (normal sort) or NC (normal sort and count).

11. *Two-Column Distributor.* Distributing unit for distributing sort or count impulses. The tens and units pickups at the right are wired from any two card columns of card reading 1. The columns can be adjacent as in a two-digit number, or they can be separated and have a major-minor relationship. When both pickups are impulsed, the C hub at the left is connected internally to a correspondingly-numbered exit. Thus, a sort or count impulse can be distributed by any punching from 00 to 99.

Group C. The group C hubs (0-9) can be used as either exits or entries. Each group C hub is connected internally to the C hub of the two-column distributor whenever the tens pickup receives a corresponding impulse. The X hub of the two-column distributor is connected to the C hub whenever the tens pickup receives an X impulse. Also, each group C hub is internally connected to one of the exit hubs in the corresponding group (0-9, 10-19, 20-29, etc.) whenever the units pickup is impulsed. For example, if the units pickup is "5," the 0 hub of group C is connected with the exit hub 05, the 1 hub of group C is connected with exit hub 15, and so on; the 9 hub of group C is connected with exit hub 95. Therefore, a sort or count impulse wired into a group C hub will be emitted from the hub in the tens group which is made active by the units pickup.

12. *GI 1-4 (Group Indication).* Four different classes of indications can be wired on one control panel from card reading 2, but only one of them can be printed for any one run, depending upon the setting of the sort selection switch. The four group indication units are made active by the sort selection switch as follows:

SORT SELECTION SWITCH SETTING	GROUP INDICATION ACTIVE
N, NC, NP, or 1	none
2	1
3	2
4	3
5	4

An active group indication unit receives data from the first correctly edited card following a print cycle.

13. *Accumulating Counters.* Two accumulating counters accumulate amounts read as cards pass second reading. Each counter has five digits of entry and can accumulate an 8-digit total. The total in counter 1 prints on the report form in the left-hand carriage; the total in counter 2 prints on the report form in the right-hand carriage.

Accumulating counters ordinarily clear as soon as the amount is printed in the column at the left of the report. They are then available for the automatic crossfooting operation which occurs while printing. Counters 1 to 30 add or subtract into accumulating counter 1; counters 31 to 60 add or subtract into accumulating counter 2. Accumulating counter 1 then transfers to accumulating counter 2 to obtain a zero balance. If the balance is zero, a single zero is printed in the check column of each report. If a final difference remains, the true or complement difference will print in the check columns. An error in only counter 1 prints on both left and right. An error in only counter 2 prints on the right and prints complement 9's on the left. If both counters contain differences, the difference in counter 1 prints on the left, and the total of the two differences prints on the right.

ACC (Accumulate). The accumulate switch must be jackplugged to make either counter operate.

T and R. Each accumulating counter has a T and an R plus hub which correspond in function to the IN and OUT hubs of unit counters. Thus, to control accumulating counters to add, COUNTS TO must be wired to T (directly or through selectors) and COUNTS RETURN must be wired from R.

CP (Couple). The two accumulating counters can be coupled for use as a single counter with nine positions of entry and capacity for a 12-digit total. Accumulating counters are coupled when the two couple hubs are connected together.

Add. Five positions of entry for each accumulating counter. When used individually, each counter has capacity for an 8-digit total. When accumulating counters are coupled, entry hubs (1-4) of accumulating counter 2 are used for the low order digits of the amount field and entry hubs (1-5) of accumulating counter 1 are used for the high order digits. In other words, the fifth position of counter entry 2 cannot be used. With coupled counters, the 12-position total prints on the report form in the left-hand carriage; the amount column of the report form in the right-hand carriage is skipped.

14. *SW and 9M.* The two SW (switch) hubs are internally connected when the 9 master switch on the front of the machine is down. The 9M hubs are wired from card reading 1. They are under control of the 9 master switch and accept only a 9 to identify a master card. The 9 master switch is set to its up position for sorting master cards into position. With the switch up, master cards are not tested for count classifications. The switch is set to its down position to make master cards stop the machine and print group total counts and amounts. For this reason, master cards are sorted into position behind groups of detail cards.

15. *Control.* The various control hubs and switches modify operation as follows:

PEI (Punch Extra Indication). When extra positions of group indication are to be punched from accumulating counters and a second summary card is to be punched in each summary punch, the PEI switch must be wired on. Normally, an extra group indication is punched from the counters into only the first summary card in each punch (cards 1 and 3), and is then cleared from the counters. However, when PEI is wired, the extra group indication is transferred to the carry-over (left-hand) positions of the counter and held for summary punching into cards 2 and 4. The extra group indication (one to four positions) is wired into accumulating counter 1 to print on the left-hand carriage and summary punch into cards 1 and 2; it is wired into accumulating counter 2 to print on the right-hand carriage and summary punch into cards 3 and 4.

GI (Group Indicate). When the sort selection switch is set on 2, 3, 4, or 5, this hub emits an impulse for the first correctly edited card following the printing of a line. Its purpose is to permit accumulating counters to function like a GI unit. The GI hub normally is wired through the T and R control hubs of accumulating counters to a RETURN hub.

Rej (T and R). The upper reject hub (T) emits an impulse whenever a card rejects. It usually is wired to the lower hub (R) through T and R STOP hubs or through IN and OUT hubs of unit counters. When wired through STOP hubs, the machine stops for cards that normally would reject. When wired through IN and OUT hubs of unit counters, cards that normally would reject are counted. Like COUNTS TO and RETURN hubs, reject T and R hubs *should never be connected together directly as this would blow a fuse.*

Stop (T and R). These two hubs constitute a path for any selected sort or count impulse in order to stop the machine. When reject (T and R) hubs are wired through T and R STOP hubs, the machine stops for cards that normally would reject. When a selected sort or count impulse is wired through T and R STOP hubs, the machine stops for the selected condition.

Reset Ctl (Reset Control). Normally, accumulating counters 1 and 2 reset as totals are printed. However, when reset control is wired, accumulating counters do not reset until the zero check column is reached. Therefore, the totals in these counters are included in the crossfoot check on a plus basis. This feature permits their use as additional unit counters. Each accumulating counter has its own reset control switch.

16. *Sample Selector.* A combination counter and distributing unit which may be installed as a special device. A count impulse wired to the I (IN) hub *(AL, 63)* advances the count one position for each card counted up to a maximum of 999. A count impulse wired to the R (RESET) hub *(AN, 63)* resets the unit to zero. If R1 *(AK, 63)* is also wired to I, the unit is reset to 1 instead of zero. The sample selector may be used to select and/or count cards at various intervals for a representative sample up to a capacity count of 999. The unit normally is reset to 0 or 1 from the last number in the series.

17. *Rec; Hold.* The REC and HOLD hubs correspond to the upper and lower pickup hubs of normal recode selectors, except that they do not receive 9 impulses. They operate in conjunction with the last ten recode selectors or column distributors 1-6 to hold them beyond one cycle. If C is wired to RS, the recode selectors are under control of REC HOLD. If C is wired to CD, the column distributors are under the control of REC HOLD.

18. *CL1, CL2.* When a card is at the first station, CL1 emits impulses 9 through 12. When a card is at the second station, CL2 emits impulses 9 through 12. These hubs normally are wired to recode selector pickups to control operations on the run-in for the first card and on the run-out for the last card.

19. *PE (Print End).* This hub is wired from any unit counter hub in row *AI (1-60.)* Its purpose is to stop printing from unit counters and return the carriage. Actual return of the carriage occurs after the zero check column is printed.

20. *P Sup (Print Suppress).* This (optional) pluggable switch is wired either directly or through selectors to suppress printing on the right carriage of 60-counter machines.

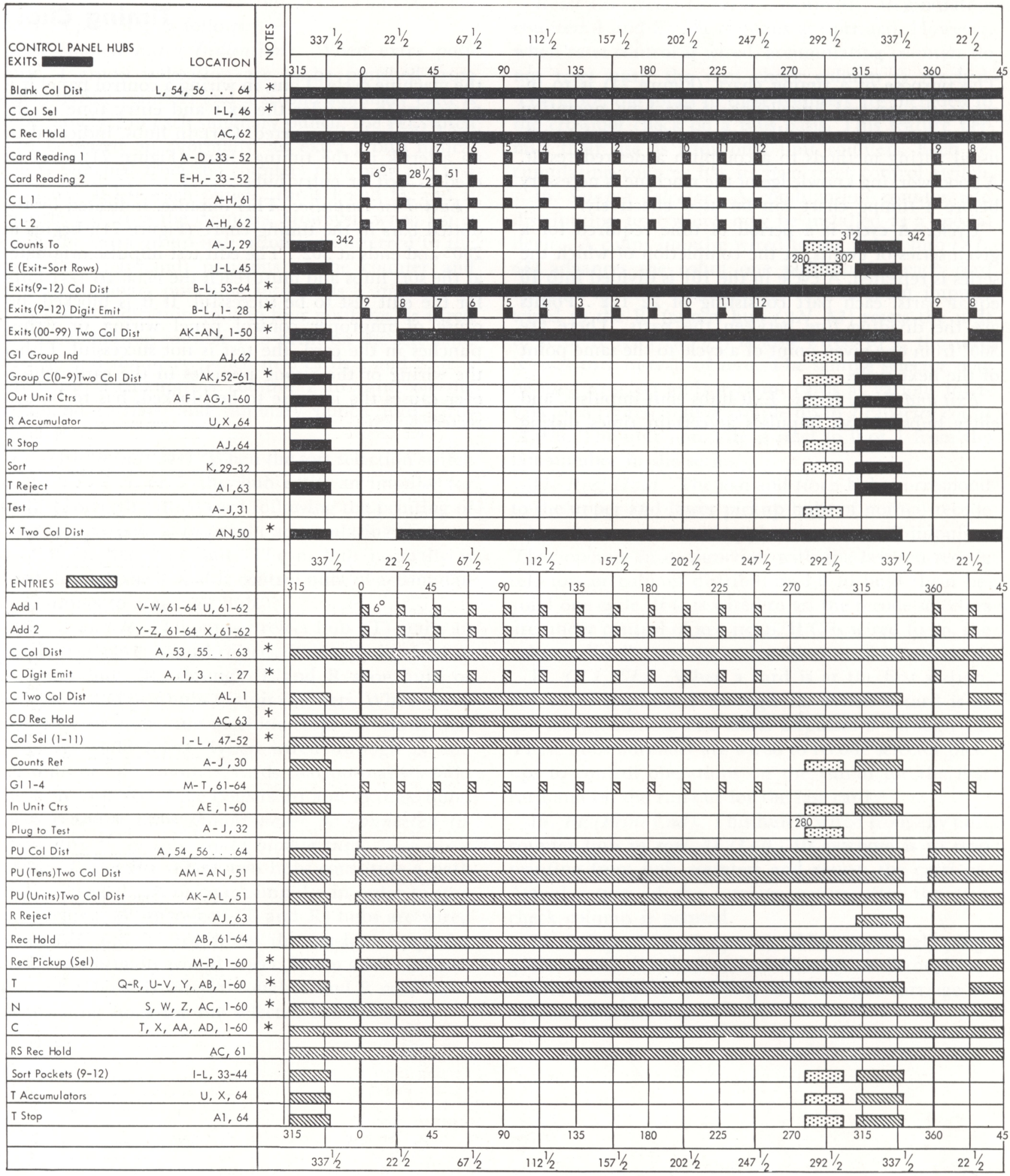
Timing Chart

The purpose of a timing chart (Figure 71) is to increase the general knowledge of machine operation and to assist experienced operators who resort to unusual wiring methods to accomplish a desired result. A good working knowledge of the machine is necessary before a timing chart can be used effectively.

Cycle: A cycle is a period of time required for a given series of events, at the completion of which the series is repeated. A cycle in the 101 is divided into 16 equal parts, each part consisting of 22 1/2°. Points are the dividing line between the parts. There are 360° from one given point of a cycle to the same point of the next cycle.

Exit and Entry Hubs: Exit hubs emit impulses, and entry hubs receive impulses at certain times during the machine cycle. Thus, in wiring a control panel it is necessary to consider the exit and entry time of the two hubs to be connected. Certain hubs, indicated by an asterisk in the timing chart (Figure 71), may be used as exit or entry hubs.

Edit Test Impulse: This impulse, indicated by the dotted bars in the timing chart (Figure 71), begins at 280° and ends at 302°. The edit test impulse originates at the sort hubs and must reach the PLUG TO TEST hubs for the edit test to be successful. If it is blocked, because of improper control panel wiring or wrong punches in the card, the test is not successful. Either the wiring or the wrong punches in the card, whichever causes the impulse to be blocked, has to be corrected.



NOTES:

* Control panel hubs may be used as exits or entries

Edit test pulse

Figure 71. Timing Chart

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