IBM

Field Engineering

Manual of Instruction

402
403
419

Accounting Machines with 923 Tape-Controlled Carriage

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Accounting Machines with 923 Tape-Controlled Carriage

This edition, Form 225-5673-4, is a revision of the preceding edition. Principal changes in this edition are as follows:

FUNCTIONAL PRINCIPLES includes the operation of the last-card auto total switch.

MECHANICAL PRINCIPLES. Photographs and drawings are corrected to show new style drive housing and two-speed clutch assembly, rocker style CRCB's and relocation of rectifier and condensers. New sections describe new control panel closure mechanism, 419 print unit, mechanical counter operation and rocker style CRCB's.

REMOVAL AND ADJUSTMENT PROCEDURES have been removed from this edition.

CIRCUIT DESCRIPTION is written to Diagram 210201R. Photographs and drawings are corrected to show rearranged fuse panel and relay gates. The sections on relays and control panel hubs are eliminated. The circuit description is in outline form with accompanying sequence and function charts.

FUNCTIONAL PRINCIPLES on the 923 TAPE-CONTROLLED CARRIAGE are essentially unchanged.

MECHANICAL PRINCIPLES on the 923 TAPE-CONTROLLED CARRIAGE has a new section on carriage lift mechanism. Removals and adjustments have been removed but are found in the 402-403 reference manual.

CARRIAGE CIRCUITS and MULTIPLE LINE PRINTING are written to Diagram 210201R and revised in outline form.

PURPOSE OF RELAYS AND CONTACTS corrected to Diagram 210201R.

PACKING AND HANDLING eliminated.

CIRCUITS REVIEW-RELAY OUTLINE eliminated.

CIRCUIT REVISIONS, Diagram 210201 from C to R print.

ALPHABETIC SUMMARY PUNCH revised in outline form.

AUXILIARY STORAGE DEVICE rewritten to Diagram 296005D.

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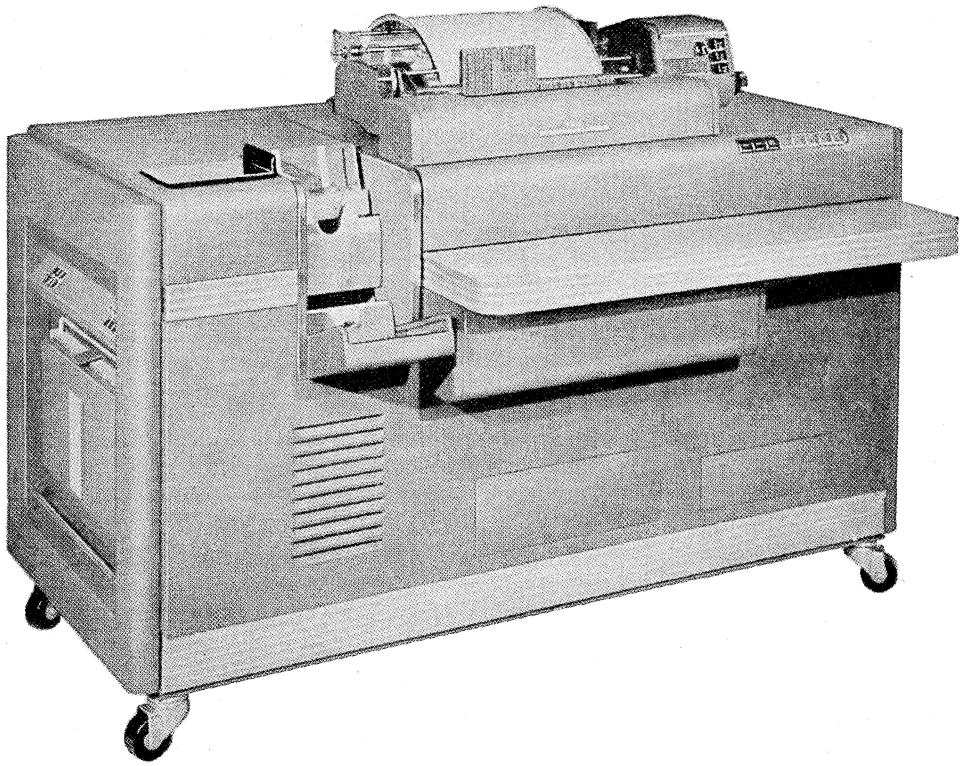
TAPE-CONTROLLED CARRIAGE



IBM 402 ACCOUNTING MACHINE

IBM 402, 403 AND 419 ACCOUNTING MACHINES

FUNCTIONAL PRINCIPLES

THE IBM CARD, which is the operating unit of the IBM Accounting method, carries all necessary information to print a finished report. The purpose of the IBM Alphabetical Accounting Machine is to convert the information punched in the card into a finished report.

The IBM card may be designed for any one of a number of applications, such as accounts payable, accounts receivable, material control, payroll, and others. In any application, the card contains two kinds of information: identifying information such as date, part number, territory, or man number; and quantitative information such as pounds, pieces, hours, or dollars and cents.

Typical card forms and completed reports are shown in Figure 1. The payroll report shown with the cards from which it is prepared illustrates the basic operations performed by the Alphabetical Accounting Machine: printing, accumulating totals, and distinguishing between groups of cards.

The billing application shown in Figure 1 may be prepared on the Type 402 Accounting Machine using a separate card for each line of printing in the address portion of the bill. The Type 402 machine has only two sets of reading brushes in the card feed unit.

The same report may also be prepared on the Type 403 machine in the same manner as with the Type 402; however, the reason for specifying the Type 403 machine is that this machine is capable of reading all three lines of the address portion of the bill from one card which is punched as shown. The Type 403 machine has three sets of reading brushes in the card feed unit and this, with the associated relay circuits, is the main difference between the Types 402 and 403 machines.

Reports that contain no alphabetic information may be prepared on the Type 419 Accounting Machine, utilizing its increased listing speed. With the exception of the printing mechanism, which will list numerical characters at a speed of 150 cards per minute, the Types 419 and 402 machines are identical. No reference will be made to the Type 419 machine except for those areas in which it differs appreciably from the Type 402.

BASIC FUNCTIONS

ON THE payroll register shown in Figure 1, one line contains the employee name, number, gross earnings, the various deductions made from gross earnings, and the resulting net earnings. Name, earnings and deductions are punched in three different types of cards, all of the cards for one employee being identified by the same employee number, which in this illustration is 1-13.

This type of report is referred to as a group printing report, because most of the printed information consists of totals for groups of cards, rather than detail printing of the information on each individual card. To produce a report of this kind, the LIST hub on the control panel is not wired. With the machine thus set, the indicative information will print from the first card in a group, and other information from all the cards in the group is accumulated and printed as a total on the same line. In this example, the group of cards from which one line of the report is printed consists of all the cards for one employee.

The first card shown is the payroll master card, from which the following identifying information is printed: name, employee number, tax code, and base rate. These items are printed as the payroll master card, the first card in the group for employee (Columns 1, 13), passes through the machine. This listing of the first card in a group, which takes place when the LIST hub is not wired, occurs on the group indication cycle, during which all information necessary to identify the total is printed. It represents the first of the basic operations performed by the machine, that is, printing information punched in the card. This first listing operation takes place at list speed, either 80 or 100 cards per minute. This speed applies to all printing operations during which the type bars are raised. The machine operates at 150 cards per minute when accumulating without printing.

The rest of the information printed on the first line of the report consists of totals from the other cards for employee number 1-13. (If an amount were punched in the first card for the group, this amount

could also be included in these totals.) From the current earnings card the following information is obtained: days, hours, current gross earnings, OASI, and withholding tax. The various types of other deductions come from the deduction cards. Each type of deduction is punched in a separate deduction card, and is identified by a distinguishing punch in a predetermined column. The amount in the current net pay column on the report is a total of gross earnings from the earnings card, less OASI and withholding tax from the same card, and less the various deductions from the deduction cards.

The information from these cards is accumulated in counters and printed on a total cycle. This part of the report illustrates the second basic operation of the machine: reading amounts punched in cards and storing them in counters until they are printed as totals on program cycles. The cards from which amounts are accumulated in this report pass through the machine at the rate of 150 cards per minute, which is called the accumulating speed. For this type of group printing report, all the cards except the first card in the group pass through the machine at this higher speed.

When all the cards in the group for employee 1-13 have passed by the third reading brushes, the machine will automatically stop and print the total on the same line with the group-indicated information. The printing takes place on a total cycle. At this time, counters which have amounts stored in them will return to zero and, at the same time, cause the type bars to be stopped to print the amount.

The third basic operation which the machine will perform is sensing the control change between groups of cards, in order to print totals for each group. This is referred to as automatic control. In this operation, the machine electrically compares the holes punched in the control field (in this case, employee number) of each card with the number punched in the control field of the card following it. When the control numbers are different, indicating that all the cards for one group have been totaled, the machine automatically gives the signal to permit total printing.

With the billing form shown in Figure 1, the heading card has the three lines to be printed, punched in three separate fields of the card. The card feed for the Type 403 has three sets of brushes and the control panel will be wired to read these three fields in consecutive order and printing will take place on the form. The heading card is normally identified by a special punching which will distinguish it from the normal or detail cards in the body of the form. The principle of operation used in obtaining the three lines of printing from one card will be discussed under *Multiple-Line Printing* in the circuits section of this manual.

With billing form operation the control panel will also be wired to cause the IBM Tape-Controlled Carriage to position the form for the printing of the heading cards or card then advance the form to the first body line. Here detail printing is taking place and, in this case, the information from each detail card such as date of order, reference or part number, cost or charge amount is being sensed by the 3rd reading brushes and listed on the form. The control panel must have an ALL CYCLES impulse wired to the LIST hub to cause the machine to perform the detail printing operation.

Whether the detail card is listed as a debit or a credit depends upon some additional identifying punching in the card; however, when the last card of the group has been read, the accounting machine will stop and complete a program cycle. During this cycle, the total of the individual amounts accumulated from the cards will be printed.

A check of the billing cards in Figure 1 shows that the punching of the customer number is 59751 and that it is the same in both the heading and the detail cards. With the control panel wired for group control, the machine will recognize by means of electrical circuits the change in customer number as the last normal or detail card of customer 59751 passes the third reading brushes and the heading card for the next customer is passing the second reading brushes. This causes the machine to stop the card feed unit and go through a program cycle, normally printing the amount accumulated in the counters and also resetting them to zero.

There are other auxiliary operations which may be performed by the Alphabetical Accounting Machine, but the three basic operations remain the principal functions:

1. Printing both alphabetic and numerical information.
2. Accumulating amounts in counters to be printed as totals when desired.
3. Sensing a change in control number or name so that totals may be printed by classification.

Each of these basic operations originates with the

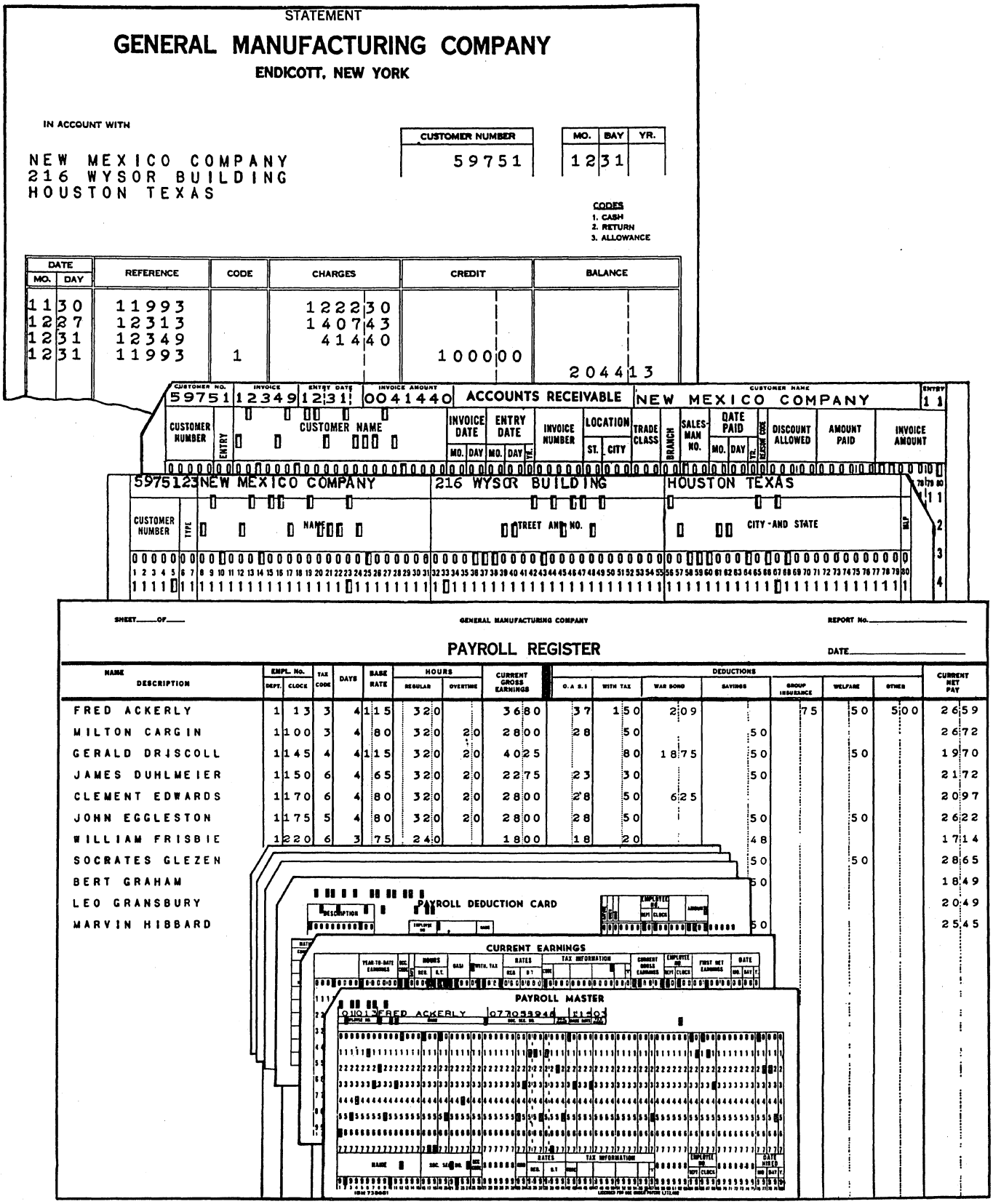


Figure 1. Typical Report Forms

holes punched in the cards. As the card is carried through the feed, some brushes fall into punched holes in those columns of the card carrying identifying information and, by electrical impulse, cause the type bars to be stopped to print the corresponding character. At the same time that brushes are sensing the identifying information, other brushes fall into punched holes in other columns of the card which contain quantitative information and, by electrical impulse, cause the counters to accumulate the quantities punched. The counters may be controlled, by other means which will be discussed later, to cause them to add or subtract the quantity sensed by the third reading brushes, and print the accumulated amount at the desired time.

There is a fixed relation between the distance the card moves past the brushes, the distance the type bar rises to print, and the distance the counter wheel turns to accumulate. The mechanical section of this manual describes that relation between the distance traveled by the card as it passes the brush which reads the hole, the distance the type bar will rise before being stopped by the print magnet stop pawl, and the distance the counter wheel turns in order to accumulate the amount punched in the card. This fixed relation between distances traveled by the card and by the component parts of the machine remains the same, regardless of the speed (80, 100 or 150 cards per minute) at which the cards pass through the machine.

OPERATING SWITCHES AND SIGNALS

Main Line Switch

To operate the machine, the main line switch, located beneath the right end of the reading table, must be turned ON.

Start Key (Figure 2)

The start key must be depressed to start the feeding of cards through the machine. It must also be depressed to resume operation after the machine has stopped for any reason other than feed interlock.

Stop Key

When the stop key is depressed, the machine will stop before the next card is fed. If a program cycle is in process or about to be started when the stop key is depressed, the cycle will be completed before the machine stops.

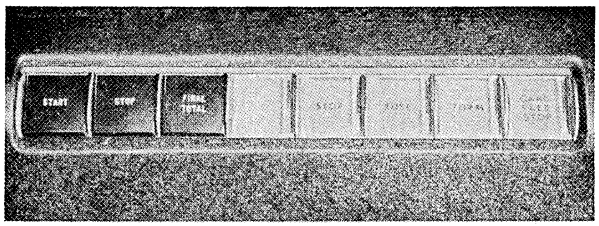


Figure 2. Operating Keys and Lights

Final Total Key

This key provides for manual control over total printing. When a counter is controlled from a final total hub on the control panel, that counter can not be cleared until the following conditions are satisfied:

1. The machine must be idling.
2. The hopper must be empty.
3. All cards must be out of the feed.
4. The start key and the final total key must be depressed simultaneously.

Red Light

The red idling light will go ON when the main line switch is turned ON and the machine is idling.

Stop Light

The red stop light will go ON whenever the machine stops because of an impulse received by a machine stop hub on the control panel. While the stop light is ON, the machine can not be restarted. To turn it OFF, the final total key must be depressed.

Fuse Light

The red fuse light goes ON and the machine stops whenever a fuse burns out. The fuses are located toward the bottom of the machine below the reading table on a fuse panel and are of the signal type.

Form Light

The red form light goes ON and the machine stops whenever the last form is within 10 inches of the platen.

Card Feed Stop

The red card feed stop light goes ON whenever a summary punch operation is started by the accounting machine or the feed interlock circuits are energized. It will remain ON if for any reason the summary punch operation is not satisfactorily completed, thus pre-

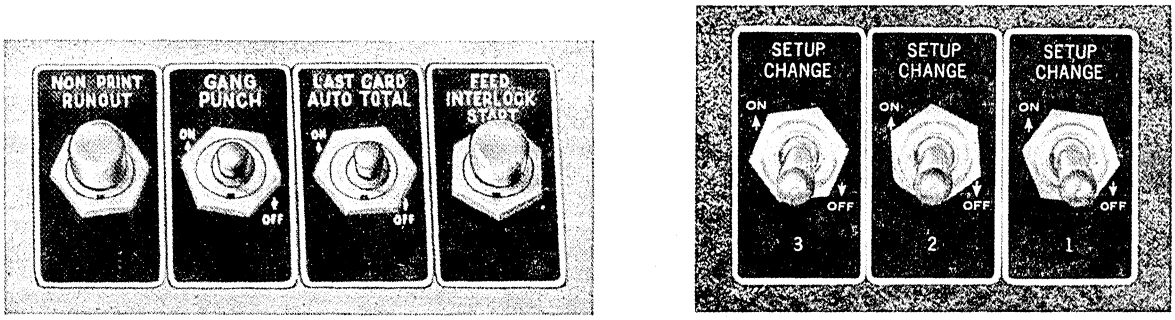


Figure 3. Switches and Push Buttons

venting further operation of the accounting machine until the reason for stopping is corrected, for example, punch magazine out of cards.

SETUP CHANGE

SU CHG (Setup Change) 1, 2, 3. Within reasonable limitations one control panel may be used for several different reports, without any change in control panel wiring, by the use of the setup change switches, located on the left end of the machine. Each setup change switch has a hub on the control panel which emits a constant impulse when the corresponding setup change switch (Figure 3) is turned on.

The setup change exits may be wired to the pickup of a co-selector or a pilot selector. The selector can then be used to change machine functions according to the position of the setup change switch. The following impulses cannot be selected: all first card impulses, and NBAC, INV. F, and SPL. PRG. switches.

RUN OUT BUTTONS AND GANG PUNCH SWITCH

Non-Print Run Out Button

The non-print run out button, located on the far end of the left side of the machine (Figure 3), may be depressed if for any reason it is desired to run cards out of the machine without printing on the report. The hopper must be empty.

Feed Interlock Button

The purpose of feed interlock is to stop the machine and prevent accidental total printing in the event of a card feed failure, as shown in Figure 101. If a card fails to feed from the hopper to position C, the machine stops. At this point there are cards in the hopper, no card at position C, and a card at positions *A* and *B*. The machine can not be restarted except by depressing the feed interlock key, after removing the cards in the hopper, at which time cards A and B run out into the stacker. Card B performs all normal functions except comparing, thus preventing a program change.

The card in the hopper which failed to feed must be corrected. Card B must then be placed in front of the corrected card and the rest of the file and placed in the hopper. To restart the machine the feed interlock button (Figure 3) must be depressed. On the run in, card B does not add, subtract or print, but only compares. The operation for succeeding cards will be normal.

If it is not desirable to continue the run, after a card feed failure, it will be necessary to clear the feed interlock before a new run may be started. This is done by passing a blank card through the machine.

Gang Punch Switch

The gang punch switch (Figure 3) is used with the Type 517 or 523 Gang Summary Punch only, when these machines do not operate under their own power. When the switch is turned ON, the accounting machine will not operate but the gang summary punch will, providing the cable between the two machines is connected.

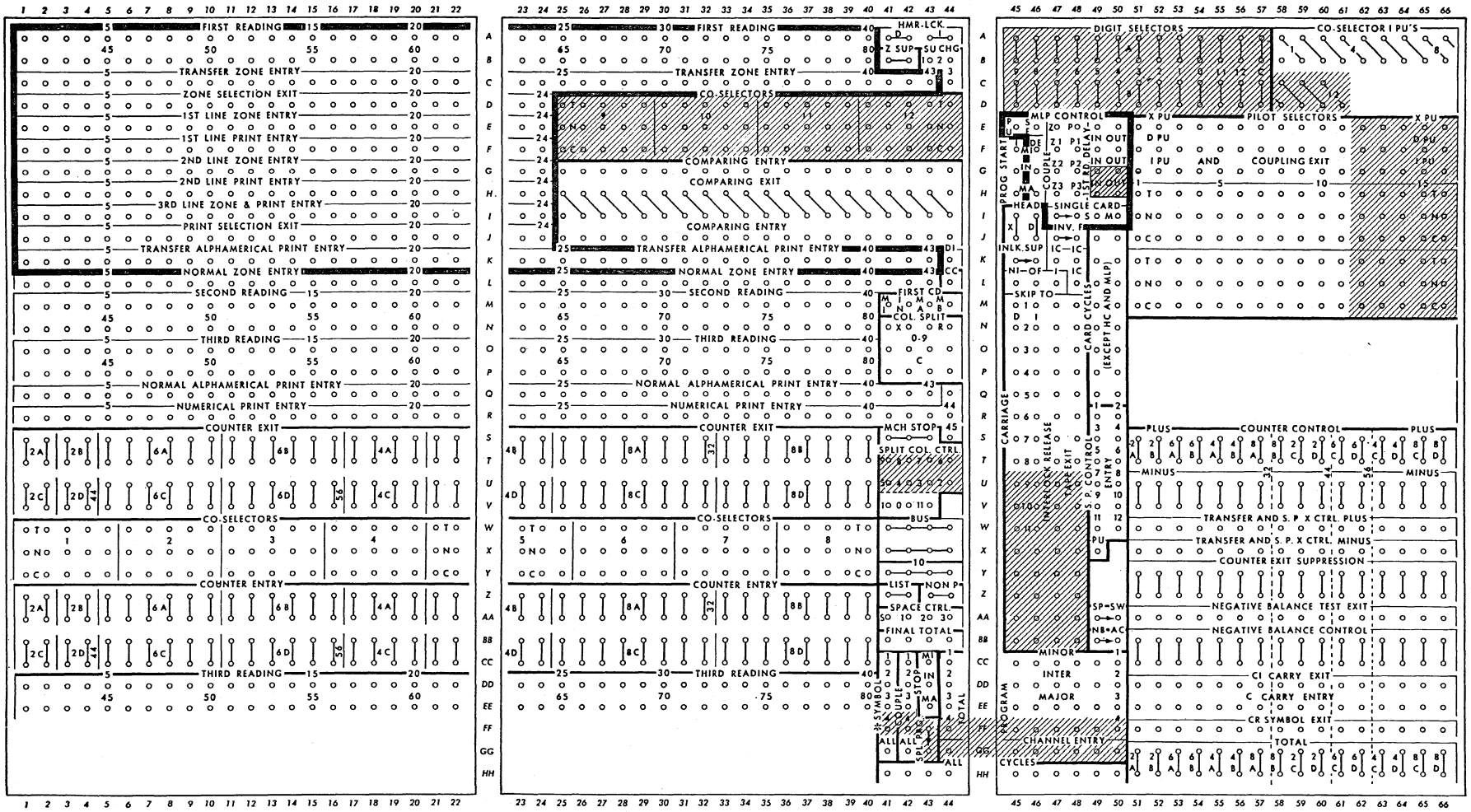


Figure 4. Control Panel

Last-Card Auto Total Switch

The primary purpose of the last-card auto total switch (Figure 3) is to provide a means of obtaining total program cycles on the runout, thus permitting automatic clearing of counters without program control. When the switch is ON, all normal program controls are suspended, and a major program change is forced on both the run-in and runout regardless of control panel wiring. Detail printing will not be suspended for MLP or heading cards if the machine is set for group printing. Carriage skipping, if initiated by one of the cards being processed, will not be suspended. When the switch is OFF, program control wiring will function in the normal manner. Whether the switch is ON or OFF, only those counters will be cleared whose total hubs are wired to clear.

CONTROL PANEL

THE AUTOMATIC operation of the accounting machines is obtained through a control panel, which directs the machine to perform various functions according to the requirements of the report being prepared. The same control panel arrangement Figure 4 serves the Type 402, 403, and 419 Accounting Machine.

A stud is located in the bottom of the control panel guide to prevent other three-section control panels such as that used with Type 405 from being installed in the Types 402-403-419 machines. The 402-403-419 control panel has a hole drilled in the bottom of the frame to accept this stud.

The machines operate from electrical impulses which result from sensing the holes punched 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 kinds 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 types of documents or reports for many different applications.

Whenever two or more hubs are connected by lines, as shown below, these hubs 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.

The control panel is divided into three parts, each part having 22 vertical rows of hubs. The rows are numbered across the top and lettered along the side of the panel for ease in identification. For example, the card cycle hubs may be readily located by reference to rows J through Q and the numbers 49 and 50.

The hubs enclosed in the heavy black lines are for use on MLP (403) machines only. The remaining hubs are used on the Type 402 and Type 403 machines. The shaded hubs show additional or optional features, which may be added to the 70 counter machine.

MACHINE UNITS

THE LOCATION of the principal units on the Type 403 Alphabetical Accounting Machine with the Three Line Listing Feature is shown in Figures 5 through 8.

The mechanical principles of operation for the Type 402, 419 and 403 are the same in all respects except for the card feed unit. The Type 402 and 419 card feed unit is equipped with two sets of brushes. The card feed unit for the Type 403 is equipped with three sets of brushes and a picker knife clutch which controls the operation of the card feed knives and the first and second set of feed rolls.

The circuit operation for the Type 402, 419 and 403 is much the same except that the Type 403 will have the Three Line Printing Feature. The machine will be built to operate at speeds of 80 list, 80 non-list, as well as 80 list, 150 non-list, and 100 list, 150 non-list. The Type 419 machine will be built to operate at a speed of 150 list, 150 non-list. The unit for speed measurement is in machine cycles per minute. Reference in this manual, however, will be to 100 card cycles DETAIL PRINTING speed and the 150 card cycles NON-PRINTING speed.

Mechanical Power Supply

A study of the means of transmitting the mechanical power from the motor to the various units should first be made. Starting at the motor (Figure 5) it will be seen that there are two belts running to pul-

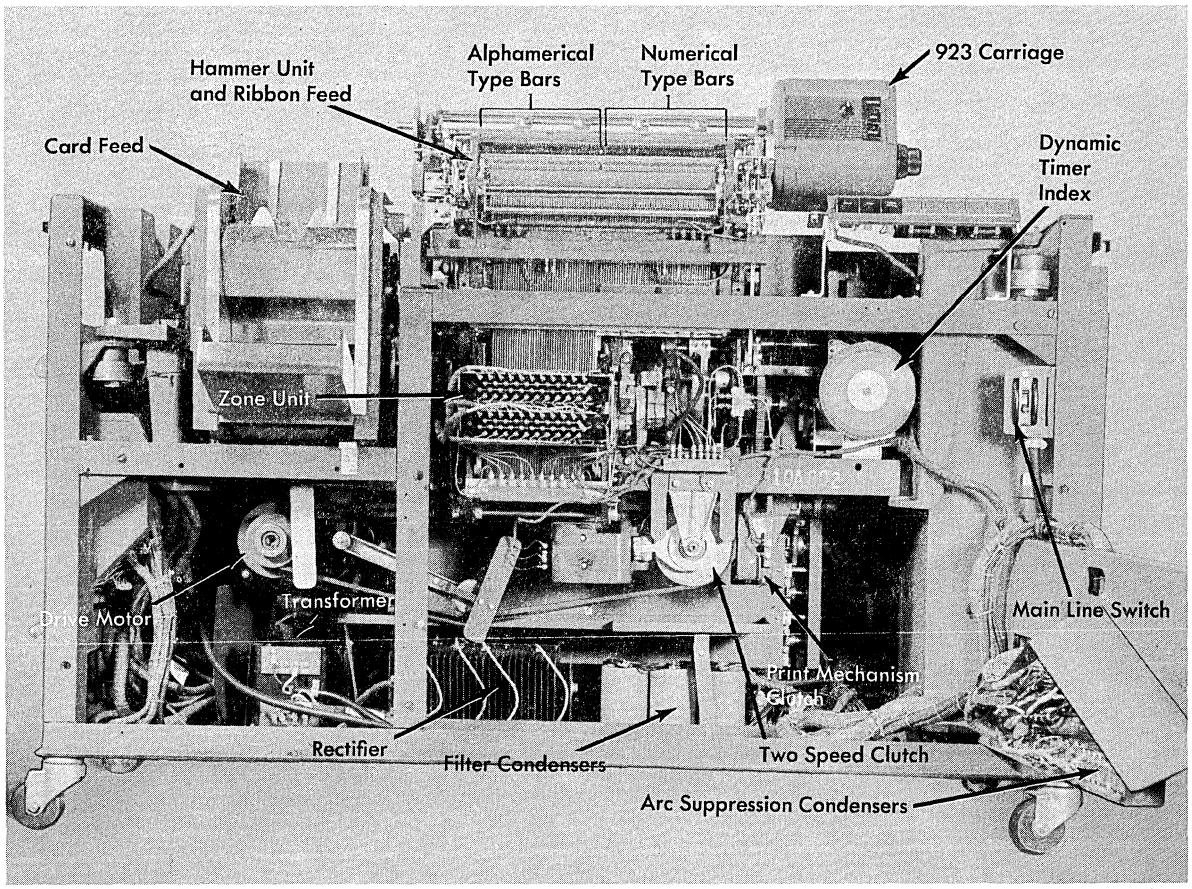


Figure 5. Front View, 403 Base

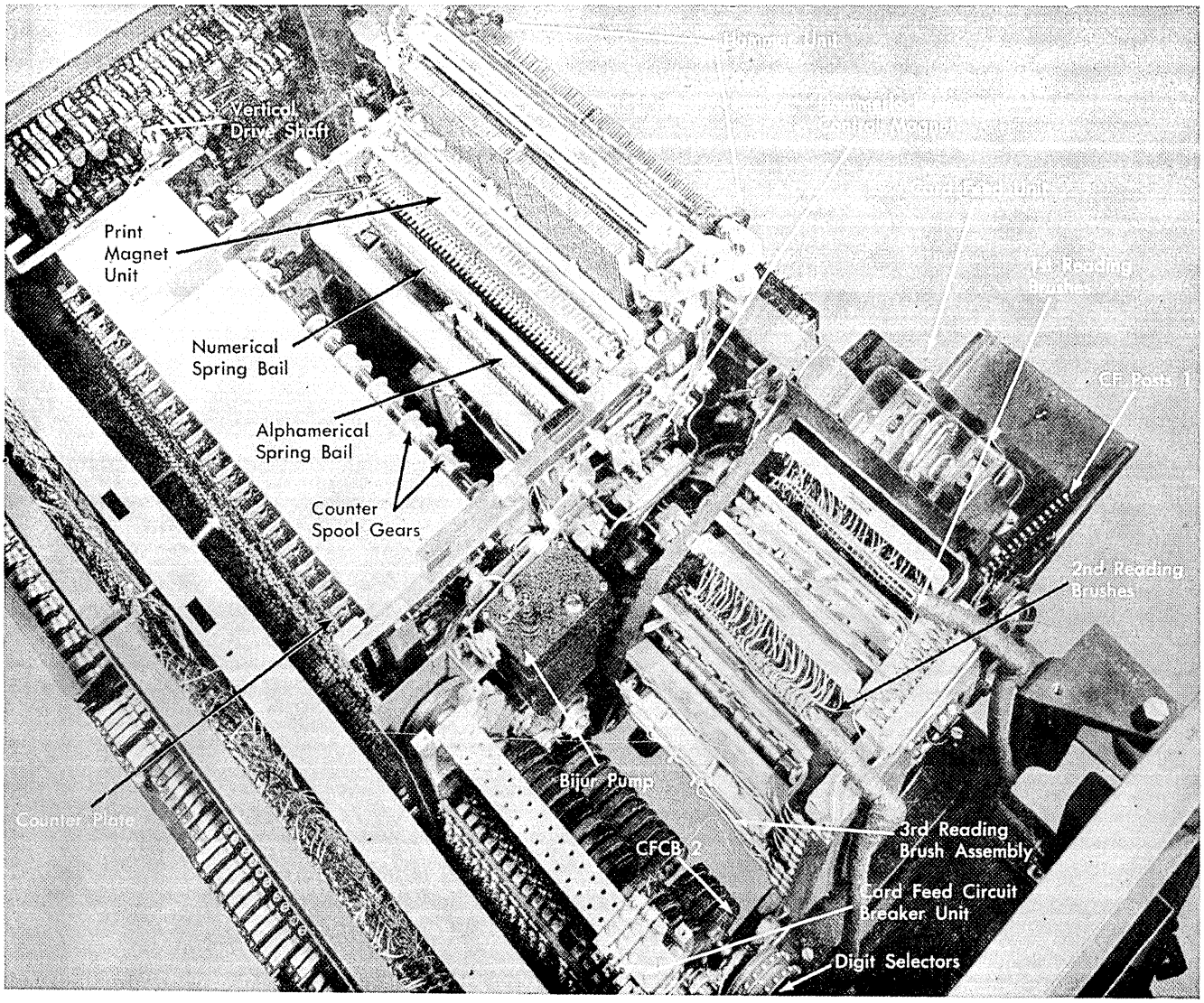


Figure 6. Feed and Card Feed Contact Units

leys on the two-speed clutch assemblies. The front pulley is the drive for the list speed, and the rear pulley is the drive for non-print operation. On AC machines both the high and low speed side of the motor pulley are adjustable so that the correct machine speed may be maintained.

The two speeds at which the machine will operate are controlled by the two-speed clutch magnets, according to the manner in which the control panel is wired. When a 100-150 machine is wired for list (detail printing), the type bars rise to print the information from the card as it passes through the machine at 100 card cycles per minute. With the machine wired for non-list, the type bars will rise only as the first card of a group passes the third brushes. The machine will operate at 100 card cycles per minute for this one printing cycle then return to 150 card cycles per minute as the remaining cards of the group pass the third brushes and the amount fields are accumulated.

DC machines have a generator driven by the motor for the 46 volt power supply. Only the list speed side of the DC motor pulley is adjustable. A motor-speed-control resistor located on the front fuse-panel gate (Figure 80) is adjusted for correct non-list speed, and the list speed is then set with the adjustable motor pulley. This will result in correct operating speed for the generator.

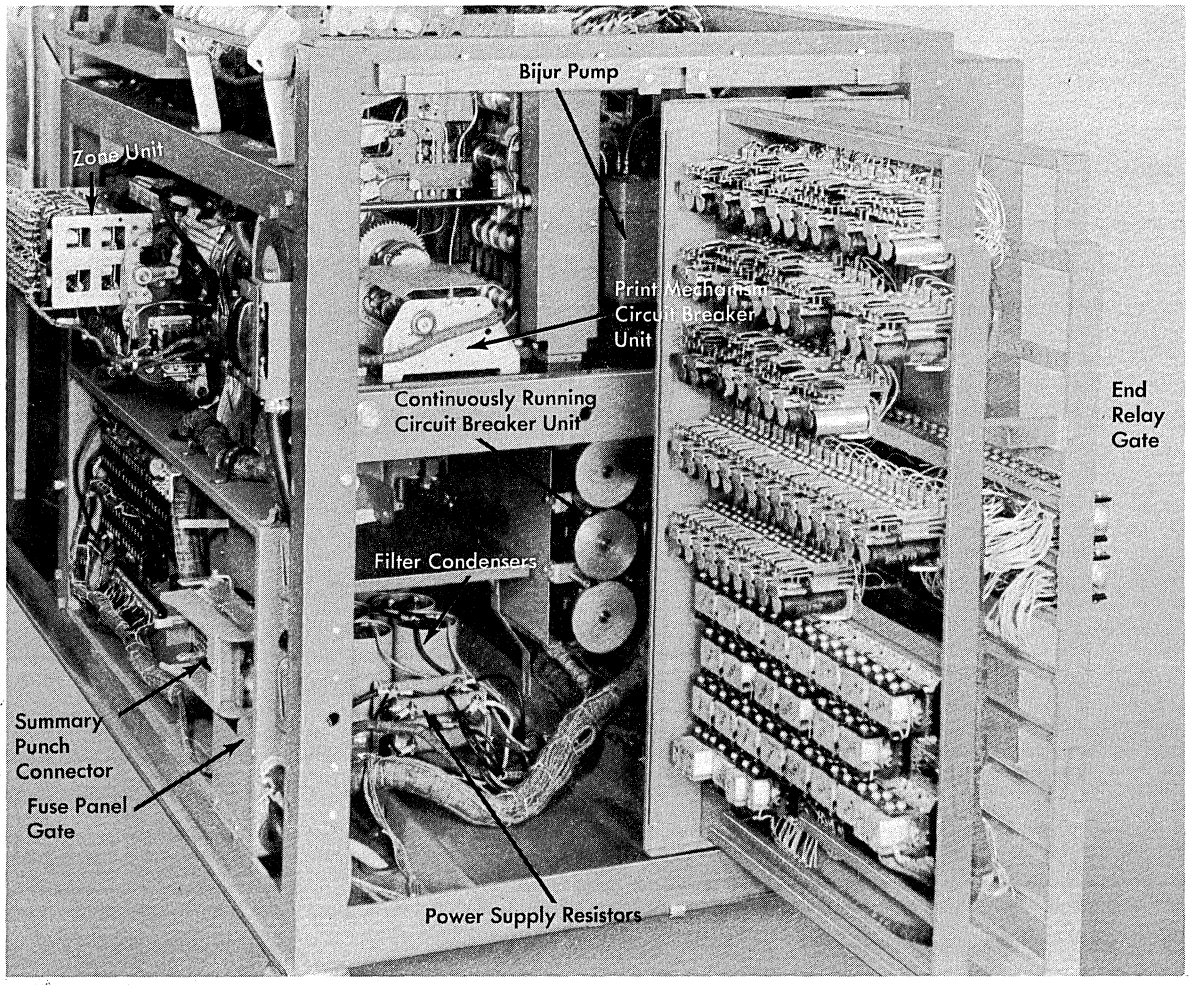


Figure 7. Right End View of the Base

Two-Speed Clutch Magnet Assembly

New Style

Figure 9 shows the armature in the two-speed clutch magnet assembly to be movable in either direction. When the list-speed magnet is energized, the armature and forked arm pivot to force the list-speed pulley into contact with the clutch disc. The clutch disc is pinned to the drive housing shaft so that a train of gears and shafts is set in motion at list speed.

The high speed magnets, when energized, cause the armature and forked arm to pivot so that the high speed pulley is brought in contact with the clutch disc. This will set the train of gears and shafts in motion at the faster speed.

Old Style

Earlier machines were equipped with an older-style two-speed clutch. The basic difference between the two models is an outer clutch disc on the list-speed side of the older-style clutch, which provides for positive drive from both sides of the list-speed pulley. The two clutches are identical in operation.

Two-Speed Drive Housing (Figure 11)

Before operating the machine either by power or with the crank, be sure that everyone, including the customer, customer engineer, or student is clear of the machine before applying power. Also be sure that the machine crank is equipped with the eject spring, so that the crank cannot be left on the machine in the engaged position.

By placing a crank on the forward end of the drive housing shaft and turning, it is possible to see the mechanism that would operate if either of the two-speed clutch pulleys is brought into contact with the clutch disc while the drive motor is running. As

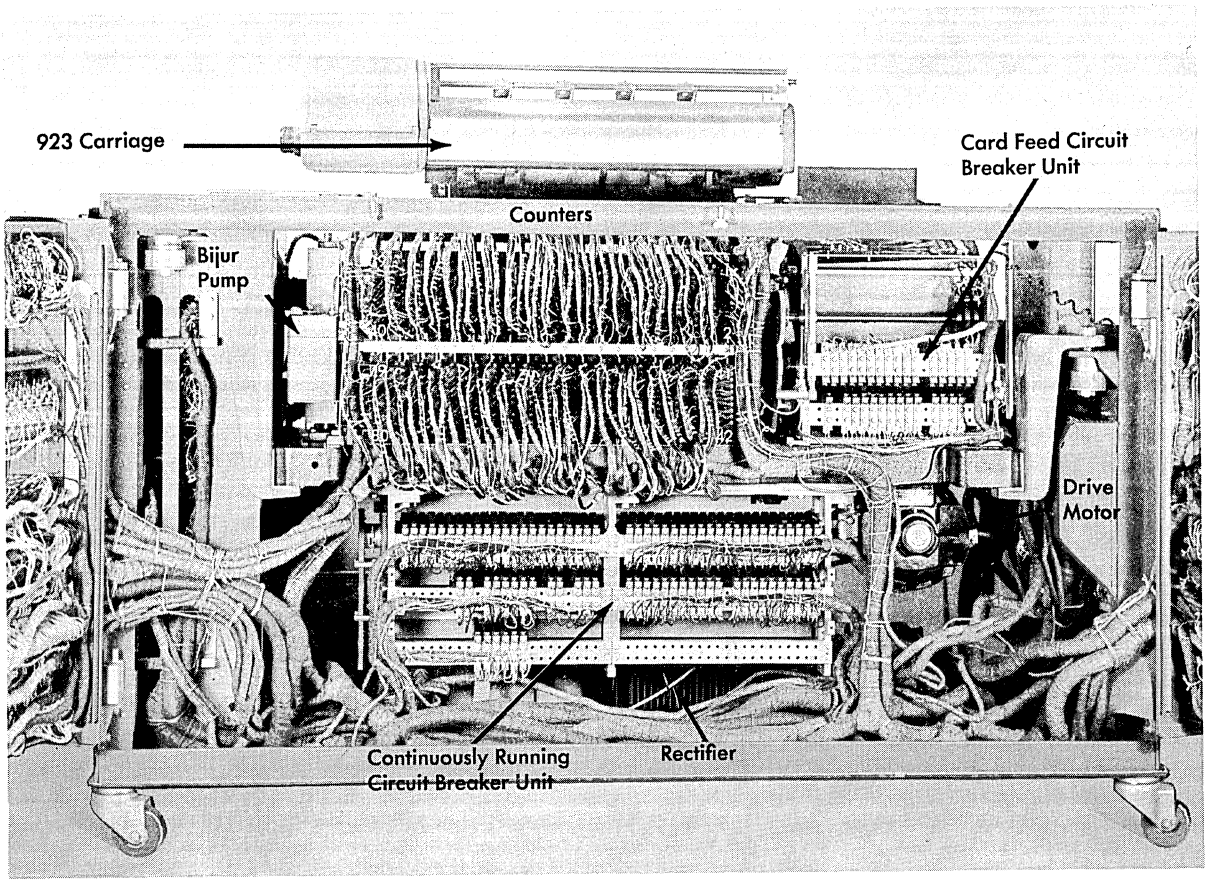


Figure 8. Rear View of the Base

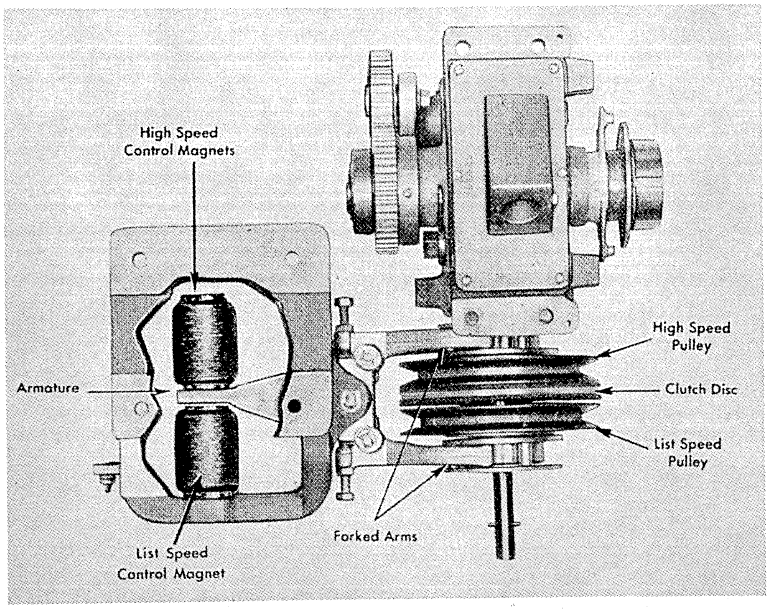


Figure 9. Two-Speed Magnets — Drive Housing and Clutch Assembly

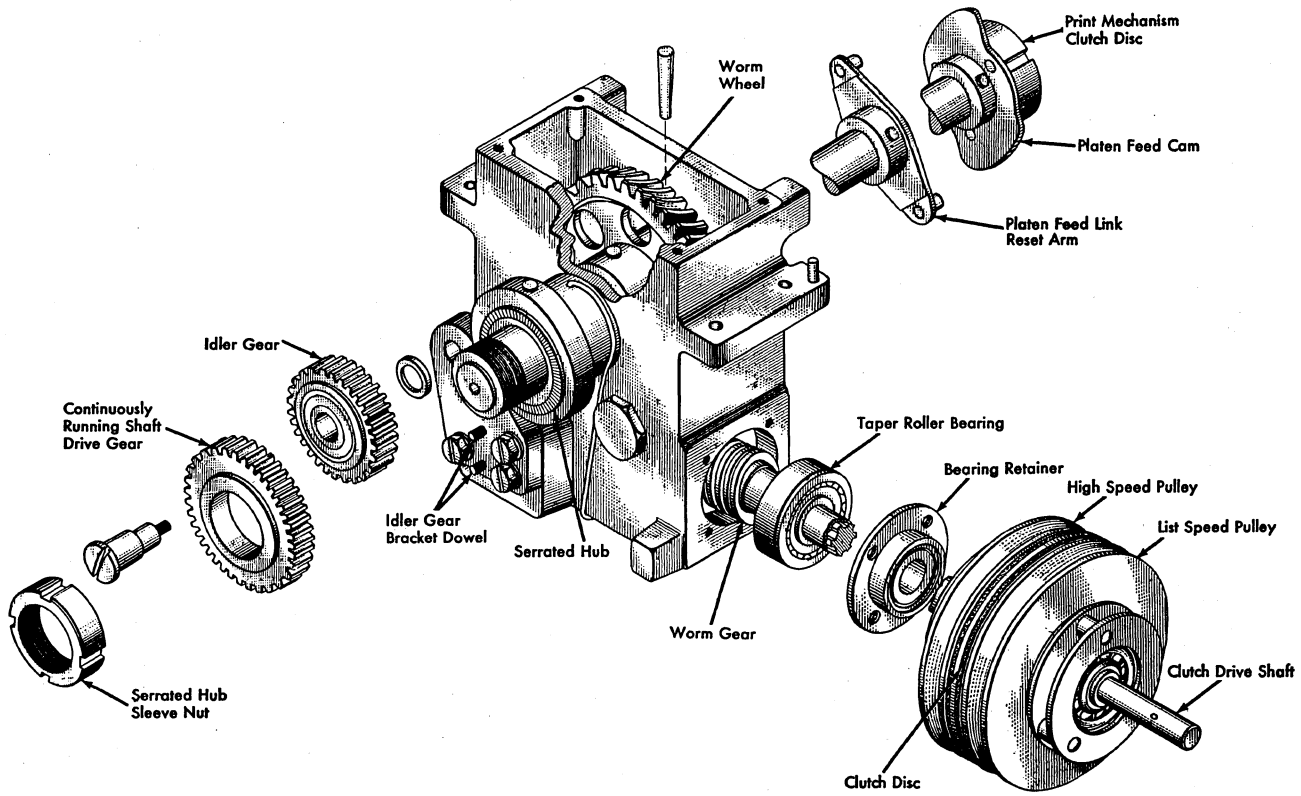


Figure 10. Drive Housing and Two-Speed Clutch

shown in Figure 10, when the crank is turned, the worm gear will turn the drive worm wheel and, through its shaft, operate the continuously running shaft drive gear on the left and the platen space reset cam, platen feed cam, and the print mechanism clutch disc on the right.

The platen spacing mechanism operated by the platen feed link reset arm and the platen feed cam will only be installed in machines to be equipped with the Type 916 Bill Feed at the factory. If the bill feed is a field installation, the platen spacing mechanism must also be added.

The purpose of the serrations between the continuously running shaft drive gear and the serrated hub is to make it possible to bring the card feed clutch disc on the continuously running shaft in time with the print mechanism clutch disc within less than one-tooth variations. With the pawl of the card feed clutch timed to engage at 330° it will allow timing of the print mechanism clutch to engage its pawl at 340°.

Continuously Running Shaft (Figure 12)

By following the continuously running shaft drive gear through the idler gear and the continuously running shaft driven gear, the definite timing relation between these three gears may be seen. The idler gear (Figure 10) is mounted on a support plate

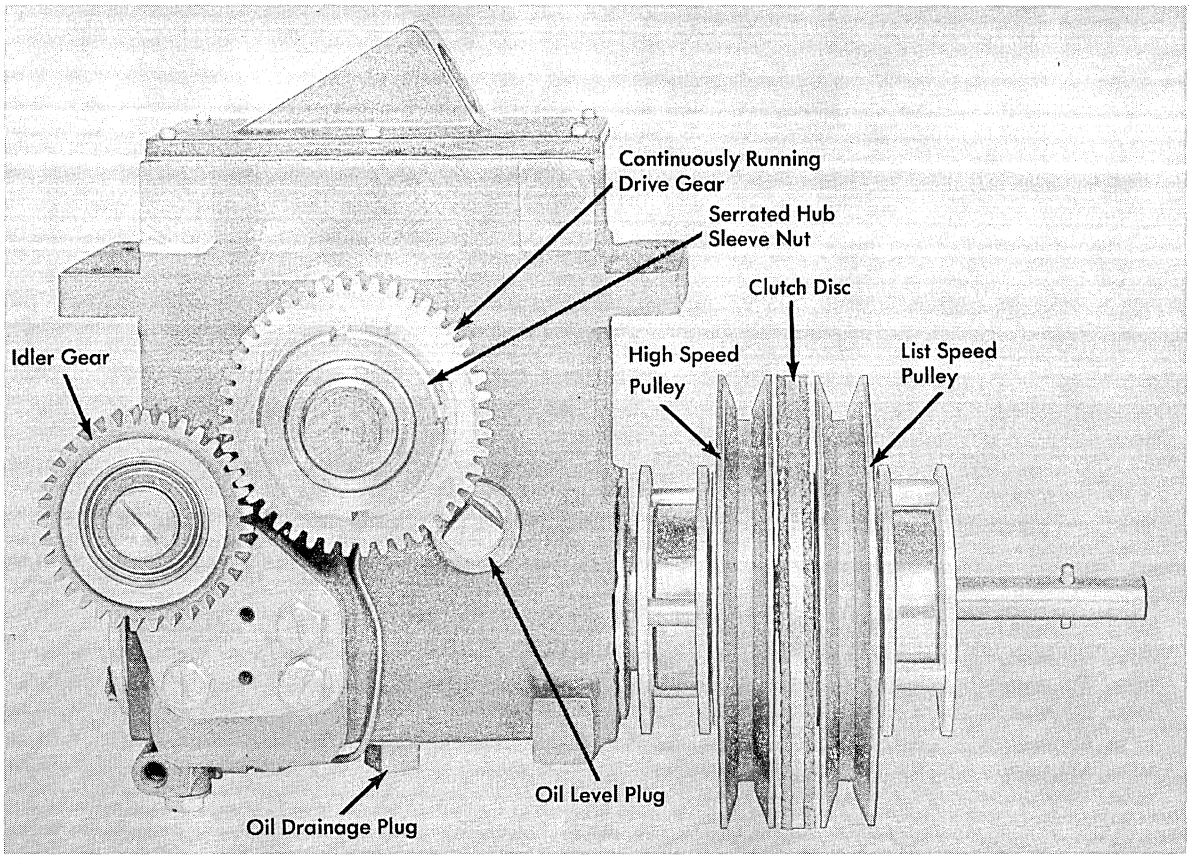


Figure 11. Drive Housing

which has oversize support screw holes so that the idler gear may be kept snug in order to eliminate any freedom of movement between the continuously running shaft driven gear and the continuously running shaft drive gear. On all later machines, once the idler support plate has been positioned, it is doweled to the drive housing casting at the factory.

At the far left end of the continuously running shaft is the card feed clutch disc which will operate the card feed when the card feed clutch magnets are energized.

At the far right end of the shaft is the counter drive beveled gear which operates the vertical counter drive shaft. Through beveled gears, the vertical drive shaft drives the four counter spool shafts which operate the individual counter drive gears. The dynamic timer shaft is turned by the vertical counter drive shaft and operates as the machine index.

It should be observed that while the continuously running shaft is in operation, the continuously running circuit breakers will also be in motion.

A study of Figure 12 shows the mechanical power supply from the two-speed clutch and it may be followed to the card feed clutch disc and the vertical counter drive shaft.

Units Operated by Card Feed Clutch Disc

If the card feed clutch lever is depressed, the card feed clutch pawl will drop down upon the surface of the card feed clutch disc. Crank the machine slowly and listen for the pawl to drop into the one-tooth ratchet of the disc. This should take place at 330°. At this time the gear train for the card feed, card feed circuit breakers, and zone control drive

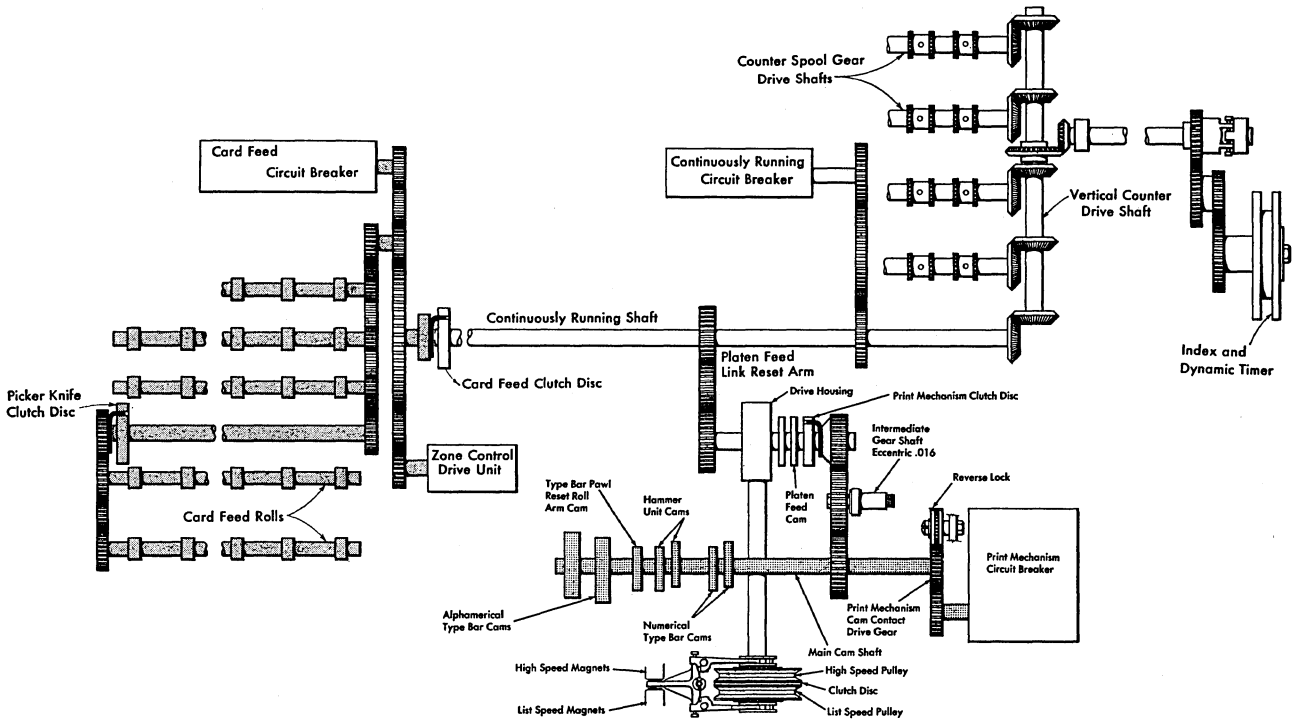


Figure 12. Mechanical Power Supply from the Two-Speed Clutch

unit should start to move, continue through the cycle until the card feed clutch again latches.

On a Type 403 assume the picker knife clutch armature is blocked so that the picker knife clutch pawl remains engaged. With three cards placed in the feed and the card feed clutch manually tripped, turning the drive housing shaft by means of the crank will cause the machine to take one card-feed cycle. Observe the location of the cards at the end of this first feed cycle. The first card in will be ready to be fed by the first reading brushes. Continue to feed cards manually and notice the relationship between first and second cards as they pass under the brushes. They will be in correspondingly identical positions under each set of brushes. If the remaining card is cranked through the machine, the same relationship can be observed between it and the cards ahead of it.

Now suppose one card is placed in the Type 403 feed and two card-feed cycles are taken manually. During the second cycle, allow the picker knife clutch to latch at 165° and continue to turn the crank until the card feed clutch latches at 330°. Observe the position of the card. The first reading brushes will be between 1 and 0 on the card. Normally the picker knife magnet is always energized each card feed cycle except when performing multiple-line printing operations. The use of the picker knife clutch will be further discussed under the card feed unit. Now check the card feed circuit breakers by engaging the card feed clutch and turning the crank. It will be seen that they are in operation only when the card feed clutch is engaged and the card feed unit is moving. This condition also holds true for the four cams of the zone control drive unit, which operates the linkages and bails in the zone unit.

Units Operated by Print Mechanism Clutch Disc

After a complete check has been made of the units operated from the card feed clutch disc, a study should be made of those units being driven from the print mechanism clutch disc. When the print mechanism clutch lever is depressed, the pawl will drop down on the surface of the clutch disc. Crank the machine slowly and listen for the pawl to drop into the one-tooth ratchet of the clutch disc. This should take place at 340°. At this time the main cam shaft and the print mechanism circuit breaker cams will start to turn.

On some machines when the print mechanism clutch is allowed to latch by hand, the print mechanism may stop at about 337°. The reason for this condition is that the pawl carrier arm is not carried to a point where it will latch behind the keeper when the machine is cranked through a cycle manually. Under power the pawl carrier arm will always be latched at the 340° position.

Mounted on the main cam shaft (Figure 12) are the alphamerical type bar cams, type bar pawl reset roll arm cam, hammer unit cams, and numerical type bar cams. At the right end of the main cam shaft is the print mechanism cam contact drive gear. It can be seen that the PM cams will be in operation only when the print mechanism clutch is engaged. The purpose of the serrations between the main cam shaft gear and the serrated hub is to make it possible to position the main cam shaft so that the type bars will be raised and restored at the correct degree on the index. Serrations allow for correcting variations of less than one tooth between the main cam shaft and the print mechanism clutch disc on the right side of the drive housing.

When the print mechanism clutch is engaged, it can be seen that the alphamerical and numerical type bar bail assemblies are raised and lowered by linkage operating from alphamerical and numerical cam followers. Before the type bars reach their upward limit of travel, a few print magnet stop pawls should be released at 3, 2, or 1 time according to the time shown on the timing chart. At 196°-199° the hammer unit cam will cause the hammers to be tripped and restored before the type bars start down. At approximately 342° the type bar pawl reset roll arm will be on the high point of the cam and will cause the manually released pawls to be restored back upon their latches. A detailed explanation of the mechanical operation of each major unit will be discussed separately with each unit in this manual.

Thus far the relationship of the one-tooth ratchets in the card feed clutch disc and the print mechanism clutch disc have been explained. Because all units driven by either disc are synchronized, the drive should be followed through the units in operation.

The movement of four basic parts (Figure 13) should be noted: the card, the type bar (alphamerical or numerical), the zone bar, and the counter. The mechanical and electrical timing charts indicate that there is one condition which is common to all operations. This is the relation between the distance from one hole on the card to the next, the distance from one tooth to the next on the alphamerical type bar,

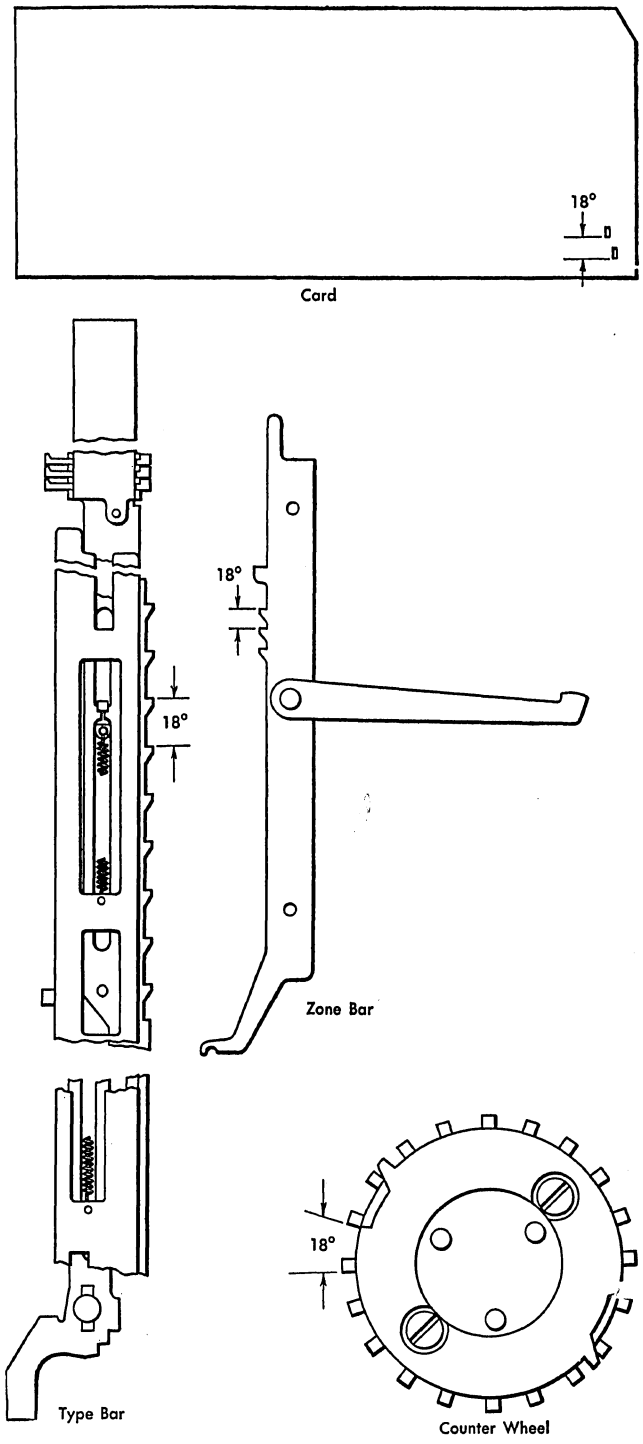


Figure 13. Cycle Point

numerical bar, or zone bar, and the distance from one detent position to the next on the counter wheel. The chart below shows that they are all 18° or one cycle point apart.

Machine Index

The dynamic timer is divided into 360°. All timings, both mechanical and electrical, are referred to this index. All machine operations require not only that the units perform their work, but also that time be allowed for the units to be restored to normal. The machine cycle is divided into 20 divisions or cycle points, and there are, therefore, 18° on the index for each cycle point. The work that the machine performs when moving from the 6 hole to the 5 hole takes place during one cycle point, during which the card moves one-fourth inch.

Since all units of the machine must work in perfect synchronism all operations *must be accurately timed* for satisfactory machine operation.

The machine index is timed to read 330° when the card-feed clutch pawl just engages with the clutch disc. The machine index is then used as a reference when all other machine units are timed. A split block adjustment is provided, which allows the index to be brought into closer timing with the card-feed clutch disc than is possible by changing the drive-gear relationship one tooth.

MACHINE CYCLES

THE VARIOUS units which have been located, operate in different combinations on the different machine cycles. The true card cycle will be used in all further discussion to mean the mechanical operations which take place when the card feed clutch is energized for one cycle. This is necessary since we describe the speed of the machine at 100 card cycles per minute when wired for LIST; however, it must be kept in mind that on multiple line printing operations there may not be 100 cards fed per minute since more than one line of printing may be read from one card.

The flexibility of the machine will be discussed under circuits where it will be explained how list cycles and other operations may be programmed by means of control panel wiring.

List Cycle (List Hub Wired)

The card feed operates at a speed of 100 card cycles per minute on a list cycle. During a list cycle,

Hole in Card	Index Time Sensed	Alpha Type Bar Stops	Numerical Type Bar Stops	Zone Bar Stops
CR or *			6°	
9	9°	24°	24°	
8	27°	42°	42°	
7	45°	60°	60°	
6	63°	78°	78°	
5	81°	96°	96°	
4	99°	114°	114°	
3	117°	132°	132°	
2	135°	150°	150°	
1	153°	168°	168°	
0	171°	186°	186°	186°
11	189°			204°
12	207°			222°

the type bars rise once each card cycle for each line of printing.

Non-List Cycle (List Hub Not Wired)

The card feed operates at a speed of 150 card cycles per minute on a non-list cycle. The machine is operated at this speed when the cards are to be accumulated. A non-list cycle occurs for all except the first card in the group (see group indication cycle below). On a non-list cycle, the type bars remain in their normal position as the cards pass through the feed at the rate of 150 card cycles per minute.

Group Indicate Cycle

With the control panel wired for group printing the first card of each group passes through the machine on a group indicate cycle at the rate of 100 card cycles per minute. The purpose of this cycle is to permit printing from the first card information which will identify the totals for the group.

Program Total Cycle

On this cycle, totals which have been accumulated from a group of cards, or from a single card, are printed. The counters are caused to revolve, and as they reach zero, send impulses to stop the type bars at the correct character. If totals are to be printed, the machine will operate at 100 cycles per minute.

Conversion Cycle

This cycle occurs only in machines equipped with negative balance circuits and will be covered in detail under *Circuits*. During a conversion cycle, complement totals standing in the counters are converted to true figures by the addition of a conversion factor. This operation takes place at 150 cycles per minute.

Summary Punching Cycle

This is a cycle during which the Accounting Machine is not in operation. The Summary Punch, which is connected to the Accounting Machine through a cable, reads the amounts standing in the counters and causes them to be punched into the summary card as it passes the die of the Summary Punch.

Special Program (Programming)

A program implies a plan of operations to be performed in a definite order. Such is the application of the special program device in the Types 402-403 and 419. It provides a means whereby various cycles of operation, such as transferring from one counter to another, listing or suppressing listing, adding or total printing, may be effected in a definite order by flexible wiring of the control panel.

Therefore, the program unit must fulfill two basic requirements: first, it must supply the source impulses to initiate proper counter operation; and second, it must provide for delaying either listing or program total printing or both for one or more cycles.

Idle Cycle

This cycle can be defined as one in which the high-speed clutch is engaged, but neither the card-feed nor the print mechanism is operating. Such operations as conversion, summary punching, and carriage skipping take place during idle cycles. For clarity a machine is considered to be idling but not in idle cycles when the drive motor is running and neither two-speed clutch magnet is energized.

Speeds

List, group indicate and program total cycle operations are normally performed at a speed of either 80 or 100 cycles per minute. If the non-print hub is impulsed, however, a relay is energized which eliminates the printing operation and returns the machine to a speed of 150 cycles per minute.

During non-list, conversion, summary punching, and carriage skipping operations the machines will operate at 150 cycles per minute.

Tables I and II show the various units which are in operation on each of the types of machine cycles.

TABLE I

CYCLE	PMCB	CRCB	CFCB
List (List hub wired)	√	√	√
Non-List (List hub not wired)		√	√
Program Total Print	√	√	
Group Indicate	√	√	√
Conversion		√	
Summary Punching		√	

TABLE II

	CONTINUOUSLY RUNNING SHAFT	COUNTERS	CARD FEED CLUTCH	PICKER KNIFE CLUTCH	ZONE CONTROL DRIVE UNIT	ZONE UNIT	PRINT MECHANISM CLUTCH	MAIN CAM SHAFT	ALPHA. AND NUMER. TYPE BARS	HAMMER UNIT	RIBBON FEED	PRINT MAGNET UNIT
List (List hub wired)	√	√	√	*√	√	√	**√	√	√	√	√	√
Non-List (List hub not wired)	√	√	√	√	√	√						
Program Total Print	√	√					**√	√	√	√	√	√
Group Indicate	√	√	√	√	√	√	√	√	√	√	√	√
Conversion	√	√										
Summary Punching	√											

* Picker knife clutch operation may be controlled by multiple-line printing control punching.

** Print clutch will not operate if the non-print hub on the control panel is wired.

These tables should be referred to in connection with the further study of standard operation of the units and mechanisms.

DIMENSIONS — CURRENT REQUIREMENTS

THE DIMENSIONS of the Types 402, 403, and 419 Accounting Machines are as follows:

MACHINE UNPACKED

Length	68″
Width	43″
Height	47″

WEIGHT

UNPACKED		PACKED	
Type 402	2390 pounds	Type 402	3100 pounds
Type 403	2515 pounds	Type 403	3141 pounds
Type 419	2110 pounds	Type 419	2800 pounds

CURRENT REQUIREMENTS

VOLTS	115 AC	230 AC	115 DC	230 DC	
Type 402	12.0	7.5	12.0	6.0	Amperes Running
Type 403	13.0	8.0	13.0	6.5	Amperes Running
Type 419	12.0	6.0			Amperes Running

With the motor-generator combination, the starting current requires a 20-ampere source of supply, preferably using number 10 wire.

HEAT DISSIPATION

Type 402	115 AC 4692 BTU per hour 100% Duty 115 DC 4800 BTU per hour 100% Duty
Type 403	115 AC 5000 BTU per hour 100% Duty 115 DC 5080 BTU per hour 100% Duty
Type 419	115 AC 3480 BTU per hour 100% Duty

MACHINE UNITS

BECAUSE the card-feed clutch engages at exactly 330° and the print mechanism clutch engages at exactly 340°, all units driven through gear trains from these clutches will be working in synchronism.

Upon completion of a study of the over-all machine operation, each unit will now be explained in detail. The method of providing power to all units included a description of the mechanical operation of the two-speed clutch magnet and the drive housing assembly.

The mechanical operation of the remaining units will now be explained.

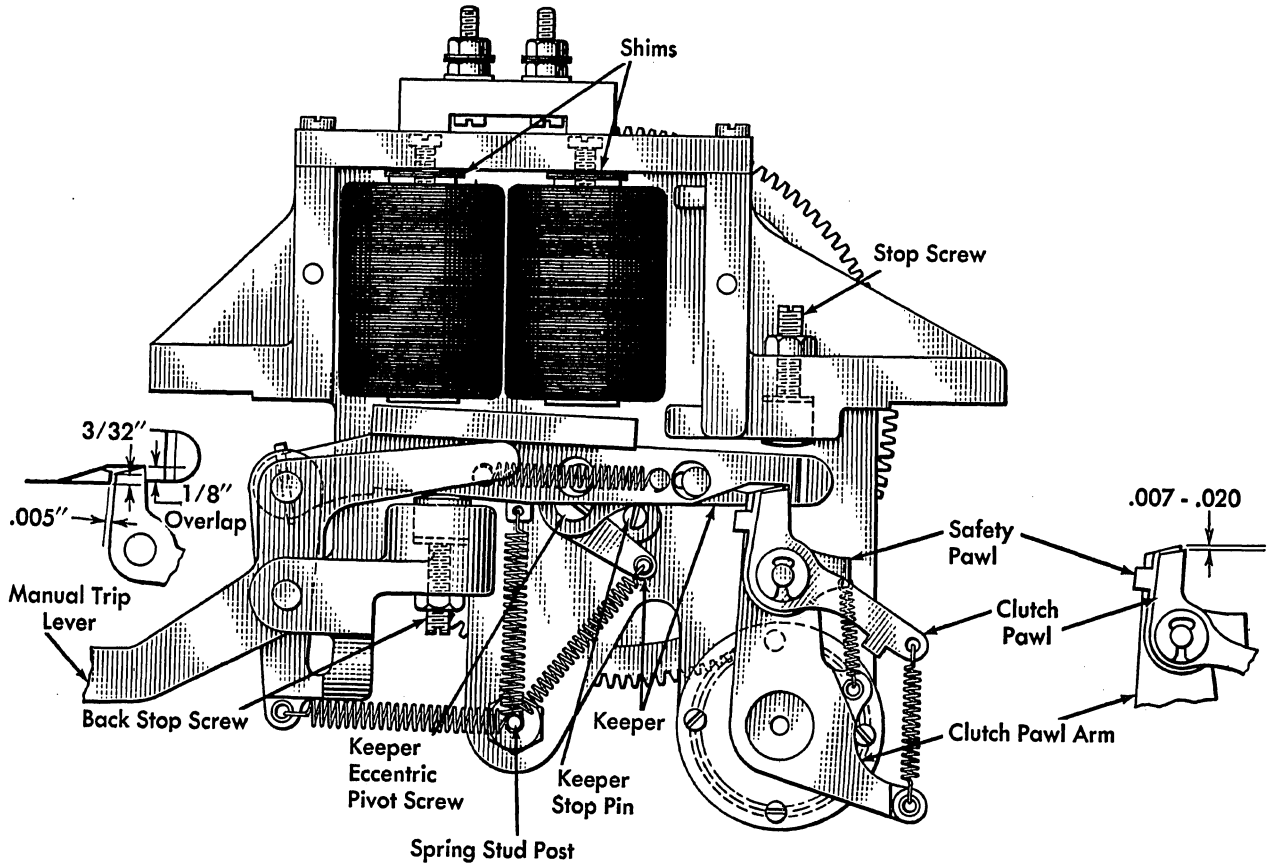


Figure 14. Card Feed Clutch

CARD FEED CLUTCH

IT HAS already been noted that the operation of the card feed unit is under the control of the card feed clutch. The card feed clutch consists basically of a pair of magnets and an armature which serves as a latch for the clutch pawl arm (Figure 14).

The card-feed clutch will be energized whenever information is to be read from a card to cause listing or accumulating by passing the card through the feed past the brushes. By energizing the card feed clutch magnets the armature is attracted, thus allowing the card feed clutch pawl to drop down on the surface of the card feed clutch disc which is pinned to the left end of the continuously running shaft. At 330°, when the one-tooth ratchet of the disc is opposite the card feed clutch pawl, the pawl will engage with the disc. In this manner the pawl by means of its arm, will cause the clutch drive gear to start all units controlled by the clutch in motion.

On inspection a check should be made periodically to see that the clutch drive gear is locked tight to its shaft and that there has not been any opportunity for wear to develop in the drive gear key.

It has already been determined that the card-feed unit operates at different speeds depending upon the machine function. At slow speed, the steady drag from the pressure on the card-feed rolls and the friction of the reading brushes on the card tend to stop the card-feed mechanism before it becomes fully latched (pawl behind the keeper). The split armature latch allows the card-feed clutch pawl to remain engaged in the card-feed clutch disc as late as possible as the index approaches 330°, thus assuring a fully latched clutch. After the clutch pawl is disengaged from the one-tooth ratchet, the spring on the free portion of the latch lifts the pawl sufficiently above the surface of the clutch disc to prevent nipping of the clutch disc when the continuously running shaft is in motion and the card-feed clutch is latched.

At high speed the momentum of the card-feed mechanism causes the clutch pawl arm to latch correctly behind the keeper. For this reason the armature on the card-feed clutch of the Type 419 machine does not have a split latch but is identical to the armature of the print-mechanism clutch. The armature latch is attached to a yoke, which is held in position by the tension of the clutch lever yoke spring. The purpose of the spring is to absorb the shock when the clutch pawl arm latches and to return the arm to the 330° position if there is any tendency to move beyond this point.

The safety pawl is a small plate under spring tension mounted on the clutch pawl stud which swings forward into the path of the latch when the armature is attracted.

The purpose of the safety pawl is to prevent the armature latch from relatching the clutch pawl arm if the electrical circuits to the clutch magnets fail before the clutch pawl has engaged with the card feed clutch disc. This prevents having the pawl engaged in the clutch disc at the same time the pawl arm is latched on the armature.

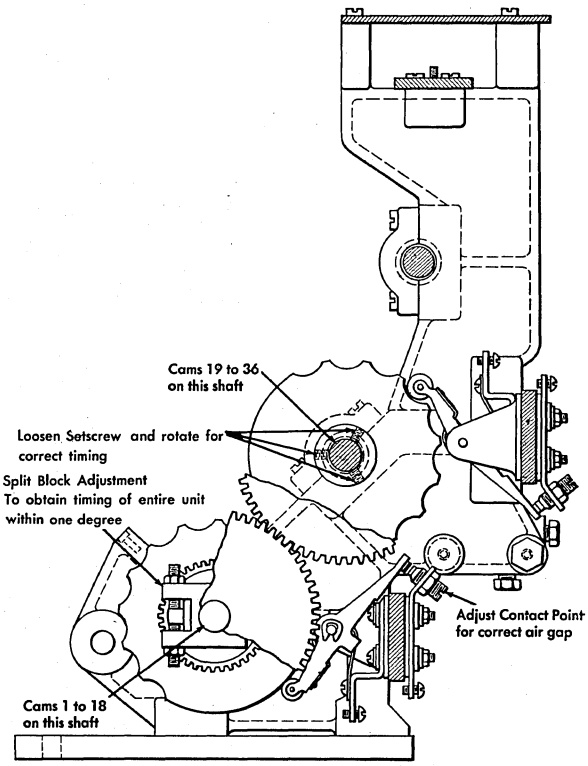


Figure 15. Card Feed Circuit Breaker Unit

CARD FEED CIRCUIT BREAKER UNIT

THE CARD feed circuit breaker assembly (Figure 15) is driven by the card feed clutch idler gear and operates with the card feed unit and the zone control drive unit.

Cams mounted on the three shafts in the circuit breaker unit revolve and open and close the circuit breaker cam contacts for a fixed duration determined by the cut of the cam.

The first cam shaft in the card feed circuit breaker unit is equipped with a split block adjustment which allows the entire unit to be brought into closer timing with the index than is possible by changing the drive gear relationship one full tooth.

CARD FEED

Card Feed Unit — Type 402 and 419

The card feed unit used on the Type 402 and 419 feeds cards past two sets of brushes which will be referred to as the second and third reading brushes. To recognize the presence of cards there is a card lever ahead of the second and third brush assemblies which will be operated before the card moves past that brush station.

Card Feed Unit—Type 403

A study of the card feed unit with reference to Figure 16 will show that it consists of two feed knives for starting cards to feed past three sets of brushes in order that these brushes may sense the holes punched in the card. Once the card has passed the three brush stations, a stacker mechanism picks up the cards and places them in the stacker.

The cards are placed in the feed 9's edge first, face down and are moved through the three brush stations by a series of feed rolls under spring tension that are driven from the card feed clutch gear.

A contact known as the hopper contact is mounted

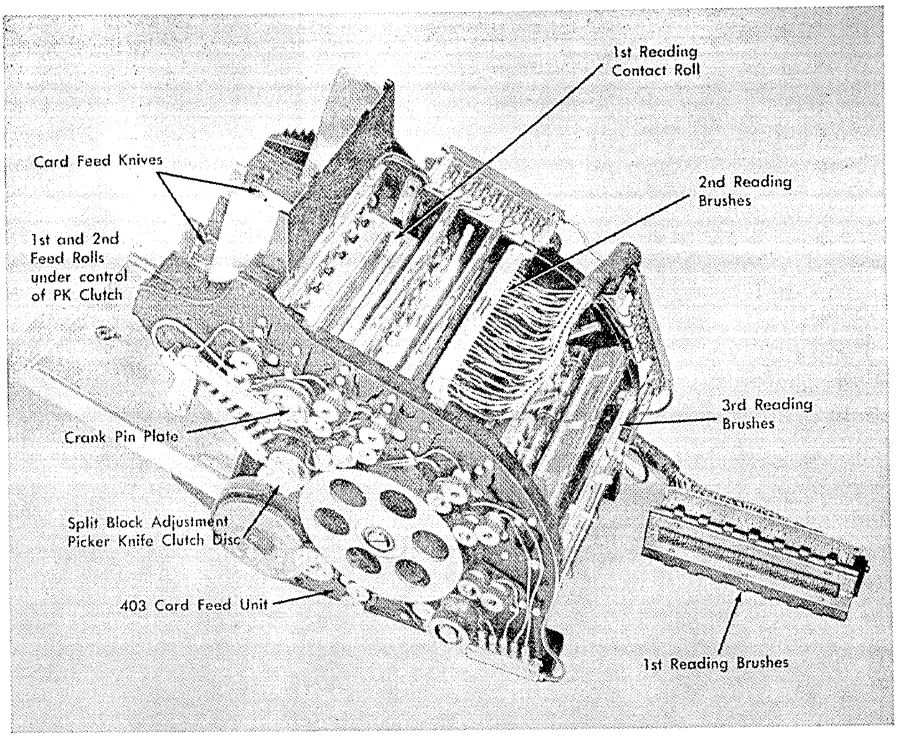


Figure 16. Card Feed Unit, Type 403 — Rear View

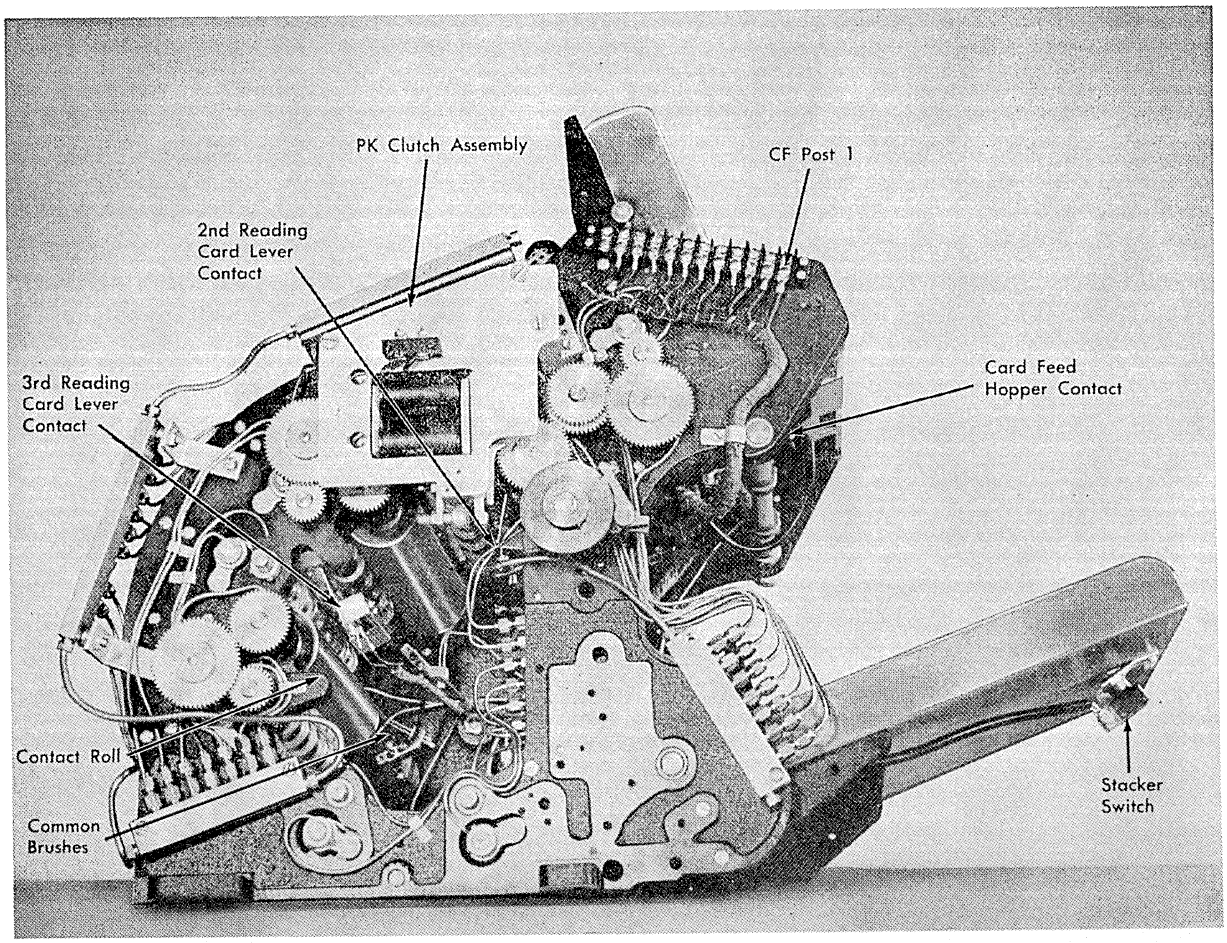


Figure 17. Card Feed Unit, Type 403 — Left Side

under the feed hopper. The purpose of this contact is to recognize the presence of cards in the hopper. Operation of the hopper contact will be covered later in the *Circuit Description.*

There are three card lever contacts inside the feed, one ahead of each brush station and operated mechanically by the card moving over the contact operating lever. The contact recognizes that a card is approaching that brush station and is used to establish circuits to the reading brushes until the last card has passed that station.

In order to provide for the necessary delays in card feeding when performing a multiple line printing operation, the card picker knives, first contact roll, and the first and second set of feed rolls are under the control of the PK (picker knife) clutch (Figure 17).

Mounted in the card magazine are two springs which prevent single cards from sliding through the throat before the card weight has been put in place.

Picker Knife Clutch

In series with the picker knife clutch magnet circuit are a number of interlock contacts which open during different multiple line printing operations. This causes the detail card following a multiple line print card to stop under the first set of brushes between the one and zero position on the card. Under all other normal operations, however, the picker knife clutch pawl is engaged in the one-tooth ratchet of the picker knife clutch disc when the card feed clutch is latched at 330° (Figure 18A).

The one-tooth clutch disc for the PK clutch is located on a shaft driven from the main card feed unit drive gear; therefore, the PK clutch is operative only when the card feed unit is in motion. The PK clutch disc is timed so that the clutch engages and disengages at 165° (Figure 18B). This is set and pinned at the factory and can be changed by removing the clutch drive gear and remeshing it with

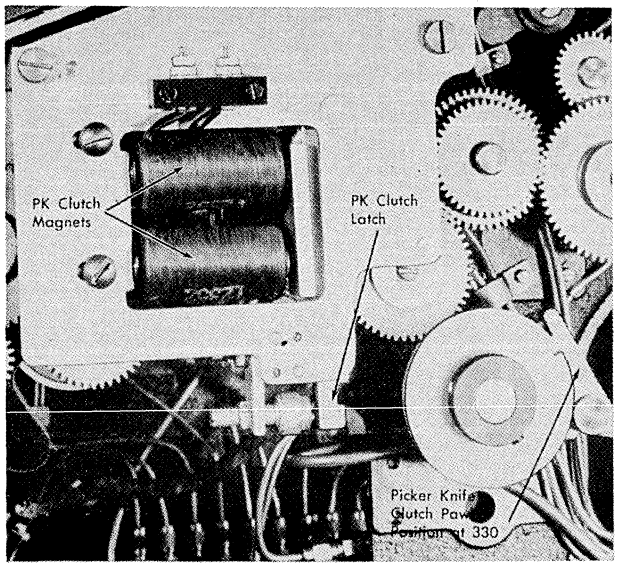


Figure 18A. PK Clutch Pawl at 330°

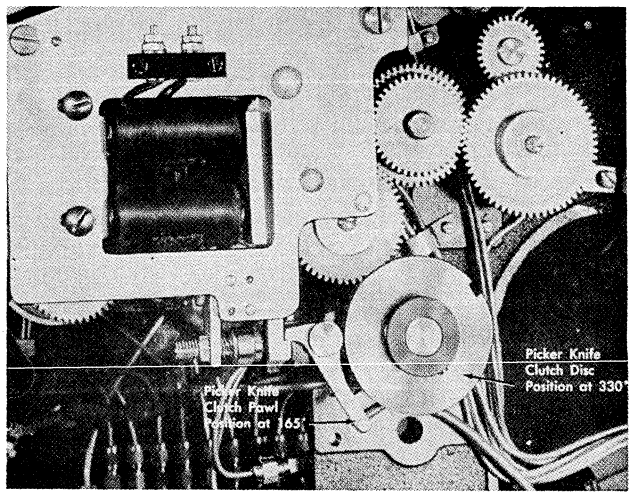


Figure 18B. PK Clutch Pawl at 165°

the gear on the feed. A split block adjustment is provided to correct any change in relationship of less than one tooth difference.

Construction of Alphamerical Type Bar

A study of the alphamerical type bar should be made to locate the following parts: hammer latch trip lockout cam, setup pawl, type bar zone slide, and the relation between the zone slide section and the type bar itself.

It may be seen from Figure 19 that placing the setup pawl in each notch at the bottom of the zone slide section also raises the upper type bar case to a new position. The purpose of the zone control drive unit and the zone unit is to raise the zone slide section of the type bar so that the setup pawl under spring tension may be free to swing into its correct zone position.

The alphamerical type bars are raised by spring tension and restored by the alphamerical type bar restoring bail assembly. This unit will be discussed with the main cam shaft but may be seen in Figure 36. The cut of the alphamerical type bar lift cam controls the rise of the type bar so that the 9-8-7-6-5-4-3-2-1-0 tooth on the main type bar assembly may be selected by the print magnet stop pawl as the numerical hole punched in the card is sensed. A comparison of the table with the type bar, starting at the top, shows that each number has its combination of zone characters. The first four characters on the bar are 9-I-R-Z, all of which require the punching of a 9 hole. The complete analysis of the type grouping is as follows:

9 group:	9	I	R	Z
8 group:	8	H	Q	Y
7 group:	7	G	P	X
6 group:	6	F	O	W
5 group:	5	E	N	V
4 group:	4	D	M	U
3 group:	3	C	L	T
2 group:	2	B	K	S
1 group:	1	A	J	

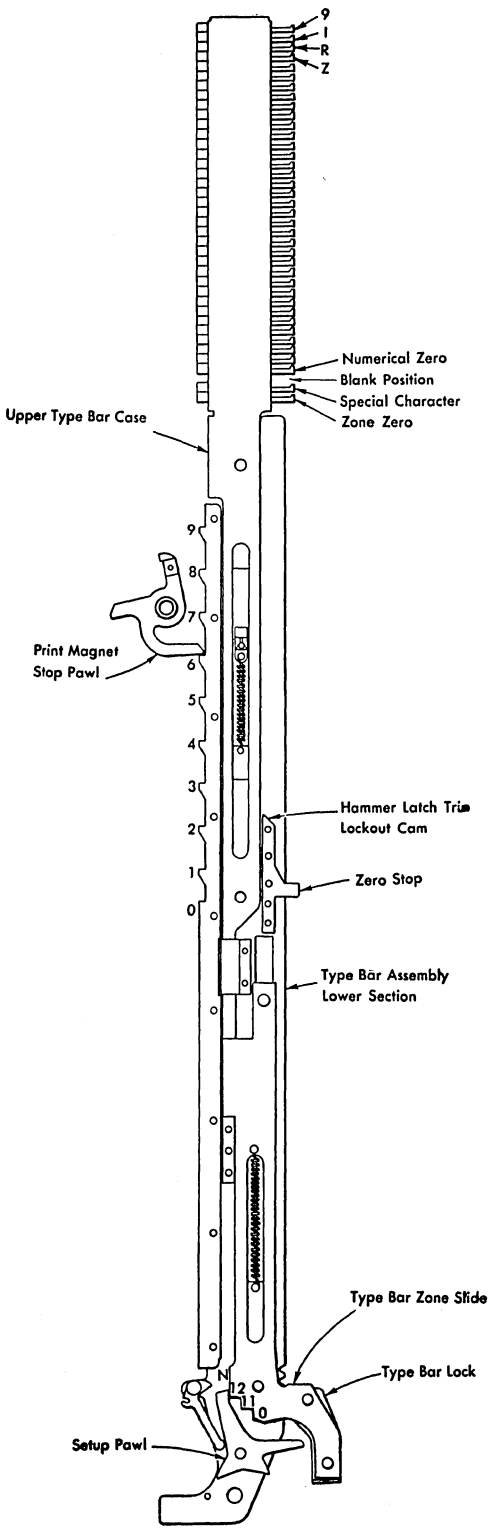


Figure 19. Alphamerical Type Bar

Study Figure 20. In all four drawings the alphamerical type bar is stopped by the 5 tooth. In each case, however, the hammer is opposite a different character. Notice that the distance between the hammer and the stop pawl never varies. The type which is struck by the hammer in each case depends upon the position of the type bar zone slide, and this is controlled by the setup pawl. Therefore, with the type bar stopped by the stop pawl in the 5 tooth, there are four possible characters which may be printed: 5, E, N or V. Which one of these characters will be printed depends upon the zoning of the type bar. Figure 21 shows the setting up of the four zone positions. It can be seen that the setup bail position is the same for all four zones, therefore the position taken by the zone slide section is determined by the tooth of the zone bar stopped by the zone bar stop pawl.

"O"—Numerical Zero—Zone Zero

The type bar includes, in addition to the alphabetic character "O," two pieces of zero type. Figure 22 shows the three positions of the type bar for printing these characters. The first section shows the alphabetic "O" positioned before the hammer, by the setting of the zone slide in the 11 zone and the print magnet stop pawl holding the type bar at the 6 tooth.

The second sketch in Figure 22 shows the type bar being positioned for a numerical zero. This condition would occur only when numerical information is to be printed from a given type bar. On the control panel, there would be a circuit from a reading brush to a type bar print magnet, but no circuit to the zone magnet. Since the zone magnet would never be impulsed, a zero punch would stop the type bar at the upper of the two zero type positions.

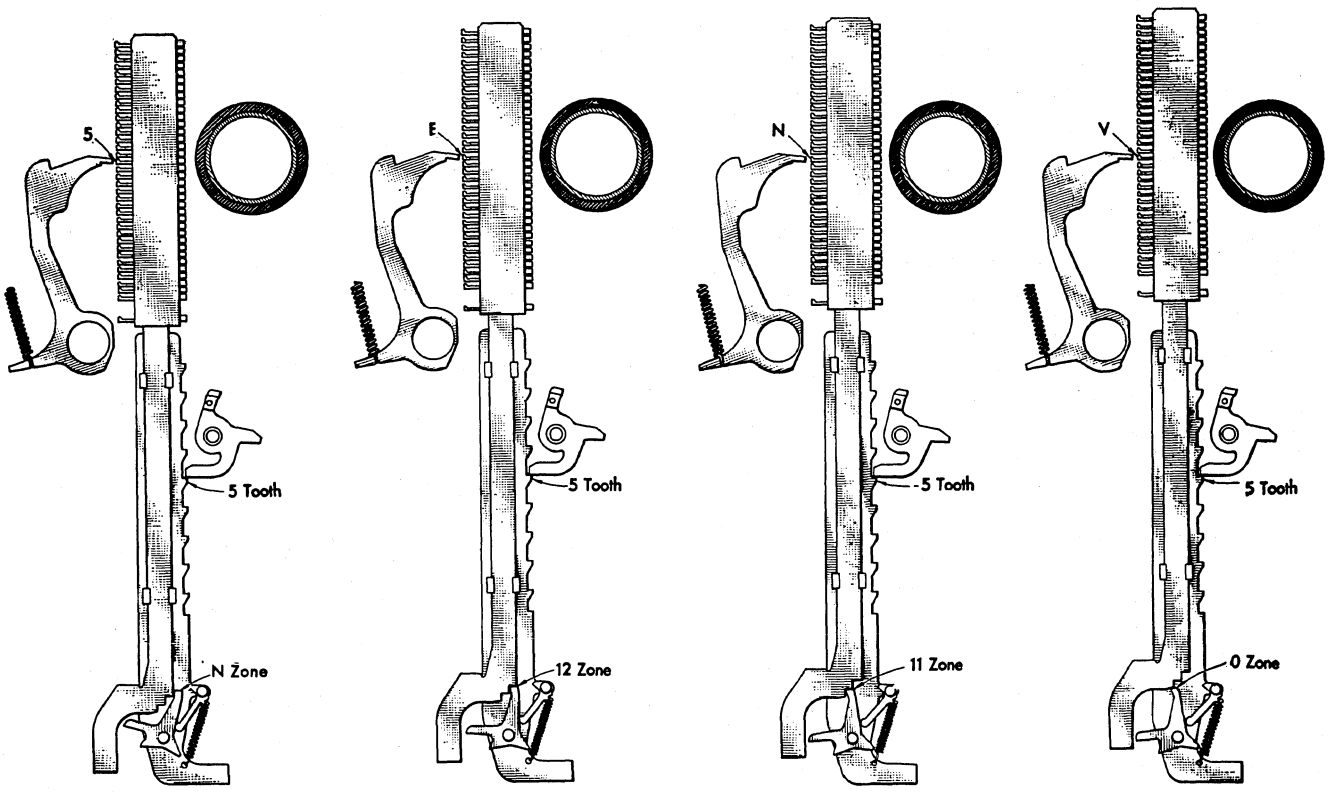


Figure 20. Alphamerical Type Bar — 4 Zones

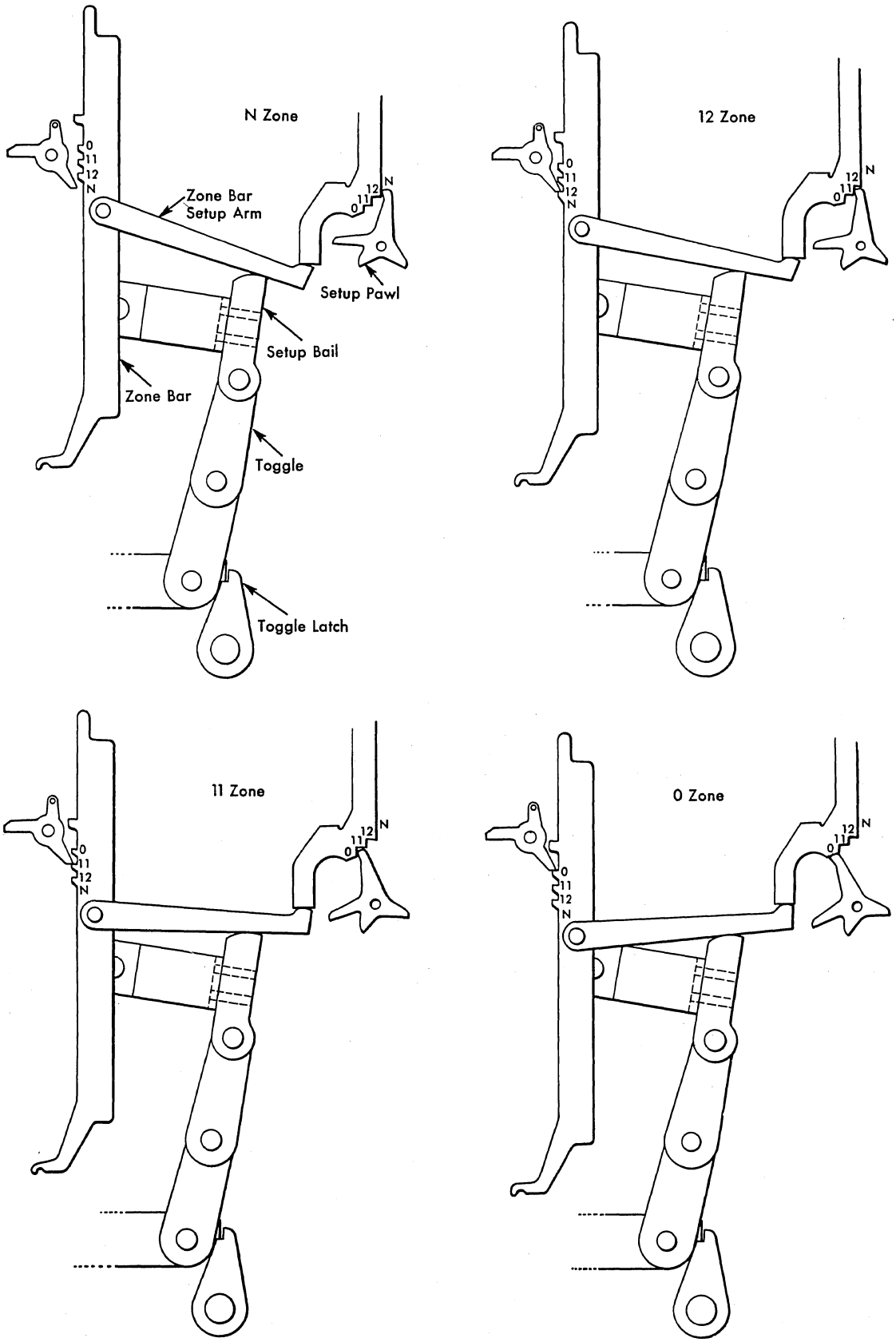


Figure 21. Zone Bar and Setup Mechanism

The third sketch in Figure 22 shows the type bar positioned for a "zero zone." There are many occasions when an alphamerical type bar will print both alphabetic and numerical information, as in printing of name and address:

```
SLUG TYPE COMPANY
1200 SANDY BOULEVARD
PORTLAND OREGON
```

Here the control panel must be wired to print alphabetic characters, which means that 0, 11 and 12 zone punches are read from the card by the second reading brushes and that all punches 9 through 0 are read by the third reading brushes.

When the zero punch in "1200 Sandy Boulevard" is read by the second reading brushes, the zone magnet will set up the zero zone in the zone bar. When this same card passes the third reading brushes, the print magnet will be impulsed and the stop pawl will stop the type bar at the zero tooth. This will place the lower zero, known as the zone zero, in front of the hammer.

Figure 23 shows the alphamerical type bar at its full limit of travel, as it stopped when neither the print magnet nor the zone magnet has been impulsed. At this point the hammer latch trip lockout cam (zero stop) rests against the upper front type bar guide support when the type bar is at its upward limit of travel. This holds the type bar in a position where the hammer, when tripped, fires at the first blank position below the numerical zero.

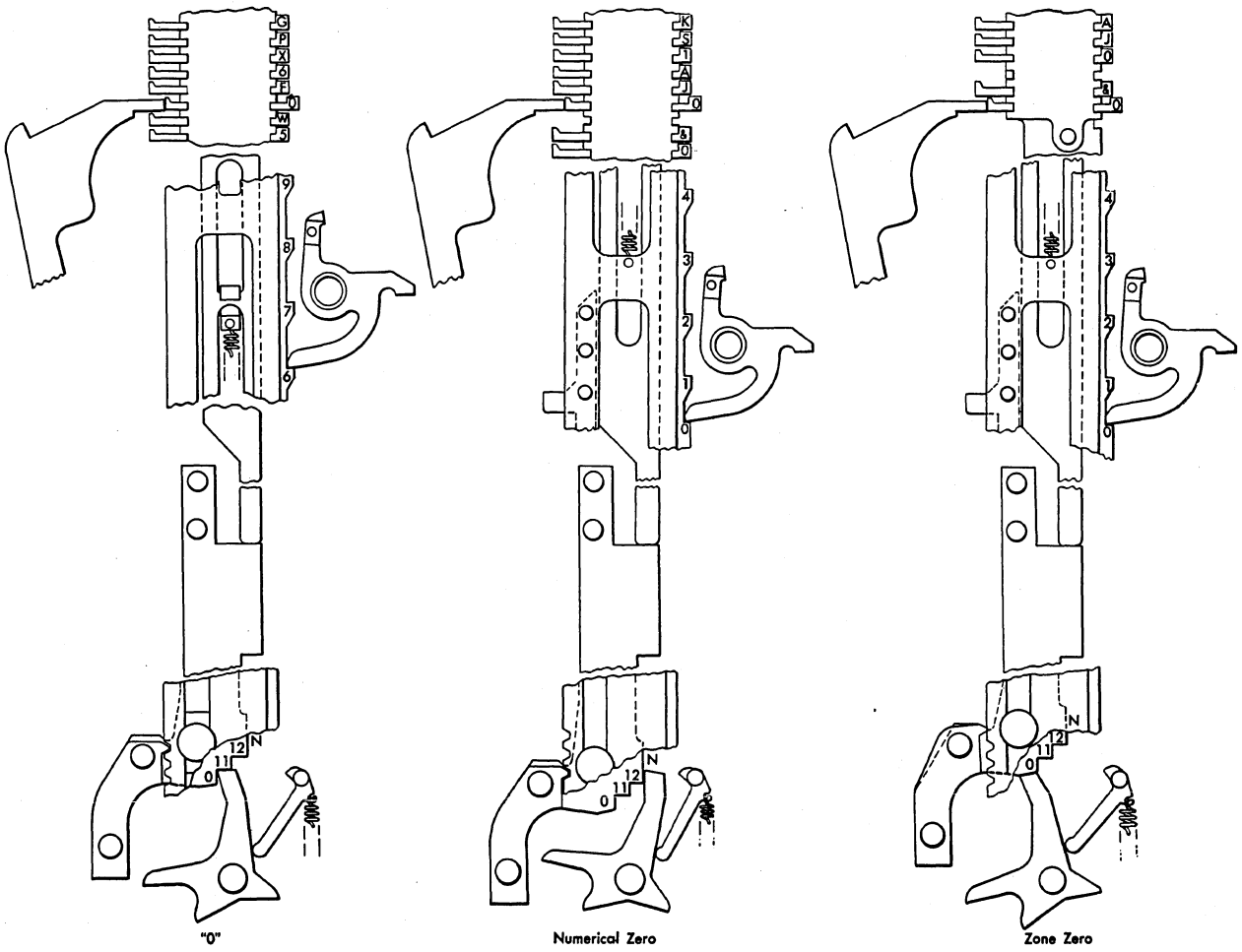


Figure 22. "0" Numerical Zero — Zone Zero Alphamerical Type Bar

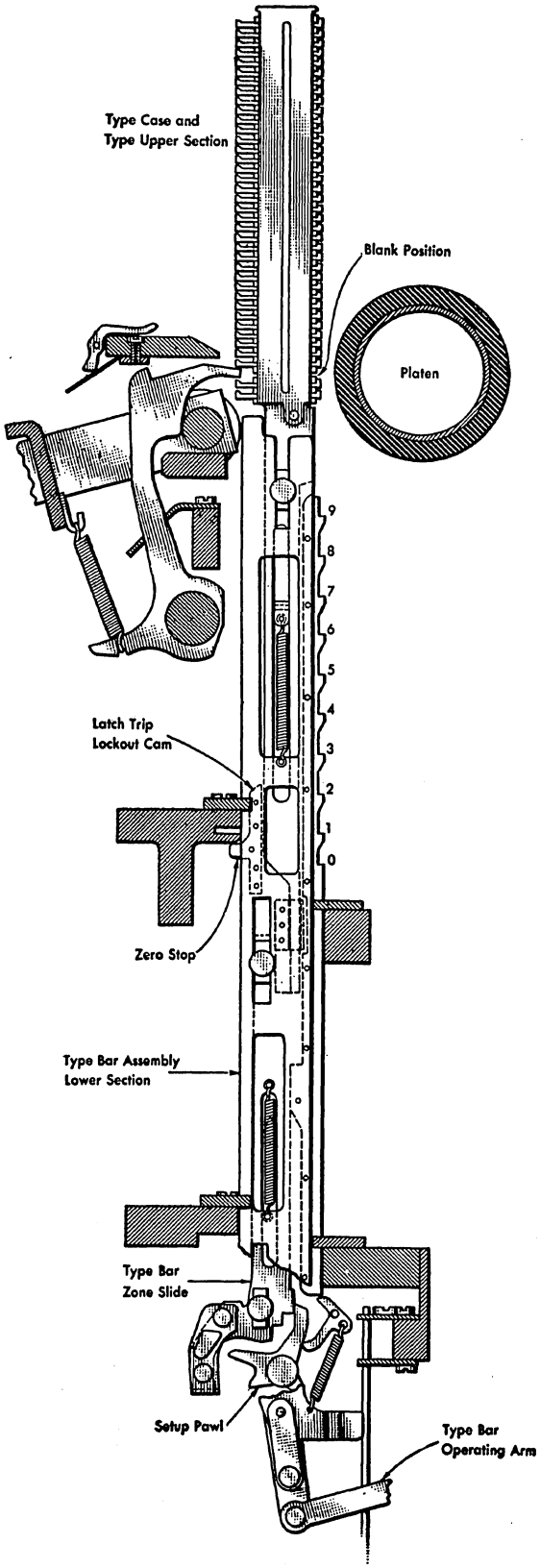


Figure 23. Alphamerical Type Bar Blank Position

Special Characters

On machines special characters may be installed, such as $, @, 1, –, or %. This special type is normally placed in the second blank position below the numerical zero. The type bar can be stopped in front of the hammer at this position from a 12 punched in the card. The 12 punch in the card causes the zone slide section to move to the 12 zone level. This in turn raises the upper case assembly so that the special character position is directly in front of the hammer. The following block diagram will give the possible combinations for positioning the type bar for printing.

		ZONE SELECTION			
		N	12	11	O
NUMERICAL SELECTION	9	9	I	R	Z
	8	8	H	Q	Y
	7	7	G	P	X
	6	6	F	O	W
	5	5	E	N	V
	4	4	D	M	U
	3	3	C	L	T
	2	2	B	K	S
	1	1	A	J	Numerical 0
	0	Numerical 0			Zone 0
	Stop	Blank	Special Character	Zone 0	

Demountable Type Bar

When a report requires printing several special characters under the control of punching in the card, demountable type bars may be used. One method is to place special type in numeric positions of the demountable head so that numeric punching in the cards can control the selection of special characters. To use the type bar for normal printing, a standard head is inserted.

The demountable type bar for the alphamerical section of the Types 402, 403 machines is equipped with a latch, which must be pivoted to permit the removal of the demountable section. The latch in its normal position pivots in front of a retainer spring, which is part of the demountable type bar shank as-

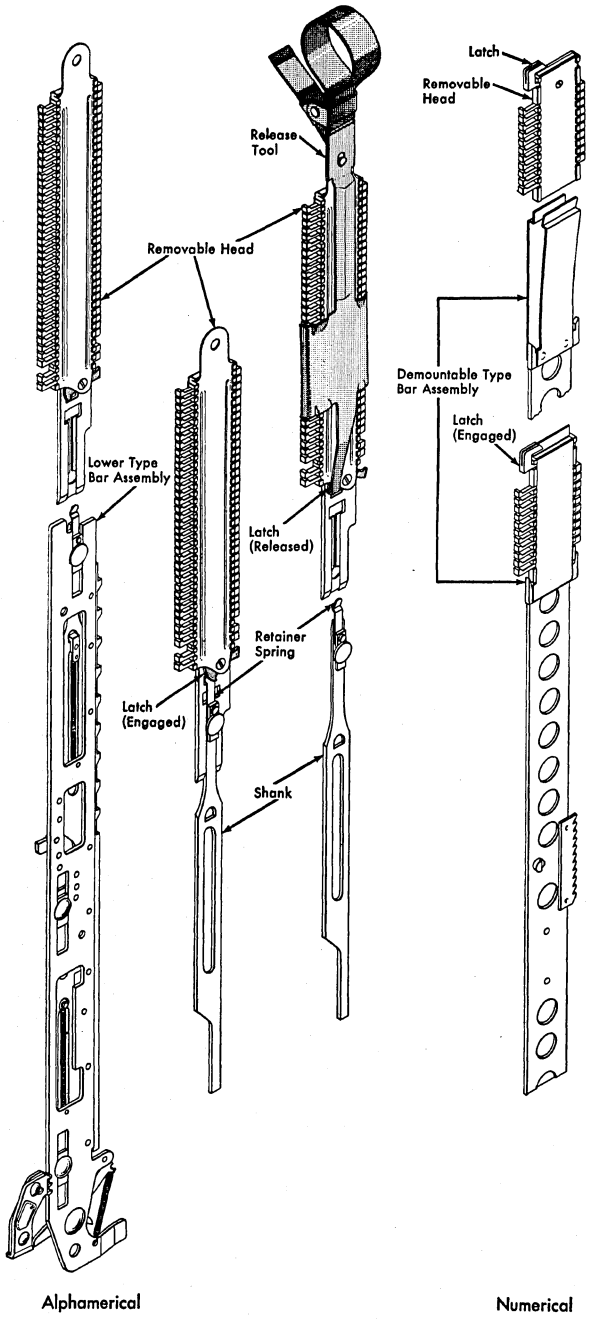


Figure 24. Demountable Type Bar Assemblies

sembly (Figure 24). This prevents the demountable section from separating from the lower type bar assembly when listing at the higher speed.

The customer is provided with a tool (Figure 24), which has a hook at its lower end. The tool is passed down along the right side of the type bar case. Its purpose is to raise the latch by pivoting it clockwise and then to lift the upper type case out of the machine.

The demountable type bar assembly for the numerical bars is released by pulling the latch at the top of the type bar case to the front of the machine and lifting the head assembly out (Figure 24).

ZONE CONTROL DRIVE UNIT

THE ZONE control drive unit (Figure 25) consists of an assembly of 4 cams which are driven by the card feed clutch idler gear and is in operation during all card cycles when the card feed clutch magnets are energized. The cams operate bails in the zone unit assembly so that it may accept the 0-11-12 information punched in the card and place this information in the corresponding type bar zone slide position.

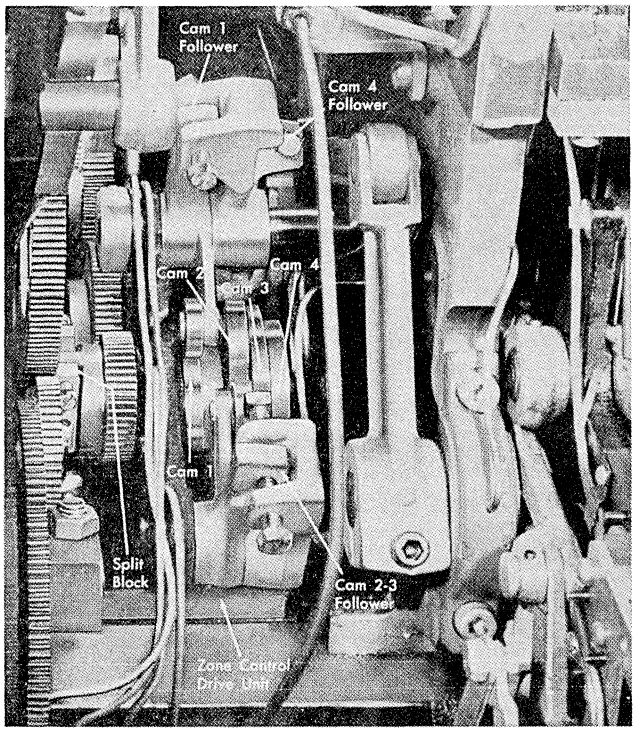


Figure 25. Zone Control Drive Unit

When alphabetic information is being listed, the zone punching (0, 11, 12) is read from the card as the card passes the reading brushes. The lower numerical punching (9 through 1) is read from the card as it passes the next set of brushes. Thus, the machine reads the zone punching of the card in one cycle and the numerical portion of the card on the following cycle in order to set up one alphabetic character.

It is possible that the card, after passing the 1st set of reading brushes, may remain standing just before the next brush station, as before any total cycle.

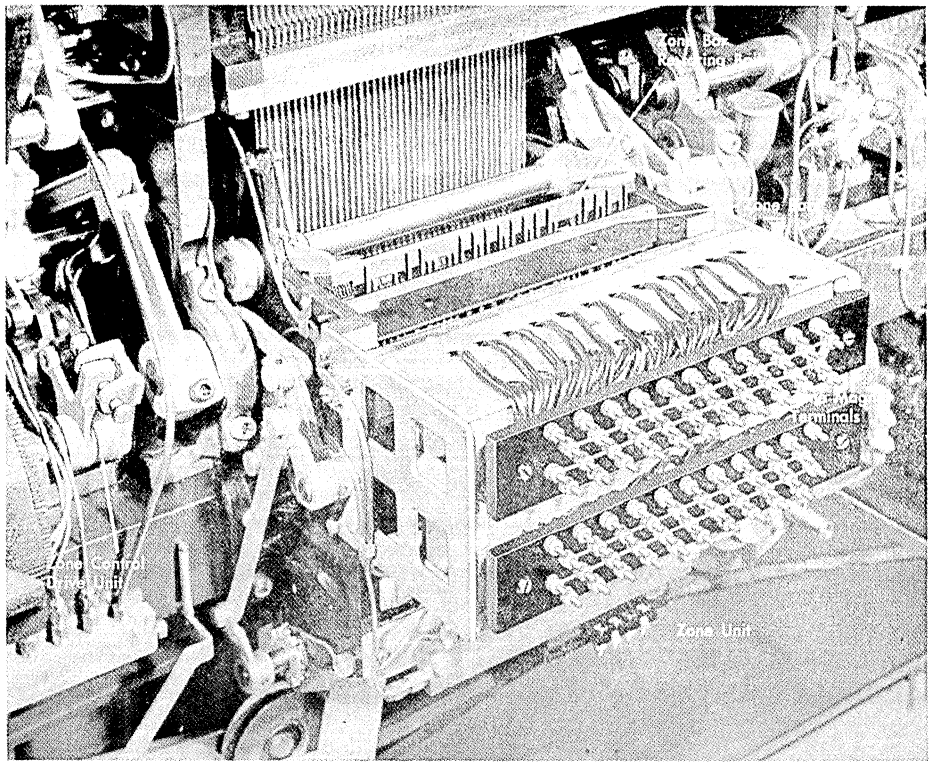


Figure 26. Zone Unit

The zone unit has the ability to accept the reading from the brushes and retain it until it is used.

ZONE UNIT ASSEMBLY

THE ZONE unit assembly (Figure 26) has 43 zone bars and zone bar setup arms, one for each alphamerical type bar. The zone bar is raised by spring tension and its position and operation is controlled by the cams of the zone control drive unit.

Zone Cam 1 — Figures 27 and 28

Cam 1 in the zone control drive unit, through arms and cam followers, operates the zone bar restoring bail. The main purpose of the bail is to control the rate at which the zone bar will rise in relation to the stop pawl. This relation of the 0, 11, and 12 teeth to the stop pawl is called zone lap and corresponds to list lap when speaking of the type bars. Zone lap is the overlap of the zone unit stop pawl on a tooth of the zone bar at the time the circuit breaker impulse is made for a 0, 11 or 12 hole, no time being allowed for slowness or delay in the action of the stop pawl or zone bar.

The time required to raise the zone bar from the 0 to the 11 tooth, or one unit, is 18° which corresponds to the distance between the 0 and 11 punches in the card. Therefore, if an impulse for an 11 hole is completed by the circuit breakers at 189° and the stop pawl brings the zone bar to rest at 204°, the zone bar will rise that distance in 15°. This will allow 3° zone lap or overlap of the stop pawl on the 0 tooth at the time the stop pawl zone magnet is energized. The 15° safety factor will give the stop pawl time to swing into position to stop the zone bar at the 11 tooth.

The restoring bail on the down movement causes the stop pawls to be restored back upon the latches. Additional linkage performs other functions; it operates the latch restoring bail and the toggle latch restoring link and causes the toggle armature latch to be restored back upon its armature.

The forked arm on the cam 1 follower is adjusted so that the zero tooth of the zone bar will come to rest against the stop pawl when the machine index is at 186°. A similar condition is also true for the 11 tooth and the 12 tooth of the zone bar at the correct time shown on the mechanical timing chart.

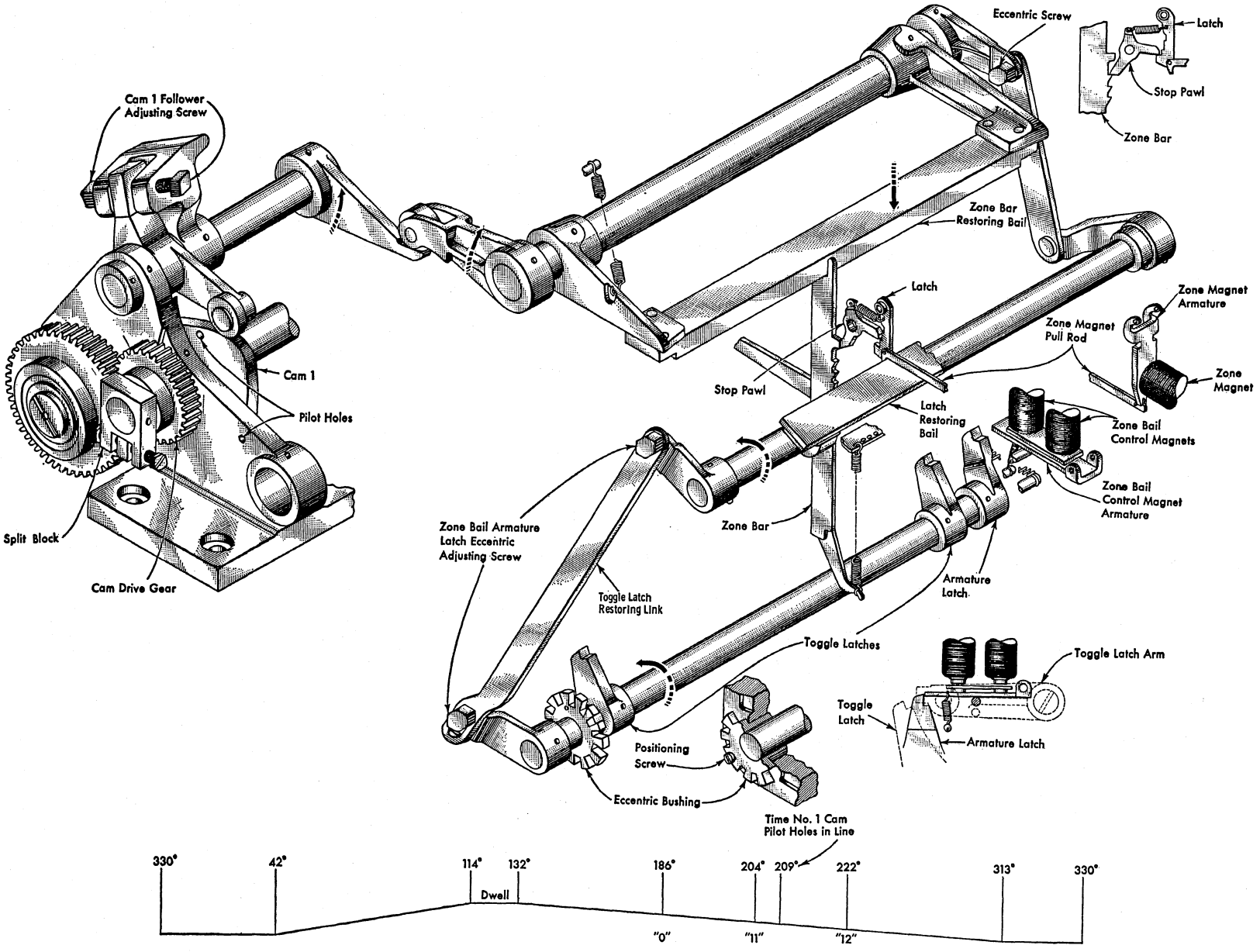


Figure 27. Zone Control Drive Unit, Cam 1 Mechanism

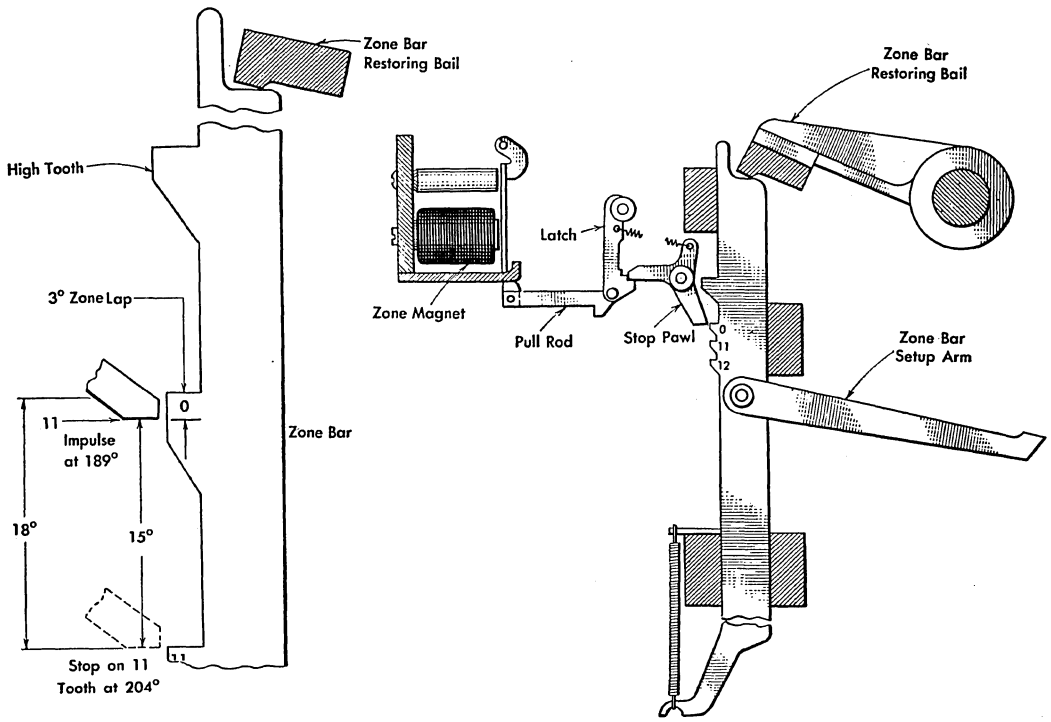


Figure 28. Zone Bar — Zone Lap

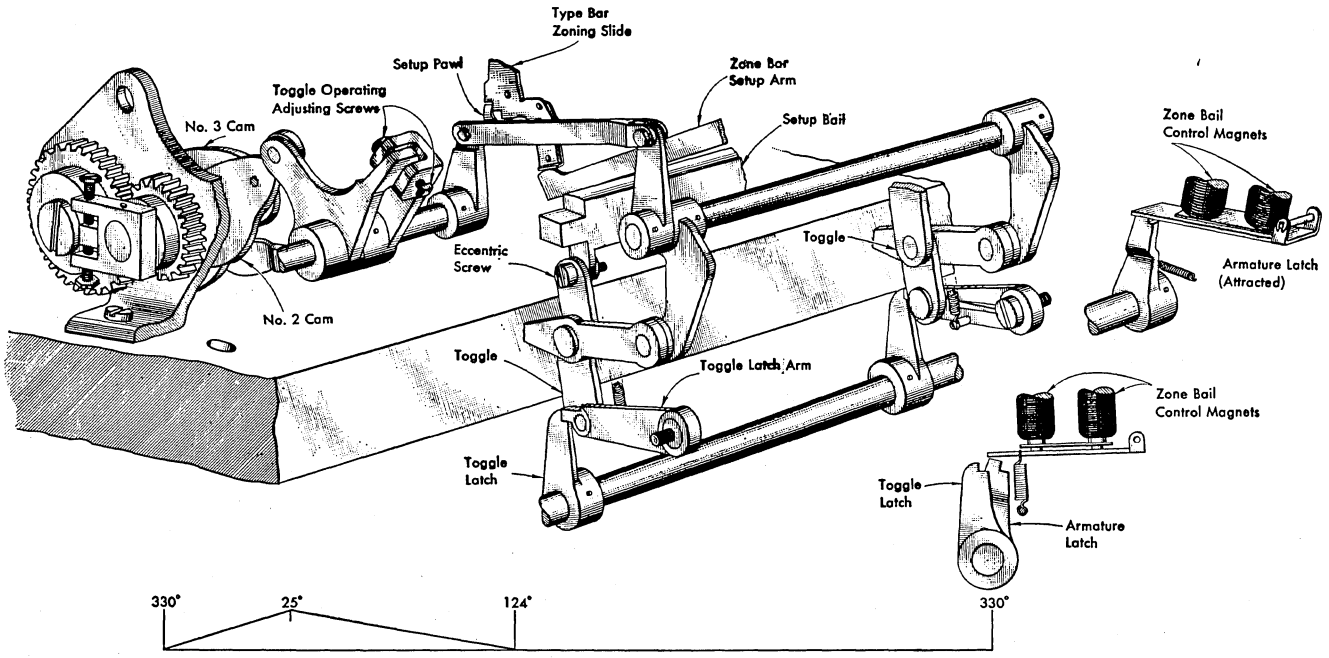


Figure 29. Zone Control Drive Unit, Cam 2 and Cam 3 Mechanism

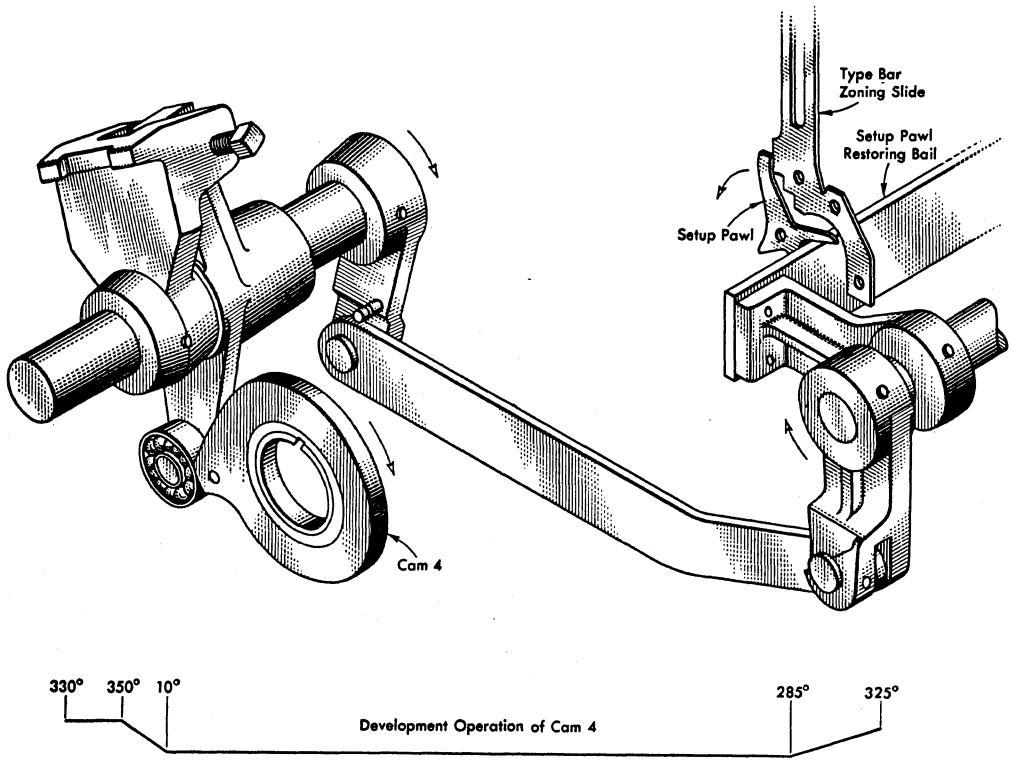


Figure 30. Zone Control Drive Unit, Cam 4 Mechanism

Zone Cam 2 — Figure 29

Cam 2 through connecting linkage causes the toggles, when resting on their latches, to straighten out. This in turn raises the setup bail and causes the zone bar setup arm to raise the type bar zone slide so that the setup pawl may fall into the correct zone position. This places in the bar the zoning originally read from the card by the reading brushes. The forked arm adjustment carries the toggle to within .040″-.060″ of the base.

Zone Cam 3 — Figure 29

Cam 3 is the complementary cam of cam 2 and, through connecting linkage, causes the toggle to be restored or returned to its normal collapsed position.

Zone Cam 4 — Figure 30

Cam 4, through connecting linkage, operates the setup pawl restoring bail. This causes the setup pawls, which have been previously zoned, to be restored to the numerical zone before accepting a new reading.

Sequence of Operation

The relation of the various parts, at the time the zone unit is completing a setup of the type bar zone slide, is shown in Figure 31. The sequence chart (Figure 32) shows the relationship of the operations performed by the cams in the zone control drive unit. These operations can be observed on the machine in the following manner.

Block the card feed clutch, print mechanism clutch levers, and the zone bail control magnet armature so they release. Crank the machine over to

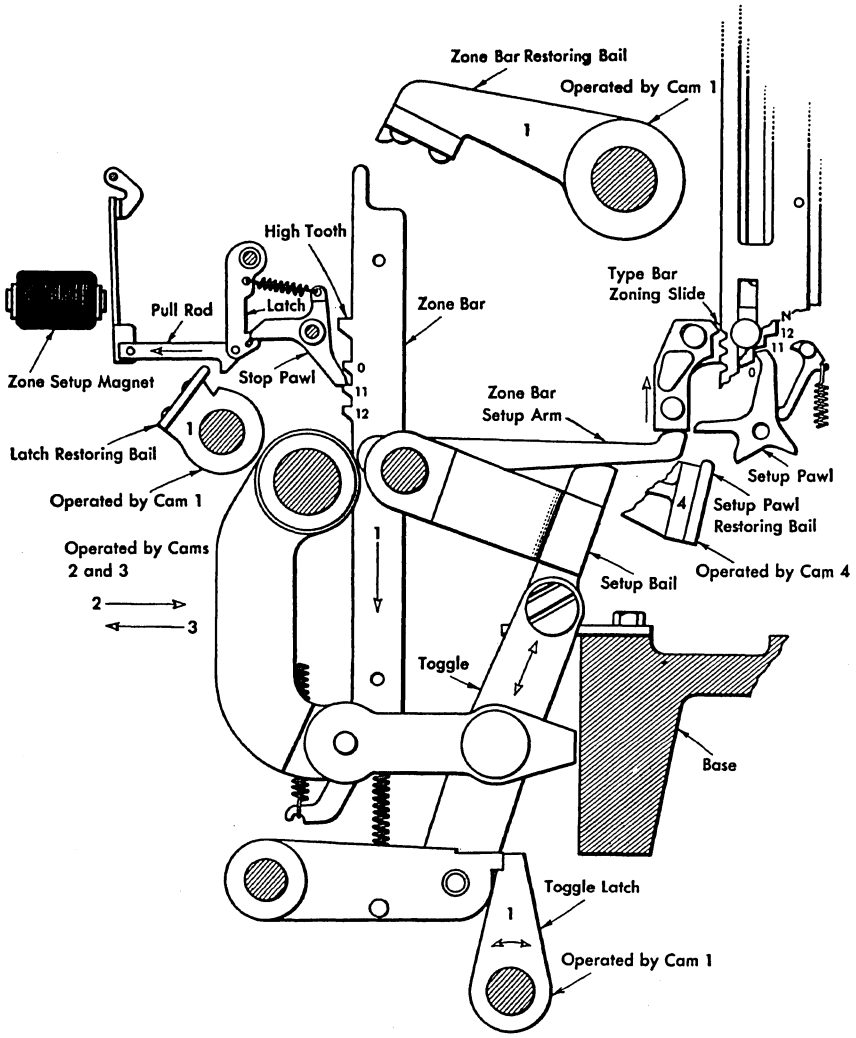


Figure 31. Schematic of Zone Unit

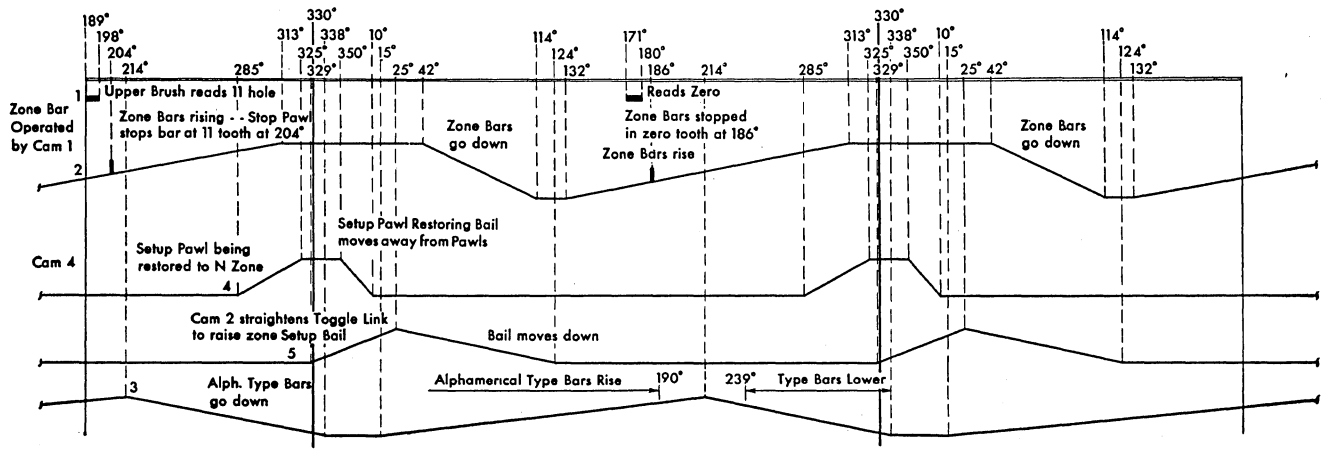


Figure 32. Mechanism Sequence of Operation

189° and attract the zone magnet armature for the first alphamerical type bar. At this time the zone bars should be on the way up and at 204° the zone bar will come to rest against the previously released pawl. The alphamerical type bars are now on their way down and will continue to go down until 338°. Between 285° and 325°, cam 4 comes into operation and operates the setup pawl restoring bail, causing the setup pawls to return to their numerical zone. This clears out the old setting in the alphamerical zone slide. While the type bar is in the down position from 338° to 15°, and following the clearing of the old zone setting, cam 2 comes into operation and straightens out the toggle mechanism. At this time the type bar zone slide is raised and the setup pawl is allowed to swing in and take its new zone position. This operation is being completed while the type bar is starting up at 15° to print the new character. Follow through this operation several times; also, remove the block from the card feed clutch following tripping of the zone magnet and the block from the zone bail control magnet armature. It may be seen that the zone bar will stand in the position at which it was stopped until such time as the card feed is again brought into operation. The time the type bar may start up will vary between 15° and 18°.

The ability of the zone unit to retain a reading is entirely due to the fact that the zone control drive unit does not operate except on a card feed cycle. Therefore, any reading placed in the zone bars will not be transferred to the alphamerical type bar zone slide until the card from which the zone section was read is ready to be moved past the brushes reading the numerical punching in that same card. When the electrical circuits are studied, it will be seen that the zone bail control magnet may be impulsed every card feed cycle when the control panel LIST hub is wired for detail printing.

Zone Bail Control Magnet

When the LIST hub is not wired (group printing), the zone bail control magnet will be energized on the group indicate cycle only. On all card feed cycles after the first one, when the LIST hub is not wired, the zone control drive unit cams will be in operation.

Cam 1 will be in operation and the zone bar restoring bail will allow the zone bars to stop in the correct position. The type bars will not be zoned, however, as the zone bail control magnet was not energized; therefore, the toggle latches were not able to be in position to support the toggle assembly operated by cam 2 and the toggle setup bail could not raise the zone bar setup arms to place the zone information in the type bar. Following this, the high tooth of the zone bar will again restore the tripped stop pawls. No zoning will take place until the zone bail control magnet is again energized and the toggle latches move into position so that the setup bail may be raised.

PRINT MECHANISM CLUTCH

THE PRINT mechanism clutch is mounted to the right, below the base, and is the means of transmitting the power from the print mechanism clutch disc on the drive housing to the main cam shaft. It is similar to the card feed clutch unit in construction and operation but does not use a split latch for the clutch pawl. The weight of the type bar assemblies, when being restored, gives the cam shaft additional momentum and the clutch pawl arm moves behind its keeper when latching thus making the split latch unnecessary (Figure 33).

Since the alphamerical type bar springs are extended when the type bars are in the restored position, care must be used in removing the print mechanism clutch. There are no spot marks on the print mechanism clutch gear, idler gear or main cam shaft gear, therefore it would be well to provide some indication as to the relationship of these gears before removing this unit.

MAIN CAM SHAFT ASSEMBLY TYPE 402, 403

THE MAIN cam shaft assembly is timed to the index by loosening the sleeve nut on the serrated hub which locks the cam shaft gear and the main cam shaft together (Figure 34).

The alphamerical type bar cams, by means of cam followers and connecting linkage to the type bar restoring bail, control the raising and the restoring of the type bars. The left cam is the active cam which causes the alphamerical type bar assembly to rise and the right or complement cam causes the bail to restore the type bars.

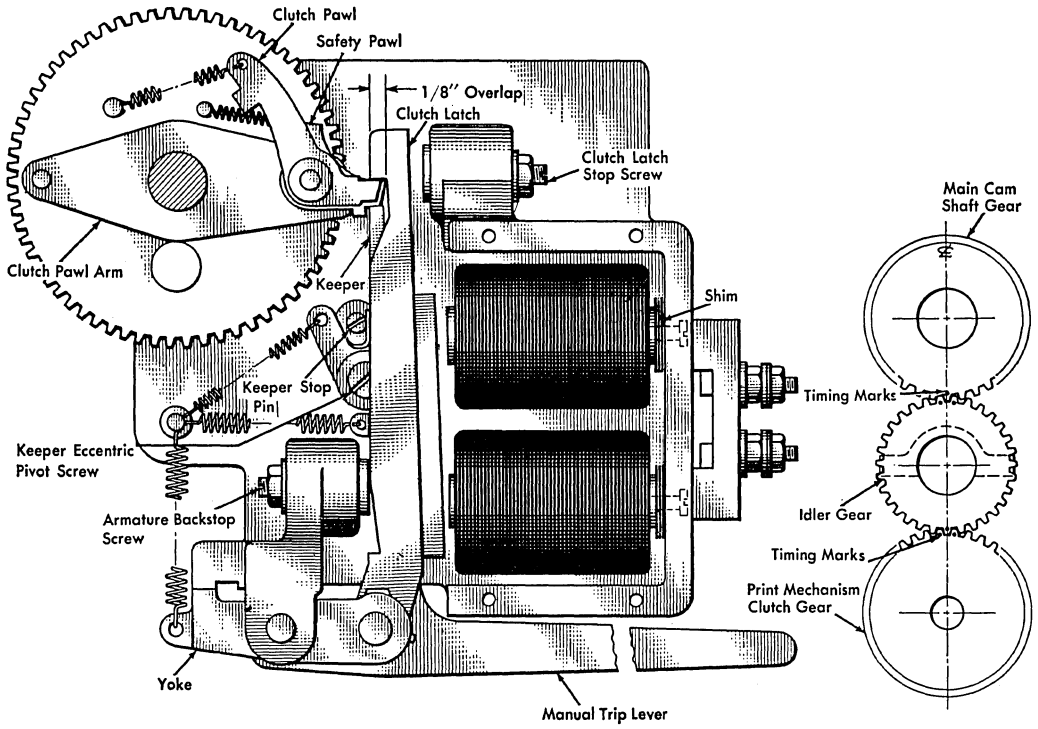


Figure 33. Print Mechanism Clutch

The type bar pawl reset roll arm is provided with a split block adjustment which may be used for controlling the operating time of the reset roll arm follower. The purpose of the reset roll arm is to raise the stop pawl relatch bail which in turn raises the stop pawl above its relatching point in the print magnet unit. It also causes the armature knockoff bail to push all armatures forward to receive the restored stop pawls.

The hammer unit cams cause the hammers to be released in those positions where printing is to take place; they also restore the hammers. The hammers must be moved clear of the type bars before the type bars start to be restored.

A secondary operation of the hammer unit cams is to drive the ribbon feed mechanism. The left cam is the active cam.

The numerical type bar cams, by means of a cam follower and connecting link, control the raising

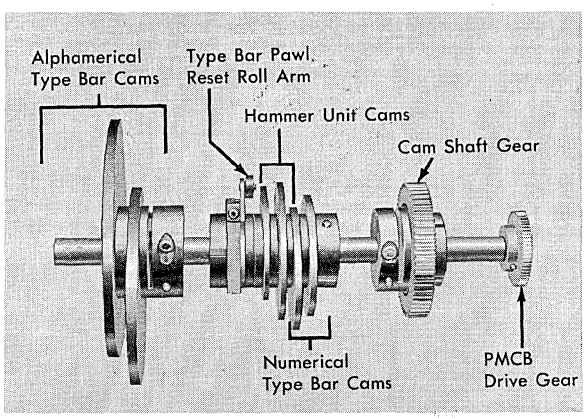


Figure 34. Main Cam Shaft Assembly Type 402-3

and restoring of the numerical type bar spring bail assembly. The right cam is the active cam which causes the numerical type bar assembly to raise, and the left or complement cam causes the bail to restore the type bars.

PRINT MECHANISM CAM CONTACT ASSEMBLY

THE PRINT mechanism cam assembly on the right front corner of the base is driven by the print mechanism drive gear at the right end of the main cam shaft. These cams turn only when the print mechanism clutch is engaged and serve as interlock controls. The positions for the cams are numbered from left to right whether there is a cam in that position or not (Figure 35). Plunger-style cams and contacts are used in this assembly. A split block adjustment is provided, which allows the unit as a whole to be brought into closer timing with the index than is possible by changing the drive-gear relationship one full tooth.

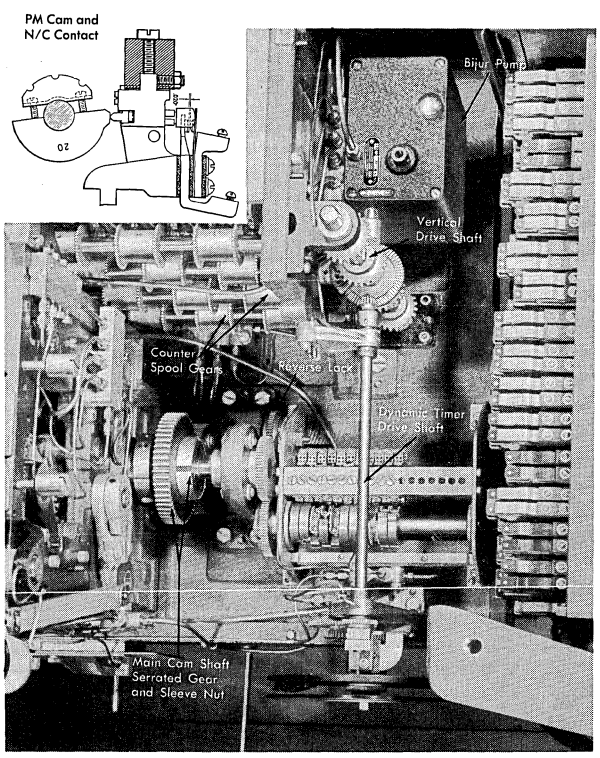


Figure 35. Print Mechanism Cam Contact Unit

Reverse Lock

The reverse lock is a device which contains five small cylinders under spring tension. They will wedge against the outside case whenever the direction of rotation of the main cam shaft is reversed. The internal section that is fixed in position provides this camming action which causes the cylinders to wedge and bind against the outside case.

In the Types 402-403 and 419 Accounting Machines the type bar springs are being extended when the restoring bail is returning the type bars to their down position. The reverse lock prevents this spring tension from reversing the direction of rotation of the main cam shaft at this time. The reverse lock is mainly of help when checking timings and when cranking the machine through its cycle by hand. It prevents the main cam shaft from being reversed if the print mechanism clutch pawl disengages before the keeper can fall behind the clutch pawl arm.

ALPHAMERICAL TYPE BAR BAIL ASSEMBLY

A STUDY of the alphamerical type bar was made when zoning was discussed. In the Types 402-403 Accounting Machines the method of raising the alphamerical type bars has been changed slightly. The alphamerical type bar spring support is mounted in the upper frame; its location is fixed and it does not move with the type bar restoring bail assembly as in the numerical half of the machine (Figure 36). This provides the type bars with the maximum lift at the time the bar is starting to move from their low dwell at 15° to 18°.

The alphamerical type bar restoring bail assembly is moved by the turning of the large alphamerical cams on the main cam shaft. Through a forked arm cam follower and connecting linkage, the restoring bail assembly may be raised and lowered. The restoring bail is equipped with a turnbuckle adjustment which permits the restoring bail to be made parallel with the print magnet unit. This allows type bars in all positions to come to rest against their individual stop pawl at the same index time for the 5 tooth.

Accelerating Arms

Mounted directly underneath the alphamerical type bar operating arms and on top of the base are the type bar accelerating arms. These accelerating arms are used to give the heavy type bars a start upward

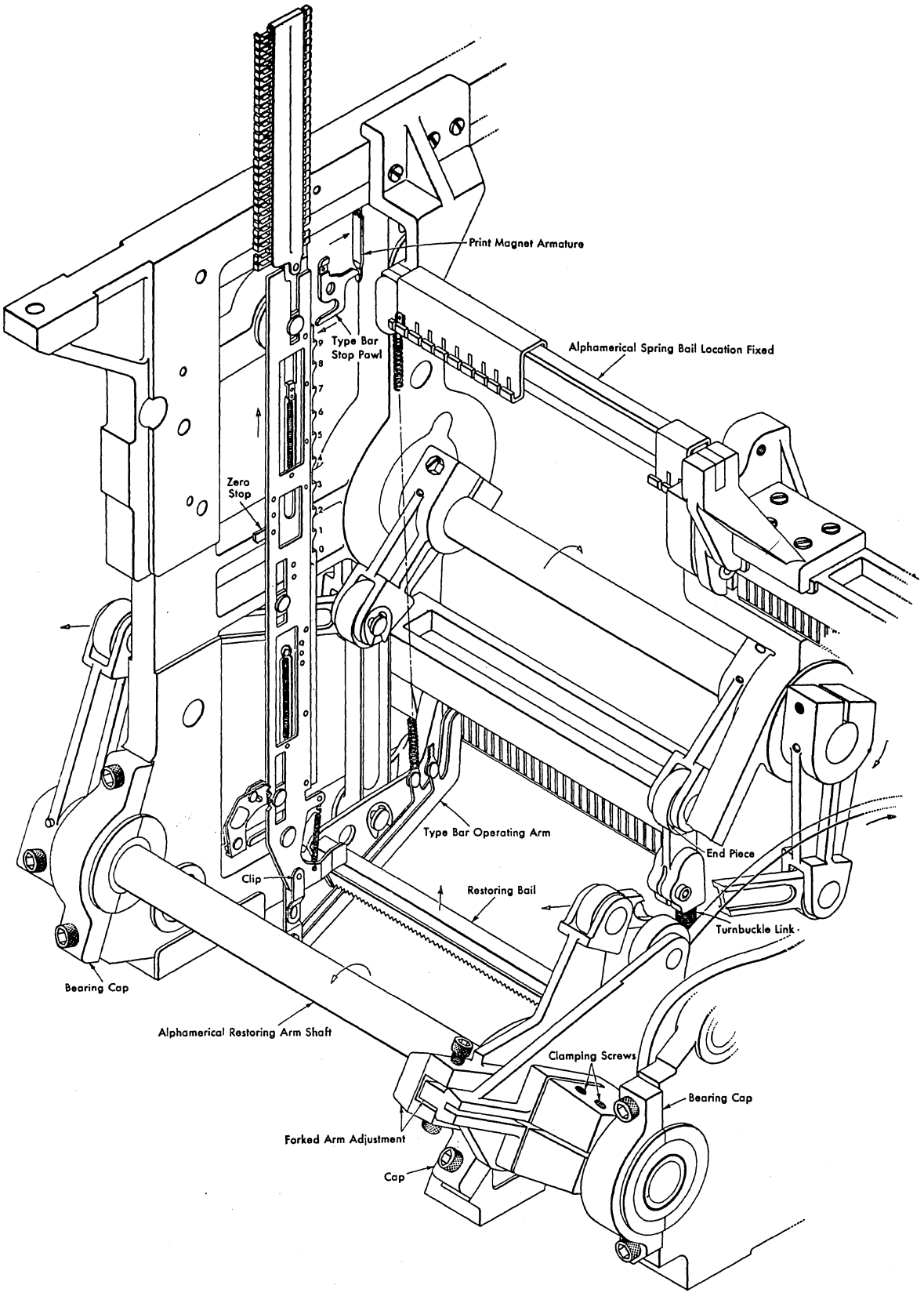


Figure 36. Alphamerical Type Bar Bail Assembly

when the active alphamerical cam starts in motion, and also to prevent these heavy bars from overthrowing when the type bar restoring bail is returning them to their normal position.

When an alphamerical type bar is not stopped by a print magnet stop pawl, its upward limit of travel is determined by the hammer latch trip lockout cam (zero stop) coming to rest against the front upper type bar guide. The guide has a slot cut along its length so that the thinner lower section may act as a shock absorber (Figure 23). The cut of the alphamerical cams have been changed so that the rate of rise of the type bars has been slowed down as it approaches this guide.

List Lap — Figure 37

List lap is the overlap of the print magnet stop pawl on a tooth of the type bar at the time the circuit breaker impulse is made for a particular character, disregarding the time allowed for slowness or delay in the action of the stop pawl or type bar.

An understanding of list lap requires a definition of the term "tooth." The surface of the type bar which comes to rest against the stop pawl is called the land. A tooth is the projection from the land of any character to the land immediately below it. The alphamerical cam requires 18° on the index to raise the type bar from one land to the next.

Therefore, if the impulse for a 5 punch is completed by the CB's at 81° and the stop pawl brings the type bar to rest at 96°, the stop pawl will have 3° list lap or overlap on the 6 tooth at the time the impulse is completed. This also allows 15° of safety factor for the stop pawl to swing into position to stop the type bar before the 5 tooth touches the pawl.

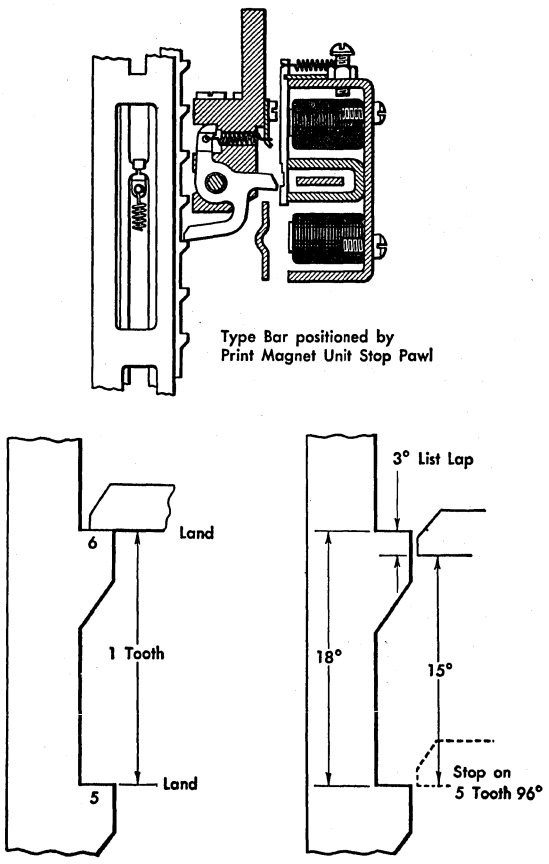


Figure 37. Type Bar List Lap

NUMERICAL TYPE BAR BAIL ASSEMBLY

THE NUMERICAL type bar bail assembly (Figure 38) is operated by the numerical type bar cams on the main cam shaft through a forked cam follower and connecting link. The bail lifts the springs connected to the type bar operating arms and, by means of the restoring bail, controls the upward and downward movement of the type bars.

There are two eccentric screws at the front end of the spring bail which are the means of leveling the restoring bail. This adjustment allows the type bars in all positions to come to rest against their individual stop pawl at the same index time for the 5 tooth.

The type bar operating arm spring used in the rear position has its loop copper plated while the loop in the front spring is cadmium plated. The springs are identified in this manner as the rear spring must be stronger since the distance from the point of attachment to the fulcrum is shorter.

The numerical type bar has a credit (CR) symbol in the even-numbered bars and an asterisk (*) in the odd-numbered bars in the top position. There are 11 pieces of type but only 10 teeth on the bar.

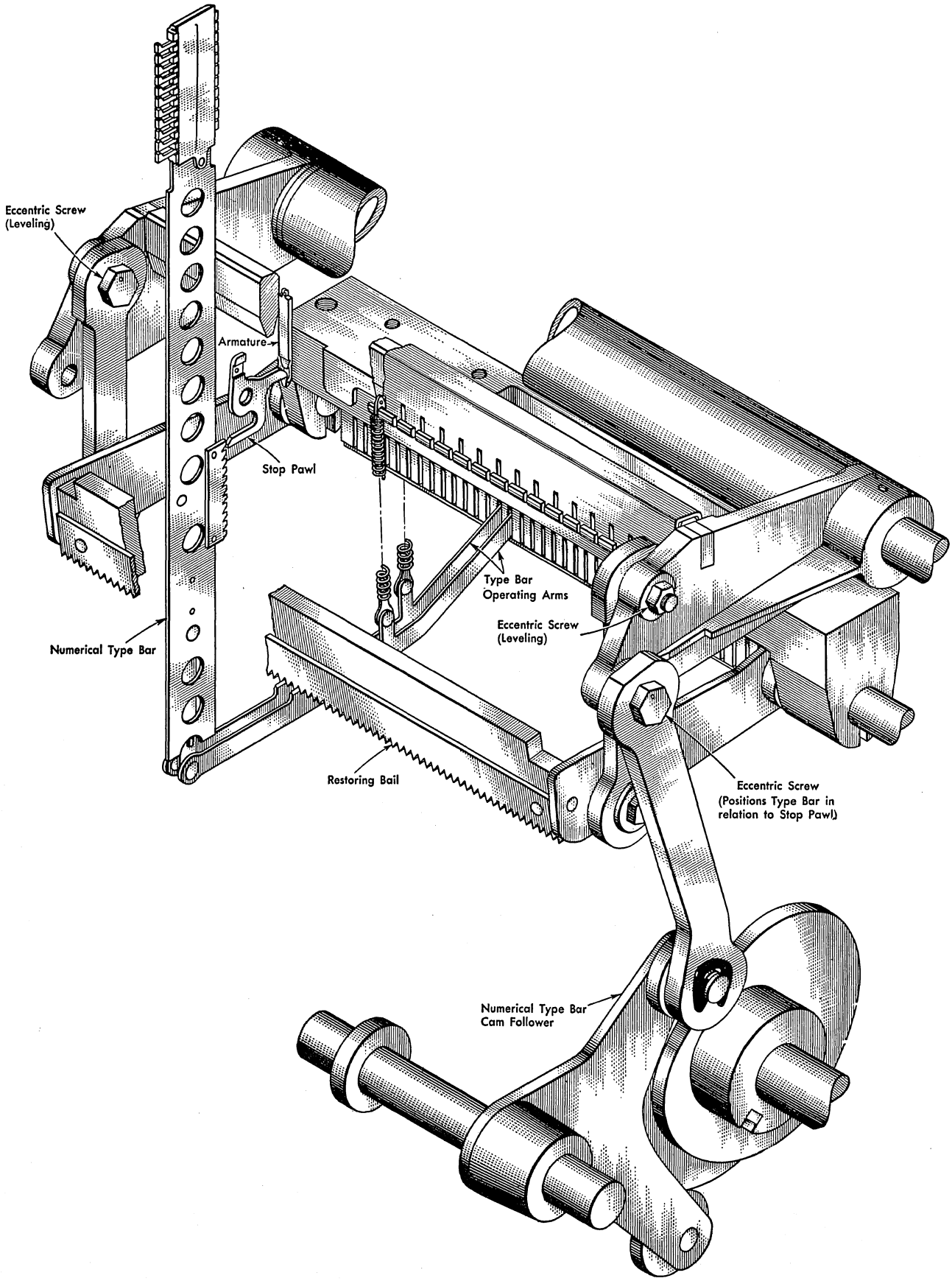


Figure 38. Numerical Type Bar Bail Assembly Type 402-3

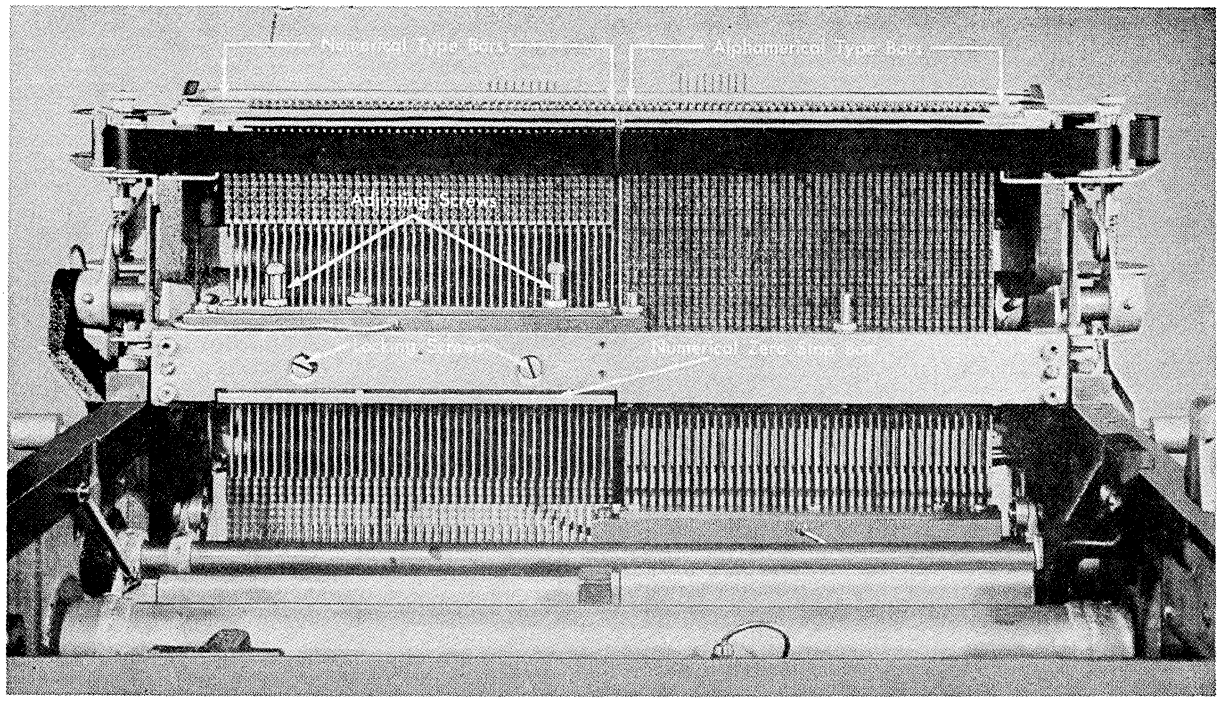


Figure 39. Numerical Zero Stop Type 402-403

Numerical Type Bar Zero Stop — Figure 39

Since there is no zero tooth on the bar, the numerical type bar zero stop fastened to the type bar guide support rear serves this purpose. As it is possible that adjacent bars may be positioned by two different stops, a method of aligning the type bars must be available. The print magnet assembly stop pawl position is permanently fixed, therefore, the numerical type bar zero stop is adjustable up and down so that type bars positioned for zeros may be brought into printing alignment with characters CR or * through 1 (for example, printing amount 100088 CR).

Print Mechanism, Type 419, Figure 40

The print mechanism of the Type 419 is fundamentally the same as that of the numeric portion of the Types 402 and 403 machines. Forty-three numerical type bars occupy the space formerly used by the alphamerical bars, and with the removal of the center ribbon guide bracket assembly, an additional numerical type bar may be added in the center. This combined with the standard forty-five numerical positions makes possible a full-capacity complement of eighty-nine numerical printing positions. Notice the relocation of the ribbon guides on the Type 419 machine (Figure 41). Two thin ribbon guides are distributed across the print bank between type bars when standard type is being used. When wide-faced type is used in type bars adjacent to ribbon guides, the guides may be moved to other positions. However, when wide-faced type is used throughout the print unit, the ribbon guides must be inserted in the center, as on the Type 402 machine. This removes one type bar from the print unit.

The print unit is capable of printing numerical

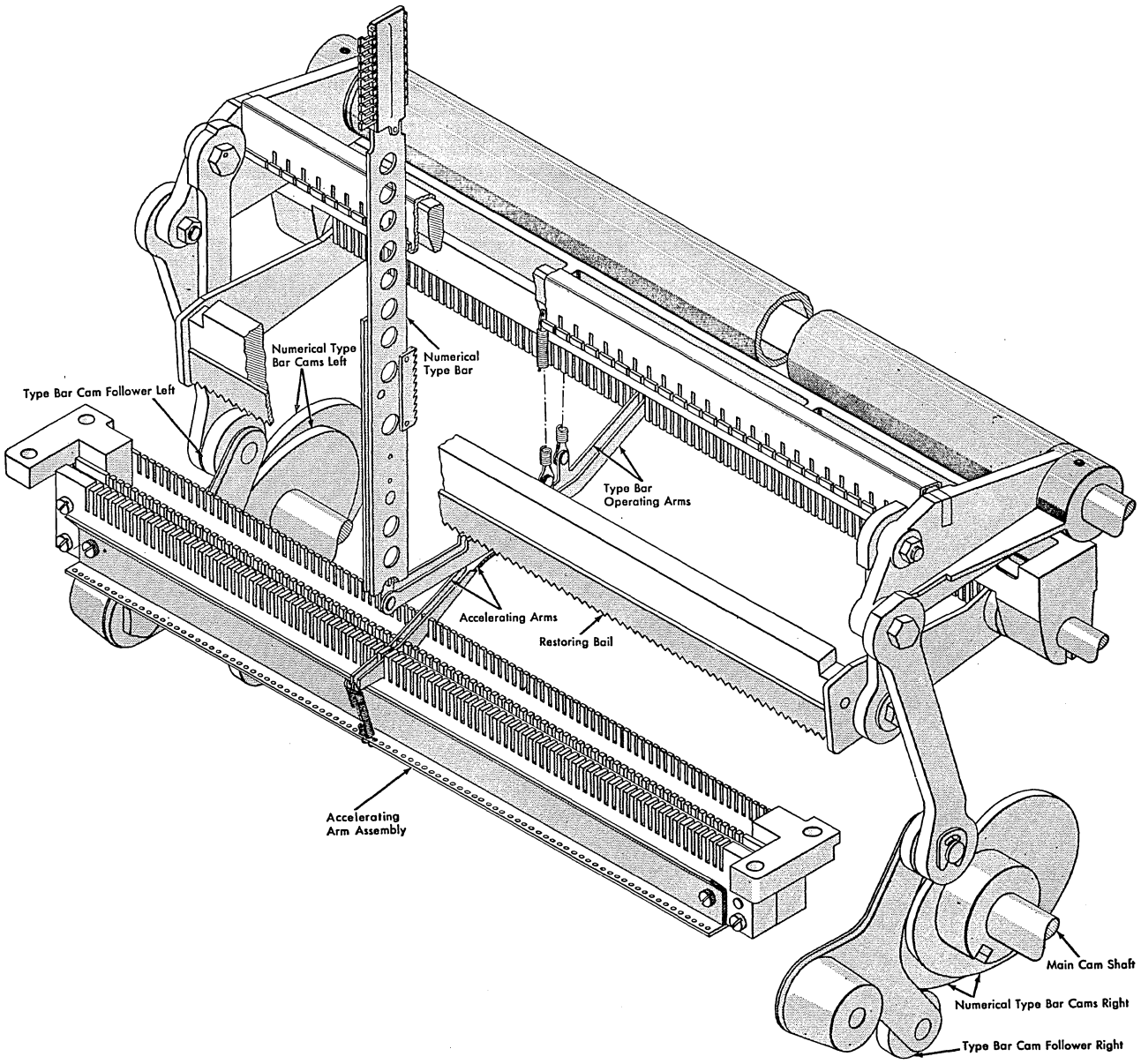


Figure 40. Numerical Type Bar Bail Assembly — Type 419

data only. It has an asterisk (*) on all odd-numbered bars, and a credit (CR) on all even-numbered bars. A variation of this arrangement may be had if the customer so specifies.

To drive the numeric type bars evenly from both sides, the main cam shaft has been lengthened to extend across the width of the print mechanism casting. The alphamerical type bar cams have been removed, and an additional pair of numerical type bar cams have been placed near the left end of the cam shaft (Figure 42). Timing of the main cam shaft and purpose of the remaining cams are the same as those on the Types 402, 403.

Because of increased listing speed (150 cycles per minute) the numerical type bar operating arms require an initial start upward in order not to lag behind the fast moving restoring bail. A set of accelerating arms mounted beneath and in front of the operating arms provides this start (Figure 43).

Provision is also made for alignment of zeros with other characters in all type bar positions by means of an adjustable zero stop. This requires a different type bar guide support rear (Figure 41).

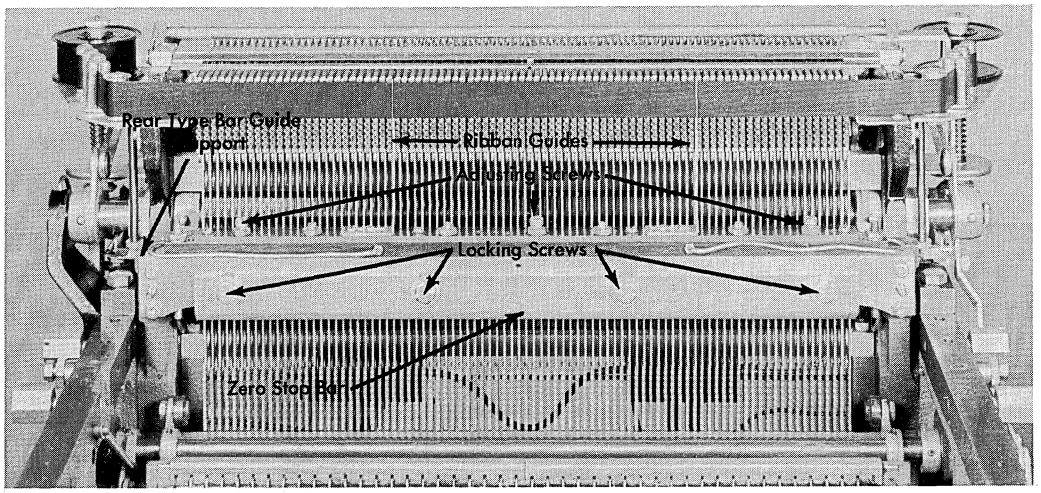


Figure 41. Numerical Zero Stop Type 419

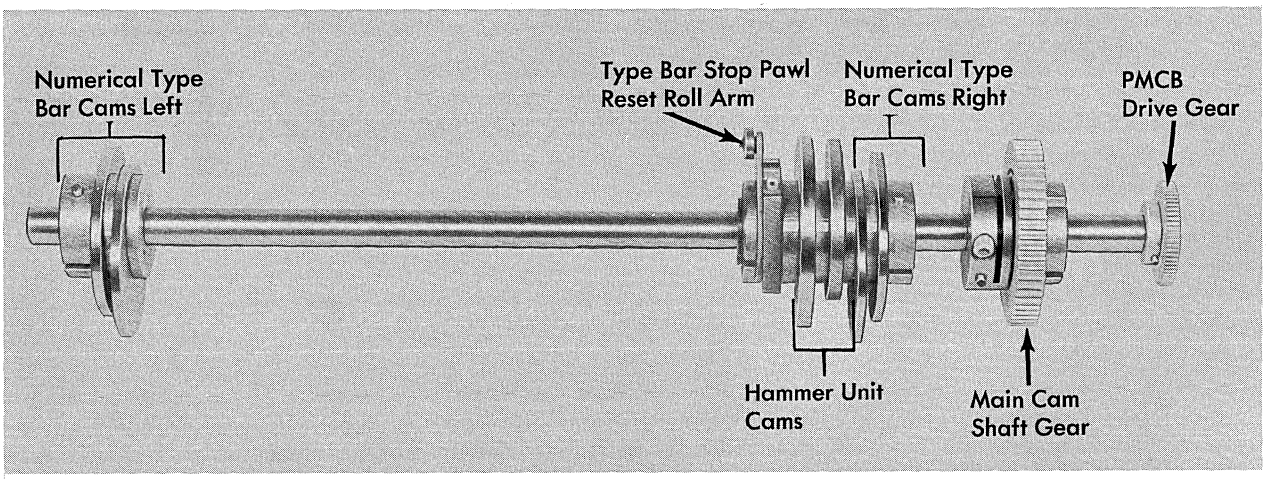


Figure 42. Main Cam Shaft Type 419

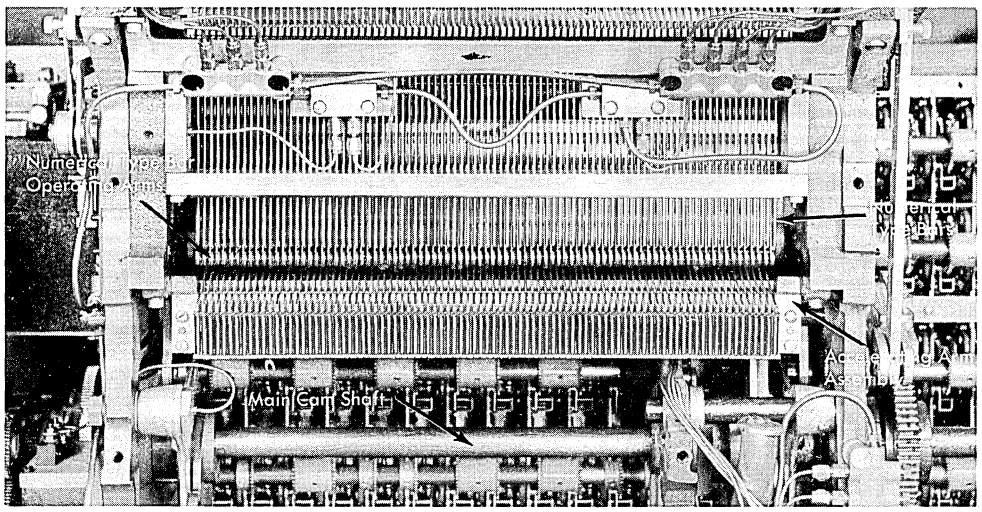


Figure 43. Accelerating Arms Type 419

PRINT MAGNET ASSEMBLY

THE TYPE bars which carry the type characters are raised and lowered by their respective type bar bails. In Figure 36 it may be seen that the type bar is raised by spring tension alone and is positively restored by the restoring bail which pushes down on the type bar operating arms. On the upstroke the type bars are raised by spring tension and, in order to position the bar for printing of any desired character, the type bar must be stopped at the correct tooth. The type bar is stopped by allowing a stop pawl of the print magnet assembly to release and swing into the path of a tooth on the bar. As the card passes through the brush stations, the holes may be sensed, and electrical impulses through circuits (to be described in the *Circuits* section) may be conducted to magnets in the print magnet unit. When the magnet is energized, the armature is attracted and the stop pawl is released. The time or degree on the index at which the print magnet is impulsed will be determined by the hole in the card and the circuit breaker impulse. This will determine at which tooth the type bar will be stopped and will place the correct character in position for printing. In order to align the type bars properly for printing, the stop pawls rest against their stop bar. This eliminates the necessity for the two step latches as used in the zone unit.

Figure 44 shows the print magnet stop pawl held by the armature. The stop pawls are normally in the latched position and the entire assembly is located in the machine so that there is .020" clearance between the stop pawls and the type bars.

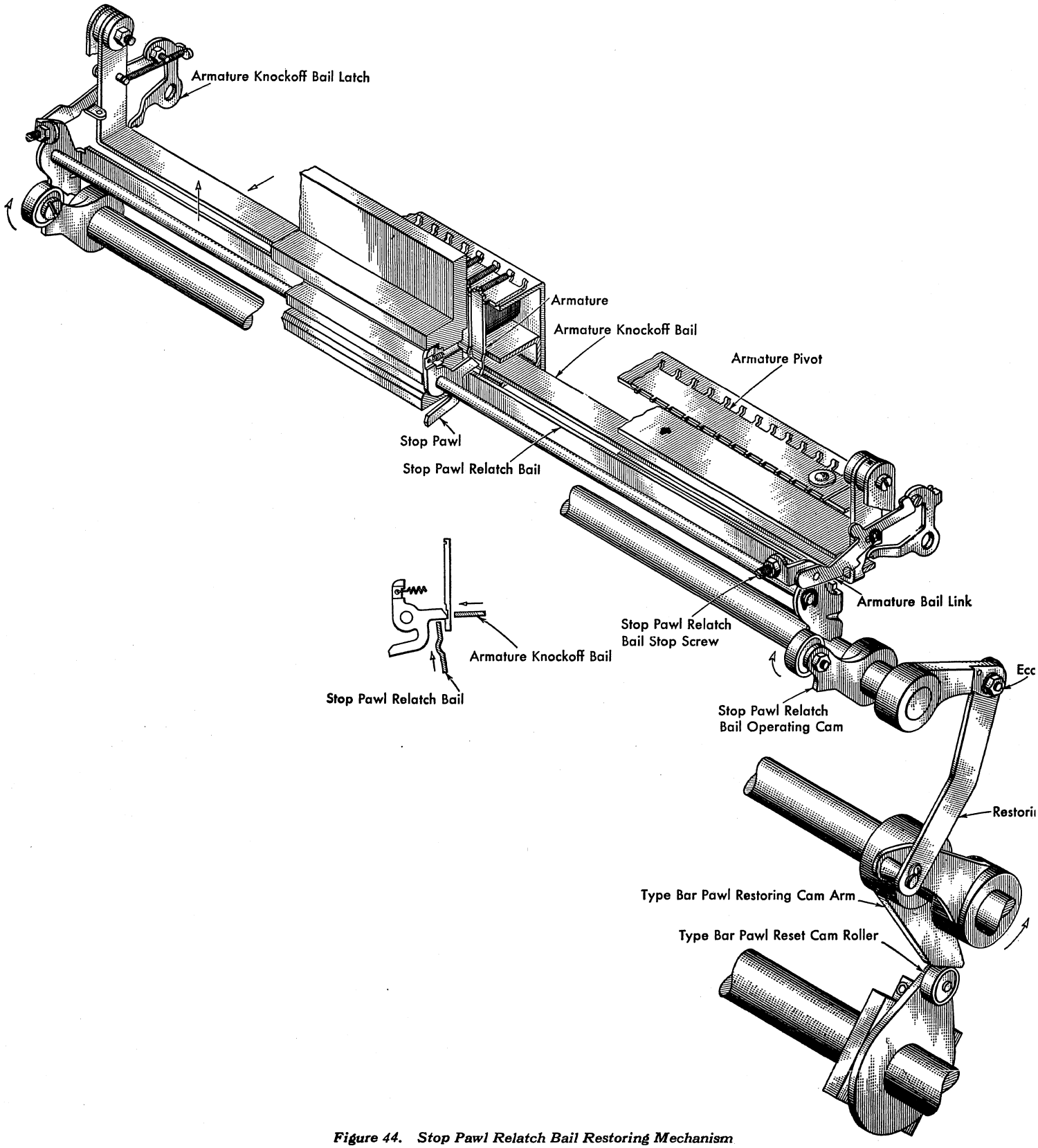


Figure 44. Stop Pawl Relatch Bail Restoring Mechanism

Once the stop pawl is released and printing has taken place, the stop pawl must be restored back upon its respective armature latch. The mechanism to perform this operation may be seen in Figure 44.

The type bar pawl reset cam roller is part of the main cam shaft and, as it revolves, it moves the type bar pawl restoring cam arm in a counterclockwise direction. The restoring link pulls on the stop pawl relatch bail operating cam which pivots on a shaft and raises the stop pawl relatching bail. The relatching bail raises the stop pawls up above the latching point and holds them until the armature bail links pull the armature knockoff bail and move the armatures to the front of the machine, thus allowing the stop pawls to be relatched. The knockoff bail also overcomes any residual magnetism which might cause the armature latch to hang up.

The mechanical timing chart shows that the hammers fire at 199° to print the characters in the type bars and that they will be fully restored at 324° 46′. The type bar restoring bail starts down at 214° 30′.

It must be kept in mind that the type bars are being held at various character printing positions by spring tension. As the type bar restoring bail returns, it restores the type bars according to the position at which they stand, starting with the type bar at the zero position and following with those at the 1-2-3-4-5-6-7-8-9 positions. All type bars should be returned to the 9 printing position at 324° 45′. Therefore, the print magnet stop pawls may be restored at any point after 325°. If the pawls were restored before 325°, the type bars, being held by stop pawls and spring tension, would be released and allowed to snap up to their limit of travel or until they strike the restoring bail.

The timing chart shows the clearance being taken up between the relatch bail and the stop pawl at 330°. The pawls will be fully restored at 341°. Check the mechanical timing chart.

The time at which the print magnet stop pawls will be restored in the Types 402-403 machines has been delayed slightly. This prevents the restoring bail from lifting the stop pawls at a time when the pawls may be in contact with a type bar which is under spring tension, for example 9, thus reducing wear.

Each end of the stop pawl relatch bail is equipped with an armature bail link. This carries the armature knockoff bail to a point where the armature knockoff bail latch on each end will fall behind the knockoff bail at 341° and hold it in the forward position (Figure 45). The purpose of the armature knockoff bail latches is to hold the knockoff bail in the forward position until the stop pawls have been lowered and have come to rest on the latching surface of the armature. This will also aid in completing the breakdown of the residual magnetism.

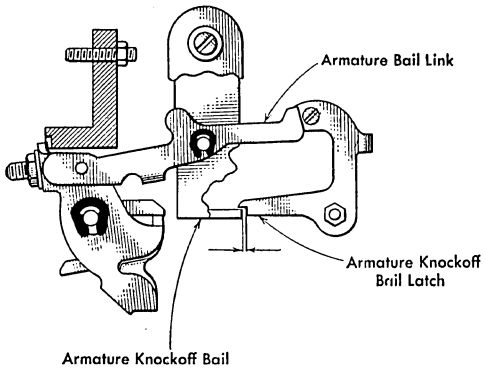


Figure 45. Armature Knockoff Mechanism

As the type bar pawl restoring cam arm drops off the high point of the cam roller, spring tension returns the restoring mechanism to its normal position. After the stop pawls have come to rest upon their armatures, the armature bail links (Figure 46) move to the rear of the machine striking the eccentric screws in the armature knockoff bail latches at 350° to release the knockoff bail and allow it to return to its normal position. The type bar stop pawl cam arm drops off the high point of the cam roller at approximately 351°.

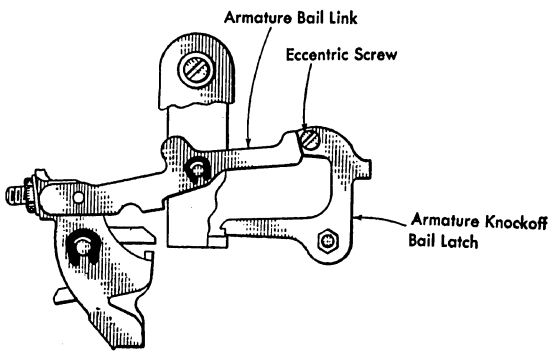


Figure 46. Armature Knockoff Mechanism

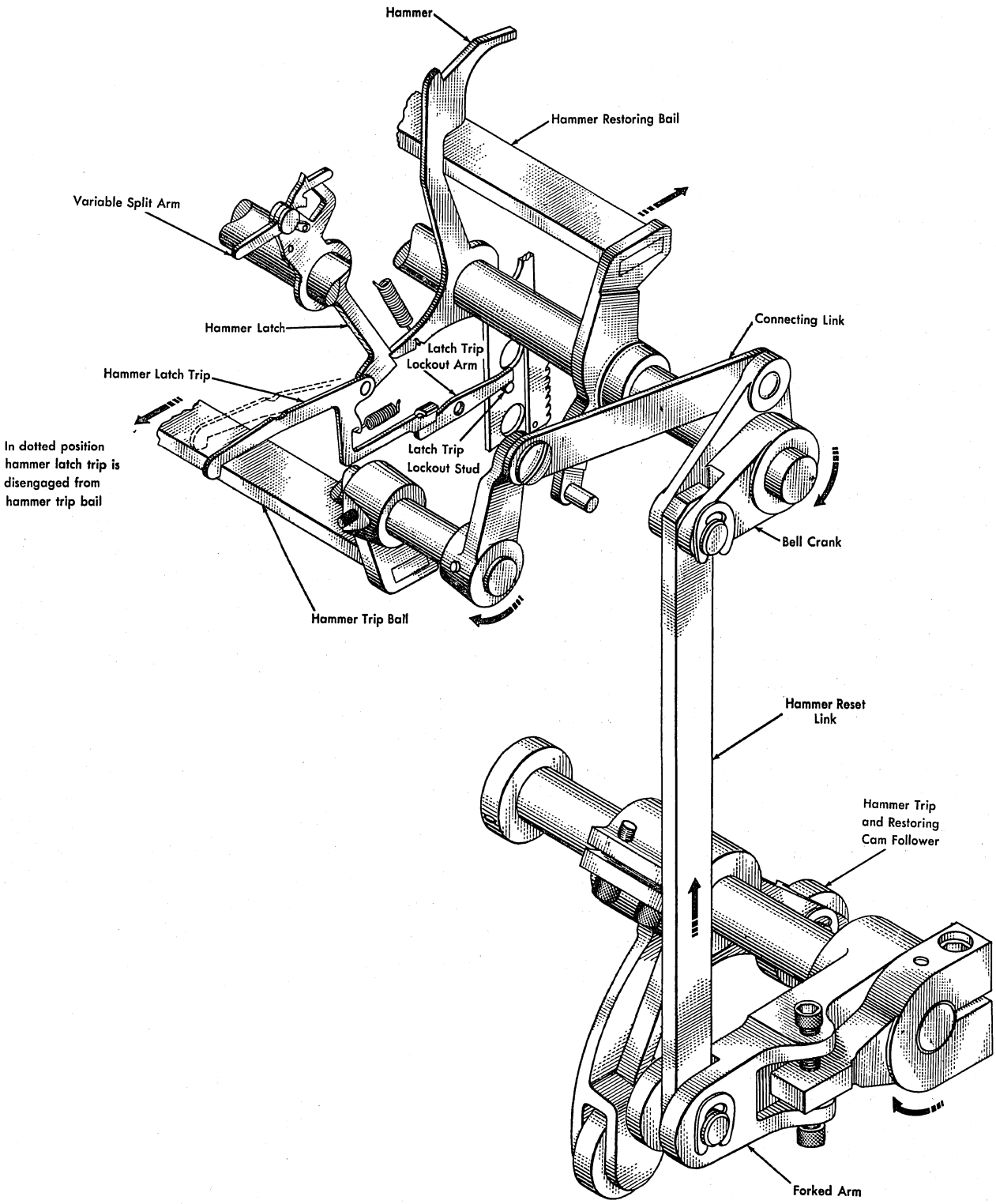


Figure 47. Hammer Unit Mechanism

HAMMER UNIT ASSEMBLY

THE HAMMER unit is designed to cause the hammers to fire at approximately 199° after the type bars have been lifted to the correct position. It will also restore the hammers clear of the type bars before the type bars begin to move down to their normal position. Also mounted on the hammer unit is the ribbon feed mechanism and the hammerlock device which will be described in another section.

Check the machine with Figure 47 and find the hammer trip and restoring cam follower. It is pinned to a shaft which operates the forked arm and drives the link, which in turn, through a bell crank and connecting link, operates the hammer trip bail.

Resting on top of the hammer trip bail are the latch trip arms for each hammer, providing the type bar is not raised to the zero or blank position. When the hammer trip bail moves to the front of the machine, it will pull on the hammer latch trip and cause the hammer latch to release the hammer.

The alphamerical type bar print magnet must be wired in order that the bar be stopped at the zero position. Each alphamerical type bar has a small block, called a hammer latch trip lockout cam, fastened to its side. When the type bar is allowed to rise to a zero or a blank position, the latch trip lockout cam strikes the latch trip lockout arm, which in turn pivots and holds the hammer latch trip clear of the hammer trip bail. This prevents the hammer from being tripped in the normal manner.

All numerical type bars will rise to a zero printing position if they are not stopped by a stop pawl. On the side of the numerical type bar is a stud which serves the same purpose as the latch trip lockout cam on the alphamerical type bar. This prevents the hammer from being tripped in the normal manner.

Variable Split Arm

At the top of the hammer latch is a lever called the variable split arm (hammersplit). Its purpose is to control the number of zeros that will print to the right of a significant number. Figure 49 demonstrates the results obtained when the variable split arms are properly used, in comparison with a report where the variable split arms have not been used. Raising the variable split arm in the units position of any field will prevent the printing of any zeros to the right of the units position.

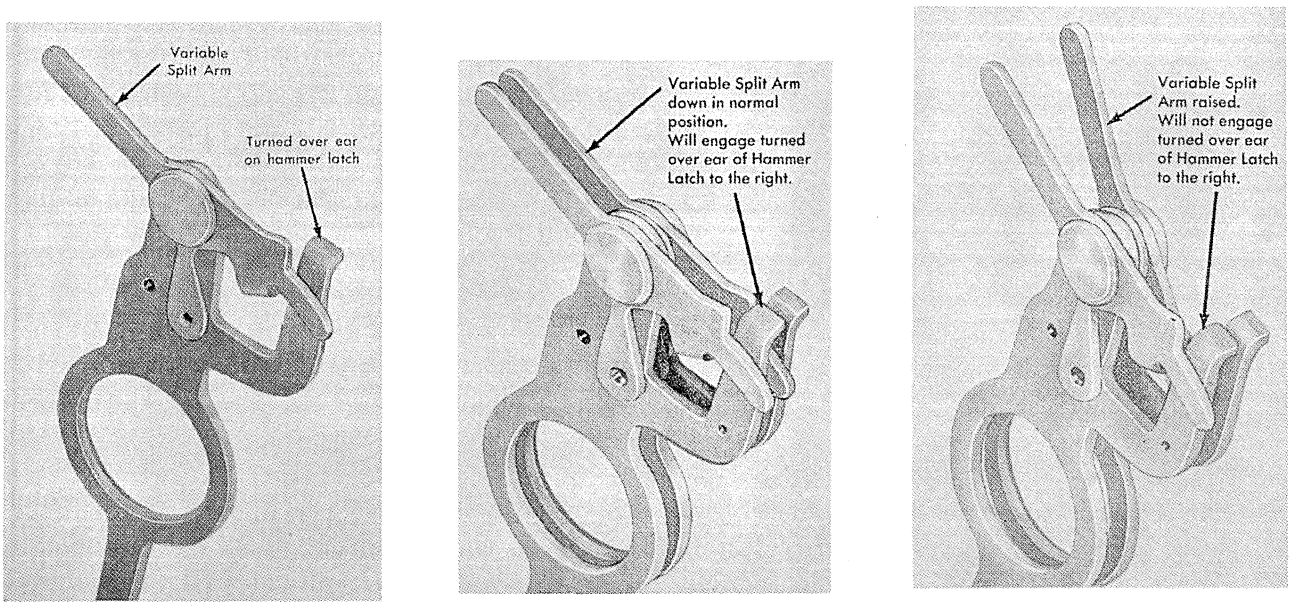


Figure 48. Variable Split Arms

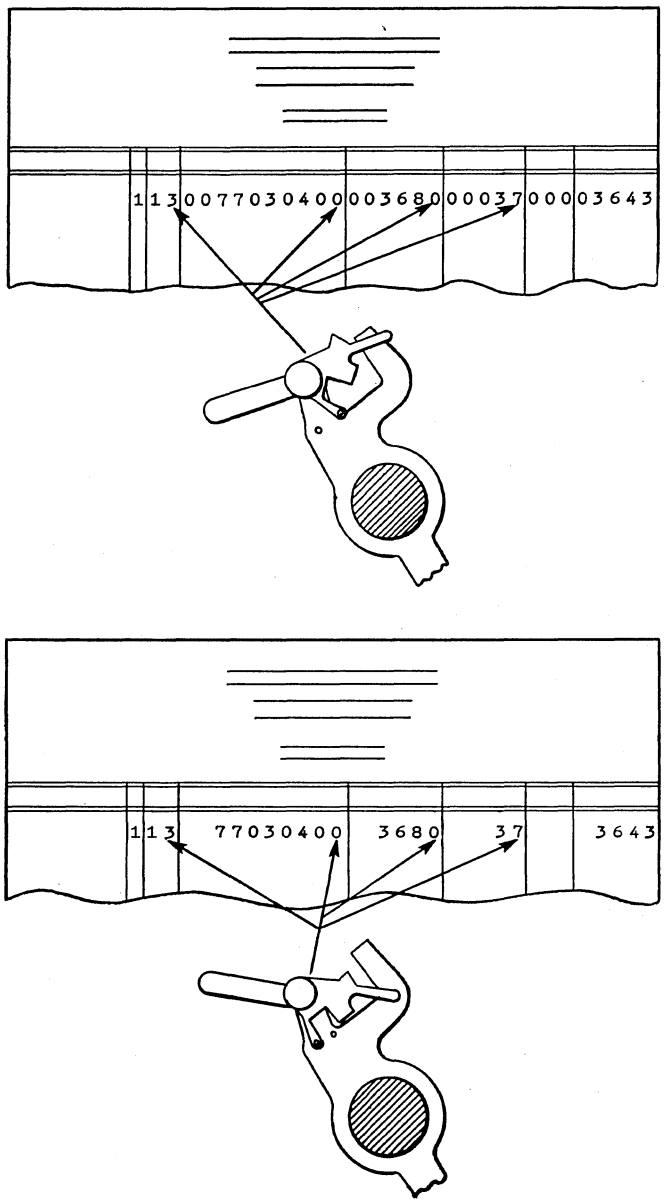


Figure 49. Zero Suppression

Each variable split arm in its normal position stands in front of the turned-over ear of the hammer latch to its right. In the raised position, the variable split arm will miss the turned-over ear on the hammer latch to the right, and no motion can be transferred to the right (Figure 48). For example, if Social Security No. 77030400 is standing in the type bars, the latch trip arms for the bars printing 77-3-4 will rest on the hammer trip bail. The hammer trip bail will pull on the hammer latch trip arms and cause the hammer latches to release the hammers. The latch trip lockout cam on the four type bars standing in the zero printing position will be holding their hammer latch trip arms above the hammer trip bail.

When the hammer latch releases the hammer for the type bar standing at 4, the variable split arm at the top moves to the rear of the machine. The split arm in this position presses on the turned-over ear of the split arm to its right and in turn transmits its motion to cause the hammers to the right to be released where type bars stand at zero.

Raising the split arm in the units position will stop all action of the zero splits beyond this particular field. The split arm will pass under the turned-over ear of the split arm to its right, ending all further action.

The hammer-spring bail shaft extends across the top of the unit and serves as a hammer stop. This prevents damage to the casing of the type bar when the type bars are stopped in the blank position and the hammers are allowed to trip.

Spring Tension Device

The hammer spring bail is provided with a method of increasing the spring tension (Figure 50). This device is mounted on a bar above the hammers and consists of a dial which, when manually operated, rotates a threaded hammer tension bushing and raises or lowers the hammer spring bail. As the threaded stud of the spring bail is raised, the hammer tension indicator will project above the spring bail support to serve as a guide when readjusting the dial for the same tension. The spring tension device is not a part of the standard machine and is installed as a special feature.

Hammerlock Assembly

The hammerlock assembly is located on top of the hammer unit, as shown in Figure 51. The three main purposes of the hammerlocks are:

1. To select or suppress all or any part of the information being listed from a card.
2. To eliminate overprinting of the listed amount from the first card and total amount when a control panel wired for detail printing is used for a group printing operation. If no change

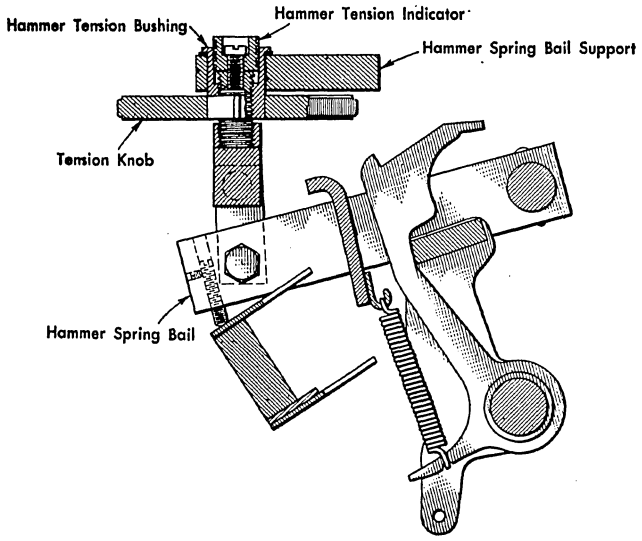


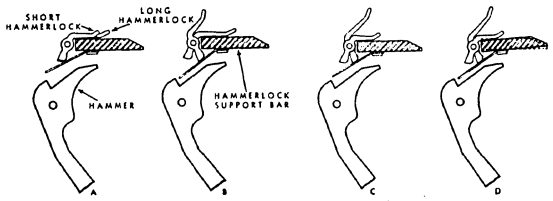
Figure 50. Spring Tension Device

is made in the wiring, overprinting would normally occur. The hammerlocks may be set to prevent any listing in those type bars where totals will be printed.

3. To group indicate by allowing information from only the first card of a new group following a total to print in a listing operation (Figure 52).

The hammerlock bar, which extends across the top of the machine, supports blue steel springs which may be depressed by raising either a long or short hammerlock lever (Figure 51). Raising a short hammerlock lever will cause the spring to move down into a cut in the top of the hammer (Figure 51B). This will block the hammer and prevent the hammer from striking the type.

The long hammerlock, when raised, will cause



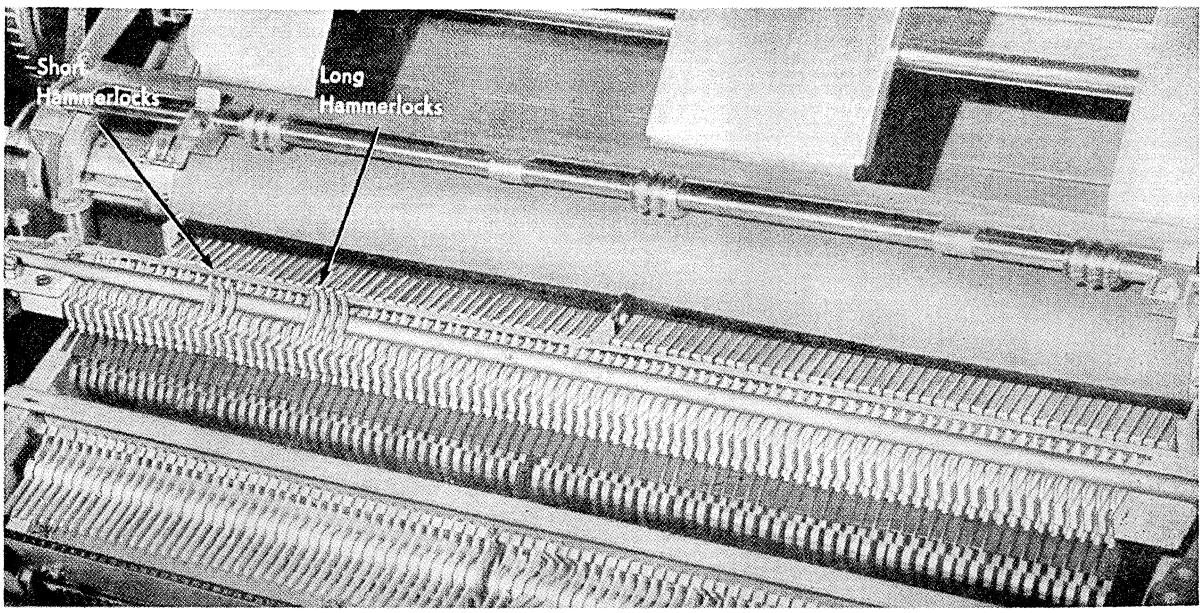


Figure 51. Hammerlock Unit

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DEDUCTION REGISTER

_____ 19__

EMPLOYEE NAME	EMPL. No. DEPT	EMPL. No. CLOCK	DEDUCTION CODE	DEDUCTIONS
FRED ACKERLY	1	13	215	50
FRED ACKERLY	1	13	314	75
FRED ACKERLY	1	13	573	500
				625 *

SHEET____OF____ GENERAL MANUFACTURING COMPANY REPORT No._____

DEDUCTION REGISTER

_____ 19__

EMPLOYEE NAME	EMPL. No. DEPT.	EMPL. No. CLOCK	DEDUCTION CODE	DEDUCTIONS
FRED ACKERLY	1	13	215	50
			314	75
			573	500
				625 *

Figure 52. Group Indication with Hammerlocks

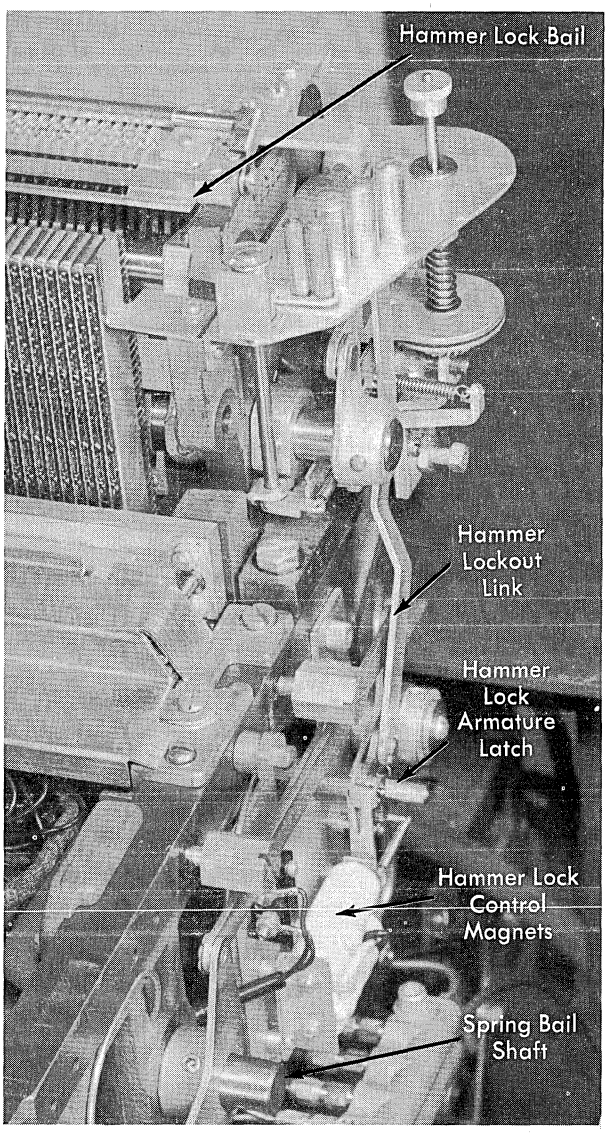


Figure 53. Hammerlock Operating Mechanism

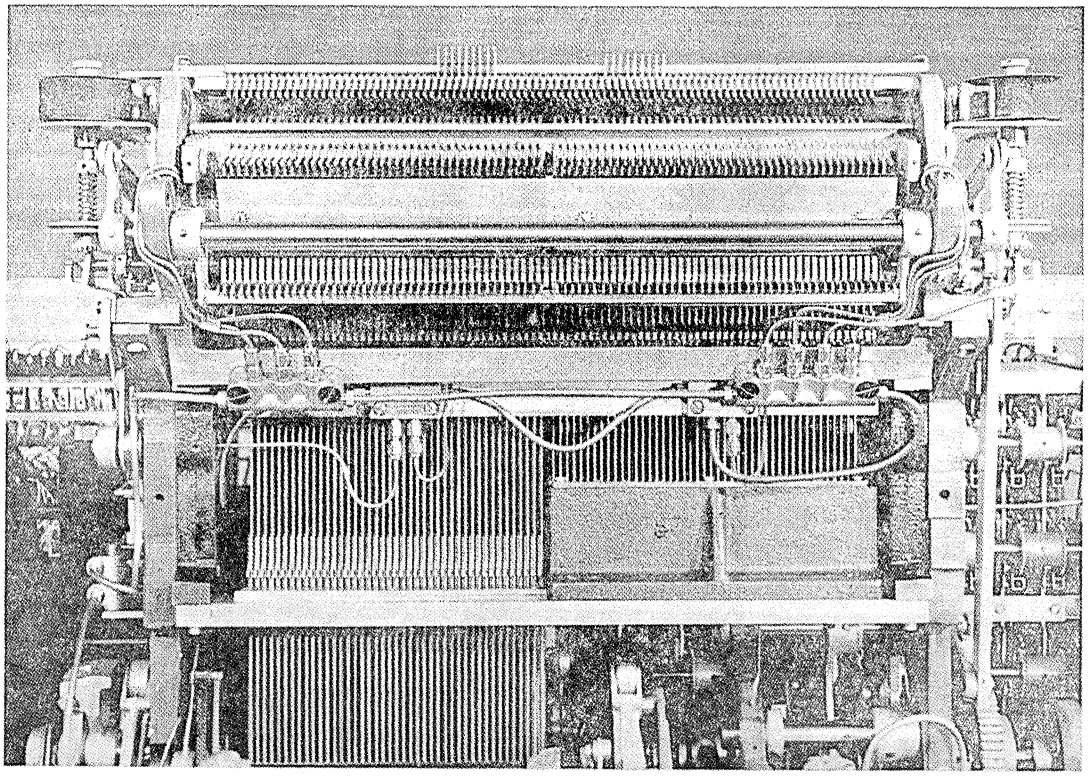
the spring to move down to within .025" to .031" of the top of the hammer (Figure 51C). All hammerlock springs are attached to the hammerlock bar which, through a link and armature arm, is supported by the hammerlock magnet armature. This means that whenever the hammerlock armature is attracted the entire hammerlock bar may be lowered. Positions where long hammerlocks are raised will be prevented from printing by the spring which blocks the hammer (Figure 51D).

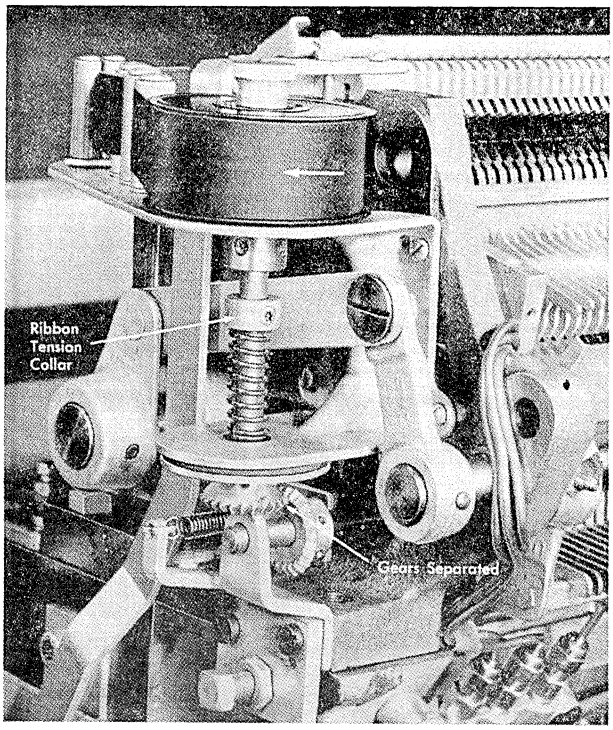
By means of control panel wiring, the armature may be controlled to pick up on every cycle except on the first card of a group (Figure 52). The circuits will be discussed in the *Circuits* section of the manual.

The hammerlock magnet assembly is mounted on the left type bar support casting, directly below the hammer unit (Figure 53).

Ribbon Feed

The ribbon feed mechanism shown in Figure 54 is designed to advance the ribbon slightly each print cycle and to reverse the direction in which the ribbon is feeding once the ribbon reaches the end, either on the right or left spool. Check the location of the ribbon feeding and reversing mechanism in the machine. Engage the print mechanism clutch and crank





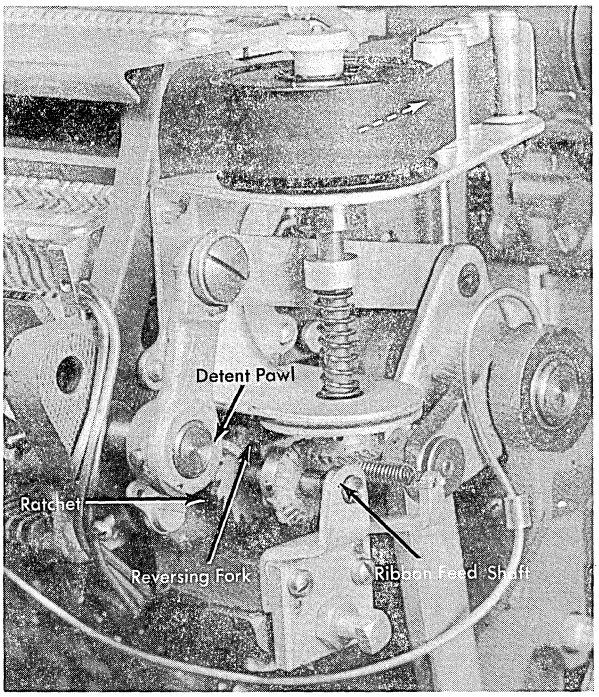


Figure 54. Hammer Unit and Ribbon Feed Mechanism

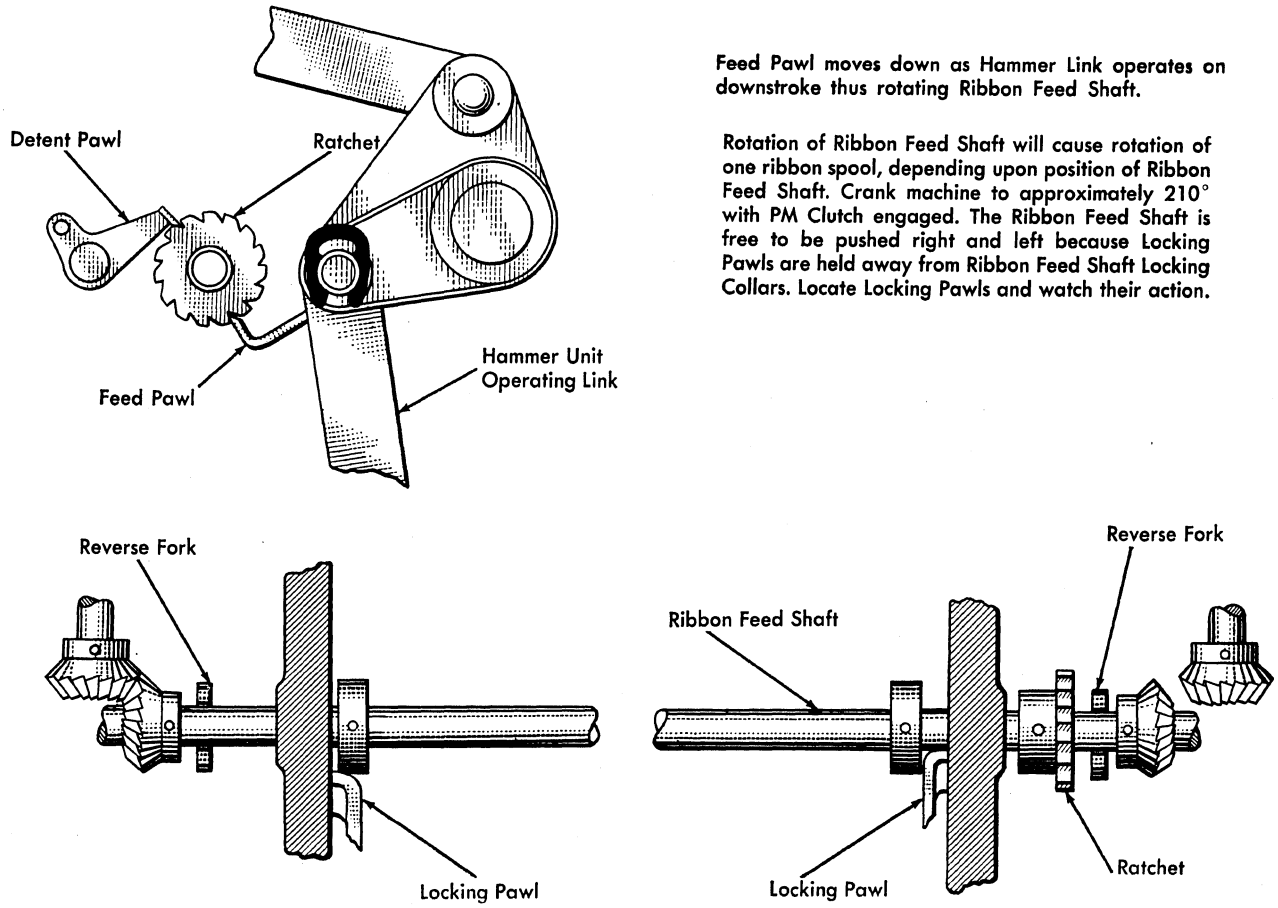


Figure 55. Ribbon Feed Drive Shaft

the machine so that the operating linkage may be followed as shown in Figures 55 and 56. It will be seen that the ribbon feed operation is a secondary operation of the hammer mechanism.

When the hammer restoring and tripping link is raised by the cam roller action, it also causes the ribbon shaft feed pawl to move to the rear and pick up a new tooth on the feed ratchet. While the restoring bail is returning the hammers to their latches, the ribbon feed pawl turns the ribbon feed shaft by means of the ratchet. The ratchet will be kept from turning backward by a detent pawl.

The ribbon shaft, depending on whether it is in its right-or left-hand position, will, through its beveled gear, advance one of the ribbon spools while the other will be kept from unwinding by a friction disc held under spring tension.

At 210° during each cycle when the hammer unit is in operation, the locking pawls will be moved clear of the ribbon feed shaft and collars. There will be no change in the direction in which the ribbon is feeding, since both the right and left reversing forks will be resting upon their latches.

Feeding will continue until such time as the ribbon reaches the end of one spool. At that time a rivet in the ribbon, attempting to pass between the two roller guides, will pull the latch clear of the reversing fork latch point.

On the next cycle, when the locking pawls are pulled clear of the shaft, the reversing fork which was unlatched will pivot through spring tension. This will move the ribbon feed shaft so that the beveled gear will mesh with the other spool to feed the ribbon in a reversed direction.

Following the shifting of the shaft, pins in collars on the restoring shaft operate against the cam surface of the reversing fork and carry them back to a relatched position. Check for freedom of movement of all parts, such as ribbon feed shaft, reversing fork, ribbon reversing fork latch, etc.

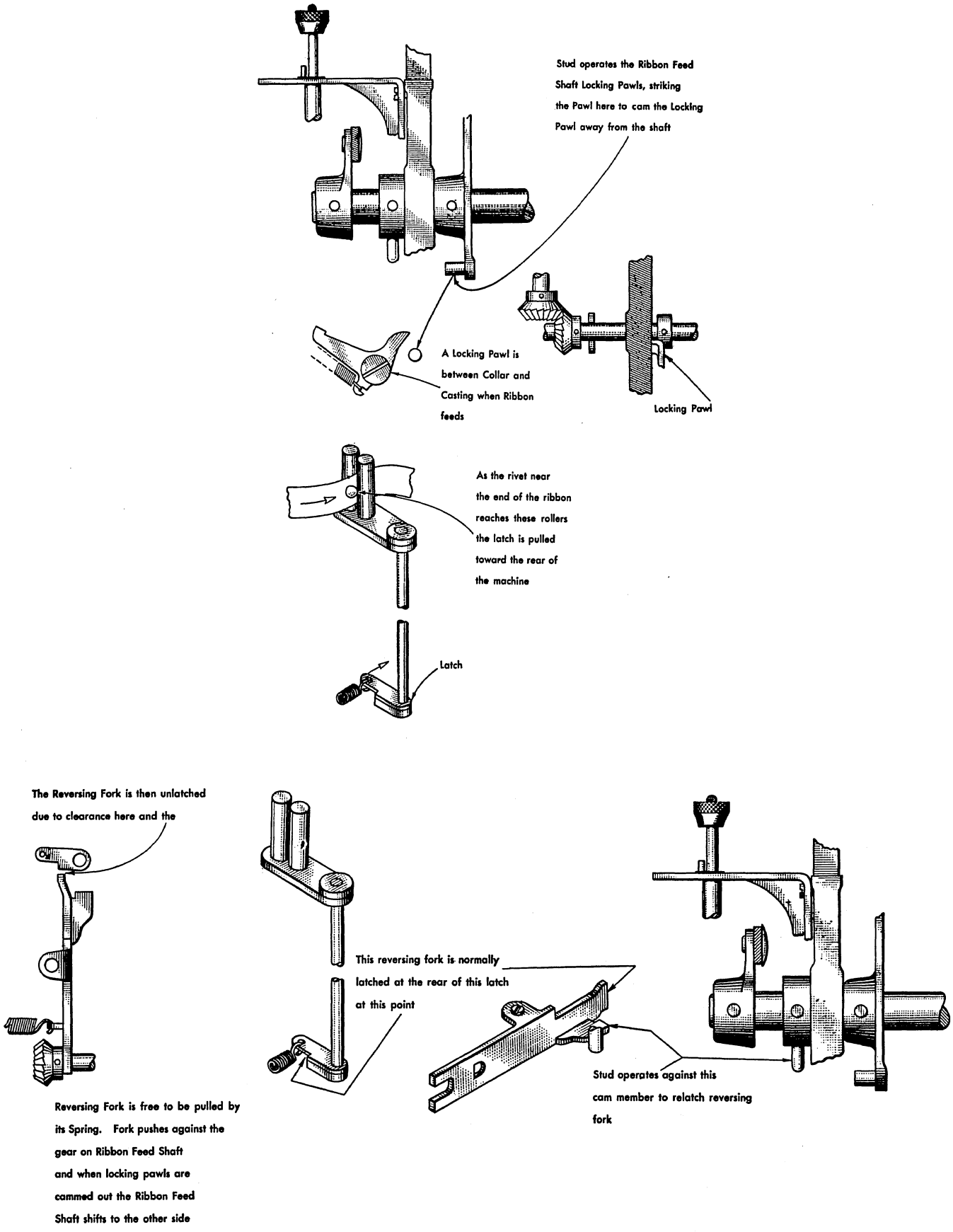


Figure 56. Operation of Ribbon Feed

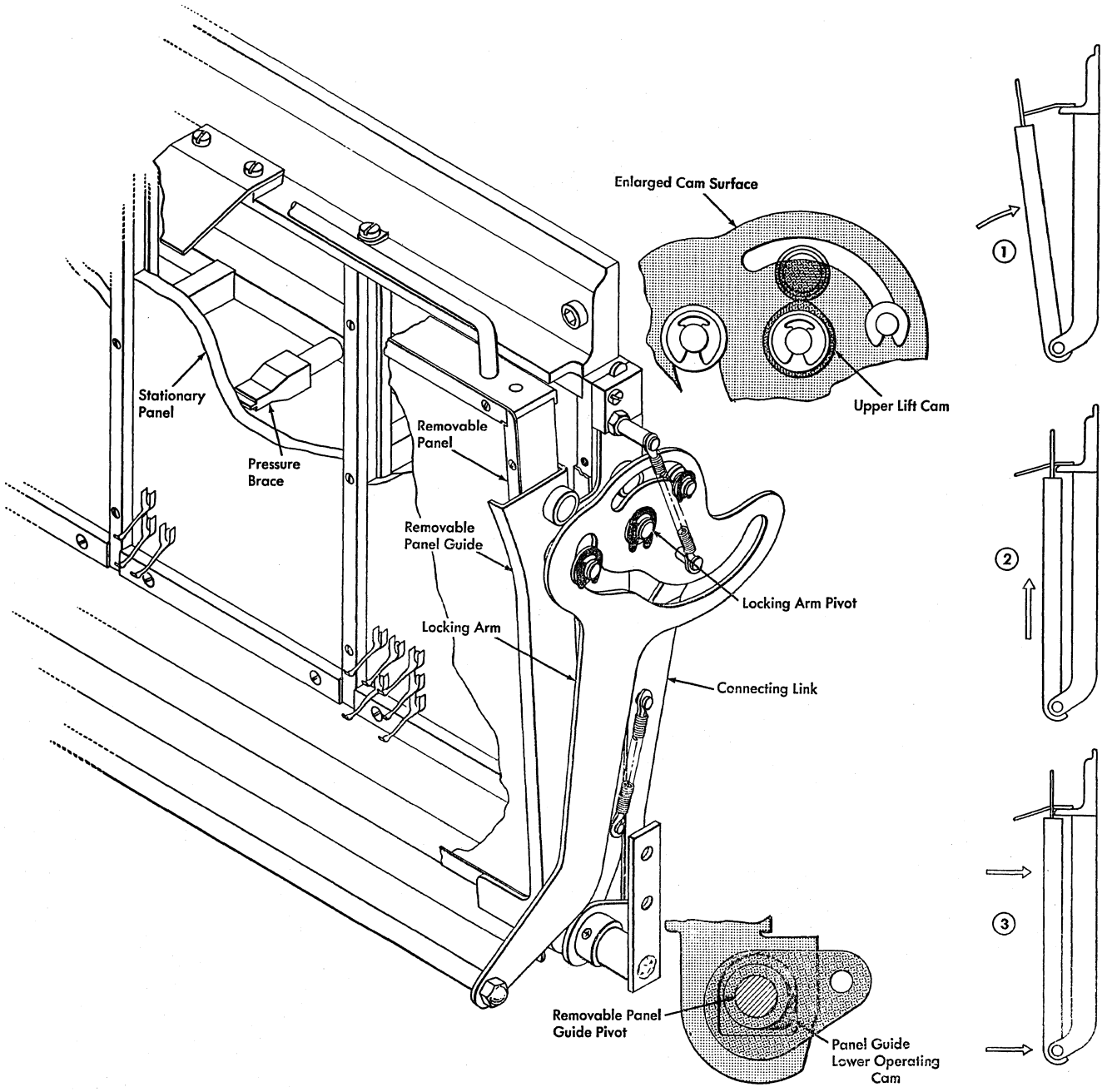


Figure 57. Control Panel Closure Mechanism

CONTROL PANEL CLOSURE MECHANISM

MACHINES shipped to the field since July 1951 have a new control panel closure mechanism (Figure 57), designed to give better wiping action to the contacts. The locking-arm assembly has an enlarged cam surface around the pivot point, which contains slots cut to give the removable control panel guide the desired motion. On the inner surface of the locking arm assemblies at their pivot points are cams that move

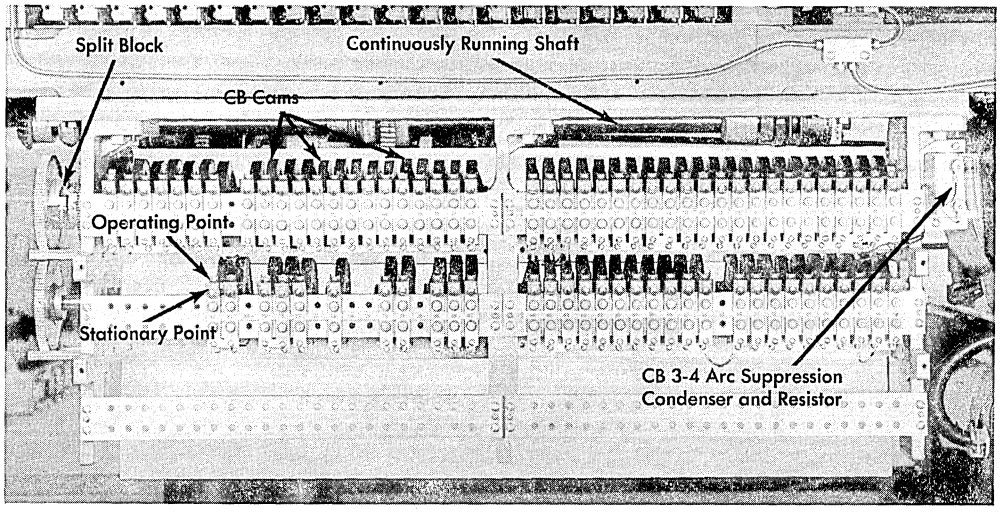


Figure 58. Continuously Running Circuit Breaker Assembly

the control panel guide up. A similar pair of cams acts as bearing surfaces for the lever pivot of the control panel guide assembly. As the locking arms are brought down into operating position, these lower cams are operated by connecting links from the locking-arm cam-surface slots.

This mechanism provides for three distinct movements of the control panel guide assembly as it moves the control panel into contact with the stationary prongs (Figure 57). The movement places the manual slide contacts almost completely under the stationary contacts (1), then moves the manual slide up to provide full contact pressure (2), and then the panel is moved into location (3). This provides wipe of contacts at full pressure for both upper and lower portions of the panel. Because the stationary contact will be on the flat section of the manual slide contact when the assembly is moved back into location, the outside pressure on the removable control panel is considerably reduced, thereby minimizing the tendency to cause excessive warpage of manual and stationary panel sections.

The primary difference between this and the former-style closure mechanism is the absence of camming movement at the lower part of the control panel guide when the panel is moved into position. The former control panel guide only rotated about its lower pivot, with the result that very little wiping action at full pressure was given the contacts on the lower portion of the control panel as it moved into position.

CONTINUOUSLY RUNNING CIRCUIT BREAKERS

THE continuously running circuit breaker assembly (Figure 58) is driven by the continuously running shaft.

Cams mounted on the two shafts in the circuit-breaker unit revolve and open and close the circuit-breaker cam contacts for a fixed duration determined by the cut of the cam.

The upper cam shaft in the continuously running circuit-breaker unit is equipped with a split block adjustment, which allows the entire unit to be brought into closer timing with the machine index than is possible by changing the drive-gear relationship one tooth.

The lower circuit-breaker cam shaft has at its right end, from the rear of the machine, a small index that may be used when checking circuit-breaker contact time. However, because all units and reading brushes are set to the dynamic timer index, it is recommended that important continuously running circuit breakers such as 1, 2, 3, and 4 be checked to the same dynamic timer index.

COUNTERS

Operation

The Types 402-403 Alphabetical Accounting Machines are available in several counter capacities. There may be 32, 44, 56, or 80 counters, and they may be capable of adding only, or of adding and subtracting. There are two counters on a plate, and

40 plates give a maximum counter capacity of 80 positions. These counter positions are arranged in sixteen groups on the control panel. There are four 2-position groups, four 4-position groups, four 6-position groups, and four 8-position groups. Only the mechanical operation of the counters is described in this section of the manual.

It has already been explained that the counter moves a definite distance in relation to card travel. The method of moving and stopping the counter is fully mechanical; the time it is impulsed is controlled by electrical circuits.

Counters are accumulating devices used for adding or subtracting quantities recorded as holes in the card. When cards are feeding and a reading brush makes contact through a hole in the card, a clutch is engaged to permit a wheel to rotate. This wheel is known as the adding wheel. Since the figure to be added may be any number from 1 through 9, the adding wheel is permitted to rotate a specific amount for each figure to be added.

As previously explained, the principle of operation which permits the correct accumulation of quantities recorded on the card is that the adding wheel will rotate 18° of machine time for every unit to be accumulated. This 18° represents one cycle point, a cycle point being the distance between two consecutive punching positions of the card. The term "cycle point" is also used with reference to the time required to move the adding wheel from one detent position to the next position. The chart following shows how much the adding wheel must turn, in degrees of machine time, in order to add any given figure.

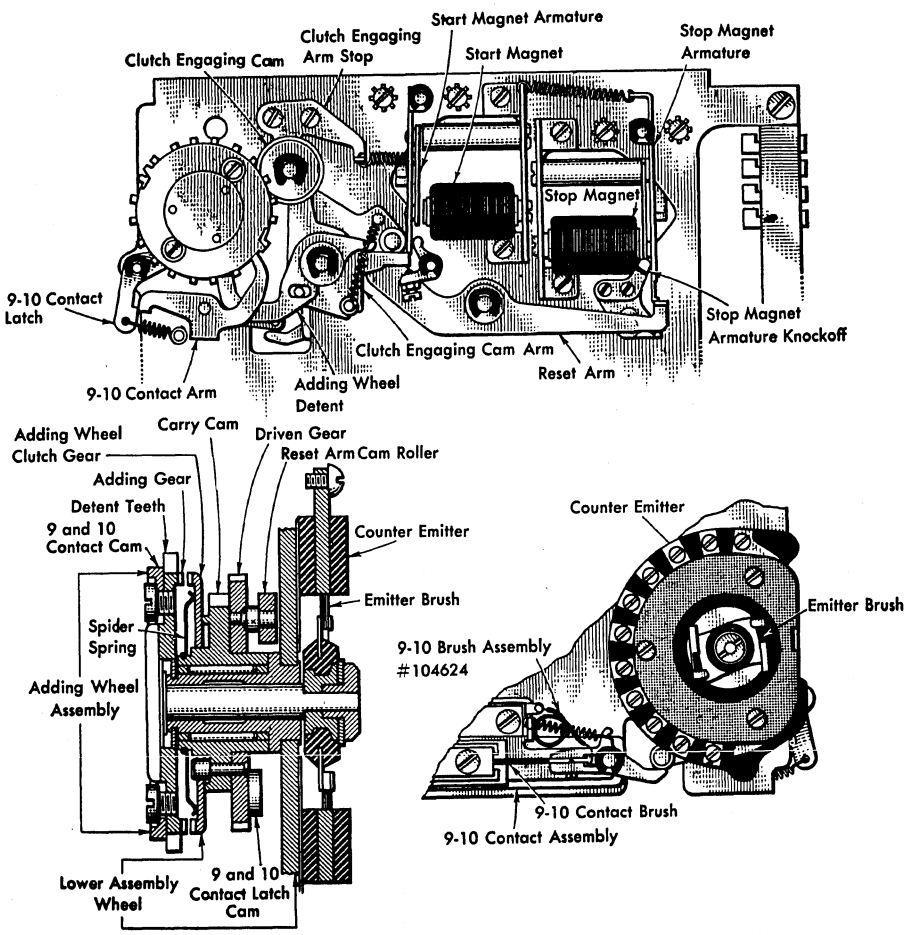


Figure 59. Counter

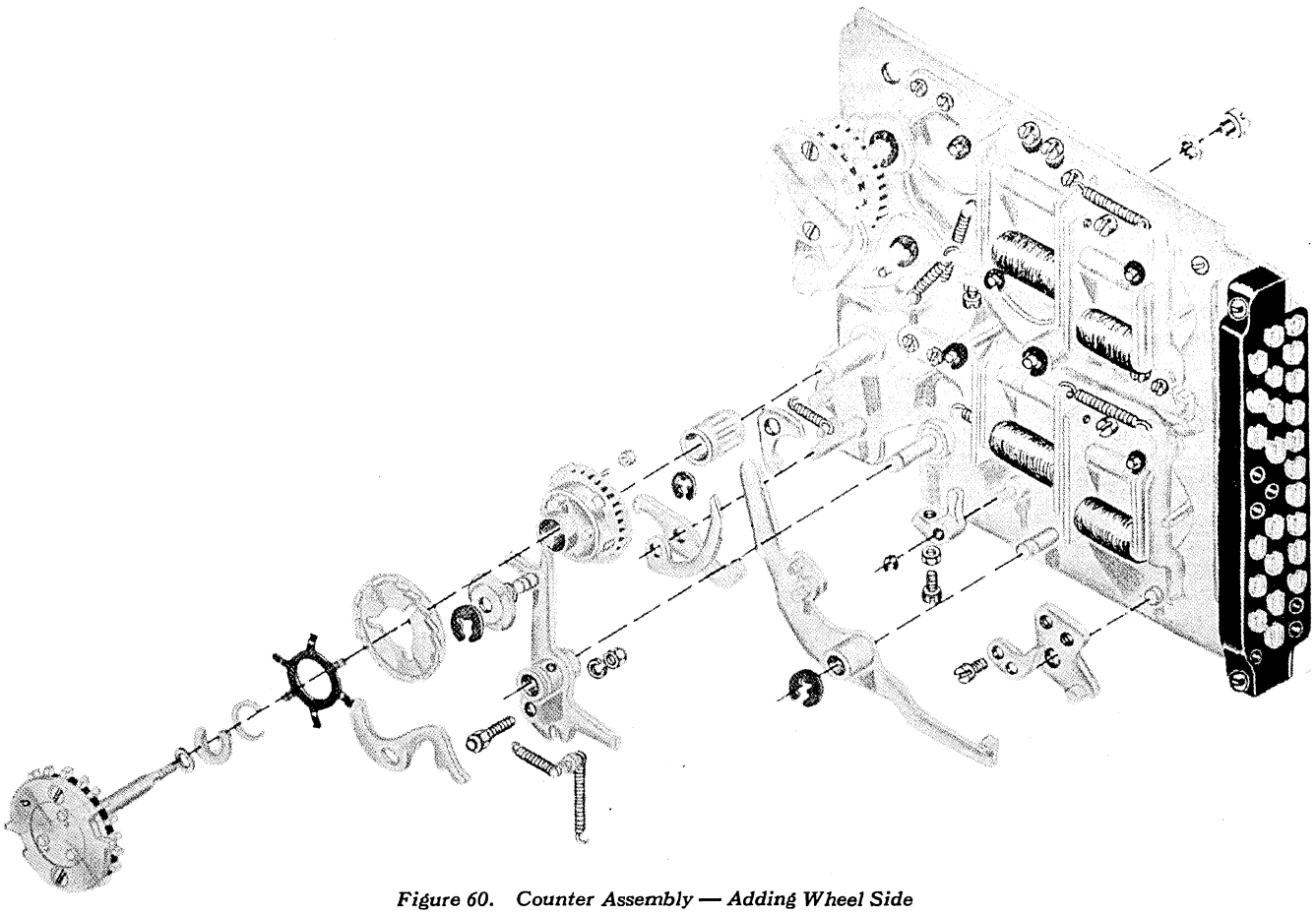


Figure 60. Counter Assembly — Adding Wheel Side

TO ADD		ADDING WHEEL MUST TURN
9	9 x 18°	162°
8		144°
7		126°
6		108°
5	5 x 18°	90°
4		72°
3		54°
2		36°
1	1 x 18°	18°
0		0°

It is important to an understanding of machine operation that this basic fact be understood: *for each unit to be accumulated, the adding wheel must turn 18°.*

Previously, the operation of the continuously running shaft to the right has been followed to show that the vertical drive shaft is turned through beveled gears (Figure 12). The four beveled gears on the vertical drive shaft in turn cause the spool gear shafts to revolve and drive the driven gears of the counter plate.

At this time, study of a counter plate will indicate the names and functions of the parts which cause the counter to operate (Figure 59). The relation of the parts may be better understood by disassembling one counter position completely and reassembling it. The position of the parts is shown also in Figures 60 and 61.

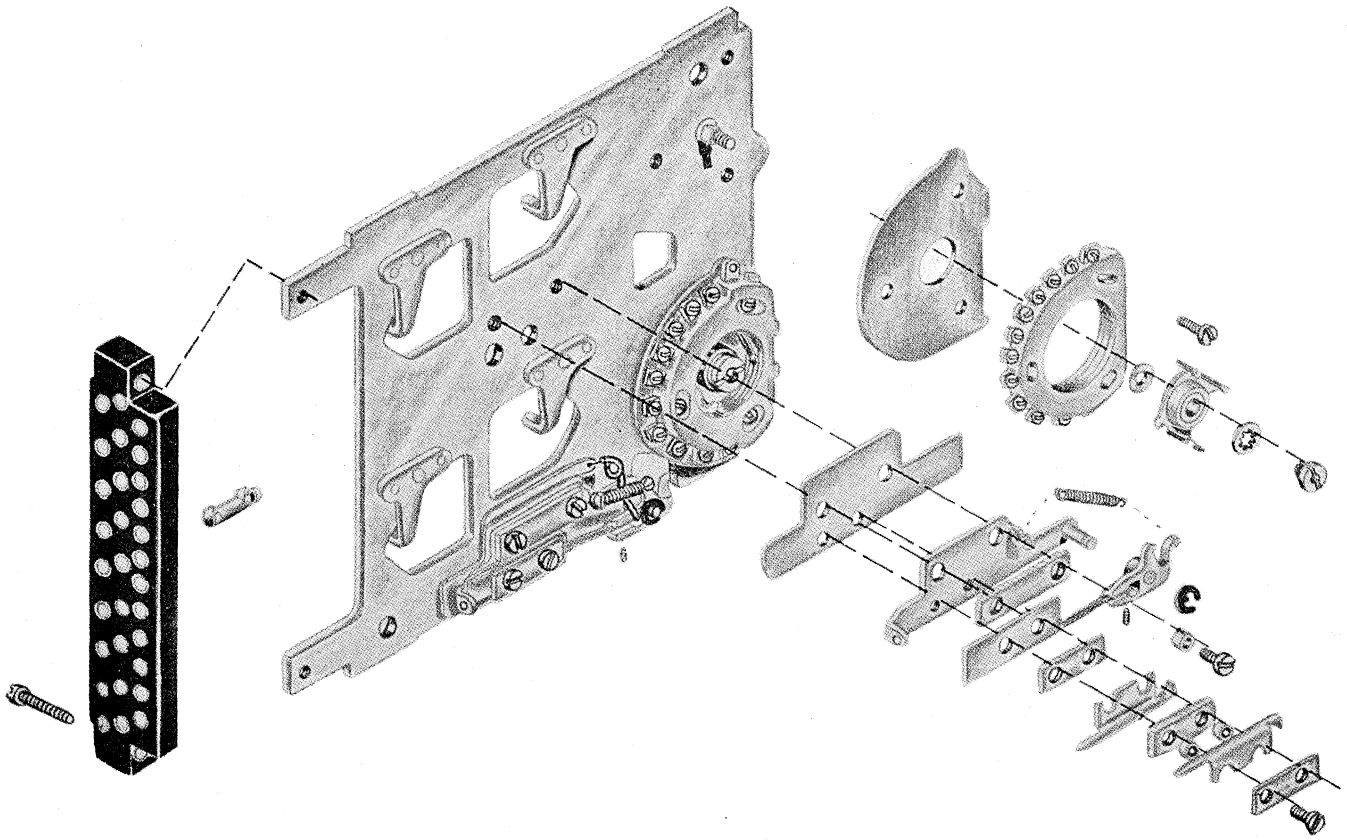


Figure 61. Counter Assembly — Emitter Side

Installing Counter in Counter Gage

As an aid to study, the counter may be timed to a counter gage and the face of the 9-10's cam marked with the units as shown in Figure 62. The index will assist in understanding the timing relationship of the counter.

Whether the counter is being timed to the spool gears in the machine or to the dummy spool gears on the counter gage, it is for one purpose, and that is to locate the first lobe of the carry cam in relation to the machine index time of 183°.

The counters may be equipped with one of two styles of carry cams (Figure 63). In earlier machines the roller-type carry cam was used. In later machines the cam-type carry cam is used. Either style may be timed to the gage by the following method:

1. Place a 9 in the counter.
2. Revolve lower wheel assembly counterclockwise until the clutch engaging arm is just over and seated behind the first carry cam or roller (Figure 63A).
3. Attract both the start- and the stop-magnet armatures. This will positively lock the counter wheels and produce a perfect clutch engagement of the clutch gear (Figure 63B). This will hold the wheel assemblies in the proper position for inserting the counter in the gage at 216°. The counter may be installed as early as 213° but not later than 216°.

Turn the gage index to any point between 9° and 171° and attract the start-magnet armature. Continue to turn the index, and it may be seen that the counter wheel, once it has started to run, will continue to turn only to 183° of the index, at which time the clutch engaging cam arm will be restored upon the start magnet armature.

There is no mechanical reason why it is necessary to place a 9 in the counter wheel when timing the counter to the gage or to the counter spool.

However, it can be used to verify proper timing by noting the results when printing *out* after installing the counter in a machine.

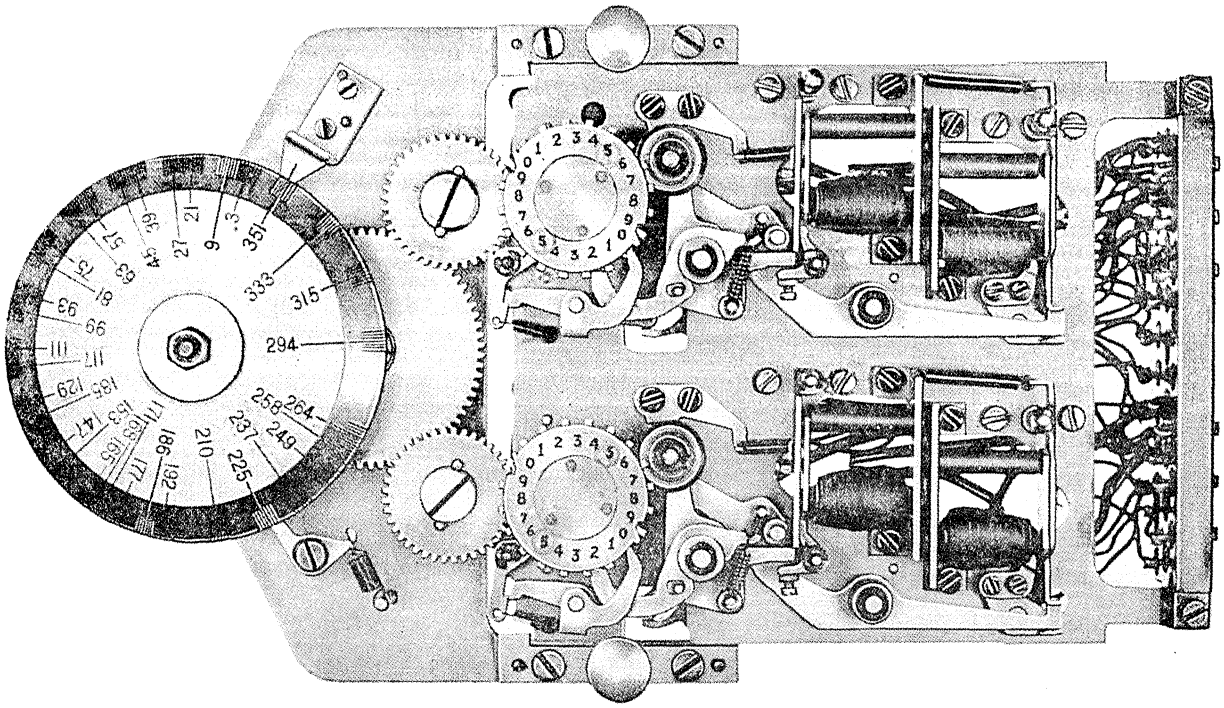


Figure 62. Counter Wheel Gage

Adding

As previously indicated, there is a definite timing relation between the hole in the card, the circuit-breaker impulse to the brush through the hole in the card, and the impulses to the add magnet. The circuit breakers allow impulses to pass to the reading brushes at the following times:

HOLE IN CARD	CB IMPULSE TIMING
9	9°
8	27°
7	45°
6	63°
5	81°
4	99°
3	117°
2	135°
1	153°

After the counter has been timed to the counter gauge correctly, turn the index to any one of the CB impulse timings. Attract the start magnet and notice that there is a fixed relation between the adding-wheel clutch gear and the adding gear (Figure 64). It is shown that there is $\frac{1}{3}$ of a tooth overlap at any one of the CB timings.

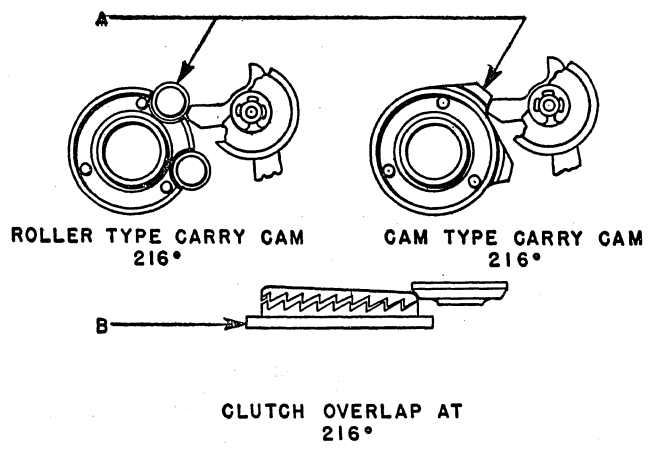


Figure 63. Universal Timing

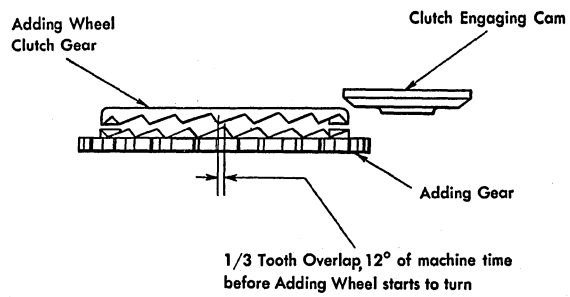


Figure 64. Counter Wheel Clutch

Continue to turn the index and notice the number of degrees required to bring the clutch teeth into full mesh. It will be found that the index will move 12° before the counter will begin to turn. Therefore, the adding wheel always starts turning 12° after the start magnet is energized by the impulse made available by the brush through the hole in the card.

Once the start magnet has been attracted, revolve the counter wheel driven gear by turning the index until the top-counter assembly stops turning. Again the stopping point will be found to be 183°.

The means by which the counter wheel is turned may be seen by watching the action when the start magnet is attracted. The clutch engaging cam arm is released and, through spring tension, it carries the engaging cam in behind the adding-wheel clutch gear. The engaging cam forces the counter-wheel clutch gear and the adding gear to mesh and, because they are mechanically driven, the counter wheel will continue to turn until 183°.

At 183° the first lobe of the carry cam will return the engaging cam arm to its original position, where it may be latched by the start-magnet armature. Notice as the clutch engaging cam arm is brought clear of the counter that an adding-wheel detent, which is mounted on the same pivot point, moves into the detent teeth of the counter wheel and holds or locks the counter wheel in the new position. The adding-wheel detent locks the counter in position and prevents it from moving or allowing the clutch teeth overlap to vary between adding operations (Figure 65).

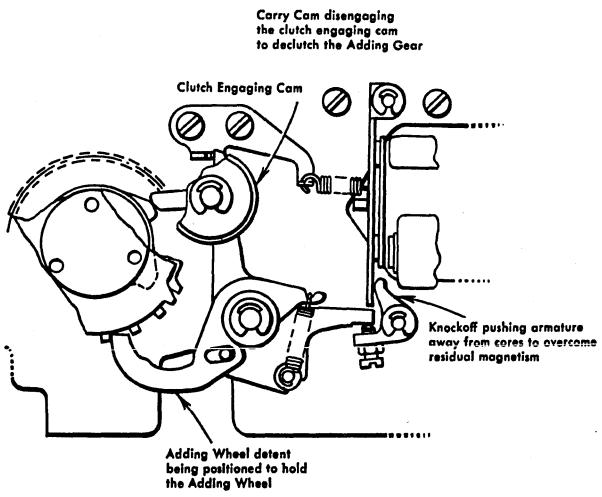


Figure 65. Counter Adding Wheel Detent

If a 5 is punched in the card and is to be accumulated, the brush will make contact through the hole in the card, and the circuit breakers will supply an impulse at 81°. The adding wheel starts to turn 12° later, or at 93°. Because the adding wheel will turn from 93° until 183°, at which time it will be stopped, it moves a total of 90°.

Because each unit requires 18°, this means the counter has added 5 units. Figure 66 shows the movement of the counter when adding 9 through 0.

Carrying

When the following amounts are added, a carry from the units to tens position results.

$$\begin{array}{r} 4 \\ 8 \\ \hline 12 \end{array}$$

The 4 in the first card causes the counter wheel to move from 0 to 4. As the 8 in the second card is read by the reading brush, it will energize the start magnet, and the counter will move from 4 past 0 to 2 on the other half of the counter, or its equivalent to 12. This results in a 1 that must be carried to the tens position; this is accomplished by electrical circuits. At present it is the mechanical recognition of this 1 that is important.

Figure 67 shows the top counter, the 9-10 contact cam, the 9-10 contact operating arm, and its latch. Observe the direction in which the top counter turns; it is evident that if an 8 impulse is completed to the start magnet of the counter with the 4 standing in it, the counter will begin to turn 12° later. Keeping in mind that an 8 is to be added to what already stands in the counter, it may be seen, by counting, that the 9-10 contact operating arm will move into the low dwell at the 9 position, then up over the high point as it passes by 0 on its way to 2. At the time the 9-10 contact operating arm is passing over the high point, the 9-10 contact latch will latch the 9-10 contact operating arm in a position where the 9-10 brush will make contact with the 10 contact (Figure 67).

The carry operation is completed by means of electrical circuits, which will not be discussed here, but a study of the mechanical timing chart on Figure 68 will be valuable.

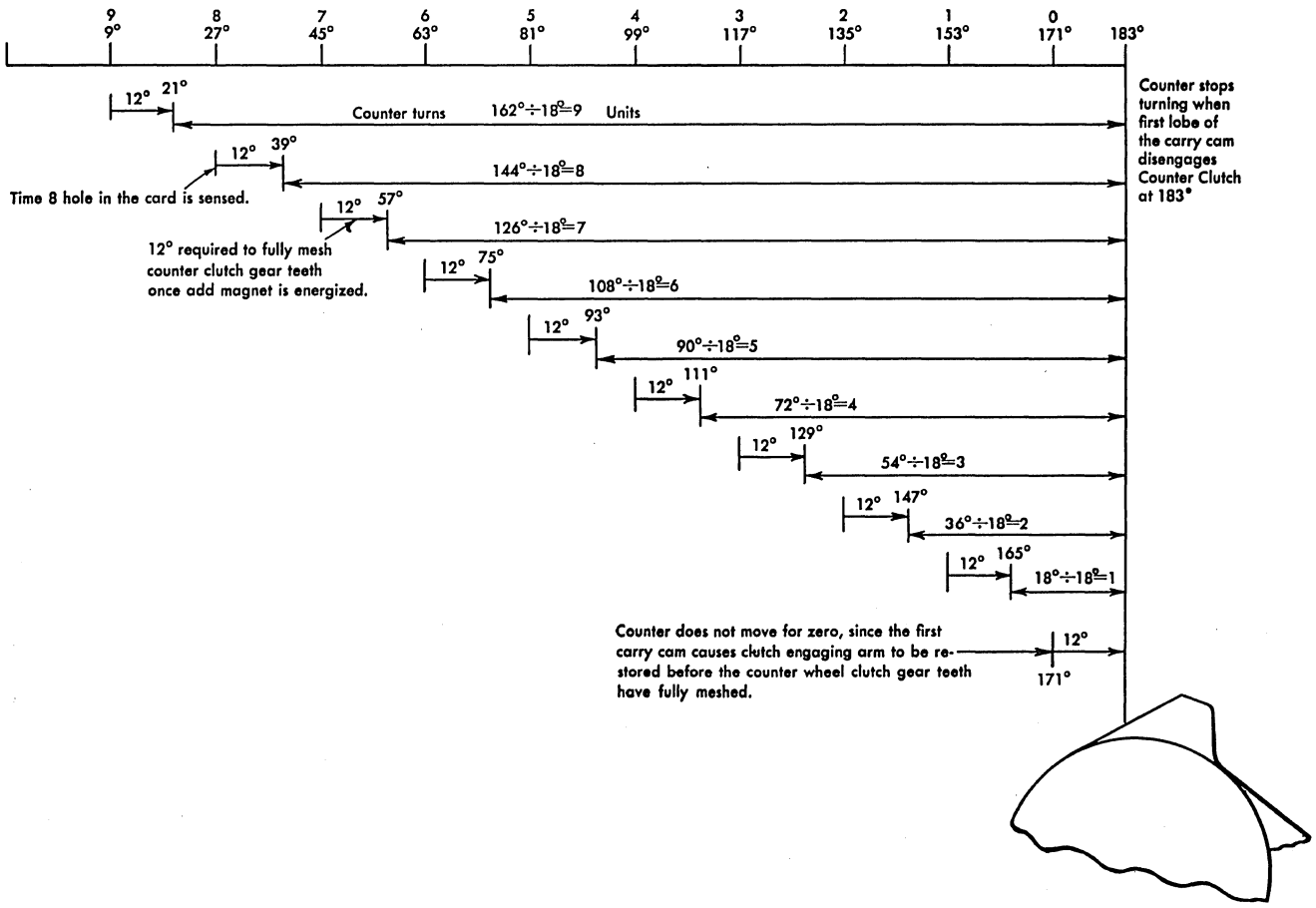


Figure 66. Counter Movement when Adding

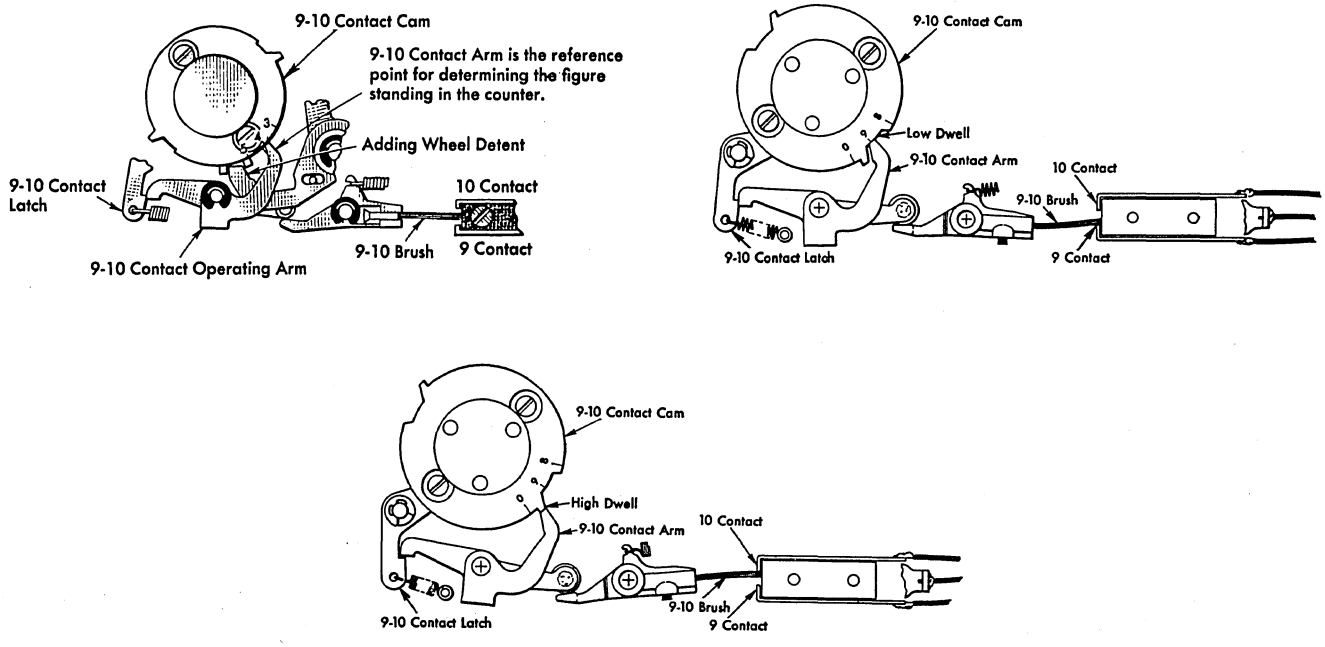


Figure 67. Counter Movement when Carrying

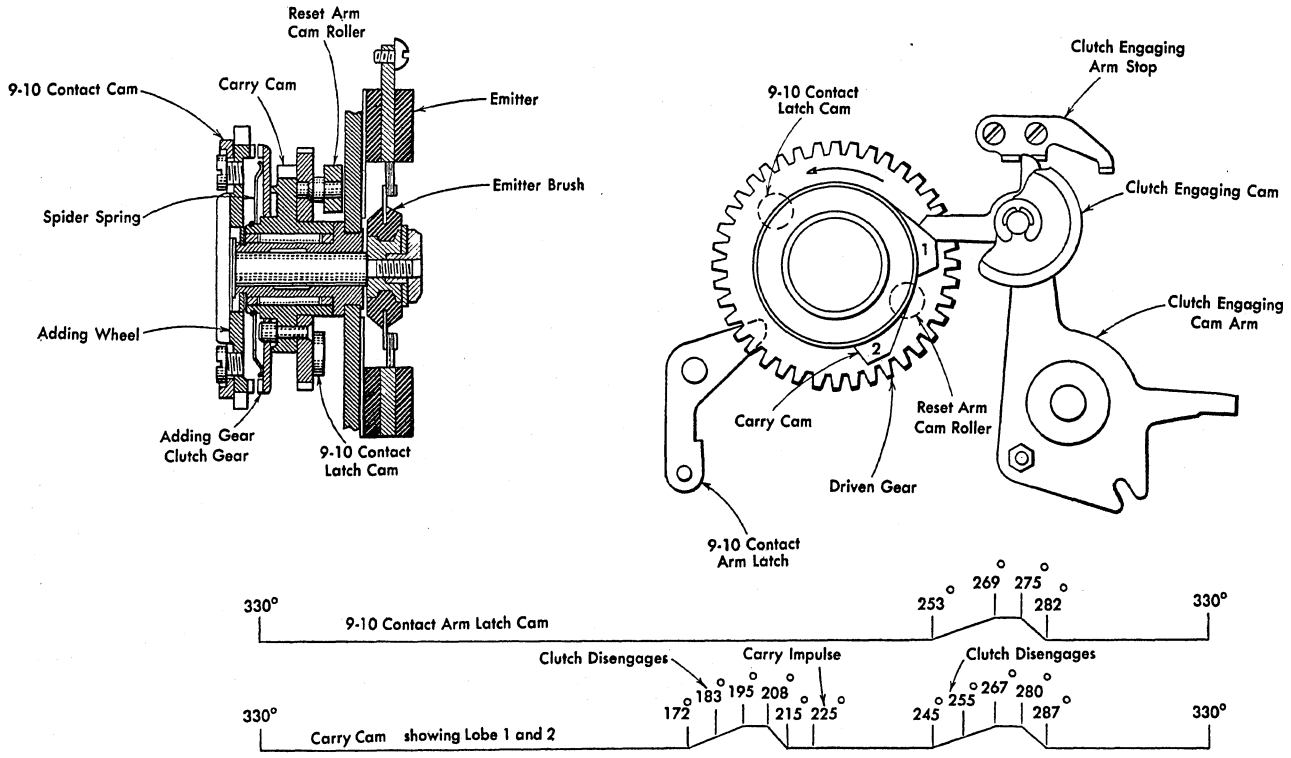


Figure 68. Mechanical Timing of Carry Cams

Through circuits the carry impulse will be established by the 9-10 brush and CB's 1, 2, 3, 4, and 10. There are two points that should be studied at this time. First, the electrical timing chart will show that CB10 makes at 219° and, in conjunction with CB's 1, 2, 3, and 4, completes an impulse at 225°. This provides the carry impulse.

The carry impulse is completed at 225° to the start magnet in the tens position, and 12° later the adding-wheel clutch teeth will be in full mesh so that the counter wheel will start turning at 237°. The counter will turn 18°, or one unit, and will be declutched at 225° by the second lobe of the carry cam. The second lobe of the carry cam performs the same function during a carry operation as the first lobe performs during a normal add operation (Figures 68 and 69).

The 9-10 contact of the units position, for the example given, will be unlatched at some point between 253° and 259° by the 9-10 contact latch cam.

The use of the 9 side of the 9-10 contact cam is illustrated in the following example:

54	
48	
92	Stop at 183° by first lobe of carry cam
11	Carry impulse at 225°
102	Stop at 255°

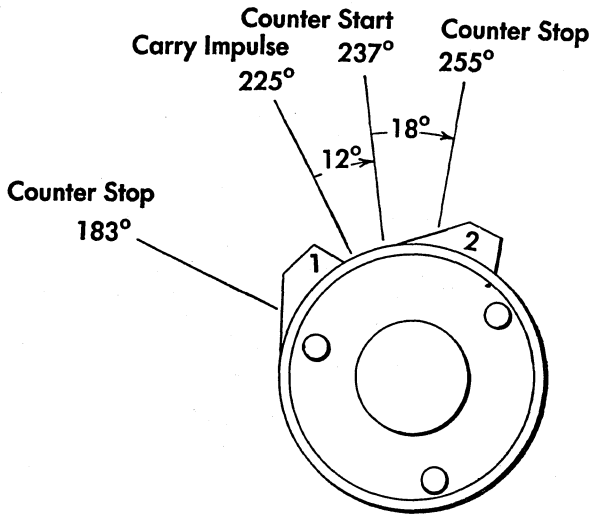


Figure 69. Carry Cam

In the preceding example a carry from the first position into the second is apparent. Because the second position has already accumulated a nine, it will pass from nine to zero, thus creating the necessity of a carry into the third position. All counters that are to add one because of a carry must start and stop at the same time, it is not possible to wait for the sec-

ond position to advance from nine to zero before the third position is started. When a counter has a nine value standing in it, the 9-10 brush will be making contact with the 9 side. Circuits are provided so that when a counter is standing at nine and it receives a carry impulse into it, parallel circuits are possible to the start magnets of that position and the next higher position, such that they both receive the same carry impulse.

Subtraction

The following is an example of manually subtracting one number from another:

$$\begin{array}{r} 46983 \\ -21692 \\ \hline 25291 \end{array}$$

Theoretically, there are two methods of performing this operation in a counter. One is to reverse the direction in which the counter wheel turns or, in another sense, turn the counter wheel back. The second is to add a figure that will roll or turn the counter in the same direction as when adding to the correct position.

It will be remembered that the continuously running shaft will turn in only one direction, and also that the adding-wheel clutch gear teeth are so cut that the adding wheel may be turned in only one direction. For this reason, the direction in which the counter turns cannot be reversed and the process of subtracting by adding figures must be used.

The number that is added is known as the complement of the number to be subtracted. In order to determine the complement of any number, subtract that number from a figure made up of as many nines as there are positions in the counter group to be used. For example, to determine the complement of 21,692 when using an 8-position counter group, subtract 21,692 from 99,999,999 as follows:

$$\begin{array}{r} 99{,}999{,}999 \\ -21{,}692 \\ \hline 99{,}978{,}307 \end{array}$$

If 21,692 is to be subtracted from 46,983, we would add the complement of 21,692. Thus:

$$\begin{array}{r} 46{,}983 \\ +99{,}978{,}307 \\ \hline 100{,}025{,}290 \end{array}$$

From the preceding example it is apparent that the units position is one low. Further study will also show that an extra one, which resulted from a carry, has appeared in the ninth position. Since an 8-position counter group is being used, this one would normally be lost; however, through control panel wiring, it is possible to make use of this one by adding it to the units position of the group, thereby correcting the results. Thus:

$$\begin{array}{r} 46{,}983 \\ +99{,}978{,}307 \\ \hline 100{,}025{,}290 \\ \llcorner\!\longrightarrow 1 \\ \hline 25{,}291 \end{array}$$

In subtracting, the electrical circuits provide a fixed impulse to all counter start magnets to start the counter add wheels turning as the card starts under the brushes. At the time the reading brush senses the hole in the card, other circuits are established to pass the impulse to the stop magnets. This stops the counter wheel. The sole purpose of the stop magnet, stop-magnet armature, and reset arm is to stop the adding wheel.

A careful study of the counter stop magnet and reset arm will show that when the reset arm is released, the reset arm and stud strike on the clutch engaging cam arm and cause it to declutch the adding wheel. This allows the counter wheel detent to move in and hold the wheel at this time (Figure 70).

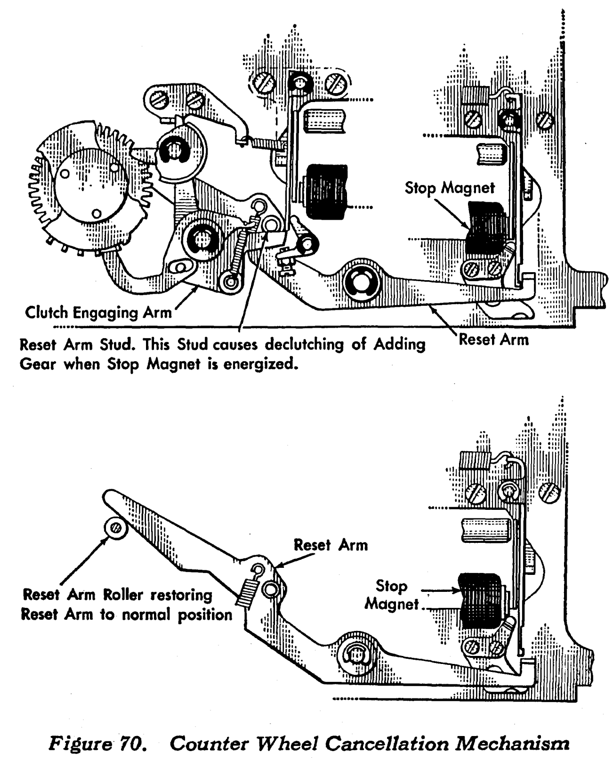


Figure 70. Counter Wheel Cancellation Mechanism

All start magnets will receive an impulse at 9°. The counter wheel will start to turn 12° later, or at 21°. If the tens position of the field in the card is punched with a 5, the hole will be sensed by the lower brush at 81°. This impulse will be passed to the stop magnet and 12° later, or at 93°, the counter wheel will stop turning. Thus, the counter has moved from 21° to 93°, or a total of 72°. Because each unit requires 18°, this means that the counter has turned 4 units, and 4 is the correct complement of 5 (Figure 71).

If the amount subtracted from a counter group is greater than the amount added, the results will appear as a complement figure. Using a six-position counter group:

Manual	*Machine*	
+8854	+ 8854	
−9768	+99 0231	
− 914	99 9085	9's complement of 914

Or if the amount subtracted is equal to the amount added:

Manual	*Machine*	
+8854	8 854	
−8854	991 145	
0000	999,999	9's complement of 000,000

If the results of the above examples were printed on a report, two problems would exist. How is the complement total recognized? How much is the true total? To recognize a complement total, there must be a sufficient number of counter positions in the counter group used to insure that the total accumulated will never carry into the high-order position and cause that counter to stand at any figure other than a zero or a nine. A zero in the high-order position of the group will designate a true total, and a nine will designate a complement total. To arrive at a true total, each digit in the complement total should be subtracted from a nine.

	999999	
Machine accumulated	999085	
	−914	True total

Total

Two functions are foremost during a total cycle: printing the total and resetting the counter to zero. In order to print a total, a timed impulse is necessary; and to reset a counter to zero, the counter must be started and then stopped when it reaches zero. Total printing and resetting the counters to zero is done in one operation.

By means of circuits on total cycles, the counter wheel start magnets are all impulsed at the same time, 351°, and the wheels start to turn 12° later or at 3°.

The 9-10 contact operating arm senses when the counter wheel is moving from its low dwell at 9 up over the high point to zero. At the time the 9-10 brush touches the 10's side, an impulse will be completed to the stop magnet to stop the counter, and at the same time, the impulse may be passed by control panel wire to the print magnet and stop the type bar at the corresponding number (Figure 72).

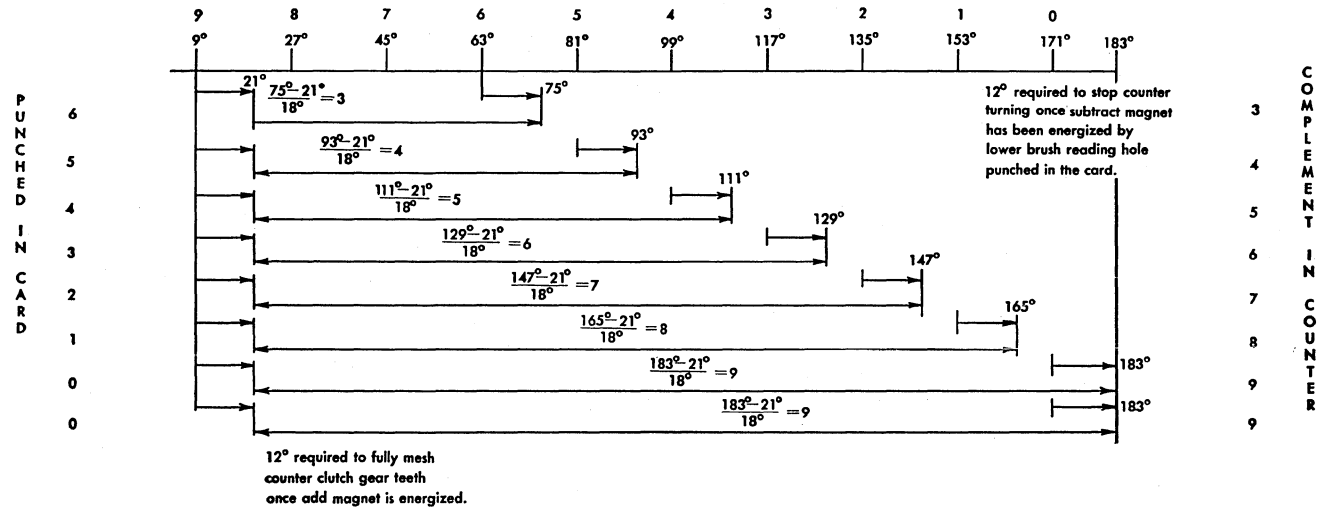


Figure 71. Counter Movement when Subtracting

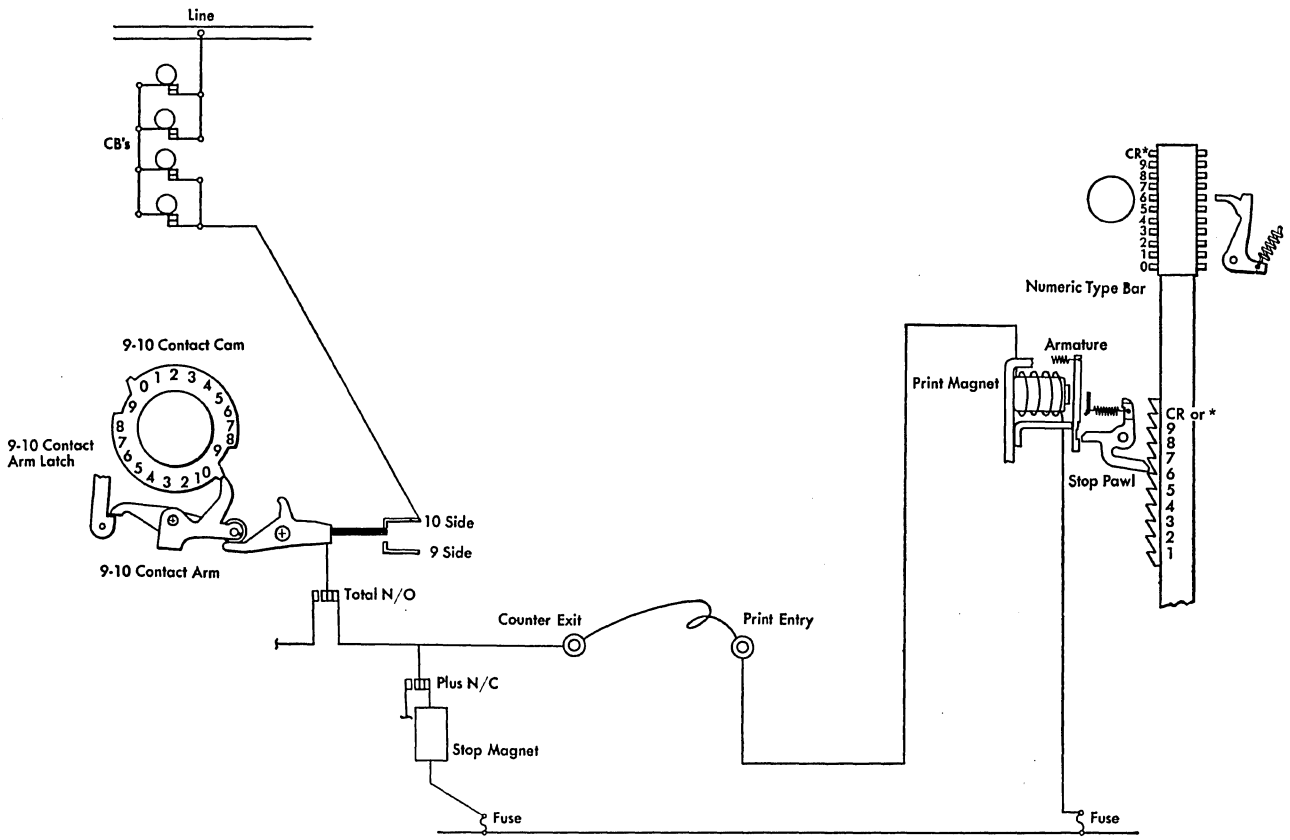


Figure 72. Schematic of Counter Total Circuit

The impulses to the stop magnet and the print magnet are established by CB's and are completed at the regular time.

CHARACTER IN TYPE BAR	CB TIME
*	351°
9	9°
8	27°
7	45°
6	63°
5	81°
4	99°
3	117°
2	135°
1	153°
0	171°

A study of Figure 73 will show that both the counter wheel and type bar start to operate at about the same time and that both assemblies will move in relation to each other.

Note that the lower the number accumulated in the counter, the longer the time required before the 9-10 brush closes on the 10 side. Also, the lower the number to be printed, the higher the type bar must rise.

With a 4 standing in the counter adding wheel, the 9-10 contact will close on the ten side at 98°. Check this, using a counter with the counter index gage, and note the time at which the 10 side of the 9-10 contact will close for different figures standing in the counter.

The circuit breakers complete an impulse at 99° for a 4. This impulse will energize the stop magnet, stopping the counter at zero, and will also energize the print magnet to stop the type bar in position to print a 4.

The start magnet received an impulse at 351°, and the adding wheel started turning at 3°. The stop magnet, receiving an impulse at 99°, will stop the adding wheel at 111°, as the adding wheel always stops at a position equivalent to 12° after the impulse to the stop magnet. The counter moves 108° or 6 cycle points; therefore, the counter must have stopped at zero. Complete Table III.

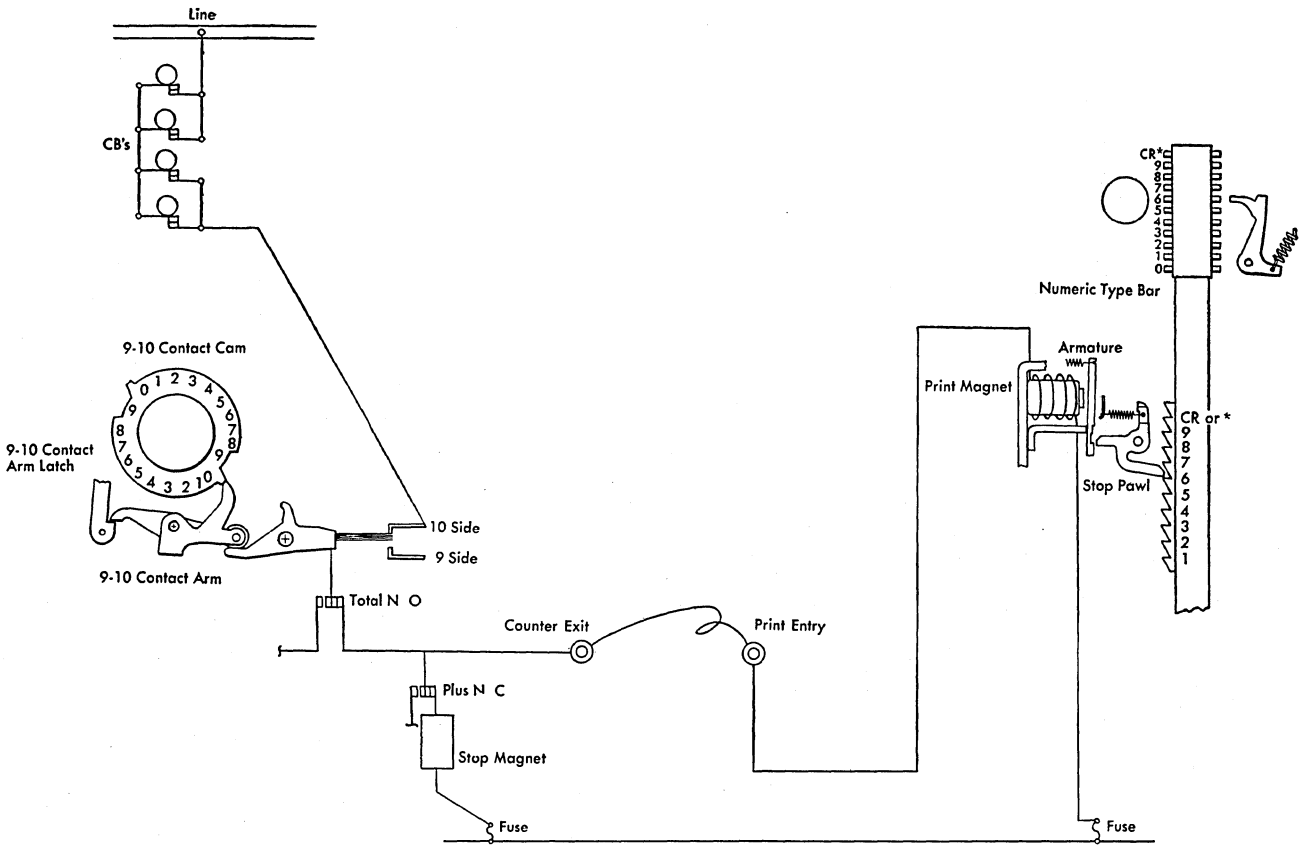


Figure 73. Counter Operation — Reset Cycle

TABLE III

Figure in Counter	Add Magnet Energized (Degrees)	Add Wheel Starts to Turn (Degrees)	9-10 Contact Closes on 10 Side (Degrees)	Impulse to Print Magnet and Stop Magnet (Degrees)	Type Bar Stops at	Add Wheel Stops at (Degrees)	Add Wheel Has Turned (Cycle Points)	Add Wheel Resets at
9	351	3	8	9	9	21	1	0
8								
7	351	3	44	45	7	57	3	0
6								
5								
4	351	3	98	99	4	111	6	0
3								
2								
1								
0								

COMPLEMENT AND TRUE FIGURES

WHEN subtract operations are performed, it is quite possible that a complement total may be accumulated. If 914 is subtracted into a 6-position counter group, the counter would accumulate 999,085. If this complement figure is total printed, the person using these figures might be misled, because they may not be accustomed to complement counter operation. Therefore, it is desirable to have some method whereby the machine could translate complement figures to true figures. This may be accomplished in two ways: net balance and double balance.

Each counter position converted is controlled through its own counter emitter (top counter).

All conversion cycles precede total printing and summary punching.

The following list of figures shows (1) amount to be subtracted, (2) the complement figure in the counter, (3) the amount added to the complement, (4) the figure that will be printed after conversion.

AMOUNT TO BE SUBTRACTED	COMPLEMENT IN COUNTER	AMOUNT ADDED (CARRYING SUPPRESSED)	FIGURE PRINTED AFTER CONVERSION
0	9	1	0
1	8	3	1
2	7	5	2
3	6	7	3
4	5	9	4
5	4	1	5
6	3	3	6
7	2	5	7
8	1	7	8
9	0	9	9

The CR symbol printed after the converted total is controlled by circuits provided when a conversion cycle occurs. It identifies the total as a negative quantity.

NET BALANCE

Principle of Converting Complement Totals to True Figures

It will be remembered that a nine standing in the highest-order position of a counter group designates a complement total. By recognizing the nine, control circuits will be established to allow conversion to take place.

The principle of converting a complement total to a true figure, before printing takes place, is the adding of a digit to each complement digit such that the sum of the two will produce the true figure. By suppressing all counter 9 and 10 carrying during the conversion cycle, the operation is made quite simple. To convert the complement total 999,085:

```
     999,085
add  111,939
     -------
     914 CR
```

DOUBLE BALANCE

Two counter groups are required to perform this type of balance printing. One counter group is referred to as the plus (or debit) counter, and the other counter is referred to as the minus (or credit) counter group.

Assume a group of cards as follows:

No X	3478
X	1647

These cards would be accumulated in the two counter groups as shown below:

```
Debit Counter 8A          Credit Counter 8B
+             3 4 7 8     - 9 9 9 9 6 5 2 1
-   9 9 9 9 8 3 5 2       +         1 6 4 7
-------------------       -----------------
  1 0 0 0 0 1 8 3 0         9 9 9 9 8 1 6 8
  |____________→1
-------------------
          1 8 3 1
```

Note that the plus cards (no X) are added into the debit counter 8A and are subtracted from the credit counter 8B. The minus cards (X) are subtracted in the debit counter 8A and added in the credit counter 8B.

Assume a different group of cards as follows:

No X	2965
X	3460

These cards would be accumulated in the counter groups as follows:

```
Debit Counter 8A          Credit Counter 8B
+           2 9 6 5       - 9 9 9 9 7 0 3 4
- 9 9 9 9 6 5 3 9         +         3 4 6 0
-----------------         -----------------
  9 9 9 9 9 5 0 4         1 0 0 0 0 0 4 9 4
                          |______________→1
                          -----------------
                                      4 9 5
```

One counter will always show the complement and one counter the true figure. Therefore, the problem becomes one of selecting the correct counter from which to print the total. The presence of a nine in the high-order position of one of the counter groups will prevent that counter group from printing, and the counter group that contains the true figure will print. In the first example, because a nine appears in the high-order position of counter group 8B, counter group 8A will print 1 8 3 1. In the record example counter group 8A contains the nine; therefore, counter group 8B will print 4 9 5 CR. Because counter group 8B accumulates credit totals, the CR symbol identifies the total as a negative figure.

LUBRICATION

Bijur System

The Bijur system of lubrication consists of a pump that forces oil under pressure through a system of tubing to metering fittings called meter-units, located at or near the bearing. The pump measures the total quantity of oil fed to the system, and the meter unit proportions this quantity according to the requirements of each bearing.

The lubricator pump is a spring-operated piston pump, with the piston being lifted by cam action. Raising the piston compresses the coil spring and draws oil through the hollow piston and check valve into the pump cylinder. The piston fit in the cylinder is sealed with a leather cup. When the cam releases the piston, the spring forces the piston down, closes the intake check valve, and feeds oil through a felt filter and oil tubes to the bearings. No attempt should be made to get more rapid delivery of oil by forcing the piston down, as this may result in damage to the pump.

The lubricator is provided with a piston-stroke adjustment, which permits changing the volume of oil delivered by each operation.

Two lubricators are used on the Types 402, 403, and 419 machines. The left lubricator (Figure 74), located at the rear of the card-feed unit, is attached to the left print-unit side frame. It lubricates the units that

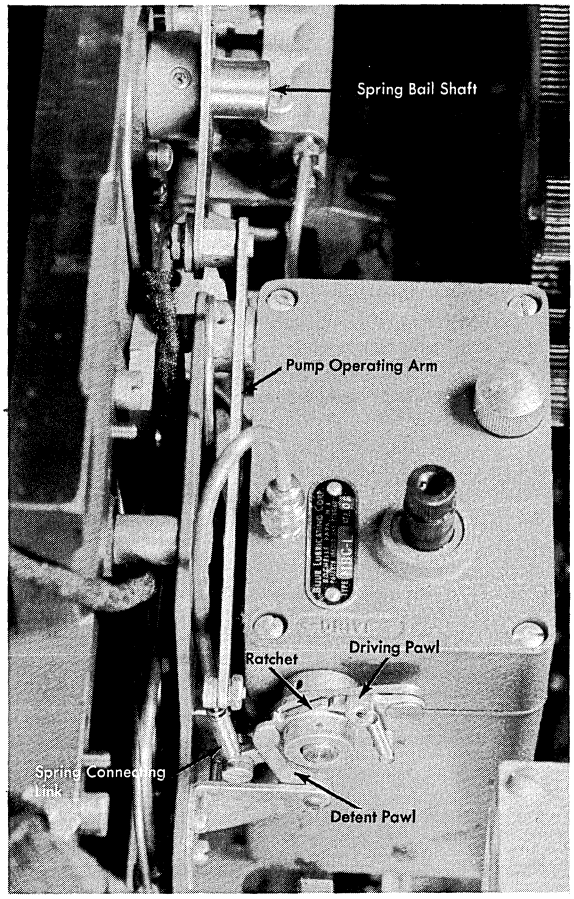


Figure 74. Print Mechanism Bijur

operate under control of the print-mechanism clutch. Each time the numeric type bar spring bail shaft operates, a pawl and ratchet mechanism advances one tooth, which in turn drives the lubricator. The right lubricator (Figure 75), located on the right side of the print unit, is driven directly from the vertical drive shaft. It lubricates the card-feed unit as well as the continuously running units.

Meter-units are made in several types and flow rates. The letters stamped on the side of the unit, such as FSA, FTA and others, are the manufacturer's style indication. The numerals such as 00, 0, 1, 2, 3, 4, or 5 indicate the flow rate of the metering unit. The larger the figure, the greater the flow (Figure 76).

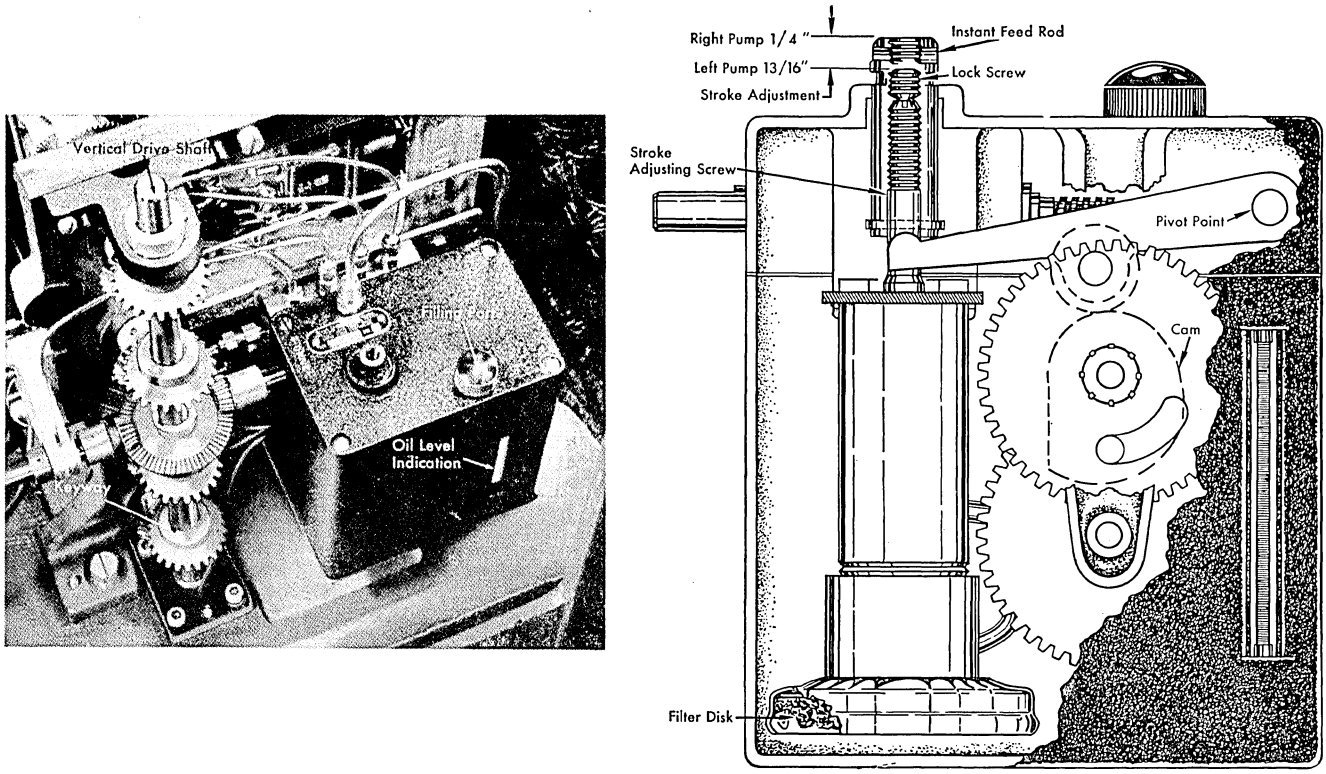
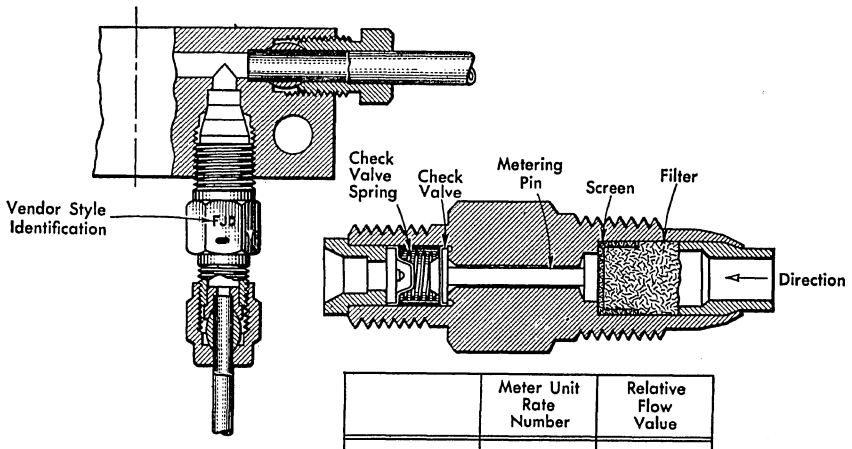


Figure 75. Bijur Pump



Courtesy Bijur Lubrication Corporation

	Meter Unit Rate Number	Relative Flow Value
Extra Low Rate	00	3
Most Commonly Used Rate	0	5
	1	10
	2	20
	3	40
	4	80
Extra High Rate	5	160

Figure 76. Bijur Metering Valve

POWER SUPPLY

Main Line Switch

The main-line switch for the Types 402, 403, and 419 Accounting Machines is located in the front cover at the right below the reading board.

The main line switch is not equipped with a thermal unit as the starting load is rather high. However, there are fusetrons in the motor circuit which will accept momentary over-loads and provide more positive protection for the machine.

Occasionally when analyzing certain types of machine operation it is desirable to crank the machine by hand with the main line switch ON so that the generator will be running. To prevent the machine from starting a power cycle unexpectedly, the practice has been in the past to remove the belts to the drive pulleys or turn the gang punch switch ON, thus preventing the two-speed clutch from operating. When working on machines equipped with selenium rectifiers, it is recommended that the two fuses in the motor circuit be removed as an improved safety precaution.

Thermal Fuses (Fusetrons)

For some types of loads, fuses do not provide satisfactory overload protection for the equipment. An example of this is motors. A ¼ horsepower motor which has a full load running current of about 5 amperes may require as much as 20 amperes starting current. A fuse rating of at least 15 amperes is required for starting. A 15 ampere fuse, however, would permit the motor to be seriously overloaded continuously without approaching the point where the fuse link melts. For protecting motors, then, some type of thermal fuse is desirable. This fuse will accommodate large overloads for short durations, but will blow at a small overload when subjected to it for a longer period. The construction of a thermal fuse is illustrated by Figure 77.

In case of a direct short circuit, the fuse link blows as in a common fuse and, when subjected to a steady overload, the heater unit gradually heats the soldered junction until the spring pulls loose the fuse link, thus opening the circuit.

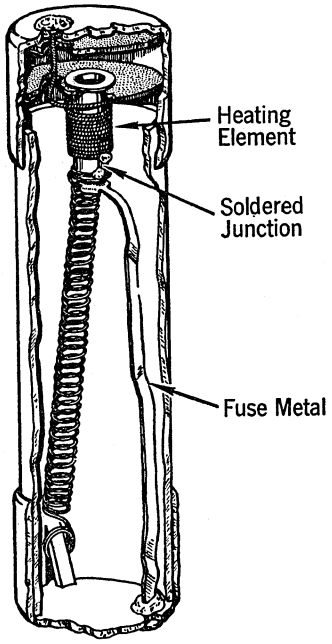


Figure 77. Thermal Fuse

Signal Fuse

The Types 402, 403 and 419 Accounting Machines are equipped with fuse panels using 5 ampere signal fuses. Built into the non-transparent signal fuse cartridge is a small brass plunger held under tension of a compression spring by the 5 ampere fuse wire. When a fuse wire breaks, the compression spring forces the plunger into contact with a bus bar mounted along each row of fuses (Figure 78).

The contact between any released plunger and a bus bar will provide a pickup for the signal fuse

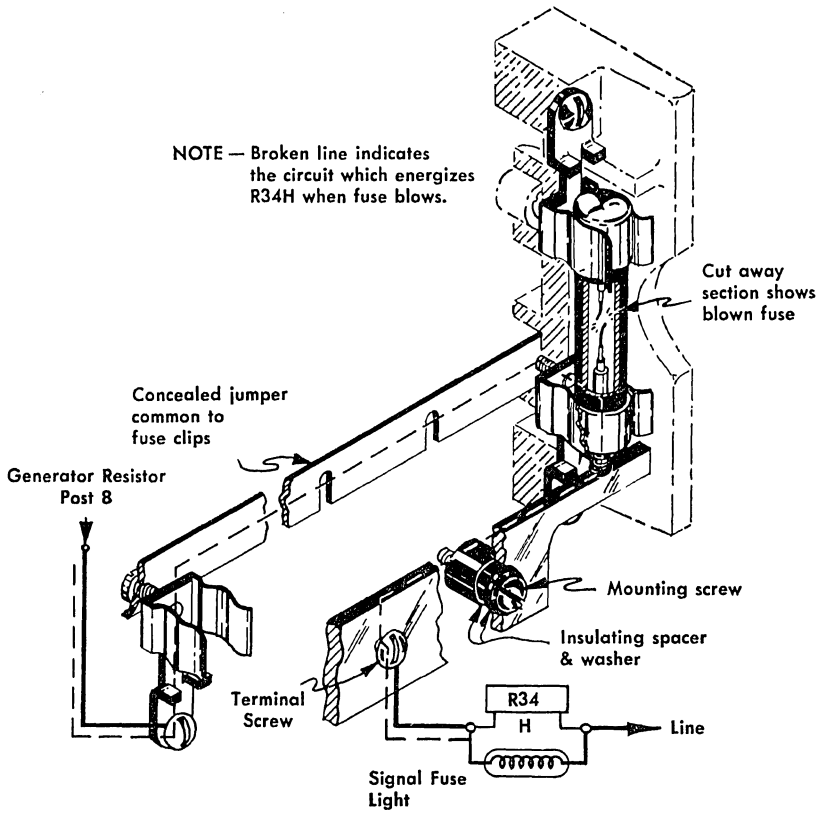


Figure 78. Signal Fuse

relay, whose points open the machine running circuit until the blown fuse is replaced. It is important that the signal fuse be inserted in its clip with the plunger end toward the bus; the customer also should be instructed in the correct use of this type of fuse.

NOTE: *Extreme caution should be used when turning the machine over by hand with power on. The machine should not be stopped with CRCB 1, 2, 3, 4 closed as the heavy current supplied through these points will cause the power supply fuse to blow and may possibly damage relay and magnet coils. The size fuses used in the power packs must not be changed without prior approval from the Customer Engineering Department at Endicott.*

A chart in section 1B of Diagram 210201R lists the correct value and type for all power-supply fuses. Care should be used in selecting the correct input supply voltage when any of these fuses are replaced.

Generator DC

The generator on the Type 402, 403, or 419 is bolted to the underside of the upper base. The output of the generator is rated at 15 amperes and is set for 46 volts, no load. There are two makes of generators now in use: The Westinghouse and the Holtzer-Cabot. To insure good commutations, two sets of generator brushes are used in both models.

Where power is supplied by the generator, it is dependent upon its own speed, which should be about 2225 rpm, and is controlled by the adjustable pulley mounted on the motor armature shaft. The correct list speed, established by means of the adjustable motor pulley, results in approximately the correct generator speed.

The output of the generator may be changed by moving the sliding portion of the variable resistor in the shunt field. When the machine voltage on machines equipped with generators is checked, it is important that the machine be allowed to run at least 15 minutes before a voltage reading is taken. This check must never be made until at least 15 minutes have passed after the machine is turned on. This time delay is necessary as there may be as much as 3 volts' difference between a *cold* and *hot* generator.

Selenium Rectifier

The selenium rectifier has come into use as a source of power to reduce the current loads required when starting the Types 402, 403, and 419 machines in installations operating from alternating current lines. The selenium rectifier also eliminates a considerable amount of the service time required to maintain a generator in best operating condition. Since the power to drive the generator is not required, the size of the motor is reduced from 1½ to ¾ horsepower.

The selenium rectifier is an assembly usually made of a series of plates mounted on a rod in series or parallel combinations. Each plate of the selenium rectifier consists of a coating of selenium on a metal plate usually of iron or aluminum. The semi-conducting coating of selenium is placed on the roughened surface of the metal plate and reduced to metallic conducting selenium approximately 0.05 millimeters thick. The selenium is then covered with a metal layer which constitutes the front or contact electrode. The application of this outer metal layer creates a barrier layer between the surface of the selenium and the contacting metallic layer. When a difference of potential is applied to the unit, electrons move readily from the contact electrode to the selenium, but a high resistance is offered to their movement from the selenium to the contacting layer. When such a device is connected in an AC circuit, it permits current to flow in one direction even though the AC voltage reverses each half cycle.

The selenium rectifier used in the Types 402, 403, and 419 is divided into two sections. The 7.5 ampere section furnishes power to the reading brushes and counters which are operated through CRCB1-2-3-4. Notice that CRCB1-2-3-4 have been disconnected from line 25. The 15 ampere section furnishes power for all remaining relays and operating circuits.

Rectifier Power Supply

Across the output of each section of the rectifier is a filter network. The 7.5-ampere section has two 100-ohm resistors in series and four 8000-microfarad condensers in parallel. The 15-ampere section has two 100-ohm resistors in parallel and two 8000-microfarad condensers in parallel. The importance of these condenser-resistor combinations should not be overlooked. Under certain conditions the 7.5-ampere section is called upon to supply in excess of 30 amperes for short periods of time, and its two filter condensers supply much of this peak load. If one of these condensers fails to function, the supply voltage to CB1, 2, 3, and 4 will drop to a point that can cause intermittent reading and counter failures.

On installation, or if the machine is moved to a new location, the output of the rectifier assembly should be checked in accordance with EAM CEM 1104. During normal preventive maintenance inspection, the condensers, resistors, and wire connectors should be checked for looseness and burning.

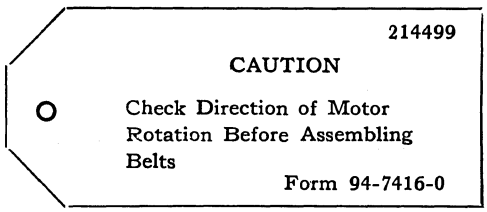
All rectifiers are expected to outlast the life of the machine; however, a burned rectifier is not unusual.

Cranking a machine under power is not recommended, because rectifiers in EAM equipment under continuous load will first, overheat; second, arc; and finally, burn. Under normal operation this is not a problem. There is a good safety factor under normal use.

When selenium rectifiers burn because of excess load or flashover, the toxic fumes of selenium dioxide are emitted. These fumes have a repulsive odor. Where there is sufficient concentration in the air to be dangerous, the condition should be remedied.

Once a selenium rectifier has burned out, it will have to be replaced. Individual burned discs of a rectifier cannot be replaced. Replace the entire unit. The charred selenium can cause burns or infection; so, the person making the replacement should be careful not to let any of the charred selenium get into a scratch or cut. Take care not to get any into the mouth by smoking or eating before washing.

Machines operating on other than single phase power supply have the two-speed clutch belts removed and a tag attached. A second caution tag is attached at a point near the start key indicating as follows:



Phase Sequence Relay

The wiring diagram, Section 2B, shows that machines operating from three-phase alternating current lines have a phase sequence relay assembly in the circuit. In some customers' installations, the wall

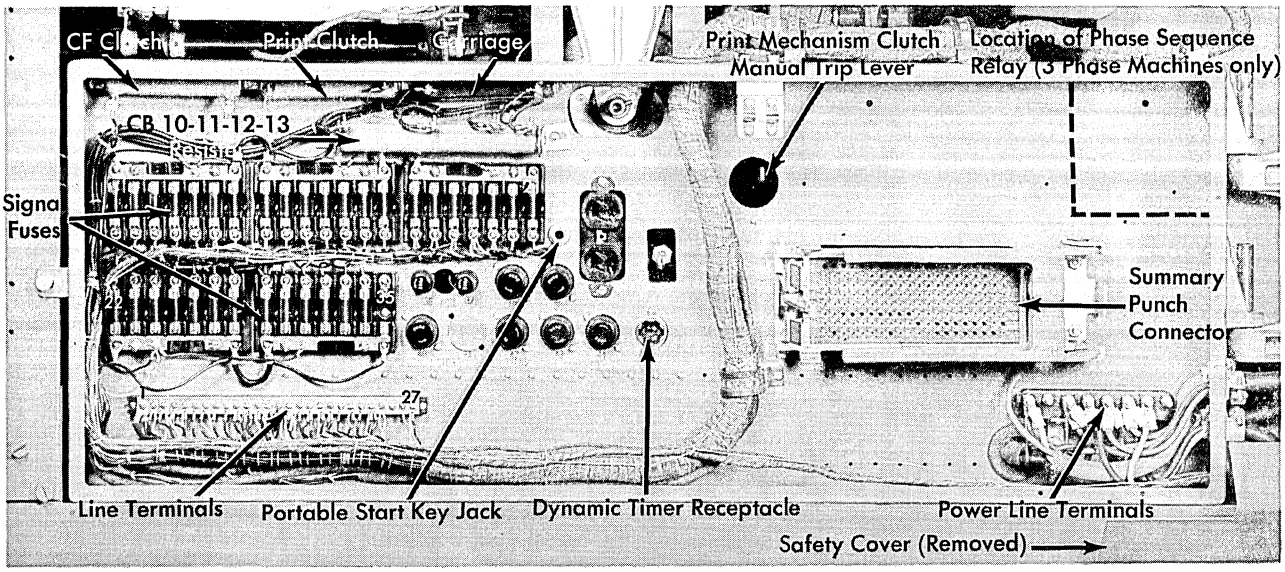


Figure 79. Fuse Panel Gate AC

outlets are double receptacles which are wired internally so that if the operator moves the main line cord for the machine from one receptacle to the other, or the machine is moved to another location in the same room, the direction of motor rotation will be reversed. The circuit from line 3 to the high and low speed clutch control magnets may only be completed when the direction of motor rotation is correct so that the phase sequence relay may be energized.

The phase sequence relay for a 230-volt, 50- and 60-cycle power supply is designed to energize at or above 180 volts and to drop from the sealed position when the voltage is 110 volts or less. The phase sequence relay for 115 volts, 50 and 60 cycles, is designed to energize at or above 90 volts and to drop from the sealed position when the voltage is 65 volts or less.

The capacitance resistance circuit for the pick of the relay is balanced and in phase with the correct direction of motor rotation. When the voltage at the main line cord receptacle is 225 volts, the voltage drop in the circuit through the phase sequence relay at this time will be 225 volts. When the operator causes the two leads to be reversed and the direction of motor rotation changes, the capacitance resistance circuit as originally established for the pick of the relay will also be out of balance. A reading of the voltage drop in the circuit at this time to pick the phase sequence relay will be 57 volts which is insufficient and the relay will not energize. Under these conditions, the circuit to the high and low speed clutch control magnets can not be completed, thereby eliminating the chance that the machine would try to run backwards. The location of this relay is shown in Figure 79.

MACHINE SPECIFICATION	SOURCE VOLTAGE	RELAY SEALED VOLTAGE	RELAY DROP VOLTAGE
208/230 60 cycle	260	269 volts	71 volts
	190	198 volts	—
208/230 50 cycle	260	225 volts	60 volts
	190	171 volts	—
115 60 cycle	130	120 volts	42 volts
	100	98 volts	32 volts

WARNING: If there is any uncertainty as to the direction of motor rotation, remove the two-speed clutch drive belts before operating the phase sequence relay manually or checking the assembly with a test light. Also remove the belts if wires are to be removed from the phase sequence relay assembly for test; rewire and check the direction of motor rotation and the energization of the phase sequence relay before replacing the belts.

If the direction of motor rotation is not correct, reverse the two main line cord leads at posts 1 and 3 of the control panel terminal below the summary punch connector on the fuse panel door.

WIRING DIAGRAM 210201R

THE WIRING diagram for the machine is drawn showing all contacts as they would be with the power turned off, all clutches in their latched position and no cards in the machine.

This diagram will be used for Types 402, 403, and 419 machines. The solid $\frac{1}{32}''$ lines indicate circuits which apply to both the Type 402 and Type 403. The $\frac{1}{16}''$ lines are for multiple line printing circuits which apply to Type 403 machines only. The long and short dash used in circuits identifies wires which apply to Types 402 and 419 machines only. The $\frac{1}{32}''$ short dash lines identify increased capacity of standard features on Types 402, 403, and 419 machines while the $\frac{1}{16}''$ short dash lines indicate increase capacity of optional or special features on Type 403 machines. All optional or special features are inclosed in a long and short dash box as indicated in section 66B of the wiring diagram.

It may be seen that all relays pertaining to one circuit are for the most part shown on consecutively-numbered sections of the diagram. As an example, summary punching is in sections 7 and 8 while carriage circuits are shown in sections 9, 10, 11, 12, 13, 14, 15, 16; also the sections are labeled.

In order that a relay coil, relay contact, cam contact, or switch may be located more easily, the wiring diagram is divided into 100 sections horizontally, numbered 1-100, and into 2 sections vertically, *A* and *B*.

Section 1-2	Motor and Generator
Section 3-4	Start Key, Feed Interlock Start Key and Two-Speed Clutch
Section 5-6	Card Feed and Print Clutch Controls
Section 7-8	Summary Punch Control
Section 9-10	Spacing and Carriage Start Relays
Section 11-12	Carriage Tape Brush Read, and Stop Circuits. The common side of all relays in this section are connected to line 9.
Section 13-14	Carriage Interposer, Clutch Magnet, Space Controls
Section 15-16	Carriage Skip to 1-11 Control Relays
Section 17-18	Multiple Line Printing Controls
Section 19-20	PK Clutch Magnets, MLP Relays
Section 21-22	Carriage Head Control Relays
Section 23-24	Single Card, MLP Successive Feed Control, Special Program Hubs
Section 25-26	Setup Change Switches, Hammerlock, Zone Suppression, Alphamerical and Numerical Print Magnets
Section 27-28	Pilot Selectors, Co-Selectors
Section 29-30	Group Control Comparing, Digit Selector, Split Column Control
Section 31-32	Minor, Inter., Major, Immediate and Delay Program Start
Section 33-34	Program Level Relays and Program Couple
Section 35-36	All Cycles, Card Cycles, Program Level. Final Total, First Card Impulses, and Program Stop.
Section 37-38	Plus, Minus Relay, Counter Exit Suppression, Transfer and Summary Punch X Control. Cr Symbol Exit.
Section 39-40	Counter Total and Negative Balance Control
Section 41-42	First, Second, Third Reading Brushes, Card Lever 1-2-3
Section 43-44	Correction, Carry, Total, Hot 9 Impulse Cams
Section 45-46	Counter Group 2A
Section 47-50	Counter Group 4B
Section 51-56	Counter Group 6C
Section 57-64	Counter Group 8D
Section 65-66	Counter, MLP Control Contact Points
Section 67-78	Location Charts
Section 79-82	Sequence Chart—Start Key Circuit
Section 83-86	Sequence Chart—Program Control
Section 87-90	Sequence Chart—MLP 3
Section 91-92	Card Feed Print Mechanism Cam Timing
Section 93-94	Cam Identification
Section 95-96	Continuously Running Circuit Breakers
Section 97-100	Mechanical Timing

It may be seen that the B side of R227 in section 20B is not shown connected to a fuse. Reference to the common fuse connections in section 1 and 2B will show that the fuse for R227 is fuse 30.

The wiring diagram does not show the actual B jumper connections to the next relay. However it must be accepted that R227 is jumpered in between relay 226 and 228 and in searching for a break in the fuse side it must be assumed that this method of wiring holds true.

In section 7 and 8A are a few of the summary punch connections (called interlocks I-20, 3, 4, 5, 6, etc.) which provide a connection between the Types 402, 403, and 419 and any of the summary punches such as the Types 513, 514, 517, 519 or 523.

The corresponding connections on the summary punch wiring diagram are marked with the same number so that the circuits may be followed from one machine to the other.

In section 8B is another symbol labelled *J24-J23* which represents the Jones plug connections located below the rear part of the Type 923 Tape-Controlled Carriage form guide and may be disconnected at the rear of the machine.

To eliminate misunderstanding between a CF circuit breaker and a CF post, it will be seen in section 41A and B that the card feed posts are labelled *6CF, 7CF, 3CF* while the circuit breakers are designated by *CF* with the number of the cam following it.

Use wiring diagram and electrical timing chart 210201R with this text unless otherwise specified.

Fuse Gate (Figures 79-80)

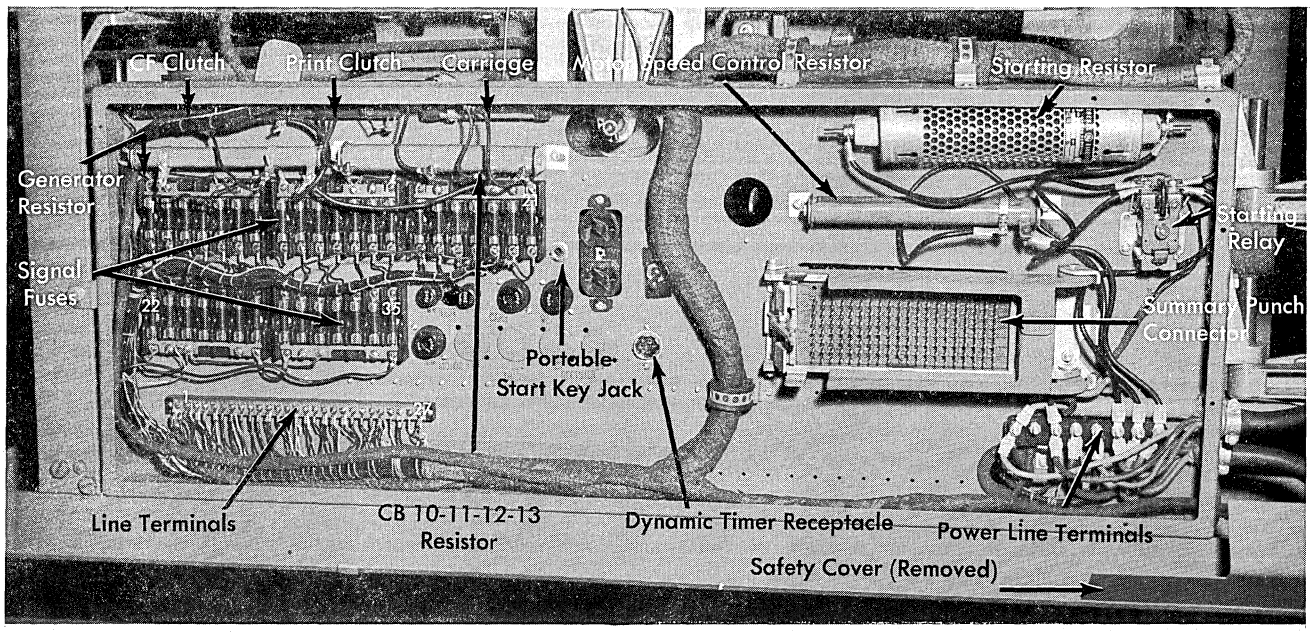
Most of the points in the Types 402-403 are common, such as line connection, fuse blocks, controlling resistors, summary punch connector and dynamic timer plug connection on the front of the gate. On the rear of the gate under a cover are located the various condensers used in the circuits to absorb or reduce the arc at critical circuit breaker points.

RELAYS

Relays (Figures 81 and 82)

The majority of the relays from 1 to 400 are standard duo type relays with the exception of relays 54, 55 and 56 which are duplicates of the slate base relay. Relays 54, 55 and 56 are high-speed relays which open circuits to stop further carriage operation once the paper or form has been advanced either by spacing or skipping to the correct position.

Wire contact relays are normally mounted below the duo relays on each gate. A numbering strip located on the inside lower relay-mounting bracket of each row of relays identifies the correct number for each relay position. The Type 403 includes a right-end relay gate that is not present on the Types 402 and 419. Also located on the right-end gate will be relays associated with special features and devices.



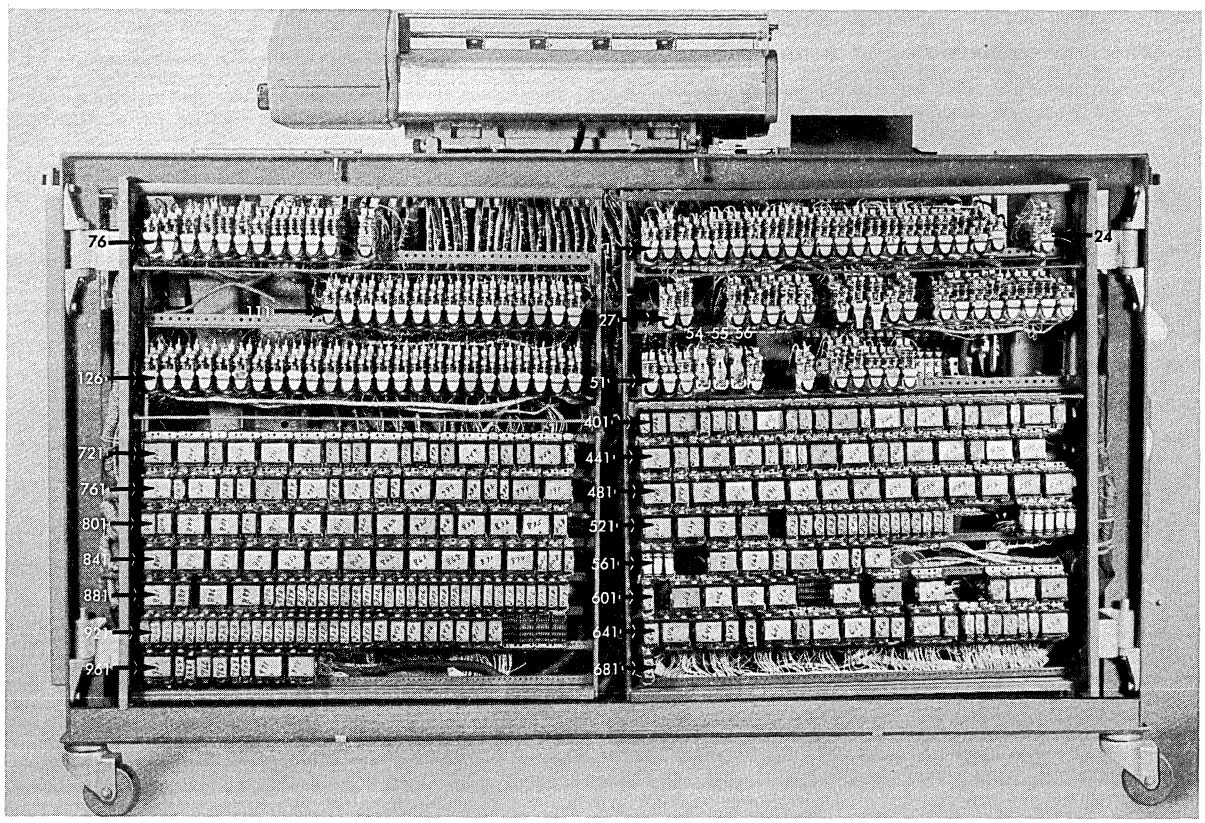


Figure 81. Rear Relay Gates

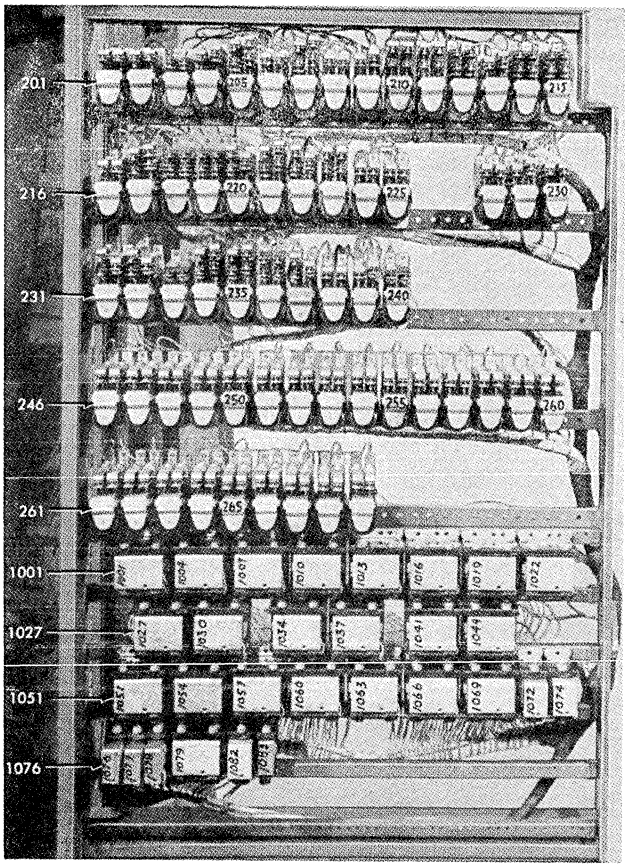


Figure 82. End Relay Gate

ELECTRICAL TIMING CHART

ALL of the circuits discussed should be traced in detail. Frequent references must be made to the timing charts which are used to show the duration of operations in a graphic manner. In the circuit outlines the emphasis will be on objectives of circuit operation.

The electrical timing chart is so arranged that the solid lines indicate the time during which the contact points are closed. The timing is indicated for every contact. In the columns on the right of the timing chart will be found the specifications for the contact involved. For example: CF2 (indicated in the third column by an M) is known as a *make* contact. B indicates that the contact is a *break* contact in sections 93-94 of the wiring diagram.

There is no difference in construction between the make and the break contacts as far as the CF, PM and the CB contacts are concerned. The distinction in the make and break contacts with respect to the CF and CB contact lies in the reference point for their timing. Because of manufacturing methods and vari-

ations in air gap adjustment of these contacts, it would be rather difficult to control accurately both the make and break timings of one contact. Therefore, the timing which is given in any case is the timing which *is the more critical* and which must be kept as accurate as possible. Hence a make contact is one which is timed with reference to the point on the index when the contact closes. A break contact is one which is timed with reference to the point on the index when the contact opens. The next column gives a description of the contact concerning its use in the machine.

The column headed *Time* indicates the time at which the contact should make or break, depending upon the type of contact, M or B, as indicated in the second column.

The column headed *Duration* indicates the number of degrees during which the contact will be closed, as these contacts are closed when the operating arm is on the lower dwell of the cam. Thus, CF2 cam has 36° of low cut, and the contact will make for 36°. This does not apply to PM cams.

The column headed *Contact Air Gap*, gives the correct air gap adjustment for the specific contact when the contact roller is on the high portion of the contact cam. Both timings and air gaps should be set as accurately as possible.

The column headed *Name* gives a descriptive use for the circuit breaker.

The last column headed *Part Number* gives the number when ordering replacement parts.

CONTROLLING MAGNETS

THERE are nine sets of controlling magnets whose location and purpose should be studied.

List and High-Speed Magnets (Section 3B)

These magnets are normally called the two-speed clutch magnets, and one pair of these magnets must be energized in order to transmit mechanical power from the drive motor through the V-belt and clutch disc to the drive housing and the continuously running shaft.

Card Feed Clutch Magnets (Section 6A)

To operate the card feed unit, the card feed clutch magnets must be energized, in addition to the list or high-speed control magnets.

PM Clutch Magnets (Section 6A)

To operate the printing mechanism, the PM clutch magnets must be energized, in addition to the list or high-speed control magnets.

It becomes apparent therefore that one of the two-speed clutch magnets must be energized for any machine operation. The card feed clutch magnets or PM clutch magnets, or both, may also be energized depending upon the operation being performed.

PK Clutch Magnet (Section 20B)

The picker knife clutch magnet is used only on the Type 403 three-station feed. The PK clutch controls the picker knives and the first two sets of feed rolls which turn with the remaining feed rolls in the machine when the card feed clutch magnet is energized. With the picker knife clutch pawl in its latched position, the picker knives and the first two sets of feed rolls do not move, even though the card feed is in operation, until such time as the PK clutch magnet is again energized. The first two sets of feed rolls will allow the first reading brushes to read the 9-8-7-6-5-4-3-2-1 punching positions of the card before they stop turning. The 0-11-12 will be read by the brushes the next time the PK clutch pawl is released and starts the feed rolls turning.

Zone Control Magnet (Section 4B)

The zone control magnet releases the zone unit toggle latches so that they may support the toggle assembly when detail printing. The zone control magnet will not be energized during cycles when the non-print or zone suppression control panel hubs are impulsed even though the list hub is wired.

Hammerlock Magnet (Section 26A)

The hammerlock magnet when energized allows the hammerlock bail assembly to lower during the first list cycle following the magnet being energized. The raising of the long hammerlock levers by the operator will control the suppressing of printing in those positions.

Print Magnets (Section 25B and 26B)

Print magnets are impulsed to select the numeric portion of type bars for printing. A maximum of eighty-nine are available; forty-three alphamerical;

forty-five numerical, and one additional in the center ribbon-guide position used on Type 419 only.

Zone Magnets (Section 25B)

Forty-three zone magnets located in the zone control unit are impulsed to set up zoning in the alphamerical type bars.

Counter Magnets (Section 45 to 64)

A start and a stop magnet are provided for each of the 80 counter positions on a full-capacity machine. These magnets determine the operation of counters activated by control panel wiring.

CONTROL CONTACTS

Hopper Contact (Section 3A)

The hopper contact is used to recognize the presence of cards in the card feed hopper.

Stacker Stop Contact (Section 4B)

The stacker stop contact opens when the stacker bed fills to capacity with cards and stops the machine.

Carriage Form Stop Contact (Section 9B)

The carriage form stop contact is held closed by either roll paper or forms passing under the paper levers and with the paper brake in the control ON position. When the end of the paper is reached, the form stop contact opens and stops the machine.

Carriage Interposer Magnet Contact (Section 14A)

The carriage interposer magnet contact is held closed whenever the interposer magnet armature is attracted. The contact provides a delay in energizing the carriage clutch magnet until after the interposer magnet has positioned the high-speed interposer. The interposer magnet will be impulsed by the all skip N/O relay point except on overflow and spacing operations.

Card Lever Contact 1 (Section 41B)

Card lever contact 1 is located just ahead of the first reading brushes and is operated mechanically by a card moving into position to pass the first reading brushes.

Card Lever Contact 2 (Section 41B)

Card lever contact 2 is located just ahead of the second reading brushes and is operated mechanically by a card moving into position to pass the second reading brushes.

Card Lever Contact 3 (Section 41B)

Card lever contact 3 is located just ahead of the third reading brushes and is operated mechanically by a card moving into position to pass the third reading brushes.

RESISTORS

Generator Variable Resistor (Section 1A)

The generator variable resistor allows the output of the generator to be set at 46 volts with no load placed on the machine. This may be checked with a voltmeter by testing between line 1 and fuse 21 which should be at negative potential.

DC Speed Control Resistor (Section 1A)

The DC speed control resistor allows the speed of the motor to be set so that a non-list speed of 150 cards per minute may be maintained. The list speed pulley is adjustable for a speed of 100 cards per minute; it will allow speeds from 80 to 108 cards per minute to be obtained.

DC Starting Resistor (Section 1A)

The DC starting resistor is a fixed resistance which reduces the braking effect of the motor shunt field when starting and a higher torque is desirable. Once the DC motor has built up the generator speed to where it is developing 40 volts, the starting relay will become energized. The points of the starting relay provided a shunt for the starting resistance which allows the full braking effect of the shunt field to maintain a constant running speed once the machine is in operation. AC motor circuits do not require a starting or speed control resistance.

Carriage Motor Control Resistor (Section 8B)

The carriage motor control resistor is adjustable so that at slow speed the brush commutator should complete 60 RPM; with the interposer magnet armature attracted, the brush commutator will operate at 131 RPM. This is approximately 4000 RPM of the motor armature.

Card Feed Clutch Magnet; Print Mechanism Clutch Magnet Resistors (Section 6A)

In series with each clutch magnet is a 100-ohm resistor the purpose of which is to provide a pre-energization and hold current to aid in the pickup and dropout of the clutch magnet. The clutch magnet alone requires 36° to operate in, the specification would require allowance of 70° for the clutch magnet to operate with accuracy. The pre-energization allows the clutch magnets to be fully energized as late as possible as the clutch magnets will energize in 18° with accuracy.

KEY AND PUSH BUTTON CONTROLS

Start Key (Section 4B)

The start key, when depressed, starts the 402, 403, and 419 card feed in operation and moves the cards to the station from which point the machine will run automatically.

Stop Key (Section 4A)

The stop key, when depressed, stops the machine at the end of the machine cycle through which it is moving.

Final Total Key (Section 4B)

The final total key, when depressed with the start key, will cause the machine to take total cycles clearing all counters wired to the final total hub in the control panel. It may be used before starting a report or to clear a final counter after completing a report and after all cards have been removed from the machine.

Non-Print Runout Push Button (Section 6B)

When the non-print runout push button is depressed, cards in the feed may be run out without causing printing to take place on the paper or form. All cards must be removed from the hopper if the machine is to be operated by the non-print runout push button.

Feed Interlock Start Push Button (Section 4B)

The feed interlock start push button is used in restarting the machine once it has stopped because a card failed to feed. Occasionally a card fails to feed because it has been damaged in handling; this would stop the machine and possibly cause a control change. The Types 402, 403, and 419 machines are provided with a circuit which will prevent the control change from taking place, and it will allow the operator to restart the machine with the damaged card repaired and all cards in order so that a normal control change may be recognized.

If a failure to feed a card occurs, the operator will remove the cards from the hopper and repair the damaged card. With the cards out of the hopper the operator depresses the feed interlock start push button and runs the cards about to enter the second and third set of brushes out of the unit. These last two cards will pass by the brushes and perform all functions except change in control. The card which was about to enter the second set of reading brushes is placed in front of the originally damaged card and both are placed in front of the remainder of the file. After the cards are replaced in the hopper and the feed interlock start push button is again depressed, the cards are run into the machine. On the run-in the first card will only be sensed for comparison of the controlling field with the repaired card and from that point on all other machine operations will return to normal.

Carriage Space Push Button (Section 10A)

The carriage space push button will cause the carriage to take a single space each time it is depressed.

Carriage Restore Push Button (Section 10A)

The carriage restore push button will cause the carriage to restore to the next hole punched in channel "one" of the tape at the slow speed. The operator should not depress the space or restore button during automatic operation of the accounting machine.

Carriage Stop Push Button (Section 10B)

The carriage stop push button is an emergency stop control and should not be used to stop the machine while in normal automatic accounting machine operation. It will stop both the carriage and the accounting machine.

CONTROL SWITCHES

Main Line Switch (Section 1A)

The main line switch is located below the right end of the reading board and, when it is turned on, completes a circuit to the drive motor. The main line cord is equipped with a 20-ampere male plug which is slightly larger than those previously used. Therefore a check of the customer's wall outlet in preparation for the use of this cord should be made.

Gang Punch Switch (Section 3A)

The gang punch switch controls the independent operation of the Types 402, 403, and 419 and Types 517, or 523 Gang Summary Punch when the summary punch cable connector is attached to the 402-403 machine. When the switch is in the ON position, the summary punch can be used as a gang punch and receives its power supply from the 402, 403, or 419 generator. When the switch is turned OFF, it allows the Types 402, 403, or 419 machine to continue normal operation.

Setup Change Switches (Section 25A)

The setup change switches complete a circuit from CB43 to the control panel setup change hubs 1-2-3. A control panel may be wired for two separate reports by the use of co-selectors or pilot selectors. The pickup of the co-selector or pilot selector may be energized by wiring the pick hub to the setup change hub 1-2 or 3. The position of the switch determines if the co-selector or pilot selector is energized each cycle or left in its normal position throughout the entire report. The following impulses cannot be selected: all first card cycles, and NBAC, INV. F, and SPL. PRG. switches.

TYPES 402, 403, AND 419 CONTROL PANEL

A COMPLETE treatment of Types 402, 403, and 419 control panel wiring is given in Types 402, 403, and 419 Principles of Operation manual, Form 22-5654-11. No attempt will be made to duplicate this work here. Only control panel wiring necessary to the understanding of circuit operation will be shown with circuit analysis.

TO AVOID any possible confusion, the circuits will first be discussed as they apply to the Type 403 Accounting Machine. A point-to-point circuit trace is not given, but rather a relay outline supplemented with function and sequence charts. Important operating points will be located to emphasize circuit operation and prevent confusion in following long traces. Refer to *Purpose of Relays and Contacts* section, located at the rear of this manual, for detail information on the various circuit components.

A check of section 66B will show the values of the lines on the wiring diagram and the machine to which they apply.

The operator turns on the main-line switch to start the drive motor and allows the generator or rectifier to build up to correct operating voltage. Once this voltage is reached, there will be certain circuits completed that will control the conditions under which the running circuit in the Types 402, 403, or 419 machine may operate.

To start the machine in either normal or summary-punching operation, the condition of R4, summary-punch card lever (Section 4A), must be known. This will be determined by wiring the summary-punch switch (R86, Section 8A), in the ON position. For all non-summary-punch operation, the summary-punch switch will be OFF so that R4 will be energized throughout most Types 402, 403 operations through the N/C R86 points.

RUNNING CIRCUIT (Without Cards)

Objective: To show how one depression of the start key will result in one cycle of the card-feed unit. It may be assumed that the machine is standing still and the index is at some point between 65° and 100°. Paper has been properly inserted in the carriage positioned for printing. It is necessary to operate the two-speed clutch so that power may be transmitted to the card-feed clutch disc. At the correct time, the card-feed clutch magnet will be energized to release the card-feed clutch pawl. Once released, the clutch pawl engages with the clutch disc, and the card-feed unit will begin to turn. The picker knife clutch must also be energized to allow the feed knives and first two feed-roll stations to operate and not latch at 165° of the feeding cycle. Because there are no cards involved in this operation, continuous running will not take place, and no card lever contacts will be operated. The function chart of Figure 83 shows the relays and magnets involved.

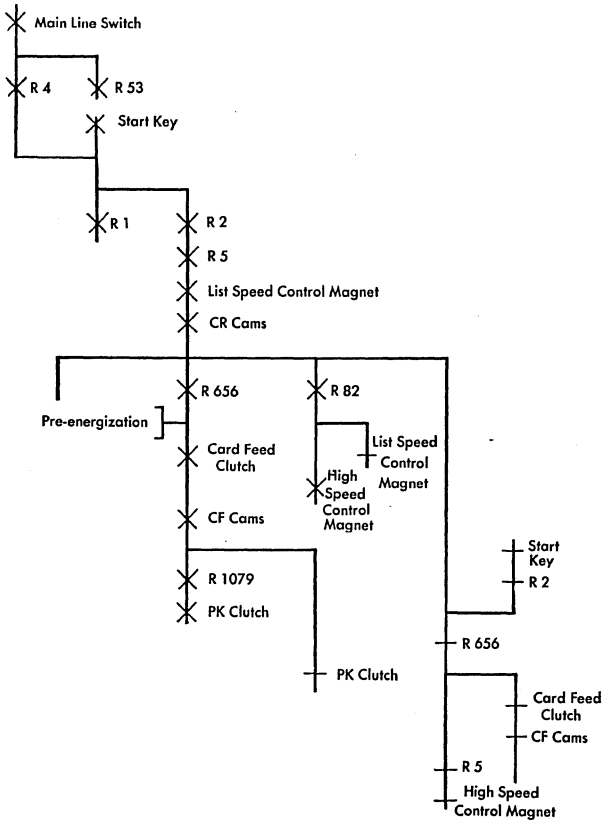


Figure 83. Relay Operation Start and Run, No Cards

Start and Run (no cards) Sequence Chart (Figure 84)

1. R4 and R53 energized by main-line switch.
   a. R4, through R86BL and BU N/C, Line 1. 4A
   b. R53, form-stop contact N/O (now closed), L7. 10B
2. R1 and R2 energized by start-key depression.
   a. R1 pick, start key, stop key, 4A, 3B, start-key jack J-27, L7. 4B
   R1 hold through 1A, 4A, L7. 4A
   b. R2 picks through 24BL, 65A N/C, start key, L7. 4B
   R2 hold cannot be established as neither 6AU nor 8BU will close without cards in the feed. 4B
3. R5 picks through 2BU, gangpunch switch, L1. 3A
   R5 hold through 5AU, CB18. 3A
4. List-speed control magnet is picked through 82B N/C, 5AL N/O, L1. 3B
5. R656 energized when CR shaft begins to turn and CB20, 21, and 24 make.

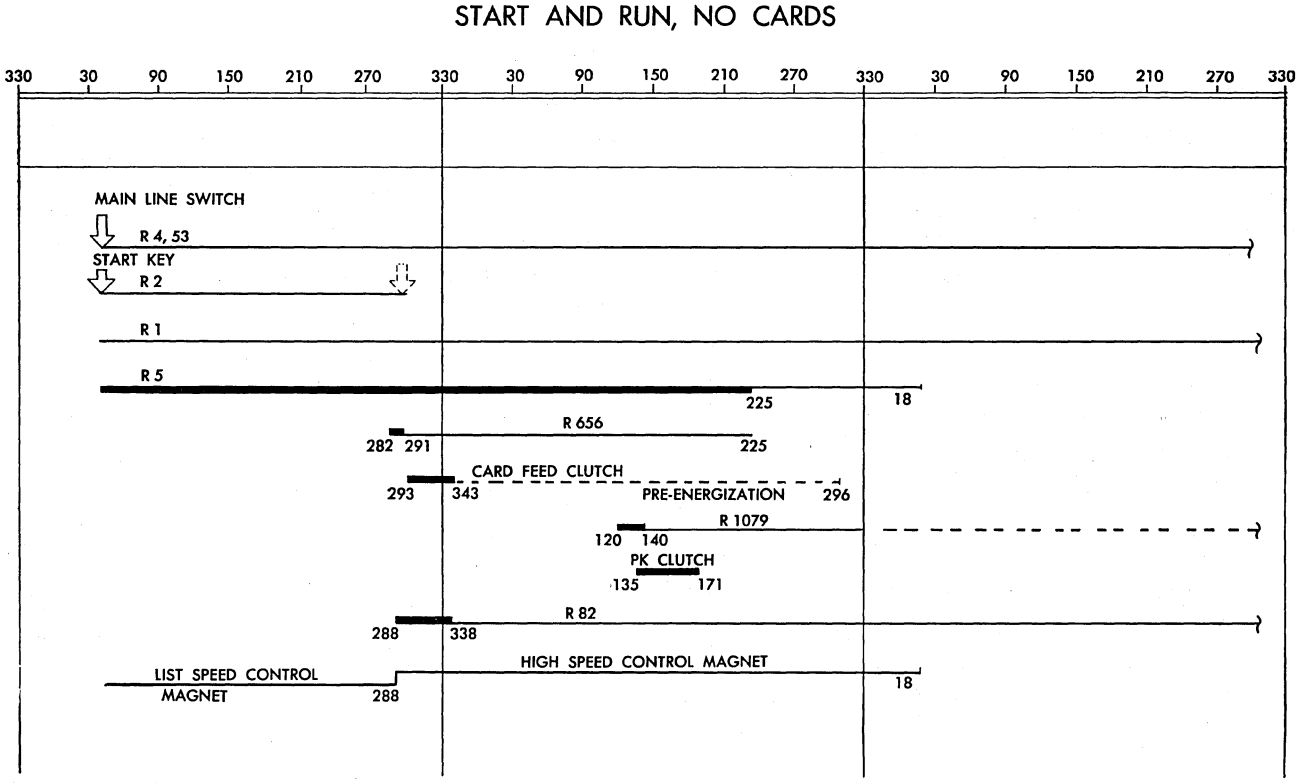


Figure 84. Start and Run, No Cards

a. R656 picks through 568-3 N/C 2AL, series of N/C points, 1B CB's 21 and 20, L3. CB21 makes the pick circuit; CB20 breaks it for a resultant timing of 282° to 291°. 5B
b. R656 hold through 656-1, CB24, L4. 6B

6. Card-feed clutch magnet energized from 293° to 343°. 6A
   a. CB28 makes from 336 to 296 to pre-energize the card-feed clutch magnet through a 100-ohm resistor. The clutch magnet alone requires 36° for full energization. With pre-energization it may be fully energized in 18°, resulting in an increased safety factor. Once energized, the pre-energization provides a hold circuit.
   b. CF clutch picks, through 656-2 and 3, CB27, L4. 6A

7. R82 picks from 288° to 338° through 79BL, 659-7, CB26, L4. 6B
   R82 hold through 82A, CB23, L4. 5A
   Notice when 82B (Section 3B) transfers, the circuit to the two-speed clutch will be shifted to the high-speed control magnet. In order to save time when running cards in or out, the accounting machine will operate at high speed.
   SPEED-CHANGE INTERLOCK PM6 and 7. 3B
   A study of PM7 time will show that the high-speed control magnet may be energized only at a time when the print mechanism clutch is latched at 340° and the PM cam contacts are not turning. PM6 provides a circuit to the list-speed control magnet, when the main cam shaft and print mechanism are in operation, until 327° regardless of the position of 82B points. The high-speed control magnet cannot be energized under these conditions before 327° because PM7 is open. This insures that the print mechanism will never operate at high speed and that there will always be a circuit to the list-speed control magnet even though the 82B points transfer during a print cycle.

8. R1079 pick will be energized through normally closed point of MLP control circuit, CF28, L13. 20A
   R1079 hold through 1079-1, CF33, L14. 22A
   For all non-MLP operation R1079 will be energized every card-feed cycle by CF28.

9. Picker knife clutch energized through 1079-3, CF27, L13. 20B

Portable Start Key

As an aid to the customer engineer in servicing the Types 402, 403, and 419, a portable start key has been incorporated in the start and run circuit. When the start-key cord assembly is plugged into the jack, the start key, final total key, and card feed interlock switch are disabled by jack terminals 4 and 5 breaking. The non-print runout key is disabled by the breaking of jack terminals 2 and 3. The pick of relays 1 and 2 is put under control of the auxiliary start key through jack terminals 1 and 3. The machine will not start except under the control of the portable start key and will not continue to run unless the portable start key is held operated. This device may then be used to start and stop the machine while an operation is observed from any vantage point.

CONTINUOUSLY RUNNING CIRCUIT — CARDS FEEDING

WITH NO cards in the machine, one depression of the start key will cause only one card-feed cycle. The CF unit will continue to run if the start key is held depressed by maintaining a pick on R2. Therefore to

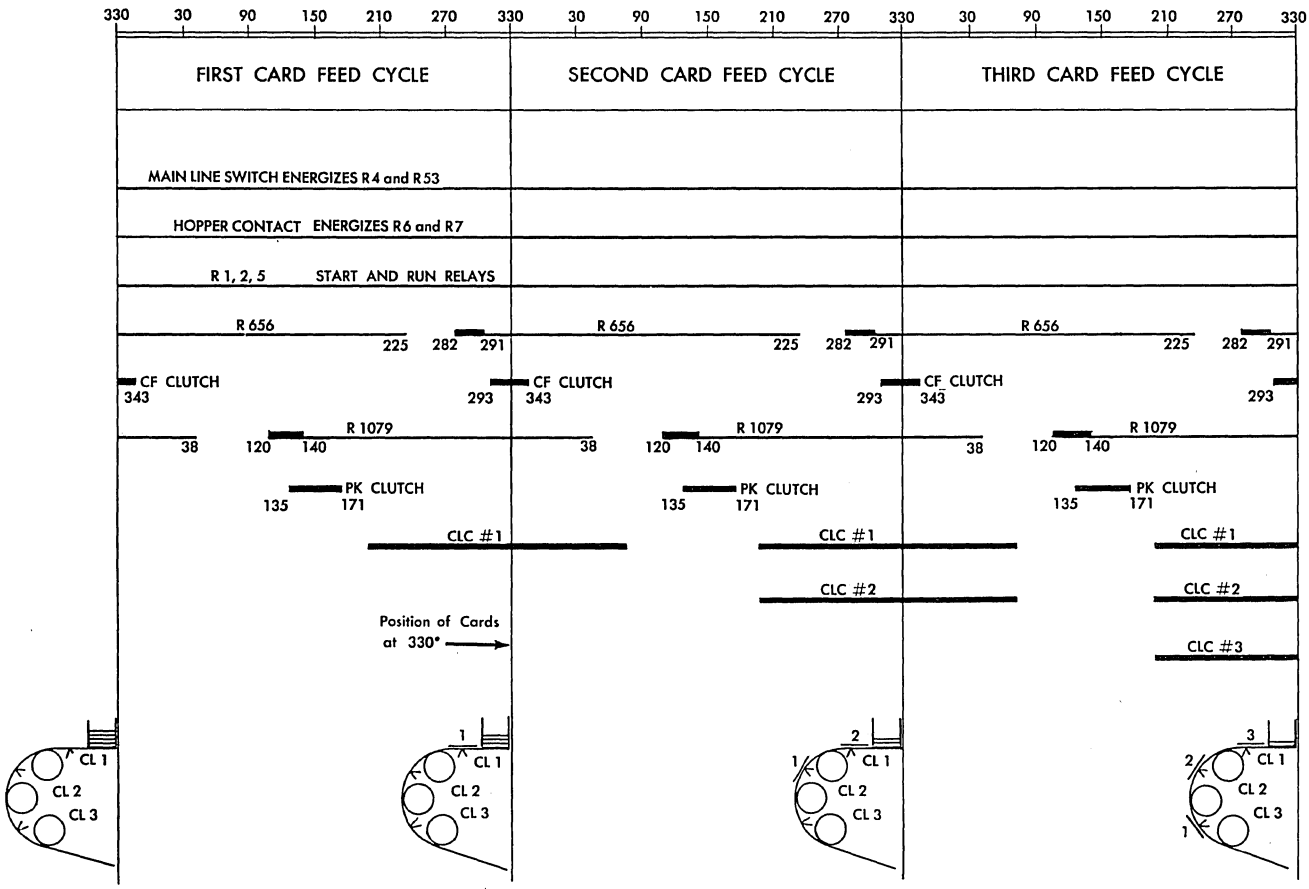


Figure 85. Card Feed Clutches and Card Lever Contacts

cause continuous running of cards, R2 must have a continuous hold. Energizing R6 and R8 will complete the hold circuit to R2 (Section 4B), and this is done with card lever contacts.

The hopper contact will remain closed as long as there are cards in the hopper. At each of the three reading brush stations is a card lever, which recognizes the presence of the card that will pass that brush station on the next card-feed cycle. Figure 85 shows the cycles and approximate timing for the card-lever contacts as cards progress through the feed.

OBJECTIVE: To show how continuously running and brush-reading circuits are set up by cards passing through the feed.

First Run-In Cycle

1. R4 and R53 are energized by main-line switch 4A, 10B
   R6 and R7 are energized by hopper contact (cards in the hopper). 3A
2. Steps 2 through 9 same as *Running Circuit* (without cards).
10. R8 and R9 are energized at 220° through card-lever contact 1.
    a. CF8 makes from 220° to 270° to pick R8 and R9. 42B
    b. CF12 hold R8 and R9 until 225° of the following cycle. 42B
11. R2 continuous hold will be established when 8BU closes, provided R2 pick coil is held energized by the start key until 220° of this cycle. 4B

Second Run-In Cycle

1. Steps 1 through 10 same as first run-in cycle.
11. R222 picked at 220° through card-lever contact 2 and CF8. 42B
    R222 hold through 222AU and CF11 until 225° of the following card-feed cycle. 42B
12. R2 hold is continuous. 4B
13. First reading contact roll is energized to sense the first card in through 8AL, CF39 and 38, CF9 and 10, CB1, 2, 3, and 4, 7.5-ampere power supply. 41A
    NOTE: Impulses to read punching in cards at all three reading stations originates at CB1, 2, 3, and 4 from the 7.5-ampere supply. 41A

Third Run-In Cycle (Continuous Running)

1. Steps 1 through 12 same as second run-in cycle.
13. R223, 10, 11, and 12 are picked through card-lever contact 3 and held from CF11. 42B
14. First- and second-reading contact rolls are energized through 8AL and 222BL respectively. 41A

Fourth Run-In Cycle (Continuous Running)

1. All card-lever relays will continue to repick and hold as previously described. 41B, 42B
2. Third-reading contact roll is energized through 223AL to sense first card in as it passes third reading station. 42A

This sequence of operation is shown in the card-lever-relay portion of Figure 88. Note that the contact rolls will not be energized to read until the cycle in which the first-card-in passes the reading station.

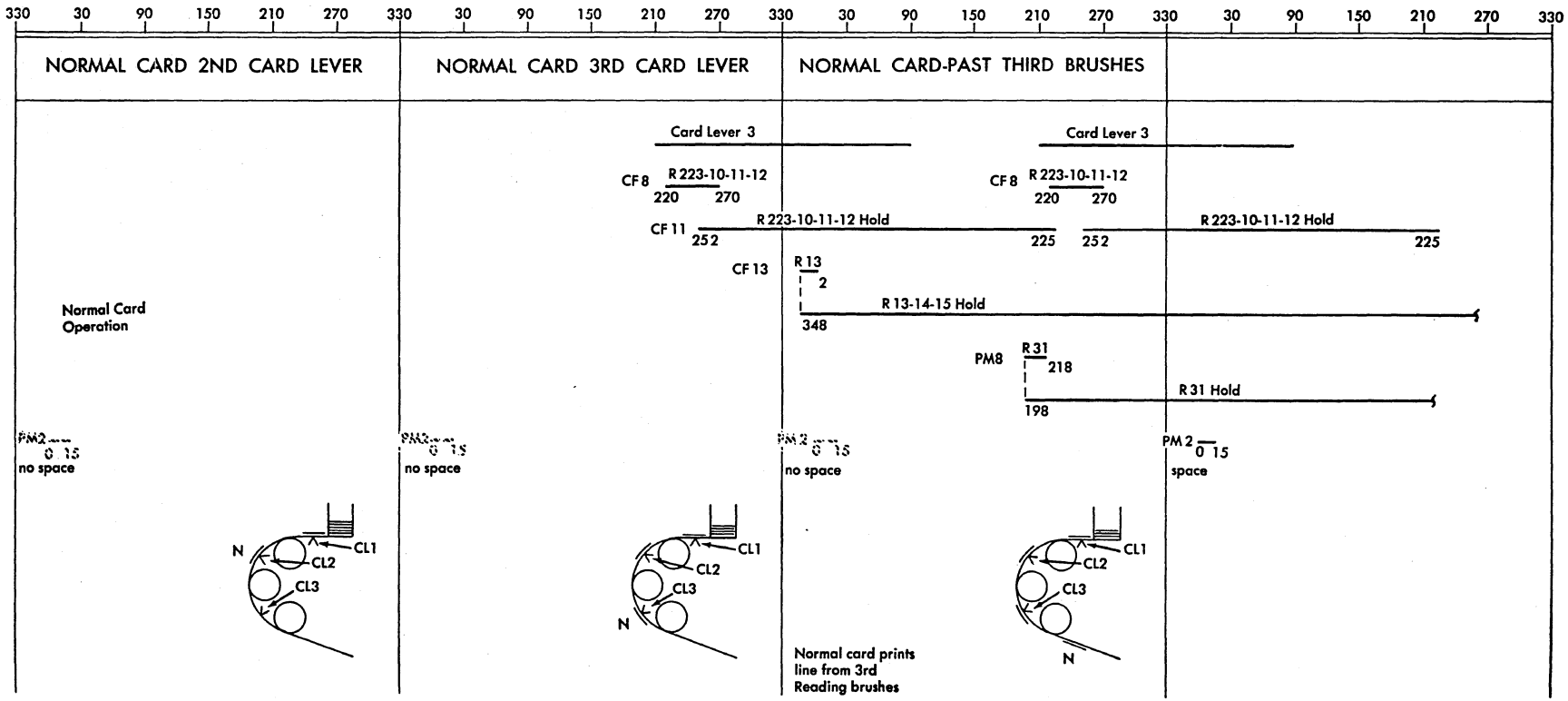


Figure 86. First Card Relays

FIRST-CARD-IN RELAYS

ASSOCIATED with third-card-lever relays are the first-card-in relays, which delay certain operations until after the first card has started by third reading brushes. First-card-in relays 13, 14, 15, and 31 prevent summary punching on run-in, false error stops, premature carriage skipping or spacing, and other operations that are affected by the position of the first-card-in. A portion of the card-lever relays and the operation of the first-card-in relays is shown in Figure 86.

OBJECTIVES: To show that first-card-in control relays 13, 14, and 15 will be energized at the beginning of the card-feed cycle in which the first card is passing third reading brushes.

To show that carriage first-card relay 31 will be energized after the first-card-in has printed or after any skipping operation has occurred.

1. R13 picked by R11AU and CF13 at 348° of cycle in which the first card passes the third brushes. 43B
2. R11AL and R13AU hold R13H and pick R14 and 15. 24B
3. R612-9 holds R13, 14, 15 during the last totals after cards run out. 24B
4. CB68 keeps R13, 14, 15 energized till 270° of last cycle. 24B
5. PM8 picks R31 after printing the first card. 24B
6. R31 is held by ALL SKIPS relay R567-8 N/C or by CF15, thus allowing R31 to drop on all skipping operations. 24B

LISTING — DETAIL PRINTING

THE LIST CIRCUITS discussed will be in terms of normal card operation when the card is zoned and printed from second and third brushes respectively.

To cause the Types 402 and 403 machines to list each card, it is necessary to wire the control panel from all cycles hub in section 35B, wiring diagram 210201R, to the list hub in Section 5A (Figure 87,

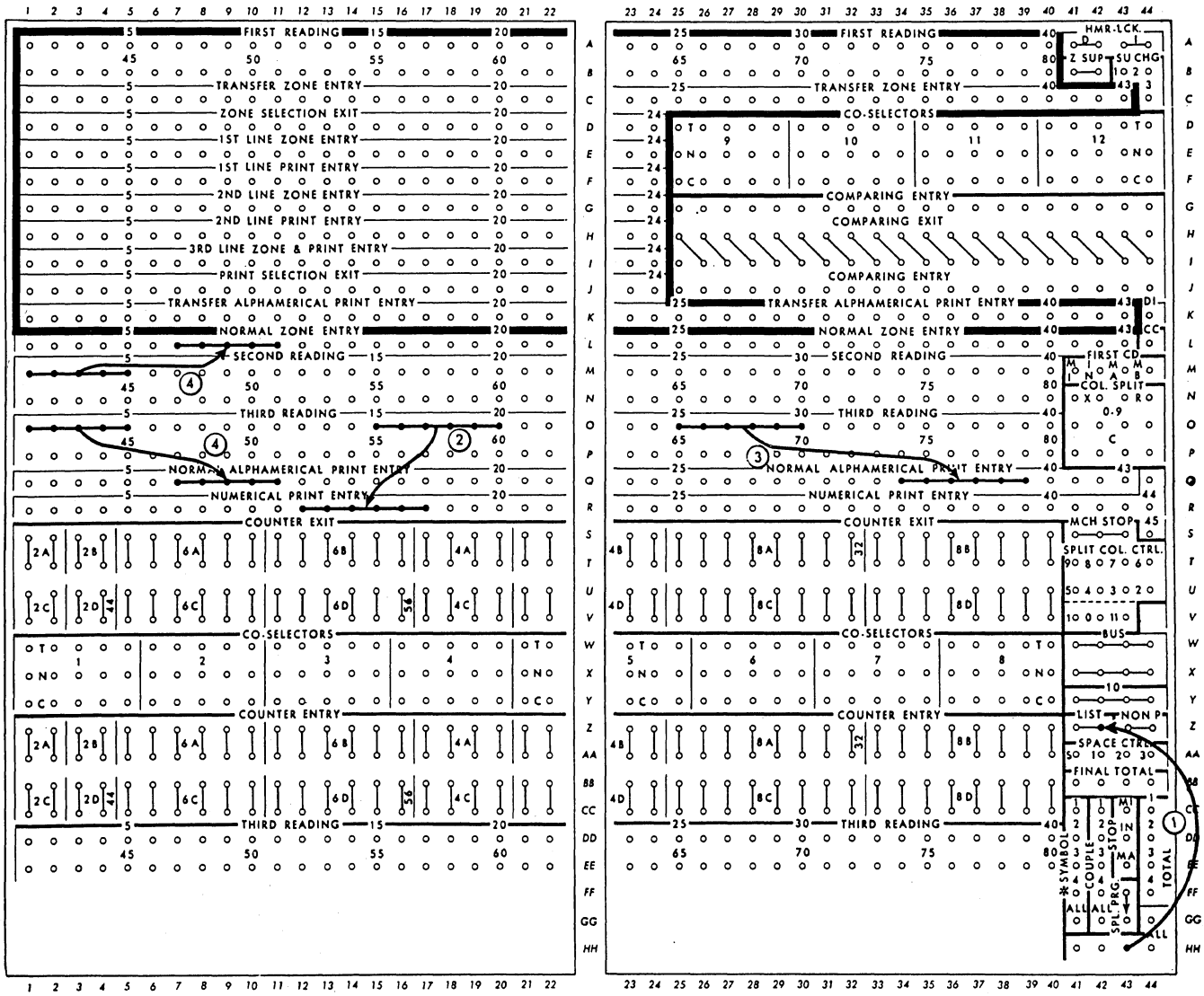


Figure 87. List

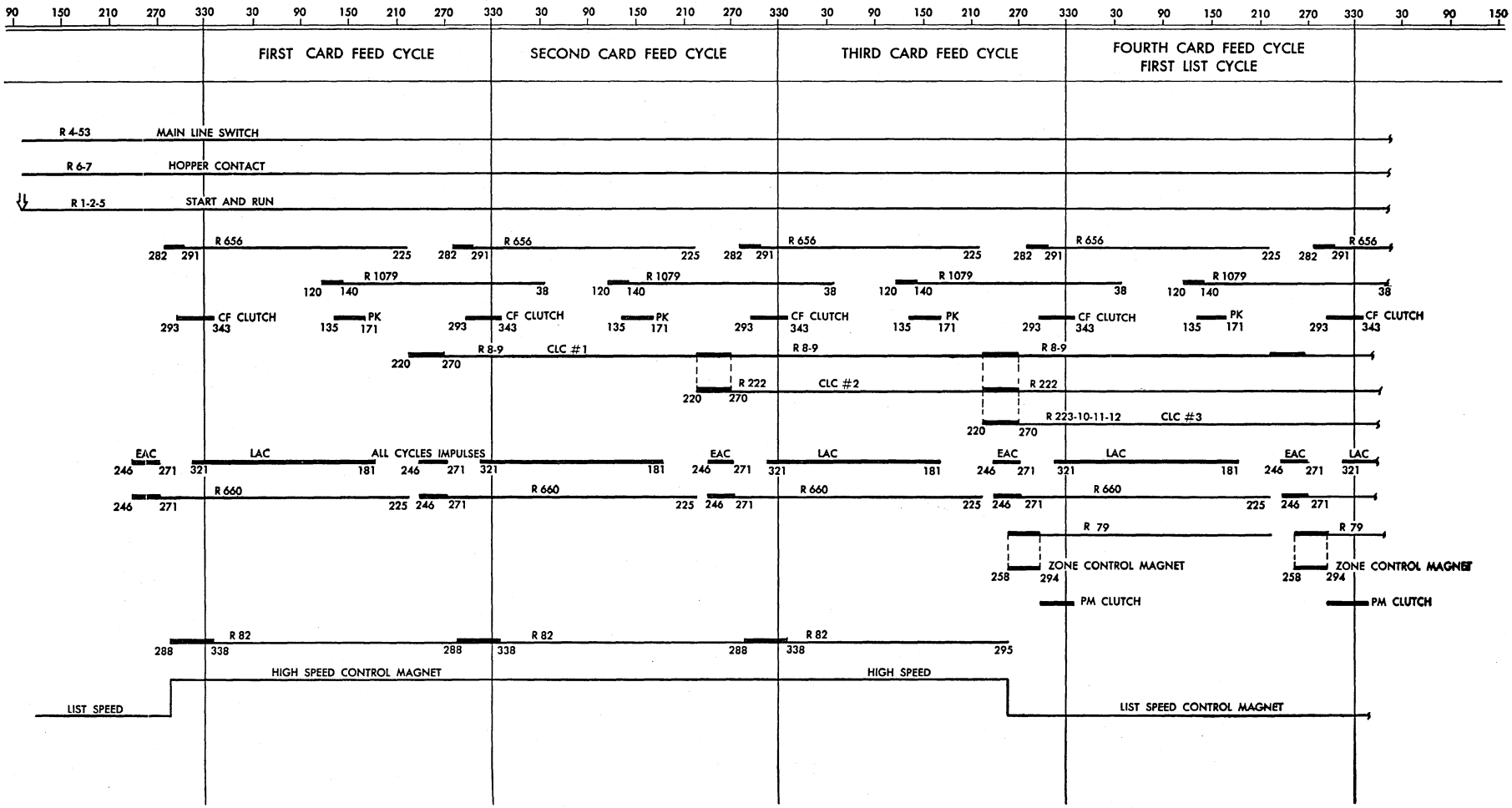


Figure 88. Card Feed Run-In and List

wire 1). Also zone and select magnets must be connected to correct reading brushes (Figure 87, wires 2, 3 and 4). The sequence chart of Figure 88 illustrates the function of key relays in the operation of the run-in and detail-list circuits. For a detailed sequence chart of all relays and components used in this operation, refer to Sections 79 through 82 of wiring diagram 210201R.

PREPARATION: Main-line switch on, control panel wired as in Figure 87, cards with alphabetic and numerical information placed in hopper, and paper in the carriage positioned properly for printing.

OBJECTIVES: To activate card cycle and all cycle hubs in time to cause correct listing of the first card.

To energize the print clutch on list cycles by impulsing the list hub.

To cause the machine to operate at list speed during all printing cycles.

To complete circuits from reading brushes to zone and select magnets to detail list the first and all following cards.

1. All cycle hubs are energized on each cycle.
   a. R635 is picked through 648-2 and CB39. 23B
   b. All cycle control panel hubs are activated by CB's 78 and 79. 35B
2. Card-cycle hubs are energized on fourth run-in cycle as first-card-in passes third brushes.
   a. R638 and R641 are picked through 11BU, 648-2, and CB39. 23B
   b. Card-cycle hubs are activated by CB's 78 and 79. 35B
3. R642 and R645, early all cycles, are picked by CB41 every operating cycle. 24B
4. R660 is picked through 645-9, control panel wire 1 (Figure 87) CB's 78 and 79. 5A & 35B
   R660 holds through CF11. 42B
5. R79 and zone control magnet are picked through 12AL 660-2, and CB19. R79 will not pick until 12AL closes during the third run-in cycle (Figure 88). 4B
   R79 holds through CB24. 6B
6. List-speed control magnet is energized in preparation for listing first-card-in.
   a. R82 cannot pick through 79BL N/C now open. 6B
   b. List-speed control magnet energized when 82B N/C remakes. 3B
7. R656 picks and holds in the normal manner during card-feed operations. 5B
8. Print clutch magnet pre-energized by CB29. 6A
9. Print clutch magnet picked through 659-2 and 3, 79AL, 656-4 and 5, and CB27. 6A
10. R500-518 picked through 656-10, CB40. 24B
11. Zone magnets energized from cards passing second reading
    a. R521-530 picked each card-feed cycle by CF3. 26B
    b. Zone magnets are impulsed through R521-530 points closed for 0, 11, and 12 time only, control panel wire 4 (Figure 87), second reading brushes, GB's 1, 2, 3, and 4. 25B
12. Alphamerical and numerical print magnets are impulsed through control panel wires 2, 3, and 4 (Figure 87), 500-518 points, third reading brushes, CB's 1, 2, 3, and 4 (41-42A). 25-26B

Impulse Timing

Control panel hubs may be divided into two groups: those that emit and those that accept impulses. For circuit timing purposes these impulses will occur either during EARLY ALL CYCLES time or LATE ALL CYCLES time. Some hubs will emit during both EAC and LAC time; ALL CYCLES, CARD CYCLES, and PROGRAM LEVEL hubs are examples. Some hubs, such as pilot selector IMMEDIATE-PICKUP will receive both EAC and LAC impulses. However, there are a number of control panel hubs that are conditioned by an EAC relay point so that they may be impulsed only between 225° to 290° or may not be impulsed during this time. The list hub is an example of one that will receive only EAC impulses. Figure 89 lists several emitting and receiving hubs, showing the time in each cycle they are active.

Zone Suppression

For some applications using Types 402 or 403 it is desirable to suppress the zoning read by the second brushes into the zone unit. Before any zoning can be transferred to the alphamerical type bars, it is necessary to impulse the zone control magnet. Zone suppression is accomplished by stopping this zone control magnet impulse. A set of common control panel hubs receives X, 12, all-cycle or card-cycle impulses to suppress zoning for all forty-three alphamerical type bars.

OBJECTIVE: To prevent energizing the zone control magnet.

1. R27 is picked through
   a. 645-8, control panel wire to ALL CYCLES or CARD CYCLES. 25A
   b. 874-10, control panel wire to an X or 12 impulse from reading brushes. 25A
   R27 hold through CF7. 26A
2. Zone control magnet cannot be energized through 27B N/C now open. 4B

Non-Print

The operator may find it desirable to suppress printing of one or more lines on a listed report. Impulsing the non-print hub will accomplish this result. Because no printing is to occur, the type bars will not rise, the print clutch will not be energized, and the machine may feed at high speed.

OBJECTIVES:

To block the pick of the print clutch.

To eliminate unnecessary transfer of zoning to type bars.

To operate machine at high speed.

1. R662 picks through control panel wire from CARD CYCLES or ALL CYCLES controlled by pilot selector. 5A
   R662 holds through CB24. 6B
2. Print clutch magnet cannot be energized through 662-2 and 3 N/C now open. 6A
3. Zone control magnet and R79 cannot pick through 662-4 N/C now open. Zone transfer will not occur. 4B
4. R82 picks through 662-6 to switch two-speed clutch to high speed. 6B

Because the print mechanism did not operate the PM cams, no carriage spacing can take place, and the paper will remain in the same place until the next normal print cycle.

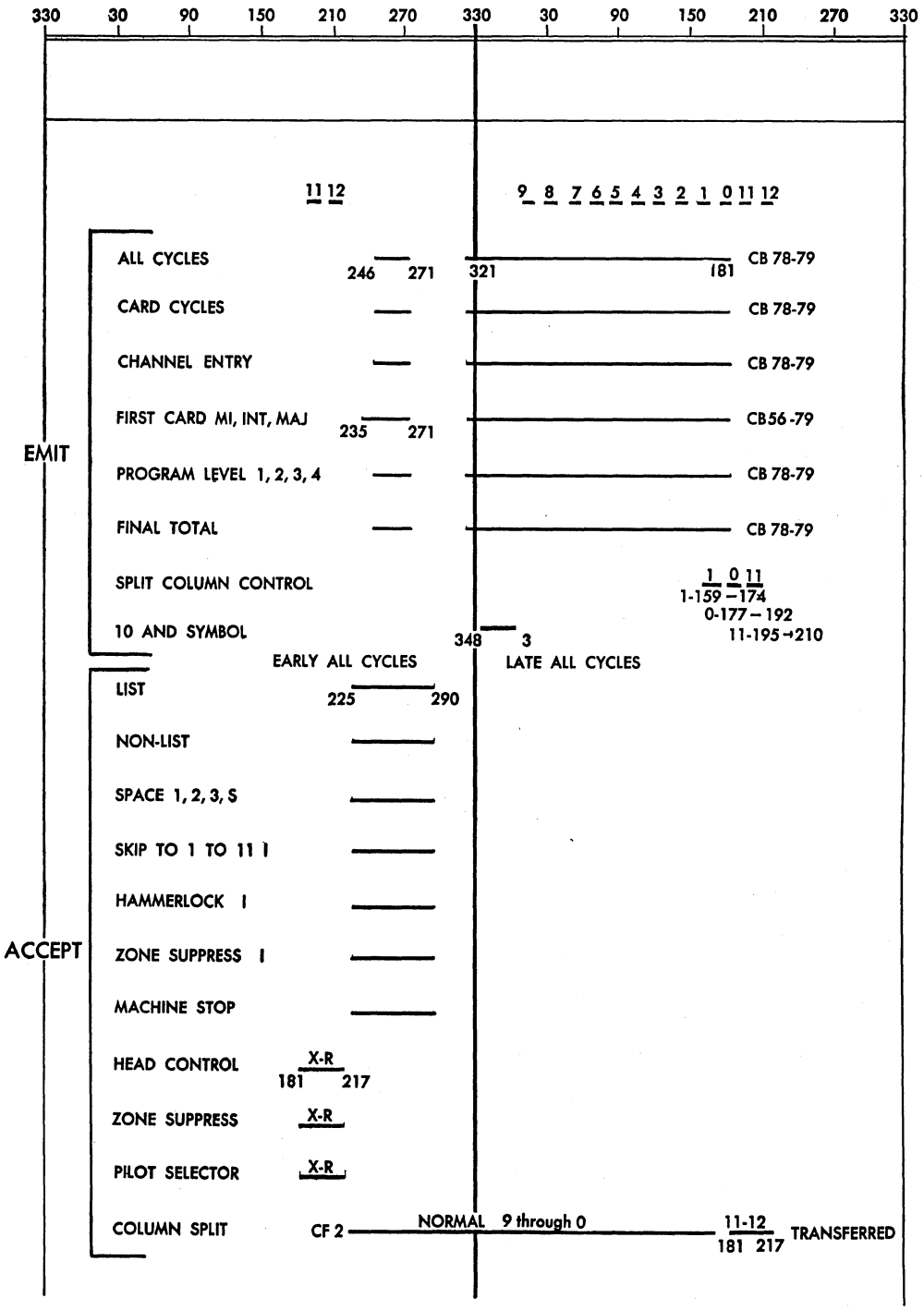


Figure 89. Impulse Timing

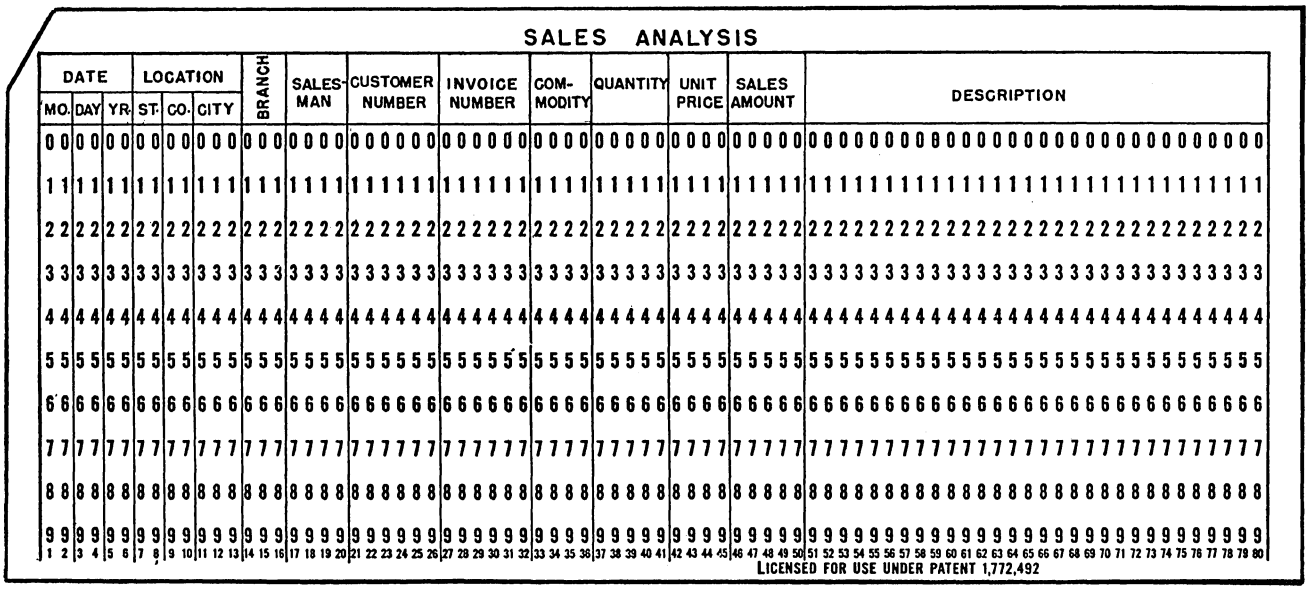


Figure 90. Sales Analysis Card

GROUP CONTROL

THERE ARE many customers that are not interested in the detail that is punched into each individual card, but do need the total of each group of cards with sufficient indication to identify it. The operation by which this is performed is called *group printing*.

Before considering the specific circuits involved in the group-control feature of this machine, it is essential to understand what is meant by group control and the problems involved in group control. In the application of this machine to accounting problems it is not sufficient to have the machine perform the functions of listing alphabetic and numerical information, adding, subtracting, and printing totals. The totals must represent the accumulation of information punched in a specific field of a group of cards.

For example, consider the application of the punched-card method to a sales analysis problem. The sales manager of a large manufacturing organization wishes to know how much of each commodity is sold for a given period of time. The information punched into the cards is shown in the card form illustrated in Figure 90.

In order to determine how much of each commodity was sold, it will be necessary to sort the cards on the commodity field. The cards will then be grouped according to the commodity code number punched in the commodity field. It is now possible to obtain a total of the sales for each commodity by running the cards through the machine in these small groups, each commodity group being run separately in order to obtain the total for that commodity group.

It is obvious that this would be a very uneconomical procedure, because of the attention it would require on the part of the operator. It is, therefore, desirable to place all of the cards in the feed magazine of the machine and have the machine automatically sense the changes in the groups as the cards progress through the machine, printing the necessary totals for each group of cards.

Such an operation would require the use of some kind of comparing unit or circuit on the machine. This unit must be capable of reading the commodity field of each card, and comparing it with the following card to see whether the two consecutive cards were alike in this field. As long as such consecutive cards were alike, the machine would continue to feed the cards and accumulate the amounts in the quantity field. However, as soon as two consecutive cards were not alike in the commodity field, the card feeding would stop and a total would be printed, indicating the end of one commodity group.

The machine functions in just this manner. Consecutive cards are compared. One card is read at the second reading brushes while the preceding card is being read at the third reading brushes. As long as these readings are alike, the feed continues to run. As soon as the machine senses the fact that these readings are not alike, the feed unit stops, the machine prints the accumulated totals, the counters are reset to zero, and the machine automatically starts feeding the cards of the next group.

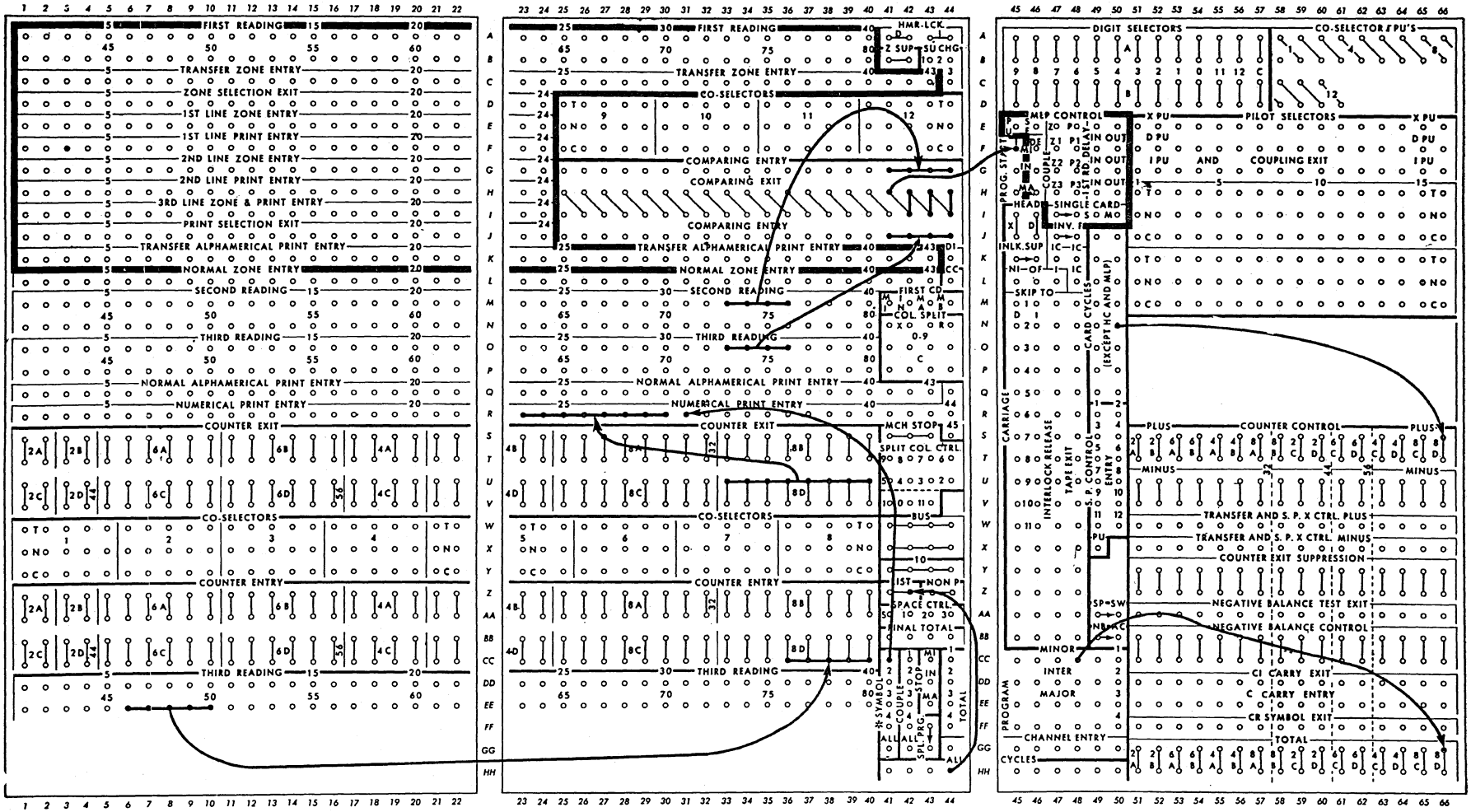


Figure 91. Sales Analysis

The control panel wiring diagram (Figure 91) shows how the control panel is wired for this operation.

The report obtained would appear somewhat as follows:

COMMODITY CODE	SALES AMOUNT
123	4758
123	65370
	70128*
125	32467
125	32567
	65034*
139	1378
139	3548
	4926*

In this case the cards are sorted only on the commodity field, and only one class of total is obtained — the total sales for each commodity.

The objective in any discussion of the group-control feature is to show how card feeding is stopped when two consecutive cards are not alike in the field being compared.

In order to make a comparison between two consecutive cards, both cards must be read at the same time. As one card is passing the third reading brushes, the following card is passing the second reading brushes. With multiple-line cards, comparison is made between the first reading and the second reading brushes.

Comparing Unit

Impulses from two different brush stations enter corresponding comparing unit hubs. The time in a machine cycle that the impulses arrive is the basis on which comparison is made. Thus, when both comparing entry hubs for a single position receive identical impulses, such as a 5 (81°-90°), comparing exit for that position will not emit an impulse signifying an equal condition. If the comparing entry hubs receive impulses at different times, then the comparing exit will emit to signify an unequal condition. Notice on the control panel (Figure 91) the two common comparing exit hubs are on a diagonal to facilitate wiring in groups. The upper exit is in a vertical line with its entry hubs.

Numerical comparing involves reading one punch per column in the two cards being sensed. Because alphabetic information consists of two punches in each column, it is necessary to check for both punches separately when alphabetic-comparing. The circuits provide for comparing the lower punches of a card from 9 through 1, and then the relay is dropped and a new comparison is made for the 11 and 12 punches. In this manner, both holes are compared separately. However, it should be noted that no comparison is made for the 0 (zero) impulse. During zero time the comparing-unit relays are being dropped out in preparation for sensing 11 and 12 impulses. Thus this unit cannot differentiate between cards punched 0 (zero) and cards with no punching at all.

OBJECTIVES:

To receive digit impulses and hold for comparison.

To provide an exit impulse immediately upon sensing a comparing difference.

1. R859 through 868 energized for 9-1, 11 and 12 impulses by CB45. 29B
2. R111 and R112 (first comparing position) pick from control panel wiring to second and third brushes. 29A & B
   R111 and R112 hold through A points and CB48. 30A
   The hold circuit is interrupted by CB48 at 0 time to prepare for sensing the zone impulses.
3. An unequal comparison picks either R111 or R112 separately and completes the circuit for comparing exit impulse through 111B N/O or 112B N/O and CB's 46 and 47. If both relays are energized or de-energized at the same time, no circuit is possible for the comparing exit impulse. 29B

Last-Card Program Start

Working with the comparing unit is the last-card program-start hub, which occupies the lower comparing-exit hub of comparing entry position one (Figure 91). An impulse will be available from this hub as the last card passes second reading and may be used to start last-card total cycles. It also emits an impulse to start clearing cycles when cards run in.

PROGRAM — GROUP CONTROL

THE MOST common use of the comparing exit impulse is to start program cycles. During program cycles the card-feed unit will latch and counters will be impulsed to total print.

Three types of totals are possible on the Types 402, 403, and 419: minor, intermediate, and major. They are also known as program levels 1, 2, and 3; or, as minor program, intermediate program, and major program. A minor program is used for the classification representing the smallest grouping, intermediate program for the next larger grouping, and major program for the largest group. If totals of sales amount were to be printed by state, by city, and by

customer number, customer number would be considered a minor group, city an intermediate group, and state a major group. When the proper programs are used for these groups, the machine automatically stops at the end of each group and will not start until the required number of total cycles is taken. For a minor program change, only one total cycle is required; for an intermediate program change, two total cycles are required; and for a major program change, three total cycles are required.

Minor Program Level

An unequal comparing impulse wired to minor program start immediate will cause the machine to stop feeding cards, read out of counters, print the total and an indentifying total symbol. After one level of total prints, the machine automatically restarts the card feed and group-indicate prints the next card. Also available after the program is an impulse from the first card minor hub. A sequence chart of this operation (Figure 92) will help to establish timing relationships between operating relays as the program progresses.

OBJECTIVES:

1. To energize the program relays:
   a. R601 picks by comparing exit impulse through control panel wire. 31A
      R601 holds through CB50, which is shunted by 612-1 N/O. 32B
   b. R609, 612 and 618 pick through 601-3 and CB52. 34A
      R609 and 612 hold through CB51 shunted by 633-3 N/C. 34B
      R618 holds with the same coil through 618-1 and CB32. 34A
2. To stop the card feed:
   a. R656 can no longer pick through 612-7 N/C now transferred. 5B
   b. Card feed clutch circuit not complete without 656-2 and 3 closed. 6A
3. To energize the print clutch:
   a. R659 picks through 612-7 N/O, 1B and CB's 20 and 21. 5B
      R659 holds through CB24. 6B
   b. Print clutch magnet, pre-energized by CB29 and 100-ohm resistor, picks through 659-2 and 3 and CB27. 6A
4. To activate program level 1 hubs:
   a. R635 picks during program cycles through 648-2 and CB39. 23B
   b. Program level 1 hubs emit EAC-LAC impulses through R618 points from CB's 78 and 79. 35B
5. To print a total symbol.
   a. On minor program level only, asterisk symbol 1 hub emits a 10 impulse: * hub, 618-11, CB67, CB's 1, 2, 3 and 4. 36B
   b. On all program levels, asterisk symbol all hub emits a 10 impulse: * hub, 612-3, CB67, CB's 1, 2, 3, and 4. 36B
6. To prevent a restart of minor program.
   a. R19 picks through 609-2 and CB54. 36A
      R19 hold through CB50, shunted by 612-1. 32B
   b. R609, 612, and 618 cannot repick because of 19BL N/C now open. 34A
7. To cause a program stop.
   a. R633 picks from CB63 through 618-9 to L23. 36B
      R633 holds by CB38. 36B
   b. R609 and R612 drop when 633-3 opens and allows CB51 to break the hold circuit. 34B
   c. R601 and R19 drop when 612-1 opens and allows CB50 to break the hold circuit. 32B
8. To energize the first card minor hub on the first cycle following minor program.
   a. R16 picks through 601-2, 633-4, CB49. 32B
   b. R16 holds by CF4. 32B
   c. R645 picks during EAC time by CB41. 24B
   e. First card minor hub energized during EAC time, through 645-6 N/O, 80AL, CB56. LAC time, through 645-6 N/C, CB's 78 and 79. 36B

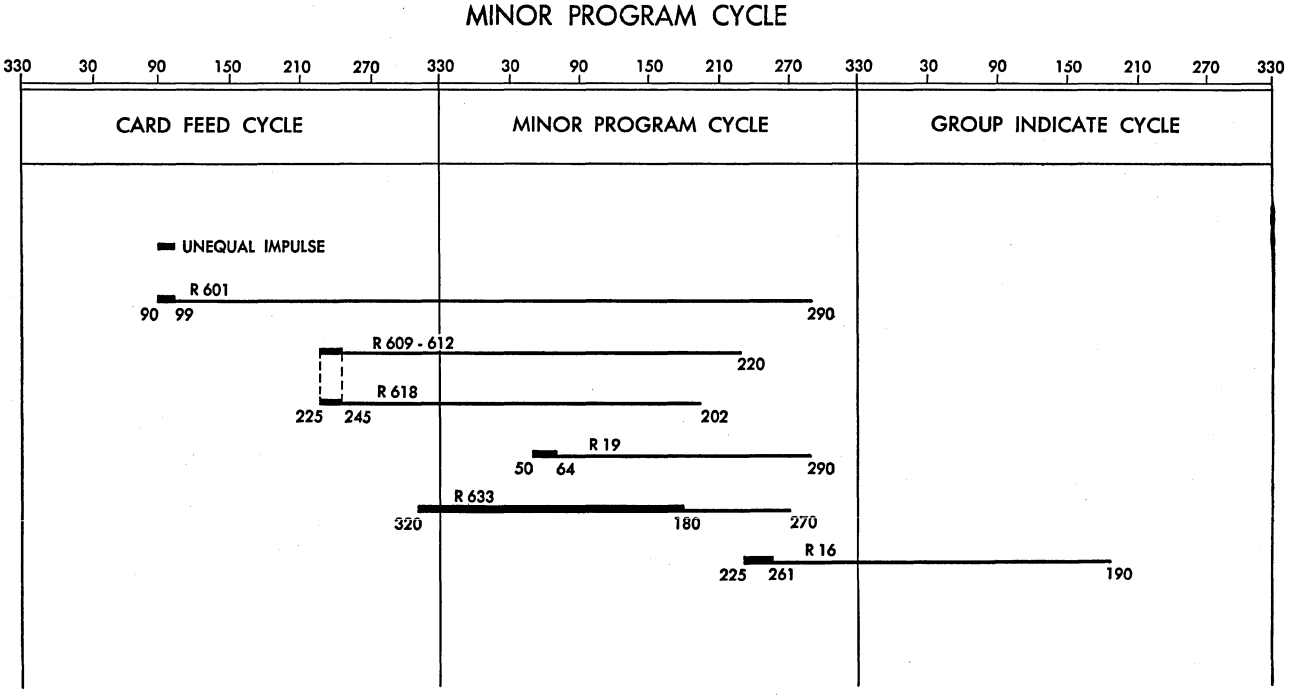


Figure 92. Minor Program Cycle

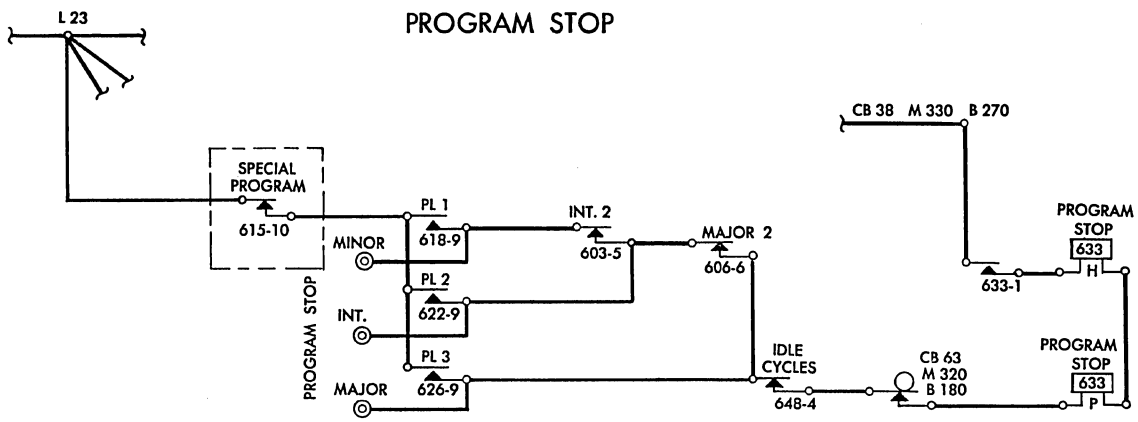


Figure 93. Program Stop

9. To provide for group-indicate print cycle when not wired to list.
   a. R656 picks when 612-7 returns to N/C side. 5B
   b. R656 holds by CB24. 6B
   c. CF clutch magnet energized through 656-2 and 3. 6A
   d. R79 and zone control magnet pick through 16BU and CB19. 4B
   e. Print clutch magnet energized through 79AL, 656-4 and 5, CB27. 6A

Intermediate and Major Program

The three *I* (immediate) hubs labelled minor, intermediate, and major, start total programming: one program for minor, two for intermediate, and three for major. If intermediate program start were wired alone, a minor total cycle would be forced before the intermediate total cycle. If major program start were wired alone, both a minor and an intermediate total cycle would be forced before the major total cycle.

Each program level has seven exit hubs that emit all cycles impulses whenever the corresponding program start is impulsed. Program start must be impulsed before these hubs become active. Minor program exits emit impulses when the minor program start is impulsed. Minor and intermediate program exits emit impulses when the intermediate program start is impulsed. Minor, intermediate, and major program exits emit impulses only when the major program start is impulsed. Each row of hubs is completely independent of the other row of hubs, and only one row is active at a time.

Program Stop. The operation of minor, intermediate, and major program cycles is controlled by program stop R633. How far program cycles advance is determined by when R633 is energized. R633 is picked by CB63 and a series of program control points (Figure 93). Intermediate 2 and major 2 normally closed points prevent program stop from occurring until the correct number of program cycles has been completed.

Major Program Level

A sample report using major control is shown by Figure 94. The three levels of grouping are commodity (minor), salesman (intermediate), and branch office (major). Minor totals are a sum of all commodity amounts within a minor group. Intermediate totals are a sum of all minor totals within the intermediate group, and major totals are a sum of all intermediate totals within the major group. Notice the first major control break shown was caused by a change in branch office number only. Minor and intermediate totals were automatically printed on the major control break.

PREPARATION: The control panel is wired for minor, intermediate, and major programming (Figure 95). The machine has sensed a major control change only as illustrated by the first major control break of Figure 94. Operation of the more important program, advance, and control relays for major programming is shown by Figure 96. For a complete sequence chart of all relays involved in major programming, refer to sections 83-86 of WD210201R.

SALES ANALYSIS REPORT

Branch Office Number (Code)	Salesman Number (Code)	Commodity Number (Code)	Total Sales by Commodity for each Salesman	Total Sales by Salesman	Total Sales by Branch Office
324	205	123	4758		
324	205	125	32467		
324	205	139	1378		
				38603*	
324	207	125	32567		
324	207	139	3548		
324	207	143	17384		
				53499*	
330	207	143	3780		92102**
330	207	159	4357		
				8137*	
330	237	123	65370		
330	237	143	5367		
				70737*	
					78874**

Figure 94. Sales Analysis Report

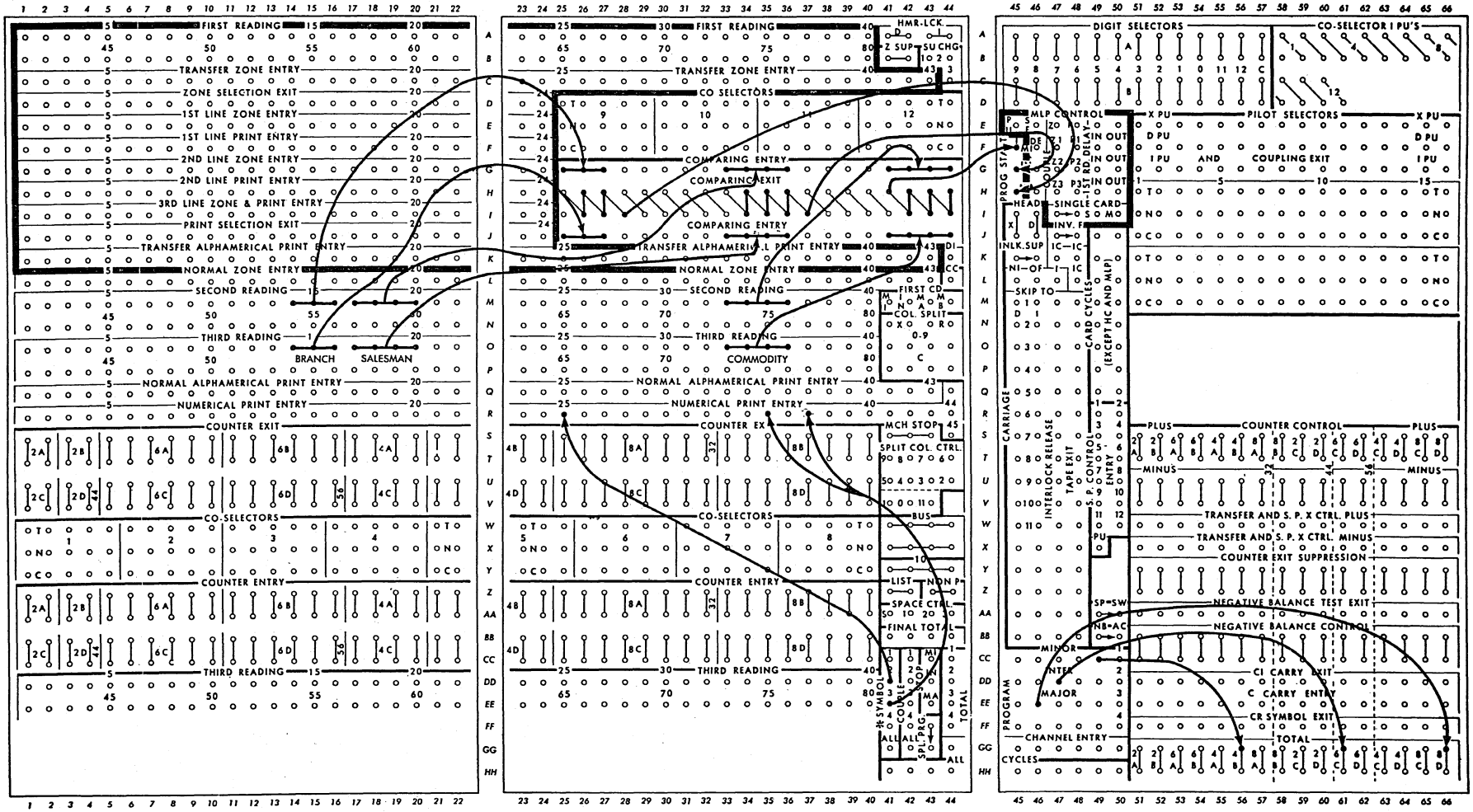


Figure 95. Sales Analysis — Minor, Intermediate and Major Control

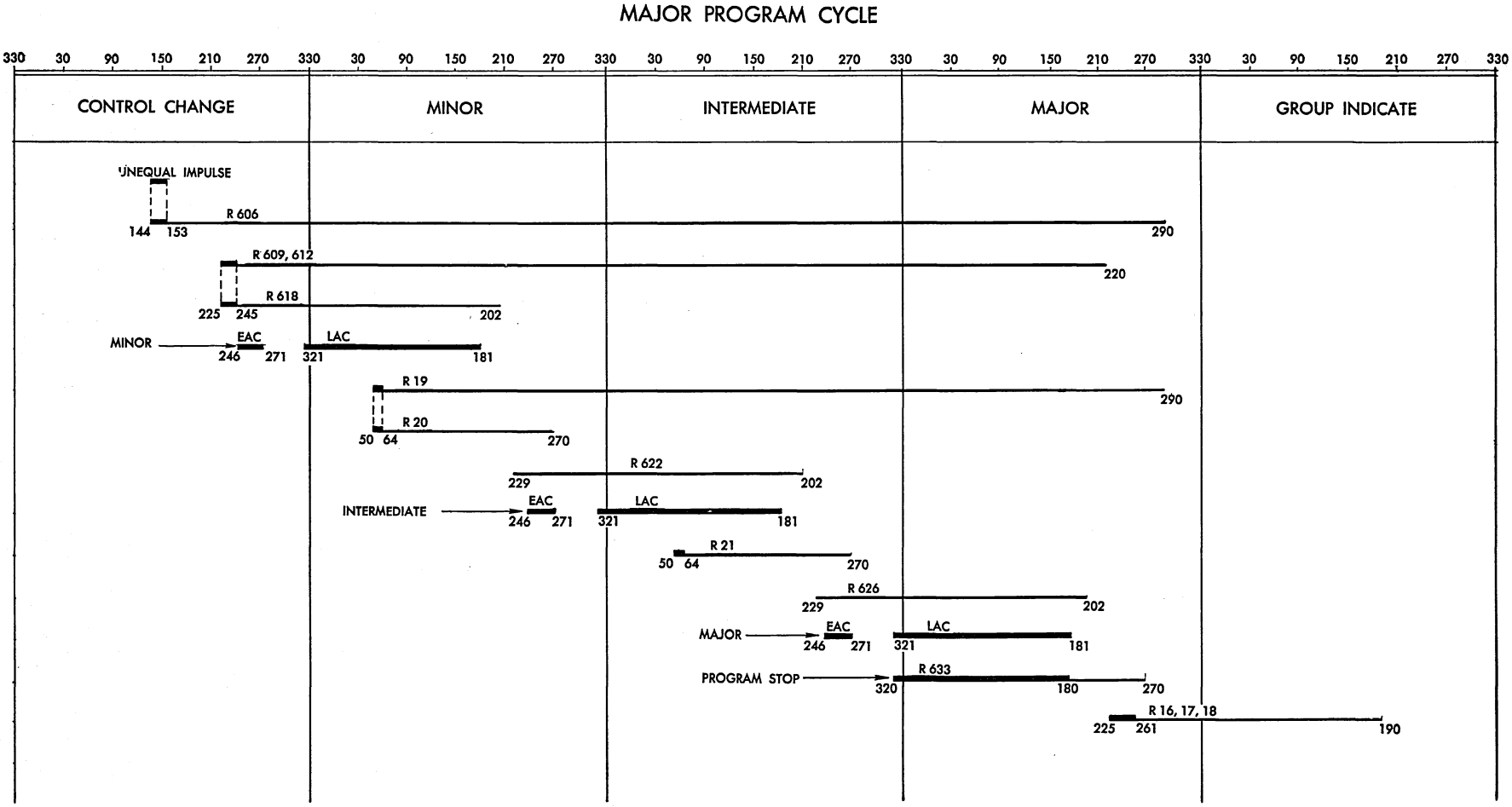


Figure 96. Major Program Cycle

OBJECTIVES:

1. To energize program relays.
   a. R606 picked by comparing exit impulse from major control field. 32B
   b. R606 holds through CB50 shunted by 612-1 N/O. 32B
   c. R609, 612 and 618 picked through 606-5 and CB52. 34A
   d. R609 and 612 hold through CB51 shunted by 633-3 N/C. 34B
   e. R618 (program level 1) holds with the same coil through 618-1 and CB32. 34A
2. To stop the card feed.
   Same as Step 2 of minor program level.
3. To energize the print clutch.
   Same as Step 3 of minor program level.
4. To prevent a restart of minor program.
   a. R19 picks through 609-2 and CB54. 36A
      R19 holds through CB50 shunted by 612-1 N/O. 32B
   b. R609, 612, and 618 cannot repick from CB52 because of 19BL N/C now open. 34A
5. To set up program levels 1, 2, and 3.
   a. Program level 1 hubs emit EAC-LAC impulses through R618 points from CB's 78 and 79. 35B
   b. R20 picks through 618-10 from CB54. 36A
      R20 hold by CB38. 36A
      At 202° of the minor program cycle, R618 drops out and completes circuit for level 2 set up.
   c. R622 (program level 2) picks through 20B, 618-1 N/C and CB32. 34B
   d. Program level 2 hubs activated through R622 points from CB's 78 and 79. 35B
   e. R21 picks through 622-10 from CB54. 36A
      R21 hold by CB38. 36A
      At 202° of the intermediate program cycle, R622 drops out and completes the circuit for level 3.
   f. R626 (program level 3) picks through 21B, 622-1 and CB32. 34B
      R626 holds with the same coil through 626-1 and CB32. 34B
   g. Program level 3 hubs activated through 626 points from CB's 78 and 79. 35B
6. To print total symbols on each level of total. Asterisk symbol hubs emit a *10* impulse from CB67 and CB's 1, 2, 3, and 4.
   a. Minor level, * symbol 1 through 618-11. 36B
   b. Intermediate level, * symbol 2 through 622-11. 36B
   c. Major level, * symbol 3 through 626-11. 36B
   d. All levels, * symbol ALL through 612-3. 36B
7. To cause a program stop.
   a. R633 picks from CB63 through 626-9. 36B
      R633 holds by CB38. 36B
   b. R609 and 612 drop when 633-3 opens to allow CB51 to break the hold circuit. 34B
8. To energize first card minor, intermediate and major hubs only on the first cycle following the major total cycle.
   a. R16, 17, and 18 pick through 606-4, 606-3 and 606-2, respectively, 633-4 and CB49. 32B
      R16, 17 and 18 hold by CF4. 32B
   b. First card minor, intermediate, and major hubs activated through 16AL, 17AL, and 18B. 36B

   Although R606 picks from a comparing exit impulse at the beginning of major programming, the first card impulses are not available until after the major total cycle because of 633-4, program stop relay point.
9. To provide for group-indicate print cycle when not wired to list.
   Same as step 9 of minor program level.

Final Total Program

There are three final total program hubs used to clear final total counters that are not under the control of minor, intermediate, or major program levels. The final total program level provides early and late all cycles impulses to operate the total relays for the final total counters.

The final total key will not initiate a program start as in normal program total printing. Because all other machine operations should be completed, the final total key circuit is designed to make the final total level active only under the following conditions:

A. There are no cards in the hopper.

B. All cards have passed the third reading station.

C. The machine is completely stopped with power on.

D. Both start key and final total key are depressed together.

The sequence chart of Figure 97 shows the operation of relays during a final total program. Actually the machine is not in programming cycles at all as R609 and 612 are not energized during final total cycles.

OBJECTIVE: To start a total cycle and cause final total hubs to emit EAC and LAC impulses for clearing final total counters by depression of start and final total keys. To provide for a final total symbol.

1. R65 energized by final total key. No hold circuit. This is possible only if conditions A, B, and C are satisfied. 4B
2. R24 and R1 pick through start key, jack, L7. 4B
   R24 holds by CB32. 34B
   R1 holds through start key jack to L7. 4A
3. R2 (start and run) cannot pick because of 24BL N/C now open. 4B
4. R5 picks through 24AL and holds by CB18. 3A
5. Two-speed clutch energized through 5AL runs at high speed until R82 drops. 3B
6. R665 picks through 24BU N/O and CB52. 34A
   R665 holds in parallel with R24. 34B
7. R659 picks through 665-6 to raise the type bars. 5B
8. Final total hubs emit EAC and LAC impulses, which come through 665 and 635 points from CB's 78 and 79. 36B
9. Asterisk symbol F hub emits a *10* impulse from 665-10. 36B
10. R82 drops when CB23 breaks and cannot pick for final total cycle because of 659-7. 6A

Total Program Couple

There may be some reason for wanting the minor, intermediate, and major totals to appear on the form in some other order than program level 1, level 2, level 3. The control panel hub 1, 2, 3 and the all program couple emits an impulse from 232° to 202°, which is longer in duration than both the early all cycles and late all cycles impulse of the program level. This impulse will also be available from the couple hub during idling cycles such as summary punching or correction and until after the program levels called for are completed, since CB32 is shunted by the R648-3 idle cycles point. They are normally wired to a selector pickup to expand program exits, or to each other to cause two or more totals to print on the same line.

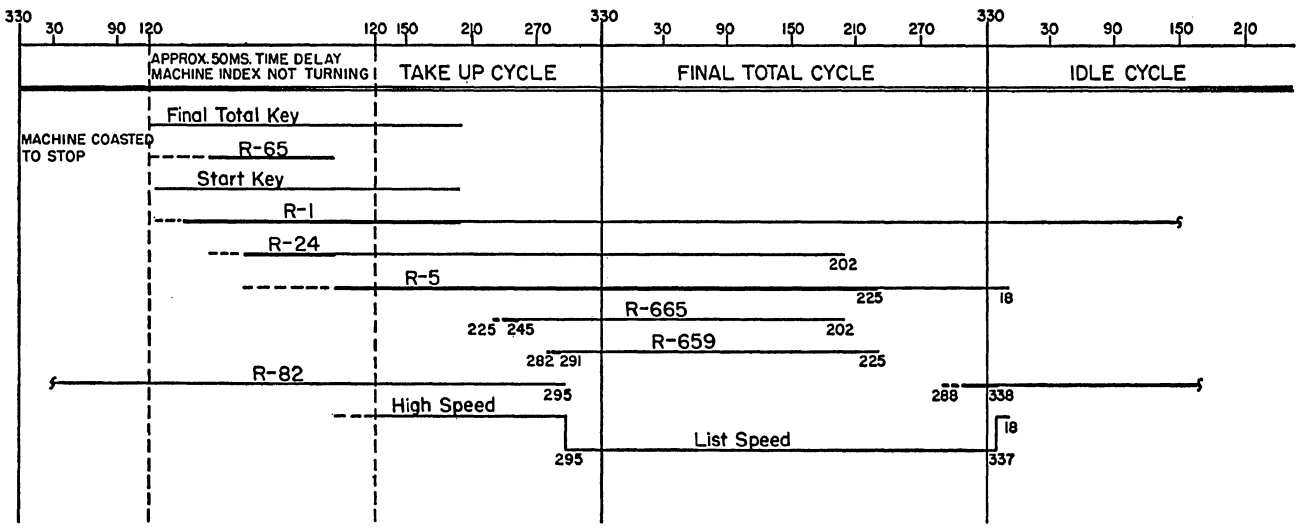


Figure 97. Final Total Sequence Chart

First Card in Control Change

With the first card in, a comparison will be made between the first card at the second reading, and no card or circuit at the third reading station.

The unequal condition will cause the comparing exit to emit an impulse to the program start that is wired on the control panel. This will cause the machine to complete the number of program levels for which it is wired on the control panel. However, printing of the totals standing in counters at this time is not desirable, and non-print will be energized automatically to prevent the type bars from rising. Also counter exit suppression will be energized automatically to prevent any totals transferring from counter group to counter group if the control panel is so wired. The foregoing results in run-in, clearing, program cycles which insures that counters wired on the control panel will be reset to zero at the beginning of a new report.

PREPARATION: Control panel wired for minor, intermediate, and major programming. The machine feed is clear, and a deck of cards has been placed in the hopper ready to run.

OBJECTIVE: To allow run-in program cycles without transferring totals or raising type bars to print.

1. R10, 11 and 12 pick through card lever contact 2, and CF8 as the first card in is passing second reading. 42B
2. The first card in as it passes second brush station compares against nothing from third brush station to cause a major control change.
3. R609, 612 and 618 are energized as a result of major control change and program cycles begin. 34A
4. R577 picks through 15BL, 612-5, 12BL and CB22. 5B
   R577 holds and picks R886 from CB24 to suppress counter exits. 6B
5. R662 hold energizes through 577-12 from CB24. 6B
6. The machine completes program levels in the regular manner, but 662-2 and 3 prevent the print clutch from energizing and the type bars from rising. 6A

Last-Card Control Change

As the last card passes the third reading station, all comparing relays wired to the third reading brushes will be energized (if those columns are punched other than zero). None of the comparing relays wired to the second reading station will be energized, as the R222BL card lever 2 point will be open. Therefore, a control change will take place on the last card-feed cycle in order to print the totals for the last group of cards.

Last-Card Automatic Total

With the last-card automatic total switch OFF, the comparing unit operates normally, and program start hubs must be impulsed before totals can be printed.

After running a report with group control and programming, an operator may wish to re-run the cards for a final total only. It would then be desirable to suspend normal comparing and allow the machine to feed all the cards, printing only a last-card automatic total. With the last-card auto total switch ON, comparing exits are made inactive, and a major program change is forced on both the run-in and runout regardless of control panel wiring. This will produce the required results.

OBJECTIVES (auto total switch on):

1. To make comparing exits inactive.
   a. Comparing exit hubs normally energized from CB's 46 and 47 cannot emit when a comparing difference occurs because of last-card auto total switch (lower) open when ON (29A). 29B
2. To force a major program on run-in and runout regardless of control panel wiring. 29A
   a. R9BU will be transferred and 222BU normal at the end of the second run-in cycle. 29B
   b. R1078 picks through last-card auto total switch ON, 9BU N/O and CF3. 32A
      R1078 holds through CF36. 32A
   c. R606 picks through 1078-2 from CF35 during the next card-feed cycle to start programming. 31B
   d. R9BU will return to normal during the cycle in which the last card passes second reading. 29B
   e. R1078 picks through last card auto total switch ON and 9BU N/C to start program delay on the runout. 32A

Run-in programming provides for normal non-print clearing. Runout programming causes last-card totals to print. The program delay relay is used to allow the last card to read at third brushes before final totals are printed.

Special Program

Special program is available at an additional monthly charge and is not a standard feature of the Types 402, 403, or 419; however, the hubs and circuits are shown on the wiring diagram.

With the special program switch wired (Figure 98), the all cycles impulses to the program levels are disconnected internally at the channel entry. They must then be externally wired, either direct to channel entry or through a pilot selector. This feature provides a means of obtaining up to 28 program cycles following a control change. Programming is started by impulsing a program start hub and stopped by impulsing the program stop hub corresponding to the program start hub that was used.

Channel Entry (Figure 98). The channel entries accept the all cycles impulse to control the activity of the channel hubs immediately above since R615 is energized and all of the R615 points are open.

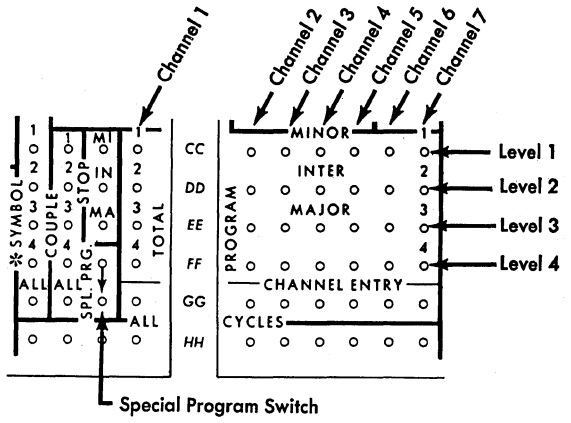


Figure 98. Special Program Control Panel Exits

When R615 special program is not wired, all hubs are internally connected and all cycles impulses are available at each program level.

Special program permits selection of one channel for four steps, another channel for a second four steps, and so on.

PREPARATION: Control panel wired for six program levels as in Figure 99. Cards have run through the feed and a minor control change has been sensed.

Control Panel Operation. Programming is started by an impulse to minor program start immediate. On the fourth program level, a pilot selector picks and all cycles impulse enters channel entry 2. Program level 6 picks minor program stop to end special programming. Refer to Figure 100 for a sequence of relay operation.

OBJECTIVES:

1. To disconnect internally all cycles impulses from minor program hubs.
   a. R615 energized through special program switch wired ON. 24A
   b. Program level hubs internally isolated from all cycles impulses by 615-1 through 7 N/C points. 35B
2. To start and hold machine in programming cycles.
   a. R609, 612, and 618 pick through 601-3, which is closed because of control impulse to minor program start immediate hub. 34A
   b. R609 and 612 hold through CB51 shunted by 633-3 N/C. Until R633 can be energized to allow R609 and 612 to drop, the machine will remain in program cycles. 34B
   c. R618 holds through and will drop when CB32 breaks. 34A
   d. Channel 1-7, level 1 hubs are connected to channel entry hubs respectively through 618-2 through 618-8. 36B
3. To cause program levels to advance and repeat themselves.
   a. R20 picks through 618-10 and holds by CB38. 36A
   b. R622 (level 2) picks through 20B when R618 drops. 34B
   c. R21 picks through 622-10 N/O and holds by CB38. 36A
   d. R626 (level 3) picks through 21B when R622 drops. 34B
   e. R22 picks through 626-10 N/O and holds by CB38. 36A
   f. R630 (level 4) picks through 22B when R626 drops. 34B
   g. R23 picks through 630-10 and holds by CB38. 36A
   h. R618 (level 1, now level 5) picks through 23B when R630 drops. 34A

From this point, special programming is a cascade circuit, picking program level relays 1, 2, 3, and 4 consecutively and then repeating until the operation is stopped.

Special Program Stop. Normally programming will be stopped after the third level (in case of major) by CB63 from L23. This circuit is now interrupted by 615-10 (35A), and program cycles can continue indefinitely or until stopped by an impulse to a program

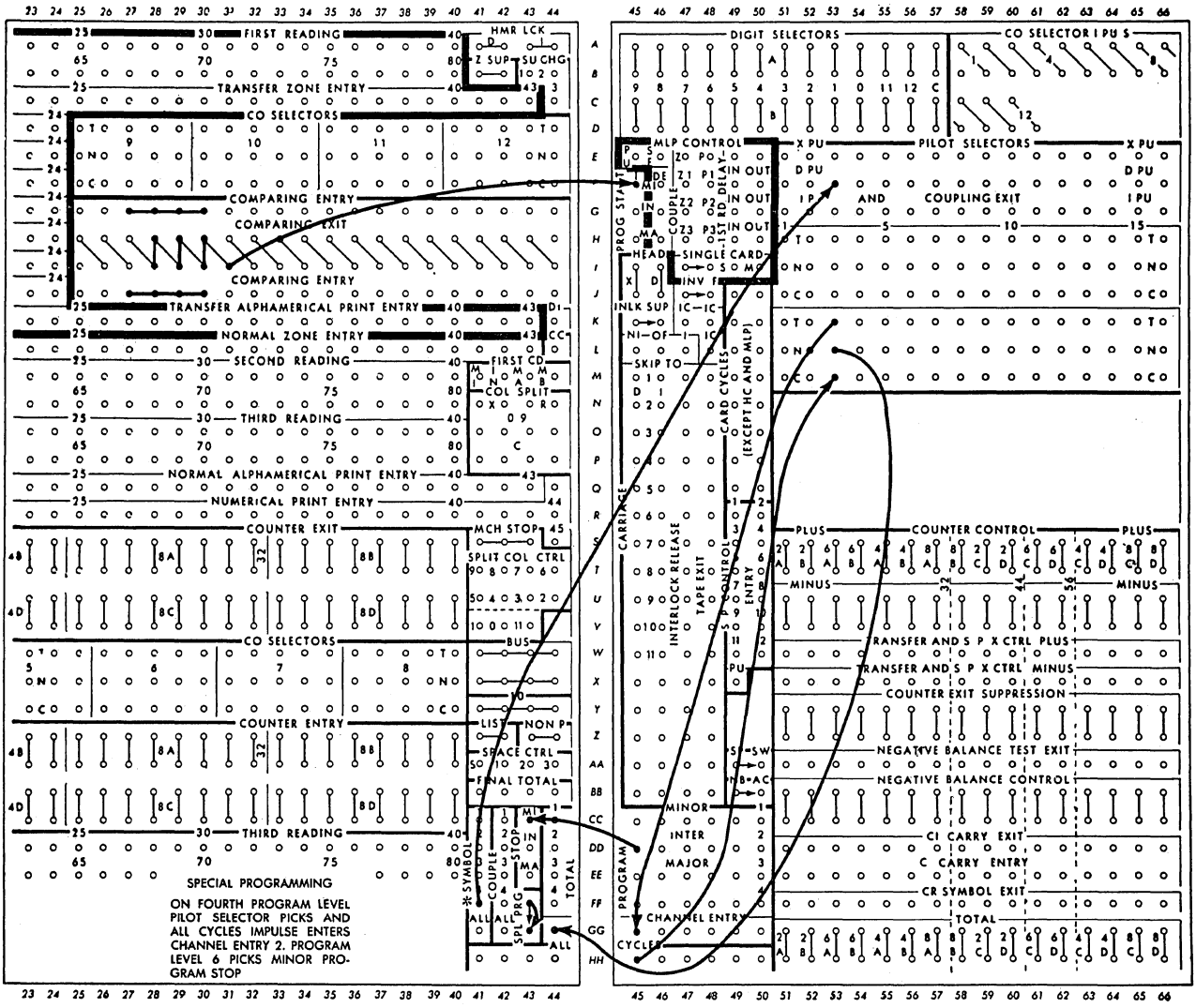


Figure 99. Special Program Six Levels

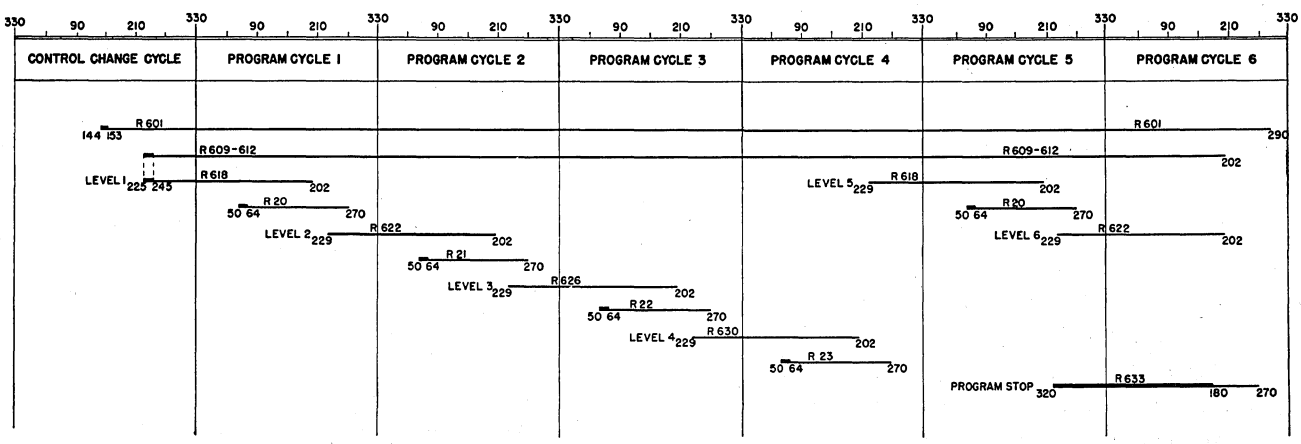


Figure 100. Relay Sequence Special Program

stop hub. High-level program stop hubs take precedence over low-level hubs when program cycles are stopped. Thus special programming started by the minor program start hub can be stopped with minor, intermediate, or major stop hubs, but special programming started by the major program start hub can be stopped only with the major stop hub.

NON-PRINT RUNOUT

THERE ARE occasions when an operator, after testing the machine, will position the form manually for line 1 before beginning a new report. He will then want to run the test cards out of the card feed and prevent the detail printing of these cards from spoiling additional forms. If any amount has been accumulated in the final total counters, it will be necessary to clear these counters manually as they will not be reset automatically when cards are run in. Before a non-print operation can be started, all cards must be removed from the hopper. This prevents the operator from starting a card-feed cycle with the non-print runout key unless the intention is to clear the feed of cards.

OBJECTIVE: To run cards out at high speed without printing or spacing when cards have been removed from the hopper.

1. R78 picks through non-print runout key, start key jack and L4. 6B
   R78 holds through 15AL closed until the last card passes third reading station. 6B
2. Two-speed clutch energized by R5, which picks through 78BU and L1. 3B
   R5 holds by CB18. 3A
3. R656 picks through 78AL from CB's 20 and 21. 5B
   R656 holds by CB24. 6B
4. Card feed clutch energizes through 656-2 and 3. 6A
5. R577 picks through 78BL and CB22. 5B
   R577 holds and picks R886 from CB24. All counter exits are suppressed by R577 and R886 points. 6B
6. R662 picks through 577-12 and holds from CB24. 6B
7. Print clutch circuit is blocked by 662-2 and 3. 6A
   R79 (list control) is blocked by 662-4. 4B
8. Spacing is suppressed because the print mechanism cams, through which the space circuit passes, do not operate.

FEED INTERLOCK

THE FEED INTERLOCK circuit is provided to avoid spoiling a form if a card should fail to feed from the hopper into card lever 1 station. When this occurs, card lever 1 has not been operated, the card lever 1 relay points open to allow the start relay hold to break. The machine will now stop with cards in the hopper, no card at card lever 1 and cards at card lever 2 and 3 stations (Figure 101).

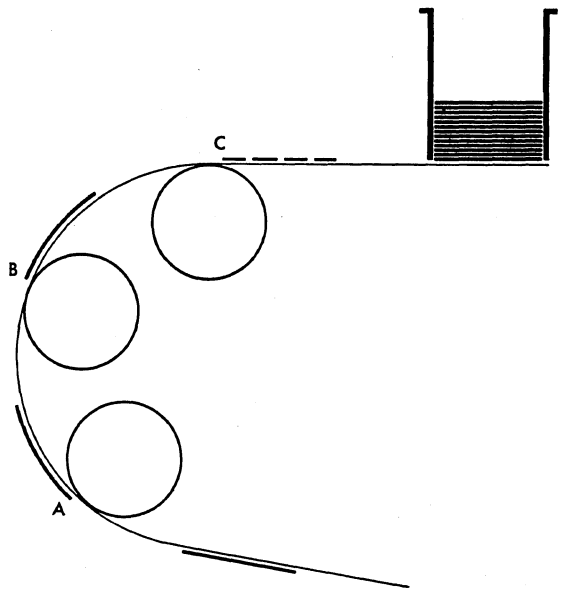


Figure 101. Feed Interlock Stop

To indicate why the machine has stopped, the card feed stop light will come on and remain on until something is done to correct the situation. To prevent further operation, the start key, non-print runout button and feed interlock start key are all inoperative. It is now desirable to run the remaining cards out of the feed, repair or replace the damaged card, and continue the run from this point.

PREPARATION: The control panel is wired for comparing from second and third reading stations, minor programming, and printing and accumulating from the third reading brushes. Cards have been continuously running and listing properly when card C (Figure 101) fails to feed from the hopper. Figure 102 shows the position of cards in the feed at the end of each runout cycle, and the condition of card lever and feed interlock relays. This figure is used as reference in the circuit description.

RUNOUT

OBJECTIVE: To run cards out of the feed without a control change if the machine has stopped because of failure to feed a card from the hopper.

Card Feed Failure Cycle

To stop the machine and energize the card feed stop light.

To prevent further operation from the start key, non-print runout button, and feed interlock start key until cards are removed from the hopper.

1. R8 and 9 drop when card lever contact 1 does not reclose. 42B
2. R62 picks through 9AL from CB31. 23B
   R62 holds and energizes R66 from CF14. 23B
3. R2 drops and stops the machine when 8BU opens. 4B
4. Card feed stop light energizes through 66BL. 8B
5. Start key inoperative because of 62AL. 4B
6. Non-print runout key inoperative because of 66AU N/C. 6B
7. Feed interlock start key inoperative because of 6BL. 4B

First Runout Cycle

To cause the feed interlock start key to operate the feed only after cards have been removed from the hopper.

To allow normal comparing between cards B and A and normal programming if a comparing difference exists.

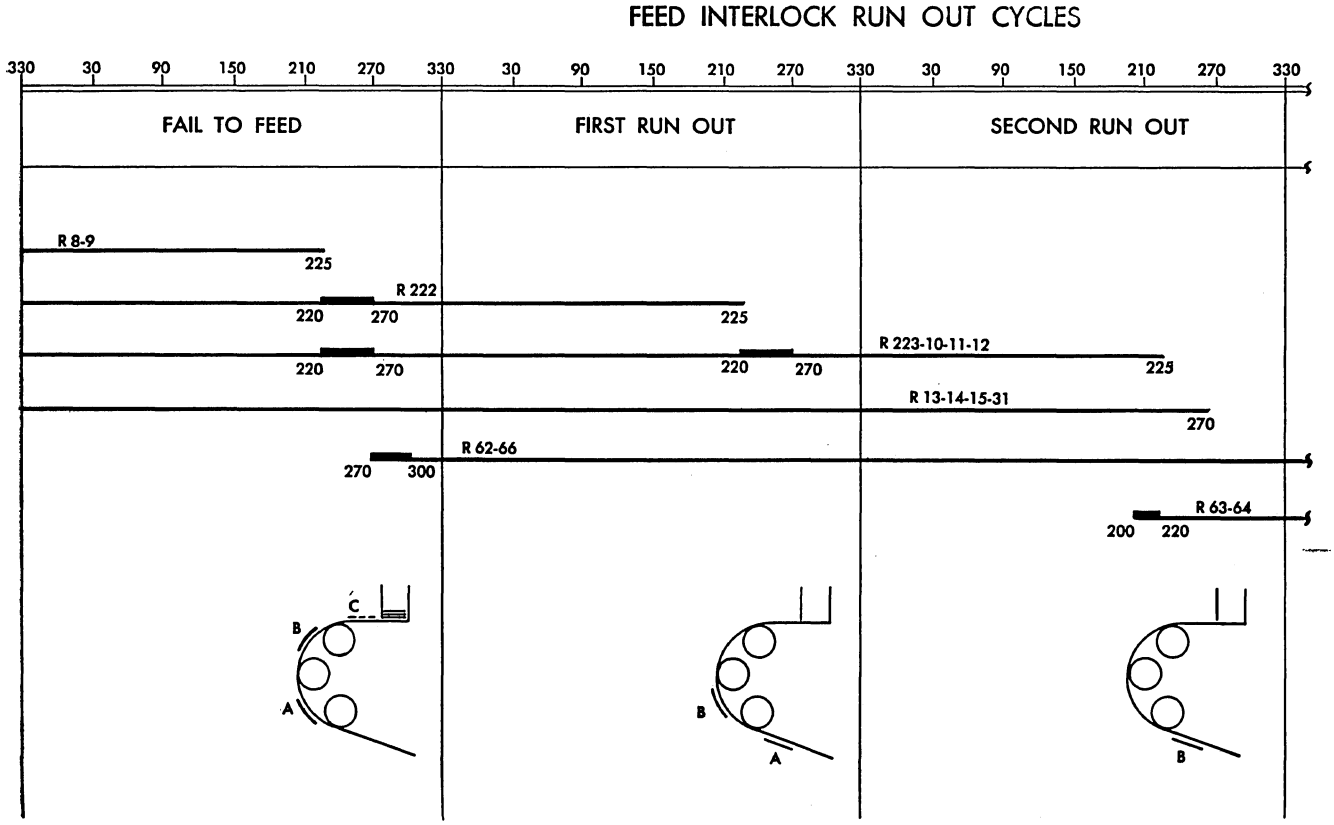


Figure 102. Feed Interlock Runout Cycles

1. R6 and 7 drop when cards are removed from the hopper. 3A
2. R62 and 66 continue to hold through 7AL. 23B
3. R2 picks through feed interlock start key, 6BL N/C, start key, and L7 to operate the feed. 4B
4. Cards B and A feed by second and third reading brushes respectively and compare normally.
5. Program cycles may be started if a comparing difference exists between A and B as 63BL N/C is still made. 34A
6. R222 drops because card lever contact 2 does not remake. 42B

Second Runout Cycle

To allow normal listing and accumulating of card B.

To suppress programming that results from a comparison between card B at third reading and nothing at second reading.

1. Feed interlock key causes card B to feed by third brushes same as before.
2. R223 and R10, 11, and 12 drop after all reading of card B has taken place at the third brushes. The third card lever relays will not repick because card lever contact 3 does not remake. 42B
3. R63 picks through 1082-5, 222AL and CF5. 23B
   R1082 picks every cycle through MLP circuits which are not active at this time.
   R63 holds and energizes R64 through CF14 or 7AL. 23B
4. R13, 14, and 15 drop when CB68 opens after R11 has de-energized. 24B
5. Feed interlock relays 62, 63, 64 and 66 now hold through 15BU N/C until R15 is energized on the run-in. 23B
6. Programming is prevented by 63BL N/C (now open), which blocks the pick to R609, 612, and 618 even though the comparing unit signals the machine to take a control break. 34A

At this point, all cards that were in the machine at the time of the feed failure have run past third reading station. Card B (the last card out) has compared with the card ahead of it (card A), accumulated, and printed from third reading in the normal manner. The only remaining function of card B is to compare with card C, and this must be done on the run-in.

RUN-IN (Figure 103)

OBJECTIVE: To run cards in without accumulating or printing from the first card and to prevent a run-in control change. The operator must take the last card run through the machine on runout (card B), place it in the hopper ahead of repaired card C, and restart the run using the feed interlock start key.

First Run-In Cycle

1. R6 and 7 are energized by placing cards in the hopper. No other card levers are up. 3A
2. R2 picks through feed interlock start key, 64-A and 62AL to start the card feed unit. 4B
3. R8 and 9 pick through card lever contact 1. 42B

Second Run-In Cycle

R222 picks through card lever contact 2. 42B

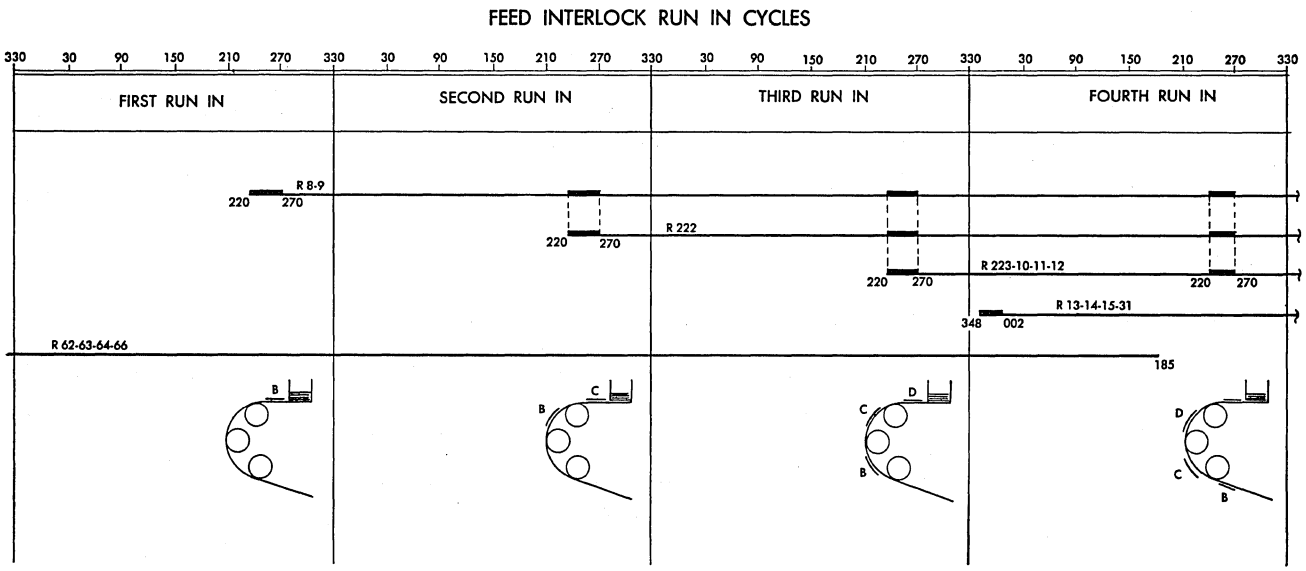


Figure 103. Feed Interlock Run-In Cycles

Third Run-In Cycle

1. Comparing unit signals the machine to start run-in control break as card B at second brushes compares against nothing at third brushes.
2. R609, 612, and 618 pick is blocked by 63BL N/C (still open) to prevent run-in programming. 34A
3. R223 and R10, 11, and 12 pick through card lever contact 3. 42B

Fourth Run-In Cycle

1. As card B (previously listed) passes third brushes
   a. reading takes place normally through 223AL. 42A
   b. listing is suppressed by 63BU, which picks exit suppression R577 and non-print R662 (through 577-12, Section 6B). 5B
   c. accumulating is suppressed by 63AL, which blocks the pick of all cycle and card cycle relays 635, 638, and 641. 23B
2. R13 picks through CF13 and 11AU. 43B
   R13 holds and energizes R14 and 15 and R31 (through 64B). 24B
3. R62, 63, 64, and 66 drop when CF14 opens after R15 is energized. 23B
4. Comparison between cards B and C can cause a control break because 63BL remakes in time to energize R609, 612, and 618. 34A

When R66BL opens (8B), the card feed stop light goes out and the remainder of the cards run normally as though no failure to feed had occurred.

PILOT SELECTOR

A PILOT SELECTOR is a relay equipped with two transfer points that are connected directly to the control panel, and act as an automatic switch. The 56- and 80-counter machines have 11 pilot selectors as standard, and 5 as optional. Control panel hubs are marked *C* for common, *N* for normal, and *T* for transferred. When the selector is normal (de-energized) a circuit is established from C to N; when transferred (energized), from C to T. The purpose of the pickup hubs marked X-PU, D-PU, and I-PU is to transfer the selector.

Each pilot selector position is composed of three relays, an X-control relay picked by an 11 or 12 impulse, a digit control relay picked by any digit impulse, and a transfer relay, which contains the actual selector points. The sequence chart of Figure 104 will be helpful in following the circuit description.

OBJECTIVE: To pick pilot selector 1 with an X or digit impulse and cause the points to be transferred during the following card feed cycle.

To pick pilot selector 1 with an impulse to the immediate pickup hub and cause the points to be transferred only during the cycle in which the pick occurred.

X-PU

1. R871 and 874 are energized every card feed cycle at 11 and 12 time from CF2. 28A
2. R893 picks from an X impulse directed to the X-PU hubs. 27A
   R893 holds through CF7. 27A
3. R889, 645, and 642 pick during EAC time from CB41. 24B
4. R895 picks through 893-2 from CB72. 27A
   R895 holds from CB44. 27A

D-PU

1. R894 picks from a digit impulse directed to the D-PU hub. 27A
   R894 holds from CF7. 27A
2. R895 picks through 894-2 from CB72. 27A
   R895 holds from CB44. 27A

I-PU

R895 picks directly from any impulse directed to the I-PU hub. 27A
R895 holds from CB44. 27A

Of importance is the fact that pilot selector X and digit control relays hold from CF7 which opens at 340°. This is beyond the latching point of the card feed clutch (330°) and allows the control relays to remain energized during program cycles. Thus, the pilot selector will transfer its points on the next card feed cycle following the one in which X- or D-PU was impulsed. Note also the I-PU hub may be used as an exit and will be active when its pilot selector transfers.

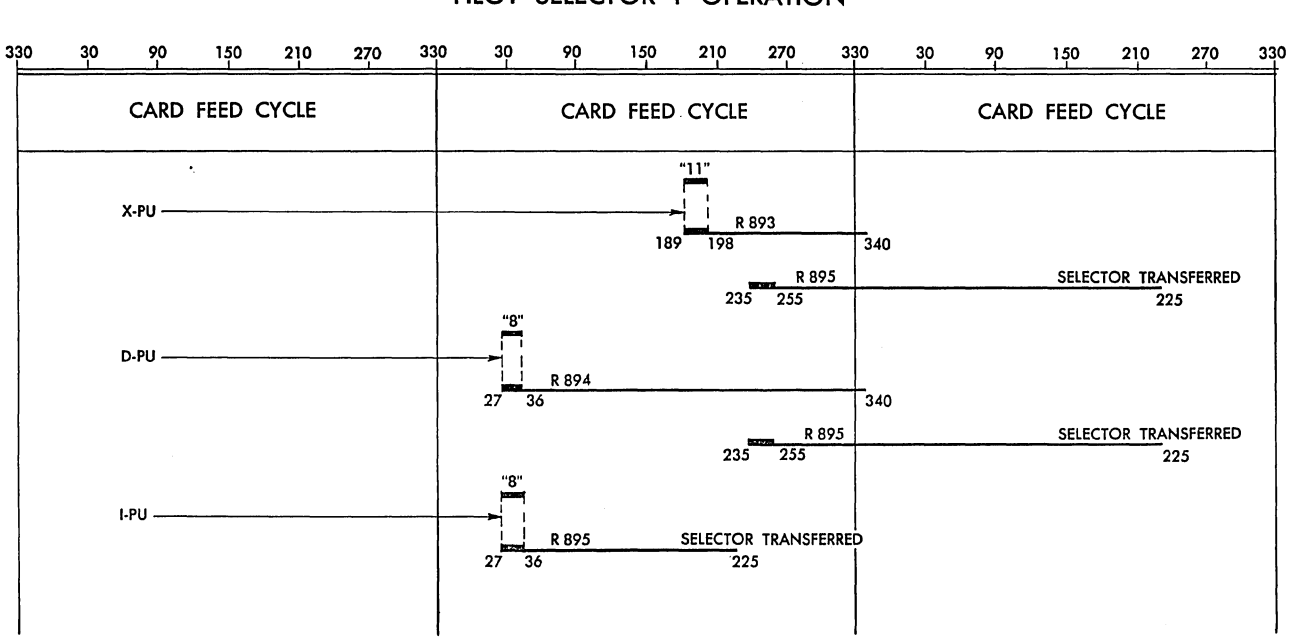


Figure 104. Pilot Selector 1 Operation

CO-SELECTOR

A CO-SELECTOR is a relay with five transfer points that are connected to the control panel in the same manner as the pilot selector points. Eight co-selectors are standard on the 56- and 80-counter machines. Each co-selector position consists of one relay whose pick coil is directly connected to its I-PU hub and hold coil through a hold point to CB44. Co-selector relays and charts showing selector, relay, and point numbers are located in section 28A and B of the wiring diagram. A co-selector may be picked by any digit impulse directed to its pickup hub and will hold only until 225° of the cycle in which it was picked. Co-selectors are normally wired to I-PU of pilot selectors for control purposes.

DIGIT SELECTOR

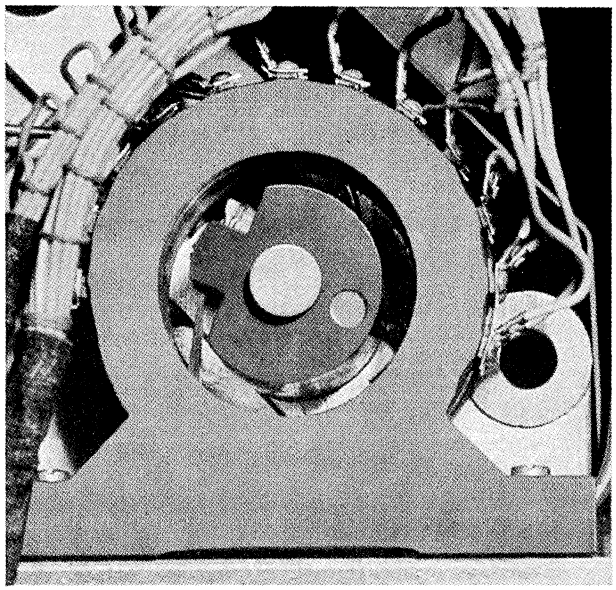
A DIGIT SELECTOR is a rotating switch that consists of two or more moving brushes that make contact against the inner circumference of an emitter moulding (Figure 105). The digit selector emitter has 12 segments, one corresponding to each of the 12 punching positions of the card. The common brush, which connects to the digit selector common hub, makes contact on the 9 segment at the same time any reading brush would read a 9 hole, and makes on the 8 segment at 8 time, etc. Therefore, if the DSC hub is wired to a reading brush, an impulse through a 9 hole in that column would come through to the digit selector 9 hub; an impulse through an 8 hole would come to the 8 digit selector hub, etc. By this means, the punching in a column may be selected, and each digit may be directed, as desired, to operate various circuits.

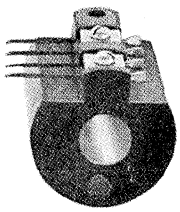
When a machine is equipped with a digit selector (section 30B), the digit selector is located on the left end of the lower shaft on the card feed circuit breaker unit. This emitter, therefore, turns only when the card feed unit is in operation.

A digit selector may also be used as a digit emitter. The DI (digit impulse) hub, section 41A, emits impulses from CB's 1, 2, 3, and 4, which can be applied at the digit selector common through a control panel wire. During card feed cycles, a single digit will be available at each digit time 9 through 12 from the corresponding digit selector hub.

HAMMERLOCK CONTROL

PRINTING from selected type bars may be suppressed by means of the hammerlock bail and springs. The position of the hammerlock bail is controlled by the hammerlock magnet energized by means of D and I hubs, section 25A. The D hub accepts any digit im-





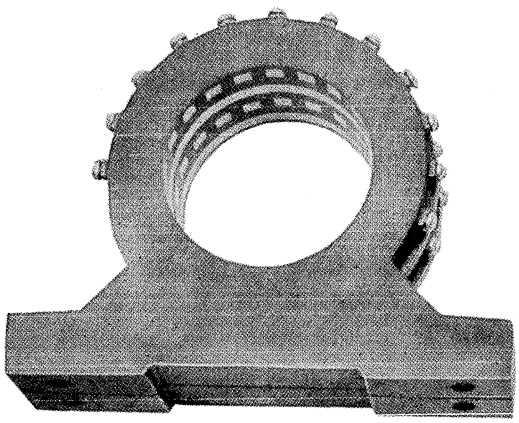


Figure 105. Digit Selector

pulse; the I hub accepts only EAC impulses (246° to 271°) and both cause the hammerlock bail to operate during the next list cycle.

OBJECTIVE: To impulse hammerlock control by a digit sensed at second brushes and cause the hammerlock bail to operate on the next list cycle that the same card passes third brushes.

PREPARATION: Control panel wired second reading brush to hammerlock control, D.

1. R76 picks from digit read at second brushes.	25A
R76 holds through CF7.	26A
2. R77 picks through 76B from CB43.	25A
R77 holds through CB24.	26A
3. Hammerlock magnet energizes through 77B from PM9 on the next list cycle.	26A

If program cycles occur after sensing the digit at the second brushes, 609-10 *(Section 25A)* prevents the pick of R77 and energization of the hammerlock magnet during total cycles. R76 remains held through CF7 to cause hammerlock operation on the first list cycle following programming. The HAMMERLOCK I hub picks R77 direct through an EAC filter point, 645-7, to accomplish the same results.

MACHINE STOP

AN EAC impulse to the machine stop hub will cause the machine to stop continuously running and not start until reset by depression of the final total key. The stop light will be energized and remain on until the machine stop circuit is reset.

OBJECTIVE: To stop continuously running operation and energize the stop light by means of an impulse to the machine stop hub.

To prevent restart of the machine by the start key until machine stop light has been reset using the final total key.

1. R3 picks from impulse to machine stop hub filtered through 645-11, EAC control.	32B
R3 holds through final total key N/C contacts and energizes the stop light.	4B
2. R2, continuously running hold circuit and start key pick circuit interrupted by 3B N/C open.	4A
3. R3 hold and stop light circuit interrupted by depression of final total key.	4B

SETUP CHANGE SWITCHES

SETUP CHANGE hubs *(Section 25A)* emit impulses from CB43 whenever the corresponding setup change switch is ON. Control panels may be wired to serve two applications by the use of co-selectors and setup change switches.

Wiring from the control panel setup change switch hub to the pickup of a co-selector places the control of the selector permanently under the setting of the switch.

COLUMN SPLIT

THE COLUMN SPLIT is a selector that is automatically

operated every card feed cycle from CF2. R874 *(Section 28A)* has four sets of transfer points that are connected directly to the column split control panel hubs. This selector is down during 9 through 0 time and up 11 and 12 time.

SPLIT COLUMN CONTROL

THE SPLIT COLUMN control hub 1 *(Section 30B)* emits an impulse ½ a cycle point after 1, the 0 hub emits an impulse ½ after 0, and the 11 hub emits an impulse ½ after 11. These three hubs are standard and 9-8-7-6-5-4-3-2 are optional at an additional installation charge.

If there are not a sufficient number of column splits, the split column control 0 hub may be wired to co-selector immediate pick and, by the use of the 5 selector transfer points, the number of column split positions may be expanded.

By similar use of any other split column control hub, a co-selector could be transferred and provide a split. For example, the 6 hub would allow 9-8-7-6 to be read through the N/C points and 5-4-3-2-1-0-11-12 to be read or eliminated through the N/O side.

CARD COUNT HUB

THE CARD COUNT hub *(Section 43A)* is under the control of CB5, which makes for 1 time.

The one impulse may be used to impulse a counter start magnet to count the number of cards in a report. It may be wired to cause program start as in the cross-footing application, or it may be wired through the transfer points of a pilot selector, which cause a counter to add the number of X-cards, or no-X-cards, or the number of heading cards.

COUNTERS

IN A STUDY of adding circuits certain basic principles must be kept in mind.

1. Adding is initiated by an impulse to the counter start magnet.
2. The counter adding wheel starts turning 12° after the start magnet is impulsed.
3. The adding wheel continues to turn until 183°, when it is mechanically disengaged by the first lobe of the carry cam.
4. For each 18° turned, the adding wheel accumulates a 1.

If it is desired to add a 5 in a counter, the adding wheel must turn 5 times 18, or 90°. Because the adding wheel always is stopped at 183° (when adding), it must start turning at 183° minus 90°, or 93°.

As the adding wheel starts turning 12° after the start magnet is energized, the impulse to the start magnet must, therefore, come at 93° minus 12°, or 81°. A check of the timing charts will show that the CB impulse through a 5 hole in the card is timed at 81°.

Using the electrical timing chart *(Section 95 and 96)* and the foregoing procedure, Table IV was constructed to show the counter movement for all digits 9 through 0. The wiring diagram shows the complete circuit for counter groups 2A, 4B, 6C, and 8D.

When a counter is accumulating, the information may be sensed at any one of the reading stations, and the impulse used to control the start or stop magnet. It will be assumed, however, that the third reading brushes are being used to sense the card as this station is normally used for all counter accumulating.

Before any counter can operate, there must be some means provided to tell the counter what to do. This

TABLE IV

FIGURE TO BE ADDED	HOLE IN CARD	CB TIME (DEGREES)	START MAGNET ENERGIZED (DEGREES)	ADD WHEEL STARTS (DEGREES)	ADD WHEEL STOPS (DEGREES)	ADD WHEEL HAS TURNED (DEGREES)	ADD WHEEL HAS TURNED (CYCLE POINTS)
9	9	9	9	21	183	162	9
8	8	27	27	39	183	144	8
7	7	45	45	57	183	126	7
6	6	63	63	75	183	108	6
5	5	81	81	93	183	90	5
4	4	99	99	111	183	72	4
3	3	117	117	129	183	54	3
2	2	135	135	147	183	36	2
1	1	153	153	165	183	18	1
0	0	171	171	*Never Starts	183	0	0

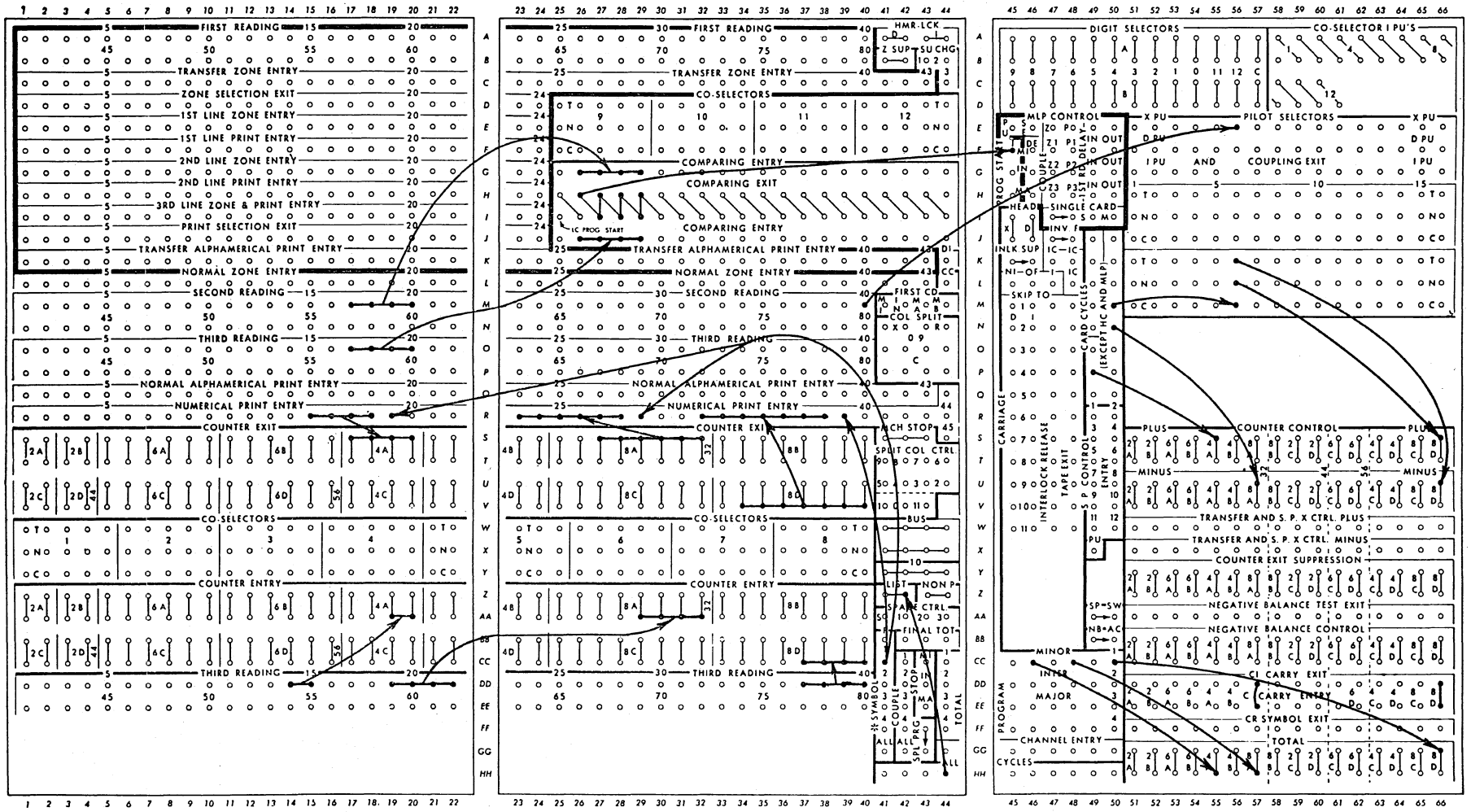


Figure 106. Counter Operation

is normally done with control panel wiring, which can be divided into four sections.

1. Read in—brushes to counter entry
2. Read out—counter exit to type bars
3. Control in—card cycles to counter plus or minus
4. Control out—program level exit to counter total control.

Figure 106 illustrates these steps of counter control. Counter 4A is wired to add only, 8A to subtract only, and 8D to add and subtract. Notice that the wiring to 8D plus and minus relays is under the control of pilot selector 6, which transfers from an X in column 40. The counter will add no-X-cards and subtract X-cards, a very common application of pilot selector control. All counters will total print and reset on a minor program cycle.

Adding and Counter List

PREPARATION: Control panel wired as in Figure 106. Using counter 8D, assume a No-X card punched 268 is accumulating from the third reading brushes.

OBJECTIVE: To impulse the start magnet of counter 80 from third brushes and add an 8. To list an 8 from the counter exit during the adding cycle.

1. R822 (plus relay) picks through control panel wire, pilot selector 6 normal, card cycles hub, CB's 78 and 79. 37A
   R822 has no hold and depends on the LAC portion of card cycles, 321° to 181°, to remain energized until after digit reading time.
2. Start magnet of counter 80 picks at 8 time (27° to 36°) through 822-8 N/O now closed, control panel wire, third reading brush, CB's 1, 2, 3, and 4. The counter will start to move 12° later at 39°, and be mechanically declutched by the first lobe of the carry cam at 183° for a total movement of 144° or 8 cycle points. 64B
3. Print magnet energized by 8 impulse through control panel wire from counter exit, 835-10 N/C, 822-8 N/O now closed, counter entry and third reading brush. 64B

The process of listing and accumulating in a counter at the same time is known as counter listing.

All counters operate in a similar manner when adding; the difference in the amounts in the counters depends upon the number of cycle points before 183° that the start magnet was energized. A recheck of Table IV will verify the number of degrees a counter will turn for each number punched in the card.

Carry and Couple

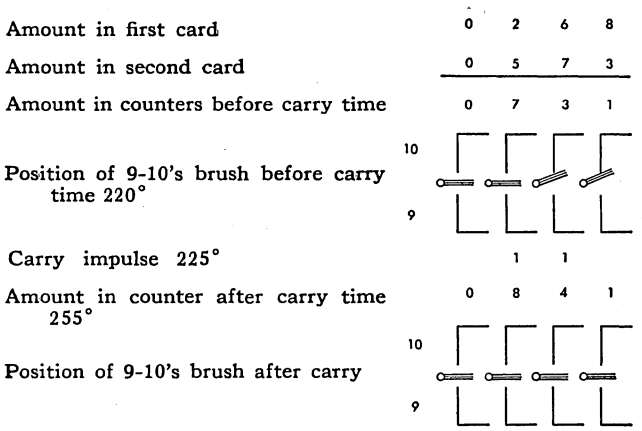
Because it is desirable to accumulate the amounts in any number of cards before program total printing, a method of carrying to the left is necessary. In the course of a run any one position may accumulate enough to carry into the next higher position several times. To prevent an accumulation of carries, the machine will test each counter position every cycle and provide a carry depending upon the position of the 9-10 brush.

All the carry relays are energized between 198° and 238° and, when the points are in their transferred position, provide a circuit for the carry impulse. Because it is impossible to predict when a counter will accumulate an amount greater than 9 and signal a carry 1 to the left, the 9-10 brush is latched on the 10 side at the time the counter passes from 9 to 0.

This allows all carry impulses to be completed at 225° after all adding or subtracting has taken place. The greatest amount that may be carried at the end of any cycle from one position to the next is a 1, the result of adding 9 and 9. For this reason the counter is designed so that when the start magnet receives the carry impulse, the receiving counter will advance only one cycle point before it is mechanically declutched by the second lobe of the carry cam.

CARRY CIRCUIT 10 SIDE

If 573 is added to the original 268 in counter 8D, a carry will occur in the units and ten positions from the 10 side of the 9-10 contacts. Example 1:



During the second add cycle, the units and ten position counters turn past 9 and 0, latching their 9-10 brushes on the ten side. A carry will result from the units to tens, and tens to hundreds positions because of the latched 9-10 brushes.

OBJECTIVE: To cause a carry of 1 from counter 80 to counter 79 as a result of the 9-10 brush latched on the tens side of counter 80.

1. Carry relays 485 through 491 and 841 through 850 pick from CB57. 38B
2. Start magnet of counter 79 picks through 850-11 N/O 10 side 9-10 brush of counter 80, cable wire, CB's 10, 11, 12, 13; and CB's 1, 2, 3, and 4. The carry impulse, 225°-234°, is provided by CB's 10, 11, 12, and 13, but timed from master CB's 1, 2, 3, and 4. 63B

Counter 79 begins to move at 237° and is mechanically declutched by the second lobe of the carry cam at 255° for a total movement of 18° or one cycle point.

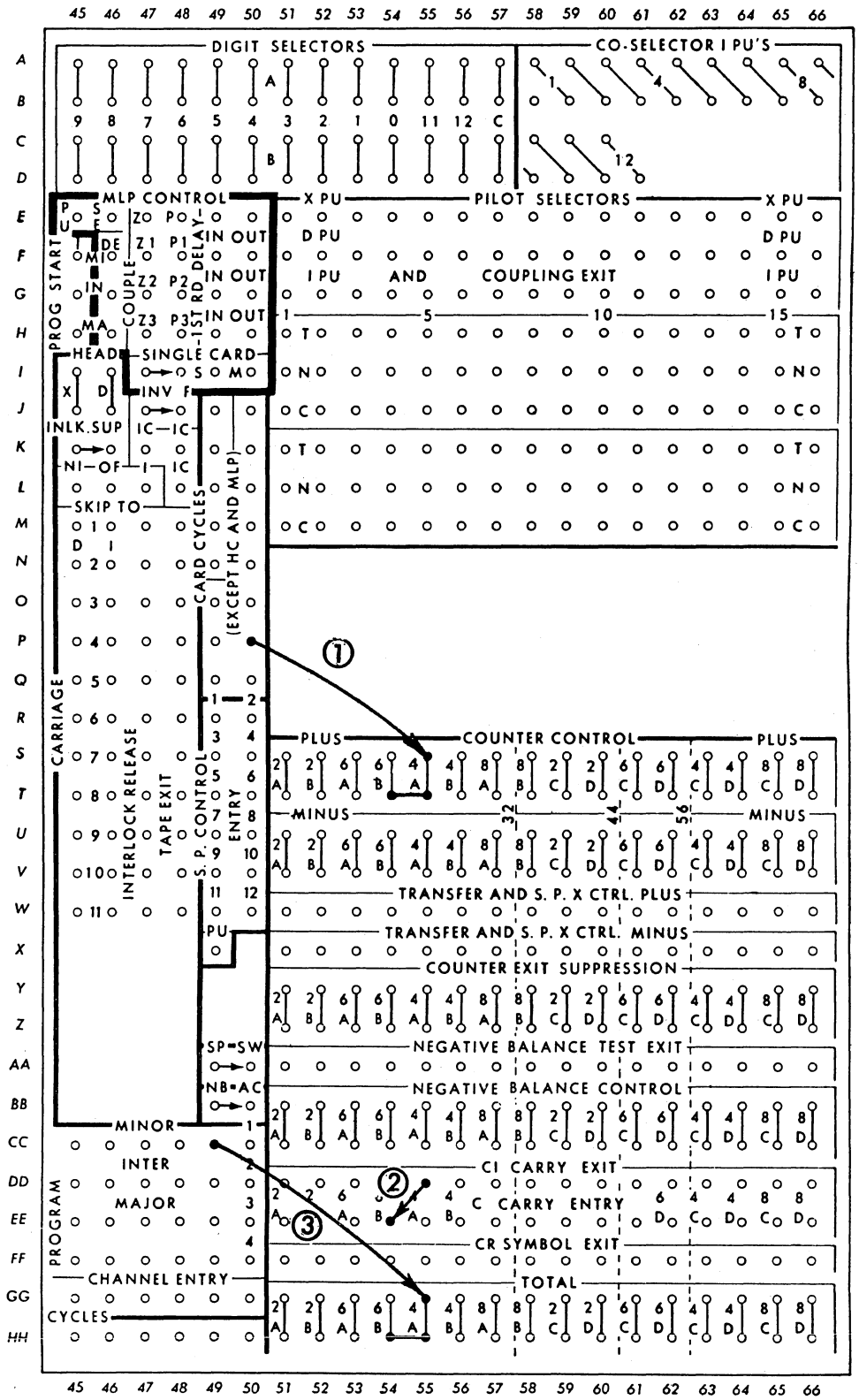
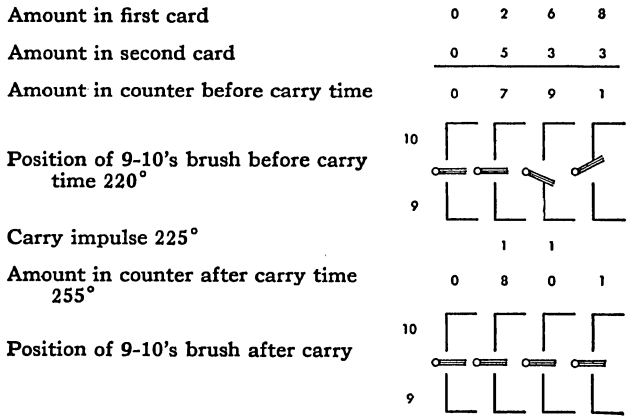


Figure 107. Counter Coupling

CARRY CIRCUIT 9 SIDE

If 533 is added to 268, a carry of a different nature will occur. Example 2:



The units position causes a carry of 1 into the tens position in the normal manner. As the tens position adds this carry, it turns past 9 to 0. This would also signal a carry, but carry time has already passed. Therefore, in order to add correctly, the tens position, whenever it has a 9, must pass any carry impulse it receives on to the hundreds position. This would apply to all counter positions.

OBJECTIVE: To cause a carry in the hundreds position of 8D when the tens position contains a 9 and the units position 9-10 brush is latched on the 10 side.

1. Start magnet of counter 79 picks through the normal circuit during carry time from latched 9-10 brush of counter 80. 63B
2. Start magnet of counter 78 picks through 850-10 N/O, 9 side of 9-10 brush counter 79, 10 side of 9-10 brush counter 80, CB's 10, 11, 12, and 13. 62B

Notice that counters containing a 9 cannot initiate a carry but only pass it on to the next higher counter. For any carry to occur, one counter must have its 9-10 brush latched on the 10 side.

COUPLING COUNTER ADDING

There are occasions when the normal counter grouping does not give the necessary counter capacity. By coupling the add magnets and carry impulse of a 6-position counter to a 4-position counter, the group can be made to operate as one 10-position counter (Figure 107).

By connecting the plus relays (1), both operate together, and the 6B counter provides additional positions for accumulation of a total up to 99,999,999.99. Connecting the carry exit of 4A to the carry entry of 6B(2) provides a means of completing the carry circuit between the fourth and fifth position of the 10-position counter group. When taking program level totals, it is also necessary to provide a circuit to the total relays off both counters from the same program level by wiring to the counters individually or by coupling the total relays (3).

These counter groups may be coupled in any combination in order to obtain counter groups of larger capacity.

Subtraction and Counter List

All subtraction on the Types 402, 403, and 419 machines is accomplished by the addition of the complements of the amount to be subtracted with the additional control panel wire from the carry exit back to the carry entry which keeps the counter accumulation built up to the 9 system.

Assume the use of counter group 6C for performing the following subtraction problem.

```
  3 6 7 4
- 2 7 3 6
---------
  9 3 8      Result
```

The same result would be obtained if we had performed the addition of the following:

```
  0 0 3 6 7 4
+ 9 9 7 2 6 3
-------------
1 0 0 0 9 3 7
  └──────────→1
-------------
      9 3 8
```

The 1 to the extreme left is returned to the units position whenever the two amounts that are added cause the 9-10's brush to signal a carry impulse. The result is, in effect 938, the correct result of the subtraction desired.

Rule for Determining Complements. In order to determine the nine complement of any number, the mental process is to subtract the number from a figure made up of all nines. For example, using a 6-position counter, determine the 9 complement of 27360.

```
  9 9 9 9 9 9
- 2 7 3 6 0
-----------
  9 7 2 6 3 9
```

Sample problem: $36748 - 27360 = X$

STRAIGHT SUBTRACTION

```
  3 6 7 4 8
- 2 7 3 6 0
-----------
    9 3 8 8
```

COMPLEMENT SUBTRACTION

```
    3 6 7 4 8
+ 9 7 2 6 3 9
-------------
1 0 0 9 3 8 7
└──────────→1
-------------
    9 3 8 8
```

To arrive at the correct answer using a nine complement system the high-order carry must be added to the units position. This carry back makes it necessary to wire CI to C on all counter groups that are subtracting.

MACHINE COMPLEMENTS

When subtracting, the third reading brushes are connected to the counter stop magnets. When a hole in the card is sensed by the brushes, the adding wheel is stopped. The method of starting the adding wheels turning will be described later.

To arrive at the machine complement before carry time, subtraction is accomplished by adding the difference between nine and the figure punched in the card.

9 add a 0
8 add a 1
7 add a 2
6 add a 3
5 add a 4
4 add a 5
3 add a 6
2 add a 7
1 add a 8
0 add a 9

This principle is applied in subtraction as follows:

Whenever a counter group is set up to subtract by energizing the minus relays from a card cycles impulse, the minus relay points transfer and a circuit is completed to energize all start magnets at 9°. If the adding wheels continued their rotation until they were stopped by the first lobe of the carry cam, they would all add nines.

Because the impulse is automatically directed to all counter positions of a group, it has become known as the *hot 9* circuit. All counters start at the same time, but they are stopped individually by the action of the reset arm which is released when the hole in the card completes a circuit to the counter stop magnet.

A check of the units position of the counter will show the operation using the 6 in the original problem.

PREPARATION: Control panel wired as in Figure 108. A 6 is sensed by third reading brush wired to entry of counter 50, the units position of 6C.

OBJECTIVE: To energize counter 50 start magnet at 9° (hot 9). To stop counter 50 with a 6 impulse from the third reading brushes. To counter list the 6.

1. R756 and 759 (minus relays) pick through control panel wire from card cycles. 37A
   R756 and 759 have no hold coils and depend on the LAC portion of card cycles, 321° to 181°, to remain energized until after digit reading time.
2. Start magnet, counter 50 picks through 756-6 N/O, cable wire to CB's 16 and 17, and CB's 1, 2, 3, and 4. CB's 16 and 17 provide a hot 9 to start the counter turning at 9 time. 56B
3. Stop magnet, counter 50 picks through 756-12 N/O, control panel wire to third reading brush, and 6 impulse read from the card. 56B
4. Print magnet energized by 6 impulse from counter exit, 765-8 N/C, 756-12 N/O now closed, counter entry, and third reading brush. 56B

The counter started 12° after 9 time and stopped 12° after 6 time for a total movement of 54° or 3 cycle points. Thus 3, the complement of 6, has been added on this subtract cycle. The individual counter operations in other positions would be similar. All counters in a subtracting counter group receive hot 9 start impulses and are stopped at various times depending on the punches in the card.

CARRY CIRCUITS SUBTRACT

Carry circuits are the same for subtraction as for addition, and for this reason they will not be repeated.

Figure 108 shows the wiring necessary when coupling two counters for subtracting only. The counter groups 4D and 8D have been coupled to function as one 12-position counter.

1. It is necessary to connect the minus relay of 4D and 8D so that they energize on the same card cycle impulse.

2. Counter 8D carry exit must be coupled to 4D carry entry to provide a carry circuit between the counter groups.

3. To provide for the return of the left-hand carry impulse to the units position, the 4D carry exit is connected to the 8D carry entry.

4. So that both 4D and 8D may receive the same program level impulse, the total hubs of 4D and 8D are coupled.

5. Counter entry is wired to the third reading brushes, and counter exit to the type bar entries as in the normal manner.

Total Print and Reset

On the program total cycle the start magnets are energized at 351° to start the adding wheels turning in synchronism with the upward movement of the type bars. The print clutch is normally energized on the program levels by transferring the R612-7 points.

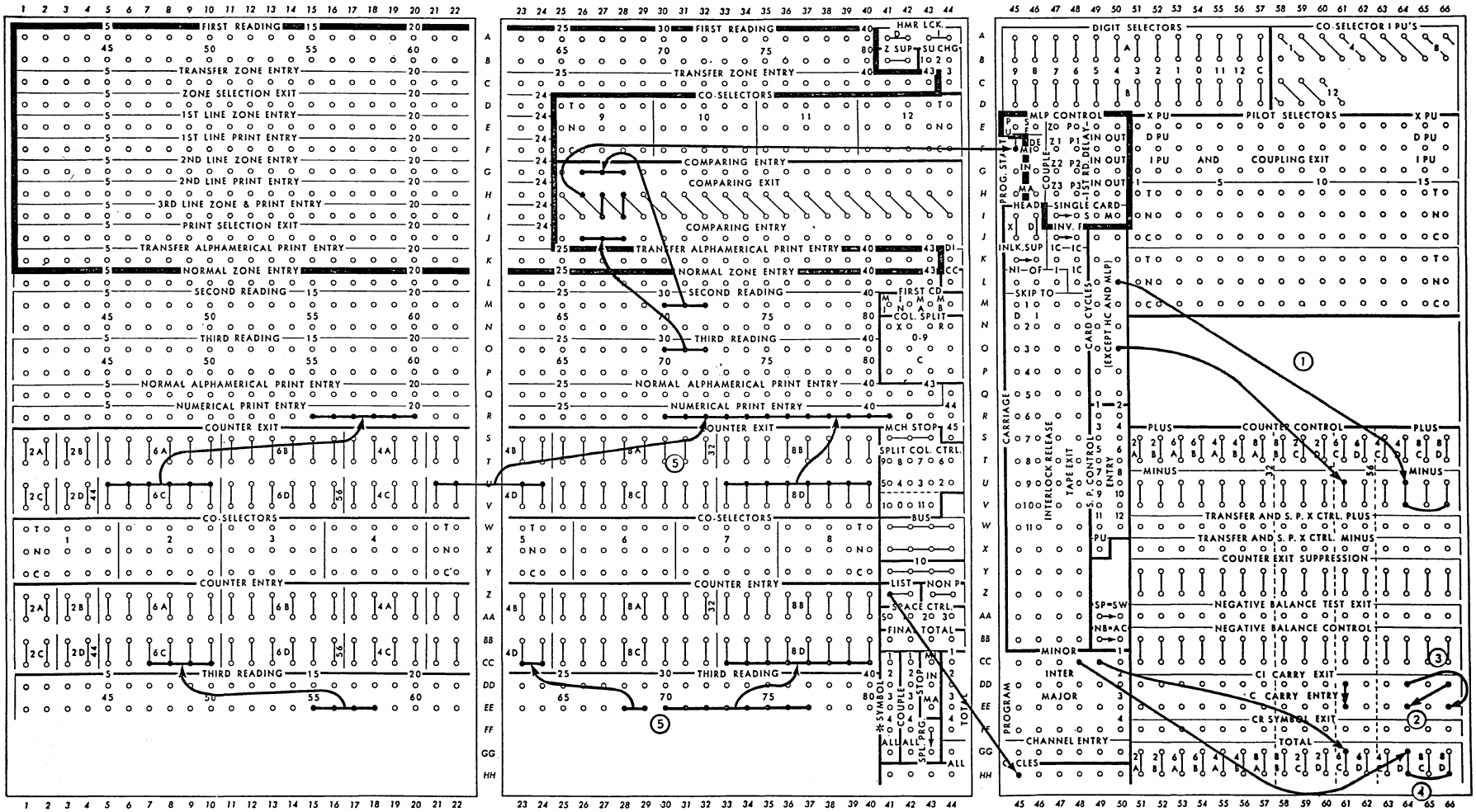


Figure 108. Counter Coupling for Subtraction

During the total cycle, the adding wheels turn, the type bars rise, and when the 9-10's brush touches the 10's contact, CB's 1, 2, 3, 4, and 10 complete circuits to the print magnets for stopping the type bar as well as an impulse to the counter stop magnet to stop the counter at zero.

Assume a 7 standing in counter 50. If it is necessary to print this 7 on the program cycle, the print magnets must be energized at 45°. Therefore, the counter must send an impulse, via control panel wire, to the print magnet at 45° in order to stop the type bar in the 7th tooth. This same impulse will also be used to stop the counter wheel at 0. The operation may be analyzed as follows:

The adding wheel always stops at a position equivalent to 12° after the impulse to the stop magnet. Therefore, if the start magnet receives an impulse at 351°, the adding wheel starts turning at 3°. The stop magnet receiving an impulse at 45° stops the adding wheel at 57°. The adding wheel has, therefore, turned 54°, or three cycle points. If the adding wheel had been standing at 7 before it started turning and had turned three cycle points, it moved 8-9-0.

If the counter stayed at zero orginally, it will revolve 10 cycle points and stop at zero on the other half of the counter 9-10's cam.

Energizing the stop magnet releases the reset arm, which, in turn, strikes a stud in the counter clutch engaging arm to stop the adding wheel. Because the 9-10's contact closes as the adding wheel is passing from nine to zero, the energization of the stop magnet at this time stops the adding wheel at zero. Other counters will stop at various times depending upon the number of cycle points the counter turns before its 9-10's brush touches the 10's contact.

PREPARATION: Control panel wired as in Figure 108. Counter 50 has accumulated a 7, and the machine is starting a minor total program.

OBJECTIVE: To start the counter at 10 time (351°). To stop the counter at 0 and provide an impulse to print a 7.

1. R761 and 764 (total relays) pick through control panel wire from minor program level exit. 39B
   R761 and 764 hold by CB58. 39B
   The hold circuit for the total relays keeps the points in series with the 9-10's brush transferred until after carry time, thus suppressing carry on total cycles.
2. Start magnet of counter 50 impulsed through 761-10 N/O, cable wire, CB's 14 and 15, CB's 1, 2, 3, and 4. 56B
3. Stop magnet of counter 50 impulsed through 755-6 N-C, 764-4 N/O now closed, 10 side of 9-10 contact, cable wire, CB's 10, 11, 12, and 13, CB's 1, 2, 3, and 4. 56B
4. Print magnet impulsed through control panel wire, counter exit, 764-4 N/O now closed, 10 side of 9-10 contact, cable wire, CB's 10, 11, 12, and 13, CB's 1, 2, 3, and 4. 56B

Because of the possibility of impulsing 80 counter stop magnets and 80 print magnets at the same time, a special arc-suppression circuit has been incorporated around CB's 10, 11, 12, and 13. CB10 breaks first, adding 0.7 ohm resistance; CB11 breaks, adding another 1.6 ohms; CB12 breaks, adding an additional 2.5 ohms and finally, CB13 and master CB's 3 and 4 open to break the circuit completely. The effect is to reduce gradually the current in the circuit to a point that will not destroy the break CB's when they interrupt current flow.

Exit Suppression

In some applications it may be desirable to suppress listing or total printing from a counter even though the counter is accumulating or taking a total cycle. Normally closed exit suppression points are located in the exits of all 80 counters. Each counter group has an individual exit suppression relay which, when energized, will block any impulse from or into the counters without affecting add, subtract, carry, total, or reset.

Two sources, external and internal, control the pick of exit suppression relays.

External. Impulses from control panel wiring to a counter exit suppression hub will cause the associated counter to be suppressed.

OBJECTIVE: To cause counter 6C exits to be suppressed by wiring card cycles into 6C exit suppression hub.

1. R765 picks through control panel wire from card cycles hub, CB's 78 and 79. 38A
   R765 holds from CB32. 38A
2. Counter 6C exits are blocked by R765-3 through −8 points being open.

Internal. Eighty-counter exit suppression will result when the exit suppress control relays are energized. Through a parallel pick circuit, exit suppress control will be energized during three separate operations:

1. On feed interlock runout and run-in cycles.
2. On non-print runout cycles.
3. On run-in program clearing cycles.

OBJECTIVE: To pick exit suppress control relays and cause 80-counter exit suppression.

1. R577 picks through 63BU or 612-5, or 78BL from CB22. 5B
   R577 holds and energizes R886 from CB24. 6B
2. R662 picks through 577-12 from CB24 to prevent the type bars from rising and allow the machine to operate at high speed. 6B
3. All counter exit suppression relays are picked through R577 and 886 points from CB's 78 and 79 and hold from CB32. 38A

Negative Numbers. Where addition and subtraction in a counter group are involved, the total amounts

to be subtracted may exceed the total amounts to be added. For example:

```
  3 4 7 9
 -5 8 6 2
-------
Result is -2 3 8 3
```

However, when subtracting by adding complements, the machine accumulates this information as follows:

```
+     3 4 7 9
+9 9 4 1 3 7
-----------
Result +9 9 7 6 1 6
```

The result is a complement figure to the nine system. To those who are acquainted with the machine operation for subtraction by adding complements, this figure is converted into a true figure, 2383, by simply subtracting from all nines. However, it is more desirable to print this complement as a true figure and identify it by a special character. Two methods may be used to print the complement as a true figure; (1) wire the control panel for net balance, or (2) wire the control panel for double balance or balance selection. Both of these methods will be discussed separately.

Double Balance Printing

Two counter groups are required to perform this type of balance printing. One counter group is referred to as the plus (or debit) counter, and the other counter is referred to as the minus (or credit) counter group. The control panel diagram (Figure 109) shows the method of wiring for this operation.

Note that the plus cards (no-X) are added into the debit counter 8A and are subtracted from the credit counter 8B. The minus cards (X) are subtracted in the debit counter 8A and added in the credit counter 8B. One counter always shows the complement and one counter shows the true figure. Therefore, the problem is to determine the algebraic

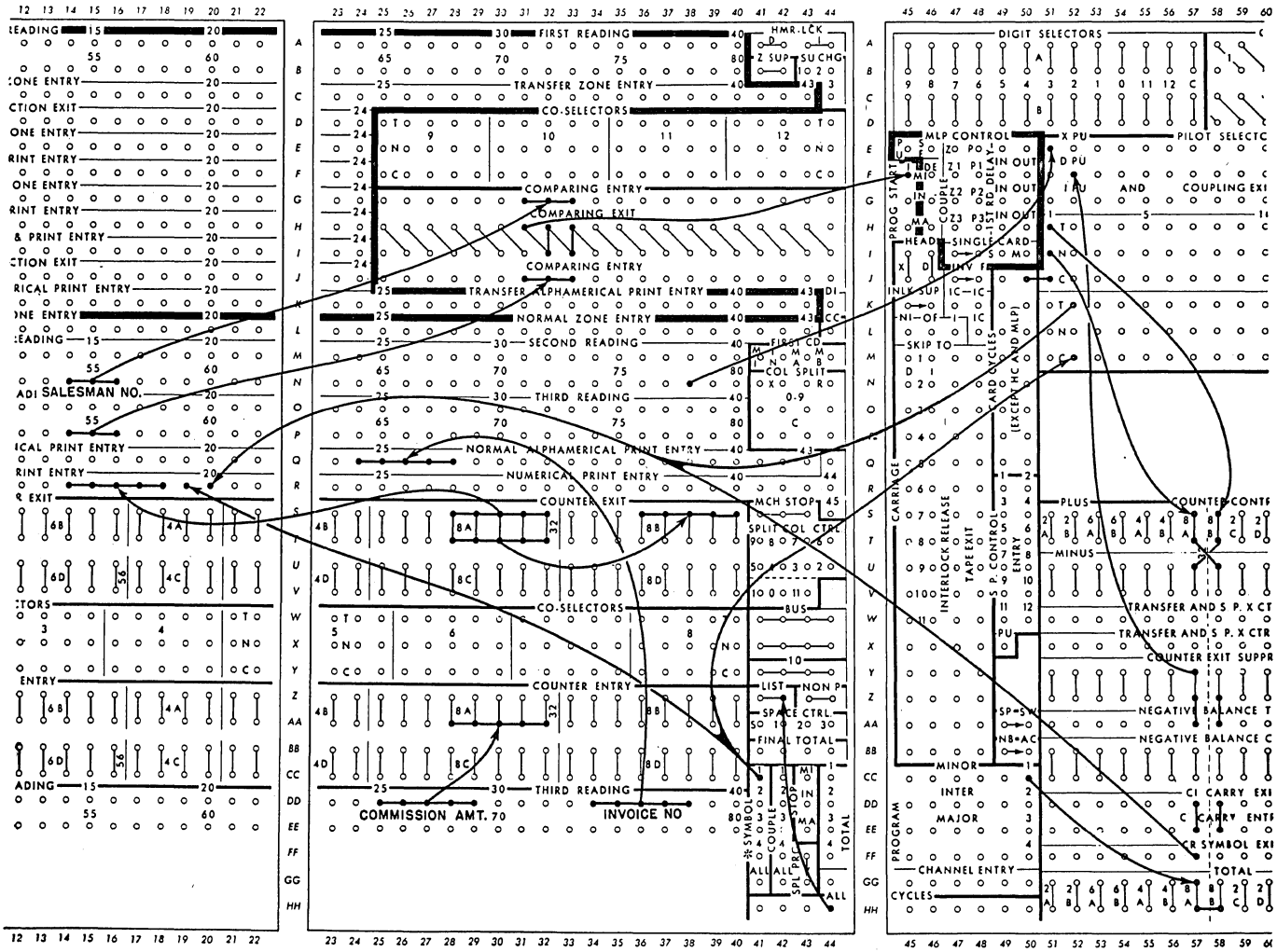


Figure 109. Non-Net Balance for Subtraction

sign of debit counter 8A and print from the correct counter.

When a counter group contains a negative number, it is in the form of a complement. A 9 always appears in the high-order position if the number is negative and does not equal or exceed the positions of the counter group. This 9 is then used to identify a negative number or total, and the size of the counter group must be chosen so that the high-order position never contains a part of the number. When a control change is sensed, the negative-balance test relays energize and complete a test circuit to the left-hand, high-order position of each counter group. This test impulse is available before the machine begins total printing from negative-balance test exit hubs. For double-balance operation it is wired to exit suppression to prevent printing of the complement figure.

OBJECTIVE: To obtain a test impulse from negative-balance test exit, counter 6C, when the high-order position contains a 9 and the machine senses a control change.

1. R609 and 612 pick as a result of break in control. 34A
2. R497 and 856 pick through 609-11 and CB56. No hold circuit. 38B
3. Negative-balance test exit emits an impulse which comes through 856-4, counter emitter brush on the 9 spot, 9 cable wire, 83AL N/C, 497-8 and 9 N/O, CB61. 51B
   Exit suppression of the negative counter is activated by negative-balance test impulse, allowing only the positive counter to print.

NEGATIVE BALANCE ALL CYCLES (38B)

When these two control panel hubs are connected, the negative-balance test relays R497 and R856 energize every cycle except during idling cycles. With the points of these relays closed, an impulse will be available out of the negative-balance test exit hub of a counter whenever that counter turns negative and will continue to emit as long as the counter remains negative. It is a means of testing for negative balance in counters on every machine cycle at 255°.

This could be used by production control to cause summary punching, control change, counter control, etc. One method is to enter a number in a counter, and each card feed cycle the card count impulse 1 would be subtracted. When the correct number of subtract cycles have taken place, the counter will be returned to 9999, and a test impulse through the counter emitter brush of the high-order position can then be used to initiate the machine function desired.

SYMBOL PRINTING, NON-NET BALANCE (Figure 109)

On non-net-balance machines, the CR symbol exit hubs emit impulses only on the detail print cycle and may be wired directly to numerical print entry 20 to print the credit symbol. They do not emit impulses on program cycles. Therefore, another means of printing the CR symbol for negative totals must be used. The asterisk symbol hub 1 emits a 10 impulse on a minor program, which is suitable for printing the CR symbol. If this impulse were wired directly to an even-numbered type bar, a CR symbol would print for every minor total. In order to control this 10 impulse so that it will reach type bar 20 (Figure 109) only for negative totals, it is wired through the transferred hubs of pilot selector 2. The pilot selector is transferred by the negative balance test exit of counter 8A, wired to the D pickup. The D pickup is used to keep the selector transferred through the first card of the next group. If the immediate pickup were used and summary punching or carriage skip cycles intervened, the selector would return to normal before the total printed and the credit symbol could not print through the transferred side of the selector.

Counter 8A is the controlling counter, as it reflects the true nature of the total, even though printing may take place from 8B. Therefore, if 8A is negative, the true figure is printed from 8B, and a CR symbol is printed, because 8A contains a complement total.

Asterisks are printed for positive or negative minor totals by wiring the asterisk (*) symbol hub 1 to numerical print entry 19.

Net Balance

One counter group is required to perform this type of balance printing. A negative number in the counter group is actually converted to its positive complement before total printing. Because the number is changed or converted, this process is known as conversion, and the machine will take a special conversion cycle to change all negative numbers to true figures.

PRINCIPLE OF CONVERTING COMPLEMENTS TO TRUE FIGURES

The principle of complement conversion to effect true balance figures is based upon adding the difference between the individual complement figure and its true figure and suppressing all counter 9 and 10 carrying during conversion cycles.

Each counter position converted is controlled through its own counter emitter (top counter).

All conversion cycles precede total printing and summary punching.

The following list of figures shows (1) amount punched in card, (2) the complement figure in the

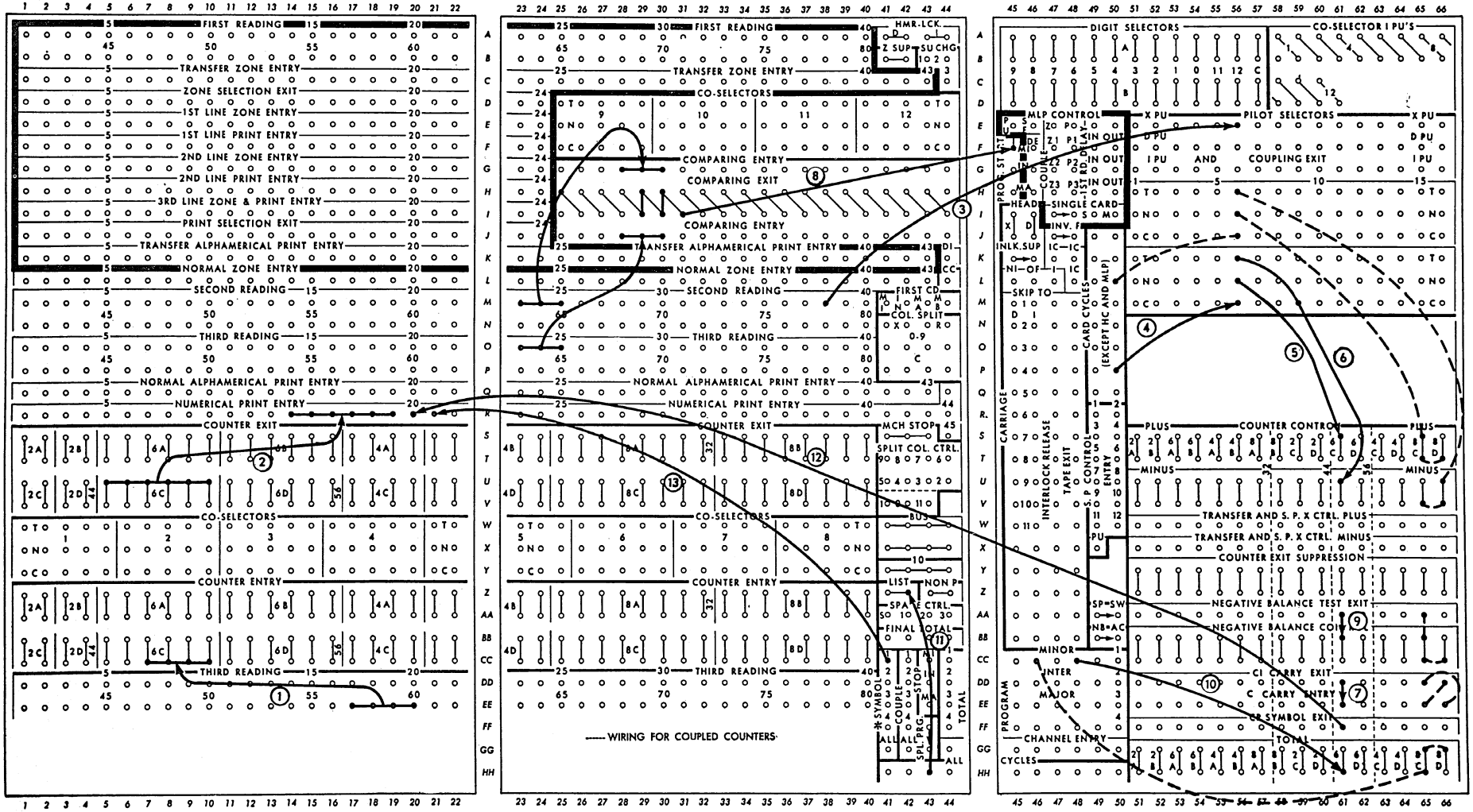


Figure 110. Group and Counter Control — Net Balance

counter, (3) the amount added to the complement, (4) the figure that will be printed after conversion.

AMOUNT PUNCHED IN CARD	COMPLEMENT IN COUNTER	AMOUNT ADDED (CARRYING SUPPRESSED)	FIGURE PRINTED AFTER CONVERSION
0	9	1	0
1	8	3	1
2	7	5	2
3	6	7	3
4	5	9	4
5	4	1	5
6	3	3	6
7	2	5	7
8	1	7	8
9	0	9	9

Whenever the position of the highest order (CI) of any group has its wheel standing in the 9 position, that counter group is recognized as having a minus balance. A wire from the negative-balance test hub to the negative-balance control hub will control the circuits necessary for conversion.

There must be a sufficient number of counter positions used to insure that the total accumulation will never carry into the high-order position and cause the counter to stand at any figure other than a zero or a nine.

Whenever a counter group is converted, a summary card of that total is identified by X-punching, or all cards are X-punched except those having the amount converted by the use of the transfer and summary punch X hubs.

The control panel diagram (Figure 110) shows the wiring necessary to operate the 6C counter adding and subtracting until there is a control change. At that time a comparing exit impulse causes the program start to be energized, which in turn will pick R609-612 program. The early all cycles portion of program exit energizes 6C total control, but the total relays do not hold at this time. If conversion is to take place, the 9 test impulse will pick negative-balance relays and signal the machine to start a conversion cycle. The program cycle that has already started must be delayed while circuits are set up to convert the negative numbers. At the completion of conversion, the program will restart and true figures from converted counters will be printed. When more than one program level is called for, conversion occurs before each level prints, and only those counters which are to total print on the next program cycle will convert.

PREPARATION: Control panel wired as in Figure 110. The comparing unit has sensed a control change and signaled for a minor program. Counter 6C contains the negative number 999287 and is used to illustrate net balance conversion. Figure 111 shows a sequence of relays involved.

OBJECTIVE: To delay minor program cycle, convert counter 6C, restart program, and print true figure.

Start Minor Program

1. R601 picks from unequal comparing impulse to program start immediate hub. 32B
   R601 holds by CB50. 32B
2. R609, 612, and 618 pick through 601-3. 34A
   R609 and 612 hold through CB51 shunted by 633-3 N/C. 34B
   R618 holds through CB32. 34A

Energize Negative-Balance Control

1. R761 and 764 pick through control panel wire from minor program level exit hubs during EAC time, (246°-271°). 39B
   R761 and 764 have no hold circuit at this time.
2. R497 and 856 pick through 609-11 from CB56. 38B
3. R768 picks by the 9-test impulse through 761-4, control panel wire to 6C negative-balance test exit, 9 spot on the counter emitter, CB61. 40B
   R768 holds by CB32. 40B
   Because of normally open total relay points in the pick circuit of negative-balance control relays, only counter groups wired to clear on the next program will be tested for a negative balance.

Start Conversion Cycle

1. R878 picks through 768-5 from CB31. 40A
   R878 holds from CB59. 40A
2. R659 (PM clutch control) scheduled to pick through 612-7 N/O, is blocked by 878-4 N/C now open. 5B
3. R648 (idle cycles) picks through 659-4 N/C, CB26. 6B
   R648 holds by CB25. 6B
4. R635 (all cycles) will not pick because of 648-2 N/C. 23B
5. R82 picks through 659-7 N/C, CB26. 6B
   R82 holds by CB23. 5A
   Machine shifts into high speed for conversion.

Delay Minor Program

1. Minor program level hubs will not emit during LAC (321°-181°) because of open R635 points. 35B
2. R633 (program stop) will not pick because of 648-4 N/C. 36B
3. R609 and 612 will hold during conversion cycle through 633-3 N/C, which shunts CB51. 34B
4. R618 will hold during conversion cycle through 648-3 which shunts CB32. 34A

Convert

1. R83, 84, and 85 pick through 878-5 from CB's 78 and 79. 39A
   No hold.
2. R966 picks through 768-2 from CB's 78 and 79. 39A
   No hold.
   Counter 6C start magnets receive impulses from their emitter brushes at a digit time determined by the spot on which the emitter brush is stopped. The complement number 999287 is standing in the counter.
3. Counter 50 (units position) start magnet picks at 5 time through emitter brush on the 7 spot, cable wire 7, 83BL N/O, CB7, CB's 1, 2, 3, and 4. 56B
4. Counter 49 start magnet picks at 3 time from CB6. 55B
   Counter 48 start magnet picks at 5 time from CB7. 54B
   Counter 47-46-45 start magnets pick at 1 time from CB5. 51-53B
   Counter 6C now contains the true figures, 000712.

Prevent Repeat of Conversion

1. R879 picks through 878-2, CB60. 40A
   R879 holds from CB32. 40B
2. R878 cannot repick because of 879-2 N/C. 40A

Restart Minor Program

1. R659 picks through 612-7 when 878-4 returns to the normally closed side. 5B
2. R635 picks when 648-2 returns to the normally closed side. 23B
3. Minor program level hubs are activated for the remaining LAC portion of the minor program through R635 points. 35B

SYMBOL PRINTING, NET BALANCE

On net-balance machines the CR symbol exit emits an impulse each card-feed cycle its associated counter subtracts. Also a symbol impulse is available during

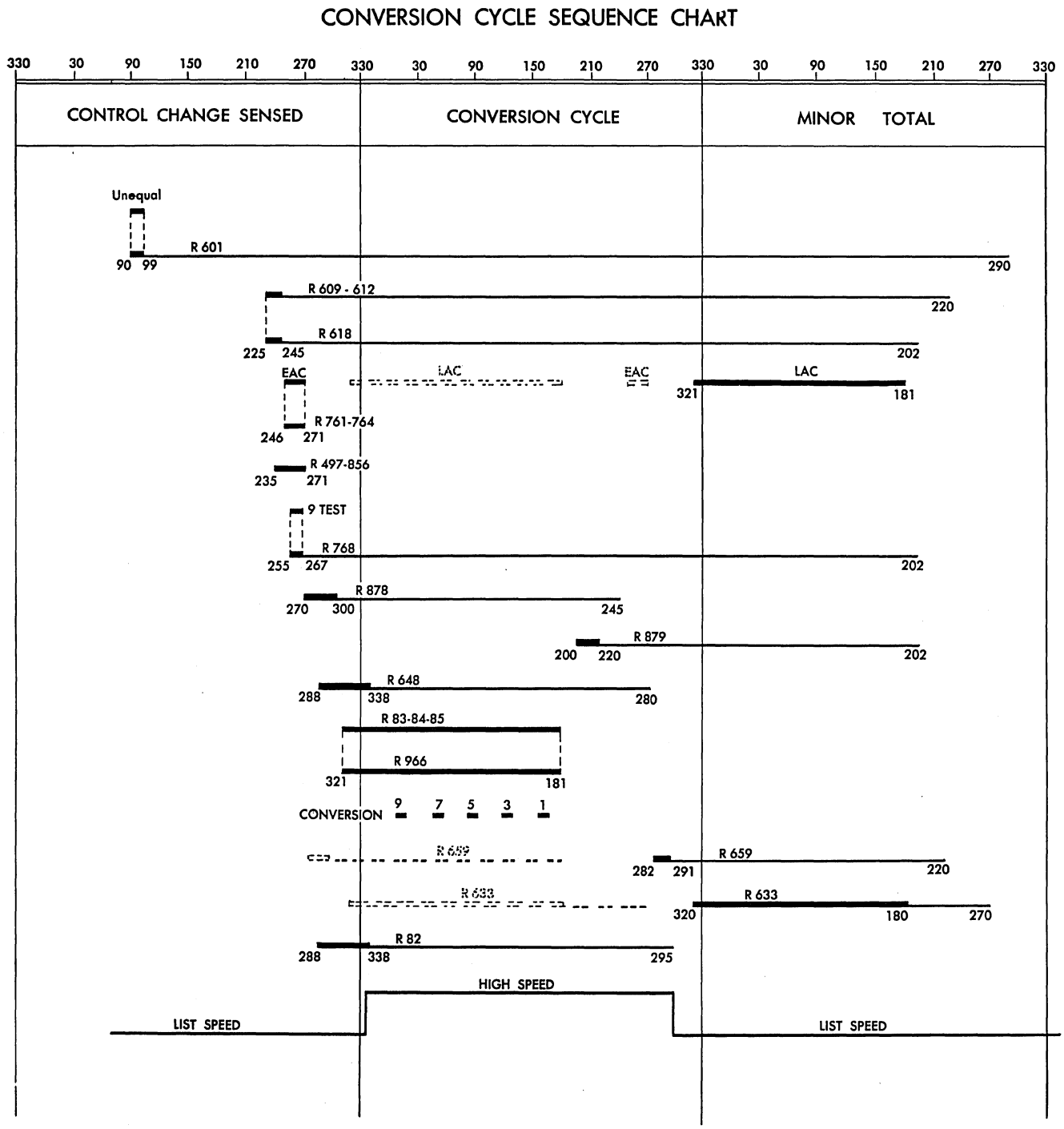


Figure 111. Conversion Cycle Sequence Chart

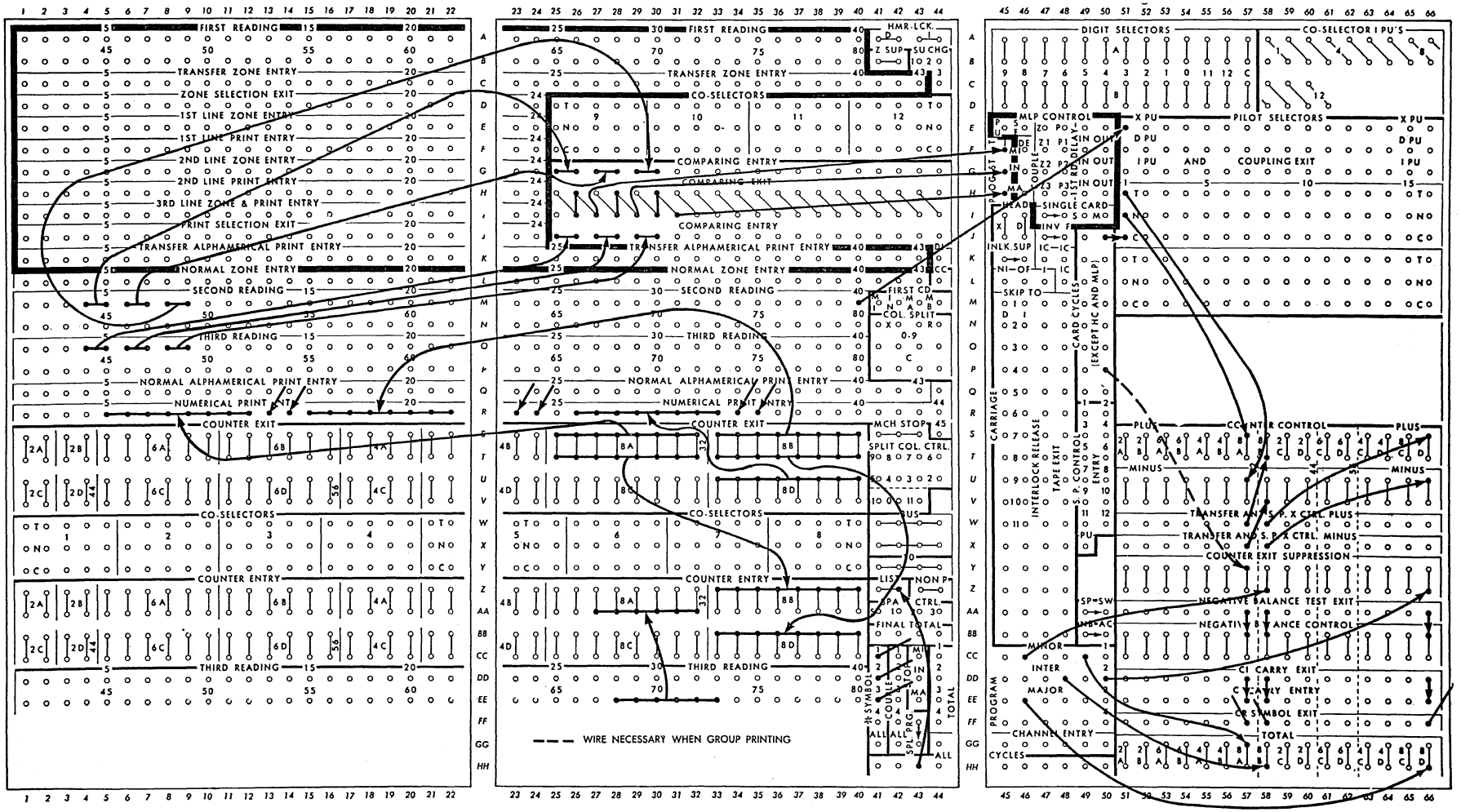


Figure 112. Total Transfer — Net Balance

MAJOR CONTROL	INTERMEDIATE CONTROL	MINOR CONTROL	MINOR TOTAL	INTERMEDIATE TOTAL	MAJOR TOTAL
BRANCH NUMBER	SALESMAN NUMBER	COMMODITY NUMBER	SALES AMOUNT	SALESMAN TOTAL	BRANCH TOTAL
22	16	123	128		
		123	125		
		123	462		
		123	783		
				Transferred	
			1498* →	1498*	
22	16	125	216		
		125	319		
				Transferred	
			535* →	535	
					Transferred
				2033* →	2033
22	17	123	245		
		123	216		
				Transferred	
			461* →	461	Transferred
				461* →	461
					2494*
				Transferred	
23	49	123	556* →	556	
		153			

Figure 113. Total-Transfer Operations, Total Print, and Different Type Bars

total cycles in which the counter is printing a number that has been converted.

OBJECTIVE: To provide CR symbol impulse during subtract card-feed cycles and credit total cycles from the counter credit symbol exit hubs. Counter 6C is used as an example.

1. Subtract Cycle: 6C CR Symbol Exit, 759-1, 656-9, CB67. 37B
2. Credit Total Cycle: 6C CR Symbol Exit, 761-2 N/O, 768-3, CB67. 37B

Whenever a zero counter balance occurs as a result of addition and subtraction (computed and converted above), that balance is identified as CR, if so wired. Whenever a zero counter balance occurs because of the fact that no counter entry has been impulsed either to add or subtract, no CR symbol is printed.

Total Transfer

Up to this point, counter total printing operation has been on an individual basis, and total transfer has not entered the discussion, because the totals have all been wired to print and reset on program level 1.

With the Types 402, 403, and 419 machines another method of wiring the counters, where more than one class of total is involved, requires consideration of total transferring.

Assume a control panel is wired for minor, intermediate, and major totals. Each total requires a separate counter. Only the minor counters adds or subtracts from the card, however. On the minor program change, the minor total prints and rolls into the intermediate counter. On an intermediate program change, the intermediate total prints and rolls into the major counter. On a major program change, the major total prints. Thus, the major total is the sum of all the intermediate totals, and the intermediate total is the sum of all the minor totals. This method of accumulating intermediate and major totals provides substantial proof that if the major total is correct, the intermediate and minor totals that contribute to the major total are also correct.

Figure 112 shows the control panel for net-balance total transfer. In order for the intermediate and major counters to accumulate during total cycles, their plus or minus relays must be energized, and their entries must be wired to the exits of other counter groups. Figure 113 (a typical report using total transfer) shows how the minor counter transfers into the intermediate counter, and how the intermediate counter transfers into the major.

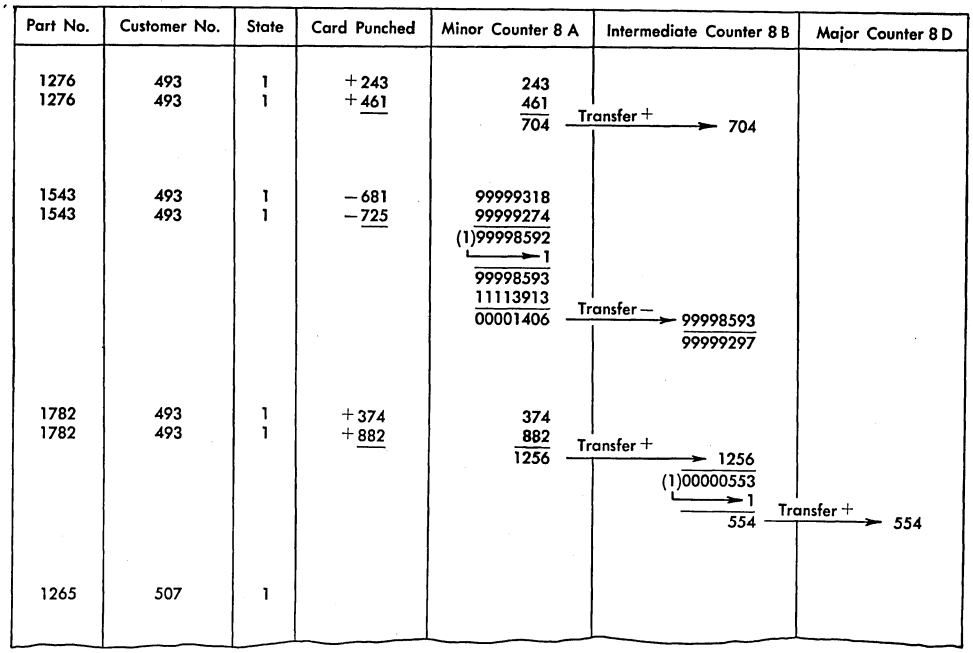


Figure 114. Total Transfer — Counter Operation Negative Numbers

Each counter group has one plus and one minus transfer and summary-punch X-control hub, which is active during the total cycle in which the counter is clearing. As minor program level begins, the minor counter is tested for a negative total. If the negative-balance control relay is energized, it causes an impulse to be available at the transfer and summary-punch X-control minus hub for the minor counter.

If on TEST, the high-order counter indicates that the total is positive, the negative-balance control relay will not be energized, and an impulse will then be available from the transfer and summary-punch X-control plus hub for the minor counter.

These hubs are wired to the plus and minus relays of the intermediate or receiving counter. In the same manner the transfer and summary-punch X-control plus and minus hubs for the intermediate counter are wired to the plus and minus relays of the major counter.

A review of the control panel wiring (Figure 112) indicates that the only new subject is the use of the transfer and summary-punch X-control plus and minus hubs. These hubs are on negative-balance machines only.

TRANSFER AND SP X-CONTROL PLUS *(Section 37B)*

When a program level signals that a total cycle is to take place, the total relay will be energized. Assume the minor counter is 6C.

OBJECTIVE: To activate transfer and summary-punch X-control plus hub as counter 6C is total-printing a debit total.

1. R761 and 764 pick through control panel wire from minor program level hubs. 39B
   Hold by CB58. 39B
2. Transfer and SP X-control plus hub is activated through 761-3 N/O from CB's 78 and 79 during the total cycle. 37B

The late all cycles impulse is used to energize the plus relay of the intermediate counter for total transfer.

TRANSFER AND SP X-CONTROL MINUS *(Section 37B)*

When a program level signals that a total cycle is to take place and negative-balance test is wired, the total relays will energize to allow the negative-balance test to be made. If there is a 9 in the high-order counter of the group, the negative-balance R768-4 is transferred. The total program will not take place until after correction.

OBJECTIVE: To activate transfer and summary-punch X-control minus hub as counter 6C is total printing a credit or converted total.

1. R761 and 764 pick through control panel wire from minor program level hub. 39B
   Hold by CB58. 39B
2. R768 picks from 9 test impulse. 40B
   Holds by CB32.
3. Transfer and SP X-control minus hub is activated through 768-4 N/O, 761-3, CB's 78 and 79 during the total cycle. 37B

The late all cycles impulse is used to energize the minus relays of the intermediate counter for total transfer. A report that requires negative amounts to be transferred is shown in Figure 114. In each case the complement total is first converted to a true figure and then subtracted into the receiving counter as it total prints.

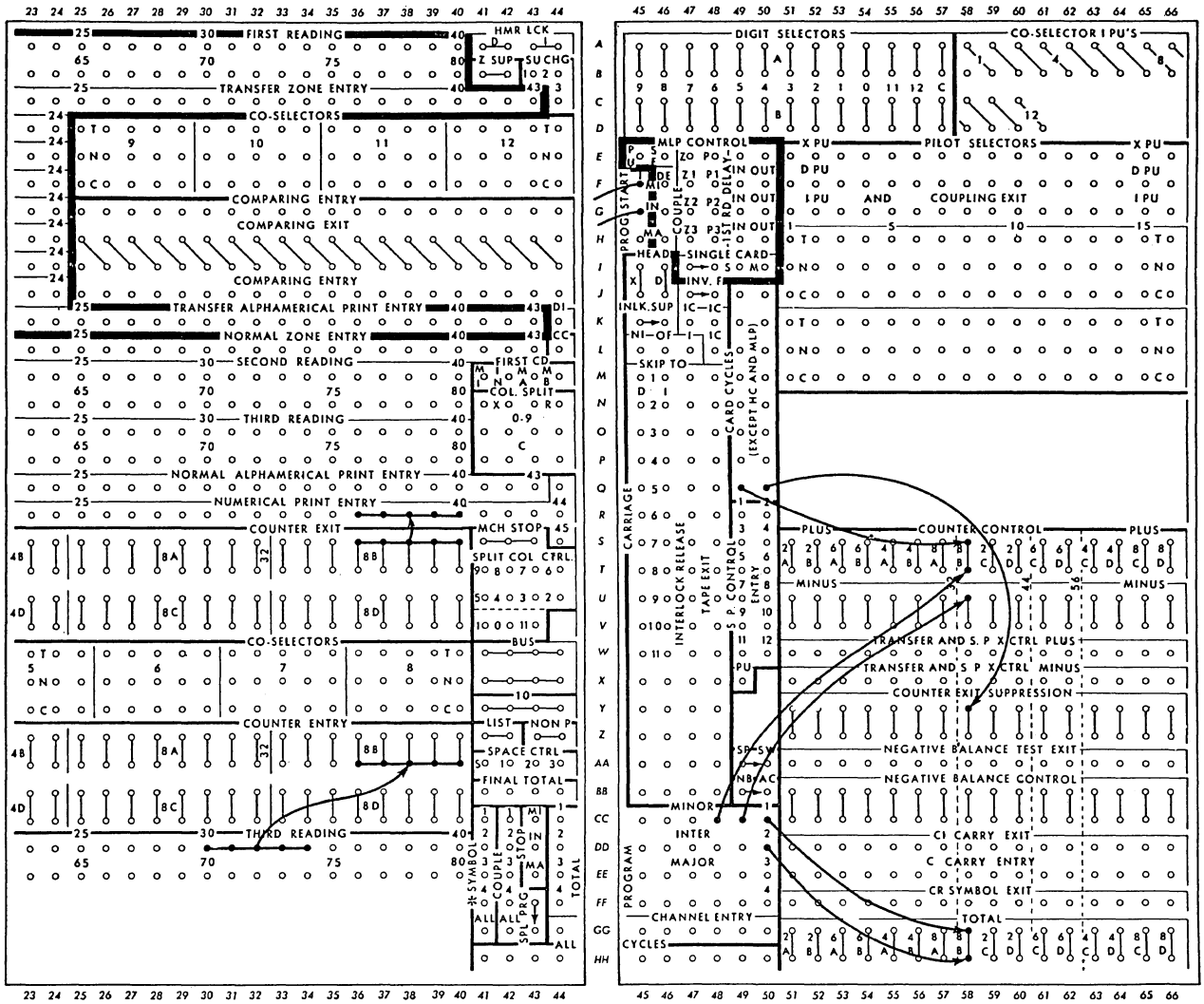


Figure 115. Progressive Total Printing

Progressive Total

To print progressive totals on the Types 402, 403, and 419 machines, it is necessary only to impulse the plus relay at the same time the counter total relay is impulsed to read out. This keeps the counter from resetting to zero, because the circuit from the 9-10's brush to the stop magnet is open during the program total cycle. Whatever adds or subtracts from the following card will add or subtract from the previous progressive total. Normally it is good practice to wire the minus and plus relays. This will prevent possible back circuits through wiring to other counter entry hubs when wired for counter total transfer (Figure 115).

Progressive total printing may be used in a number of ways either to provide progressive totals of sales amounts, and quantity amounts or to provide page totals.

SUMMARY PUNCHING

SUMMARY PUNCHING is the automatic preparation of one total card to replace a group of detail cards. A total or summary card contains the identification of a control group and one or more totals accumulated for that group. The primary purpose of summary cards is to reduce the card volume which accelerates the preparation of periodic reports.

The Types 513, 514, 517, 519, and 523 Summary Punch Machines may be used with the Types 402, 403, or 419 Accounting Machines The summary-punch machine has a cable that must be connected to the summary-punch receptacle provided for it on the accounting machine. When the control panels of both machines are properly wired, the exits of all the counters are made available on the summary-punch control panel. Only information introduced into the

counters of the accounting machine may be summary punched.

Functional Principles

Assume control panels wired for summary punching are placed in the Types 403 and 514, and the two machines are interconnected by the summary-punch cable. To prevent operation of the Type 403 before cards are correctly positioned in the 514, the card lever circuits of both machines are interlocked. If the summary-punch hopper empties, if cards fail to feed, or if no cards have been run in, the start and continuously run circuit of the 403 is interrupted. When the machines are properly set up, the job is started and runs normally until the control break, on which summary punching is to occur, begins. The total cycle is interrupted and, while the Type 403 idles at high speed, the Type 514 punches digits that are in 403 counters wired for summary punching. When punching is completed, the 403 total cycle restarts, and totals are printed in the normal manner. If the accumulated total were negative and the 403 were wired for net balance, a conversion cycle precedes the summary punching. Provision is made to summary punch X with credit totals by using the transfer and summary X-control hubs.

TYPE 514 ATTACHED TO TYPES 402, 403, AND 419 WIRING DIAGRAMS 210201R AND 223601M

THE TYPE 514 Reproducing Punch is capable of reproducing, gang punching, and comparing, either in combination with summary punching or independently.

For summary punching, the connector on the end of the summary-punch cable must be placed in the receptacle on the Types 402, 403, or 419 Accounting Machines. This connects the interlock wiring and all other necessary connections to complete the summary-punching circuits.

The wiring diagram (Figure 116 in the back cover pocket of the manual) shows the circuits affected connected by dotted lines. Circuits in the Types 402 or 403 end at connectors in the receptacle on the accounting machine. Circuits in the Type 514, which are taken into the cable, end at contacts in the summary-punch cable connector.

When the Type 514 is used with the Types, 402, 403, or 419 for summary punching, both power supplies are used. The interlock circuits between the two machines are independent of each other and are operated from their own current supply. With this method there is no necessity for turning off one power supply as with earlier machines. Types 517 and 523 Summary Punches may be ordered without power supplies, in which case the accounting machine supplies the necessary 40 volts DC. Interlocks I17 and I18 assure the summary-punch cable being returned to the Type 514 when summary punching is not being done.

Comparing-Magnet Connections. Notice the hubs marked *comparing magnets* or *counter total exit* on the Type 514 control panel. Eighty of these hubs are dual-purpose hubs, the wires from these control panel hubs going into the summary-punch cable connector. When the cable connector is placed in the summary-punch receptacle on the Type 514, the foregoing hubs are connected to comparing magnets 41-80 (2 coils each). When the cable connector is placed in the 402, 403, or 419 receptacle, those hubs are connected to the counter emitter commons for counters 1-80 and become summary-punch counter total exits.

Therefore, Type 514 comparing magnets 41-80 cannot be used while summary punching. Also, when using the Types 402, 403, or 419 Accounting Machines without summary punching, the summary-punch cable connector should be removed from the receptacle on the accounting machine and placed in the receptacle of the punch. If this is not done, and a control panel wired for comparing is placed in the Type 514, circuits through the bare contact roll in the 514 will cause improper operation of the accounting machine on correction cycles, even though the 514 is not operating.

Circuits

Start and Run Interlock. Assume control panels are wired as shown in Figure 117. The Types 403 and 514 are properly connected for summary punching and cards are placed in the 403 feed and the 514 punch feed. Combinational diagram (Figure 116) will be used to trace circuits.

OBJECTIVE: To prevent Type 403 feed operation until cards have been properly run into the Type 514.

1. R86 picks when the summary-punch switch is plugged on and holds by the pick circuit from L5. **2C**
2. R22 picks through summary-punch cable I9 when R86 is energized. **2B**
   Although R22 is located in the 514, it uses power from the 403 and thus the fuse circuit must pass through I-10 back to fuse 39 (section 1C) in the 403. Circuits that originate in one machine may pass through the summary-punch cable into the other but will always return via the cable to the original power source.
3. R4 drops when 86BL and BU transfer. These points place the pick of R4 under the control of 514 card lever relay points. **1B**

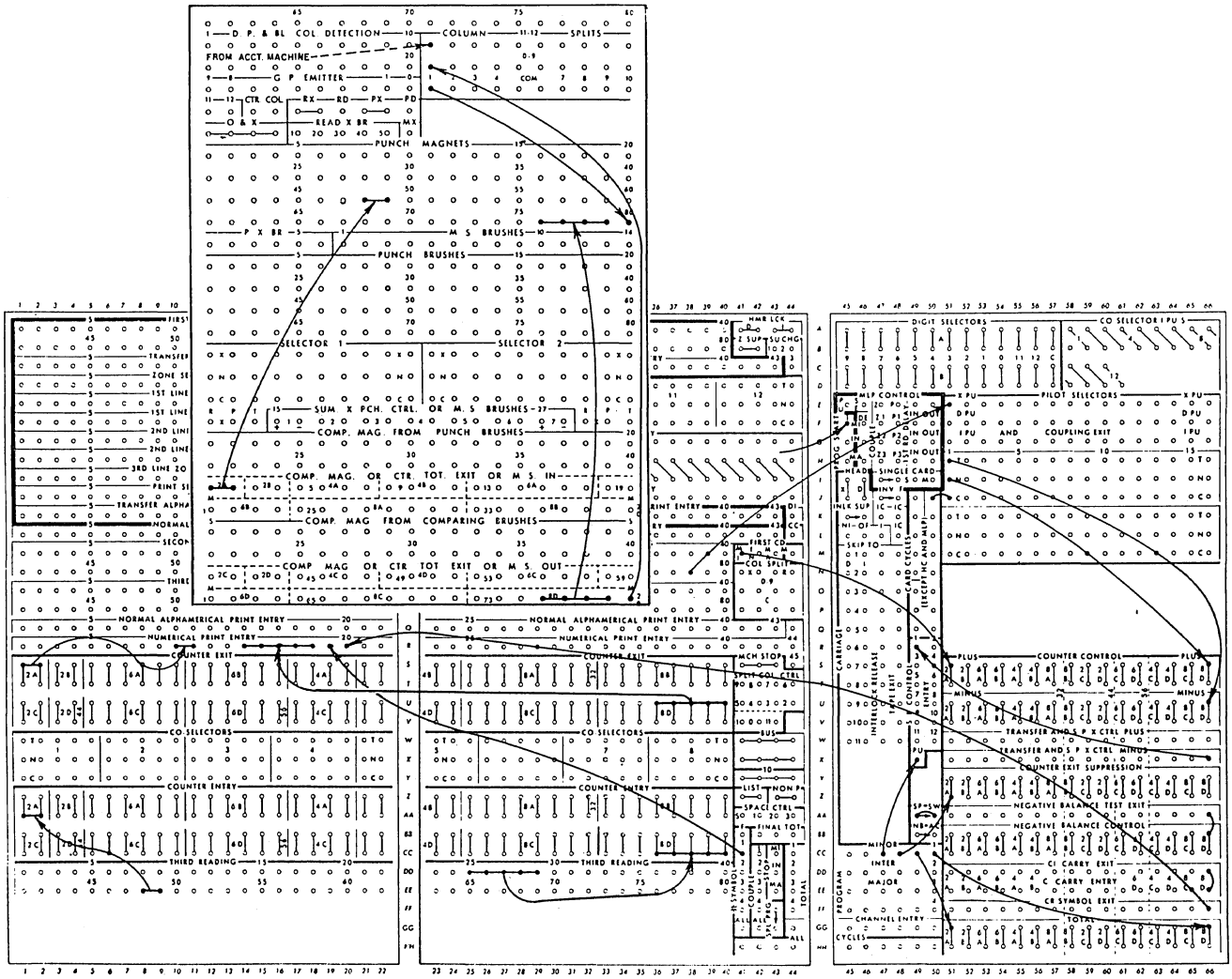


Figure 117. Net Balance Summary Punching

4. Card feed stop light is energized through 4B N/C from L5. 2C
5. Start key, R1, and R2 pick and hold are inoperative because of 4A N/O. 1C

514 Start Key Circuit. In the Summary Punch with R22 energized, one depression of the start key will cause two run-in punch-feed cycles. This is accomplished by holding R10. When gangpunching and summary punching are done simultaneously, these two run-in cycles allow the first master card to pass the die without punching.

OBJECTIVE: To cause the 514 to feed two cards on the run-in by one depression of the start key.

1. R10 picks through start key from 40V-5. 1A
   R10 holds through 10-2, R5 and P6. 1A
2. Punch clutch picks in the normal manner for gangpunching.
3. R1 picks when first card in closes die card lever contact. 1A
   R1 holds by the pick circuit as the die card lever contact remains closed.
4. R10 now has a parallel hold through 10-1, 1-2, 22-3 N/O, 2-2 N/C, stop switch, 40V-5. 1A
5. R2 picks through 1-3 and P3. 2A
   R2 holds through the die card lever contact. 2A

   The hold circuit through R2-2 will keep R10 energized until the original hold through P6 is re-established, causing a second run-in card feed cycle. R2 then energizes, and any subsequent feeding will be under the control of summary-punch circuits in the Type 403.

NOTE: When reproducing and summary punching are done simultaneously, a blank card should be placed first in the read feed so that the first reproduce card will not be lost on the two-cycle run-in.

Type 403 Start and Run Circuit. With cards in the summary punch, the start and continuously run circuit of the accounting machine is active, and the card feed stop light is off. Cards are placed in the hopper, and the machine starts and runs normally. If the Type 514 hopper becomes empty or a card jam occurs, the Type 403 will stop until the condition is corrected.

OBJECTIVE: To establish start and continuously running circuits in the 403, which will be under the control of 514 card levers.

1. R4 picks and holds through I-12 into the 514, reproducing switch number 2 right (off position), I-11 into the 403, L1. 1B
2. R1 and 2 will now pick and hold normally through 4A, start key jack, L7. 1C

As long as die delay and punch magazine card lever points are closed, R4 will remain energized. If the 514 were set up to reproduce and summary punch simultaneously, read magazine and read card lever 1 points would also be in the circuit to energize R4. Thus, any interruption in the normal feeding of cards in the 514 will stop the 403.

Summary-Punch Circuits. Automatic operation of summary punching falls into definite objectives that may be accomplished one at a time. With control panels wired as in Figure 117, minor totals will summary punch automatically. Assume the 403 has sensed a control change and stopped for a minor program.

OBJECTIVE: To delay the normal total cycle of the accounting machine so that summary punching can take place.

1. R877 picks through summary-punch control PU hub, control panel wire, minor program level on the early all cycles portion of minor program. 2C
   R877 holds by CB42. 2C
2. R494 picks through 877-2 from CB33. 2C
   R494 holds through 88BL N/C to L5. 2C
3. R581, 853, 881, and 884 are energized in parallel with R494 hold. 2C
   When 494-3 points open, the circuit is broken to the R659 print clutch control and R656 card feed clutch control relays. Whenever this occurs, the idle cycles relay R648 is energized, and R648-2 in the circuit to the all cycles R635 relay opens. The points of R635 then prevent the late all cycles impulse from getting through to the program levels, and this suppresses the total cycle until after summary punching.
4. Card feed stop light is energized through 853-11. 2C
   The Type 403 is now set up to summary punch and awaits action by the 514.

Automatic Start Circuit

OBJECTIVE: To start the summary punch.

1. 514-R23 picks through I-4 into the 403 to R494 hold coil. The fuse side of the circuit progresses from R23 coil through I-10, fuse 39, to 403 fuse common. 2B
2. 514-R10 picks through I-5 into the 403, normally closed negative-balance relay points, CB69, I-6 into the 514, 23-1, 2-2 N/O, stop switch, 40V-5. 1A
3. 514-R9 and HD1 pick through 10-5 and 6 to start the summary-punch cycle. 1A

In the Type 403, CB69, which makes at 267° for the summary-punch start, is sufficiently late to allow negative-balance test to be completed through CB61 and counter emitter brushes from 255° to 267°. This allows the normally closed negative-balance control relay points to open if the test demands a correction cycle, thus delaying the summary-punch start circuit until after correction.

Punching Circuits. On the summary-punch control panel, the punch magnet hubs for the card columns to be punched are wired from the counter total exit hubs for the counters in which the totals are accumulated.

The summary-punch emitter is mounted on the front end of the C-cam shaft and revolves in time with the index; that is, when the emitter brush is making on the 2 spot, the index is at 2, and the card is in position to be punched a 2, etc.

It can be seen that timed impulses from the Type 514 emitter are delivered via the summary-punch cable to corresponding spots on Type 403 counter emitter moulding (Figure 116, Section 3B, C). As the summary card is fed past the die, circuits are established for punching, depending upon the numbers standing in the counters. If the 6 in counter 2 is to be punched, the following circuit can be completed to punch magnet 49 when the summary-punch circuit breakers make at 6 index time.

Punch magnet 49 (3A), control panel wire to 2A counter total exit (4A), through summary-punch cable and connector to 403 counter 2 emitter common (4C), emitter brush, 6 spot, cable wire, 83BU N/C, into summary punch on 6 wire, SP emitter 6 spot (3A), emitter common, 40V-8, C11, 12, 13, and 14, P1, 40V-5.

Similar circuits will be completed to all summary counter emitter mouldings to cause summary punching of all digits 0 through 9 standing in the counters.

One Cycle Interlock. As previously mentioned, 514-R2 picks when P3 makes at 13 on the first cycle that the start key is depressed to run cards in. R2 holds through 2-1 and the die card lever contact and, therefore, will remain energized until cards run out or fail to feed. After this first cycle, R2-2 N/C will always be open when P6 breaks and R10 cannot be held energized past 9.2 on the index.

It is also necessary to prevent more than one pick impulse to R10 for each control change because CB69 in the 403 closes each idling cycle. In addition, as the summary punch picks up speed to begin the punching cycle and as it coasts to a stop after punching is completed, the SP emitter will sweep, so that it is necessary to limit the emitter to one active cycle per summary card.

OBJECTIVE: To prevent the summary punch from punching more than one card for each program level. Relays involved are located in the Type 514.

1. R10 picks when 23-1 closes to start the summary-punch cycle. 1A
2. R9 and HD1 pick through 10-5 and -6 from 40V-5. 1A
3. R8 picks through 10-7, 23-2, P2, 40V-5. 1A
   R8 holds through P2. 1A
   R8 is energized at the beginning of the punching cycle and remains up until after summary-punch end drops R23.
4. R8-2 prevents the repick of R10. 1A
   R8-3 -4 and -5 allow the SP emitter to be active on the punch cycle only. 3A

Summary-Punch End. The accounting machine total cycle was delayed indirectly by opening the

R494-3 points in the 403. Therefore to release the total program cycle, it is necessary to de-energize R494 and close the 494-3 points near the end of the summary-punch cycle.

OBJECTIVE: To release the suspended program cycle and allow continuation of normal total printing.

1. R88 picks through I-7 into the 514, P5, I-1 into the 403, L1. 2C
   R88 holds through CB32. 2C
2. R494, 581, 853, 881, and 884 drop out when 88BL N/C opens. 2C
3. 514-R10 is prevented from repicking by 88-BU when summary punching is through. 2C
4. R877 is prevented from repicking from the delayed program cycle by 88AL. 2C
5. Card feed stop light goes out when 853-11 opens. 2C

R494-3 *(Section 5B; 402-403 and 419)* closes and allows the print clutch control R659 to be energized. R659-4 opens the circuit to the idling cycle R648, which in turn allows R648-2 to close; this completes the circuit to R635 all cycles. R635, now energized again, allows the program late all cycle impulses to be available at the program level hubs.

Because the idle cycles R648 hold did not de-energize until CB25 opened at 280°, the all cycles R635 did not energize until after the early all cycles from 246° to 271° time had passed. Therefore, the program levels will not emit an impulse at test time after the summary-punch cycle is completed. The machine will now start program level total printing and such other operations as were demanded on the test prior to correction and summary punching.

Net-Balance X-Punching for Credit Indication. When summary punching totals that may have been converted by net-balance circuits, it is possible to indicate by X-punching those totals that have been converted. This is accomplished by utilizing a point of the negative-balance selection relay for the counter group concerned. It will be recalled that these relays are held energized through the conversion cycle and summary-punching cycle up to 202° of the program level cycle for which they were impulsed for symbol printing. This is possible because CB32 is shunted by an idle cycle point R648-3, which does not open until the program level 1 total print operation has started.

On the accounting machine control panel, a wire is inserted from the transfer and summary-punch X-control minus of the counter group used, to a summary punch control entry hub. On the summary-punch control panel a wire is used to connect the C hub of the corresponding column split to the PUNCH MAGNET hub for the column in which the X is to be punched. Figure 117 shows this wiring using counter 8A, SP control entry 1 and column splits 1. The credit X will be punched in column 80 along with digits from the units position of 8A. For circuit description, use counter 8D wired as 8A in the foregoing application and the combinational wiring diagram.

OBJECTIVE: To summary punch an X in column 80 whenever summary counter 8D contains a credit total that has been converted on the previous cycle.

1. R838 (negative-balance control of 8D) will hold during the summary-punch cycle through 648-3, which shunts CB32.
2. R581, 853, 881, and 884 energize when R494 holds through 88BL N/C, L5, (2C).
3. Punch Magnet 80 at 11 time on 514 index energizes through control panel wire from column splits 1 common (4B), 11-1 N/O, summary-punch cable wire into 403, summary-punch control entry 1 (4B), control panel wire to 8D transfer and SP X-control minus (3C), 838-4 N/O, 853-9 N/O, summary-punch cable wire into 514, SP emitter 11 spot, emitter common, 40V-8, C-11, 12, 13, and 14, P1, 40V-5.

It will be noted that this circuit can be completed only if the negative-balance control relays have been energized. There is one negative-balance control relay for each counter group, and the relay picks only when the particular counter group is to be converted.

If an X-punch is desired to identify plus summary totals, then transfer and SP X-control *plus* would be wired to the summary punch control entry on the 403 control panel.

TAPE - CONTROLLED CARRIAGE

Type 923

FUNCTIONAL PRINCIPLES

THE Tape-Controlled Carriage controls the feeding and spacing of forms at high speed while documents or reports are being prepared on Type 402, 403 and 419 Accounting Machines. This carriage is controlled by punched holes in a narrow paper tape which exactly corresponds in length to the length of one or more forms. Holes punched in the tape stop the form when it reaches any predetermined position. A hole punched in channel 12 of the tape can be used to control the Accounting Machine for taking page totals or to start overflow skipping to the next form.

The Type 923 Carriage is standard on the Type 402, 403, and 419 Accounting Machines and is shown in Figure 118.

Flexibility in Form Design

The carriage will accommodate continuous forms measured in 6ths of an inch up to a maximum of 22″ in length and 19½″ in width, including punched margins. While forms of any size within these limits can be handled by the carriage, forms of standard sizes available from the forms manufacturers can be obtained more quickly and economically.

Forms can be designed to permit printing in practically any desired arrangement. Skipping can be controlled to 8 different sections of the form. The number of sections can be increased by 3 as an optional feature, or in some instances by repeated use of the same holes in the tape. This is determined by the number of "Skip to" circuits of which 1 through 8 are installed on a standard machine and 9, 10, 11 are optional.

Variable Line Spacing and Uniform Skipping

Single, double or triple spacing can vary between lines as controlled by wiring on the control panel. Thus, the heading section of a form may be single spaced and the body section double spaced.

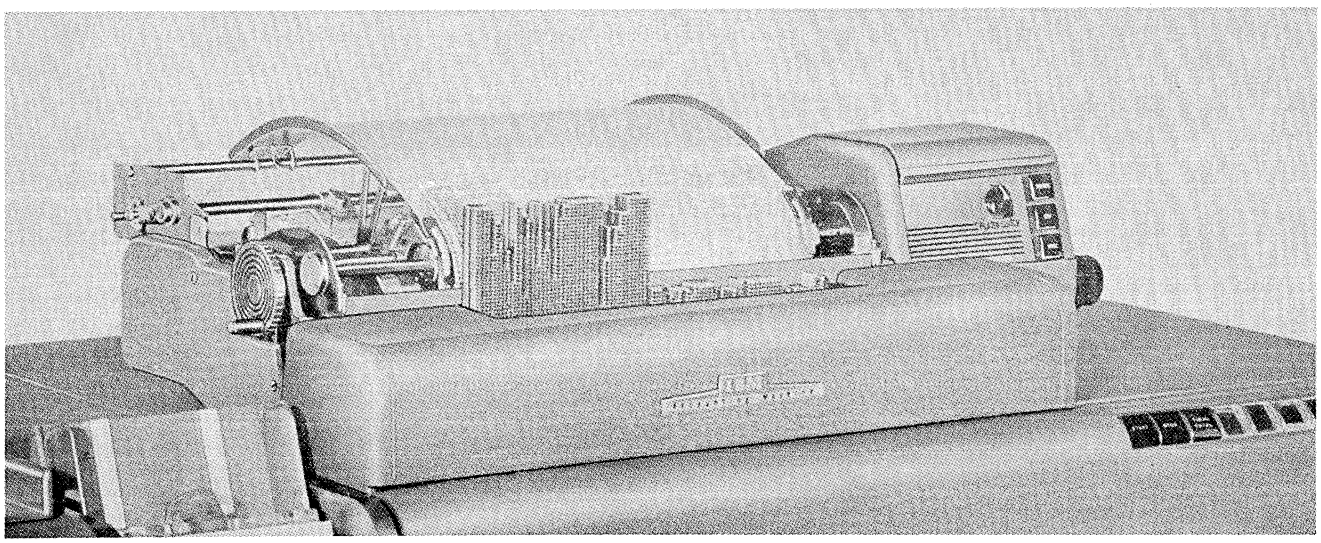


Figure 118. Type 923 Carriage

When more than half inch (triple) spacing is required, it must be controlled by the tape. This is skipping, a smooth, high-speed advance of the form, which is stopped by a prepunched tape hole. When the control panel is properly wired, skipping will not stop or interlock the accounting machine unless the skip is of such length that printing in flight would result. The Type 923 carriage is capable of performing a $3\frac{2}{3}$ inch skip without interlocking the Types 402 and 403 machines, and a $2\frac{1}{3}$ inch skip without interlocking the Type 419 machine.

Overflow Skipping

When one form is completely filled, it can be ejected and the next form can be advanced to the first printing line or to the first body line. This "overflow skipping" is caused by sensing a punch in a specific position of the tape, which starts advancing the paper to the required line on the next form. If the last card of a group prints on the last available detail printing line, the total will print before skipping to the next form takes place. Overflow is slower than other skipping, therefore, it is desirable to reduce overflow skipping to a minimum by correct design of the customer's forms.

Page Totals

The overflow punch in the tape can also be used to start other operations, if desired, before ejecting the completely filled form. For example, a total may be printed at the bottom of each page before advancing to the next form.

Predetermined Total Line

Any class of total can be printed on a predetermined line, whether the form is completely filled or not. For example, although only two or three items have been printed on a form, the total of these items may be printed on a designated line of the form instead of directly beneath the last item printed.

Single Sheet Forms

Single sheet forms can be fed easily without moving the carriage in any way. With tape control, each form can be advanced to any desired line for printing. Thus, "line-finding" operations can be performed. After one or more lines or sections have been printed, the form can be ejected automatically.

CONTROL TAPE

THE control tape (Figure 119) has 12 columnar positions indicated by vertical lines. These positions are called "channels." Holes can be punched in each channel throughout the length of the tape. A maximum of 22" (132 lines) can be used for control of a form, although for convenience the tape blanks are slightly longer. Horizontal lines are spaced 6 to the inch for the entire length of the tape. Round holes in the center of the tape are prepunched for a pin-feed drive in a tape sensing mechanism which controls the carriage. The tape advances through the mechanism in synchronism with the movement of a printed form through the carriage. The effect is exactly the same as though the control holes were punched along the edge of each form. The tape should be reordered by pad only, using part number 216513.

IBM glue, part number 221030, which is more pliable than that purchased locally should be used to fasten the ends of the tape. If possible, control punching in the glued portion of the tape should be avoided.

Tape Channels

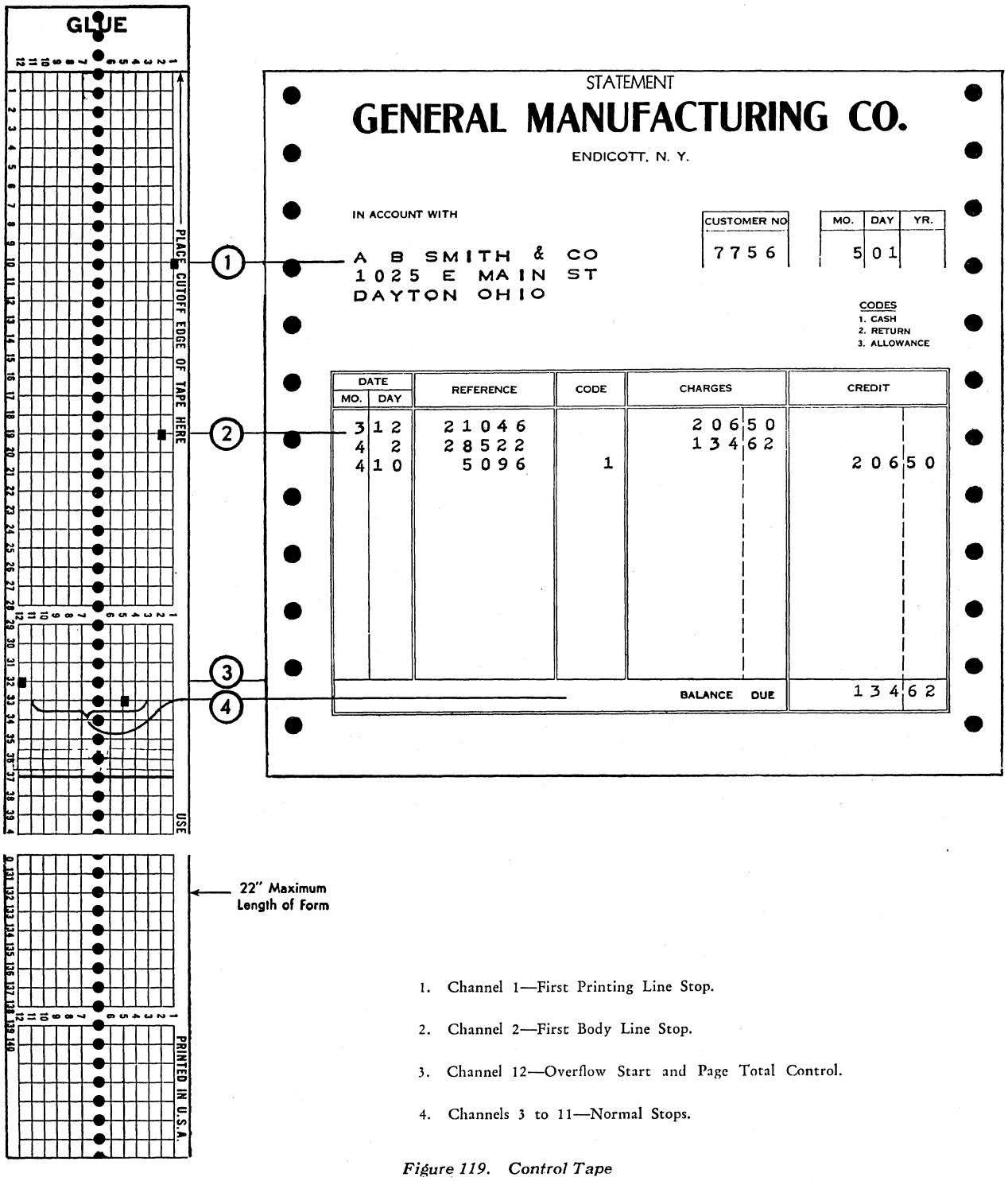
Channels are punched to control the following functions:

First Printing Line Stop. Channel 1 is always punched for the first printing line of a form. This is the starting or "home" position.

First Body Line Stop. Channel 2 is always punched for the first body line of a conventional two-part form whenever heading cards are used. Without heading control, channel 2 may be used as a normal skip stop.

Normal Skip Stops. Channels 3 through 8 are used to stop a form at one of 6 positions after skipping has been started. They may be used in any order or sequence. Three additional normal skip stops (9 through 11) may be specified as an optional feature. A control impulse, such as X, digit, or comparing exit, can be used to start skipping to any position on the form.

Overflow and Page Total Control. The 12th channel of the tape will normally be punched in a position corresponding to the last printing line of the



1. Channel 1—First Printing Line Stop.
2. Channel 2—First Body Line Stop.
3. Channel 12—Overflow Start and Page Total Control.
4. Channels 3 to 11—Normal Stops.

Figure 119. Control Tape

form. This punch is normally used to cause immediate overflow skipping but may also be used to start a program to perform other operations before overflow skipping takes place.

If a prior demand has energized a skipping circuit and a hole punched in channel 12 is passed, the overflow brush circuit will not be effective.

It is also possible that control panel wiring may

demand a double or triple space at the same time that an overflow condition is sensed. If this is the case, the hole in channel 12 should be punched one position early so that sufficient lines may be provided at the bottom of the sheet.

When head control is not wired, an overflow skip is made to the first printing line of the next form (channel 1). When head control is wired, overflow skipping is made to the first printing line if overflow page identification is to be printed; if not, the skip is made directly to the first body line (channel 2).

Interlock Release

Normally, the tape-controlled carriage stops the feeding of cards through the accounting machine during every skip regardless of its length. The feeding of cards is resumed after the skip is completed, but at least one card cycle is lost for every skip taken. This is called *interlocking,* and its primary purpose is to prevent printing in flight for skips longer than $3\frac{2}{3}$ inches on the Types 402 and 403, and $2\frac{1}{3}$ inches on the Type 419. If the skip is equal to, or less than, the defined maximum, the control panel can be wired to release the interlock and thereby allow continuous operation of the accounting machine. When the distance is greater than the maximum limit, the machine is interlocked at the start of the skip. However, the interlock may be released at the point that the remaining distance to be skipped is $3\frac{2}{3}$ or $2\frac{1}{3}$ inches. This feature will reduce to a minimum the number of cycles lost whenever long skips are required.

In designing forms, distances which are to be skipped frequently should, if possible, be kept within the specified maximum for most efficient operation. These distances may or may not be between 2 successive sections of a form. For example, in a billing form with sections for SOLD TO, SHIP TO, and BODY, skips may frequently be made over the SHIP TO section, because there is no shipping address. In this case it is desirable, for increased operating speed, to make the distance from the SOLD TO line to the BODY line $3\frac{2}{3}$" or less.

Tape Punching

A small compact punch (Figure 120) is provided for punching the tape. The tape is first marked in the channels in which the holes are to be punched.

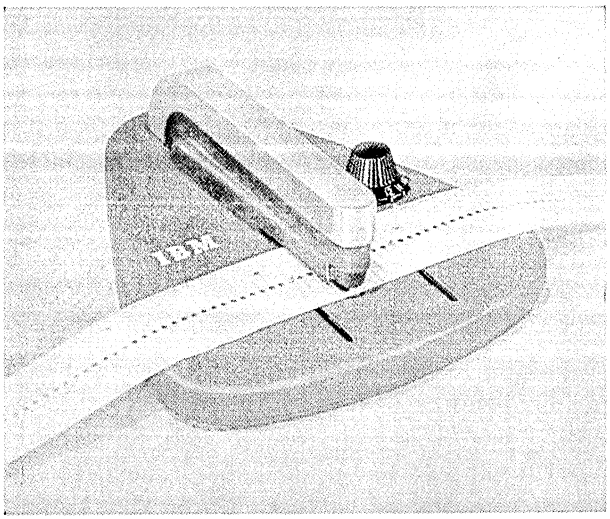


Figure 120. Tape Punch

This can be done easily by laying the tape beside the left edge of the form which it is to control, with the top line (immediately under the GLUE portion) even with the top edge of the form. A mark is made in the first channel on the line which corresponds to the first printing line on the form. Additional marks are made in the appropriate channels for each of the other skip stops and the overflow signal required for the form.

The marking for one form should be repeated as many times as the usable length of the tape (22") will allow. Thus, the tape can serve to control several forms in one revolution through the sensing mechanism, thereby increasing the life of the tape. Finally, the line corresponding to the bottom edge of the last form should be marked for cutting after the tape is punched.

The tape is inserted in the punch by placing the line to be punched over a guide line on the base of the punch and placing the center feed holes of the tape over the pins projecting from the base. The dial is then turned until the arrow points at the number of the channel to be punched. Pressing on the top of the punch, toward the back, cuts a rectangular hole at the intersection of a vertical and horizontal line in the required channel of the tape.

After the tape is punched, it is cut and looped into a belt. The bottom line is glued to the top line by use of the section marked GLUE. The center feed holes should coincide when the two ends of the tape are glued together.

Platen Clutch

When the arrow on the platen clutch knob is pointing upward, the platen is engaged and can be turned manually only by the vernier knob. To disengage the platen from machine control, the platen clutch is turned to the right. The platen can then be turned manually by the platen knob.

Restore Key

The carriage is set at the start or home position by depressing the restore key. This is done while the platen is disengaged. Restoring is necessary because the distance which each form travels through the carriage, as it is being printed, is measured by the tape. Starting from the first printing line of one form, the tape moves in synchronism with the form, until the first printing line of the next form is reached. The brushes must be latched in their operating positions.

Stop Key

Depression of this key stops the carriage operation instantly, and the accounting machine at the end of the cycle.

Space Key

When the accounting machine is stopped, a form can be advanced by depressing the space key. The form advances by single spacing during depression of this key, regardless of the spacing for which the space control is wired. The first form can be fed into position by depressing the space key if the platen clutch is engaged, but the platen clutch should then be disengaged to permit restoring the tape without advancing the form.

Platen Knob

The platen knob can be turned backward or forward to position the form only when the platen clutch is disengaged.

Vernier Knob

The vernier knob is used for moving a form up or down to obtain exact registration in relation to the horizontal lines. This adjustment can be made while the machine is in operation.

Inserting Tape in Carriage

The cover of the carriage is tilted back to gain access to the tape reading mechanism (Figure 121).

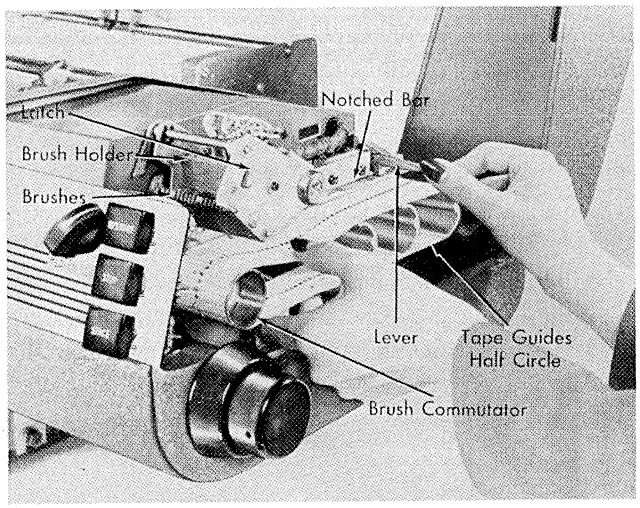


Figure 121. Inserting Tape in Carriage

The platen clutch is turned to a disengaged position, and the brushes are raised by moving to the left the latch located on the side of the brush holder. With the tape held so that the printing captions can be read, one end of the loop is placed over the pin feed drive wheel so that the pins engage the center drive holes. The opposite end of the loop is placed over the nearest half-circle guide piece. The excess slack is removed from the tape by lifting the lever away from the notched bar and by moving the guide piece unit to the right. The tape should be just tight enough so that it will give slightly when the top and bottom portions of the loop are pressed together as shown in Figure 121. It should not fit too tightly or the pin-feed holes will be damaged.

After the tape is in position, the brushes are latched down and the cover is closed. The restore key is depressed to bring the tape to its home position and the platen clutch is turned back to the engaged position. The carriage is then ready to operate.

Tapes can be changed readily and used repeatedly over a considerable period of time.

When the operator fails to relatch the brush assembly and the restoring key is depressed, the carriage will continue to feed forms until the stop key is depressed.

Form Feed

As in a typewriter, the first form is placed on the

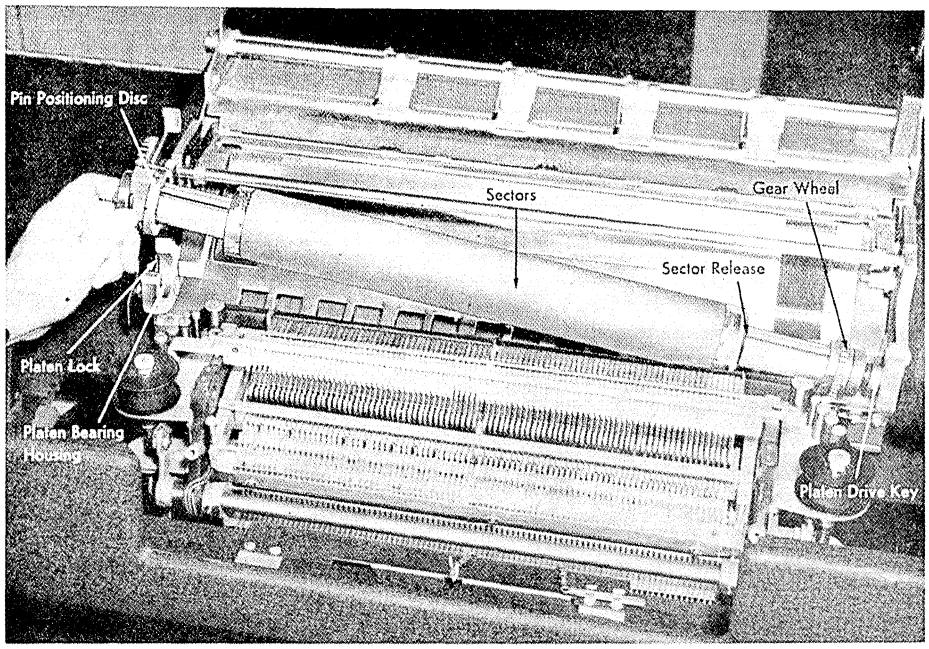


Figure 122. Platen

paper table and advanced into printing position by turning the platen knob. The carriage need not be moved in any way except for minute adjustments in horizontal registration and vertical alignment.

Platen

The carriage is equipped with an easily removable IBM Pin-Feed Platen or a solid platen may be specified for use with an IBM above-platen feed.

Either the pin-feed or the solid platen may be easily removed (Figure 122) by raising the platen lock on the left side, pulling the platen to the left and lifting it from the platen bearing housing. When the platen is inserted, the end with the gear wheel should be placed in the hole on the right of the carriage and the left end should be dropped into the platen bearing housing. The platen must then be moved to the right turning it back and forth, in order to fit the platen drive key into the carriage drive mechanism. The platen lock is then closed.

If pin feeding is not desired, the pins may be made inoperative by turning the ring gear housing (pin positioning disc) clockwise.

The platen sectors vary in size to accommodate forms of different widths. They may be easily removed by loosening the sector release, shifting it to the right and pulling the two sectors apart.

Form Thickness Adjustment Device

The distance between the type bars and the platen is adjustable, for thickness of paper stock or for varying number of copies, by the use of the form thickness adjustment device (Figure 123) located under the cover between the brushes and the print unit. This device contains 7 notches numbered from 0 through 6. When the dial is in the 0 notch, the type bars are 1/8" (.125) of an inch from the platen. Each of the remaining six notches adds to the 1/8" distance by approximately .005". When the dial is set to 6, the distance is increased to .155". The dial should be set wherever the best results are obtained. To adjust for varying thicknesses, the dial lock is pulled out and the dial is turned clockwise to increase the distance between the type bars and the platen, and counterclockwise to decrease the distance.

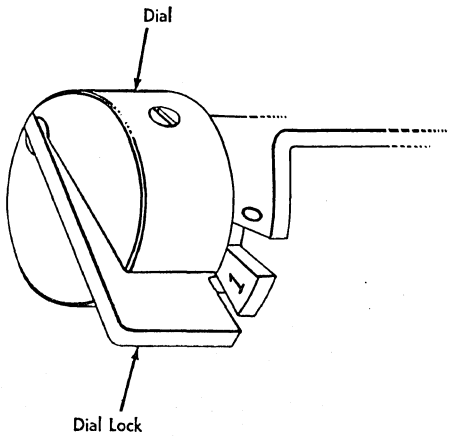


Figure 123. Forms Thickness Adjustment Device

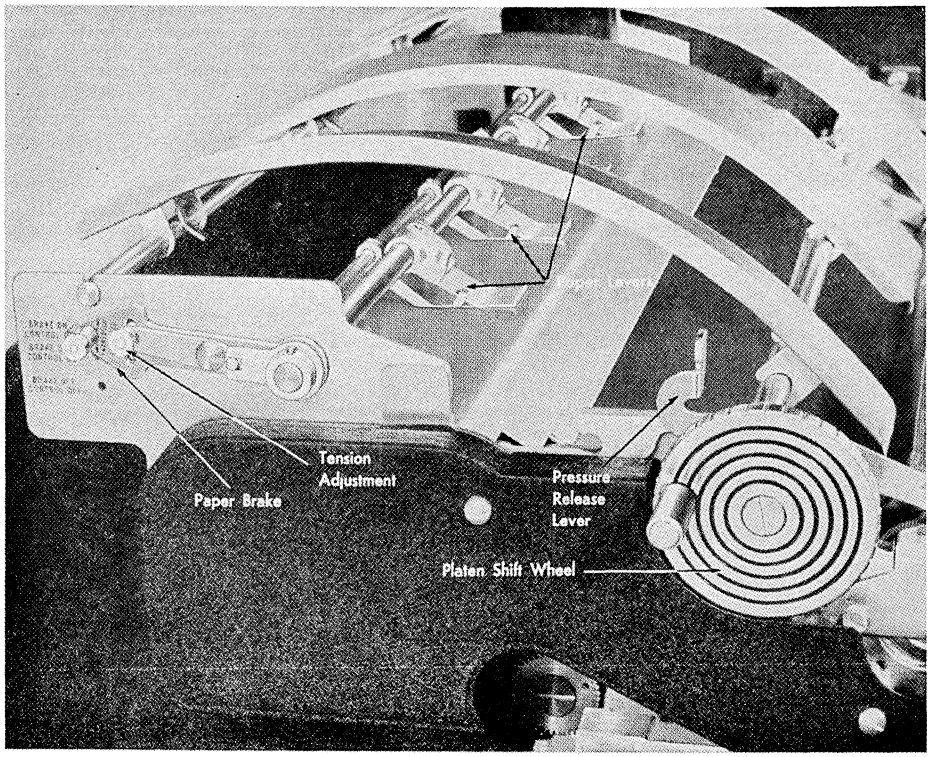


Figure 124. Carriage Mechanical Controls

Paper Brake and Form Stop Device

In back of the platen is a paper brake device (Figure 124) for adjusting the drag or tension on the paper. As a part of the brake device there are three paper levers which stop the machine when the carriage runs out of paper. The form feeds under the paper levers. When the bottom edge of the last form passes the paper levers, they drop into slots as shown, and the machine stops. The distance between these stops and the printing line is approximately ten inches.

Both paper brake and paper lever are made operative, separately or together, by a lever at the left side of the carriage. When the lever is in the top notch, as illustrated, both the paper brake and form stop are operative. When the lever is in the middle notch, the paper brake device is OFF and the form control is ON. When the lever is in the bottom notch, the paper brake and the form control are OFF.

Tension (Vernier Adjustment)

The drag on a form may be increased or decreased to obtain the best operation for a specific form, by regulating the vernier located on the outside of the paper brake device. The dial may be set in one of four positions above the middle line to decrease tension, or in one of four positions below the middle to increase tension.

Pressure Release Lever

When this lever is pushed to the rear, the feed rolls are released so that the paper can be moved freely around the platen. Pressure should always be released when form feeding devices are in use. Pressure should be applied when form feeding devices are not in use. It is also recommended that the form or paper be placed in the carriage so that the edges can not be picked up by the ends of the pressure rolls and cause the paper to buckle.

Platen Shift

The platen may be shifted laterally approximately 5⅝″ to the left or right by turning the platen shift wheel. This adjustment can be made while the machine is in operation.

FORM CONTROL

SKIPPING is started by wiring on the control panel and is stopped by holes in the tape. The control panel wiring illustrated in the circuit section is based

on the use of the Type 402-403 circuits with normal cards and only that wiring is shown which relates directly to the carriage operation.

The examples illustrate operating principles and are not necessarily the only arrangements of tape channel punching which can be used.

SINGLE HEADING FORMS

IN ANY operation in which heading and detail cards are used, the machine can be controlled to print the heading cards in the heading section of a form and the detail cards in the body section, as well as provide for overflow.

Head Control. Heading cards are usually identified by a significant punch, such as an X or digit. The head control X and D hubs receive impulses to cause the following functions to take place:

a. Print all heading cards.
b. Suspend all programming during printing of heading cards.
c. Cause an automatic skip from the heading to the body, before the first body card is printed.
d. Make the card cycles hubs inoperative during the printing of heading cards.
e. Activate the first card MB (minor body) hub so that it will emit an impulse for the first card of each minor group in the body. Without head control wiring, the MB hub is the same as the first card minor. Head X or D should be wired from the second station with normal cards.

Inverted Form (Inv. F). Whenever body cards precede heading cards, the form is inverted and the INV-F (inverted form) switch must be connected. When head control is wired, automatic skipping always takes place from channel 1 in the tape to channel 2. Normally, this skipping takes place whenever there is a change from heading cards to body cards. When the inverted form switch is ON, skipping is caused by a change from body cards to heading cards. Similarly, the inverted form switch also operates the overflow skip in the reverse manner. Normally, the overflow skip is from channel 12 to channel 2. For inverted form operation, the overflow skip is from channel 12 to channel 1. Moreover, when body cards are missing and a program change is recognized between two sets of heading cards, skipping takes place automatically to channel 2.

SINGLE SHEET FORM FEEDING

MANY business forms and documents prepared as single sheets can be completed with prepunched cards or with cards used otherwise for record-keeping. Single sheets can be inserted in the carriage easily by placing each form on the paper table in back of the platen. Adjustable side guides can be set to facilitate hand feeding of each form. The first form is fed and positioned manually. Each additional form placed on the paper table is inserted manually and positioned automatically to the first printing line by depressing the restore key. It is not necessary ever to raise and lower the entire platen mechanism for any sheet insertion.

For single sheet forms, a hole must be punched in the tape three lines below the bottom edge of the form. Any available channel can be used that is not already used for other purposes. The reason for this skip stop punch is to insure ejection of the sheet out of the platen upon sensing a minor program change. The feeding of the first card of the next control group is stopped by wiring minor first card to machine stop.

The tape must be punched 14 spaces beyond the last hole punched to compensate for the distance which a single sheet form must travel around the platen before it can be advanced from the top edge to the first printing line.

Depressing the restore key feeds the single sheet form from the paper table to the first printing line.

The first card of the next control group is fed by first depressing the final total key to turn off the machine stop light and then by depressing the start key.

THE CARRIAGE motor is located under the rear paper guide and may be reached by loosening two hex screws at top of guide on each side and two screws at the rear; remove guide by tipping back (Figure 125).

The power supply is a 1/50 h.p. Robbins Meyers shunt wound motor which operates on 45 volt DC at 4000 R.P.M. It is equipped with ball bearings and does not require any lubrication. At the right end of the motor shaft is a knob by which the carriage may be operated manually when turned counterclockwise.

The hand wheel, which is used to move the carriage laterally, as well as the form thickness device, which moves the entire carriage and platen away from its normal position in relation to the type bars, may be seen. This provides additional clearance between the platen and the type bars when using forms of increased thickness and is obtained by rotating eccentric sleeves which are pinned to the shaft that turns within the carriage base casting when the form thickness knob is moved to a new position. The Jones plug is the means of completing the circuit connection between the Type 402-403-419 and the Type 923 Carriage.

The form stop contact is controlled by the position of the paper brake and the paper levers which drop through the paper guide as the end of the form passes that point. The paper brake is a means of providing drag to the paper so that it will be held snug as it passes around the platen.

NOTE: Because of their location and weight, some units, such as the Tape-Controlled Carriage, card feed and others are difficult to remove. In accordance with IBM Branch Office Manual Safety Practices, a request for assistance must be made when it is necessary to remove such units from the machine.

CARRIAGE DRIVE UNIT

THE carriage drive unit is mounted at the right end of the carriage frame and supplies all power to the platen for spacing or skipping operations.

By turning the motor knob clockwise the power supply may be traced to the two clutches (Figure 126).

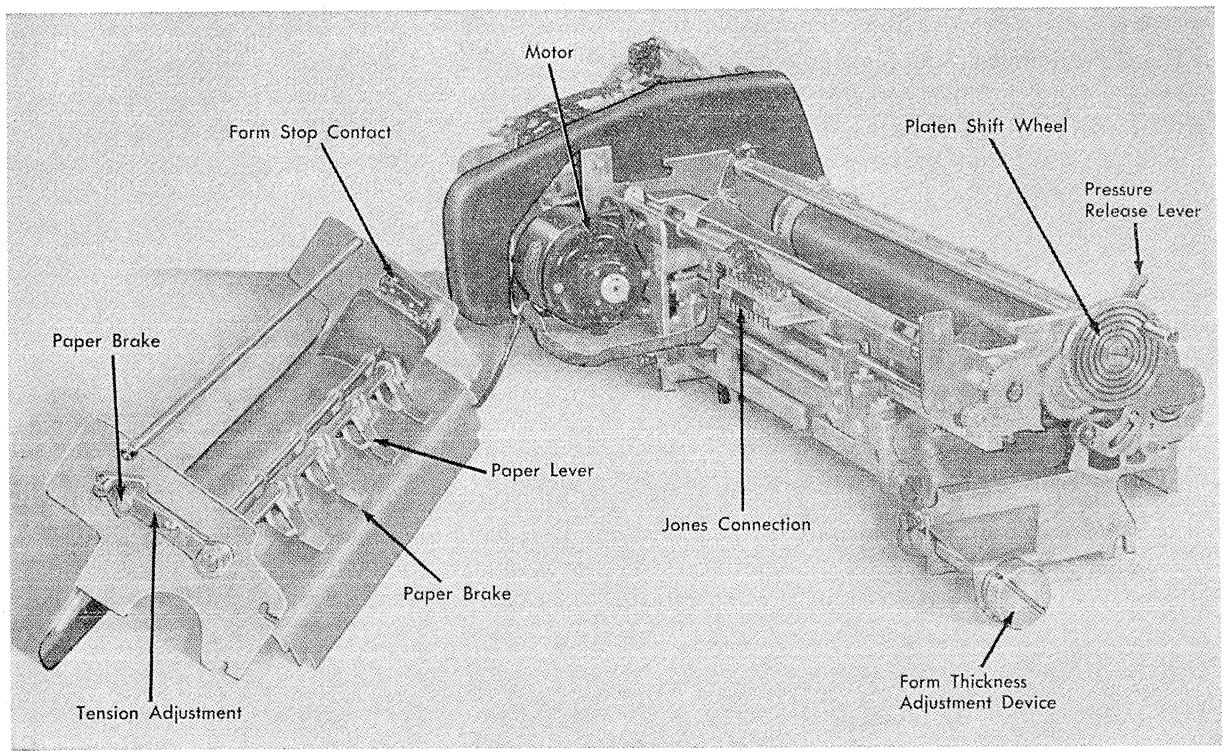


Figure 125. Carriage Rear View

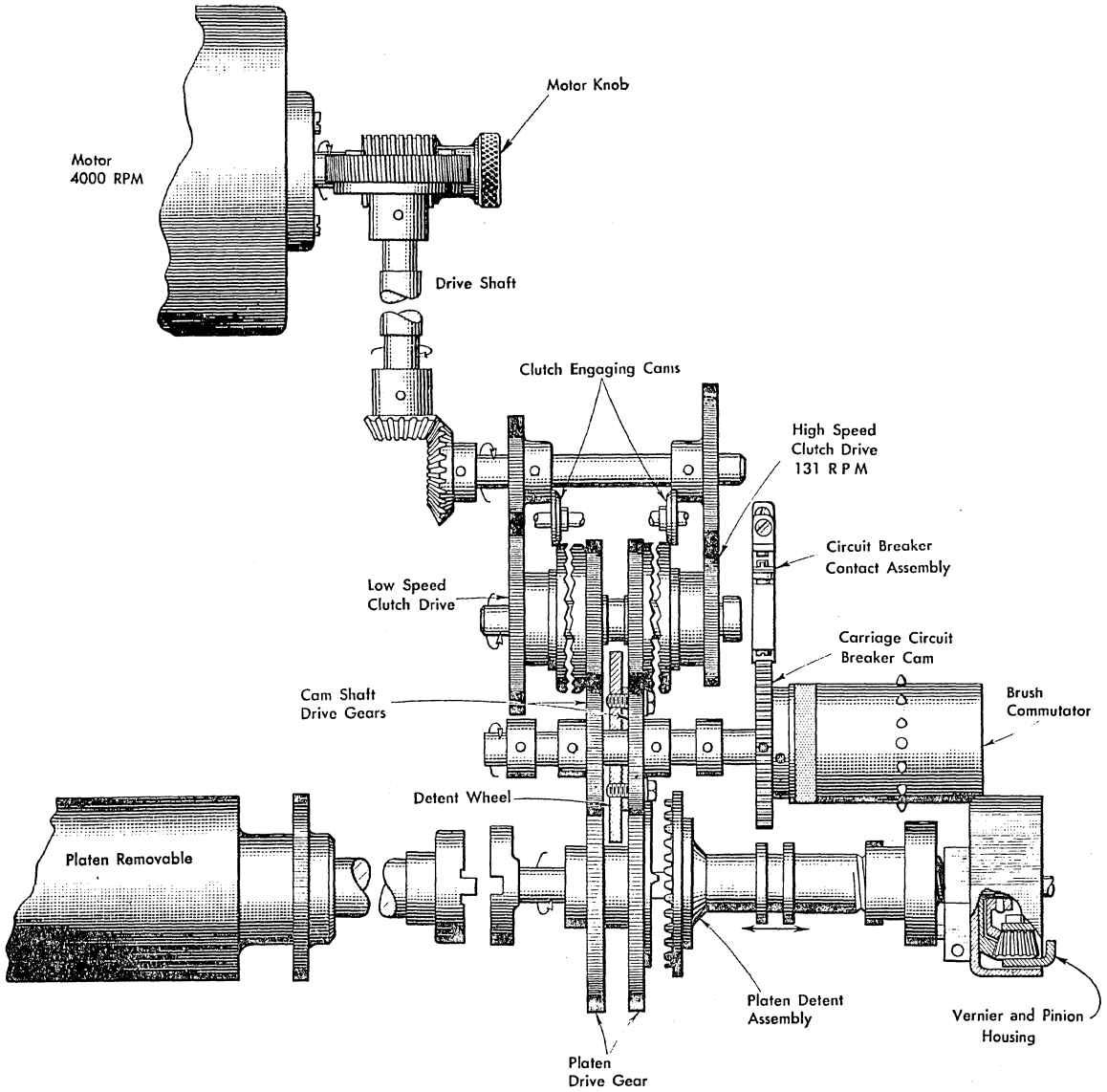


Figure 126. Carriage Mechanical Power Supply

Rotate the motor armature clockwise and the worm gear will turn through a fiber gear the first of two drive shafts. By means of a beveled gear, power is transmitted to the second shaft which has a low speed gear with 28 teeth and a high speed gear of 43 teeth. These two gears supply power to the drive section of the high and low speed clutch. With power turned ON, the gears up to this point are continuously running.

Each of the clutches has two faces that contain interlocking teeth. Clutch engaging cams, operating against the movable driving face of either clutch, force the clutch teeth together and drive the carriage mechanism at the proper speed. An interposer interlock prevents both drive clutches from attempting to engage at the same time. Former-style clutches had a shroud, which fitted inside the driving clutch face, was under spring tension, had teeth similar to the clutch teeth and normally was positioned slightly in advance of the clutch teeth. This shroud prevented the two clutch faces from meshing if the teeth were approximately point for point at the time the clutch magnet was energized. Present clutches are not equipped with the shroud.

The clutch magnet must be energized whether the carriage is to space or skip. Spacing is normal advancement of the platen by either single, double or triple spaces which may be caused by internal circuits or through control panel wiring. Skipping is the term used when intending to move the platen by circuits other than those used for single, double or triple spacing. This would normally be thought of as a multiple number of spaces greater than three. The low speed clutch is used for all spacing operations and overflow; the high speed clutch is used for all skipping operations other than overflow.

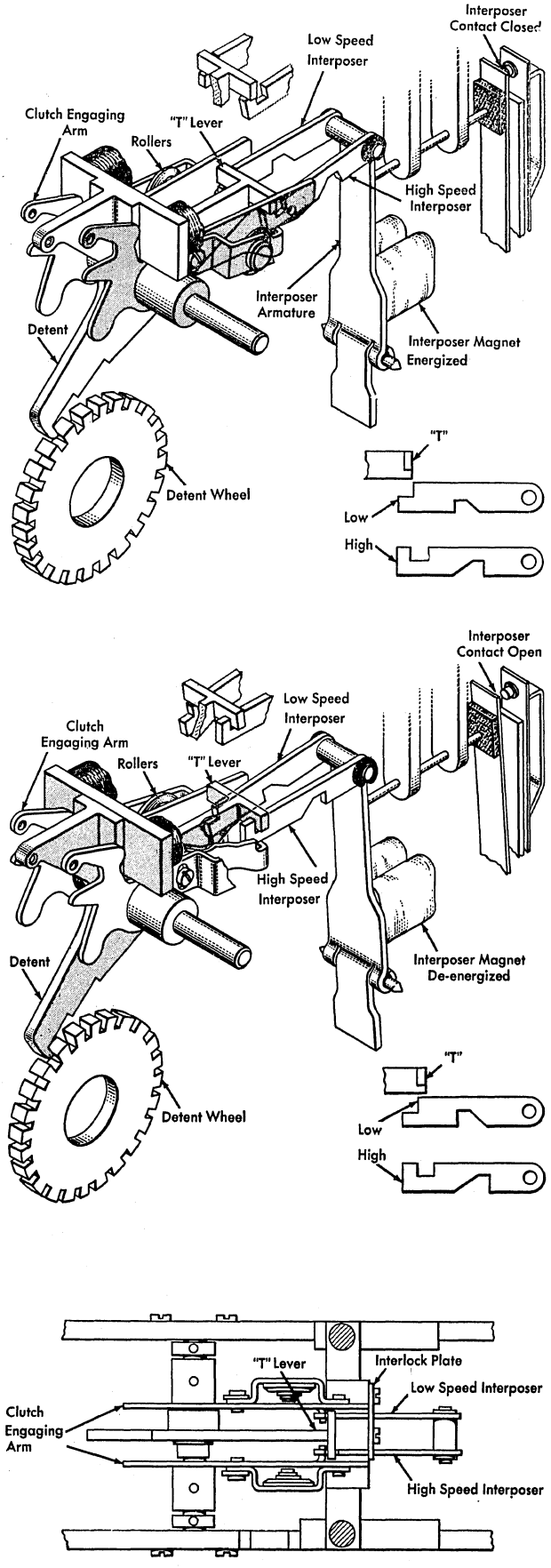


Figure 127. Carriage Interposer Operation

Figure 127 shows the method used in selecting mechanically the correct clutch for either spacing or skipping. To operate a clutch engaging arm, an interposer must be positioned between the T lever and the clutch engaging arm. The selection of the low and high speed interposers is determined by the electrical circuits which cause the interposer magnet to be energized. When the interposer armature is in the normal position, the low speed interposer will be operated by the T lever, and the low speed clutch will supply power to the platen. When the interposer armature is attracted, the low speed interposer will be moved to a position where the interlock plate will support it but the T lever will move in the cut away portion of the low speed interposer. At the same time, however, the high speed interposer has been moved into position so that the T lever will cause the high speed clutch engaging arm to operate.

For normal spacing and overflow the circuit will be directly to the clutch magnet. For all skipping operations the normal circuit to the clutch will be open and the interposer magnet will be energized first. To insure that the interposers are correctly positioned, the circuit to the clutch magnet cannot be completed except through the interposer contact which will not close until the armature has traveled its full distance. This prevents the T lever from operating either clutch until the high speed interposer is fully positioned.

By referring to Figure 126 it will be seen that, with either clutch engaged, power through the cam shaft drive gear, platen drive gear and platen detent assembly, when engaged, will cause the platen to advance. At the correct time, the carriage circuit breaker will cause the clutch magnet to de-energize thus allowing the detent to latch the detent wheel and in turn hold the platen in a fixed position.

Figure 128 shows the two clutches, the cam shaft drive gear, and the detent wheel being held by the detent latch. Also at the right end of the shaft may be seen part of the carriage circuit breaker and the brush commutator. The platen clutch lever which is operated by the platen clutch knob has been pivoted to the left; this causes the platen detent assembly to move to the right and unmesh the platen detent assembly which drives the platen shaft from teeth on the side of the platen drive gear. This permits the operator to disconnect the platen from the drive unit and the latched detent wheel so that the platen

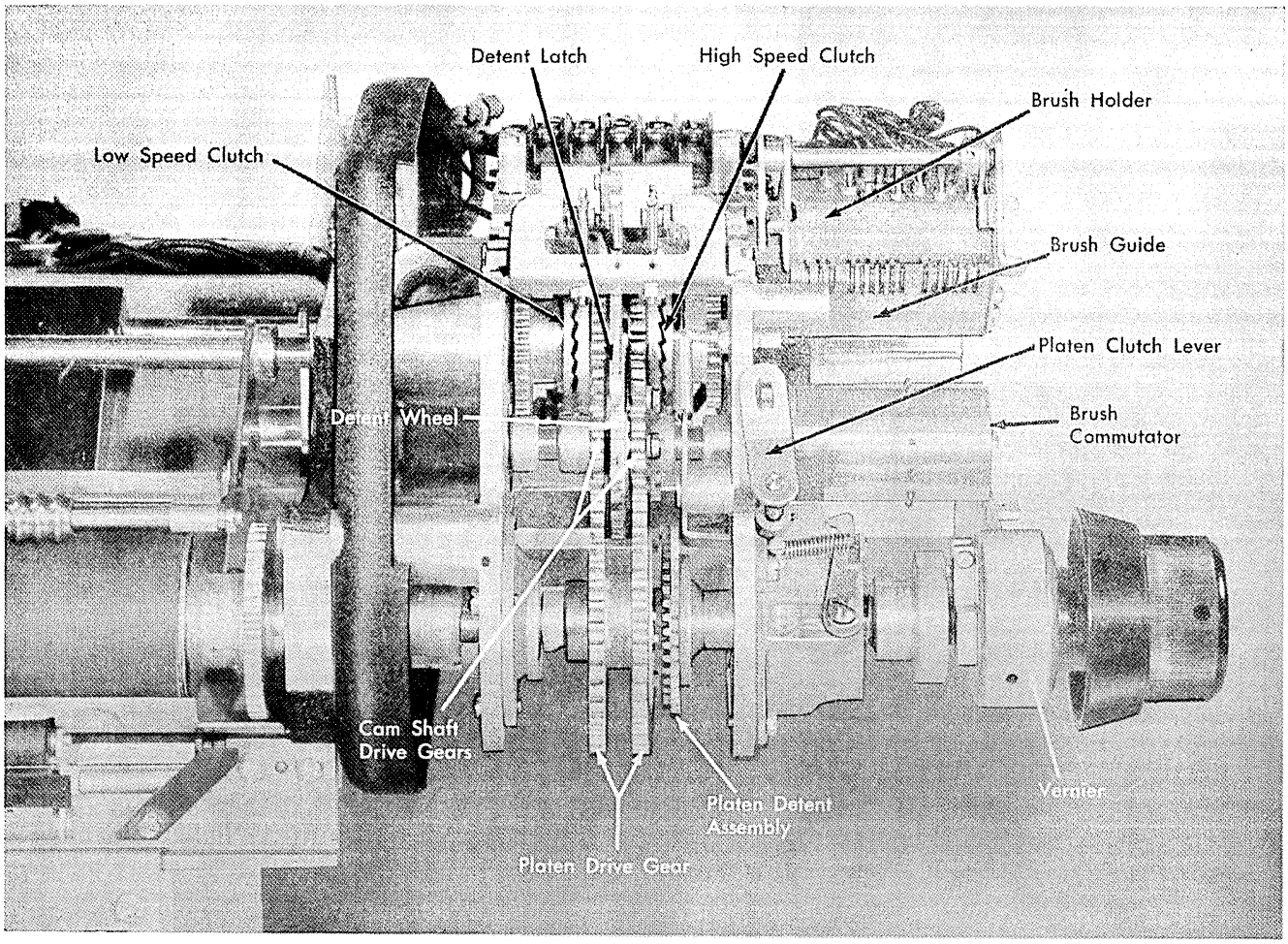


Figure 128. Carriage Drive Unit

may be positioned independently of the carriage tape mechanism.

Once the paper or form is located for the first printing line, the operator can restore the tape to the first line position by depressing the restore button. The tape mechanism will move the tape until a punch is read by the number one carriage brush but will not move the platen. The operator can then connect the carriage drive mechanism to the platen by turning the platen clutch knob to the left. This remeshes the platen detent assembly with the teeth on the platen drive gear.

The platen detent assembly is similar to a tube in construction through the center of which passes the platen shaft; however, the platen detent assembly is connected to the original vernier platen knob. The beveled gears in the vernier housing provides a connection between the vernier platen knob and the platen shaft. Thus, it may be correctly stated that, when the platen drive gear is in mesh with the platen detent assembly, power from the drive unit is transmitted to the platen shaft through the vernier. Whenever the platen clutch knob is turned to the right, a detent pin is lowered into the teeth on the platen detent and holds the detent teeth in alignment with the three teeth on the platen drive gear. Turning the platen clutch knob to the left allows the teeth to remesh and also raises the detent pin, which is under spring tension, clear of the teeth on the platen detent assembly.

Figure 129 shows the location of the interposer contact which closes when the interposer magnet is fully energized. Attached at the top of the interposer magnet armature are the low speed and high speed interposers which control the selection of the correct clutch.

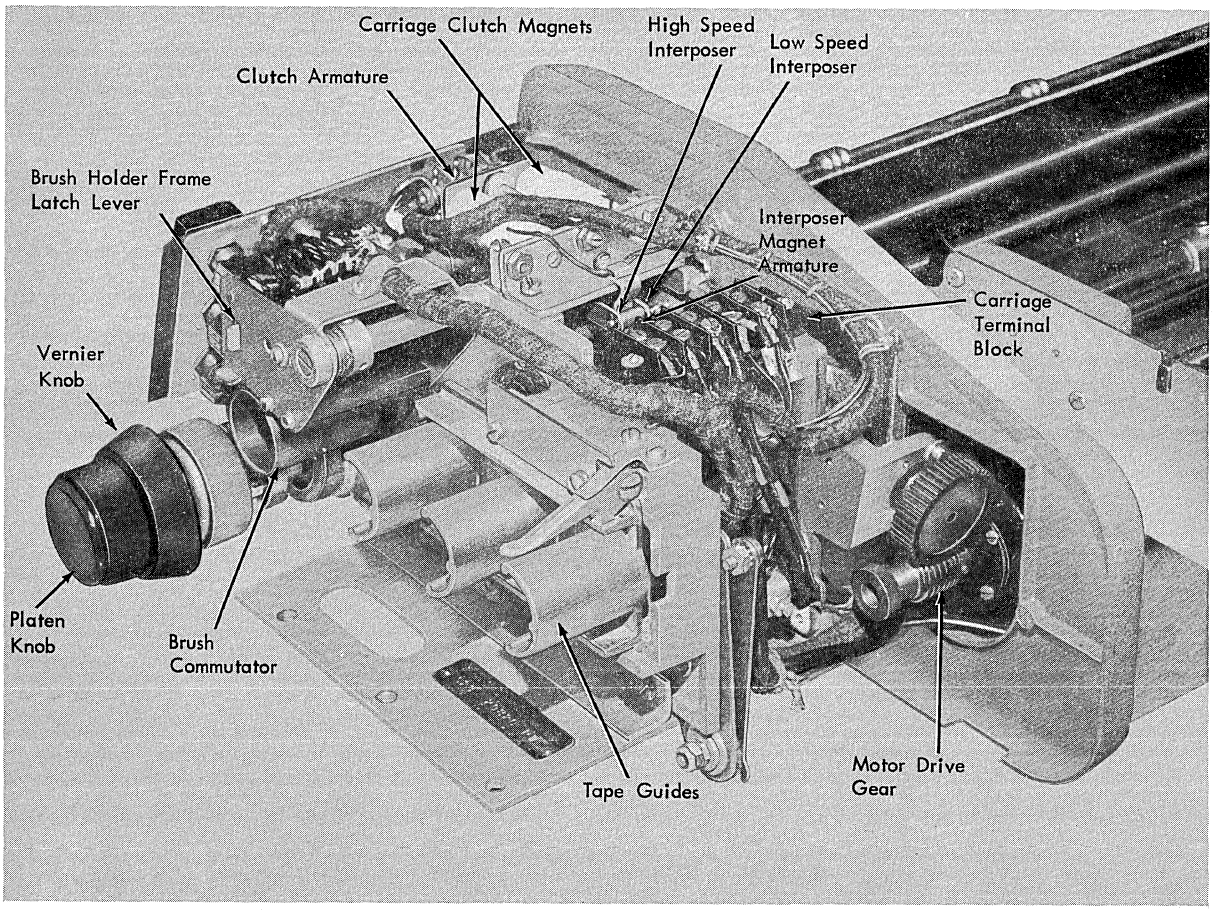


Figure 129. Carriage Drive Unit — Interposer

Figure 130 shows, from a slightly different angle, the carriage circuit breaker contact, circuit breaker cam, and the brush commutator with the control tape feed pins. The tape may be passed over any guide position, and the guide may be shifted from left to right and locked in any position. The base will be located on the Type 402, 403, or 419 machine by means of the carriage stop screws. The location of the center of the platen printing line may be raised or lowered by turning eccentric adjusting screws as necessary.

Vernier

At the right end of the platen shaft is attached a platen knob by means of a socket setscrew which may be removed. Next is a bakelite vernier knob which is screwed to the original vernier pinion housing. Revolve the vernier knob until the hole in the platen beveled gear assembly is in line with the hole in the vernier pinion housing. A taper punch placed through the two pieces serves as a lock and the vernier pinion knob may be removed by turning it counterclockwise (Figure 131).

The vernier pinion housing is positioned on the platen shaft and held under spring tension by means of the vernier pinion collar and three socket setscrews. Remove the screws and the vernier pinion housing will slide off its shaft. A study may now be made of the gear teeth cut in the platen beveled gear assembly and the teeth of the platen drive shaft gear. It will also be noted that there are three beveled gears in the vernier pinion housing placed 120° apart. Each of the gears will align with one tooth of the platen bevel gear assembly and a tooth of the platen drive shaft gear. Only one position in each 120° arc will be aligned, as all other gear teeth in each 120° arc are slightly

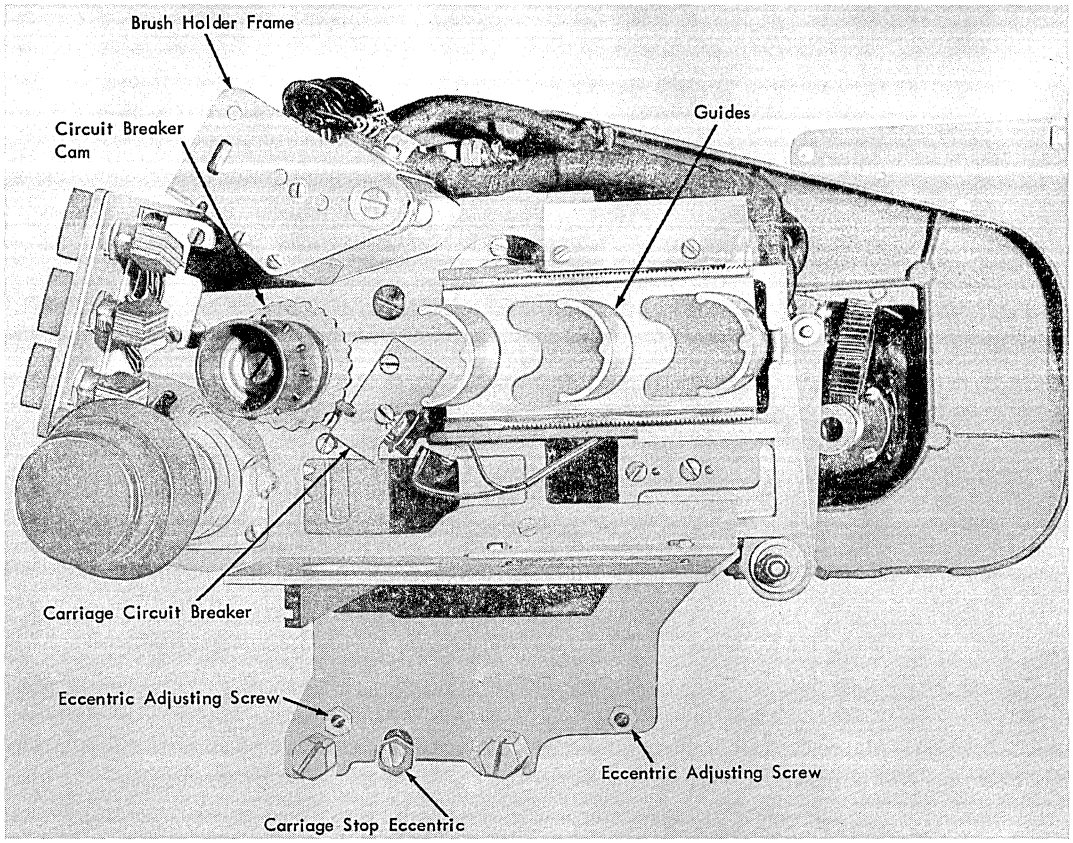
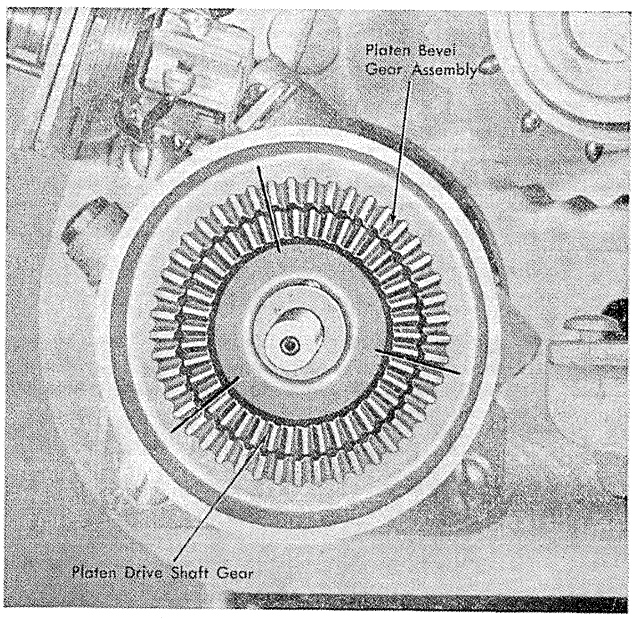


Figure 130. Carriage Drive Unit — Commutator Roll



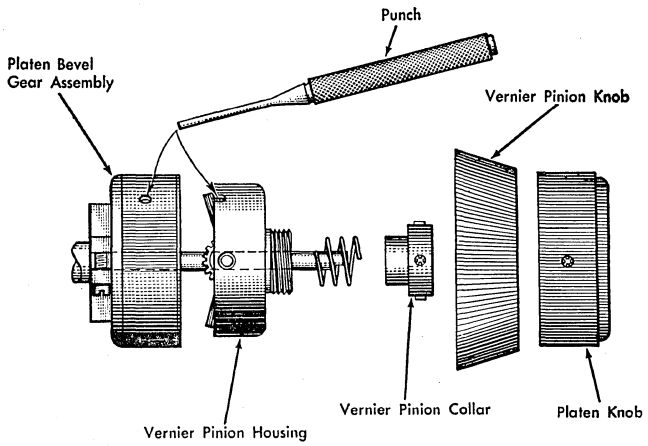


Figure 131. Vernier

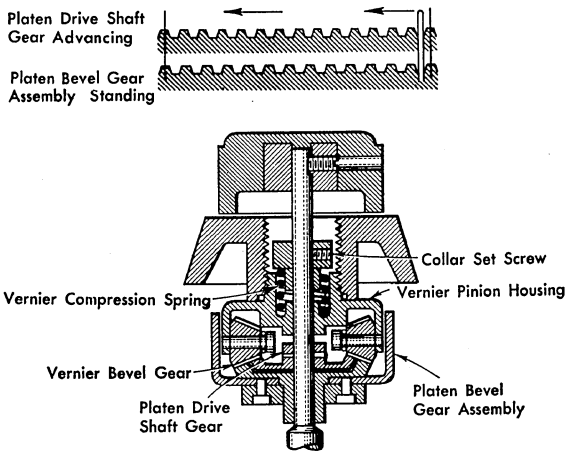


Figure 132. Vernier Motion

offset in relation to each other, there being 45 teeth on the platen beveled gear assembly and 42 teeth on the platen drive shaft gear. Thus, as the vernier pinion housing is turned counterclockwise, the teeth of the beveled gear forces the platen drive shaft gear slightly ahead so that the next tooth may be brought into alignment with the platen beveled gear. This action of the beveled gear moving ahead forces the offset teeth of the platen drive shaft gear to also move ahead, and thus causing the platen to advance a short distance for each tooth of the beveled gear. Figure 132 demonstrates this motion.

Carriage Reading Brushes

The carriage reading brushes are mounted in a frame and held in a brush block similar to other machines. The brush commutator is insulated from the rest of the machine, therefore, the inner brush serves as the common for the circuits established by the brushes 1 through 12 (Figure 133).

6 TO 8 LINE DRIVE (FIGURE 134)

THE 6 to 8 line drive is available on a B/M and includes parts necessary and instructions for field installation. There is an installation charge for this device.

The standard platen shaft shown in Figure 126 is removed and replaced with one which provides a method of gear drive to the platen.

By means of the gear shift arm, the customer may place the gear shift assembly in one of two positions.

When the gear shift arm is moved to the left, the drive for the platen is from the platen drive shaft through the platen drive shaft gear, the right section of the shift gear, to the left section of the shift gear then to the left section of the platen drive gear. This provides a gear reduction from 6 to 8 lines per inch.

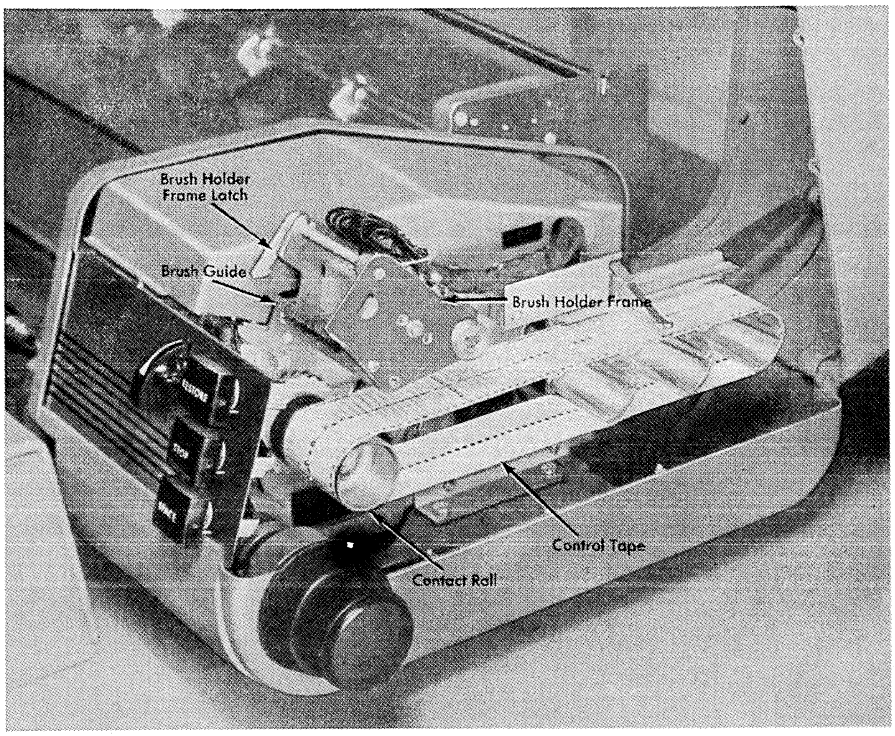


Figure 133. Carriage Brush Assembly

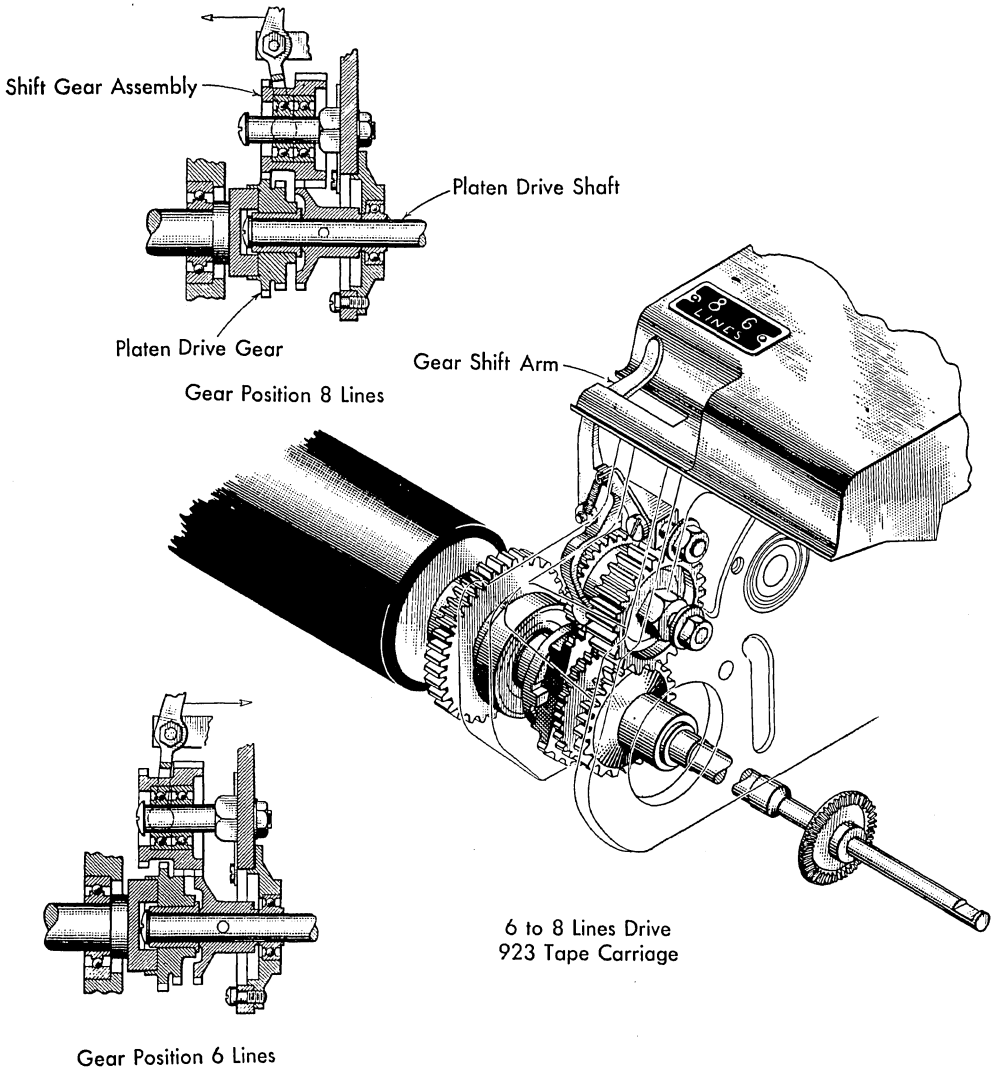


Figure 134. Six- or Eight-to-the-Inch Line-Spacing Device

When the arm is moved to the right, the drive for the platen is from the platen drive shaft through the platen drive shaft gear, the right section of the shift gear assembly to the right section of the platen drive gear. This provides direct drive for 6 lines to the inch.

NOTE: It is recommended that the customer change the position of the gear shift arm in the following manner:

1. Allow machine to idle.
2. Turn platen clutch knob to the right.
3. Move gear shift arm to new position at the same time rotating the platen so that the platen drive gear will mesh freely with the shift gear.
4. Turn platen clutch knob to the left and test carriage for correct spacing with the space key.

CARRIAGE LIFT MECHANISM

MACHINES with both Type 923 Tape-Controlled Carriage and Type 916 Bill Feed are equipped with a manually operated lift mechanism. To raise the Type 923, no covers need be removed, but the carriage must be positioned to the extreme left, and the carriage down lock must be released. A cover hinge door on the upper front cover allows a special carriage lift mechanism crank to be installed (Figure 135). This crank is not interchangeable with the standard machine crank. Clockwise rotation of the crank raises the carriage to a vertical position.

The lift mechanism consists of a worm drive, which

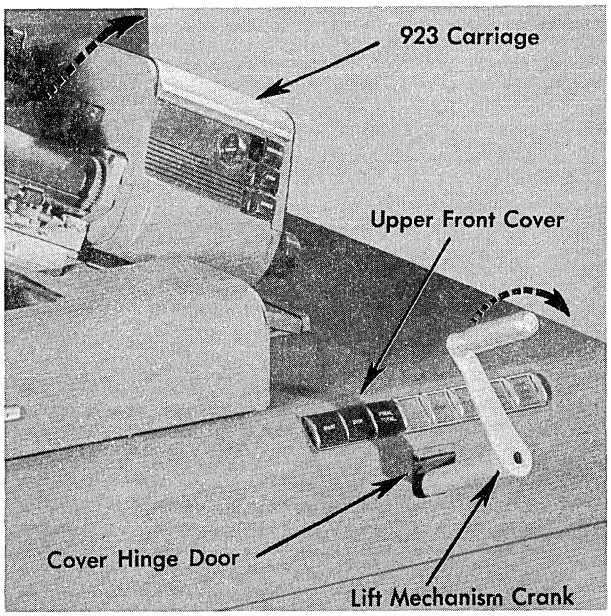


Figure 135. Lift Mechanism Crank

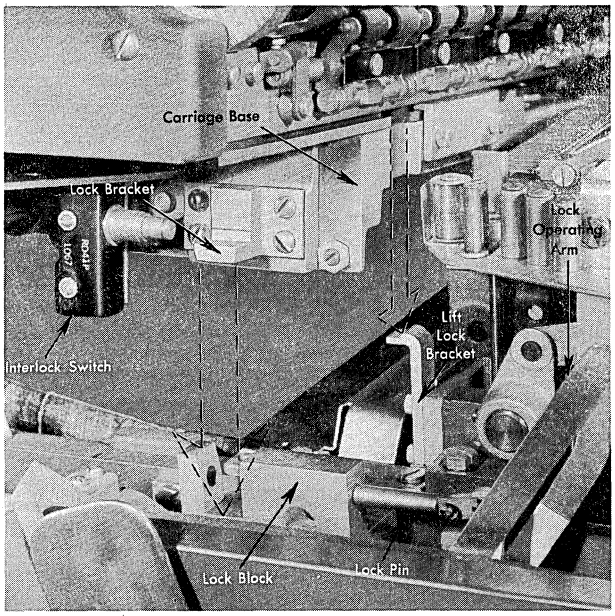


Figure 137. Carriage Down Interlocks

operates a large sector gear to which is attached the carriage lift link (Figure 136). When vertical, the carriage is locked safely in position by a safety link, which latches over the carriage mounting bracket. Release this safety link before lowering the carriage.

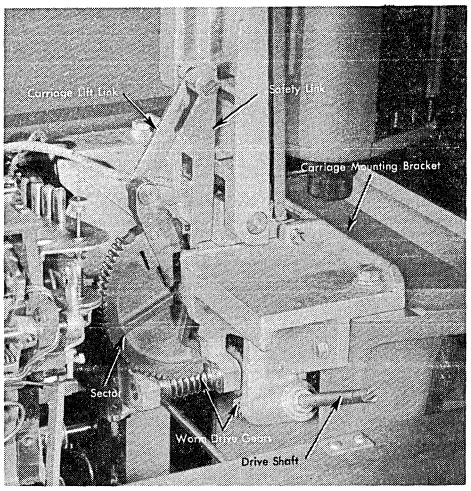


Figure 136. Carriage Lift Mechanism

When the Type 923 is lowered, a lock bracket mounted on the carriage base fits into the carriage lock block (Figure 137). A carriage lock pin moved into position by the lock operating arm securely holds the carriage in place and closes the carriage down interlock switch. This lock must be in place before the carriage drive motor will run. Notice also the lift lock bracket, which fits into a groove along the front of the carriage base. Unless the carriage is moved to the extreme left, it cannot clear this bracket and be raised.

When the carriage is lowered to its operating position, it is important that no force be placed on the carriage base by the lifting mechanism. It should be cranked to a point where backlash is evident in the mechanism when it is moved in either direction.

THE POWER supply to the carriage is 46 volts DC from the motor generator or 49 volts ± 2 volts from the rectifier of the Type 402-403-419. The carriage motor control resistor should be adjusted to maintain a motor speed between 3950 and 4050 R.P.M. which will result in the brush commutator turning at 62 R.P.M. with the low speed clutch engaged and 136 R.P.M. with the high speed clutch engaged.

Motor Circuit, Figure 138

The motor will operate as long as both the main line switch for the accounting machine is ON and the gang punch switch is in the OFF position.

The armature circuit is from gang punch switch, through Post 3, armature, Post 2, carriage motor control resistor, fuse 18.

The field circuit is also from Post 3, field, Post 1, carriage motor control resistor variable arm, resistor, fuse.

Speed

The speed of the carriage is in terms of the R.P.M. of the brush commutator. Slow speed which is 62 R.P.M. is used for all normal spacing, restoring and overflow operation.

High speed is 136 R.P.M. and is used for all skip-to operations.

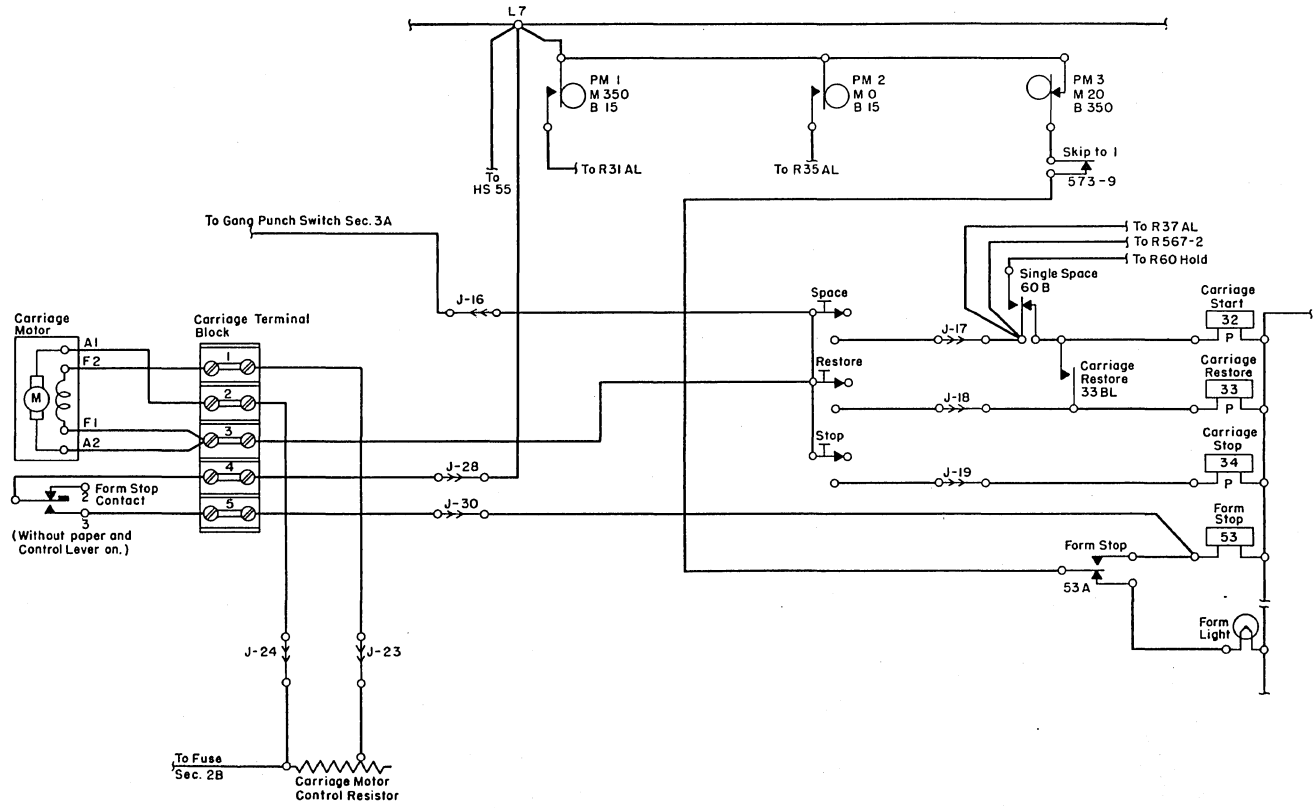


Figure 138. Carriage Motor Circuit

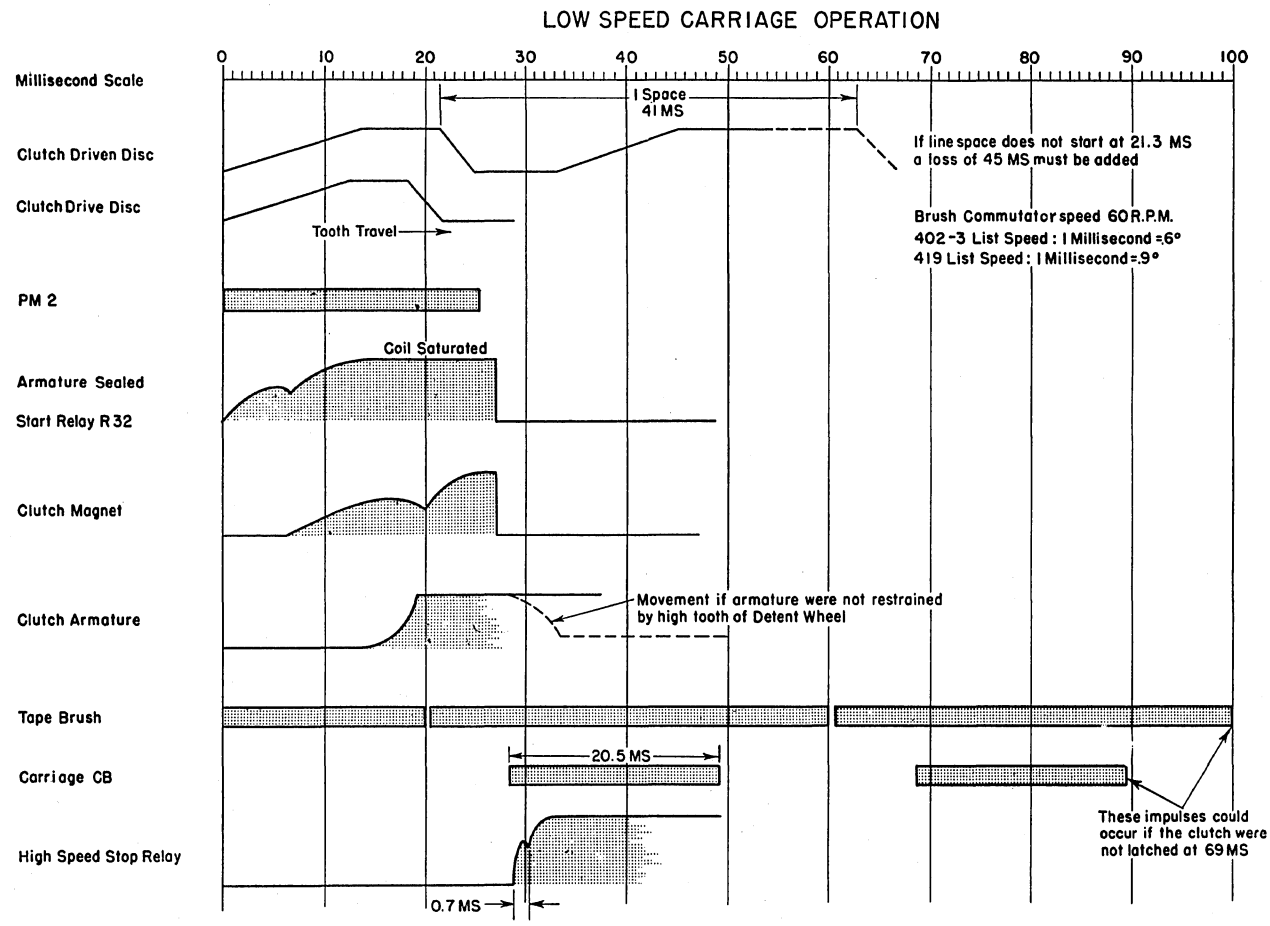


Figure 139. Type 923 Low-Speed Chart Relative Timing

The slow speed chart (Figure 139) is drawn to a millisecond scale. To convert milliseconds time to index degrees, use .6° per millisecond if operation is at 100 cards per minute, or .9° per millisecond if operation is at 150 cards per minute.

The slow speed chart (Figure 139) is drawn to a millisecond scale and the degree of 402-403 time is estimated on the basis that the carriage is being used when the accounting machine is wired for detail printing.

When printing is being done, the space operation is timed by the closing of PM2 and the speed at which the components of the carriage circuit operates are indicated. The time necessary for the carriage start relay to be energized is shown; this results in a circuit to the carriage clutch magnet. In both cases a point is indicated at which the next operation is set up before the coil reaches saturation. When the clutch magnet armature is attracted to the point where the detent latch is clear of the detent wheel, the clutch will begin to drive the platen and at the same time the carriage CB will start to turn. At the time that the CB closes, the detent latch overlaps the tooth of the detent wheel approximately 1/3 on the leading edges. When the CB

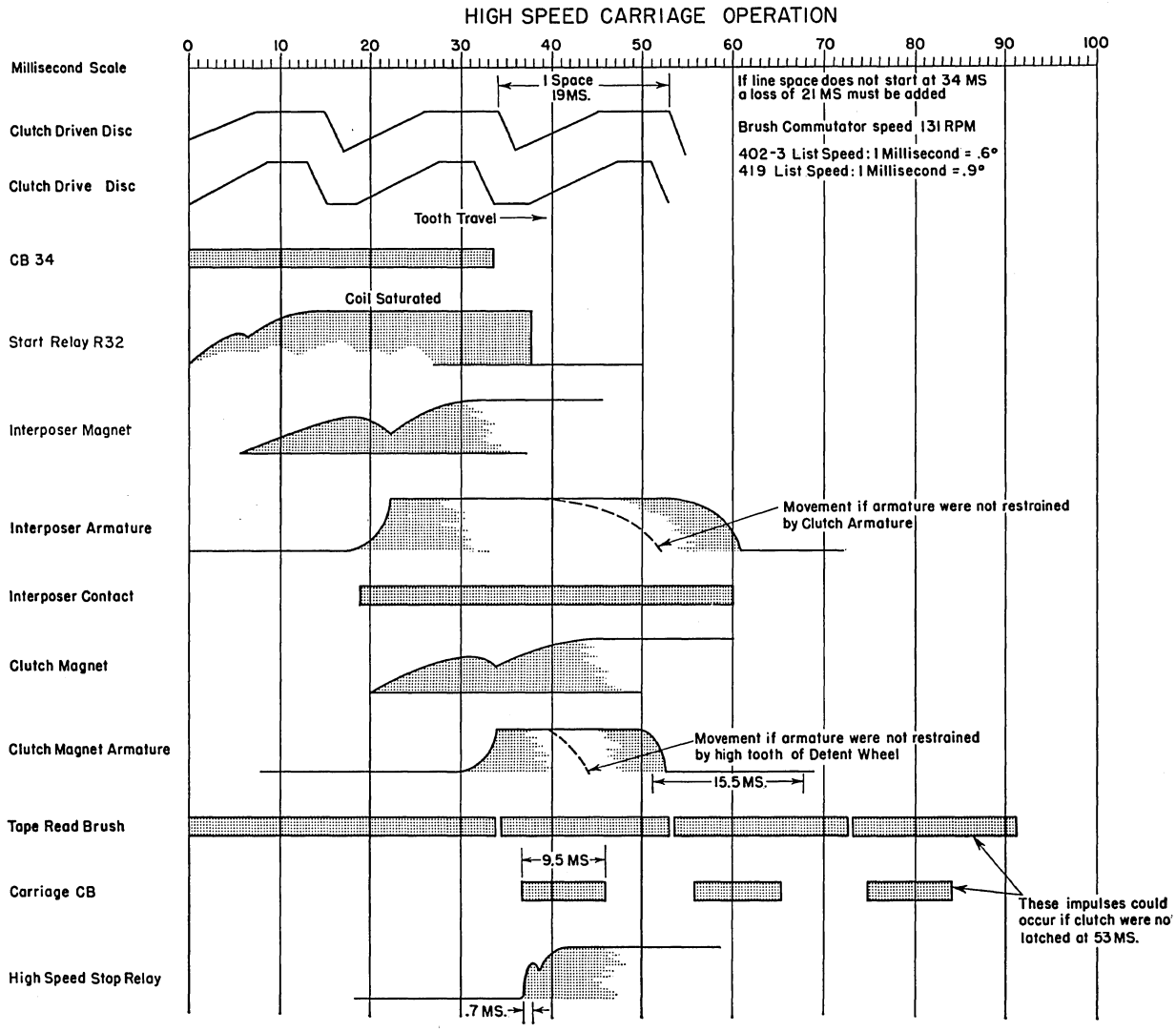


Figure 140. Type 923 High-Speed Chart Relative Timing

opens, the detent latch overlaps the detent tooth approximately 1/3 on the trailing edge; therefore, the CB points are open when the detent latch is seated in the detent wheel. A check of the tape read brush also shows that the brush has two strands still making contact with the brush commutator through the hole which was just read when the detent latch engaged with the detent wheel. If the column following is punched, it is possible that a few of the heel strands will also make contact with the brush commutator.

At one hundred list speed a millisecond is equal to .6° of 402-403 time. There is no way of fixing the relationship between the Type 923 and the Type 402-403-419, but with the information shown it is possible to work out the approximate details of the carriage operation to fill the needs of a sequence chart.

Figure 140 shows the approximate speed of operation when the high speed clutch is engaged. The impulse to start a skip operation begins with CB34 in section 10A which makes at 265° and breaks at 285°. With high speed operation the circuits cause the interposer magnet to be energized first so that the interposers may be correctly positioned before the clutch magnet circuit is completed.

This additional operation causes the first high speed skip to require approximately 20° to start where the first space required approximately 13°. When skipping is being performed, each additional skip will require an additional 11.4°; this is assuming that the clutch magnet remains energized.

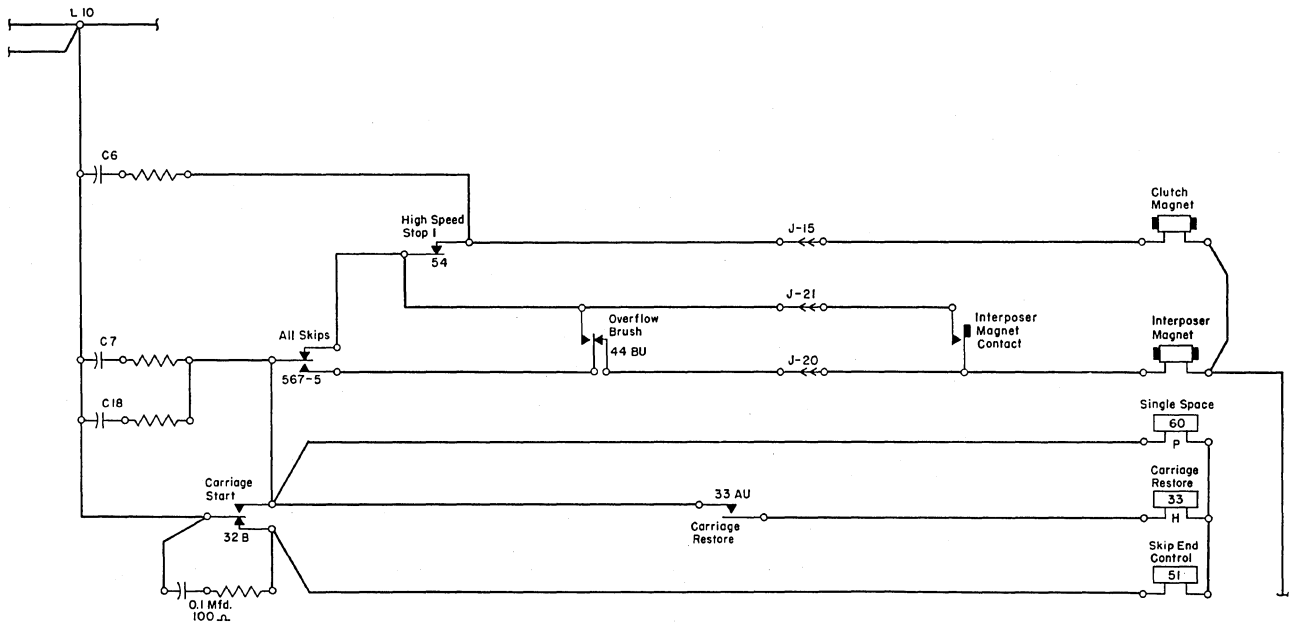


Figure 141. Type 923 Carriage Magnet Control Circuit

In the schematic (Figure 141) it may be seen that, with the carriage start relay R32B N/O closed, the clutch magnet is energized through R567-5 N/C and R54. If the next operation were to be a "skip to," the clutch magnet would be energized through the interposer contact since the R567-5 N/O points will be closed. R567-5 N/O causes the interposer magnet to energize first. As the interposer armature seals, the interposer contact closes and completes the circuit to the clutch magnet.

It is necessary to operate either the machine or the manual keys in order to energize the clutch magnet and cause the platen to advance.

MANUAL CONTROL

Mounted on the front of the carriage drive housing are the manual control keys.

Space Key (Section 10A)

When this key is depressed, it causes one space regardless of how long it is held. The operation will be at low speed, and no control panel wiring is necessary. Figure 142 shows a function chart of the relays involved.

OBJECTIVE: To energize the clutch magnet for one space only.

1. R32 picks through space key, gangpunch switch, L1. 10A
   R32 holds through HS55 N/C from L7. 10B
2. Clutch magnet picks through 32B N/O from L10. 14A
3. R60 picks through 32B N/O from L10. 14A
   R60 holds from CB35 and is repicked by the space key through 60B N/O.
   As soon as the clutch magnet armature is energized and the detent latch clears the detent wheel, the low-speed clutch will cause the drive mechanism to advance. The cam shaft drive gear turns and with it the carriage circuit breaker; this provides a circuit to the high-speed stop relays.
4. HSR54 and 55 pick through N/C points 33AL, 536-5, 39BU, carriage CB to fuse 18. 12A
5. Clutch magnet drops when HSR54 opens. 14A
6. R32 drops when HSR55 opens and will not repick if the space key has been held because of 60B N/C. 10B

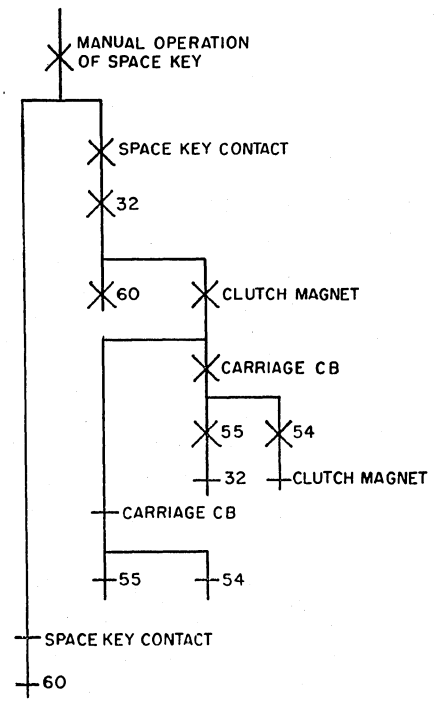


Figure 142. Space Key Operation

All circuits on section 11 and 12 are connected to L9. This prevents the relays from operating from any source connected to the line side of the machine.

When the high-speed stop 1, R54, which is similar to the slate base relay in construction, energizes, its single point opens the clutch magnet circuit. The high-speed stop 2, R55, energizes and opens its point in the R32 hold circuit.

The high-speed relay is designed to pick in less than one millisecond and, because the circuit breaker closes as soon as the space starts, the clutch magnet circuit is broken immediately. The detent latch is under spring tension; this will force the latch into the detent wheel and break any residual magnetism at the armature.

Stop Key (Section 10B)

This emergency stop button should not be used to stop the machine while it is in automatic operation. It will stop both the carriage and the accounting machine but is intended to be used with the carriage alone.

OBJECTIVE: To stop operation of the 402, 403, and 419 continuously running circuit and 923 space, restore and skip circuits by depression of the carriage stop key.

1. R34 picks through stop key, gangpunch switch, L1. 10B
   R34 holds only as long as stop key contact is made.
2. R1 and 2 drop when 34AL N/C opens. 4B
3. R32 drops when 34BL N/C opens. 10B
4. RESTORE and SKIP TO relays drop when 34BU N/C opens. 16A & B

The carriage stop key stops operation of the accounting machine at the end of any type of cycle, whereas the 402, 403, and 419 stop key will not stop operation until automatic cycles, such as conversion or total levels, have been completed. In certain cases the accounting machine continues to idle under power at high speed even though circuit operation has stopped. Be cautious when approaching mechanical mechanisms after the machine has been stopped with the carriage stop key.

Restore Key

When this button is depressed, the carriage restores to the hole punched in column 1 of the tape. This restoration takes place at slow speed, and the position of the platen clutch knob determines whether the platen advances at the same time with the control tape. No control panel wiring is necessary.

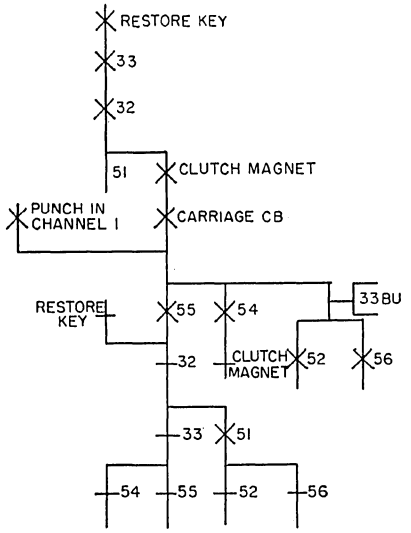


Figure 143. Restore Key Operation

OBJECTIVE: To energize the clutch magnet and keep it energized until a hole is sensed in channel 1. (Function chart Figure 143.)

1. R33 picks through restore key, gangpunch switch, L1. 10A
2. R32 picks through 33BL and restore key. 10A
   R32 and 33 continue to pick as long as restore key is operated.
3. R51 drops when 32B N/C opens. 14A
4. Clutch magnet picks through 32B N/O. 14A
5. R33 holds through 32B N/O. 14A
   The carriage begins to move, and the carriage CB closes, but high-speed stops R54 and 55 will not be energized immediately because of R33AL *(Section 12A)*. The carriage control tape will continue to advance until the column 1 tape read brush makes contact through a *one* hole punched in the tape. At that time the carriage stop circuit will be set up.
6. HSR54 and 55 pick through 33AL N/O, 536-4, tape, channel 1 brush, carriage CB, fuse 18. 12A
7. HSR56 and R52 pick through 33BU from carriage CB. 12A
   HSR56, 55, 54 and R52 hold through 51B N/C and fuse 18. 12B
8. Clutch magnet drops when HSR54 opens. 14A
9. R32 drops when HSR55 opens. 9B
   When R32B goes back to normal, the carriage restore R33H is de-energized, and the carriage stops with the last two strands of the tape read brush just ready to leave the *one* hole punched in the control tape.
10. R51 picks through 32B N/C from L10. 14B
11. R52 and HSR56, 55, and 54 drop when 51B N/C opens. 12A
    The purpose of the R52 and 56 hold circuit is to provide a slight relay delay so that R52A and R52B points in section 16 are open sufficiently long enough to allow any overflow or skip to relays that have been picked to be fully de-energized. The operator is demanding that the form advance to line 1, which necessitates cancelling all other carriage operations.
    If the carriage restore key is held until after the tape has reached column 1, a new restoring operation will not be initiated. R33 and R32 will be energized by holding the restore key, but HSR54 holds and interrupts the clutch magnet circuit after being picked by the stop impulse from channel one of the tape.
12. HSR54 and 55 hold through 33BU, 51B N/C, fuse 18 until the restore key is released. 12A

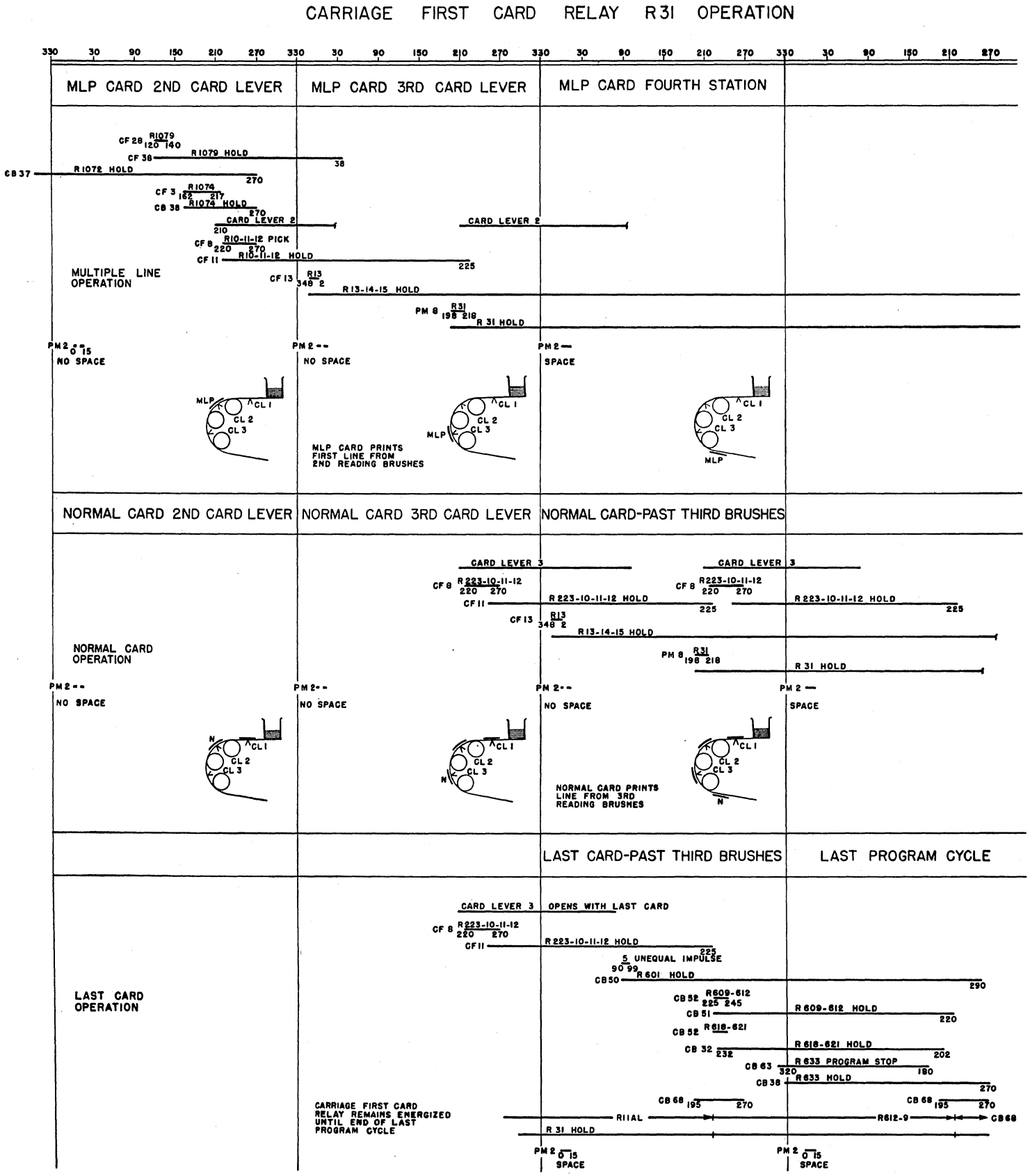


Figure 144. Sequence Chart First Card In Circuit

CARRIAGE FIRST CARD RELAY

BEFORE beginning a study of any spacing circuits it will be necessary to study the operation of carriage first card R31 as it is necessary that it be energized before any spacing impulse may be made available. from PM2.

The sequence chart (Figure 144) helps to show the conditions under which the carriage first card is energized.

When the first card in is a multiline card, circuits are set up so that printing may take place from the second reading brushes. Under this condition the lower card lever relays R10, 11, 12 will be energized when the card moves over card lever 2. The first card in R13 will energize at the correct time and will allow PM8 to pick R31 *(Section 24B)*.

With normal cards, listing takes place from the third reading brushes; therefore, the lower card lever relay R10, 11, 12 energizes when the first card in passes over card lever number 3. This energizes R13 at the correct time and allows PM8 to pick R31.

In either case, the space cam PM2 is closed from 0° to 15° on the first list cycle and PM8, which energizes R31, does not close until 198°; therefore, the R31BL points *(Section 9A)* are not closed until after the first line printing operation has taken place. The sequence chart shows the different times at which the first card relay R31 may be energized.

R31 may also be energized by the feed interlock 2, R64B, points which close during the second runout cycle. Under this condition the operator removes the cards from the hopper and depresses the feed interlock button. This causes the cards remaining in the feed to be treated in the normal manner and the carriage to space correctly. Also after the damaged card is repaired, the cards are run in with the feed interlock push button, and R64B causes R31 pick to energize and allow an upstroke space before detail printing the first card on the run-in, thus maintaining normal spacing under these conditions.

R31 hold circuit will be completed until such time as a skip to circuit is established, the main line switch is turned off, or the last program level operation following the last card has been completed.

A study of the sequence chart for the total cycle following the last card shows R31 held by R11AL until the last card leaves card lever 3, at 225°. At 225° the program relays will be energized because of a control change, and R612-9 should keep R31 hold energized. To prevent any chance of R31 hold dropping at this time due to the close overlap and to avoid any chance of the brushes arcing, CB68 will maintain the hold circuit from 195° to 270° and also take the break arc after the last operation as it remains closed until 270° while R612-9 points open at 220°.

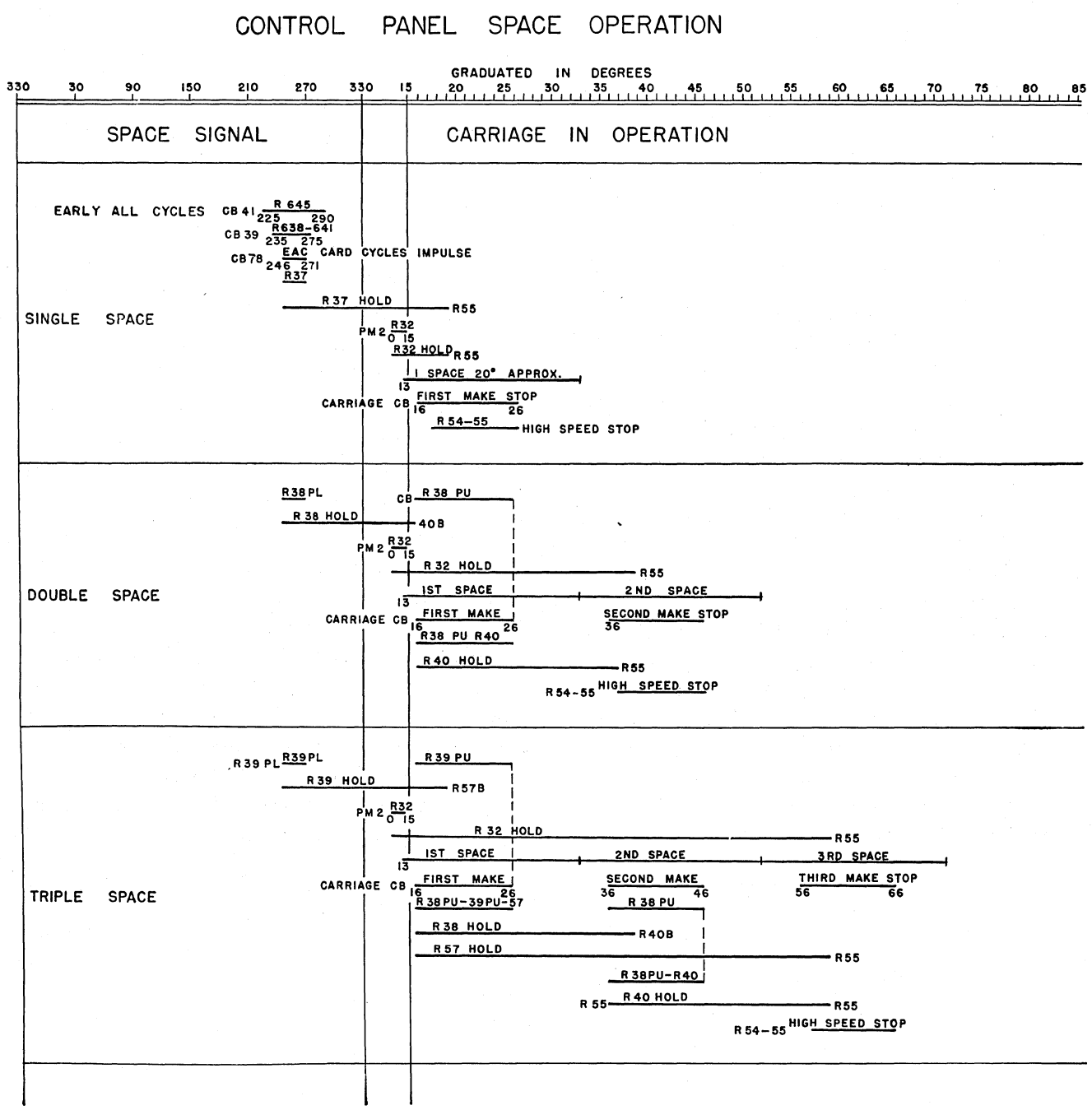


Figure 145. Sequence Chart — Single, Double, and Triple Space

SPACING FROM CONTROL PANEL WIRING

THERE MAY be some condition that requires a single, double, or triple space during normal carriage operation when listing. If the means of recognizing this is an X-punch in a card, the impulse will be used to control a pilot selector. A card cycle impulse will be made available at the selector and used to impulse either single, double, or triple spacing. The space hubs are conditioned by early all cycles relay points. A sequence chart of single, double, and triple space operation is shown by Figure 145. The cycle in which the carriage mechanism is actually moving is shown expanded from the point at which movement began. The scale is graduated in degrees movement of the accounting machine index, assuming a list speed of 100 cards per minute. Function charts of relay operation are shown with single-, double-, and triple-space circuit outlines to clarify relay operation sequence and illustrate cause and effect relationships.

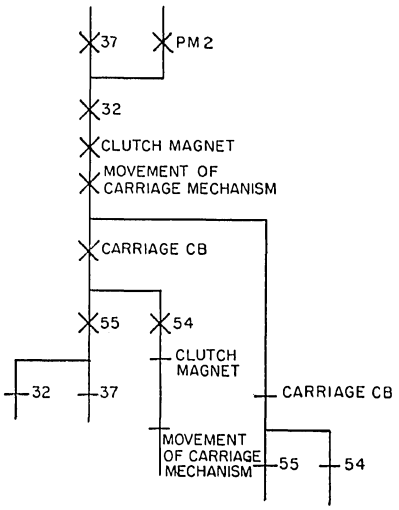


Figure 146. Single Space

Single Space

The most common use for the single-space feature is to change an automatic internal double-space operation to a single-space operation.

When the single-space control panel hub is impulsed with an all or card cycle impulse, the carriage clutch magnet will be energized just long enough to cause the platen to advance the paper form one space (Figure 146).

OBJECTIVE: To cause the carriage to move one space (carriage CB to make once) by impulsing space control 1 hub.

1. R37 picks from EAC portion of all or card cycles through control panel wire to space control 1 hub. 14B
   R37 holds through HSR55 from L7. 10B
2. R32 picks through 37AL from PM2. 10A
   R32 holds through HSR55 from L7. 10B
3. Clutch magnet energizes through 32B N/O from L10. 14A
4. HSR55 and 54 pick through 33AL N/C, 536-5 N/C, 37B N/O, Carriage CB, fuse 18. 12A
5. Carriage clutch magnet de-energizes when HSR54 opens. 14A
6. R32 and 37 drop when HSR55 opens. 10B

On a single space, high-speed stop relays are energized the first time the carriage CB makes to limit carriage movement to one space.

Double Space

When the space control 2 hub is impulsed from all or card cycle hubs, there will be a single clutch operation, which will be sustained until the platen moves two lines (Figure 147).

OBJECTIVE: To cause the carriage to advance two spaces (carriage CB to make twice) in one movement by impulsing space control 2 hub.

1. R38PL picks through control panel wire to space control 2 hub. 14B
   R38 holds through 40B and HSR55 from L7. 10B
2. R32 picks through 38AL from PM2. 10A
   R32 holds through HSR55 from L7. 10B
3. Clutch magnet energizes through 32B N/O from L10. 14A

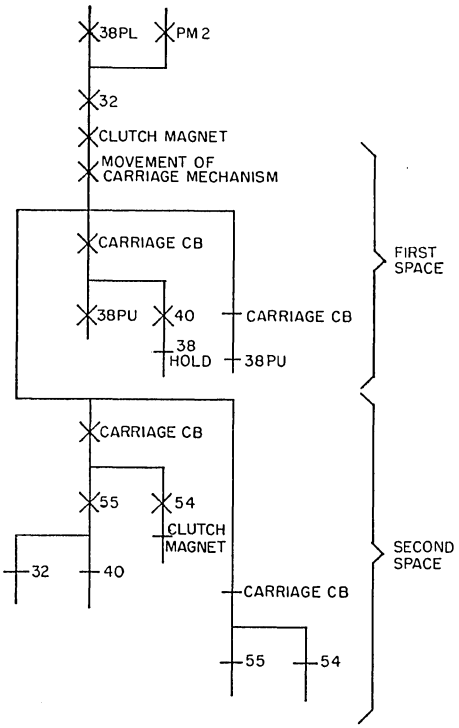


Figure 147. Double Space

On the first space

4. R40 and R38PU pick through 38BU N/O and carriage CB. 12A
   R38PU acts as a hold until the first space is complete.
   R40 holds through HSR55 from L7. 10B
5. R38 drops when 40B N/C opens and carriage CB breaks. 10B

On the second space

6. HSR55 and 54 pick through 33AL, 38BU N/C and carriage CB to stop the carriage as before. 12A

Double space requires the high-speed stop relays to be energized on the second make of the carriage CB to stop the movement after an advance of two line spaces.

Triple Space

When the space control 3 hub is impulsed from all or card cycle hubs, there will be a single clutch operation, which will be sustained until the platen moves three lines (Figure 148).

OBJECTIVE: To cause the carriage to advance three spaces in one movement (carriage CB to make three times) by impulsing the space control 3 hub.

1. R39PL picks during EAC time through control panel wire. 14B
   R39 holds through 57B, HSR55 and L7. 10B
2. R32 picks through 39BL from PM2. 10A
   R32 holds through HSR55 from L7. 10B
3. Carriage clutch magnet energizes through 32B N/O. 14A

On the first space

4. R57, 39PU, and 38PU pick through 39BU N/O from carriage CB. 12A
   R57 holds through HSR55. 10B
   R38 holds through 40B, HSR55 and L7. 10B
   R39PU acts as a hold until the first space is completed and then drops. 12A
5. R39 drops when 57B N/C opens and carriage CB breaks. 10B

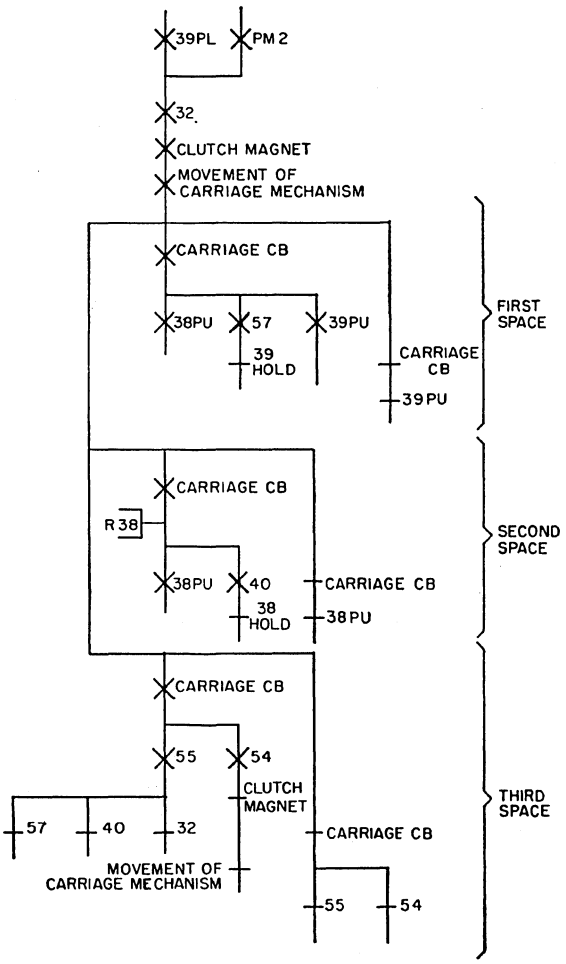


Figure 148. Triple Space

On the second space

6. R40 and R38PU pick through 38BU N/O, 39BU N/C and carriage CB. 12A
   R40 holds through HSR55. 10B
   R38PU acts as a hold until the second space is complete and then drops. 12A
7. R38 drops when 40B N/C opens and carriage CB breaks. 10B

On the third space

8. HSR55 and 54 pick through 33AL, 38BU N/C, 39BU N/C, and carriage CB to stop the carriage. 12A

The impulse to pick high-speed stop relays is delayed until the third make of the carriage CB, allowing a platen movement of three spaces.

A space called for from the control panel will always supersede any space called for at the same time by internally wired circuits.

Internal single space is superseded by control panel double or triple space, because double-space R38BU N/C, or triple-space R39BU N/C opens the internally wired single-space-stop circuit.

Internal double space is superseded by a control panel single space by closing the single-space R37B N/O point which completes the circuit to the high-speed stop relay R54, R55 by shunting the R38BU N/O points.

Internal double space is superseded by control panel triple space as triple space R39BU N/C opens, when energized, the normal circuit to the high-speed stop relay R54, R55.

SPACE SUPPRESSION

IF IT becomes necessary to suppress spacing, an EAC impulse directed to the space suppress hub will accomplish this purpose.

OBJECTIVE: To suppress normal spacing from control panel wiring or internal circuits.

1. R35 picks through control panel wiring to space control S hub. 14B
   R35 holds from CB32. 10B
2. R32 is blocked by 35AL. 10A
3. R38 and 39 hold circuit is opened by 35BU. 10B

NORMAL SPACING

THE CARRIAGE will basically single space, and internal circuits will normally provide for a single space before each printing operation. All spacing will be upstroke spacing. Any single-space operation may be changed to a double or triple space, and all spacing may be suppressed by proper wiring.

With the control panel list hub wired ON, there will be a single space before each detail-printed item, a single space before each total, and a double space before the listing of the first card of the next control group.

With the control panel list hub left unwired, there will be no space before a minor total, a single space before an intermediate or major total, and a double space before the listing of the first card of the next control group.

List Hub Wired On

For correct spacing when detail printing, the list hub must be wired to ALL CYCLES, otherwise the machine spacing will be incorrect and similar to that obtained when group printing. The carriage will perform all spacing operations at the printing speed of 100 or 150 cpm.

The circuits for complete spacing operation will not be repeated beyond setting up the pick circuit of R32. Beyond this point, operation is the same as for single, double or triple spacing. Keep in mind all spacing is upstroke, and in every case the impulse will originate with PM2 at 0° to 15° except when the

SAMPLE LIST	OPERATION	MAN NUMBER	DEPT. NO.	FACTORY NO.	LABOR		
					MAN	DEPT.	FACTORY
R79BU (R31BL open)	List	125	16	3	500		
R79BU	List	125	16	3	700		
R660-4	Minor Total				1200*		
R660-4, R621-3 closed	Inter. Total					4600*	
R660-4, R621-3 closed	Major Total						12547*
R16BL, R17BU, R38AL	Space						
R79BU or Double 2nd Space	List	146	17	4	4600		
R79BU	List	146	17	4	325		

Figure 149. Detail Printing — Spacing with a Major Control Change

space button is used. The carriage drive mechanism operates at low speed for all spacing operations. Normal spacing (no space control panel wiring) for a detail list report with major control change is shown in Figure 149.

OBJECTIVE: To cause a single space before each detail listed item, a single space before each total, and a double space before the listing of the first card of the next control group.

Single space: *Before detail list*
R32 picks through 79BU and PM2. 10A
Before totals
R32 picks through 660-4, 609-7, and PM2. 10A
Double Space: *Before first card of next group*
R38 picks through 645-2 N/C, 16BL, PM1. 14B
R32 picks through 38AL, PM2, and a double space occurs as previously described. 10A

List Hub Not Wired (Group Printing)

When the list hub is not wired, there is no means by which the list control R660 may be energized; therefore, list relay R79 must be energized by some means other than R660-2.

At the end of the program level 1, 2, or 3 minor 3 R16 is energized, and the R16BU points will cause the circuit to be completed to list R79 so that a space on the minor first card or group indicate cycle may take place.

When running cards in, remember that there will not be any spacing until after the carriage first card R31BL points are closed, so that printing from the first card in will be on the line for which the paper is positioned.

Normal spacing for a group print report with major control change is shown in Figure 150.

OBJECTIVE: To prevent spacing before minor totals, cause single space before intermediate and major totals, and double space before listing the first card of the next control group.

No space: *Before minor totals*
R32 has no pick circuit because list relays 660 and 79 are de-energized and 618-12 N/C is open. 10A
Single space: *Before intermediate and major totals*
R32 picks through 618-12 N/C, PM2. 10A
Double space: *Before first card of next group*
R38 picks through 17BU, PM1. 14B
R32 picks through 38AL, PM2 and a normal double space results. 10A

NORMAL SKIP TO OPERATION

Control Tape

The control tape is always punched with a hole in channel one designating the first printed line of the form and a 12 hole indicating the last printed or overflow line of the form.

When a form involving heading cards is used, a 2 punch always designates the first printed line of the second portion of the form whether the second portion be detail cards, as in a standard form, or heading cards as in an inverted form.

Holes in any other column may be used as stops for intervening skips; however, it is recommended that you use the read brush positions in the order 3 through 8 to obtain the best interlock condition.

The carriage will perform all spacing operations at the slower speed before the hammers fire for printing. When an overflow condition is recognized, that also

SAMPLE GROUP PRINTING		OPERATION	MAN NUMBER	DEPT. NO.	FACTORY NO.	LABOR AMOUNT		
						MAN	DEPT.	FACTORY
(R31BL open) R79BU open	(R618-12 open)	GI-Minor Total	125	16	3	1200*		
R31BL closed	R618-12 closed	Inter Total					4600*	
R31BL closed	R618-12 closed	Major Total						12547*
R17BU-R38PL		Space						
R79BU or Double 2nd Space	(R618-12 open)	GI-Minor Total	146	17	4	5362*		
R79BU	(R618-12 open)	GI-Minor Total	148	17	4	6173*		

Figure 150. Group Printing — Spacing with a Major Control Change

operates at the slower speed, and interlocking with the printer is automatic.

All other spacing operations are classified as a skip and require that the accounting machine be interlocked while the skip occurs. To prevent printing in flight, it is necessary that interlocks be provided so that the Types 402-403-419 wait until the paper is in position, or can be in position, before printing takes place. Provisions have been made for the release of this interlock under certain conditions in order that the over-all operation may be speeded up.

For a list speed of 100 cpm

1. A skip of less than $3\frac{2}{3}$ inches, or 22 line spaces, may be made without interlocking. In these cases the interlock is released by a tape hole punched ahead of the skip to stop point. This release punching must not be more than $3\frac{2}{3}$ inches or 22 lines in advance of the stop point.

2. A skip of greater than $3\frac{2}{3}$ inches will require interlocking of the accounting machine.

For a list speed of 150 cpm the maximum skipping distance without interlocking is $2\frac{1}{3}$ inches, or 14 line spaces. Interlock release punching must not be more than $2\frac{1}{3}$ inches ahead of the skip to stop.

When all the skip-to operations from any part of the form to any other part of the form are less than $3\frac{2}{3}$ or $2\frac{1}{3}$ inches, the control panel carriage interlock suppression switch may be wired, and this avoids necessity for wiring the interlock release for each skip-to operation. However, it will not be effective on overflow. The interlock release circuits will be discussed in a separate section.

A sample report using standard form is shown in Figure 151, with a control tape punched for this application. Tape punches define the following form lines.

1	First printing line
5	Predetermined total line
12	Overflow

Necessary carriage control panel wiring is shown in Figure 152.

Detail-listed items single space as previously discussed. When the last printing line of the form is reached, the carriage senses a channel twelve punch in the tape, stops the accounting machine printing, and overflows at low speed to line one of the next form. Detail printing resumes until a minor control change is sensed. Minor program level signals the carriage to skip to 5, the predetermined total line. After the total has printed, first card minor hub instructs the carriage to skip to 1, the first line of the following form, and detail listing of the next control group begins. Both skip to 5 and 1 are accomplished at high speed by the carriage, but because interlock release is not wired, the accounting machine will stop and idle while the carriage is skipping. Circuits will be outlined as they occur on this sample report, using Figures 151 and 152.

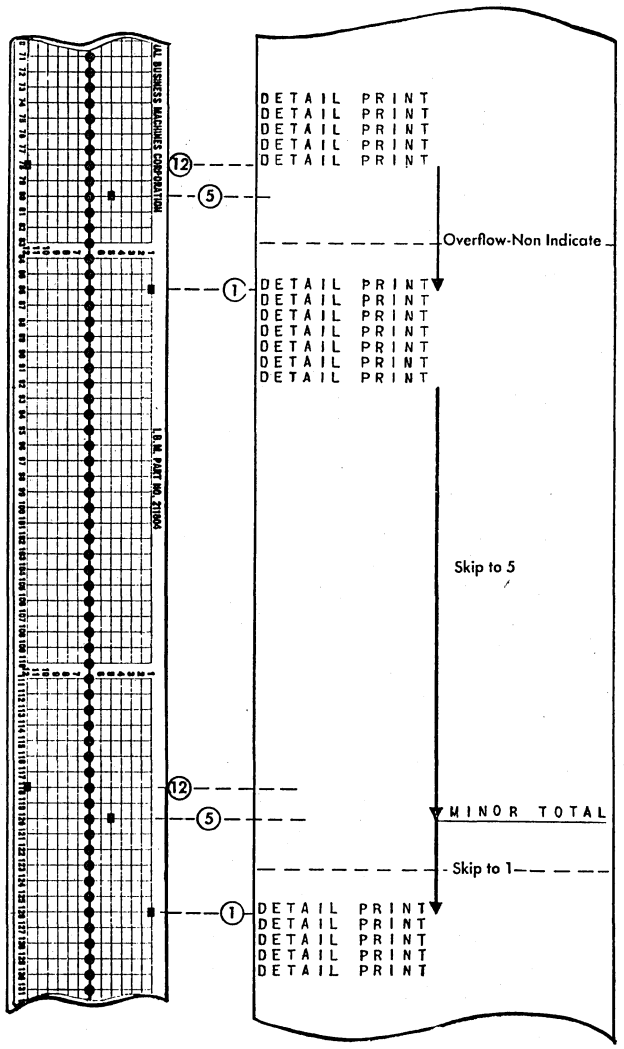


Figure 151. Standard Form Operation

Overflow—Non-Indicate

A function chart of overflow—non-indicate is shown in Figure 153.

OBJECTIVE: To sense a hole in channel 12 and cause an overflow skip to the next hole in channel 1. No head control wired.

1. R43 picks through channel 12 brush, hole in the tape, carriage CB, fuse 18.	12B
R43 holds and R44 energizes through 52B, L11.	16A

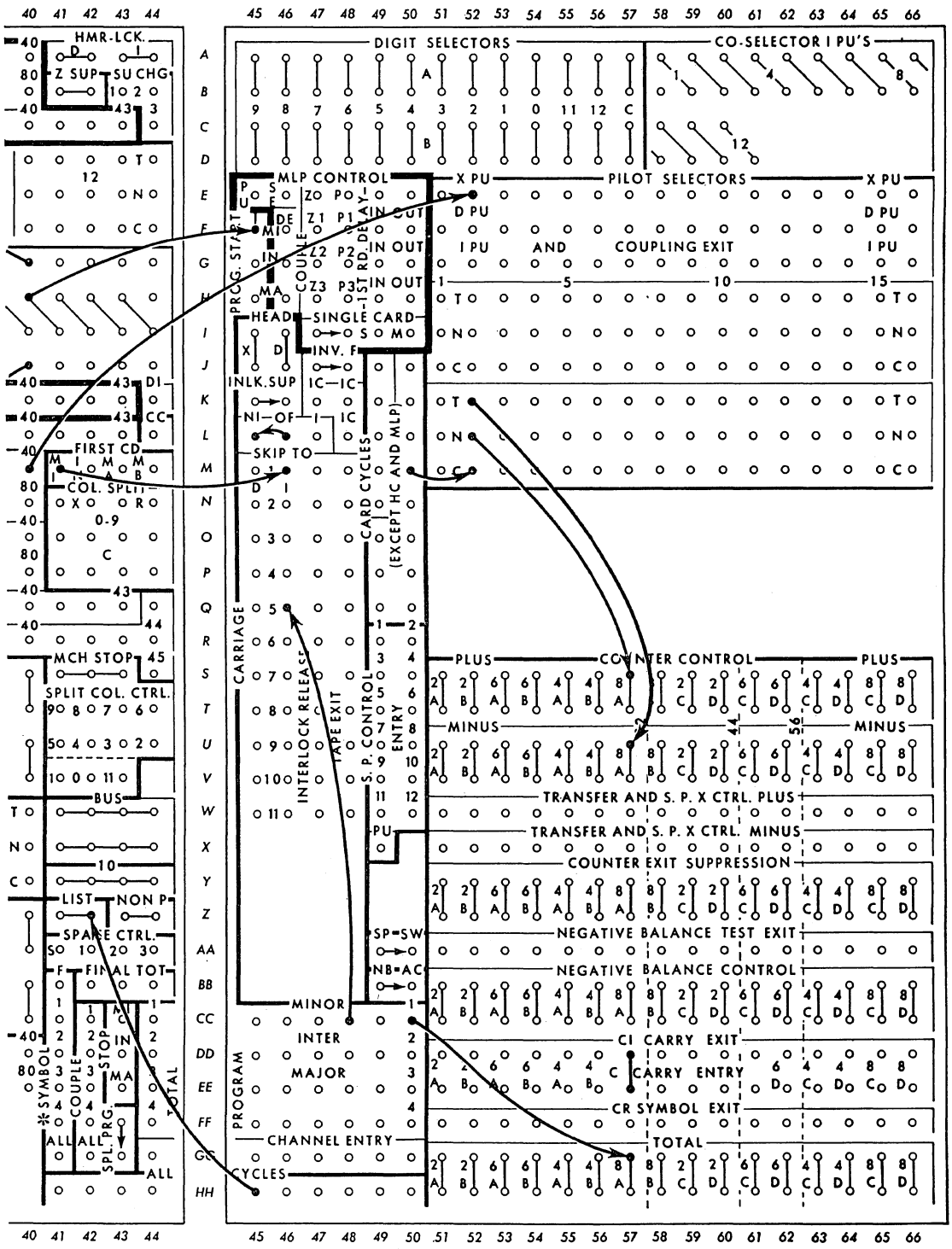


Figure 152. Standard Form with Overflow and Predetermined Total Line

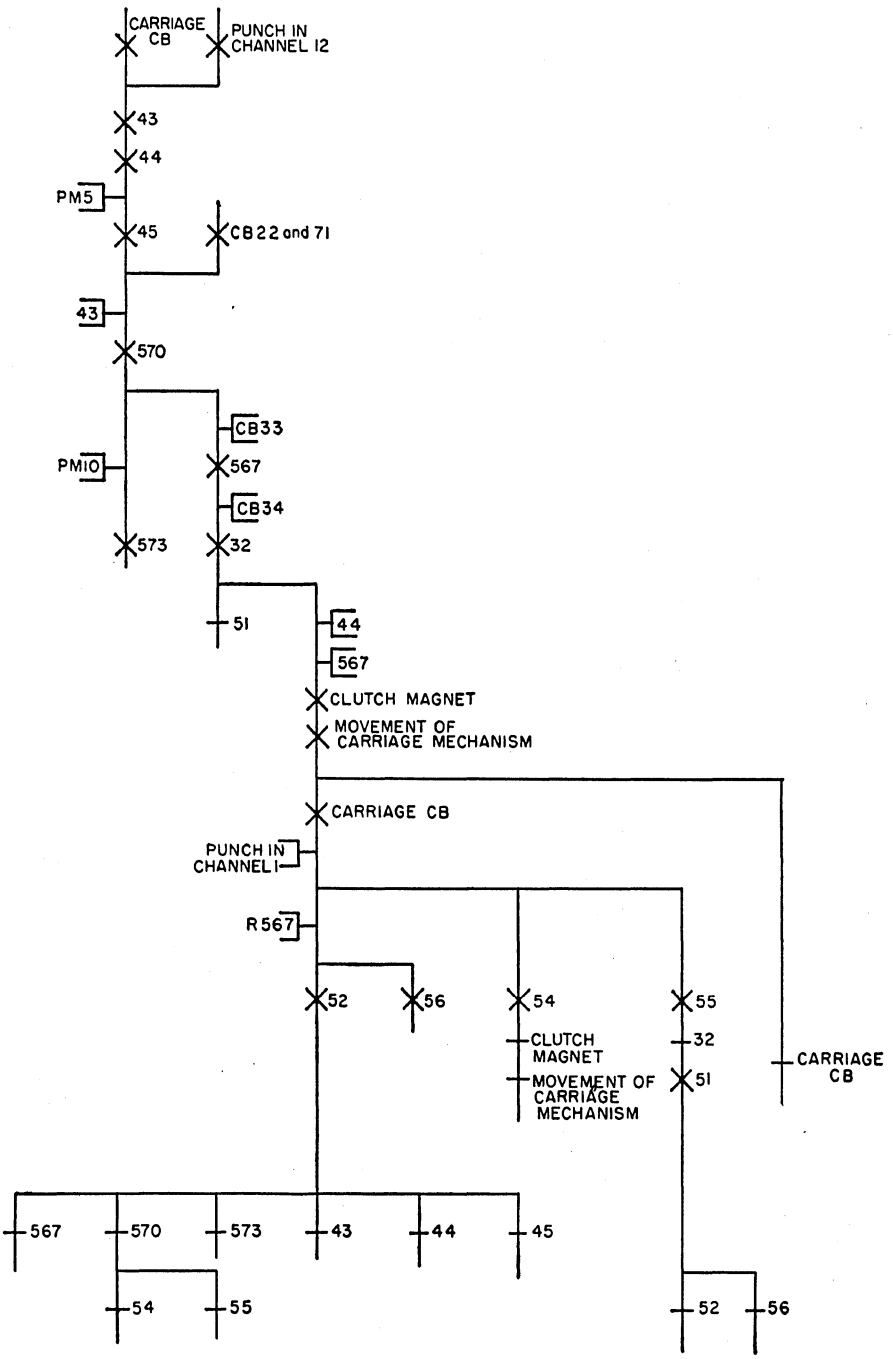


Figure 153. Overflow Non-Indicate

2. R45 picks through 44AL, 660-6, PM5. 14B
   R45 holds through 52B, L11. 16A
3. R570 picks through 45BL, control panel wired NI to OF, CB71, CB22. 14B
   R570 holds through 52B, L11. 16B
4. R573 picks through 570-2, PM10. 16A
   R573 holds through 52B, L11. 16B
5. R567 picks through 570-6, CB33. 10B
   R567 holds through 52B, L11. 16B
6. R32 picks through 567-2, CB34. 10A
   R32 holds through HS55, L7. 10B
7. R51 drops when 32B N/C opens. 14A
8. Clutch magnet picks through 44BU N/O, 567-5, 32B, L10. 14A
9. The direct circuit from carriage CB to HS stop relays is broken by 567-4, thus requiring the circuit to go through brush 1. 11A
10. HSR54 and 55 pick through 33AL N/C, 573-5 N/O, carriage brush 1, carriage CB, fuse 18. 12A
    HSR56 and R52 pick through 567-7 in parallel with the pick of HSR54 and 55. 12A
    HSR56, 54, 55 and R52 hold through HS56 N/O, 51B N/C, fuse 18. 12A
11. R43, 44, 45, 567, 570, and 573 drop when 52B N/C opens. 16A
12. Carriage clutch magnet de-energizes when HS54 opens. 14A
13. R32 drops when HS55 opens. 10B
14. HSR54 and 55 drop when 567-7 opens. 12A
15. R51 picks through 32B N/C. 14A
16. HSR56 and R52 drop when 51B N/C opens. 12A

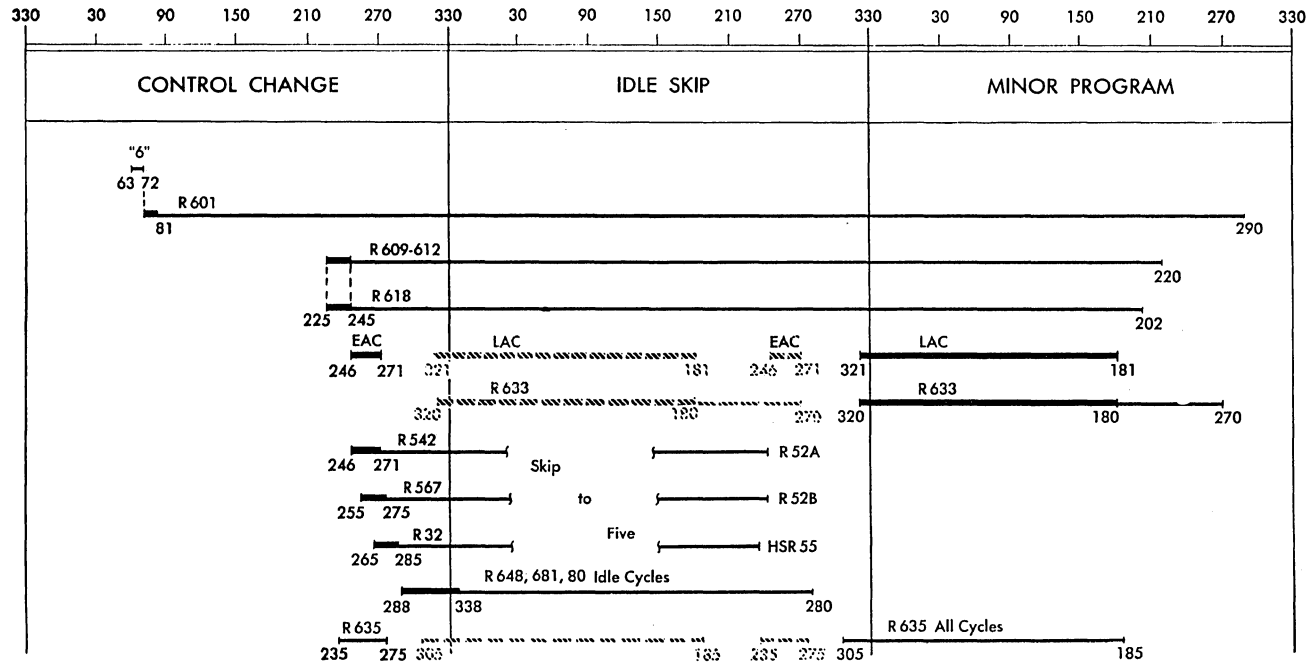


Figure 154. Skip to Predetermined Total Line (Seq Chart)

Predetermined Total Line Skip to 5

When the machine senses a control break, minor program start is impulsed to cause total printing. Minor program exit signals the carriage to skip to 5 immediate at the same time counters are impulsed to total print. Sometimes the distance between the point at which the control change is recognized and the predetermined total line is 3⅔ inches or less. In this case the form would be stopped in position to print before total listing occurs, and the interlock could be wired to release.

When the distance between the control change point and the predetermined total line is more than 3⅔ inches, it is necessary to delay program level printing until the form is in position. This is the case shown in Figure 151 and described by the circuit outline. A sequence chart of relay operation is given in Figure 154 to illustrate the program delay during carriage skipping. Control panel wiring is that of Figure 152.

OBJECTIVE: To skip to channel 5 hole for predetermined total over a distance greater than 3-2/3 inches.

1. R542 picks through control panel wire SKIP TO 5 I to MI PROGRAM LEVEL 1 by EAC portion of program impulse. 16B
   R542 holds through 52A N/C, L11. 16B
2. R567 and 41 pick through 542-2, CB33. 10B
   R567 and 41 hold through 52B and 52A, respectively. 16B
3. R32 picks through 567-2, CB34. 10A
   R32 holds through HSR55. 10B
4. Interposer magnet picks through 567-5, 32B, L10. 14A
5. Clutch magnet picks through interposer magnet contact after the interposer has shifted for high speed. 14A
6. High-speed stop relay immediate pick from carriage CB blocked by 567-4. 12A
7. Carriage brush 1 and 2 stop circuit blocked by 41AL and 41BL. 11A
8. R659 pick is blocked by 567-9 to stop the print mechanism while skipping. 5B
9. Idle cycles R648, 681, and 80 energize as a result of no CF or PM operation to delay the total cycle. 6B
   The carriage continues to move at high speed until the brushes sense a hole punched in channel 5.
10. HSR54 and 55 pick through 542-4, carriage brush 5, carriage CB, fuse 18. 12A
    HSR56 and R52 pick through 567-7 with HSR54 and 55. 12A
    HSR54, 55, 56 and R52 hold through 51B N/C. 12A
11. The remainder of skip stop operation is the same as items 11 through 16 of overflow—non-indicate.

First Printed Line Skip to 1

After total printing is complete, FIRST CARD MINOR signals the carriage to SKIP TO 1 IMMEDIATE in preparation for listing the next group. Interlock release is not wired; therefore, the accounting machine will take an idle cycle while the carriage is skipping.

OBJECTIVE: To skip to channel 1 at high speed. First card minor wired to skip to 1 immediate.

1. R573 picks through control panel wire from first card minor hub. 16A
   R573 holds through 52B, L11. 16B
2. R567 picks through 573-2, CB33. 10B
   R567 holds through 52B, L11. 16B
3. R32 picks through 567-2. 10A
   R32 holds through HSR55. 10B
4. Interposer magnet picks through 567-5 and 32B. 14A
5. Clutch magnet picks through interposer magnet contact after the interposer has shifted for high speed. 14A
6. With skip to 1 R573 energized, the stop circuits are set up to ignore all punches except those in channel one. Skip stop operation is the same as that discussed for overflow—non-indicate items 9 through 16.

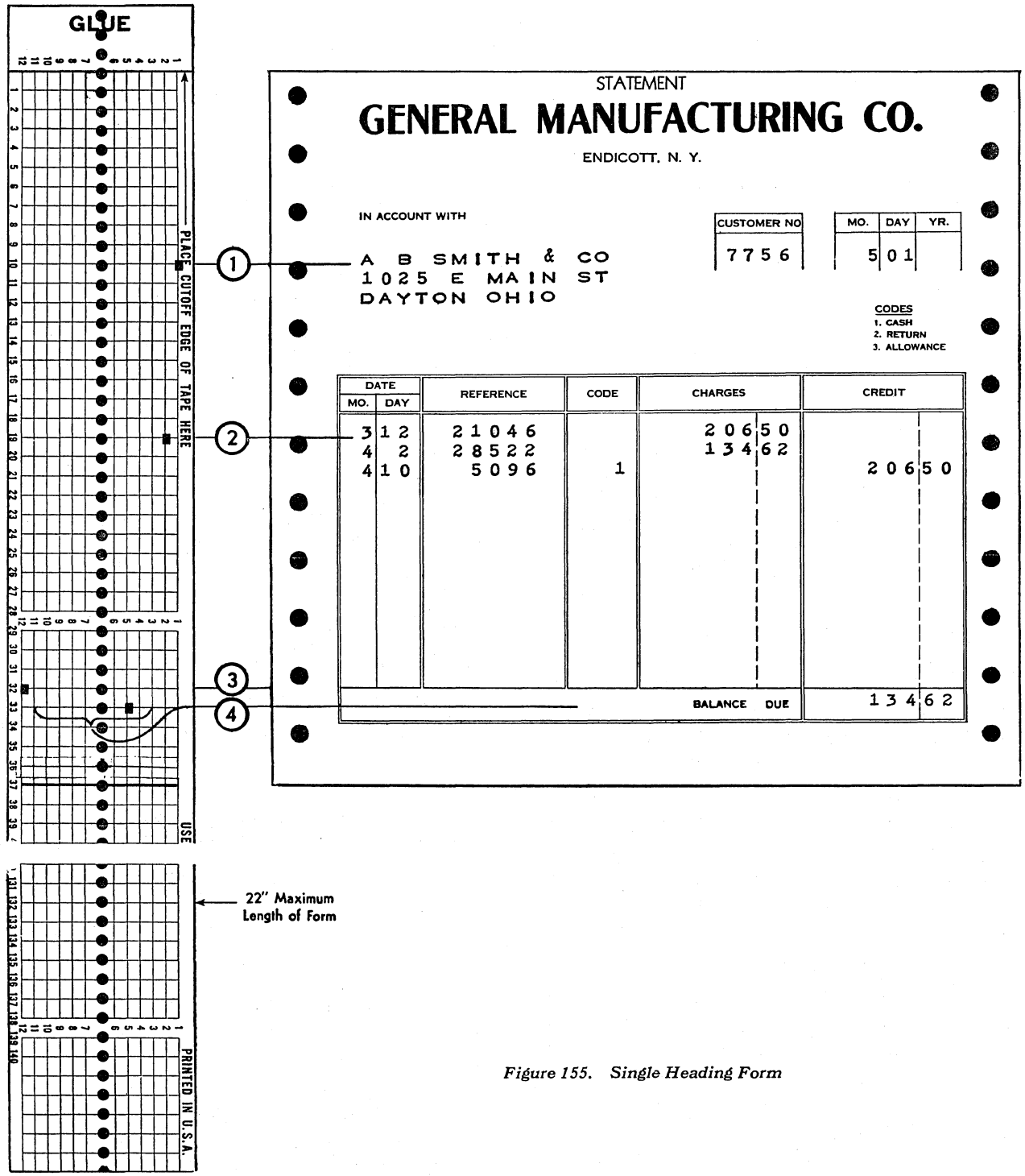


Figure 155. Single Heading Form

On this operation the signal to advance the paper to the first line of the next form came from a source other than overflow. As the form skipped to the predetermined total line, the channel 12 hole passed the sensing brush but overflow—non-indicate was not started because of R567-6 *(Section 12B)*. Overflow will be suppressed on any skipping operation that uses the all skips relay, 567.

SINGLE HEADING FORM

THE BILLING form (Figure 155) demonstrates the use of the Type 923 Tape-Controlled Carriage where there are heading and detail cards. A heading card will usually contain name and address information, identifying account or customer numbers, and date; the detail cards supply itemized lists with amounts

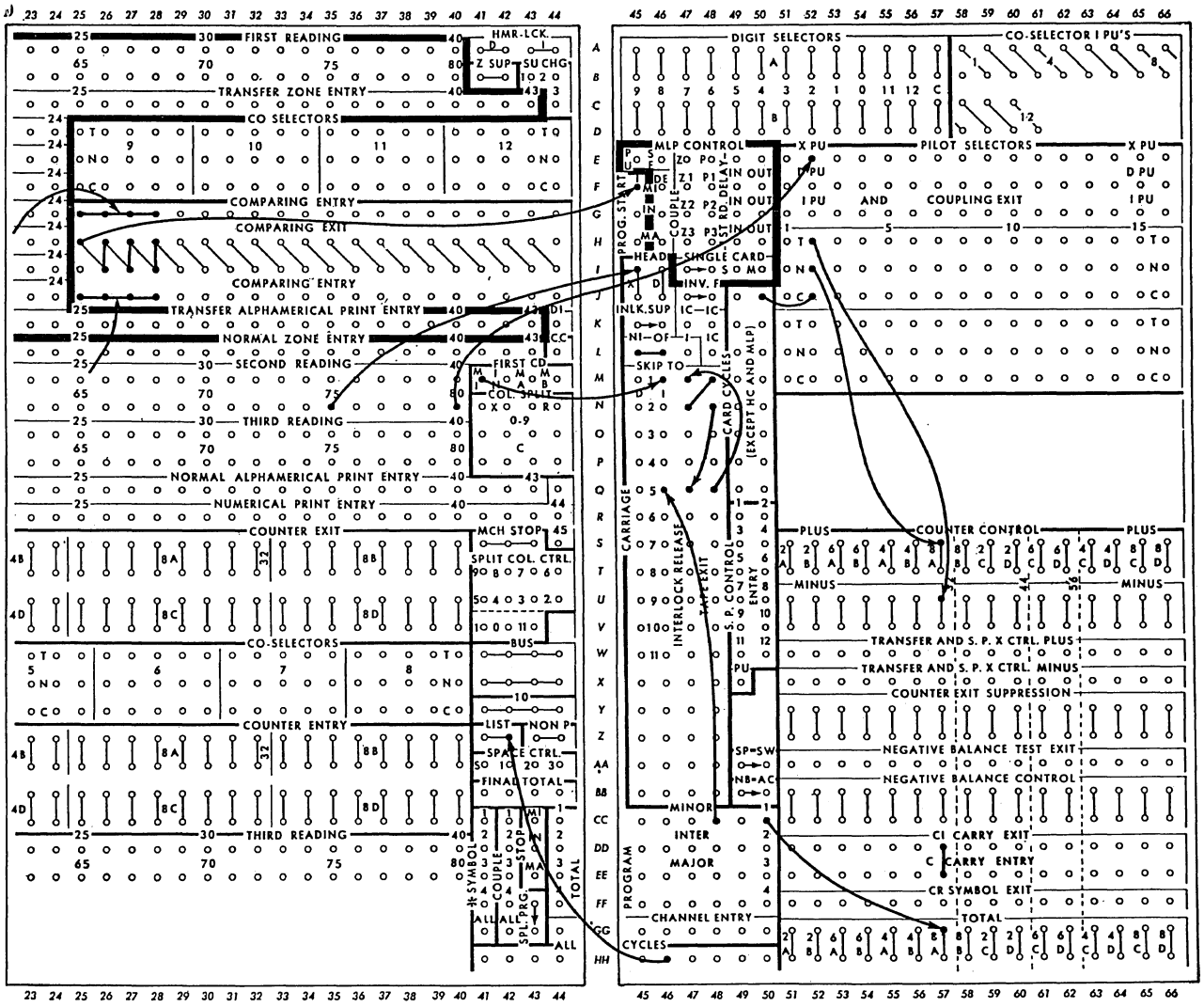


Figure 156. Single Heading Form

and code numbers. All heading cards will be identified by an X- or digit punch, which is not common to the detail cards.

The carriage control tape will have a *1* punch corresponding to the first heading line, a *2* for the location of the first body line, *12* for the last body line to signal overflow, and a *5* to indicate the predetermined total line.

In this type of work, the detail and heading cards are punched with the customer number or account number, which is used to control the printing of totals. It will also be used to cause the carriage skip to a predetermined total print line, and from one form to the next after total printing. The detail cards may be also punched with a second control number, which represents department number such as shoes, millinery, and household in a department store.

The control panel has all wiring necessary for the billing operation, including the following carriage wiring (Figure 156):

1. Wire from the first card minor to the skip to 1 immediate hub.

2. Wire the OF to NI for overflow control as previously explained.

3. Wire to HEADING CONTROL X-PICKUP from second reading.

4. A wire from program level 1 to skip to 5 for total printing on a predetermined line as previously outlined.

With normal X-punched heading cards, the X will be sensed at the second reading brushes and a wire to head X will cause head control circuits to be set up. The object of heading control is to cause the carriage and accounting machine to perform automatically,

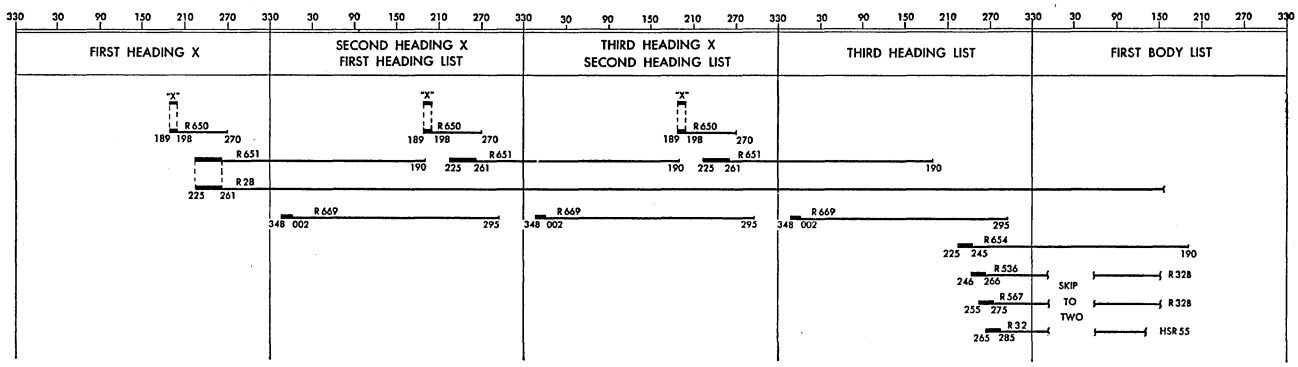


Figure 157. Heading Card Operation

and without additional control panel wiring, certain functions that are common to all single heading form operations.

Heading control will accomplish the following items.

1. *Print all heading cards* even if the control panel is not wired to list.
2. *Suspend all* programming during printing of heading cards.
3. *Cause an automatic skip to 2* from the last heading line to the first body line before the first body card is printed.
4. *Cause an overflow to 2* instead of 1 from a channel 12 punch, so that body information will not list in the heading portion of the following form.
5. *Make inoperative all but five card cycles hubs* during heading card listing so that counters will not accumulate unintentionally.
6. *Activate first card MB* (MINOR BODY) hub so that it will emit an impulse for the first card of each minor group in the body. Without head control wiring, the MB hub is the same as first card minor.

In addition to these operations, head control circuits will take care of situations that arise when heading cards or detail cards are missing from the customer's deck. This prevents the listing of different heading and body cards on the same form and keeps the carriage in step with the cards as they pass through the accounting machine.

Head Control

The first group of a run *must have at least one* heading card in order for the carriage to operate properly with the first form. After the first form, internal circuits will automatically take care of missing heading or detail cards. Skipping is controlled by the presence or absence of heading X's. The sequence chart of Figure 157 illustrates the operation of head control relays as three heading cards pass through the feed and also shows the automatic skip to 2 after heading cards have printed. The circuit outline covers this operation.

OBJECTIVE: To list all heading X-cards (even though the machine is not wired to list), to cause the carriage to skip to 2 after they have printed, and to suspend programming.

First heading card at second brushes:

1. R650 picks through control panel wire from heading X impulse at second reading. 21A
   R650 holds through CF31. 22B
2. R651 and 28 pick through 650-2, CB49. 21B
   R651 holds through CF30. 22B
   R28 holds through 10BL, L14 until cards run out. 22B
3. R79 picks through 651-3 to cause printing for the first heading card. 4B

First heading card at third brushes:

4. R669 picks through 651-9, CF13, L27. 21B
   R669 holds through CB23. 5A
5. R609-612 pick is blocked by 669-2. This prevents programming but permits an unequal impulse and a first card impulse due to R669-3 *(Section 31B)*. 34A
6. R654 pick is blocked by 650-3 N/C, which will remain open as long as heading cards pass second reading. 21B

Last heading card at third brushes:

7. R650 does not repick due to the absence of a heading X. 21A
   R651 remains energized until 190° of the last heading card print cycle. 22B
8. R654 picks through 650-3 N/C, 1082-3, CF17. 21B
   R654 holds through its pick coil from CF4. 21B
   R229 and 1082 pick every non-Mlp card feed cycle from CF26 and 28. 19B

Automatic Skip to 2 (first body line)

9. R536 picks through 651-7 N/C, 654-5 N/O, PM11. 16A
   R536 holds through 52B N/C. 16B
10. R567 picks through 536-2 from CB33. 10B
    R567 holds through 52B N/C. 16B
11. R32 picks through 567-2, CB34. 10A
    R32 holds through HSR55. 10B
12. Interposer magnet picks through 567-5, 32B, L10. 14A
13. Clutch magnet picks through interposer magnet contact. 14A
14. High-speed stop relay circuits are set up to ignore all but a channel 2 punch because of energized R567 and R536. 12A
15. HSR54 and 55 pick through 33AL N/C, 573-5 N/C, 536-5 N/O, channel 2 brush, carriage CB, fuse 18. 12A
    HSR56 and R52 pick through 567-7 in parallel with HSR54 and 55.
    HSR54, 55, 56, and R52 hold through 51B, fuse 18 and the carriage stops in the normal manner. 12A

Billing Form Overflow — Non-Indicate

When there are more items to be listed than one form will hold, brush 12 will sense the last body line and cause the skip circuit to be set up. Because there are more detail cards to be listed, the form should then advance from the last line of one form to the first body line of the next form.

An overflow on this type of form will have to cause a skip to 2. The conditions for energizing the overflow control non-indicate R570 will remain the same as before but will include two conditions:

1. The next card to be printed is not a heading card.
2. A skip to 1 has not been called for by the first card control hub.

OBJECTIVE: To cause an overflow skip to 2 from a punch in channel 12 with heading control operative.

1. R43 picks through channel 12 brush and carriage CB. 12B
   R43 holds and energizes R44 through 52B N/C, L11. 16A
2. R45 picks through 660-6, PM5 as the last line lists. 14B
   R45 holds through 52B N/C, L11. 16A
3. R570 picks through 45BL, control panel wire NI to OF, CB71, CB22. 14B
   R570 holds through 52B N/C, L11. 16B
4. R573 (skip to 1) picks through 570-2, PM 10. 16A
   R536 (skip to 2) picks through 48AU N/C, 570-3 N/O, PM10. 16A
   R573 and 536 holds through 52B N/C, L11. 16B
   The carriage has now been given two conflicting orders, a skip to 1 and a skip to 2. The circuits have been so arranged that when any other *skip-to* order is received along with a skip to 1 order, the carriage will first pass one and then stop at the position called for by the other order.
   NOTE: To have control tape signals operate correctly there should be at least two spaces between the one punch and any other following *skip-to* punch so that sufficient time will be allowed for relays to operate properly.
5. R567 picks through 570-6 N/O, CB33. 10B
   R567 holds through 52B N/C. 16B
6. R32 picks through 567-2, CB34. 10A
   R32 holds through HSR55, L7. 10B
7. Clutch magnet picks through 44BU N/O, 567-5 N/O, 32B, L10, and the carriage begins moving at low speed. 14A
8. A channel 1 punch will not stop the carriage but set up circuits to go *past 1*.
   R580 picks through 536-4 N/O, channel 1 brush, carriage CB. 12A
   R580 holds through 52B N/C. 16A
9. With *past 1* relay energized, a stop at the channel 2 punch is set up.
   HSR54, 55, 56, and R52 pick through 33AL N/C, 580-2 N/O, 536-5 N/O, channel 2 brush, carriage CB. 12A
   HSR54, 55, 56, and R52 hold through 51B N/C. 12A
   The carriage stops in the normal manner as previously outlined.

Billing Form — Missing Detail Cards

Normally, the last heading card is followed by a detail card of the same control group. The absence of a heading X causes the carriage to move the form to the first body line. With missing detail cards, the last heading card of one group will be followed by the first heading card of the next group. The change in group number will cause the comparing unit to impulse program start. The presence of a heading X will eliminate the skip to 2 and keep energized the heading control relays. Total programming will be suspended by heading control circuits, but the first card minor hub will emit an impulse to skip to 1 and cause the carriage to go direct to line 1 of the next form. The report may now continue in correct sequence.

OBJECTIVE: To suppress skip to 2 and total programming and to cause a skip to 1 because of missing detail cards.

1. R650 picks from next group's heading X and causes repick of R651 and R669. 21B
2. R536 (skip to 2) pick is blocked by 651-7 transferred and 654-5 normal. 15A
3. Programming is suspended by R669-2 N/C open. 34A
4. R16 picks through 601-2, 669-3, CB49. 32B
   R16 holds through CF4. 32B
5. R573 (skip to 1) picks through control panel wire from first card minor to cause the carriage to skip to 1. 16A
6. R567 energizes through 573-2 *(Section 10B)*, picks R32 through 567-2 and causes a normal skip to 1 operation. 10A

Billing Form — Missing Heading Cards

If heading cards are missing, there is a control change between the last detail card of one control group and the first detail card of the next control group. In this case the head control relays are not energized as there are no heading cards. The machine will total print on the predetermined line, and first card minor will impulse skip to 1. The fact that heading control is not energized causes the carriage to move the form past 1 and stop at the next punch in channel 2. Printing may continue now in proper sequence.

OBJECTIVE: To initiate a skip from the predetermined total line to the first body line of the following form because of missing heading cards.

1. Head control R650, 651, 669, and 654 will not be energized in the absence of heading cards. 21B
2. R573 (skip to 1) picks through control panel wire from first card minor. 16A
   R573 holds through 52B N/C, L11. 16A
3. R536 (skip to 2) picks through 651-7 N/C, 573-4 N/O, 654-5 N/C, PM 11. 16A
   R536 holds through 52B N/C, L11. 16B
4. R567 picks through 573-2. 10B
   R567 holds through 52B N/C. 16B
5. R32 picks through 567-2. 10A
   R32 holds through HSR55, L7. 10B
   Once the carriage skip circuit has been established, the control tape will advance to the point where channel 1 brush senses the punched hole.
6. R580 (past 1) picks through 536-4 N/O, channel 1 brush, carriage CB. 12A
   R580 holds through 52B N/C. 16A
   Without stopping at 1, the carriage advances to the punch in channel 2.
7. HSR54, 55, 56, and R52 pick through 2 brush, carriage CB, and the carriage stops in the normal manner. The form is now in position to print the first detail card of the new group. 12A

Notice that the early all cycle impulse from first card minor originates through 645-6 N/O *(Section 36B)*, and CB56 rather than from CB78, the normal EAC source. This allows skip to 1, R573, to energize and close 573-4 N/O *(Section 15A)* before PM11 establishes a circuit to skip to 2, R536. A summation of single heading form circuit operation is shown in Figure 158.

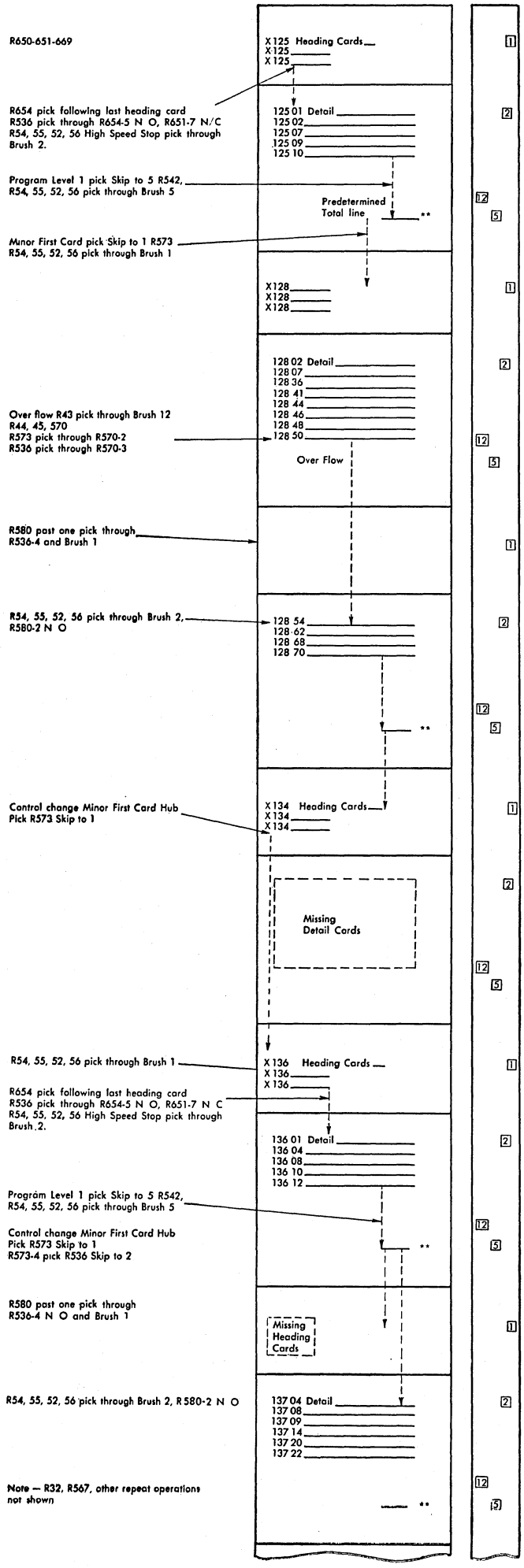


Figure 158. Review of Single Heading Form Circuits

INTERLOCK RELEASE

THE CARRIAGE and printer are so interlocked that, unless some control panel wiring has been provided, the accounting machine card feed clutch will always latch during a skip operation when the R567-9 points are open *(Section 5B)*.

The carriage skip speed is such that it will cover the distance equal to 3⅔″ or 22 line spaces during one 402, 403 print cycle before the hammer can again trip. The starting point of the skip operation is determined by CB34 closing at 265°. Because it is not necessary to latch the card feed for skips of less than this distance, two means have been provided on the control panel for shunting the interlock point.

1. *Interlock suppression.* When all normal skips from any part of the form to any other part of the form are less than 3⅔″, the interlocking may be suppressed by wiring the interlock suppression switch ON *(Section 5B)*. If the condition on the form is an overflow, the card feed clutch always latches because R570-5 points are open and, if the operator tries to wire *OF* to skip to 1, R44AU *(Section 5B)* opens. It is possible, however, to move from the bottom of one form to the top of the next by normal skipping when a condition other than overflow exists and, in this case, the interlock may be released. Where a signal to skip is recognized for a length greater than 3⅔″ and the interlock suppression is wired ON, printing in flight will result.

2. When some of the skips on the form are less than 3⅔″ and others are longer, the interlock may be released for the short skip only. This is accomplished by wiring from a brush position tape exit to the interlock release hub for the skip involved (Figure 159).

The interlock release relays are a latch-type, wire-contact relay, which may be energized from a punch 1 through 11 in the tape and will be dropped when the tape hole moves to the brush that is internally wired to the same relay latch trip coil.

More than one interlock release may be wired to one tape exit position if a number of skips are within 3⅔″ or that point in the tape. Existing holes in the tape being used as skip stops may also double as interlock release pickups if they are within the correct distance of the skip to point, or punchings may be added to the tape to serve only as interlock release points as necessary.

If, on a skip that is longer than 3⅔″, a hole is punched 3⅔″ ahead of the skip stop point, it may be wired for interlock release with the result of a possible saving in time, because otherwise the card feed clutch would remain latched for the entire skip.

The objective of the interlock release network *(Section 13A-B)* is to provide a pick circuit for R50 from CB35. This will close 50B N/O *(Section 5B)* and provide a circuit around 567-9 to energize the card feed clutch control R656 and allow printing during skipping.

The interlock release network is arranged so that each release circuit is established through the normally closed points of all the higher-order skips. Thus, when more than one skip is called for at a time, the release circuit cannot be completed until the interlock release control point is closed for the highest-order skip.

PREPARATION: Control panel wired for interlock release (Figure 156). Operation of interlock release from channel 2 to channel 5 using the single heading standard form and associated control tape of Figure 159 will be described by the circuit outline. Assume the carriage has just completed a skip to 1.

OBJECTIVE: To release the interlock between channel 2 and channel 5.

1. R560LP energizes through control panel wire from interlock release 5 to tape exit 2, channel 2 brush, carriage CB. R650 remains transferred while body cards list and will not unlatch until the latch trip coil is energized. As the last detail card prints, the machine senses a minor control change.	12B
2. R542 (skip to 5I) picks through control panel wire from minor program level hub and energizes R567 and 32 to start the skip to predetermined total line.	16B
3. R50 picks through 573-3 N/C, 560-2, 542-3 N/O, CB35. R50 holds through CB42.	14B 14A
4. R50B shunts R567-9 (now open) to allow pick of R659 and to keep the machine in operation. The tape advances to a punch in channel 5. High-speed relays pick in the normal manner to stop the carriage.	5B
5. R560LT energizes through channel 5 brush and carriage CB from the same impulse that stopped the carriage.	12B

Any skip in combination with a skip to 1 requires that the carriage move from one form to the highest-order skip called for on the next form. In this case, the interlock release control relays will be dropped as the carriage passes the corresponding skip stop point in the tape.

As an example, Figure 159 shows an operation where the individual skips called for are less than 3⅔″. However, with missing heading cards, when the predetermined total line of the first form is printed, two signals are received for the next operation. Because of the control change, the skip to 1, R573, is picked by an impulse from the minor first card hub. Because there are missing heading cards, skip to 2, R536, is

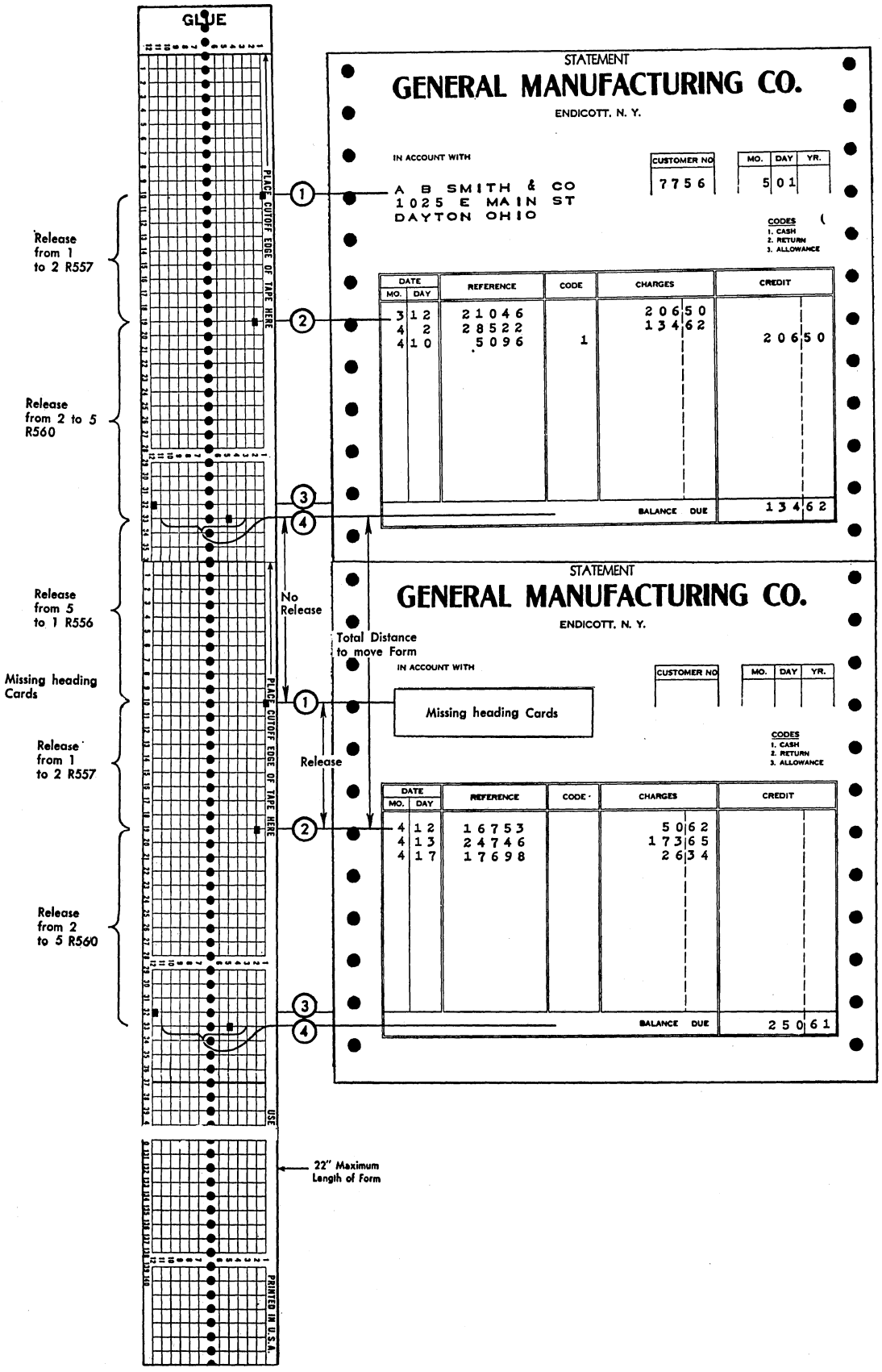


Figure 159. Interlock Release Operation

picked through 573-4 *(Section 15A)*. The brush in hole 5 has also caused the interlock release control R556 to pick. In this operation, the total distance could be more than $3\frac{2}{3}$" for one continuous skip. When CB35 *(Section 13A)* closes, the interlock release R50 cannot be energized, because the R536-3 points are transferred and a circuit will not be completed through R556-2 and R573-3 N/O to R50. Thus, the interlock release will not be effective to the heading line of the second form.

When brush 1 senses the hole in the tape, the latch trip coil of R556 is energized, opening the first interlock release circuit. Also, at this time, a circuit from brush 1 is completed to the past 1, R580, and through control panel wiring to interlock release R557. This allows interlock release to become active as soon as the tape advances past the channel 1 punch.

OBJECTIVE: To delay interlock release until the carriage has moved past channel 1 punch during a combination skip to 1 and 2.

1. R573 and 536 (skip to 1 and 2) are energized simultaneously from first card minor and PM11 respectively because of missing heading cards. 16A
2. Until the tape moves past a channel 1 punch, R50 pick is blocked by 536-3 N/C being open *(Section 13A)*. 14B
3. R580 through 536-4, R556LT and R557LP through control panel wire from tape exit 1 all pick from channel 1 punch and carriage CB. 12A
4. R50 picks through 580-3, 557-2, 536-3 N/O, CB35 to shunt the interlock point 567-9 and set up the pick circuit to card feed and print clutch control relays *(Section 5B)*. Thus printing may safely begin any time after the tape passes channel 1, as the distance to 2 is less than $3\frac{2}{3}$". 14B

Operation of interlock release on other than normal skips may be summarized as follows:

1. If the interlock release point for the highest order skip called for is sensed before 1, the interlock release circuit will be effective when past 1, R580, is energized as the 1 hole is passed.

2. If the highest-order skip to of the combination is to be released after 1, the interlock release control relays are released when the carriage passes the corresponding stop point on th previous form, and the release is not effective until the interlock release control relay is again picked at some point $3\frac{2}{3}$" before the stop point of the high-order skip to.

MULTIPLE HEADING FORM

THE conventional form and control panel diagram (Figures 160 and 161) show an extended application of the Type 923 Tape-Controlled Carriage to head control. Basically, the operation is that of the single heading form with the addition of intermediate skips in the heading portion and overflow indicate. When

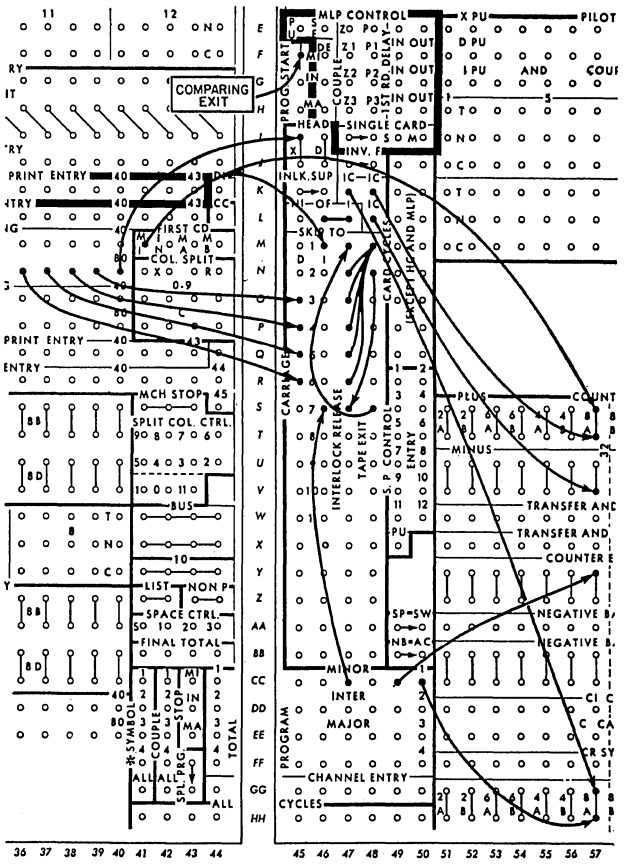


Figure 160. Multiple Heading Group

an overflow occurs, an overflow indication cycle takes place to provide information at the top of the second form for identifying purposes.

There are two conditions under which skips take place by control wiring.

1. A skip initiated by an X- or digit punching in individual cards may occur within heading groups, detail groups, or both groups. These skips may be assigned to any of the skip 3 to 11 brushes if heading cards are not being used. As indicated previously, the 1 brush is always used for the first printing line, the 2 brush for the first body line with heading cards, the 3 to 11 brushes for intermediate skips with heading cards, and the 2 to 11 brushes for intermediate skips without heading cards. Brush number 12 is reserved for overflow brush control and cannot be wired.

2. A control panel wire from the program level to skip to for the predetermined total printing line.

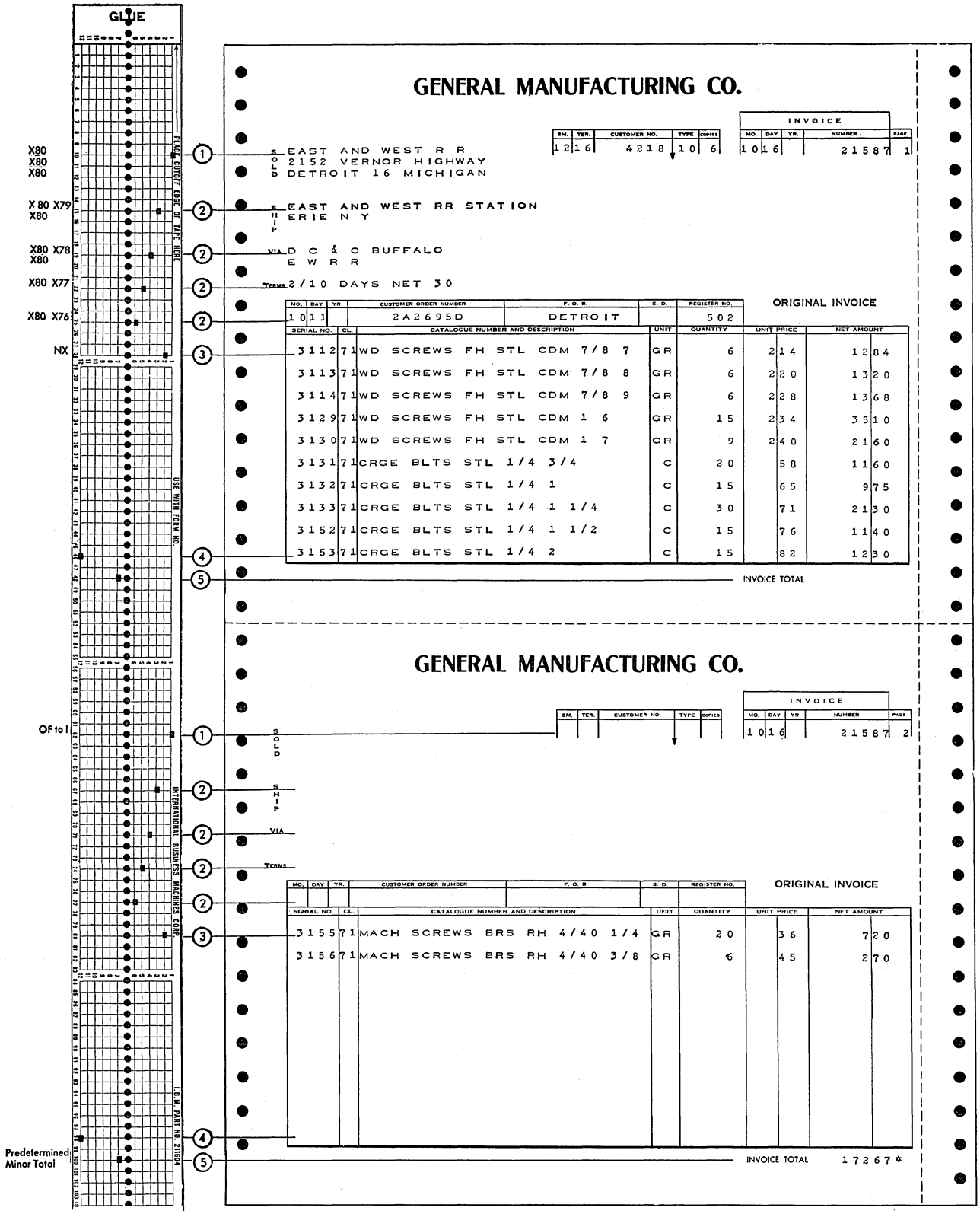


Figure 161. Multiple Heading Form

Intermediate Skip To

All headings cards on this application are punched with a common X in column 80, and those cards that require an intermediate skip will be identified by a separate X as required. The first intermediate skip group will have heading X80 and X79 in the first card of this group. Skip-to operation is identical to that previously discussed except that it is initiated with the SKIP TO D hub. The X79 is sensed at the second reading brush station and wired to the D pickup hub of skip to 3. If the X were punched in a field which also contained numerical information, the X-impulse to the D hub should then be wired through a column split.

OBJECTIVE: To cause a skip to 3 initiated by an X sensed at second reading brushes.

1. R539 picks through control panel wire by an X impulse from brush 79. 16A
   R539 holds through CB36. 15B
2. R538 picks through 539-2 N/O, CB22, and causes a skip to 3 in the normal manner. 16A
   The pick of R538 (skip to 3) is delayed by CB22, which causes the actual skipping to occur just before the X-79 card lists from third reading.

Overflow — Indicate

Provision has been made in the circuit for indication on the first line of the form before skipping to the body line on overflow if overflow indication is desired. In this case the OF outlet hub is wired to I rather than to NI. Additional control wires will be required from an IC outlet hub to the counter total hub, one to the plus relay, and one to the minus relay of the same counter to control counter read out for printing the indication.

As may be seen on the sample form (Figure 161) the carriage must skip to 1 when an overflow is sensed and, after printing the indication, skip to 2.

Corresponding points used to condition the overflow control non-indicate R570 are used to condition the overflow control indicate R568. Therefore, the conditions under which the relay may be picked are identical with those previously described for normal overflow.

PREPARATION: Control panel wired as shown in Figure 160. Assume the report has listed detail cards until the carriage brush senses a punch in channel 12.

OBJECTIVE: To overflow at low speed to channel 1, cause a single list cycle, and automatically skip to 2 at high speed.

1. R43 picks through channel 12 brush, carriage CB. 12B
   R43 holds and energizes R44 through 52B N/C. 16A
2. R45 picks through 44AL, PM5. 14B
   R45 holds through 52B N/C. 16A
3. R568 picks through 45AL, control panel wire OF to I, CB71, CB22. 14B
   R568 holds through PM4. 14B
4. R567 (all skips) picks through 568-6 N/O, CB33. 10B
   R567 holds through 52B N/C. 16B
5. R573 (skip to 1) picks through 568-2, PM10. 16A
   R573 holds through 52B N/C. The clutch magnet energizes the same as overflow—non-indicate and the carriage advances at low speed until a hole is sensed in channel 1. 16B
6. HSR54, 55, 56, and R52 picks through 33AL N/C, 573-5 N/O, channel 1 brush, carriage CB to stop the overflow at 1. 12A
7. R46 picks through 568-4 and the channel 1 brush. 12A
   R46 holds and energizes R47 through PM4. 14B
8. R659 (print clutch control) picks through 568-3 N/O, 47AL, 568-5 N/O, CB20 and 21 to start the indicate print cycle. 5B
9. Indicate Control (IC) hubs are activated through 47AU, 47BU, 47BL, from CB78 and 79. These are wired to control counter 8A (Figure 160). One control wire causes the counter to roll, while the other two control wires impulse the plus and minus relays so that the counter cannot be stopped at zero on the reset. This, in effect, is a progressive total operation and may be used for invoice or page numbering. 13B
10. On the indication cycle, PM5 closes and completes a circuit to skip to 2.
    R536 picks through 48AU N/C, 46BL N/O, PM5. 16A
    R536 holds through 52B N/C. The carriage skips at high speed to a punch in channel 2 and stops in the normal manner to complete overflow indicate operation. 16B

INVERTED FORM

VOUCHER CHECKS, such as the one illustrated in Figure 162, are known as inverted forms because detail cards are listed first, followed by the heading cards. This type of operation is necessary when totals from the detail cards must be printed with the heading information. In this example, check identification and amount are printed with an address on a check.

The control for an inverted form is punched in tape channel 1 for the first printing line of the first half of the form. Tape channel 2 is punched for the first line of the address. This is not the body line, although the body line stop is used. A normal skip stop is punched for the predetermined total line. Channel 12 is used for the overflow; a punch in this channel is ineffective when passed by skipping as R567-6 points are open. Wiring inverted form switch on the control panel OF changes the operation of the machine so that an overflow advances the form to the first printing line of the next form.

Overflow sheet indications can be printed on the first address line of the inverted forms. For this, the control panel switch OFF is wired to I to cause a skip to the first address line where the indication is printed from counters wired for progressive operation. A skip then occurs to the first printing line of the next form.

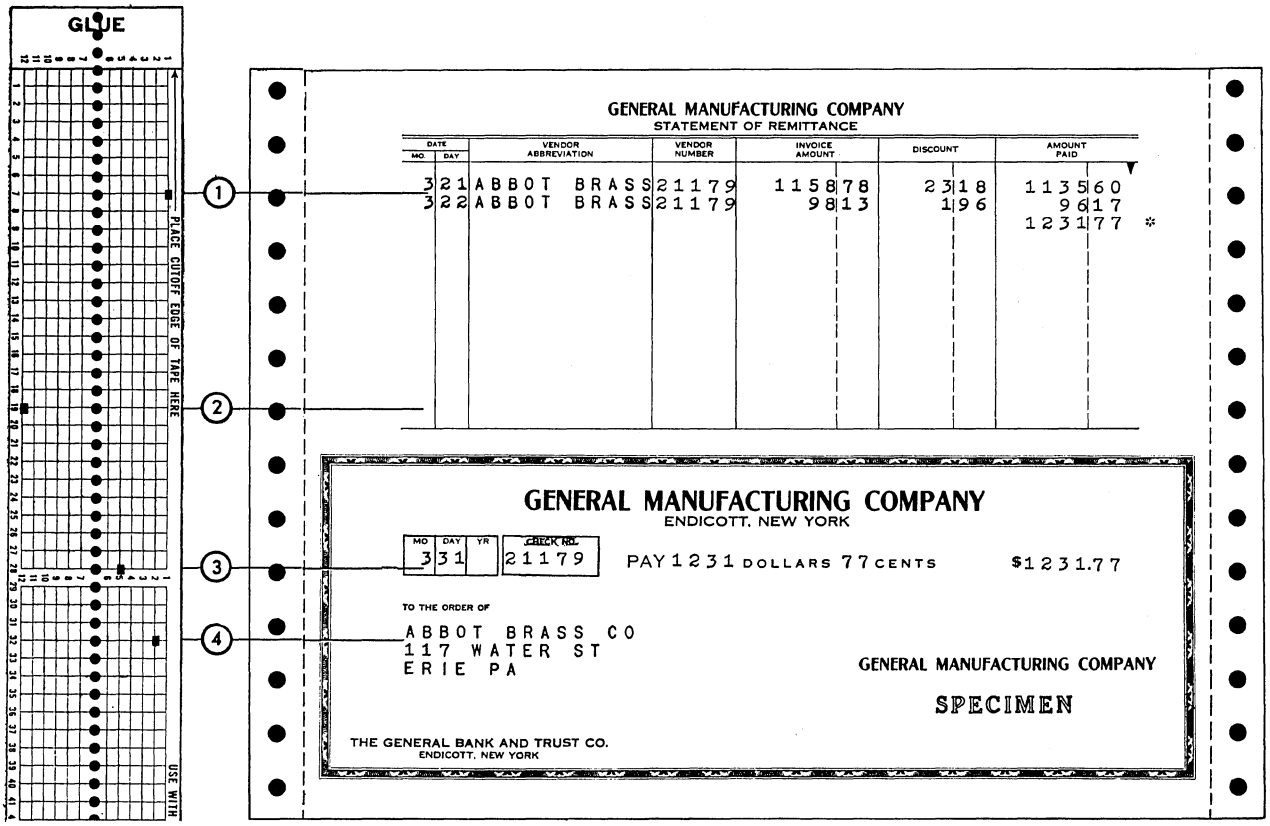


Figure 162. Voucher Check — Inverted Form

If either detail or heading cards are missing for any control group, the form will automatically advance to the proper line for the next type of card to be printed.

Inverted Form Operation

Operation of, and control panel wiring for, inverted forms are essentially the same as that for standard single heading forms. The main difference is in the method used to cause a control change between detail and heading cards of the same control group. In the application of Figure 162, the objective is to provide a total of the detail items, and yet not to reset the counters to zero on the minor program level. This is accomplished by wiring from the minor program level to both the plus and minus relays, as well as the total relays of the counter group. The counter will roll on the total cycle but will not reset to zero, because the circuit to the counter stop magnet is open.

Before the intermediate program level printing takes place, a skip to 5 circuit is established, and this causes the form to be advanced to the predetermined line to receive the total printing on the check. On the intermediate program level operation, the same counter is again caused to total print, and it is also allowed to reset to zero because the plus and minus relays are not energized.

The next card is recognized as a heading card, and through internal circuits a skip to 2 is set up that will cause the form to advance until the hole in channel 2 is sensed, which is the first line for address printing.

When the control change between the last heading card and the first detail card of the next group is recognized, the major first card impulses skip to 1 and cause the carriage to advance the next form. Because the form is being advanced by skipping, the R567-8 points will open R31 hold and suppress all spacing that would normally be set up by the control change.

A normal overflow is recognized by a punch in channel 12 at the last time for printing the detail cards. With inverted forms, the first detail printing line is identified by a punch in channel 1; therefore, if no indication printing is involved, an overflow would require that the form advance to the first detail printing line of the next form rather than to a channel 2 position as with a normal billing operation.

Inverted Form Switch

When the inverted form switch is wired ON, carriage circuits are altered to accomplish inverted form objectives.

1. R48 and 49 continually energize through inverted form switch from L10. 14B
2. R28 continually energizes through 49BL, 10BL, and L14 as long as there are cards in the machine. 22B
   The head control R28 must operate in this manner when dealing with inverted forms, because the heading cards follow the detail cards. If an overflow, for which an indication was required, occurred on the first form before heading cards were sensed, the circuit to pick skip to 1 after printing the indication would be open because R28AL *(Section 15A)*, would not be closed at this time.

Inverted Form — Detail to Heading Skip

A DETAIL-TO-HEADING CARD SKIP is a condition that did not occur with conventional forms except when moving to the heading cards of the next group by means of a first card impulse. Before skipping to 2 (first heading card line) on the inverted form, it is necessary to print a total of detail items on the body, skip to a predetermined total line for check amount total printing, and then skip to 2 for heading card listing.

PREPARATION: Control panel wired as in Figure 163. Assume that the last detail card has completed listing and that the first heading card is recognized at second reading by its X-punch.

OBJECTIVE: To print a total of detail items; to cause a skip to 2 after total-printing on the predetermined line.

1. Comparison of the column that contains the heading X causes an unequal impulse to intermediate program start. The minor level 1 provides for total printing of detail items in the body section of the form without clearing the counter to zero.
2. R542 (skip to 5) picks through control panel wire from intermediate program level exit and causes a skip to 5 in the normal manner. 16B
3. When intermediate level 2 takes place, the check amount is printed, and the counter resets to zero.
4. Because heading cards are following detail cards, the first heading card was recognized by the heading X. This energized heading controlled R650 and R651 at the same time that the comparing unit called for an intermediate program.
   R536 (skip to 2) picks through 609-12 N/C, 651-7 N/O, 669-4, 654-5 N/C, and PM11, which causes the carriage to advance the form to the punch in channel 2, the first heading line. Note that the skip to 2 operation was delayed by 609-12 *(Section 15A)* while minor and intermediate totals were being printed. 16A

Inverted Form — Heading to Detail Skip

A skip to 2 operation on conventional form caused by heading to detail card condition is prevented by the inverted form switch. Instead, control panel wiring causes the form to skip to 1, the first detail line of the new group.

OBJECTIVE: To skip from the last heading card of one control group to the first detail card of the next control group.

1. R651 is down and R654 up with a heading card at the third brushes and a detail card at the second brushes.
2. R536 (skip to 2) pick is blocked by 48BL being open. 16A
3. R573 (skip to 1) picks through control panel wire from first card major and a normal skip to 1 results. 16A

Inverted Form — Overflow Non-Indicate

OBJECTIVE: To sense a channel 12 punch and cause an overflow at low speed past 2 to a channel 1 punch.

1. R43, 44, 45, 570, 567, and 32 pick and hold in the normal manner for overflow operation.
2. R573 (skip to 1) picks through 48AU N/O, 570-3, PM10 to set up stop circuit from punch in channel 1. 16A
3. R536 (skip to 2) pick through 573-4 is blocked by 48BL, N/C, being open. 15A
4. Clutch magnet is energized through 44BU and L10, the form moves past 2, stops at the next punch in channel 1, and listing of detail items resumes. 14A

Inverted Form — Missing Heading Cards

A control change between groups of detail cards causes skip to 1, R573, to be energized after total printing has taken place by the first card major hub. Because there are no heading cards, the skip to 2 relay is not energized, and R651-7 remains in its normally closed position.

R573-2 causes R567 all skips to energize, and the carriage will advance the tape until channel 1 is sensed and stops the form at that position.

Inverted Form — Missing Detail Cards

When heading cards of one group are followed by heading cards of another, a major control change takes place.

The control panel wire from first card major energizes skip to 1. Because there are more heading cards, the head control relays remains energized. This allows skip to 2 to pick so that the carriage may move on to the first heading line of the following form.

OBJECTIVE: To skip from the last heading card of one form, past channel 1 to channel 2 of the following form.

1. R573 (skip to 1) picks through control panel wire from first card major. 16A
   R573 holds through 52B N/C. 16B
2. Heading cards at both the second and third brushes have R651, 669 up and R654 down. 21B
3. R536 (skip to 2) picks through 651-7 N/O, 573-6, 654-5 N/C, PM11. 16A
4. R567 picks and energizes R32 and the clutch magnet to advance the carriage to a channel 1 punch. 10B
5. R580 (past 1) picks through 536-4 as the carriage brush senses a hole in channel 1. 12A
   R580 holds through 52B and sets up the stop circuit from brush 2. 16A
6. When the carriage has reached the position where the tape control brush senses the hole punched in channel 2, the stop circuit to HSR54, 55, 56 and R52 will be completed, and the form will be in position for printing the second group of heading cards. This is the correct position for heading card printing when inverted forms are used.

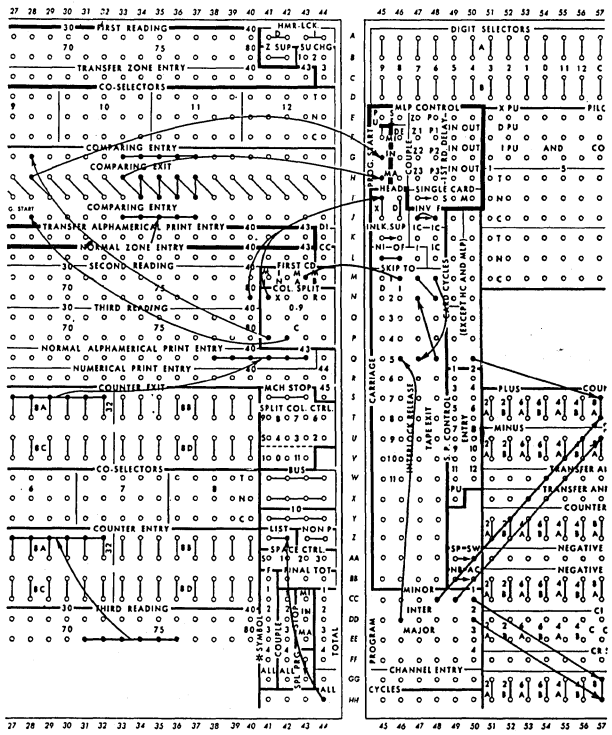


Figure 163. Inverted Form

Inverted Form — Missing Heading Followed by Missing Detail Cards

When detail cards are followed by heading cards of a different control group, the unequal condition will start a major program. When program total printing is complete, the carriage should move the form to the first heading line of the next form before listing is resumed.

OBJECTIVE: On a control change between detail cards and heading cards, to skip past channel 2 of the first form, past channel 1 of the second form, and to stop at channel 2 of the second form.

1. R542 (skip to 5) picks from intermediate program level hub and causes the intermediate total to print on the predetermined total line. 16B
2. R573 (skip to 1) picks through control panel wire from first card major. 16A
3. Heading card at the second brushes causes the pick of R651, but not R654 or 669. 21B
4. R536 (skip to 2) picks through 651-7 N/O, 573-6, 654-5 N/C, PM11. 16A
   From this point, operation is the same as items 4, 5, and 6 of Inverted Form—Missing Detail Cards.

Inverted Form — Overflow Indicate

Overflow indication for an inverted form requires that the carriage skip to 2, and after indication is printed, skip to 1 on the next form. The conditions under which the overflow control indicate relay can pick are identical to those of a conventional form, but overflow is further conditioned in the case of an inverted form by points of the inverted form relay R48.

PREPARATION: Control panel is wired for overflow indicate, heading control, and inverted form operation. The carriage tape has a 1 punch for first body line, 12 punch for overflow, and a 2 punch for first heading line.

OBJECTIVE: To sense a channel 12 punch and cause an overflow skip to 2, to cause an indicate print cycle, and to skip to 1 after the overflow indication is completed.

1. R43, 44, 45, 567, and 32 pick and hold in the normal manner for overflow operation.
2. R568 picks through control panel wire NI to OF from CB71 and 22. 14B
   R568 holds through PM4. 14B
3. R536 (skip to 2) picks through 48BU N/O, 568-2, PM10. 16A
   R536 holds through 52B N/C. 16B
4. Clutch magnet energizes through 44BU N/O and causes the carriage to advance until a punch in channel 2 is sensed. 14A
5. HSR54, 55, 56, and R52 pick through 33AL N/C, 536-5 N/O, channel 2 brush, carriage CB to stop the carriage in the normal manner. 12A
6. R46 picks in parallel with high-speed stop relays through 568-4, 49AL N/O. 12A
   R46 holds and energizes R47 through 46AU from PM4. 14B
   R46 and 47 causes an indication cycle as previously discussed under overflow—indicate items 8 and 9.
7. R573 (skip to 1) picks during the indicate cycle through 48AU N/O, 46BL N/O, PM5. 16A
   R573 holds through 52B N/C and causes a skip to 1, where listing of detail items resumes. 16B

MULTILINE OPERATION

FOR THE multiline printing operations heading cards are identified by an X- or digit punching read from the first reading station. The digit is wired to head card digit delay to store this signal if the MLP card is declutched at station 1 prior to zone time. At 160° on the card cycle that this card is about to feed again, this digit signal is transferred to the head control read relay R650, and the following operation is standard. Heading card control relays 1 and 2 serve the same functions as with a digit or X in a normal heading card.

NOTE: Normal heading cards and multiline heading cards cannot be used together in the same operation.

MULTIPLE LINE PRINTING

THE TYPE 403 Accounting Machine with multiple line printing is designed to allow printing of more than one line from the same card. It is used mainly with billing applications to print address information such as name, street, city in the heading portion of the bill.

Another advantage is that it allows the name and address file to be reduced to approximately one third its original size, which represents a saving in cities where office storage space is expensive. In addition, the fact that the entire name and address is in one card eliminates possible errors in handling by cards being accidentally placed out of order.

The Type 403 Accounting Machine is different from the Type 402 in that the card feed unit is a three station feed equipped with first, second, and third reading brushes (Figure 164).

The first and second reading brushes are used for comparing on the control field when performing multiple line printing operations. All adding and subtracting normally takes place from the third reading station.

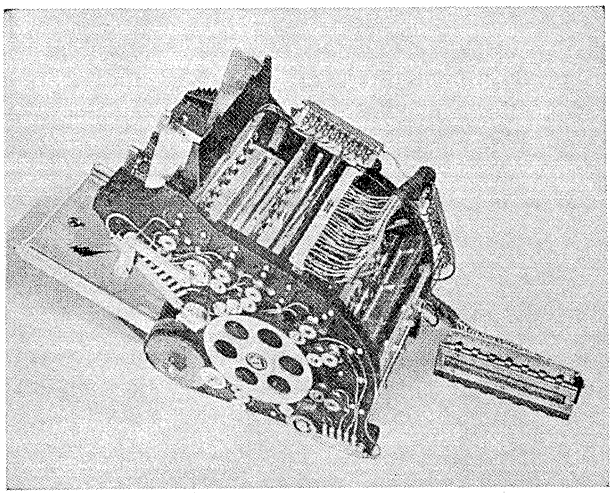
When the Type 403 is being used with normal cards only, the control sensing is completed between the second and third reading brushes, and all accumulating takes place from the third reading station. The first reading brushes are then considered the extra set and their main use is with multiple line printing; however, some crossfooting operations use the first and second reading brushes as well as the third for sensing amount fields. These special applications are discussed in the Type 402-403-419 Manual of Operation.

Multiple line cards are placed in the card feed in the same position as normal cards, 9 edge first and face down and are read in the normal manner by the reading brush making contact through the hole in the card with the contact roll.

Unpunched positions on a card separate the brushes from the contact roll so that no impulses can be emitted by the brushes.

After passing all reading stations, the cards enter the stacker, which has a capacity of approximately 1000 cards. The machine stops when the last card has left the hopper, and the start key must be depressed to run the remaining cards to the stacker. Whenever the stacker is filled, the machine automatically stops.

As previously discussed the Type 403 card feed unit is equipped with an additional clutch which is called the picker knife clutch. The picker or feed knives are operated in the same manner, but the crank pin plate gear which causes them to oscillate as well as the first and second set of feed rolls, are now under the control of the picker knife clutch magnet.



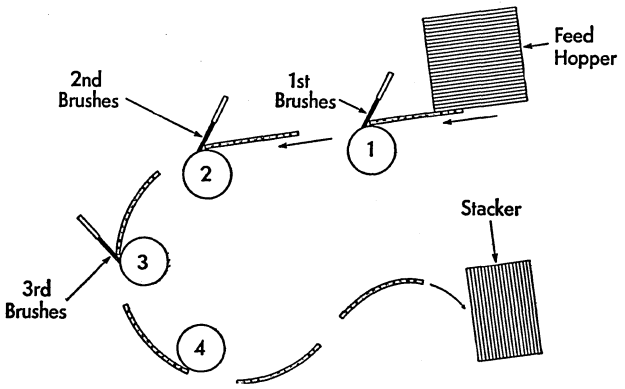


Figure 164. Type 403 Card Feed

Since more than one line may be printed from one multiple line card, it is necessary that the following multiple line card or normal card be controlled so that, when it starts to advance, the information from this card will not interfere with the printing operation of the preceding card.

The picker clutch magnet is then under the control of internal circuits which recognize the necessity for delaying the feeding of any card following a multiple line card until all printing operations are complete from the first card. When that necessity for delay is eliminated, such as feeding normal cards successively, the picker knives and the first two sets of feed rolls will not be allowed to latch.

When multiple line cards are being used, the interlock circuit allows the picker knife clutch to latch and stops the picker knives, the first and second set of feed rolls, and the card that is being transported at 165° on the index. This places the card following the multiple line card part-way through the first reading station and stops it with the first reading brushes between the 1 and 0 position of the card. The card will remain in this position until the multiple line printing operations for the card preceding it are completed.

CARD DESIGN

A LINE controlled card is designed with separate fields for each line to be listed, as illustrated in Figure 166. An internally controlled selector system is so designed that the card field (A) to be listed on the first line may contain as many as 24 columns, the card field (B) to be listed on the second line may contain as many as 24 columns, and the card field (C) to be listed on the third line may contain as many as 24 columns. Fields A, B, and C may be arranged in any sequence on the card.

All multiple line controlled cards are identified with both a 9 and an 8 punched in a single column. From a multiple line card, 1, 2, or 3 lines may be listed. The control column punched 8 and 9 must also be punched 1, 2, or 3 to signal the number of lines to be printed from that card. The 1, 2 or 3 punch controls the cycling of the internally wired selectors.

There is, in addition to the 9-8 punch with a 1, 2 or 3, a new combination of 9-8-4 which eliminates an idling cycle, a characteristic of a 9-8-1 operation. Circuits have been provided to allow a one line card which would normally be punched 9-8-1 to be punched 9-8-4. This takes care of the delay or lost cycle which would take place under certain conditions of interspersed multiple line 1 cards with normal cards. This allows the cards to follow one another as there will be no lost cycle since the normal card and the multiple line 4 card will both be sensed for numerical punching and printing as they pass the 3rd brush station.

SEQUENCE OF CARDS	PK CLUTCH LATCHED	IDLE FEED CYCLE
Normal to Normal	0 cycles	0 cycles
Normal to MLP 1-2-3	1	0
MLP1 to Normal	0	1 MLP4 eliminates this cycle
MLP1 to MLP 1-2-3	0	0
MLP2 to Normal	0	0
MLP2 to MLP 1-2-3	1	0
MLP3 to Normal	1	0
MLP3 to MLP 1-2-3	2	0
MLP4 to Normal	0	0
MLP4 to MLP 1-2-3	1	0

Line controlled cards for listing 1, 2, or 3 lines may be referred to as MLP1, MLP2, MLP3, or MLP4 cards.

Cards from which multiple lines are never listed are considered "normal" cards and do not carry the line control code punching.

CONTROL PANEL HUBS

EACH group of hubs may be readily located on the wiring diagram by section number from Figure 165.

The same control panel is used with Type 402, 403, and 419 machines. All hubs shown outlined with the heavy border are for 403 multiple line printing. In all other respects the control hubs are used in the same manner on both machines.

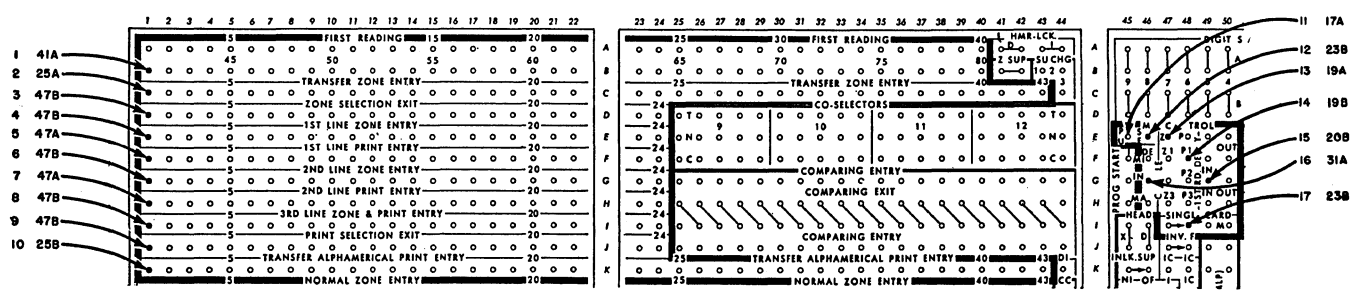
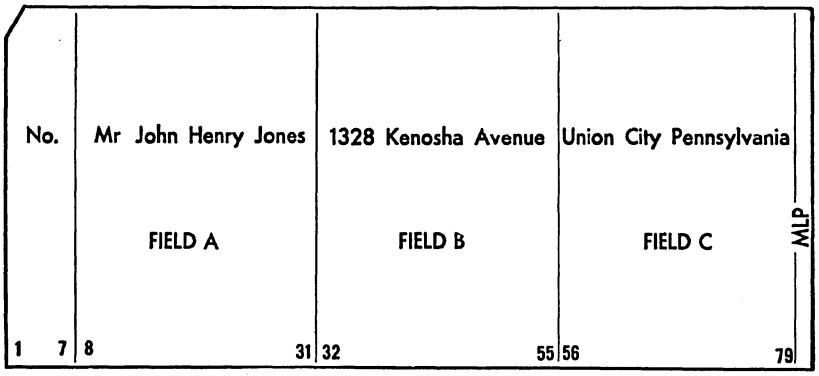


Figure 165. MLP Control Panel Hubs



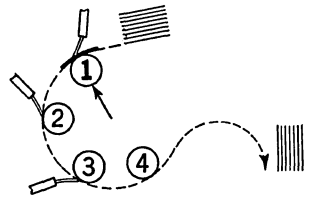
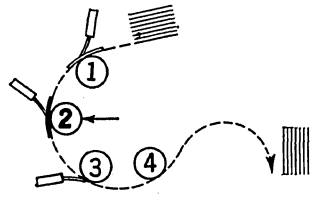
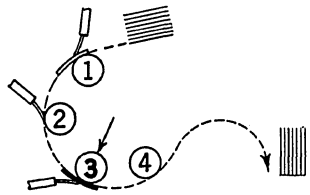
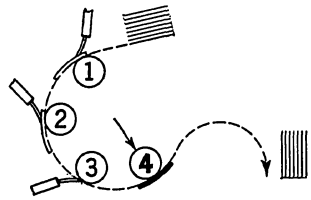
PATH OF CARD	PRINTING FROM CARD	OPERATION
		Zone punching from Field A zones the type bars.
	MR JOHN HENRY JONES	Digit punching in Field A is combined with zone punching for Field A, and Field A is printed. Zone punching from Field B zones the type bars.
	MR JOHN HENRY JONES 1328 KENOSHA AVENUE	Digit punching in Field B is combined with zone punching for Field B, and Field B is printed. The normal card following an MLP3 card remains stationary at the first station (between 0 and 1) as the second line prints. Digit punching for Field C is stored in counters. Type bars are zoned for Field C.
	MR JOHN HENRY JONES 1328 KENOSHA AVENUE UNION CITY PENNSYLVANIA	Digit punching and zone punching for Field C are combined, and Field C is printed. The normal card advances from the first to the second station.

Figure 166. MLP Card Form

PRINCIPLES OF OPERATION

Detail Printing from a Line Controlled Card

To detail print multiple lines from a line controlled card, the fields to be printed are wired to the corresponding selector entries, and the selector exits are wired to the transfer alphamerical print entry. The line control column from a 1st reading brush is wired to MLP control PU.

In printing any *single* line of alphabetic data from a card, the type bars are zoned at one brush station, and at the following card station numerical punching is combined with the zone punching to cause printing.

Similarly, when *two* lines of alphabetic data are being printed from a single card, the zone punching for each line is read at one reading station, and at the following reading station numerical punching for that line is combined with the zone punching from the same field of the card to cause printing. Type bars are zoned for the first line of printing as the field to be printed on the first line is read at the 1st reading brushes. Corresponding numerical punching is read from the 2nd reading brushes, and combines with the zone punching to cause printing of the first line. Type bars are zoned for the second line of printing as the field to be printed on the second line is read at the 2nd reading brushes; corresponding numerical punching is read at the 3rd brushes, and combines with the zone punching to cause printing of the 2nd line. No unusual principles are involved in listing the first and second lines.

In order to follow these same principles for listing a *third* line, however, a 4th set of brushes would be necessary to read the numerical punching for that line. Instead, both zone punching and numerical punching for the third line are read at the 3rd brushes. The zone punching zones the type bars for the 3rd line, and the numerical punching is automatically read into counters 2A, 2B, 6A, 6B, 4A, and 4B where it is stored for one card cycle. As the card passes the 4th card station, the numerical impulses for the 3rd line are automatically read out from the storage counters, through the selector, and to the type bars. Numerical punching and zone punching are combined to cause printing of the 3rd line, as the card passes the 4th card station.

As the third line is printed, the storage counters are allowed to reset to zero. For subsequent normal cards the counters may be used for normal accumulating operations, and for subsequent line controlled cards they may again be used to effect third line printing, providing they are reset to zero before starting the multiple line operation.

Card Feeding

As the second and third lines of a line controlled card are listed, feeding of all subsequent cards is suspended. The card immediately following a line controlled card is stopped under the 1st reading brushes after the numerical punching is read and before the zone punching is read. It remains stationary between the 1 and 0 punching positions until the machine has listed the required number of lines from the line controlled card. This prevents zone interference from the card following a line controlled

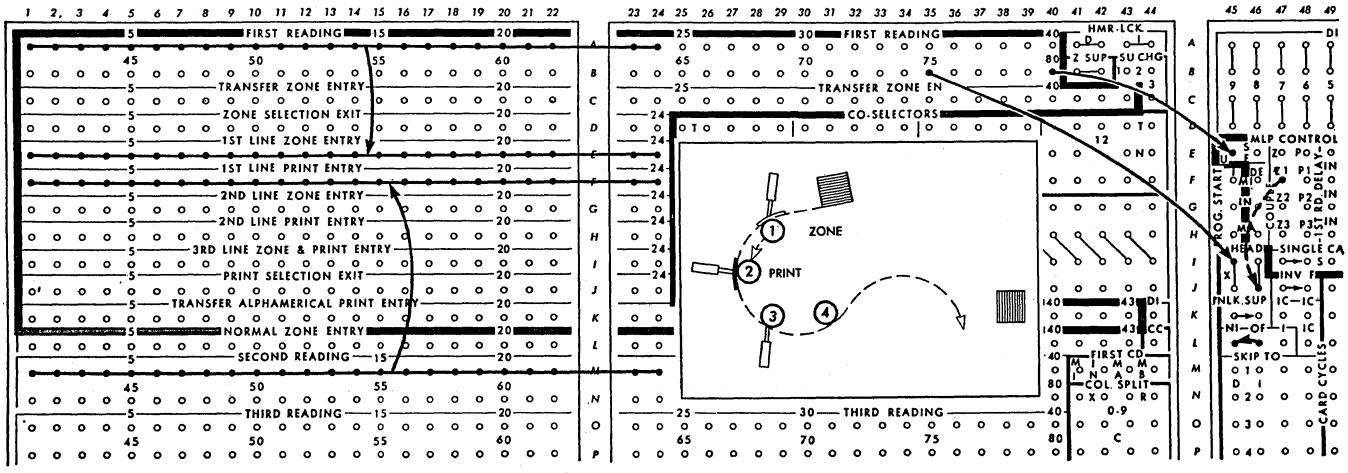


Figure 167. 1st Line Read of MLP3

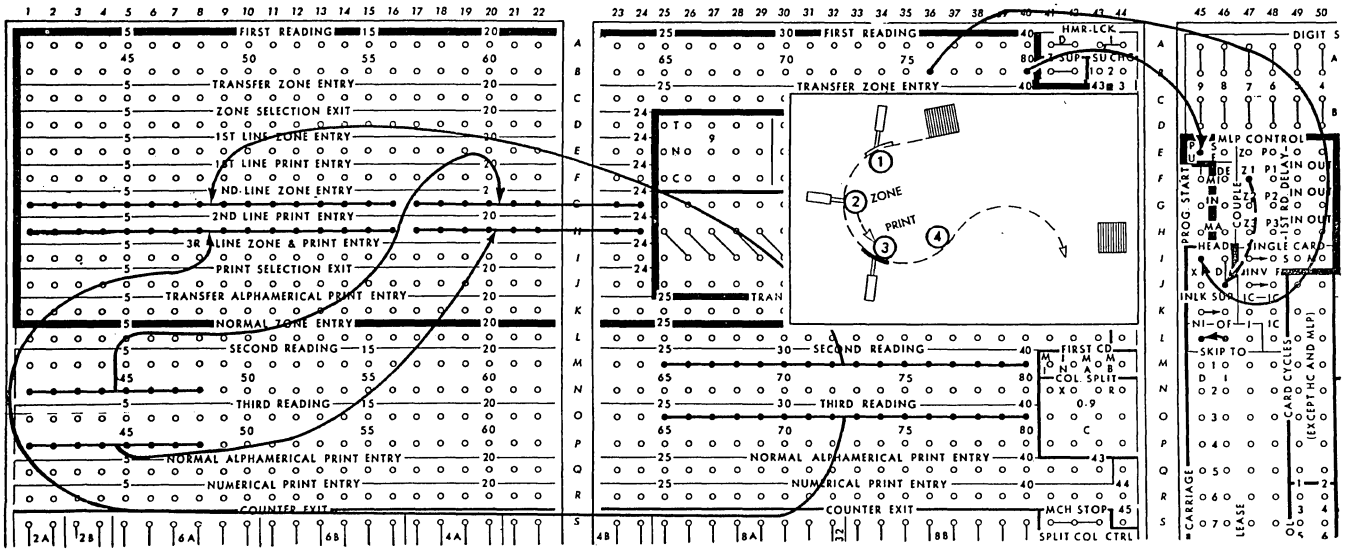


Figure 168. 2nd Line Read of MLP3

card, but permits comparison of the numerically punched control field in any two cards as they are read at the 1st and 2nd brushes.

CONTROL PANEL WIRING

Entering the First Line from an MLP3 Card

To list the first line from a line controlled card (Figure 167), the first reading brushes, which read the first field to be listed, are wired to the 1st line zone entries. The second reading brushes, which read this field, are wired to the first line print entry.

Entering the Second Line from an MLP3 Card

To list the second line from a line controlled card (Figure 168) the second reading brushes, which read the second field to be listed, are wired to the 2nd line zone entry, and the third reading brushes which read this field are wired to the 2nd line print entry.

Entering the Third Line from an MLP3 Card

To list the third line from a line controlled card (Figure 169) the third reading brushes, which read the third field to be listed, are wired to the third line zone and print entry.

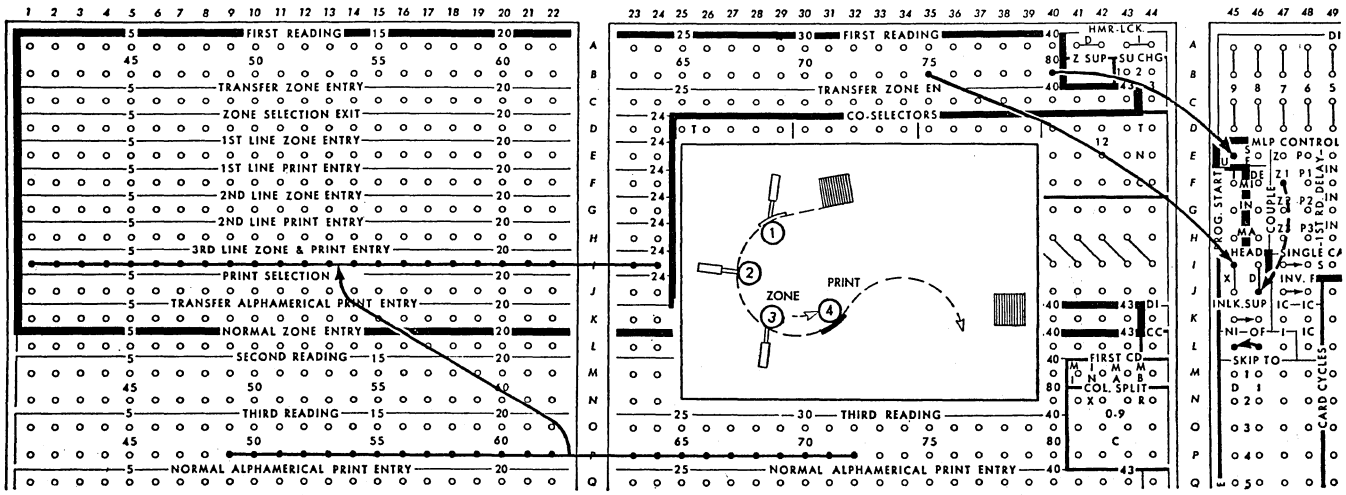


Figure 169. 3rd Line Read of MLP3

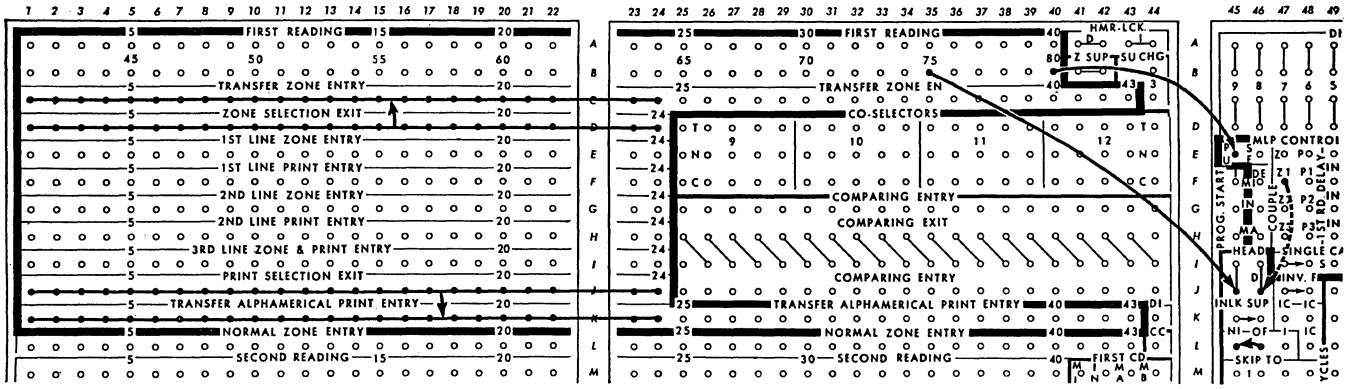


Figure 170. Zone and Print Exit Impulse

Wiring for the Zone Magnet and Print Magnet

The zone selection exit row is wired to the transfer zone entries, corresponding to the alphamerical type bars from which the lines are to be listed; the print selection exit row is wired to the transfer alphamerical print entry, corresponding to the type bars from which the field is to be listed as illustrated in Figure 170.

Composite of Three Line Operation

Sample wiring is shown in Figure 178 for the first, second, and third line of printing for an MLP3 card. Zoning for the 1st, 2nd, and 3rd lines is brought to the 1st, 2nd, and 3rd line zone entry. Numerical punching for the 1st, 2nd and 3rd lines is brought to the 1st, 2nd and 3rd line print entry. Zone selection common exits are wired to the controlled zone entries, and the print selection exits are wired to the transfer alphamerical print entry. The first reading brush sensing the line control column is wired to the MLP inlet to control the selector column.

As the MLP3 card passes the first reading brushes, the zone punching for the 1st line to be printed is accepted by the 1st line zone entry which passes it through an internal selector system to the zone selection exit and by control panel wire to the transfer zone entry.

As the card passes the second reading brushes, the numerical punching for this field is accepted by the 1st line print entry which passes it through a second internal selector system to the print selection exit and by control panel wire to the transfer alphamerical print entry. The numerical punching combines with the zone punching to cause printing of the first line. Figure 171 shows the schematic circuit for the first line operation.

As the MLP3 card passes the second reading brushes, the zone punching for the second line to be printed is accepted by the second line zone entry which passes it through an internal selector to the zone selection exit and by control panel wire to the transfer zone entry.

As the card passes the third reading brushes, the numerical punching for this field is accepted by the 2nd line print entry which passes it through an internal selector to the print selection exit and by control panel wire to the transfer alphamerical print entry. Numerical punching combines with zone punching to cause printing of the second line. Figure 172 shows the schematic circuit for the second line operation.

As the MLP3 card passes the third reading brushes, the numerical punching is sensed first. Since there is no fourth reading station, the impulses from the third reading brushes for the third line are accepted by the 3rd line zone and print entry and passed it through the internal selector to counter start magnets to be stored in counters. Counter groups 2A, 2B, 6A, 6B, 4A, and 4B will act as storage counters for the 24 possible columns of third line printing.

As the zone portion of the card passes the third reading brushes, the zone punching for the third line to be printed is accepted by the third line zone entry which passes it through the internal selector

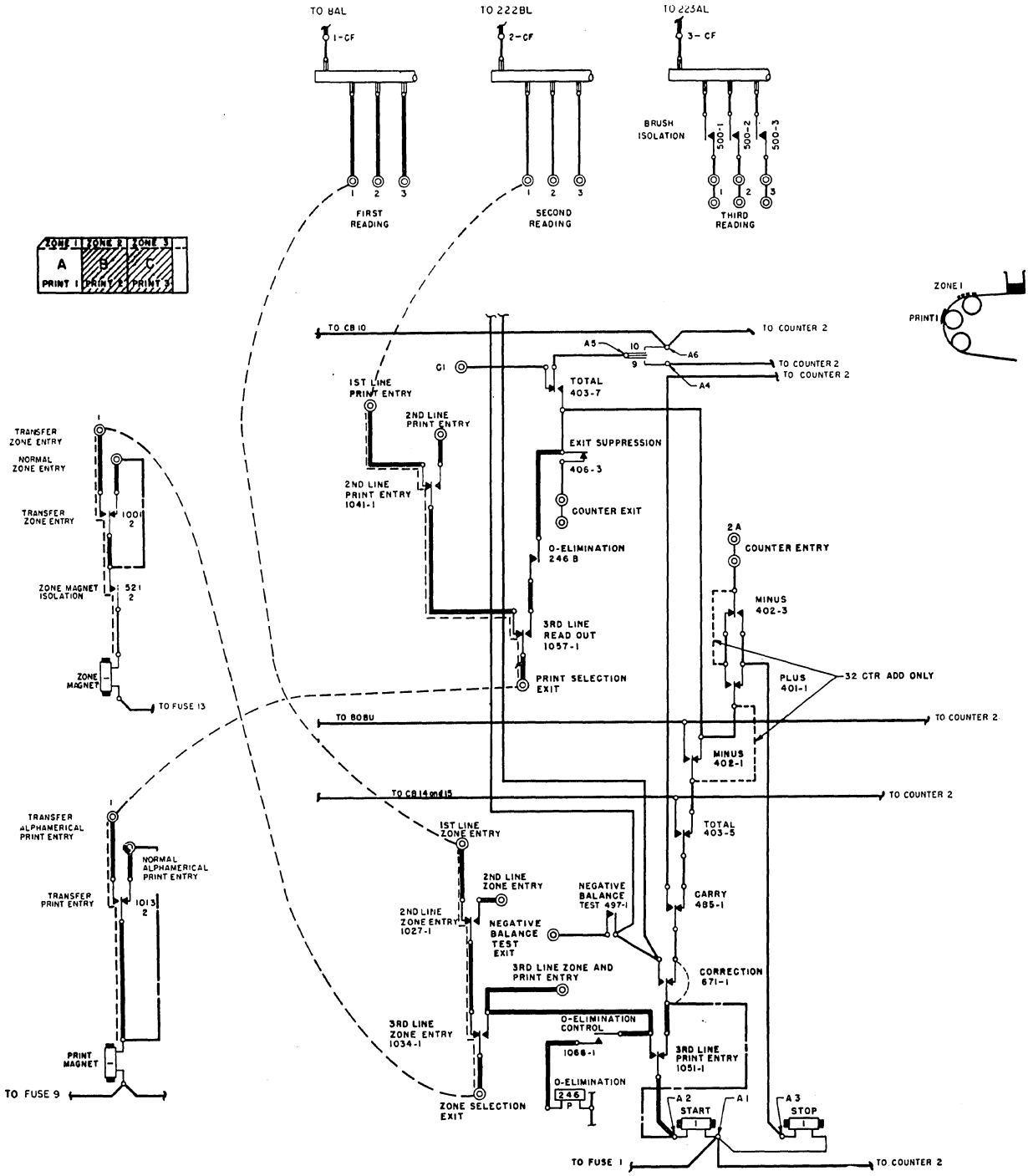


Figure 171. 1st Line Zone and Print Reading Circuit

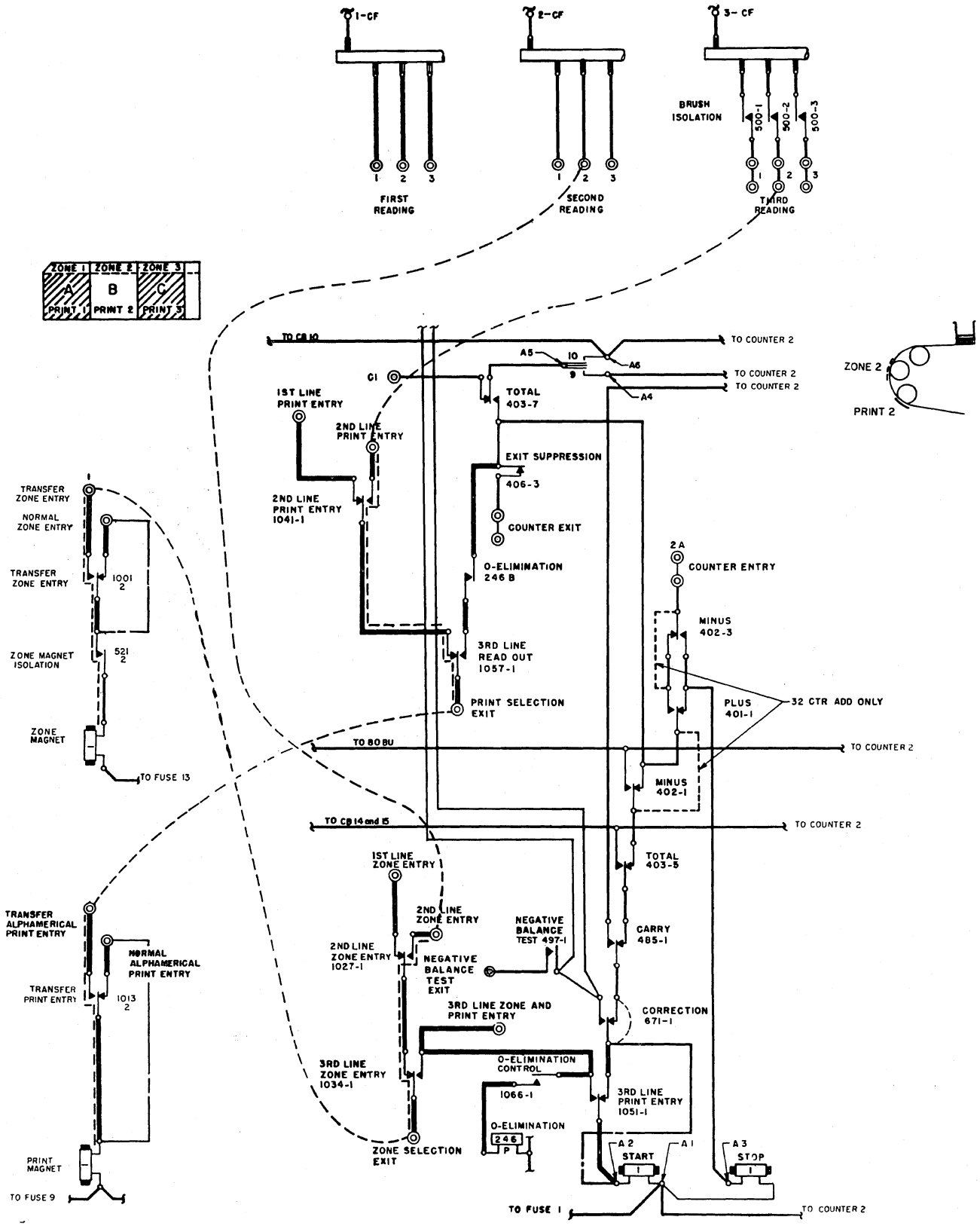


Figure 172. 2nd Line Zone and Print Reading Circuit

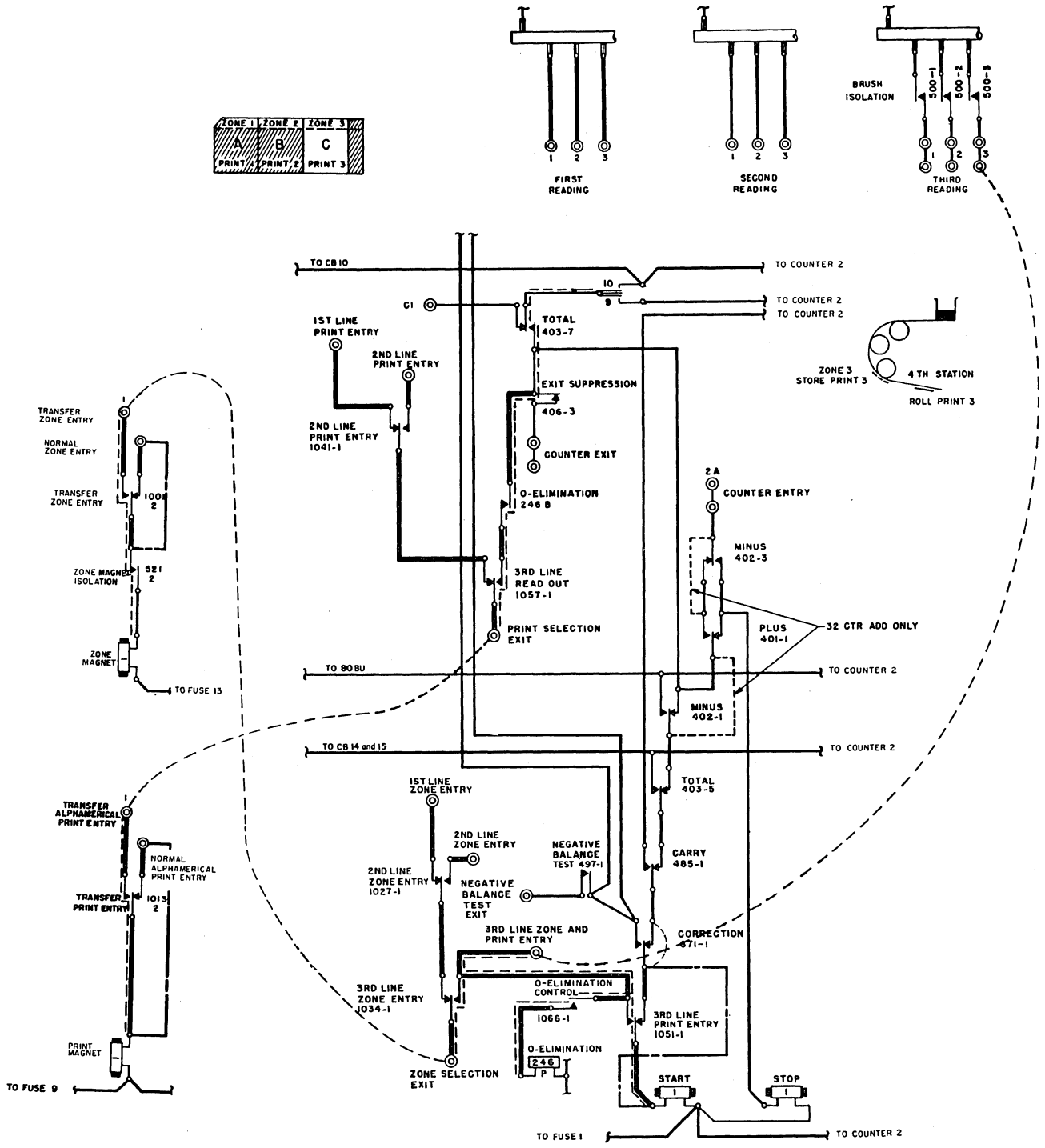


Figure 173. 3rd Line Zone and Print Circuit

to the zone selection exit and by control panel wire to the transfer zone entry. Figure 173 shows the schematic circuit for the third line operation which includes reading the numerical information into the storage counters, the impulse to the zone magnets, and the path for the print magnet impulse from the counter 9-10's brush as the card passes the fourth station.

MLP CARD SEQUENCE OF OPERATION

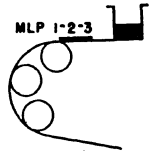
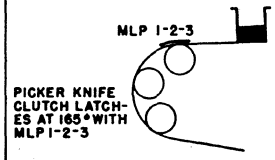
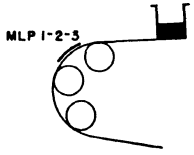
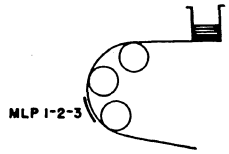
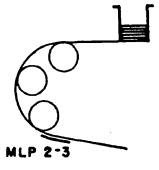
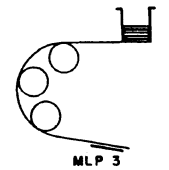
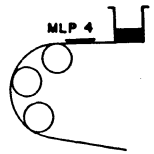
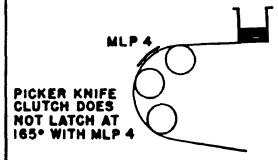
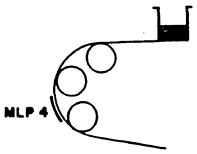
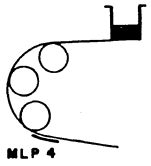
		MLP CARD SENSED				
MLP 1			ZONE 1ST LINE	PRINT 1ST LINE		
MLP 2			ZONE 1ST LINE	ZONE 2ND LINE PRINT 1ST LINE	PRINT 2ND LINE	
MLP 3			ZONE 1ST LINE	ZONE 2ND LINE PRINT 1ST LINE	ZONE 3RD LINE PRINT 2ND LINE READ 3RD LINE	COUNTER ROLL PRINT 3RD LINE
						
MLP 4			ZONE 2ND LINE	PRINT 2ND LINE		
						

Figure 174. Card Feeding Sequence

CIRCUIT DESCRIPTION

THE circuit description for multiple-line printing deals with the zoning, printing, and control circuits. When MLP cards pass through the machine, there are always a variable number of lines of printing demanded by the control punching in the card. For this reason the card signals are dealt with individually.

Circuits from reading brushes, through MLP internal selectors into transfer entry hubs are shown by Figures 171, 172, and 173. Zone and print entry from each of the three fields of an MLP card is shown, and these circuts are not traced in the circuit outline. The objective of MLP circuit outlines is to set up internal selector and transfer entry relays so that the desired reading circuits may be completed. Accompanying each circuit outline is a sequence chart divided into two major sections. The upper section is of objective relays and shows the print entry, zone entry, and transfer relays necessary to list from a particular field in the card. The lower section shows sequence of operation of control relays necessary to energize the objective relays in the correct cycle. Each outline describes the operation of an MLP card preceded and followed by normal cards.

LINE-CONTROLLED PRINTING—MLP 1 CARD

A REVIEW of the sequence shown in Figure 174 will help to keep the objective in mind. The MLP1 card is zoned from first reading, and numerical information is sensed at second reading. The MLP1 card is punched 9, 8, and 1 in the line control column, and a wire from the first reading brush sensing this column is wired to the MLP control hub.

A normal card preceding an MLP1 card passes the second brushes as the MLP card is passing the first. This causes the normal card to zone from the second brushes while the MLP card zones from the first. Therefore, it is necessary to latch the picker knife clutch at 165° and stop the MLP card between one and zero while the normal card completes zoning. This same situation arises with MLP2 and 3 cards also, so that it is always necessary to latch the PK clutch for one cycle allowing the preceding card to zone without interference.

For reference purposes the cycles of MLP operation will be numbered beginning with cycle 1 when the MLP control punching is first sensed. MLP1 sequence chart (Figure 175):

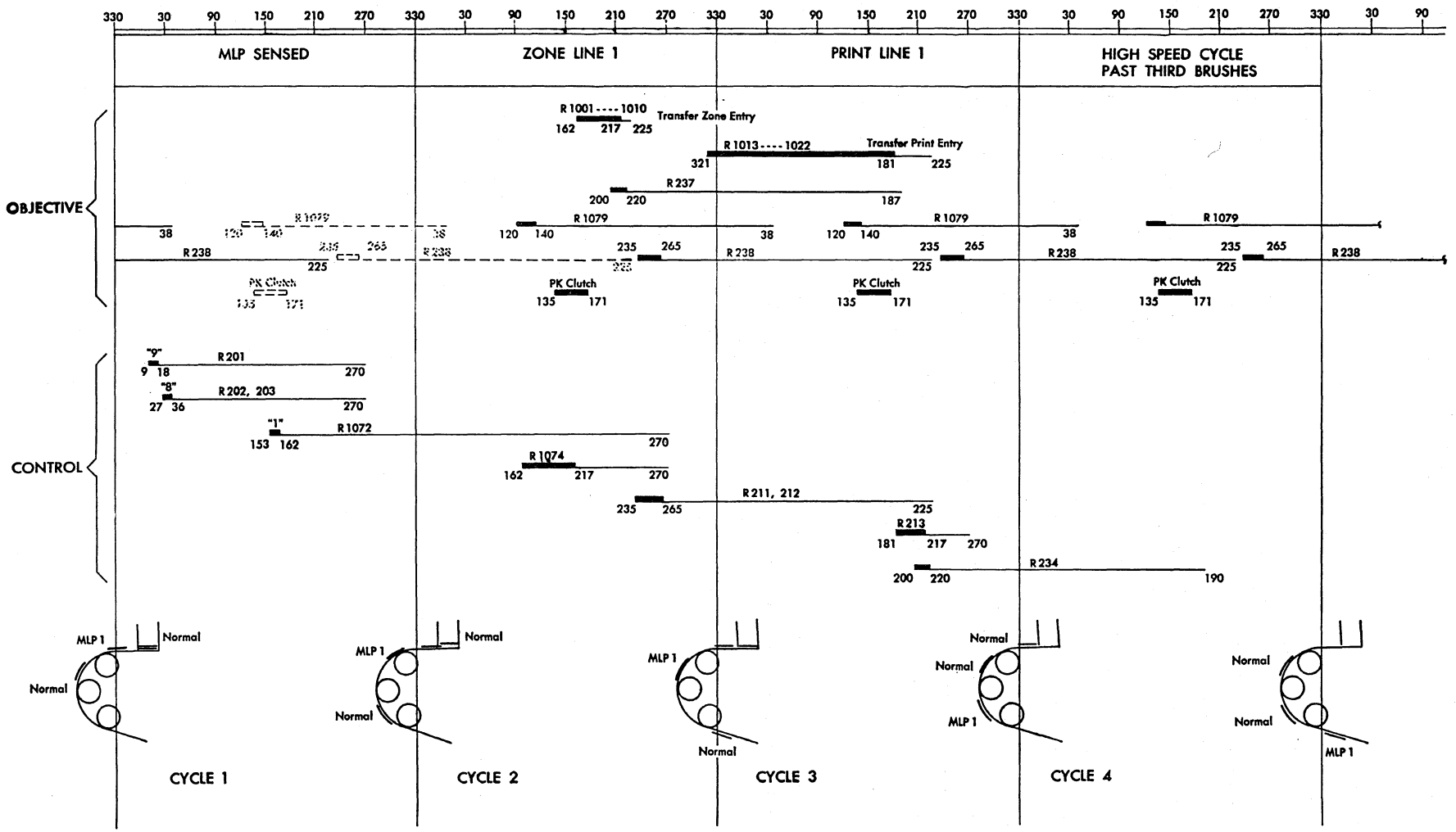


Figure 175. MLP1 Sequence

OBJECTIVES

Previous to Cycle 1

1. To energize the picker knife clutch and allow normal card reading.
   a. R1079 picks through 203A N/C from CF28. 20B
      R1079 holds from CF33. 22A
   b. R238 picks through 1079-6 from CB43. 18A
      R238 holds from CF29, and 238BL completes the reading circuit to the first brushes (41A). 18B

In Cycle 1

Normal cards at third and second stations, MLP1 card at first station.

2. To recognize an MLP1 card.
   a. R201 picks through CB76 *(9)* and control panel wire by a 9 sensed at the first brushes. 17A
      R201 holds from CB38. 17B
   b. R202 picks through CF20 *(8)* and control panel wire by an 8 sensed at the first brushes. 17A
      R202 holds and energizes R203 from CB38. 17B
   c. R1072 picks through CF24 *(3-2-1)* by a 1 impulse from first reading. 17B
      R1072 holds through CB37 and later through 1079-8. 17B
3. To stop the MLP1 card at the first station between 1 and 0 so that the preceding card may zone correctly.
   a. R1079 pick circuit is blocked by 203A N/C now open. 20B
   b. PK clutch pick circuit is blocked by 1079-3. 20B
   c. R238BL remains closed until 225° and allows reading of digits 9 through 1 from first brushes for comparing purposes. 41A

In Cycle 2

Normal card at third station, no card at second station, MLP1 card at first station.

4. To energize the PK clutch and feed the MLP1 card to the second station.
   a. R1079 picks through 203A N/C (now made). 20B
      R1079 holds from CF33. 22A
   b. PK clutch picks through 1079-3. 20B
5. To energize transfer zone entry relays.
   a. R1001-1004-1007-1010 pick through 1072-2; 1079-2 from CF3. 19A
      R1001-1010 hold through 1001-1 from CF29. 21B
6. To prevent reading from bare contact roll at the second station.
   a. R222 pick is not energized because of open CLC2. 42B
   b. Second station reading circuit is blocked by 222BL N/O. 41A
7. To set up transfer print entry and PM clutch circuit for cycle 3.
   a. R1074 picks through 1072-6 and 1079-10 from CF3. 18A
      R1074 holds from CB38. 18A
   b. R211 picks through 1074-2 from CB43. 18A
      R211 holds and energizes R212 from CF29. 18A
   c. R237 picks through 1010-9 from CF5. 23A
      R237 holds from CF34. 23A

In Cycle 3

No card at third station, MLP1 card at second station, normal card at first station.

8. To energize transfer print entry relays.
   a. R1013-1016-1019-1022 pick through 211AL from CB's 78 and 79. 19A
      R1013-1022 hold through 1013-1 from CF29. 21B
9. To prevent reading from the bare contact roll at the third station and to keep energized lower card lever relays while CLC3 is open.
   a. R223 pick is not energized because of open CLC3. 42B
   b. Third station reading circuit blocked by 223AL N/O. 42A
   c. R10, 11, and 12 pick circuit is transferred to CLC2 through 1074-3, and the operation of lower card lever relays remains undisturbed. 42B
10. To energize the print clutch magnet for MLP first line printing even if the control panel is not wired for listing.
    a. R79 and the zone control magnet pick through 237B from CB19. 4B
       R79 holds from CB24. 6B
    b. Print clutch magnet energizes through 79AL in the manner for listing. 6A
11. To set up high-speed operation for cycle 4.
    a. R212 picks during cycle 2. 18A
    b. R234 picks through 212BL from CF5. 20A
       R234 holds from CF4. 20A

In Cycle 4

MLP 1 card at third station, normal cards at second and first stations.

12. To cause a high-speed card-feed cycle as the MLP1 card passes the third station.
    a. R79 pick circuit blocked by 234BL N/C. 4B
    b. PM clutch magnet not energized because of 79AL N/O. 6A
    c. R82 picks through 79BL N/C to cause high-speed operation. 6B

    As the normal card passes the second station at high speed, it zones in the normal manner.

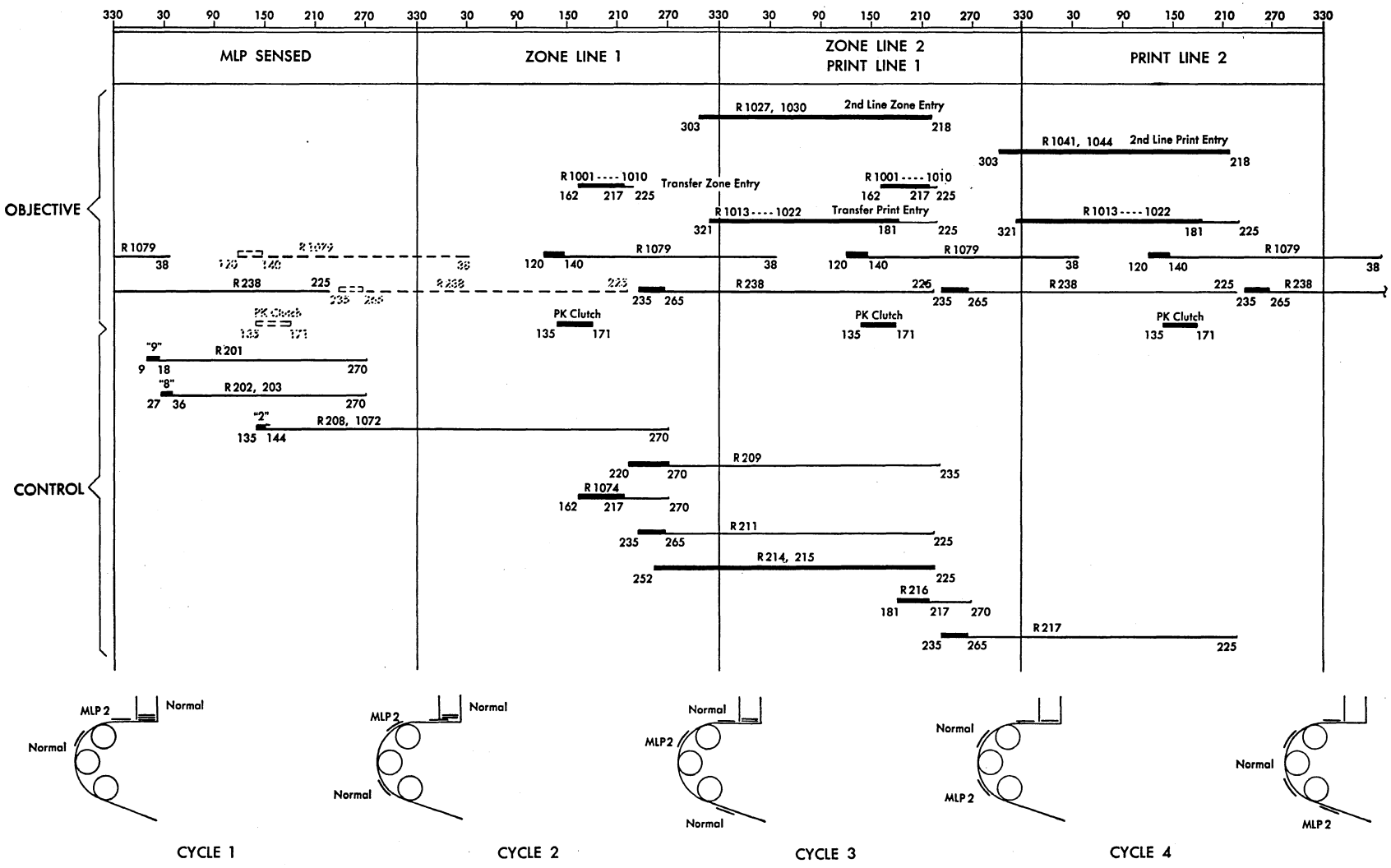


Figure 176. MLP2 Sequence

LINE-CONTROLLED PRINTING—MLP 2 CARD

THE DEMAND punching in the MLP2 card is 9-8-2. The picker knife control R1079 will be interrupted when an MLP2 card is being fed, the same as when an MLP1 card is being moved. Therefore, the circuits will be the same for starting all MLP card operations, and for this reason only the objectives will be listed.

OBJECTIVES

Previous to Cycle 1

1. To energize the PK clutch and allow normal card sensing.
   Same as objective 1 of MLP1.

In Cycle 1: Zone preceding Normal card.

Normal card at second station, MLP2 card at first station.

2. To recognize an MLP2 card.
   a. R201
   b. R202 and 203 } pick and hold same as MLP1.
   c. R1072
   d. R208 picks through CF23 *(2)* by a 2 impulse from first reading. 17B
      R208 holds through CB37 and later 1079-8. 17B
   e. R209 picks through 208B, 1079-5 from CF8. 17B
      R209 holds through 217BL N/C from L11. 17B
3. To stop the MLP2 card at the first station between 1 and 0 so that the preceding card may zone correctly.
   Same as objective 3 of MLP1.

In Cycle 2: Zone first line

Normal card at third station, no card at second station, MLP2 card at first station.

4. To energize the PK clutch and feed the MLP2 card to the second station.
   Same as objective 4 of MLP1.
5. To energize transfer zone entry relays.
   Same as objective 5 of MLP1.
6. To prevent reading from bare contact roll at the second station.
   Same as objective 6 of MLP1.
7. To set up transfer zone entry, transfer print entry, second line zone entry, and PM clutch circuit for cycle 3.
   a. R1074 picks through 1072-6 and 1079-10 from CF3. 18A
      R1074 holds from CB38. 18A
   b. R211 picks through 1074-2 from CB43. 18A
      R211 holds through 211AU from CF29. 18A
   c. R214 and 215 energize through 209B and R211 hold circuit. 18B
   d. R237 picks through 1010-9 from CF5. 23A
      R237 holds from CF34. 23A

In Cycle 3: Print first line, zone second line.

No card at third station, MLP2 card at second station, normal card at first station.

8. To energize transfer zone and print entry relays.
   a. R1001-1004-1007-1010 pick through 215AU from CB's 78 and 79. Hold same as before (21B). 19A
   b. R1013-1016-1019-1022 pick through 211AL from CB's 78 and 79 19A
      R1013-1022 hold from CF29. 21B
9. To energize second line zone entry relays.
   a. R1027 and 1030 pick through 214BL from CB74. 19B
      No additional hold is required.
10. To prevent reading from the bare contact roll at the third station and to keep energized lower card lever relays while CLC3 is open.
11. To energize the print clutch magnet for first line printing.
    Same as objective 10 of MLP1.
12. To set up transfer print entry, second line print entry, and PM clutch circuits for cycle 4.
    a. R216 picks through 214BU from CF2. 18B
       R216 holds from CB38. 18B
    b. R217 picks through 216B from CB43. 18B
       R217 holds from CF29. 18B
    c. R237 picks through 1010-9 from CF5. 23A
       R237 holds from CF34. 23A

In Cycle 4: Print second line

MLP2 card at third station, normal cards at second and first stations.

13. To energize transfer print entry and second line print entry relays.
    a. R1013-1016-1019-1022 pick through 217AU. 19A
    b. R1041-1044 pick through 217BU. 19B
14. To energize the PM clutch magnet for second line printing.
    Same as objective 10 of MLP1.

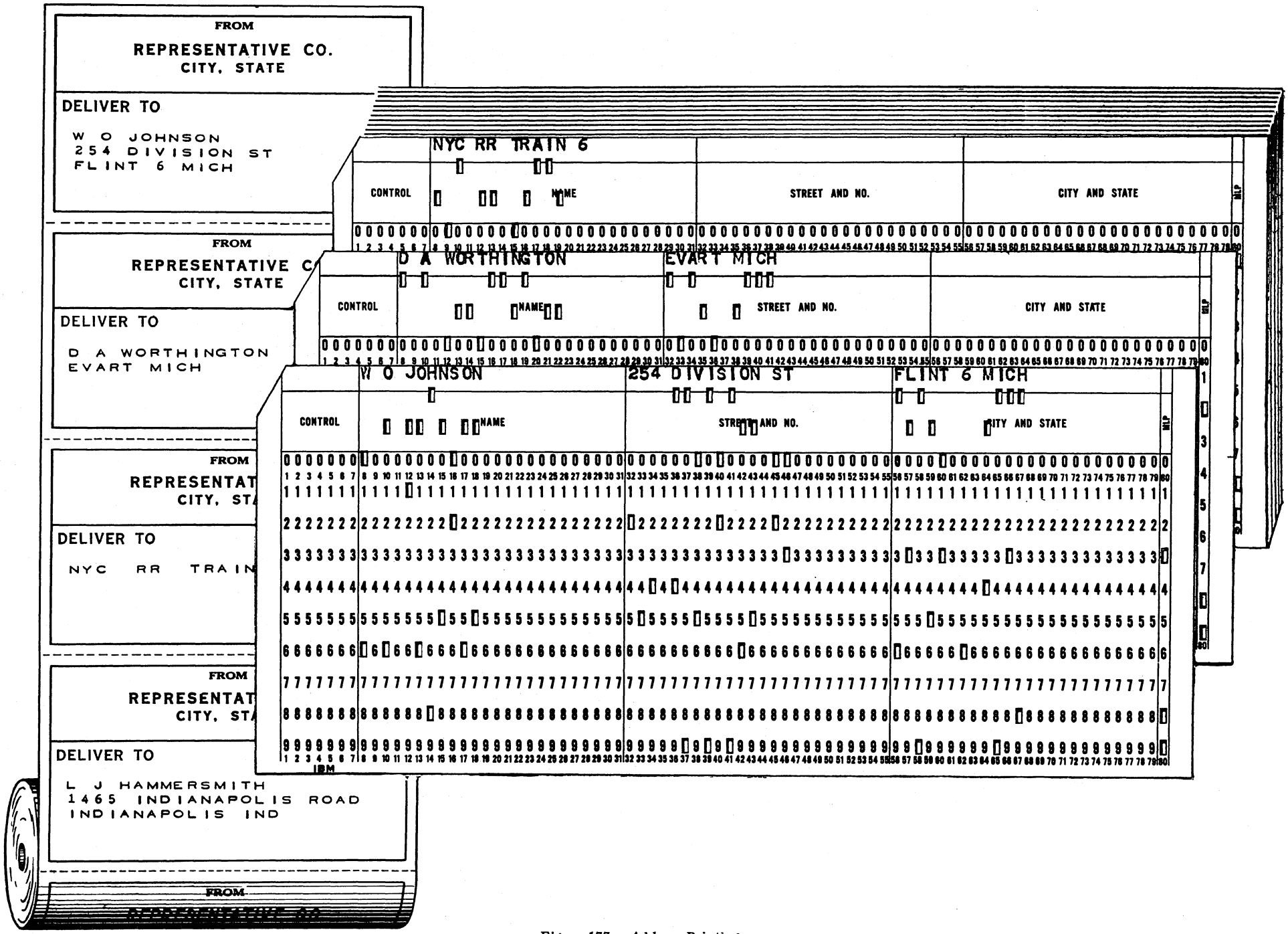


Figure 177. Address Printing

LINE-CONTROLLED PRINTING—MLP 3 CARD

Address Printing

Labels will be considered as a sample operation as the cards are MLP cards (Figure 177). Ejection from one form to the next takes place because of the wiring from Z1 to carriage skip to 1D hub. Z1 emits an impulse at 160° just before the zone for the first line is sensed by the first reading brushes. When this impulse is wired to skip to 1D, it will cause the form to skip to the first line just before zoning the first line of each new MLP card.

The D carriage hub must be used because the immediate hub will not accept Z1 impulses or any digit impulse, because it is conditioned for early all cycles impulses only. When program start is not involved, the D hub acts immediately.

A card count impulse cannot be used to cause the skip to 1 because the card count impulse will not be available until the card passes the third card lever before the third reading station. The skip-to operation is not desirable at this time because an MLP3 card would have completed only the second line of printing after passing this station.

An unequal impulse cannot be used to cause the skip to 1 in this problem, because the comparison is made between the first and second brushes, and the resulting comparing exit impulse would cause ejection as the MLP3 card passes the second reading station; this is too early for both the MLP2 and an MLP3 card. See control panel (Figure 178).

Interlock suppression is wired, because all forms are less than 3⅔″ in length. Each time a skip is started, the exit hub emits an impulse which, when wired to the entry hub beside it, suppresses the interlock on all skips, thus assuring rapid ejection with no loss of time.

Listing MLP 3 Card

The demand punching in the MLP3 card is 9-8-3. The picker knife control R1079 will be interrupted when feeding an MLP3 card, the same as when moving a MLP1 or 2 card through the first reading station.

The picker knives will again latch as the MLP3 card passes the second reading station and hold the following card at the first station in the 1-0 position until the first MLP card can complete its operations without interference.

Inspection of Figure 174 shows the MLP3 card zoning at the third station. This operation must be completed before zoning from the following card begins. If the following card is an MLP, zoning at the first station must wait until the preceding MLP3 has passed the third station. As the counters roll to provide the print magnet numerical impulses from the fourth station, the next MLP card may zone for first line printing from the first station.

If the MLP card had been followed by a normal card, there would be one less delay cycle. The normal card would start to advance as the MLP3 card passed the third reading station. This is possible because the normal card, if it were punched alphabetically, would

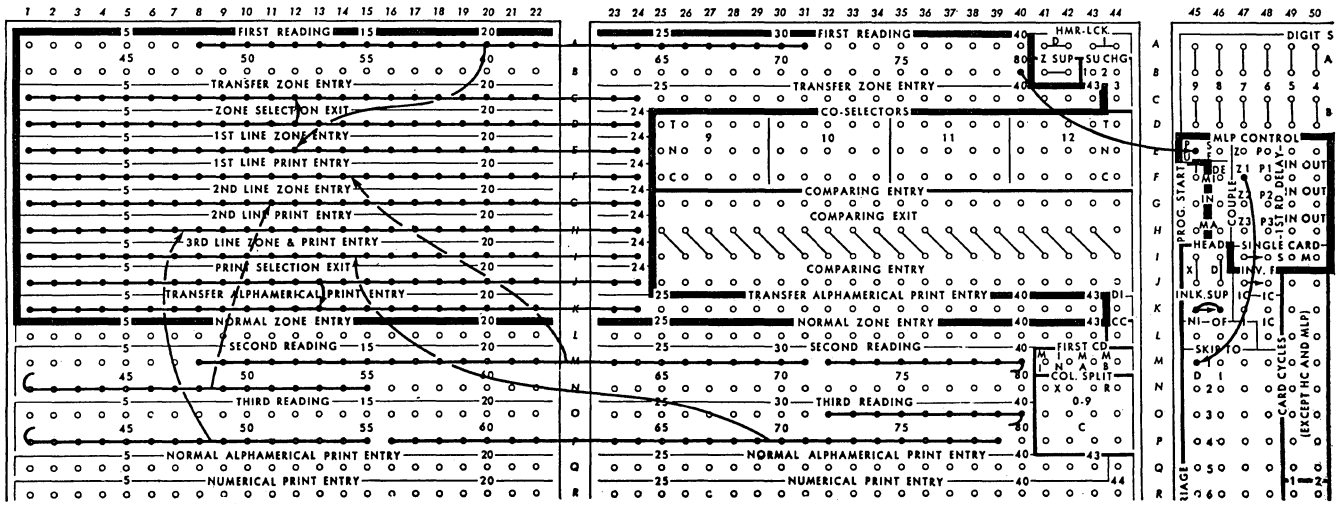


Figure 178. Multiple Line Printing

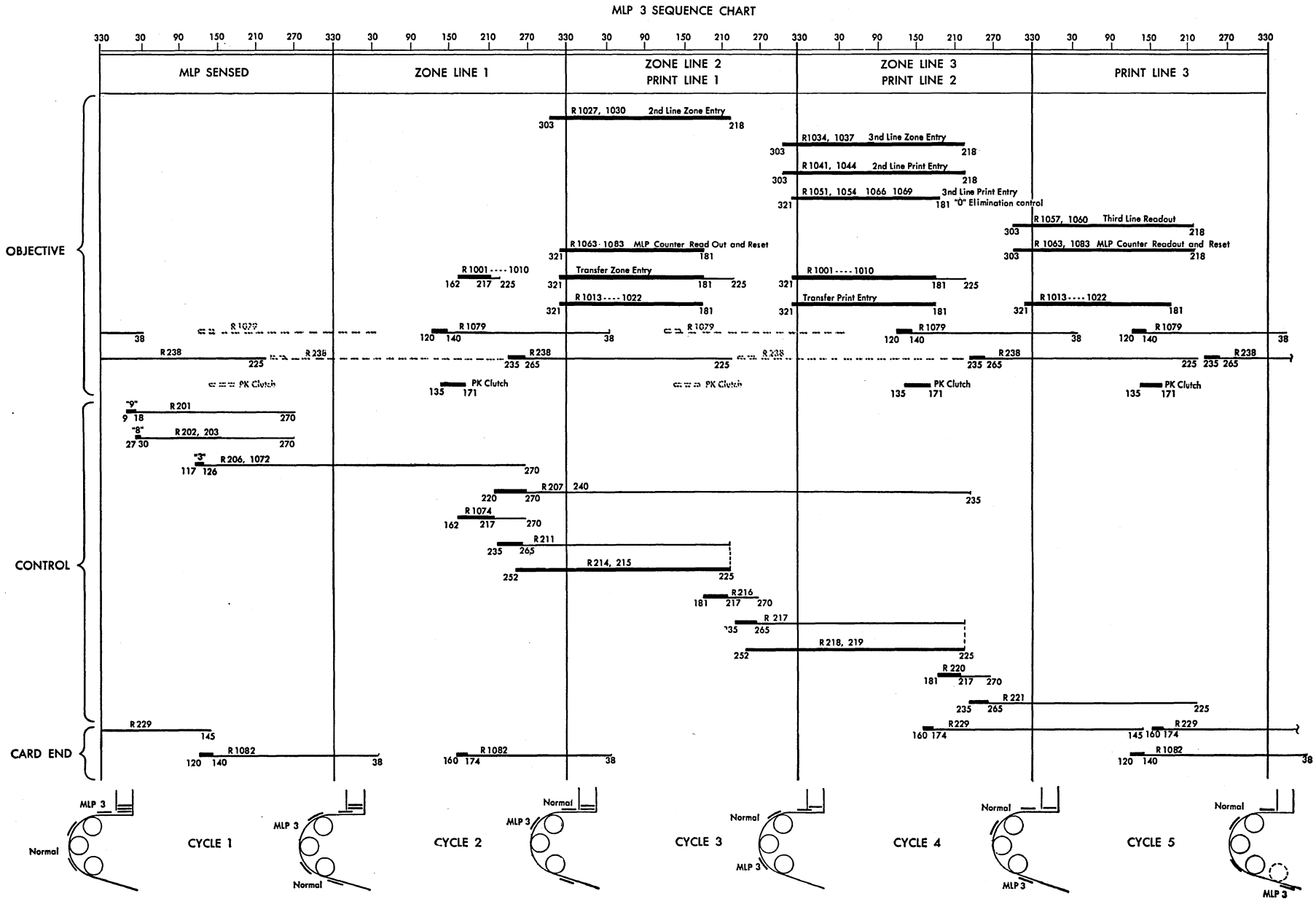


Figure 179. MLP3 Sequence

not be sensed for listing until it passes the second and third reading station. By the time the normal card is sensed at the third reading station, the MLP3 card has completed its fourth station operation and moved away.

Basically, the operation for the MLP3 card at the first reading station is the same as with MLP1 and 2 cards, and the same as MLP2 cards when passing the second and third reading station.

The MLP3 card operation differs from that previously studied for MLP1 and MLP2 cards when the third line is to be listed. Figure 166 shows that the MLP3 card is zone-sensed as it passes the third reading station and that the numerical information is also read and stored in counters at this time. The counters act as substitutes for a fourth set of reading brushes, and are controlled automatically by internal circuits to reset before the MLP3 card passes the third reading station, to add when MLP3 passes the third reading station, and to roll and reset when the MLP3 card passes the fourth station position.

The circuit outline describes an MLP3 card running between normal cards and deals with objective, control, and card end relay operation. Figures 171, 172, and 173 may be used as a reference for the actual zoning and listing circuits from the three fields of an MLP3 card. A detailed sequence chart of MLP3 operation is shown in sections 87 through 90 of WD210201R, but for circuit description purposes the simplified diagram of Figure 179 will be used.

OBJECTIVES

Previous to Cycle 1

1. To energize the PK clutch and allow normal card sensing.
   a. R1079 picks through 203A N/c. 20B
   R1079 holds from CF33, and 1079-3 energizes the PK clutch (20B). 22A
   b. R238 picks through 1079-6. 18A
   R238 holds from CF29 and 238BL completes the reading circuit to the first brushes (41A). 18B

In Cycle 1: Zone preceding normal card

Normal card at second station, MLP3 at first station.

2. To recognize an MLP3 card.
   a. R201 picks through CB76 *(9)*. 17A
   R201 holds from CB38. 17B
   b. R202 picks through CF20 *(8)*. 17A
   R202 holds and energizes R203 from CB38. 17B
   c. R206 picks through CF22 *(3)*. 17A
   R206 holds from CB37 and later through 1079-8. 17B
   d. R1072 picks through CF24 *(3, 2, and 1)*. 17B
   R1072 holds from CB37 and later 1079-8 N/c. 17B

3. To stop the MLP3 card at the first station between 1 and 0 so that the preceding card may zone correctly.
   a. R1079 pick blocked by 203A N/c, now open. 20B
   b. R238BL remains closed until 225° and allows reading of digits 9 through 1 from the first brushes for comparing purposes. 41A
   c. PK clutch pick circuit blocked by 1079-3. 20B

In Cycle 2: Zone first line

Normal card at third station, no card at second station, MLP3 card at first station.

4. To energize the PK clutch and feed the MLP card to the second station.
   a. R1079 picks through 203A N/c. 20B
   R1079 holds from CF33. 22A
   b. PK clutch picks through 1079-3. 20B

5. To energize transfer zone entry relays.
   a. R1001-1004-1007-1010 pick through 1072-2 and 1079-2. 19A
   R1001-1010 hold through 1001-1 from CF29. 21B

6. To prevent reading from bare contact roll at the second station.
   a. R222 not picked because of open CLC2. 42B
   b. Second brush reading circuit blocked by 222BL N/o. 41A

7. To set up transfer zone entry, transfer print entry, second line zone entry and PM clutch circuit for cycle 3.
   a. R1074 picks through 1072-6 and 1079-10. 18A
   R1074 holds from CB38. 18A
   b. R211 picks through 1074-2. 18A
   R211 holds through 211AU from CF29. 18A
   c. R214 and 215 pick through 207AL N/o, 209B N/c and R211 hold circuit. 18B
   d. R207 picks through 206B. 17B
   R207 holds and energizes R240 through 221BL N/c from L11. 17B
   e. R237 picks through 1010-9 from CF5. 23A
   R237 holds from CF34. 23A

In Cycle 3: Print first line, zone second line, clear MLP counters.

No card at third station, MLP3 card at second station, normal card at first station.

8. To energize transfer zone and print entry relays.
   a. R1001-1010 pick through 215AU. Hold same as before (21B). 19A
   b. R1013-1022 pick through 211AL. Hold same as before (21B). 19A

9. To energize second line zone entry relays.
   a. R1027 and 1030 pick through 214BL. No hold. 19B

10. To prevent reading from bare, third station contact roll to keep energized lower card lever relays while CLC3 is open.
   a. R223 does not pick because of open CLC3. 42B
   b. Third station reading circuit blocked by 223AL N/o. 42A
   c. R10, 11, and 12 pick circuit is transferred to CLC2 through 1074-3, and the operation of lower card lever relays remains undisturbed. 42B

11. To energize the print clutch magnet for first line printing.
   a. R79 and the zone control magnet pick through 237B. 4B
   R79 holds as before. 6B
   b. Print clutch magnet energizes through 79AL in the normal manner for listing. 6A

12. To stop the following normal card at the first station until MLP3 operation is complete.
   a. R1079 pick is blocked by 214AL N/c and 207BL N/c being open. 20B

13. To clear MLP counters of any figures standing in them without printing.
   a. R1063 and 1083 pick through 214AU, 240A from CB's 78 and 79. No hold. 19B
   b. Total relays for counters 2A, 2B, 6A, 6B, 4A, and 4B pick through 1063-7 to 12, respectively, from CB's 78 and 79 to cause the counters to reset. 39B
   c. Exit suppression relays for counters 2A, 2B, 6A, 6B, 4A, and 4B pick through 1063-1 to 6 from CB's 78 and 79 to eliminate printing and total transfer. 38B

When MLP3 cards pass the third brush station and the numerical punching for the second line printing is sensed, circuits must be set up so that the numerical punching for the third line may also be stored in counters.

14. To set up transfer zone and print entry, second line print entry, third line zone entry, third line print entry, 0-elmination control, and PM clutch circuit for cycle 4.
    a. R216 picks through 214BU from CF2. 18B
    R216 holds from CB38. 18B
    b. R217 picks through 216B from CB43. 18B
    R217 holds through 217AL from CF29. 18B
    c. R218 and 219 pick and hold through 207BU and R217 hold circuit. 18B
    d. R237 picks through 1010-9; holds from CF34. 23A

In Cycle 4: Print second line, zone third line, store third line numeric.

MLP3 card at third station, no card at second station, normal card between 1 and 0 at first station.

15. To energize transfer zone and print entry relays.
    a. R1001-1010 pick through 218AU. Hold same as before (21B). 19A
    b. R1013-1022 pick through 217AU; hold same as before (21B). 19A
16. To energize second line print entry relays.
    R1041 and 1044 pick through 217BU; no hold. 19B
17. To energize third line zone entry relays.
    R1034 and 1037 pick through 218BU; no hold. 19B
18. To energize third line print entry and 0-elimination control relays.
    R1051-1054-1066-1069 pick through 219BU; no hold. 19B
    Circuits are now set up to channel digit impulses from third line zone and print entry hubs to counter start magnets for storage. Zone impulses will be directed out of the zone selection exit hubs to transfer zone entry for actual zoning of the third line.
19. To energize zero elimination relays, only in positions that receive a digit for storage.
    a. R246 will pick through 1066-1, only if the third station reading brush to which third line zone and print entry hub 1 is connected senses a digit. 45B
    R246 holds from CF30 and later 1082-2. 22B
    Operation of other third line zero elimination relays is the same.
20. To energize the PK clutch and allow the following normal card to feed to the second station.
    a. R1079 picks through 214AL N/C, 1072-3 N/C, and 203A N/C. 20B
    b. PK clutch magnet energizes through 1079-3. 20B
21. PM clutch magnet energizes through 79AL the same as for line 1. 6A
22. Reading from second station bare contact roll stopped by R222BL N/O. R222 not energized because of open CLC2. 42B
23. To set up transfer print entry, third line readout, MLP counter total relays, and PM clutch circuit for cycle 5.
    a. R220 picks through 218BL from CF2. 18B
    R220 holds from CB38. 18B
    b. R221 picks through 220AL from CB43. 18B
    R221 holds from CF29. 18B

In Cycle 5: Print third line

MLP3 card at fourth station, no card at third station, normal cards at second and first stations.

24. To energize transfer print entry relays.
    a. R1013-1022 pick through 221BU; hold same as before (21B). 19A
25. To energize third line readout relays.
    a. R1057 and 1060 pick through 221AL; no hold. 19B
26. To energize MLP counter total and exit suppression relays.
    a. R1063 and 1083 pick through 214AU N/C and 221AL. 19B
    b. Total relays for MLP counters pick through 1063-7 to 12, inclusive, from CB's 78 and 79. 39B
    c. Exit suppression relays for MLP counters pick through 1063-1 to 6, inclusive. 38B
27. PM clutch magnet energizes through 79AL in the normal manner. 6A
28. To stop reading from the bare third station contact roll but maintain lower card lever relays.
    a. Reading circuit from third station blocked by N/O R223AL. 42A
    b. Lower card lever relays 10, 11, and 12 hold through R220B N/O from L24. 42B

Zero Elimination

The points of relays R1066, 1069 provide a circuit from the third line zone and print entry hub to the 0-elimination relays, one for each counter position.

When printing alphabetic information, such as name or address, there will always be a space between characters in city names (Examples: Pass a Grille Beach, Des Moines, San Francisco); or between city and state, such as Endicott, New York. To prevent the type bars in the positions between parts of a city name, or city and state from receiving any impulse, such as a zero impulse, from a counter standing at zero, a 0-elimination point is placed in series with each print selection exit. Therefore, only the counters that receive a numerical impulse from the third line being sensed as it passes the third reading station will be capable of emitting impulses on the roll or fourth station operation. Notice that when zeros are punched in the third field of an MLP3 card nothing will add into the MLP counters, but the 0-elimination relays will be energized. This allows printing of zeros, which is desirable at this time.

LINE-CONTROLLED PRINTING—MLP 4 CARD

MLP4 cards are punched in the second field and read from stations 2 and 3. Because these are the normal reading stations, it is not necessary to delay the MLP4 cards at the first station for one cycle as with MLP1, 2, or 3 cards. The MLP4 card thus follows directly behind the preceding detail card and, as shown in the chart on zoning and printing cycles (Figure 174) arrives at brush station 2 one cycle sooner than did the other MLP cards. The MLP card, in turn, may be followed immediately by any detail card. In effect, the MLP4 card acts as a normal card except that information must be punched in the second field.

Listing MLP 4 Cards

The demand punching in an MLP4 card is 9-8-4, and the picker clutch control relay R1079 will be energized each cycle to prevent latching at the 1st station when moving the 1-line card in.

The circuits that are new with the MLP4 operation are the result of sensing the 4 punch in the control column. The circuts provided should allow the card

to advance until the zone is sensed by the second reading brushes. Figure 180 is a sequence chart of MLP4 operation. The MLP4 card is preceded and followed by normal cards.

OBJECTIVES

Previous to Cycle 1

1. The PK clutch energizes in the normal manner to allow card feeding through the first station. 20B

In Cycle 1: Zone the preceding normal card
Normal cards at the third and second stations, MLP4 card at the 1st station.

2. To recognize an MLP4 card
   a. R201 } pick and hold same as before. 17A and 17B
   b. R202 and 203 }
   c. R204 and 205 pick through CF21 from a 4 impulse. 17A
      R204 and 205 hold from CB37 and later 1079-8 N/C. 17B

3. To prevent the MLP4 card from stopping in station 1.
   a. R1079 picks through 205BU. 20B
      R1079 holds from CF33 and energizes the PK clutch. 22A

4. To set up transfer zone entry and second line zone entry for cycle 2.
   a. R210 picks through 205AL from CB43. 18A
      R210 holds through CF29. 18A
   b. R214 and 215 pick through 210AL from CF29; no hold. 18B

In Cycle 2

5. To energize transfer zone entry and second line zone entry relays.
   a. R1001-1010 pick through 215AU from CB's 78 and 79. 19A
      R1001-1010 hold from CF29. 21B
   b. R1027-1030 pick through 214BL from CB74; no hold. 19B
6. To set up transfer print entry and second line print entry for cycle 3.
   a. R216 picks through 214BU. 18B
      R216 holds from CB38. 18B
   b. R217 picks through 216B from CB43. 18B
      R217 holds from CF29. 18B

In Cycle 3

7. To energize transfer print entry and second line print entry.
   a. R1013-1022 pick through 217AU. 19A
      R1013-1022 hold from CF29. 21B
   b. R1041-1044 pick through 217BU; no hold. 19B

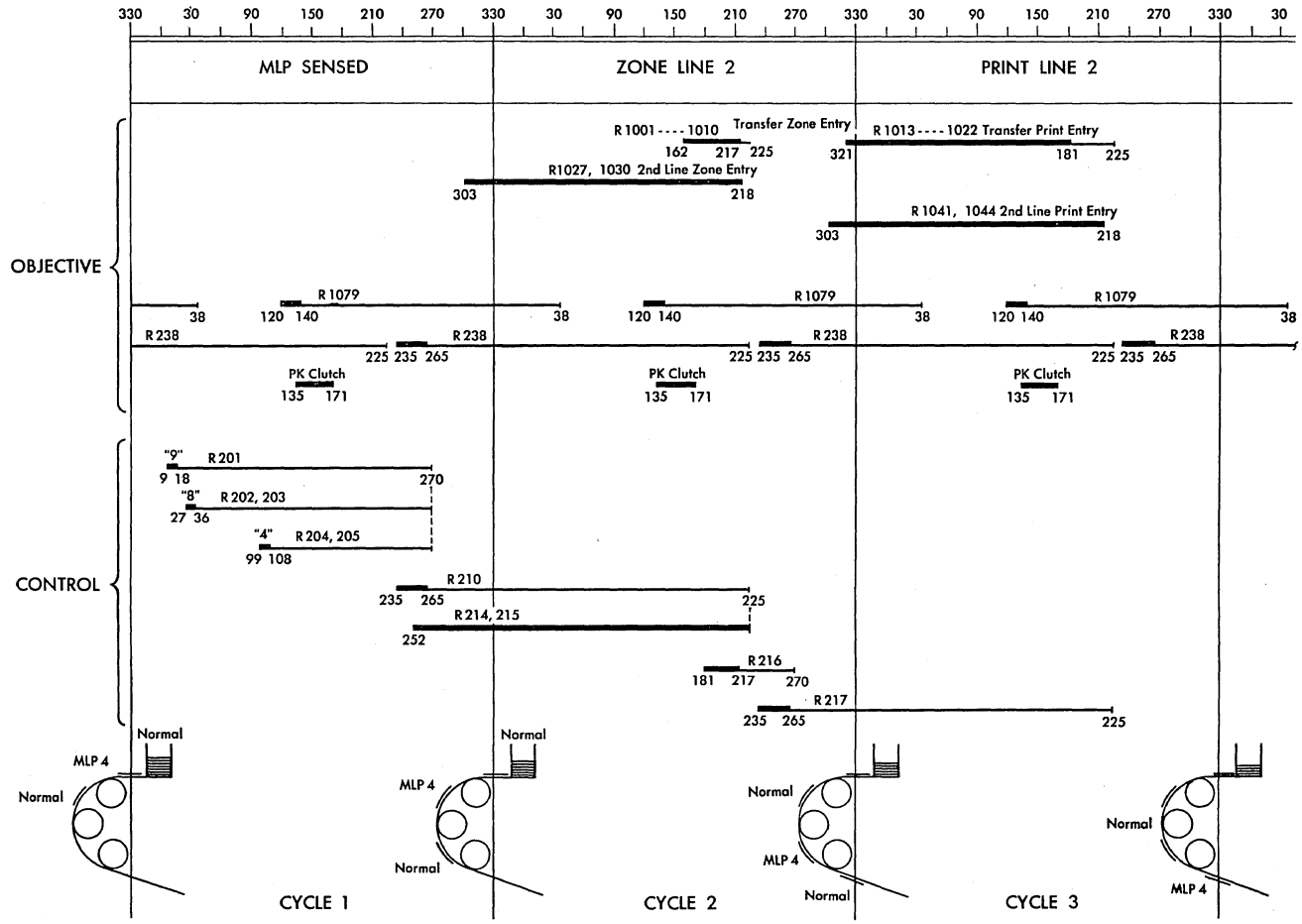


Figure 180. MLP4 Sequence

FIRST READ DELAY

AN MLP card or a detail card following an MLP card is held at the first reading station when the picker knife clutch latches up at 165°. A digit sensed as the card passes the first reading station would not be effective, because the card has been stopped with brushes between one and zero. For this reason the digit impulse, sensed by first reading station, may be wired to 1st read delay IN *(Section 20B)* and from OUT to the D pickup of a pilot selector.

The OUT hub will not emit an impulse to a selector until the card starts to advance again, because R1079-4 is in series with the OUT hub.

PREPARATION: The control panel is wired for MLP operation. A digit in column 78 is used to control pilot selector 1. Column 78 of the first brushes is wired to number one first read delay IN. Number one first read delay OUT is wired to pilot selector 1 digit pick hub. Sequence chart of first read delay: Figure 181.

OBJECTIVE: To impulse the first read delay IN with a 9 and cause an OUT impulse to transfer pilot selector 1 on the next cycle after the card resumes feeding at the first station.

1. R224 picks from a 9 sensed at first reading before the PK clutch latches at 165°. 20B
   R224 holds from CB37 and R1079-8 N/C during the time the PK clutch is latched. 20B
   On the following cycle the PK clutch is energized and the card completes reading at the first brushes. At this time an OUT impulse is available to pick pilot selector 1.
2. R894 (D-PU, pilot selector one) picks through control panel wire from number one first read delay OUT *(Section 20B)*, 224B, 1079-4, CF26. 27A
   R894 holds and causes pilot selector one (R895) to transfer in the normal manner. 27A

MLP CONTROL SUCCESSIVE FEED

THE SUCCESSIVE feed control is available with the Type 403 Accounting Machine only. In normal operation a detail card following an MLP3 card is held at the first reading station until the MLP card has finished printing the first line. This is necessary because the detail cards must print below the MLP listing rather than on the same line with the MLP listing. At times it may be found advantageous to print additional information, such as due date and contract number beside the name in positions not used for MLP printing.

In order to print two cards simultaneously, however, the detail card must follow immediately behind the MLP card so that, as line 2 is being printed from the MLP card at the third reading station, the detail card will be at the second reading station and will print beside line 2. As line 3 from the MLP card is being printed at the fourth station, the detail card

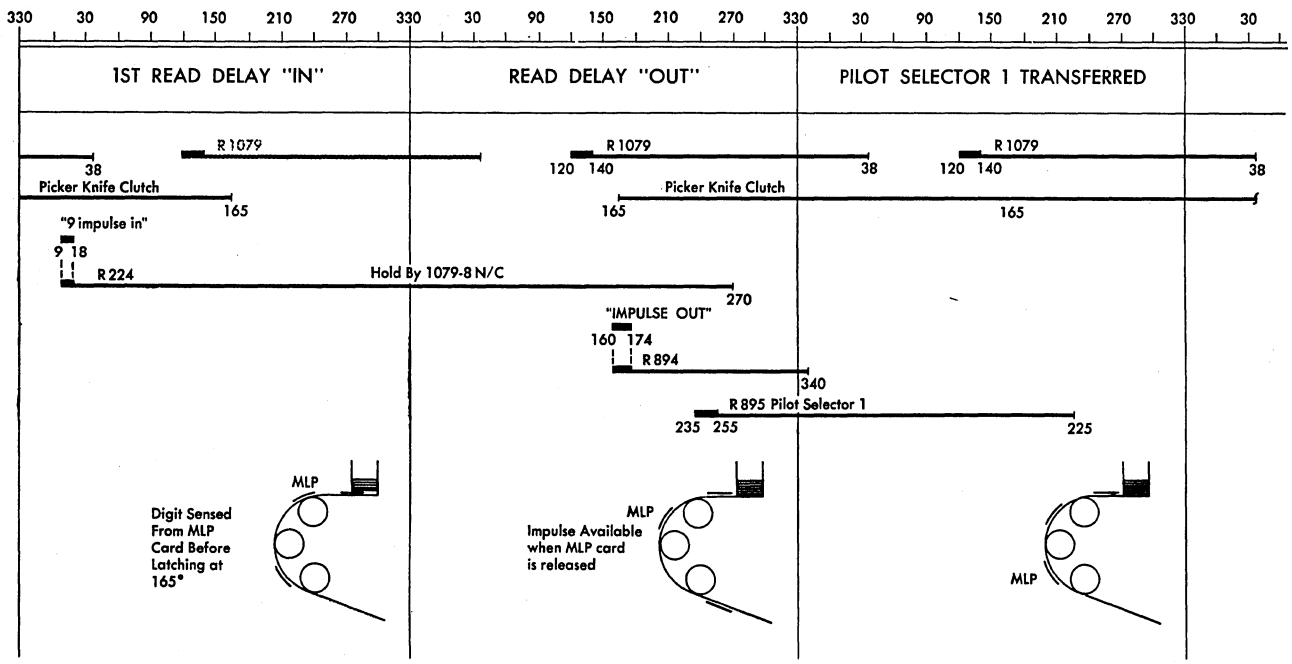


Figure 181. MLP 1st Read Delay

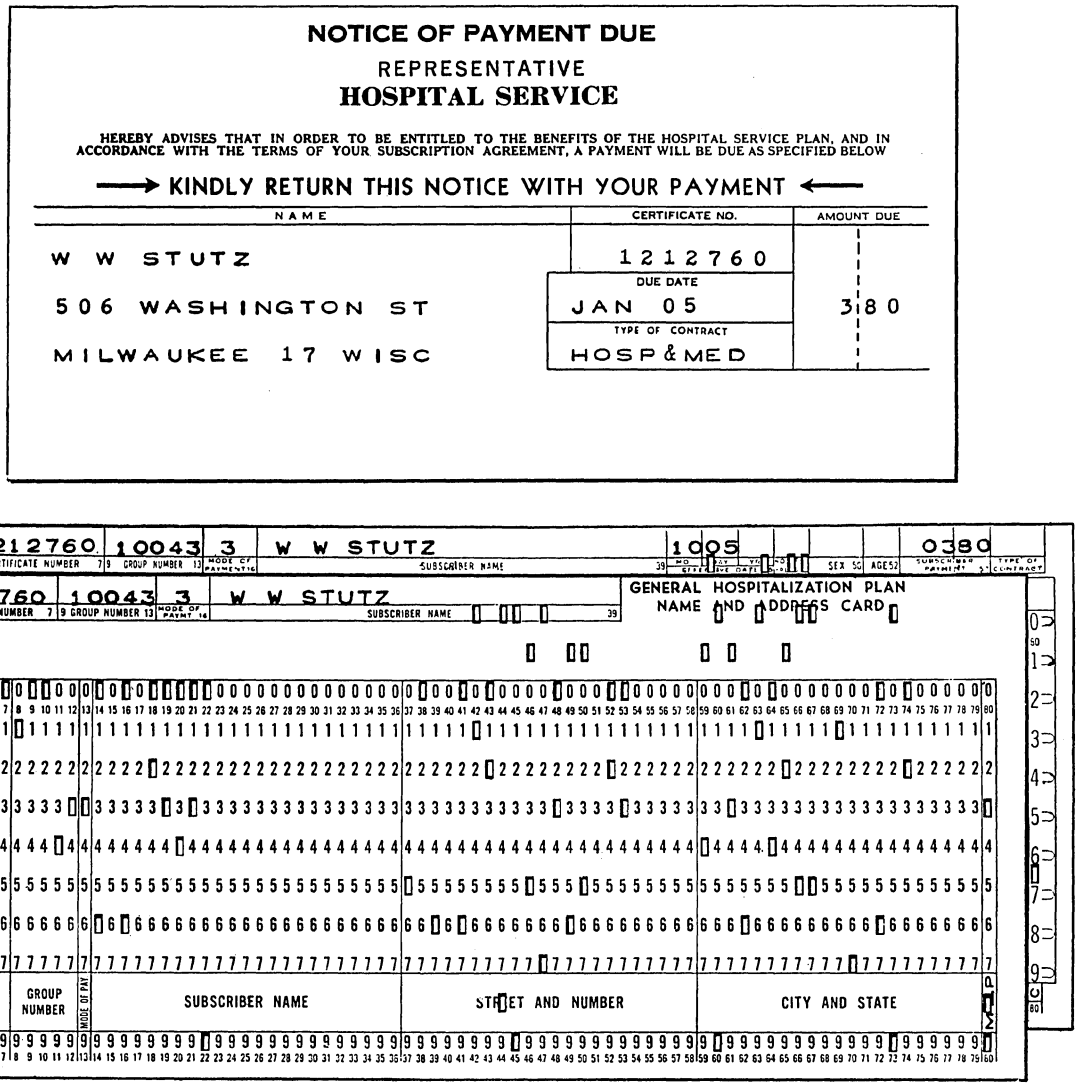


Figure 182. Successive Feed Operation

at the third reading station will print beside line 3 (Figure 182). The certificate number is read from the MLP3 card as it passes the second reading brushes. The month January is read from the digit selector, but the date 05 and the zone for the type of contract are read from the detail card and sensed at the second reading brushes while the MLP3 card is at the third station for the third line of printing, the numerical information for the type of contract is being read from the detail card at the third reading brushes.

In order to accomplish such an operation, the detail card behind the MLP card must be punched with a 6 and wired to the MLP control successive feed hub from the first reading brushes. The 6 may be punched in any column of the detail card including the column used for MLP control.

When successive feed is wired, a comparison is being made between the MLP and the 6 card behind it. With the comparing exit wired to program start, the following internal functions take place:

1. Control is suspended between the MLP card and the following 6 card.

2. When the wrong number 6 card follows an MLP card, the unequal impulse is interrupted before reaching the program start and is directed internally to the machine stop. Thus, the machine stops after the full line prints and the stop light glows.

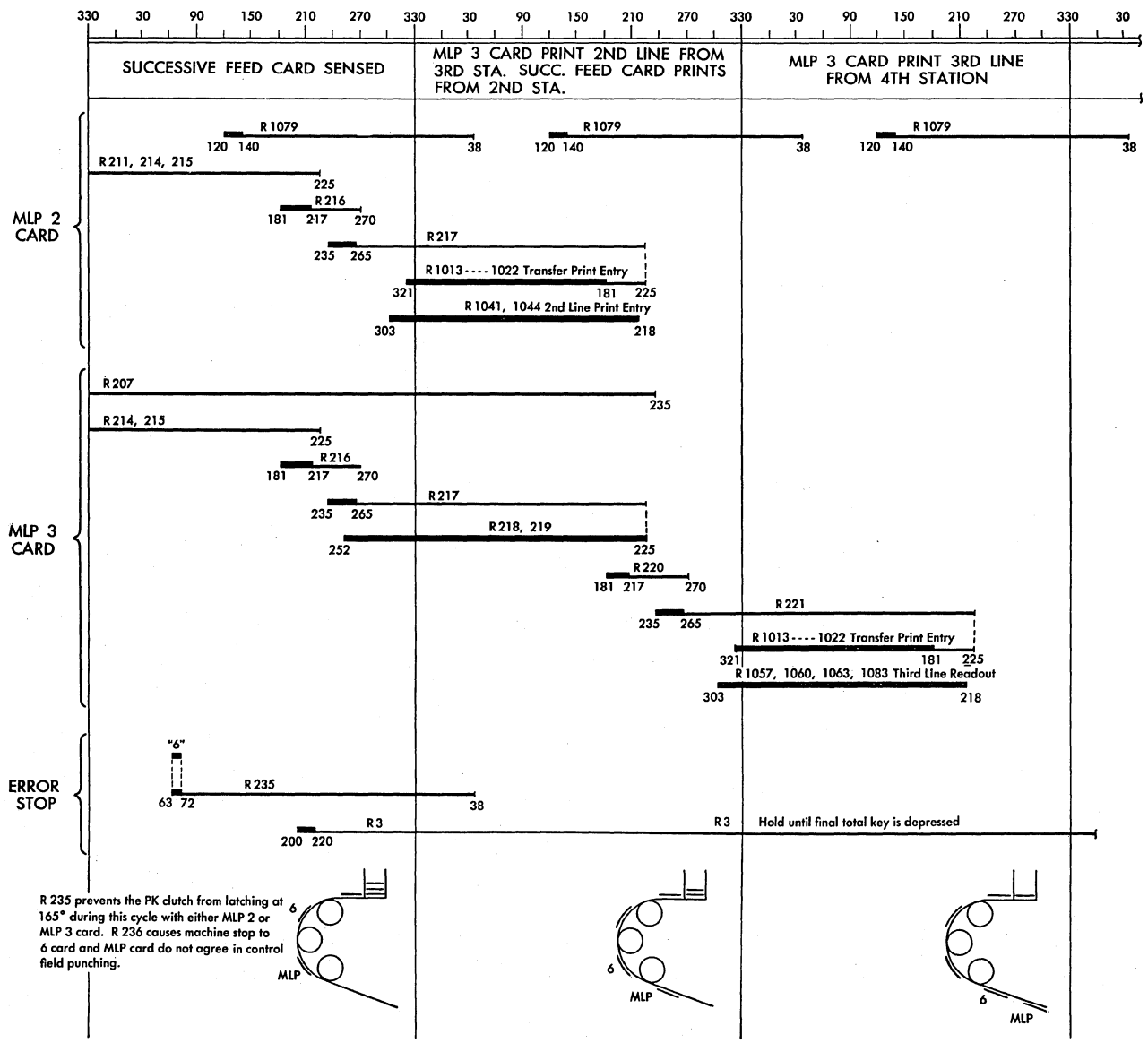


Figure 183. Successive Feed Operation

The sequence chart (Figure 183) shows the position of the MLP card and the normal card punched 6 following it.

OBJECTIVE: To allow a card punched 6 to follow immediately behind the MLP3 ccard and print on the same line. Also, to stop the machine if there is a control change between the MLP3 card and the 6 card.

1. R235 picks through CF37 from a 6 impulse. 23B
   R235 holds and energizes R236 from CF33. 22A
2. R1079 picks through 235AL to prevent holding the 6 card at station 1. 20B
3. MLP control relays are held energized through 235BU, which shunts 1079-8 and CB37. 17A
4. If a control change occurs between MLP3 and the 6 card, circuits are set up to energize the machine stop relay R3. R3 picks through 645-11 N/C, 236BL N/O or 236AL N/O or 236AU N/O, and 235BL N/O from CF5. 32B
   R3 holds and the stop light energizes through N/C final total key contact from L7. 4B
5. R1 and 2 are dropped by 3B to stop the machine.

SINGLE CARD TOTAL ELIMINATION

WHEN THE machine is being operated with the control panel for group printing, the program total will appear on the same line with the group indication.

By additional control panel wiring, a single card group amount may be detail printed and the total cycle eliminated; thus one machine cycle for each single card group may be saved.

In a billing application the heading cards are normally MLP cards, and the control field is sensed as the card passes the first and second reading stations. With SINGLE CARD wired, the hub labeled S emits a card cycles impulse when single cards are passing the third reading station, if the control field is wired for comparing between the first and second reading brushes. The machine recognizes a single card by two successive program changes, as in the following example, if the card were listed:

CUSTOMER NO.	QUANTITY	COMMODITY NO.	AMOUNT
1235	5	476	760
1235	5	476	760
1235	5	476	760
1235	5	479 Ctrl. Chg.	586
1235	5	483 Ctrl. Chg.	493
1235	5	483	493
1235	5	492 Ctrl. Chg.	610
1235	5	492	610

The quantity indicates five pieces, but in this application the cards are pulled from a denominated tub file, in which case the minimum amount sold is five pieces. When 40 are called for, eight cards are pulled, each prepunched with the 5. When a quantity of five is called for, only one card is pulled. Because the commodity number on the single cards differs from the commodity number on the multiple card groups, a minor control change would be sensed, causing a minor program start to set up the total print circuits for program level 1.

If it is necessary to count the number of single-card orders and multiple card orders, an S hub and an M hub are available on the control panel. They may be wired to any hub that will accept a card cycles impulse, and one of the most common uses of these hubs would be to control a counter to add or subtract a 1 from card count.

When the single card switch is wired ON, it is possible to eliminate the total program cycle for single card groups, and the following internal functions are performed.

1. When a single card group is recognized, minor program start is suspended. Any information wired from the single card to the type bars will list automatically.

2. When control is suspended, the first card of the following multiple or single card is group-indicated in the normal manner.

3. If the card of the intermediate group is a single card, the intermediate program is initiated, and the minor program will be suspended. The intermediate program in this case does not force a minor program, because the intermediate program level 2 relays will be energized directly.

4. The S and M hubs are active all the time; however, the single card switch must be wired to cancel program start.

Single Card Total Elimination Wiring

An application of single card elimination is shown by the control panel of Figure 184. The single card switch is wired ON. This causes all single cards to list, and the minor program start to be suspended. However, it does allow the following group to list indicate. Instead of using the card cycles impulse to control the counters, the S and M hubs are used. Amounts from the single cards are added into the intermediate counter by wiring S to 8B plus relay. They are listed from counter 8B exit; and, because multiple card amounts cannot enter 8B from the brushes, no counter exit suppression wiring is necessary. Amounts from multiple card groups are added into the minor counter 8A by wiring M to 8A plus relay.

The total of the multiple card amounts is rolled from counter 8A into counter 8B and added to the total of the single card amounts by impulsing counter 8A to read out and by wiring 8A TRANSFER and SP CONTROL EXIT to counter 8B plus relay.

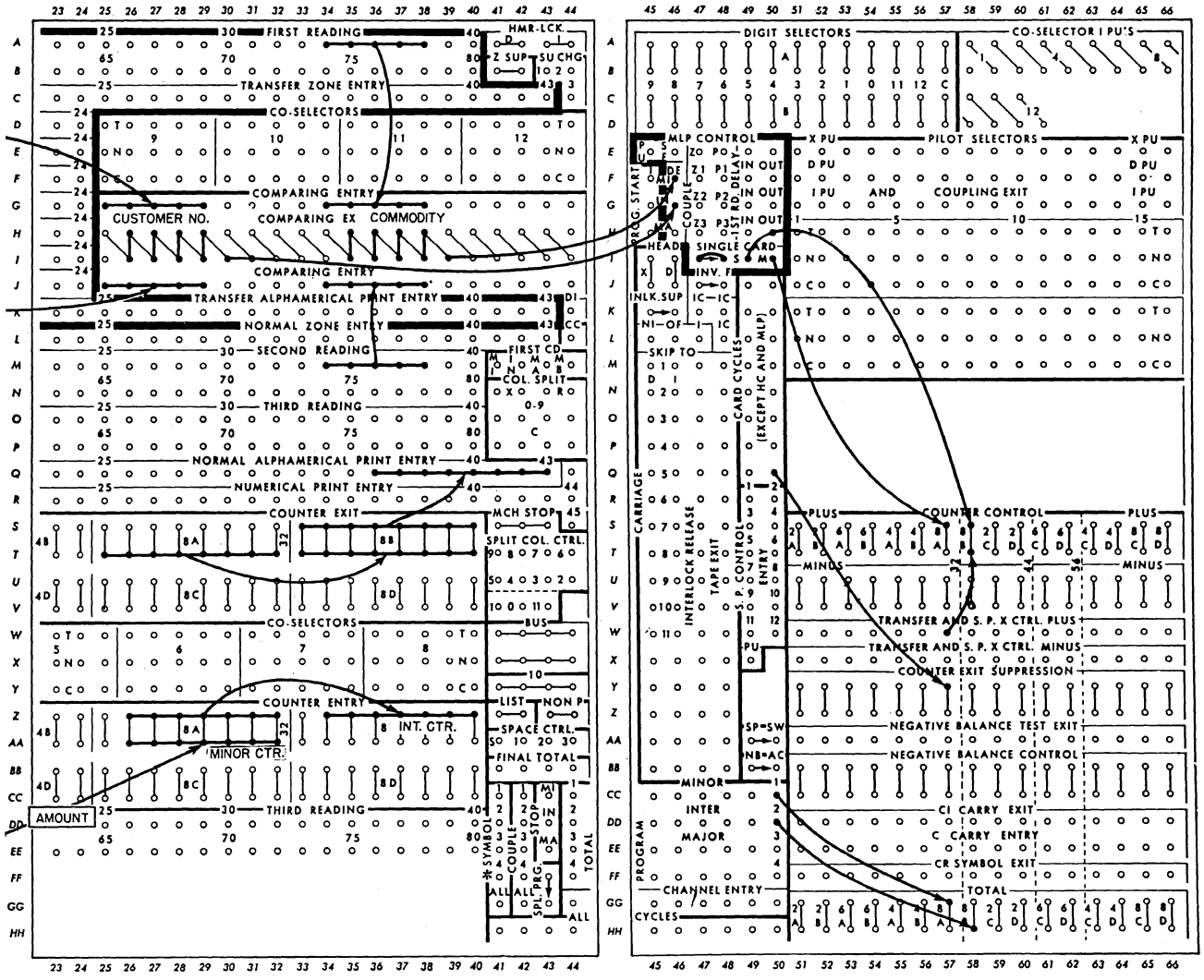


Figure 184. Single Card Total Elimination

PREPARATION: The control panel is wired as shown in Figure 184. The sequence chart of Figure 185 illustrates the step-by-step operation of single card total elimination.

OBJECTIVE: To recognize a single card group and to cause the machine to suppress programming, but to allow for group indication of the next group.

During cycles in which a single card group passes the first and second brushes:

1. R1076 picks through control panel wire by an unequal impulse from the comparing unit. 32A
   R1076 holds from CF36. 32A

During cycles in which a single card group passes the second brushes:

2. R601P2 picks through 1076-2 from CF35. 32A
   R601 holds from CB50 . 32A
3. R1076 repicks from second unequal impulse. 32A
   R1076 holds from CF36. 32A
4. R231 picks through 1076-3 and 601-4 from CB49. 32B
   R231 holds from CF4. 32B
5. R232 picks through single card switch and 231B from CB67. 23B
   R232 holds and energizes R233 from CB42. 24A
6. R609, 612, and 618 pick blocked by 232B. 34A
7. Single card S hub emits an impulse through 231AL from CB's 78 and 79 to add in the intermediate counter and list the card. 35B
8. R16 (MI first card) picks through 601-2 and 233B for group indication of the next group. 32B

If an intermediate program is called for by the single card, minor program level R618 would have been bypassed through 232AL N/O *(Section 34A)* and intermediate level R622 picked directly.

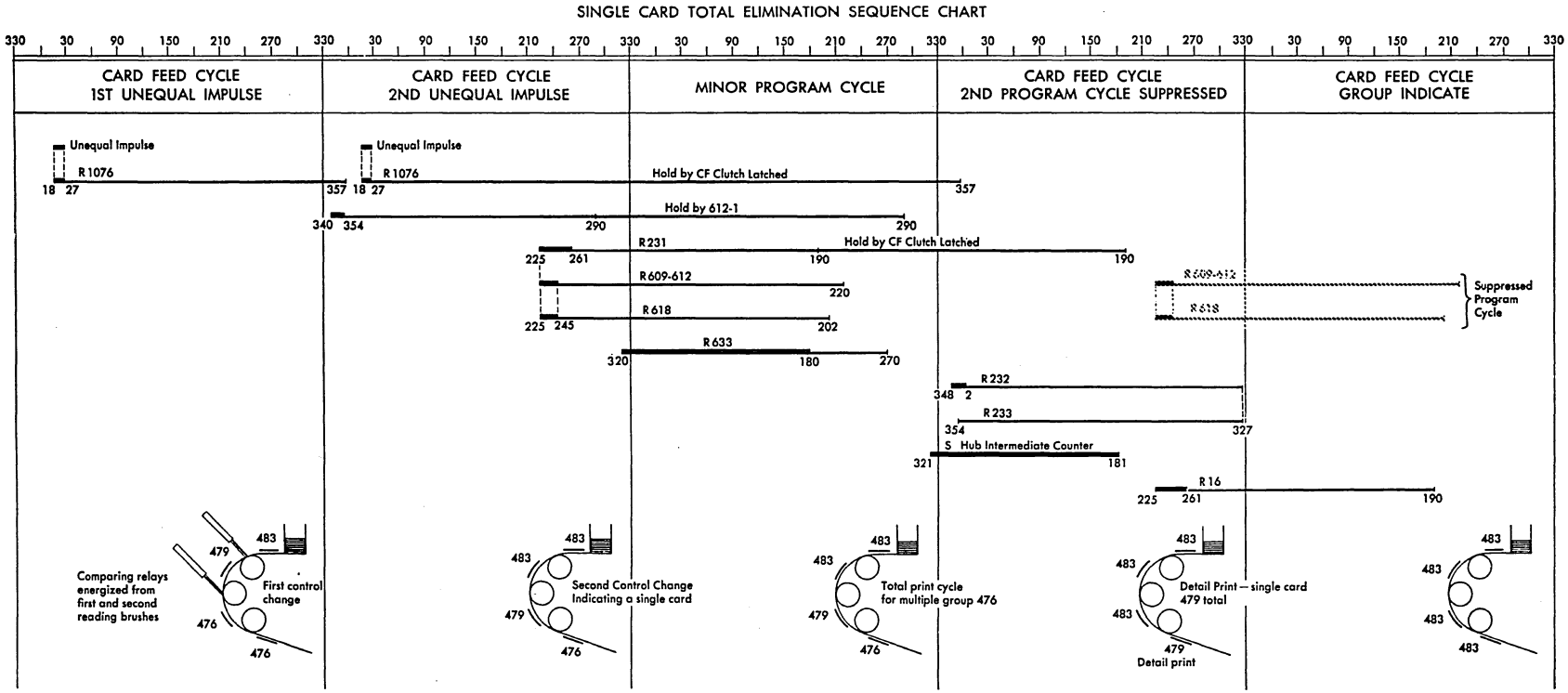


Figure 185. Single Card Total Elimination

PURPOSE OF RELAYS AND CONTACTS

RELAYS

Start Relay 1

R1 picks up normally when feed interlock key or start key is depressed and interlocks are normal.

R1A is a hold point.

R1B permits energization of print clutch and CF clutch control relays.

Start Relay 2

R2 picks up normally with R1 except when a final total is taken.

R2AL completes circuit to CF clutch control relay for normal operation.

R2AU is a hold point.

R2BU completes circuit to the two speed clutch control relay under normal operating conditions.

R2BL prevents zone control magnet and list 79 from being energized by CB19 if R2 hold has been opened because the form stop, stacker stop contact has operated or machine stop R3 energized.

Machine Stop

R3 is energized by an early all cycles impulse through the control panel or is energized when successive feed conditions are incorrect and set up a control change to stop the machine.

R3A is a hold point.

R3B opens a circuit to R1 and R2 hold coils to stop the machine when the relay is energized by means of successive feed conditions or wiring on the control panel.

Summary Punch Card Lever

R4 is controlled by the presence of cards under the card levers in the summary punch when the summary punch switch is ON. When not summary punching and the summary punch switch is not wired, R4 will be energized as long as the main line switch remains on.

R4A. When summary punching is being performed, this contact prevents starting the accounting machine unless a card is in punching position, and in the punch magazine in the summary punch.

R4B causes the summary punch or card feed stop light to operate when the summary punch has run out of cards or a card has failed to feed. During normal operation, the light is on with the passage of each card in the summary punch.

Two Speed Clutch Control

R5 is energized primarily by start point 2BU to complete a circuit to two speed clutch magnets.

R5AL completes circuit to high and low speed control magnets. When it is in a de-energized position, the idling light glows.

R5AU is a hold point.

R5BL completes circuit to final total R65 which prevents taking of final totals except when the machine is not in operation.

R5BU opens the circuit to R60 hold in case the machine on completion of an operation coasts to a point where CB35 would be closed.

Card Feed Hopper

R6 energizes when cards are in the hopper.

R6AL prevents pickup of card lever station relay 3 when the last card is a one-line card at the third station and the hopper is empty during run out.

R6AU must be up to hold R2 and permit automatic operation of the accounting machine and opens hold circuit when cards run out of the hopper.

R6BL insures that cards have been removed from the hopper before the feed interlock key is used to run cards out.

R6BU permits picking up of R78 (non-print run out), when cards are removed from hopper and the non-print run out key is depressed.

Card Feed Hopper

R7 is energized when cards are in the hopper.

R7AL prevents starting of the machine, by means of a feed interlock start key, until cards are first removed from hopper and the remaining cards are run out of the feed.

R7AU is a hold point for R7.

R7BL prevents picking up final total R65 unless the hopper is empty.

R7BU picks feed interlock R62 in conjunction with card lever R12AU and R9AL points if a card has failed to feed from the hopper.

Card Lever 1

R8 picks up from CL1.

R8AL completes a circuit to brushes of first reading station.

R8AU is a hold point.

R8BL allows 9-8, 1-2-3 circuit to multiline control relay 1 only when the card is at the first brush station.

R8BU opens the hold circuit to R2 hold when cards fail to feed.

R9AL, normally closed point, indicates feeding failure in conjunction with hopper R7BU and lower card lever R12AU to pick up R62.

R9AU prevents idle feed tab R234 from being energized after the last card has passed card lever 1, thus preventing suppression of total printing.

R9BL picks R239 on run out when last card is an MLP1 card to cause an immediate pick of R601, P2.

R9BU provides last card program start impulse and last card auto total if LC Auto-Total Switch is ON during run-in and runout.

Lower Card Lever

R10, 11, 12 pick up from card lever 2 or card lever 3 or the 4th station depending upon standard or multiline operation.

R10AL provides an impulse for last card program start or auto total (auto total switch ON) for Type 402 machines.

R10AU is a hold point R10 and pick of R11, 12.

R10BL opens a hold circuit for head control switch R28 when cards are run out of the feed.

R10BU prevents a pick of final total R65 until cards have been cleared from the third reading station.

R11AU provides a circuit for pickup of R13 first card in by normal cards at card lever 3 or on multiline at card lever 2.

R11AL provides a hold circuit for R13 (first card in).

R11BU prevents R638-641 card cycles from energizing and making card cycles impulses available without cards in the machine.

R11BL provides a circuit to third reading or lower brushes when the lower card lever is closed on the Type 402 machine.

R12AU prevents a circuit to R62 pick during a run in of cards.

R12AL provides a circuit to energize list relay R79 and the zone control magnet at the proper card reading time.

R12BU energizes brush isolation relays R500-518 with the Type 402 machine.

R12BL in conjunction with R612-5 and R15BL causes R577 and 662 to energize on the run-in.

R13 is picked up from lower card lever at 348° during the first card read cycle.

R13AL provides a circuit for a "hot 9" impulse to counters for subtraction.

R13AU holds for R13; picks R14, and R15.

R13BL, in conjunction with R13AL, provides a circuit for a "hot 9" impulse to the counter for subtraction.

R13BU prevents the summary punch control R877 from picking on program cycles caused when running cards in; it also prevents summary punching before the first group of cards have been accumulated.

R14AL (see *15AU*) prevents hold circuits for skip relays on program cycles when running cards in.

R14AU prevents machine stop R3 from being energized on run in or until cards are passing third reading brushes.

R14BL makes all skips R567 inoperative unless this relay is energized, indicating that the first card in is ready to be listed.

R15AL provides a hold for non-print run out R78, once energized, until after cards have run out.

R15AU prevents skip operations from initial program cycles during run in.

R15BU keeps feed interlock relay R62, R63 energized when cards are put back in the hopper and until first card is passing third reading position.

R15BL prevents non-print R662, 664 being picked on program cycles after first card in.

Minor 3

R16 picks up during the last program level after a minor control change.

R16AL provides a circuit to the minor first card hub after a minor control break or after last heading card operation.

R16AU is a hold point.

R16BL provides a circuit to double space relay R38, which double spaces first card of next group when listing, except when head control R654 is energized.

R16BU provides a circuit to energize list relay and zone control magnet on a group indicate cycle when list control R660 is not wired on control panel (group printing operation).

Intermediate 3

R17 picks up on an intermediate control change during the last program level.

R17AL provides a circuit to the intermediate first card hub after an intermediate control break.

R17AU is a hold point.

R17BU causes double spacing after an intermediate or major control change.

Major 3

R18 picks up on a major control break during last program level.

R18B provides a circuit to major first card hub after major control break.

R18A is a hold point.

Program Interlock

R19. This relay picks up during program level 1, 2 or 3.

R19AU is a hold point.

R19BL prevents a second impulse to program relay R609-612 and program level 1 or program level 2.

Interlock 1

R20 interlocks the advance from program level 1 to program level 2.

R20A is a hold point.

R20B permits advancing to program level 2 when R618 drops out.

Interlock 2

R21 interlocks the advance from program level 2 to program level 3.

R21A is a hold point.

R21B permits advancing to program level 3 when R622 drops out.

Interlock 3

R22A is a hold point.

R22B permits advancing to program level 4 when R626 drops out.

Interlock 4

R23A is a hold point.

R23B permits return to program level 1 when special program is wired and R630 drops out.

Final Total Control

R24 may be energized by depressing the start and final total key after all cards are out of the hopper and the card feed, and the machine is idling.

R24AL energizes the two speed clutch control relay when taking a final total.

R24AU is a hold point.

R24BL prevents energizing start relay R2 and 25 during the final total cycle.

R24BU N/O completes a circuit to pick up final total relay R665. R24BU N/C completes a circuit to pick R609-612 when CB61 negative balance test is used to cause a program start.

Zone Suppression

R27 picks up from an early all cycles impulse or an X through control panel to prevent zoning.

R27A is a hold point.

R27B opens circuit to zone bail control magnet when this relay is impulsed.

Heading Control Switch

R28 picks up from a head card X or D passing the first or second brushes and remains up until cards run out.

R28AL completes circuit to "skip to 2 R536" when an overflow occurs in a run involving heading cards. With inverted forms, picks skip to 1 R573.

R28AU is a hold point when standard forms are being run.

R28BL completes a circuit to energize skip to two (normal form) when skipping from last heading card line to first detail card line of a form, etc.

Carriage First Card

R31 picks up after spacing time on first print cycle after skipping and is dropped out by a point of all skip relays.

R31AU is a hold point.

R31AL prevents pickup of double space R38 on first print cycle after a skip. (R38 may hold over and give double space on second listed item.)

R31BL prevents a space after a skip before printing or before the first card in has passed the third reading brushes.

R31BU prevents a hold circuit for single, double, or triple space relays until after the first card has passed the third reading station.

Carriage Start

R32 is impulsed by space key or from PM2 under various conditions or CB34 with all skip relay R567 energized.

R32A is a hold point.

R32B, when picked up, times the impulse to the clutch magnet or interposer magnet and furnishes a hold for the carriage restore relay R33. De-energized, it energizes skip end control relay (R51).

Carriage Restore

R33 is energized manually to cause the form to restore to line one.

R33AU is a hold point.

R33AL N/O prevents the normal carriage CB impulse from picking high speed stop 1 and 2, as when spacing; instead it closes the circuit to permit a 1 tape brush impulse to energize high speed stop 1 and 2 if R33 is energized.

R33BU permits skip end R52 and R56 to pick up with R55 and R54 when restoring takes place to de-energize all other skip to controls.

R33BL provides a circuit to energize carriage start R32.

Carriage Stop

R34 is an emergency stop that stops both carriage and accounting machine when the carriage stop button is depressed or a signal fuse blows.

R34AL opens the circuit to start relay R1 hold to stop the accounting machine.

R34BL opens CARRIAGE START R32 hold to stop carriage operation.

R34BU opens the circuit to all SKIP TO relays, etc.; holds when the carriage stop key has been depressed.

Space Suppression

R35. Relay 35 is energized at early all cycles time through the control panel to suppress spacing.

R35AL opens the circuit to carriage start relay to prevent any spacing.

R35AU is a hold point for R35, R36 pick.

R35BL prevents overflow operation until the space suppress cycle is completed.

R35BU opens the hold circuit to double- and triple-space relays as space suppression takes precedence over any other setup.

Single Space

R37 picks up from the early all cycles impulse.

R37AL provides a circuit to energize carriage start R32.

R37AU is a hold point.

R37BL provides a circuit to high speed stop relays R54, 55 to supersede an internal double space as may be called for by R38BU.

Double Space

R38 picks from early all cycles impulse.

R38AU is a hold point.

R38AL provides a circuit to energize carriage start R32.

R38BU prevents stopping for a normal single space and also provides a pickup circuit for R40 space interlock. In addition it holds R38 energized for the duration of the carriage circuit breaker impulse while the regular hold for R38 is opened by R40B.

Triple Space

R39 picks up from an early all cycles impulse.

R39AL is a hold circuit.

R39AU. The normally closed points provide a temporary hold for R38 during double space. The normally open points permit the picking up of R38 from triple space operation.

R39BL completes a circuit to carriage start R32.

R39BU. The normally closed point completes the stop circuit for double or single space and prevents stopping taking place when triple space is called for. The normally open point picks triple space R39, which acts as a hold for the duration of the carriage CB, and also picks R38PU and triple-space interlock R57.

Space Interlock

R40 picks up on first space of a double space operation or the second space of a triple space operation.

R40A is a hold point.

R40B opens the circuit to R38 hold coil when carriage CB closes, thus permitting R38PU to drop out when CB opens.

Skip to 3 through 11 Control

R41 picks up when a skip is called for, column 3 to 11 inclusive.

R41AU is a hold point.

R41AL opens the circuit to high speed stop relay R54, 55 from brush 2 when skip to 3 through 11 has been called for.

R41BL. The normally closed points open in the skip to one stop circuit. The normally open points complete a circuit to skip past 1 R580 from tape brush 1.

R41BU opens to allow skip to 3 to 11, called for by the card, to take precedence over the regular skip to 2 which would take place on overflow non-indicate.

Overflow Brush

R43 and 44 pick up from brush 12 in the carriage.

R43A holds for R43 and picks for R44.

R43B completes circuit to OF hub when overflow occurs.

R44AL permits energizing overflow brush control R45 during a detail printing, program stop, or total elimination.

R44AU opens to prevent the operator from circumventing overflow interlocks on overflow by wiring OF to SKIP TO 1 and obtaining high speed carriage operation.

R44BU prevents the interposer magnet from energizing on an overflow operation and forces slow carriage speed.

R44BL prevents an interlock release R50 from energizing during an overflow.

Overflow Brush Control

R45 is picked up on an overflow during a detail printing, program, or total elimination operation.

R45AU is a hold point.

R45AL provides circuits to pick up overflow control indicator R568 when wired.

R45BL provides a circuit to pick up overflow control non-indicate R570 when wired.

Overflow Indicate Cycle

R46 and 47 are picked up at the end of skip to 1 when indicating on an overflow.

R46AU is a hold point.

R46AL prevents a second impulse to all skips R567 on an overflow indicate cycle.

R46BL provides a circuit to skip to 2 after line 1 is printed when wired for overflow indication.

R46BU prevents card cycles relays R638, R641 from energizing during an overflow operation to prevent pick of plus and minus relays, etc.

R47AL completes a circuit to print clutch control relay R659 to cause printing of the position indicated by the punch in channel 1 of the carriage tape.

R47AU provides a circuit to IC outlet hub.

R47BU provides a circuit to IC outlet hub.

R47BL provides a circuit to IC outlet hub.

Inverted Form

R48 and 49 are picked up through a control panel switch.

R48AU transfers skip to 2 impulse for normal cards to skip to 1 with or without indication for inverted forms.

R48BU reverses connections from skip to 1, to skip to 2 when overflow control indication takes place for inverted forms.

R48AL provides a circuit to skip to 2 when passing from detail to heading cards with inverted forms.

R48BL opens to prevent a conventional heading to detail skip to 2 pickup circuit with inverted forms.

R49AL transfers so that brush 2 instead of brush 1 now energizes R46 on an overflow indication cycle with inverted forms.

R49BL transfers to pick the head control switch as long as cards are in the machine with inverted forms.

Interlock Release

R50 picks up when a skip of less than 3-2/3" is about to be made if the control panel is properly wired.

R50A is a hold point.

R50B shunts all skip points to permit an impulse to card feed clutch relay R656 when any skip to be made is less than 3-2/3".

Skip End Control

R51 picks up when carriage start relay drops out.

R51B opens hold circuit to skip end relays R52 and R56 to provide a delayed dropout to insure that the skip to relays will be fully de-energized.

Skip End

R52 picks up with high speed stop relays after a restore or skipping operation.

R52A is a hold point.

R52B breaks the hold circuit to all skip to relays and skipping control relays on completion of the skipping operation.

Form Stop

R53 remains energized while there is sufficient paper in the carriage.

R53A holds R53 energized until 155° of a print cycle after paper has run out. Through L PM3 when detail printing or until R609-6 opens when group printing. The normally closed point lights an indicator light.

R53B opens a hold circuit for start relay R2 when there is no paper in the carriage.

High Speed Stop 1

R54 receives an impulse timed by the carriage CB to stop the carriage operation.

Contact 54 opens the circuit to the clutch magnet.

High Speed Stop 2

R55 high speed stop 2 (same as 54).

Contact 55 opens hold circuits to carriage start, single space, etc., relays.

Skip End

R56 is energized with skip end relay R52.

R56 provides a hold circuit for R52, R56 until R51B opens.

Triple Space Interlock

R57 is energized when the carriage circuit breaker closes for the first time on triple space operation.

R57A is a hold point.

R57B opens the hold circuit to triple space R39 on the first of the three carriage circuit breaker impulses.

Single Space

R60 picks on every carriage clutch magnet operation.

R60A is a hold point.

R60B N/C points allow carriage start R32 to be energized with the space key. R60B N/O provides a hold circuit and prevents R32 from being impulsed a second time if the space key is held depressed.

Feed Interlock 1

R62 picks up when a card fails to feed.

R62AU is a hold point.

R62AL, when energized, makes the start key circuit inoperative and provides an alternate circuit to energize start relay 1 under control of feed interlock start button.

R62BU provides a pickup circuit for feed interlock 2 R63.

R62BL prevents a control change for MLP1 card and successive feed cards when a card fails to feed and there is a bare contact roll.

Feed Interlock 2

R63 and 64 pick up when the last card passes the last reading station.

R63AU holds R63 and picks and holds R64.

R63AL opens a circuit to all cycles R635 and card cycles control relays R638, R641.

R63BU provides a circuit to pick exit suppression R577.

R63BL opens a circuit to R609-R612 preventing programming on run out and run in of cards with the feed interlock push button.

R64A provides a circuit to run cards into the feed when restarting the run and the cards have been returned to the hopper.

R64B provides a space for the first listed item when rerunning cards; establishes a shunt circuit around PM8 to energize R31.

Final Total

R65 picks up from the final total key if the hopper is empty, if cards have been run out, and if machine has stopped.

R65A transfers the circuit so that when start key and final total key are both depressed, the final total control relay R24 is picked up.

Feed Interlock

R66 picks with R62 hold to provide additional points and it is energized when a card fails to feed.

R66AL. When a card fails to feed, the cards are run out by use of the feed interlock push button; this would result in dropping R10 and opening the R10BL points in R28 hold circuit. R66A prevents the head control switch R28 from de-energizing under these conditions.

R66AU prevents mistaken use of non-print run-out key for feed interlock start key.

R66BL lights the card feed stop (summary punch) light when a card fails to feed.

Hammerlock 1

R76 can be energized from control panel by any impulse.

R76A is a hold point.

R76B provides a circuit to energize R77.

Hammerlock 2

R77 picks up from R76 or an early all cycles impulse through control panel wiring.

R77A is a hold point.

R77B provides a circuit to the hammerlock magnet.

Non-Print Run Out

R78 is picked up by non-print run out key.

R78AU is a hold point.

R78AL provides circuit for card feed clutch control R656 to run out cards.

R78BL provides a circuit to pick exit suppression R577.

R78BU provides a circuit to energize two speed clutch control relay R5.

List Relay

R79 picks up to control printing.

R79AL closes the circuit to the print clutch magnet when listing.

R79AU is a hold point.

R79BL prevents energizing speed change relay R82 during printing operations.

R79BU causes carriage start R32 to energize when detail printing or group indicating.

Idle Cycles (See R648)

R80 picks on idle cycles.

R80AL prevents testing for a negative balance during idle cycle.

R80AU prevents carry operation during idle cycle.

R80BL and R80BU prevent emitting a 9 impulse to counter start magnets during idling cycle. (Might be double-wired minus and SP entry from transfer hubs.)

Non-Print Run Out

R81 picks with R78H after cards have been removed or run out of the hopper and the non-print run out key is depressed.

R81AU is a hold point.

R81AL prevents program R609-R612 from energizing when the non-print run out button is depressed.

R81BL prevents minor 3 R16, intermediate 3 R17, and major 3 R18 from being energized if a control change takes place when the non-print run out button is used.

Speed Change

R82 controls 2 speed clutch.

R82A is a hold point.

R82B, when energized, transfers circuit from the list speed magnet to the high speed control magnet.

Punch Bus Interlock

R83 to R85 pick up during conversion cycle. The points transfer the counter emitter segment commons from the summary punch emitter to the CB's emitting the conversion digits.

Summary Punch Switch

R86 picks up from a wired switch on the control panel.

R86AL prevents picking up R877 unless the switch is wired on.

R86AU, in conjunction with CB77, will provide a hold for R86 and keep it permanently energized when the customer controls the summary punch switch R86 through a pilot selector under the control of a setup change switch. The setup change switch energizes the pilot selector from 235° to 265°. The pilot selector holds through CB44 until 225°, and CB77 provides a hold for R86 from 210° to 295°, thus preventing R86 from de-energizing until the setup change switch is turned off. This prevents any change in the control of R4 and, in turn, R1. It also keeps R22 in the Type 513 energized.

R86BU and R86BL, when off, keep R4 picked up continuously to provide running interlocks for the accounting machine; when on, provide power to interlocks I1, I11, I12 to summary punch connector.

Summary Punch End

R88 signals the end of the summary punching operation.

R88AU is a hold point.

R88AL prevents impulsing summary punch control R877 a second time for any program level while the summary punch end R88 is up.

R88BU interlocks the restarting of the summary punch to prevent more than one card being summary punched.

R88BL drops out summary punch relays at the end of summary punch cycle.

Comparing Relays

R111-R150 pick up from controlling field of cards.

R111A-R150A are hold points.

R111B-R150B operate in conjunction with its counterpart to detect unequal impulses.

MLP Control 1

R201 picks up from the 9 code of an MLP card.

R201A is a hold point.

R201B provides a circuit to pick 202 if an 8 code punch appears with a 9.

MLP Control 2

R202 and R203 pick up from an 8 code if preceded by a 9 in the same card.

R202A holds for R202 and picks for R203.

R202B provides a circuit to pick up relays indicating the type of MLP card.

R203A declutches all MLP cards (unless preceded by a 1-line card punched 9-8-1 or unless the MLP card is a 1-line card punched 9-8-4).

MLP Control 4

R204 and R205 pick up from MLP4 card.

R204A is a hold point for R204.

R204B opens circuit for 3-and 2-line setup relays R206, 208 and first line zone control R1072.

R205AL provides a circuit for MLP4 station 2 relay R210.

R205AU is a hold point for 205.

R205BL delays energizing head control relay 1 cycle for MLP4 cards and also R28 first time.

R205BU prevents declutching a 1-line (4) card at station 1.

3-Line Setup Relay

R206 picks from a 3 MLP card.

R206A is a hold point.

R206B provides a circuit for 3-line control relay R207.

3-Line Control Relay

R207 picks up from 3-line setup relay R206B.

R207AU is a hold point.

R207AL permits MLP control relay progression for MLP3 cards. Provides a circuit for zoning the second line of MLP3 by energizing R214, 215. Opening the N/C points prevents R212 pickup during 3-line operation.

R207BL opens the PK control relay R1079 circuit, when a 3-line card is zoning the second line.

R207BU provides a circuit for zoning the 3rd line of MLP3 by energizing R218 and R219.

2-Line Setup

R208 picks from a 2 hole in the MLP card.

R208A is a hold point.

R208B provides a circuit for 2-line control relay R209.

2-Line Control Relay

R209 picks up from 2-line setup.

R209A is a hold point.

R209B provides a circuit for picking the 2nd line zone relay R214 and R215 for an MLP2 card. N/C points, in opening, prevent R212 pickup.

MLP4 Station 2

R210 picks from MLP4 control.

R210AU is a hold point.

R210AL picks 2nd line zone relays R214, 215 for an MLP4 card.

R210BU delays dropout of head control read relay R650 while MLP4 is in second station.

R210BL when an MLP3 card is followed by an MLP4 card and the MLP3 is passing the 4th station, R221 is energized. At this time the MLP4 card will be passing the 2nd reading station and R210, R214, R215 will be energized. R210BL shunts R214AU N/C so that a circuit from R221AL will cause R1063, R1083 to pick with R1057 and R1060. This will provide the read-out circuit for the MLP3 card at the fourth station.

MLP Second Station

R211 picks up when MLP1, 2, or 3 card is at second station.

R211AU is a hold point for R211, provides a pickup circuit for R212 or R214 and R215.

R211AL picks up transfer print entry relays R1013, R1016, R1019, and R1022.

R211BU completes a circuit to hub P1 (first line print entry).

1-Line Card at 2nd Station

R212 picks up from MLP 2nd station relay point for 1-line card only.

R212AL closes to prevent declutching MLP cards at station 1 if preceded by an MLP1 card (1) at station 2.

R212AU picks R213.

R212BL picks idle feed tab relay R234 when the following card is an MLP4 card or normal card.

R212BU picks R239 when the MLP1 card (1) is followed by an MLP1, 2, or 3 card to force a control break on the same cycle as initiated by unequal impulse.

1 Line 3rd Station Transfer

R213 picks from 1-line card at second station to control 1-line card run out.

R213A is a hold point.

R213B opens pickup circuit of card lever 3 relays R10-11-12-223, as last 1-line card runs out of the feed and completes the circuit if followed by an MLP4 card at the

second card lever to keep R10-11-12 energized until the MLP4 card passes the third reading station.

Second Line Zone Control

R214-R215 pick from MLP 2nd station point or MLP4 2nd station point.

R214AU N/C *(Section 19B)* provides a pick circuit R1063-1083 to cause the storage counters to reset for the MLP3 card at the fourth station. R214 N/O provides a pick for R1063-1083 in conjunction with R240A to cause the storage counters to reset to zero before accepting the numerical information for the third line of MLP3 cards only.

R214AL causes a card to remain at 1st station one more cycle if it is preceded by an MLP3 card.

R214BL picks for 2nd line zone entry R1027, R1030

R214BU picks 3rd station transfer R216.

R215AL allows successive feed R235 to be energized when an MLP card is followed by a normal card punched 6 and wired to the MLP successive feed hub so that the information in normal card may print on the second line with the MLP card.

R215AU provides a pick for transfer zone entry R1001, R1004, R1007, and R1010 with MLP2 cards.

Third Station Transfer

R216 picks up from 2nd line zone control R-214BU.

R216A is a hold point.

R216B picks for MLP 3rd station relay R217.

MLP 3rd Station

R217 picks up from 3rd station transfer R216B.

R217AU provides a pick circuit for transfer print entry R1013, R1016, R1019, R1022.

R217AL is a hold point for R217 and provides a circuit to 3rd line zone control relays R218, R219.

R217BU provides a pick circuit for 2nd line print entry R1041, R1044.

R217BL causes 2-line control relay R209 to de-energize.

Third Line Zone Control

R218-R219 are energized through R207BU 3rd line control point to delay controlling as a 3-line card passes the 3rd reading brush station.

R218AU picks up transfer zone entry relay R1001, R1004, R1007, and R1010.

R218AL prevents the program start delay circuit R1076, R1077, and R1078 from causing a control change until after the MLP3 card is past the third station.

R218BU picks up 3rd line zone entry relay R1034, R1037.

R218BL provides a pick circuit to 4th station transfer R220.

R219AU prevents breaking the hold circuit of the delay control relays R1076, R1077, and R1078 until after the 3rd line print cycle has started.

R219AL, in conjunction with R207BL, prevents the PK control R1079 from picking up for the 2nd latched cycle of an MLP3 line card if it is followed by a second MLP3 card.

R219BU provides a circuit to the third line print entry R1051, R1054, R1056, and R1069.

Fourth Station Transfer

R220 is picked by 3rd line zone relay R218BL.

R220AU is a hold point.

R220AL picks MLP 4th station relay R221.

R220B keeps the lower card lever relays R10, R11, and R12 energized during passing of MLP3 card through the fourth station.

MLP 4th Station

R221 is picked by 4th station transfer point R220AL.

R221AU is a hold point.

R221AL picks 3rd line read-out relays R1057, R1060, R1063, and R1083.

R221BU picks transfer print entry relay R1013, R1016, R1019, and R1022.

R221BL opens hold circuit of 3 line control relay R207.

Card Lever 2

R222 is energized when cards move past card lever 2.

R222AU is a hold point.

R222AL prevents feed interlock 2, R63, from picking up normally except when a card has failed to feed and cards are being run out.

R222BU provides last card program start impulse on Type 403 machines on runout and run-in.

R222BL completes a circuit to 2nd reading brushes.

Card Lever 3

R223 is energized when a card moves past card lever 3.

R223AU is a hold point.

R223AL completes a circuit to the 3rd reading brushes.

R223BL completes a circuit to brush isolation R500-518 after cards have reached the 3rd card lever.

1st Brush Digit Delay

R224, when energized, transforms any digit impulse fed into D IN hub to a pulse approximately at zero time which is emitted from the OUT hub.

R224A is a hold point.

R224B closes the circuit to the OUT hub.

R225, R226, R227. Same as R224.

Head Control Digit Delay

R228 permits the head control read circuit to be established from a digit.

R228A is a hold point.

R228B picks head control relay R650 pickup 2.

Card End Transfer

R229 picks up each normal card cycle and when no MLP card is being zoned from first brush station.

R229A is a hold point.

R229B N/C allows card end relay R1082 to energize with MLP cards 1-2-3. On normal card cycles, card end relay R1082 picks through R229B N/O and also prevents impulses to the Z1 hub.

1-Line Skip

R230 is energized during MLP idling cycles.

R230A is a hold point.

R230B. During idle feed high speed cycles PM11 will not turn because idle feed tab R234 is energized and causes the non-print R662-2, R662-3 points in the print clutch circuit to open. R230B completes the circuit to skip to 2 under these conditions.

Single Card Group

R231 is energized if both the minor program start delay R1076 and regular minor 2 R601 are picked.

R231AU is a hold point.

R231AL controls the exit impulse from the S or M hub depending upon single or multiple-line groups. The detail use of these hubs is explained under single card total elimination.

R231B provides a circuit to pick total elimination R232 when the control panel single card hub is wired.

Total Elimination

R232 will be energized on single card groups if wired on the control panel.

R232AU provides a hold for R232 and pick for R233.

R232AL. Transferring this point permits skipping of program level 1 on intermediate and major control changes.

R232B. Opening this contact prevents programming for a minor control change *only.*

R233A insures that overflow brush relay R45 is picked when an overflow is sensed at the same time that a single card group is printed on a detail or a group printing operation.

R233B permits a group indication cycle after a list cycle which is a result of a single card group being recognized.

Idle Feed Tabulate

R234 is energized when an MLP1 card is followed by a normal card and provides an

idling cycle while the zone is being read from the normal card at second reading brushes.

R234AU is a hold point.

R234AL opens a circuit to all cycles R635 and card cycles relays R638, 641.

R234BL opens to prevent list R79 from energizing and causing the print mechanism to operate during an idle feed tabulate cycle.

R234BU provides a circuit to energize R230 1-line skip control. (See R230.)

Successive Feed

R235-236 is picked from a six impulse in the card wired to the successive feed control panel hub.

R235AU is a hold point for R235 pick of R236.

R235AL allows PK control relay R1079 to energize. This prevents declutching of the picker knives when a successive feed card follows an MLP3 card to permit both cards to print simultaneously.

R235BU provides a shunt around CB37 to prevent the dropping of the MLP setup relays when a successive feed card follows an MLP card and R1079-8 would be open.

R235BL permits immediate machine stop before printing when successive feed card does not agree with the MLP card in the control field punching. Also cuts off regular impulse from CF35 to the control relays and provides an earlier impulse from CF5 at 200° to 220°.

R236AU-236AL-236BL transfers the early impulse from the control relays to the machine stop relay R3.

R236BU prevents picking of card end R1082 during passage of the successive feed card.

Multiline Cycle

R237 is energized through a transfer zone entry point.

R237AU is a hold point.

R237AL opens the circuit to the card cycles R638 during multiline print cycles.

R237B provides a circuit to list relay R79 when a multiple-line card is printing and the control panel is wired for a group printing operation (tab).

PK Clutch Interlock

R238 picks through R1079-6 point to provide a circuit to the first reading brushes when the PK control R1079 is not energized for the full reading cycle.

R238A is a hold point.

R238B provides a shunt around the points R1079-11, R1079-12, to the first reading brushes from 306° to 162°.

1-Line Control Change

R239 picks when an MLP1 card is followed by any MLP card, as R212BU will be closed on an MLP9-8-1 signal punch only.

R239A is a hold point.

R239B permits immediate control change when an MLP1 card is followed by another MLP card and the unequal impulse is wired to program start delay minor, intermediate, or major control panel hub.

3-Line Control

R240 is energized with R207 3-line control to provide a pick circuit for R1063-R1083.

R240A provides a pick circuit in conjunction with R214AU for R1063-R1083. Its purpose is to open R1083-1 to prevent an impulse from transfer and SP X control during multiline operation since the hub may be wired for use with normal cards only.

Zero Elimination

R246 to R269 pick when digit entry is made into the counter as the 3rd line numerical listing of an MLP3 card is stored.

R246A is a hold point.

R246B, when closed, provides a circuit from the 9-10's brush touching on the 10 side when the storage counter clears for the 3rd line numerical listing of an MLP3 card. Unpunched columns of the alphabetic field, such as spaces between initials or words, will not cause R246 to 269 to energize. Therefore, the R246 to R269B points will remain open and prevent a normal zero in the counter from emitting an impulse.

Plus Relay

R401 is energized with a late all cycles impulse through a pilot selector on control panel.

R401-1,2, when in the N/C position, allow the counter to be reset to zero on program cycles and permit printing of minus cards; when in the N/O position, allow the counter to accumulate on the impulsing of the start magnet and permit printing of plus cards.

Minus Relay

R402 is energized with a late all cycles impulse through a pilot selector on control panel.

R402-1,2, when in the N/C position, allow the counter start magnet to be energized when adding cards; when in the N/O position, will provide a circuit for a "hot 9" impulse to start magnets when subtracting.

R402-3,4, when in the N/C position, allow the counter start magnet to be impulsed when adding and also permit printing of plus cards; when in the N/O position, provide the circuit to impulse the stop magnet when subtracting.

R402-5 provides a circuit to counter credit symbol exit hub with a 10 impulse on minus card operation.

Total

R403 is picked by an early and late all cycles impulse through control panel wiring or by internal wiring for the 3rd line read-out of MLP cards.

R403-1 is a hold point. Its only purpose is to prevent carry on total cycles.

R403-2 provides a circuit for the 10 impulse from the credit symbol exit hub on a total cycle when the counter has a negative balance.

R403-3 provides circuit for a late all cycles impulse from plus or minus transfer and summary punch X control hub depending upon recognition of a negative on total cycle. It also provides an impulse through summary punch control entry on the control panel to summary punch an X for debit or credit punching.

R403-4. With these points closed, an early impulse may test the counter for a negative balance through control panel wiring from negative balance test to negative balance control.

R403-5,6, in the N/C position, provide a circuit to the start magnet when adding or for a "hot 9" impulse when subtracting; in the N/O position, provide a circuit for a 10 impulse to the start magnet on total cycles.

R403-7,8, in the N/C position, provide a circuit for the carry impulse when adding and subtracting; in the N/O position, provide a circuit from counter 10's brush to the stop magnet leaving the counter at zero and to the counter exit hub for total printing.

Exit Suppression

R406 relays are energized through the control panel from a card cycles or first card cycles impulse to suppress listing and through points of R1063 during the read-out cycle of MLP3 cards.

R406-1 is a hold point.

R406-2, when open, suppresses the credit symbol when the counter exit is also suppressed.

R406-3,4 opens a circuit to counter exit hub on the control panel. One application on which it is used is double balance.

Negative Balance

R407 is energized from the negative balance test hub of a counter having a complement figure at negative balance test time.

R407-1 is a hold point.

R407-2 provides a circuit to pick the correction relay R671.

R407-3 provides a circuit to the credit symbol exit hub if the counter on test was a complement at total print time.

R407-4 controls selection of plus or minus transfer and summary punch X control hub depending upon the counter at negative balance test time.

R407-5 provides a circuit to conversion cycle relay R878 to perform conversion.

R407-6 opens as soon as the machine recognizes that a conversion cycle must take place and delays starting of the summary-punch cycle.

Carry

R485-R488-R491 are picked up on each machine cycle except when idle cycle relay R80 is energized.

R485-1. The N/C point completes circuit to the counter start magnet for adding, to the 9 impulse for subtraction, to the 10 impulse for totals. The N/O point places the start magnet in the 9-10's brush carry circuit depending upon the amounts accumulated in the counter.

Summary Punch

R494 is picked up through the summary punch control point to start the summary punch.

R494-1 is a hold point and provides a circuit to interlock I4 and one cycle control relay in the summary punch.

R494-2 completes a circuit to start the summary punch.

R494-3 opens a circuit to the print clutch R659 and card feed clutch control relay R656 of the accounting machine during the summary punch cycle.

R494-4, 5 prevent back circuits through counter plus and minus relays when summary punching.

R494-6, 12 transfer the transfer and summary punch X control hubs from the total print circuit to the summary punch X impulse interlock.

Negative Balance Test

R497 is energized any machine cycle when a control change is recognized except on idling cycles when R80 is picked. If the control panel is wired for negative balance-all cycles, a test will be made every machine cycle except when R80 idling cycles relay is picked. Its purpose is to test for a complement in a counter by checking the counter emitter brush in the high order position to see if it stands at 9.

R497-1,7 provide a circuit from counter emitter common to negative balance test. Hubs 2 through 7 serve their individual counters.

R497-8,9 transfer the 9 counter emitter circuit from the summary punch bus circuit to a circuit for a negative balance test impulse at 258°.

Brush Isolation

R500-R518 energize every card feed cycle to isolate the third reading brushes from the bare contact roll to prevent back circuits and improve dropout conditions of certain relay and magnet combinations.

Zone Magnet Isolation

R521-R530 pick up each card feed cycle at zone time. The relay points isolate the zone magnets when they are not being impulsed.

Skip to Control 1

R535 is picked up by any digit from the first or second brushes.

R535-1 is a hold point.

R535-2 provides a circuit to pick R573 on the next cycle.

Skip to 2

R536 is picked up from control panel skip to 2 immediate hub or internally through the overflow control non-indicate point R570-3 as well as by a combination of R654-5 and R651-7 points.

R536-1 is a hold point.

R536-2 pick R567 all skips relay and open skip 3 to 11 to control R41 circuit.

R536-3 provides part of a circuit to energize interlock release R50 when the tape brush reaches a hole punched in column 2 of the tape.

R536-4 provides a circuit to energize past 1 relay R580 when skip to 2 is called and an impulse is received from tape brush one.

R536-5 prevents the normal stopping of the carriage and allows brush two to pick the high speed stop 1 and 2, R54, R55 through the N/O R580-2 points.

Skip to Control 2

R537 is picked up by any digit from the first or second reading brushes.

R537-1 is a hold point.

R537-2 provides a circuit to energize skip to 2 R536 on the next cycle.

Skip to 3

R538 is picked up from the control panel skip to 3 immediate hub.

R538-1 is a hold point.

R538-2 provides a circuit to all skips relay R567 and skip 3 to 11 to control R41.

R538-3 provides part of the circuit to energize interlock release R50.

R538-4 provides a circuit to energize the high speed stop 1 and 2, R54, R55, and skip end relay R52, 56.

R539 to R555 are similar to the above relays in operation.

Interlock Release Control 1

R556 relays must be picked up from tape exit hubs *only,* because the relays in *Section 12A* and *12B* are connected to L9 instead of the fuse.

R556-2 completes circuit to interlock release relay R50 to allow accounting machine clutch circuits to be re-established.

R557-566. Similar to relay R556.

All Skips

R567 is picked up by any skip to relay point, overflow control indicate, and non-indicate.

R567-1 is a hold point.

R567-2 provides a pick for carriage start R32.

R567-4 opens the normal stop circuit used when spacing.

R567-5 N/C provides a pick circuit to carriage clutch magnet R32 on all spacing operations; N/O points provide a circuit to energize the interposer magnet for high speed on all skip operations except overflow.

R567-6 prevents overflow brush relay R43 from energizing after skipping has been established from some other source.

R567-7 provides a circuit to energize skip end relays R52 and R56 when carriage high speed stops 1 and 2 are impulsed.

R567-8 forces carriage first card R31 hold to open so that R31BL can prevent an upstroke space operation on the first card cycle following the skip operation.

R567-9 allows the card feed clutch to latch up. Control panel wiring can provide a shunt through R50B or by wiring interlock suppression. If the skip is longer than 3-2/3" and the interlock suppression hub is wired, the accounting machine will print with paper in flight.

R567-10 provides a shunt around R15AU which will open when cards run out after the last program level. If a first card hub is wired to skip to 1, the last program level will be followed by an automatic restoring of the carriage.

Overflow Control Indicate

R568 is picked up under overflow conditions if the control panel is wired from OF to I.

R568-1 is a hold point.

R568-2 closes a circuit on normal overflow for skip to 1 R573 to permit indication on first line of form.

R568-3 completes a circuit to print clutch control R659 and blocks the circuit to card feed clutch control R656 during an overflow indicate cycle.

R568-4 permits overflow indicate relay R46 to pick when tape read brush 1 makes contact. Will cause indication to be printed and prevent all skips R567 from picking up a second time through the overflow indicate point.

R568-5 N/C points provide the normal print clutch and card feed clutch control relay R656, R659 circuit. On overflow N/O points, with the overflow indicate cycle R47AL, provide pick for print clutch control relay R659 on an indicate cycle.

R568-6 permits pickup of all skip relay R567 without skip 3 to 11 control R41.

R568-7, with the N/C points open, prevents past 1 R580 from being energized when OF is wired to I and a skip to 1, the indicate line, is called for in conjunction with a skip to 2 or skip to 3 to 11 signal. The N/O points complete the circuit to the high speed stop R54, 55, 52, 56 and force the carriage to stop at the indicate line.

R568-8 shunts skip end R52A to prevent dropping the skip to relays on an overflow indicate operation.

Overflow Non-Indicate

R570 picks up when control panel hub OF is wired to NI and an overflow condition exists.

R570-1 is a hold point.

R570-2 permits pick of skip to 1 relay R573.

R570-3 permits pick of skip to 2 relay R536.

R570-5 opens the circuit to card feed clutch control R656 while an overflow is taking place.

R570-6 permits energizing of all skips R567 without energizing skip 3 to 11 control R41.

Skip to 1

R573 picks up either through the control panel with an early all cycles impulse or internally after overflow indicate or non-indicate operation. It may also be energized through the skip to control 1 point.

R573-1 is a hold point.

R573-2 energizes the all skip R567 without picking skip 3 to 11 control R41.

R573-3 provides part of circuit through N/O points in conjunction with R556-2 to energize interlock release relay R50.

R573-4. If there are missing heading cards, this point causes a skip to 2 operation on the next form.

R573-5 opens the high speed stop circuit for any skip to 3 to 11 so that carriage will not stop between the skip to 1 start and the tape brush reading *one* punch for the next form.

R573-6. During inverted form operation heading cards may be followed by more heading cards. This point completes a circuit to skip to 2 relay R536 on form skip (eject class of total).

R573-7 prevents overflow control indicate R568 from energizing when an eject class of total control change occurs.

R573-8 prevents overflow control non-indicate R570 from energizing when an eject class of total control change occurs.

R573-9 opens on carriage restore when PM3 is not turning, to stop the machine if the end of the form is reached.

Exit Suppression Control

R577 prevents any amount left in a counter from a previous operation from being transferred from minor, intermediate or major into the final total counter if the control panel is so wired.

R577-1 holds R577 and picks R886.

R577-2 to R577-8 energize counter exit suppression control relays to prevent any amount left in a counter from being transferred to a final total counter on the run in program operation.

R577-9 opens to block R79 pick and prevent operation of the print mechanism during cycles in which exit suppression is active.

R577-10 prevents spacing when exit suppression is called for.

R577-12 allows non-print R662 to be energized whenever exit suppression is called for.

Past 1 Relay

R580 is energized by means of brush 1 when a skip 3 to 11 or skip to 2 are called for during a form to form operation.

R580-1 is a hold point.

R580-2 provides a circuit to stop the carriage at 2 when both skip 1 and 2 are up, also skip 3-11 stop circuit. When the point is normal, it provides standard circuit to stop for all spacing and skipping.

R580-3 provides a circuit to interlock release relay R50 during a form to form skip when skip to 1 and any other skip is called for.

Summary Punch

R581 in conjunction with R881-R884 eliminates a back circuit through control panel wiring and the common jumper of the plus and minus relays which cause extraneous X punchings in the summary card. For example; the transfer and summary punch X control of counter 2A+ is wired to 4B+ relay, 2A– is wired to 4B– relay, 6C– relay is wired to 8D minus transfer and summary punch X hub, by split wire to a

summary punch control hub and in turn to a punch magnet. The impulse from the summary punch X emitter spot, R494-6 N/O R407-4 N/C, 4B+ coil R455, common jumper, R756, R759, 6C– to 8D– hub as a terminal, to the summary punch control regardless of the position of R838-4 point.

R581-1 to 12 open the circuits to the counter plus and minus relays during summary punching.

Minor 2

R601 is picked up when comparing on the control field by an unequal impulse to the program immediate minor control panel hub or through internal wiring when the program start delay minor relay R1076 is impulsed.

R601-1 is a hold point.

R601-2 provides a circuit to pick up the minor 3 R16 first card impulse relay.

R601-3 provides a circuit to pick program R609-R612.

R601-4 provides a test circuit with program start delay minor 1 R1076-3 for single card group R231.

Intermediate 2

R603 is energized from an unequal impulse on the control panel to program start immediate-intermediate hub.

R603-1 is a hold point.

R603-2 provides a circuit to pick first card indication relay intermediate 3 R17.

R603-3 provides a circuit to pick first card indication relay minor 3 R16.

R603-4 provides a circuit to pick program R609-R612.

R603-5 prevents program stop R633 from being energized on a program level 1 impulse if there is an intermediate control change.

R603-6 provides a circuit to program couple 2 hub on an intermediate control change.

R603-7 prevents premature energization of the first card indication relays minor 3 R16 and intermediate 3 R17 when a single card control change takes place on intermediate.

Major 2

R606 is energized from an unequal impulse on the control panel to program start immediate major hub.

R606-1 is a hold point.

R606-2 provides a circuit to pick first card indication major 3 R18.

R606-3 provides a circuit to pick first card indication intermediate 3 R17.

R606-4 provides a circuit to pick first card indication minor 3 R16.

R606-5 provides a circuit to pick program R609-R612.

R606-6 prevents program stop R633 from being energized on program level 1 or 2 impulse if there is a major control change.

R606-7 provides a circuit to program couple 2 intermediate on a major control change.

R606-8 provides a circuit to program couple 3 major on a major control change.

R606-9 prevents premature energization of the first card indication relays minor 3 R16, intermediate 3 R17 and major 3 R18 when a single card control change takes place on a major control change.

Program

R609-R612 are impulsed as a result of a change in the control field being recognized on either minor, intermediate or major control.

R609-1 holds R609-R612.

R609-2 provides a pick circuit to R19 to prevent a repeat of program level 1.

R609-3 delays the energizing of overflow control indicate R658 until after programming is completed.

R609-4 delays the energizing overflow control non-indicate R570 until after programming is completed.

R609-5 delays the impulse to skip to relays R573, R536, R538, etc. until after programming.

R609-7 provides a circuit with program level 1 R618-12, list control R660-4, and special program R615-11 for a spacing circuit when total printing.

R609-8, 9 provides an early all cycles impulse to the program couple all hub during programming.

R609-10 delay pickup of hammerlock 2 R77 until after programming.

R609-11 completes circuit for negative balance test only during programming; however, it can be shunted by the net balance all cycles switch on the control panel.

R609-12 provides a delay to prevent a skip to with head cards until after programming is completed when inverted forms are being used.

R612-1 provides a hold for minor 2 R601, intermediate 2 R603, major 2 R606, program interlock R19 during program cycles by shunting CB50.

R612-2 prevents a skip to control relay picked up by a digit on X read at the second reading brushes during the same cycle a control change is sensed from de-energizing if a predetermined total skip to is to take place first.

R612-3 completes circuit for the 10 impulse to symbol all hub on the control panel.

R612-4 opens a circuit to card cycles relays R638, R641 during program cycles.

R612-5. When cards are being run in, program cycles take place but this point suppresses the print circuits by energizing exit suppression and non-print relays.

R612-7 transfers to open the card feed clutch control R656 circuit and to close print clutch control R659 circuit.

R612-8 prevents list R79 or the zone control magnet from energizing during a program cycle.

R612-9 prevents dropout of the first card in R13H, R14, R15 and the carriage first card when spacing until after the last program cycle is completed.

R612-10 completes circuit to two speed clutch control R5 during program cycles if start 2 R2 hold is opened for some reason.

Special Program

R615 is permanently energized if the control panel hub is wired.

R615-1 to 7 points open the normal common to the total program exits to permit selection through the control panel.

R615-8 shunts intermediate 2 R603-6, major 2 R606-7 points so that program couple 2 intermediate is directly connected to program level 2 relays R622, R625 and may be used as an entry or exit hub on the control panel.

R615-9 shunts major 2 R606-8 point so that program couple 3 major is directly connected to program level 3 relays R626, R629, and may be used as an entry or exit hub on the control panel.

R615-10 opens the normal program stop R633 pickup circuit and requires this relay to be energized through control panel wiring.

R615-11 provides a space circuit to R32 during special program operation when the control panel may be wired for group printing.

Program Level 1

R618 is energized with program R609-R612 or by program level 4 relay.

R618-1 is a hold point.

R618-2 to 8 connect program level 1 minor hubs to an all cycles impulse.

R618-9 provides a circuit to program stop R633 to stop programming during normal operation.

R618-10 completes circuit to interlock relay R20.

R618-11 provides a circuit for program level 1 asterisk symbol print exit.

R618-12 prevents spacing before a minor total when wired for group printing.

Program Level 2

R622 may be energized through interlock 1 R20B after first program level is completed, by impulse to program couple 2, or with program R609-R612 when there is an intermediate control change and a single card group.

R622-1 is a hold point.

R622-2 to 8 connect program level 2 intermediate hubs to an all cycles impulse.

R622-9 provides a circuit to program stop R633 to stop programming during normal operation after the intermediate program level has operated.

R622-10 completes a circuit to interlock relay R21.

R622-11 provides a circuit for program level 2 asterisk symbol print exit.

Program Level 3

R626 may be energized through the interlock 2 R21B or by impulse to program couple 3 major.

R626-1 is a hold point.

R626-2 to 8 connect program level 3 major hub to an all cycles impulse.

R626-9 provides a circuit to program stop R633 to stop programming during normal operation.

R626-10 provides a circuit to energize interlock 3 R22.

R626-11 provides a circuit for program level 2 asterisk symbol print exit.

Program Level 4

R630 is energized through interlock 3 R22B or program couple 4.

R630-1 is a hold point.

R630-2 to 8 connects program level 4 hub to an all cycles impulse.

R630-9 provides a circuit for program level 4 asterisk symbol print exit.

R630-10 provides a circuit to pick interlock 4 R23.

Program Stop

R633 will be energized normally to stop program cycles or will be picked with special program through control panel wiring when the desired number of program cycles are completed.

R633-1 is a hold point.

R633-2 prevents any more impulses from energizing the interlock relays.

R633-3 in a closed position, provides a shunt around CB51 to maintain a hold circuit for program R609 and R612 hold until programming is completed.

R633-4 provides a circuit to energize minor 3 R16, intermediate 3 R17, major 3 R18 to set up a group indicate cycle.

R633-5 energizes overflow brush control R45 at the end of programming when list R660 is not wired on the control panel.

All Cycles

R635 picks up every cycle except on idle cycles, on idle feed tab cycles when MLP1 card passes third reading station and on cycles when a card fails to feed and the feed interlock operates.

R635-1 to 10 act as isolation points for the control panel hubs which emit all cycles impulses.

R635-11, 12 act as isolation point for the final total control panel hubs.

Card Cycles

R638 picks up every cycle except during program carriage overflow, head card, of multiple-line operation, etc.

R638-1 to 11 act as isolation points for the control panel hubs emitting all cycles impulses.

R638-12 controls the impulse that may be emitted from the S and M single card hubs.

R641 picks so that the first five hubs in the left row of card cycles are available on all card cycles including head card and multi-line card operation.

R641-1 through 5 provide card cycles impulses as described above.

R641-6 provides for a hot 10 available on all card cycles.

Early All Cycles

R642-R645, when energized, close points from 225° to 290°.

R642-1 to 11 allow the immediate hubs of the skip to 1 through 11 to accept impulses at early all cycles time only.

R645-1 to 3 allow their respective circuits to accept impulses at early all cycles time only.

R642-12 is the filter for space suppression R35.

R645-4 will be open from 225° to 290°. This prevents the correction relays R671 to R974, and punch bus interlock relays R83-

84-85 from being energized at this time, since CB61 makes the test for 9 through R83AL N/C from 255° to 267° and the punch bus.

R645-5 will be open from 225° to 290°. Negative balance test is made by CB61 from 255° to 267° and, if a complement is in the counter, this would cause the negative balance relay to be energized. Since CB78 and 79 will close from 246° to 271°, R645-5 being open will prevent an impulse through R768-4 N/C in series with the 6C transfer and summary punch plus hub, then through R768-4 N/O and the minus hub during test time. This prevents the R768-4 from being damaged by arcing of the contact points.

R645-6 N/O allows the early all cycles impulse from CB56 at 235° to 271° to be available at the first card minor, intermediate or major hub. This is particularly desirable when heading cards are missing and a control change is sensed as the control panel may be wired from minor first card to skip to 1 and R573 will be energized. In this way R573-4 in *Section 15A* can close before PM11 will make at 246° to pick skip to 2 R536.

R645-7 to 11 allow their respective circuits to accept impulses at early all cycles time only.

R645-12 allows R635 to energize so that an early all cycles impulse will be available at the final total hubs, since R648-2 is open until 280°.

Idle Cycles

R648 picks up only when both the card feed clutch control R656 and the print clutch control R659 are de-energized.

R648-1 is a hold point.

R648-2 opens circuit to all cycles R635 and card cycles R638, R641 so that their control panel hubs will isolate circuits at this time.

R648-3 prevents dropout of program levels during idling cycles and keeps R88 summary punch end picked until completion of summary punching.

R648-4 prevents pickup of program stop R633 during idle cycles.

R648-5 provides a hold for hammerlock R77H, non-print R662H and exit suppression R577 and 886.

R648-6 provides a circuit to R82 for high-speed operation during idle cycles.

Head Control Read

R650 energized by an X impulse through control panel wiring to the head X hub. It may also be energized indirectly by an impulse to the D hub.

R650-1 is a hold point.

R650-2 provides a circuit to head control 1 R651 and head card switch R28.

R650-3 in conjunction with R651-2, tests for the presence of heading cards and prevents pickup of R654 until the last heading card is read.

Head Control 1

R651 is picked up as a result of X or digit impulse to head control X or D hub.

R651-1 is a hold point.

R651-3 provides a circuit for list R79 for heading cards when list control R660 is not wired.

R651-4 prevents minor body hub from emitting a first card impulse for heading cards when there is a control change.

R651-5 prevents overflow control indicate R568 from energizing if the next card is a heading card.

R651-6 prevents overflow control non-indicate R570 from energizing if next card is a heading card.

R651-7 N/C permits a skip to 2 impulse after last heading card. N/O completes a skip to 2 for the first head card when an inverted form is used.

R651-8 prevents card cycles R638 from energizing if heading cards are passing through the feed.

R651-9 provides circuit to pick head control 3 R669.

Head Control 2

R654 picks upon last heading card cycle to set up circuits for first body line operations.

R654-1 is a hold point.

R654-2 allows body minor hub to provide a minor first card impulse for first body or detail card following the heading card.

R654-3 causes the first body card after last heading card to list.

R654-4 prevents energizing double space R38 on minor first card when heading cards are used.

R654-5 N/O causes skip to 2 after last heading card. N/C provides an impulse on inverted forms, to skip to 2 for first heading card.

Card Feed Clutch Control

R656 picks up to control the card feed clutch.

R656-1 is a hold point.

R656-2, 3 provide a circuit to the card feed clutch magnet.

R656-4, 5 provide a circuit to the print clutch magnet.

R656-6 permits idle cycles R648 to energize when the circuit to both the print clutch control relay and the card feed clutch control is open.

R656-7 permits transfer print entry R1013, R1016, R1019, and R1022 to energize during card feed cycles only.

R656-8 controls a circuit to energize third line print entry relays R1027, R1030, R1034, R1037, R1041, R1044, R1057, R1060, R1063, R1083.

R656-9 allows a credit symbol impulse through the minus relay point only when the card feed is operating.

R656-10 controls the pickup of brush isolation relays R500, R503, R506, R509, R512, R515, R518.

R656-11 maintains a pickup circuit for two speed clutch control R5 if start key is held down for only a short time.

R656-12 provides a circuit to transfer zone entry relays R1001, R1004, R1007, R1010 for second and third line zone control.

Print Clutch Control

R659 provides controls for a printing operation.

R659-1 is a hold point.

R659-2, 3 provides a circuit to print clutch magnet.

R659-4 allows idle cycles R648 to energize when both card feed control clutch and print clutch control relays are de-energized.

R659-5 permits IC hubs to emit impulses only on print cycles.

R659-6 prevents the type bars from locking up when the stop key is depressed between 18° and 45° on an overflow indicate cycle.

R659-7 causes speed change R82 to pick when running cards in for the first two cycles and last card out after passing third reading brush station.

List Control

R660 receives an early all cycles impulse through the control panel to cause the machine to list.

R660-1 is a hold point.

R660-2 causes list relay R79 to energize when listing.

R660-3 provides a circuit to permit printing of first card of the next group after a minor control change one space lower as a result of energizing double space R38.

R660-4 provides a circuit for all spaces before totals when wired for detail printing.

R660-6 provides a circuit to overflow brush control relay R45 when detail printing and when tape brush 12 has caused overflow brush R43, R44 to energize.

Non-Print

R662-664 is energized by an early all cycles impulse through the control panel.

R662-1 is a hold point.

R662-2, 3 open the circuit to the print clutch magnet.

R662-4 prevents list relay R79 and zone bail control magnet from being picked.

R662-5 prevents spacing when a non-print operation is called for.

R662-6 allows the pick of R82 for high-speed operation during idle cycles.

R664-2 opens a hold circuit of carriage single, double, and triple space relays.

R664-3 prevents the overflow brush control R45 from energizing.

R664-4 causes speed change relay R82 to energize so that non-list cycles will take place at high speed.

Final Total Level

R665 is energized when the final total and start key are both depressed after all cards are out of the hopper and feed to cause those counters so wired to clear.

R665-1 is a hold point.

R665-3 to 5 provide a circuit to the final total hubs and isolate them when not in use.

R665-6 causes print clutch control R659 to energize for the final total printing level.

R665-7 completes a circuit to all cycles R635 during final total level with R645-12.

R665-8 forces negative balance test relays R856, R497 to energize during final total level.

R665-9 provides a circuit to carriage start R32 during a final total cycle when the control panel is wired for single, double, or triple space.

R665-10 provides a final total asterisk symbol impulse during final total printing.

R665-11 provides a hold circuit for single-, double-, or triple-space relays if used on a final total.

Head Control 3

R669 energizes while heading cards are being listed.

R669-1 is a hold point for R669.

R669-2 prevents program R609-12 being energized while heading cards are listed or between last heading and first detail card when they may not agree on some sub-control field.

R669-3 provides a circuit to the first card relays, minor 3 R16, intermediate 3 R17, major 3 R18 when head cards are feeding and a control change takes place.

R669-4 when using inverted form prevents a skip to 2 when heading cards are present until after program is over.

R669-5 in conjunction with head control read R650-3 tests for the presence of heading cards and prevents the pick of R654 until the last heading card is read.

Correction Relays

R671, R678 are picked up during a conversion cycle if its counter group stands negative. The points transfer the counter start magnet from the standard entry circuits to counter emitter common in order to accept the conversion digits. Counters 1 to 32.

Idle Cycles

R681 picks with R648, 80 when both the card feed clutch control R656 and the print clutch control R659 are de-energized. This occurs during conversion, summary punching and skipping when interlock release is not operative.

R681-1 opens to prevent pilot selectors or co-selectors from being picked through the program level symbol hubs during summary punching, conversion, or skip idle cycles.

R681-2 opens the internal pick circuit to counter exit suppression and total relays during idle cycles.

Counter Relays

R721 to R838 are all similar to R401 to R497 in operation and apply to counters 33 to 80.

Carry

R841, R844, R847, R850 are all similar to R485, R488, R491 in operation and apply to counters 33 to 80.

Summary Punch

R853 is similar to R494 in operation and applies to counter groups, including counters 33 to 80.

R853-1 through 9 provide a circuit for summary-punch X-impulse to transfer and summary-punch X-control hubs of counter groups 8B through 8D.

R853-10 provides for an early pick of R20 and 21 on the summary punch with balance selectors through 13.

R853-11 energizes the card feed stop light during summary-punch cycles.

Negative Balance Test

R856 is energized on program cycles or by control panel wiring on all non-idling cycles and serves counter groups including counters 33 to 80. Similar to relay 497 in operation.

Zero Control

R859, R862, R865, R868 are energized for digits 9 through 1, 11, 12 and are down for 0 impulse. The points are in series with the comparing entry hubs to open the circuits at zero time so that on alphabetic control more time can be allowed for the hold coils of the comparing relays to be de-energized before comparing the zone punching.

X-R

R871, R874 are energized only at 11 and 12 time, and their points are in series with certain control panel hubs which should accept only an 11 or 12 impulse. They act as a filter.

Summary Punch Control

R877 is energized by a control panel impulse such as one from a program level.

R877-1 is a hold point.

R877-2 provides a circuit to energize the summary punch relay R494.

R877-3 provides a circuit through I3 to pick up the balance test relay in the summary punch. It is used with double balance operation.

Conversion Cycle

R878 is energized if any negative balance control relays are picked up due to a complement in the counter on test for a 9.

R878-1 is a hold point.

R878-2 provides a circuit to energize the conversion cycle interlock R879 and assures conversion of negative final totals.

R878-4 opens a circuit to card feed clutch control R656 and print clutch control R659.

R878-5 provides a circuit to pick up correction relays for those counters with a complement on negative balance test and the punch bus interlock.

Conversion Cycle Interlock

R879 is energized by conversion relay R878 on recognition of a complement in a counter.

R879-1 is a hold point.

R879-2 opens a circuit to conversion cycle relay R878 to prevent a second successive conversion cycle.

R879-3 starts the summary punch after conversion in the accounting machine is completed.

Summary Punch

R881-884 are similar to R581 in operation and apply to counter groups including counters 33 to 80.

Exit Suppression Control

R886 energizes counter exit suppression relays to prevent any amount left in the counters from previous operations from being transferred to a final total counter on the run in program operation.

R886-1 to R886-9 pick counter exit suppression relays for counters 33 to 80.

Digit Transfer

R889-R892 are energized every machine cycle. The points of these relays provide circuits to pick up selector transfer relays from a previously energized selector control relay. Their purpose is to allow the selector transfer relay to complete its operation without being disturbed and to let the selector control relay return to normal before accepting a new X or digit impulse.

Selector Control 1

R893 may be energized either from a digit or an X. It is held by a card feed CB.

R893-1 is a hold point.

R893-2 provides a circuit to the selector transfer 1 R895.

R894 may be energized from a digit.

R894-1 is a hold point.

R894-2 provides a circuit to the selector transfer 1 R895.

Selector Transfer 1

R895, R895-1 are hold points.

R895-2, 3 provide transfer points on the control panel which act as automatic switches.

Pilot Selectors

R896-941 operate in the same manner as R893 R894 and R895.

Co-Selector 1

R942 energizes transfer 5 selector points as a group and it is normally impulsed from the immediate hub of a pilot selector.

R942-1 is a hold point.

R942-2 to 6 are transfer points of the selector.

Co-Selectors 2 to 12

R943-R958 eight selectors are standard and there is space for 4 optional selectors which operate similar to R942.

Correction Relays

R961-974 is picked up during a conversion cycle if its counter group stands negative. Its points transfer the counter start magnet from the standard entry circuit to the counter emitter common in order to accept the conversion digits, counters 33 to 80.

Transfer Zone Entry

R1001, R1004, R1007, and R1010 operate together on MLP card operations and will be energized only if the MLP control hub has received a 9-8 with a 1, 2, 3 or 4 impulse.

R1001-1 is a hold point.

R1001-2 transfers zone magnet from normal zone entry to transfer zone entry hub. Points R1001-3 to R1010-8 operate in a like manner.

Transfer Print Entry

R1013, R1016, R1019, R1022 operate together on MLP card operations and will be energized only if the MLP control hub has received a 9-8 with a 1, 2, 3, or 4 impulse.

R1013-1 is a hold point.

R1013-2 transfers the print magnet from normal print entry to transfer print entry hub points R1013-3 to R1022-8 operate in a like manner.

Second Line Zone Entry

R1027 and R1030 are energized through second line zone control R214BL point.

R1027-1 transfers to provide a circuit from the second line zone entry to the zone selection exit for zone read from second brushes.

R1027-2 to R1030-12 are transfer points which operate similarly to the R1027-1 point.

Third Line Zone Entry

R1034-1037 are energized through the third line zone control R218BU point.

R1034-1 transfers to provide a circuit from the third line zone and print entry hub to the zone selection exit hub so that the zone may be read from third brush station.

R1034-2 to 1037-12 are transfer points which operate similarly to the R1034-1 point.

Second Line Print Entry

R1041-1044 are energized through the MLP third station R217BU.

R1041-1 transfers to provide a circuit from the second line print entry to the print selection exit so that the numerical punching may be read at third brush station.

R1041-2 to R1044-12 are transfer points which operate similarly to R1041-1 point.

Third Line Print Entry

R1051, R1054, R1066, R1069 are energized through the 3-line zone control R219BU point.

R1051-1 is a transfer point which provides a circuit from the third line zone and print entry to the counter start magnet so that the third line numerical punching may be stored in a counter.

R1051-2 to R1054-12 are transfer points which operate similarly to R1051-1.

R1066-1 closes to allow R246 to be energized only when the third reading brush reads a numerical punch to the third line zone and print entry. When open, R246B, will then prevent a zero impulse from a counter which was not advanced when the third reading brush read a blank column on the card.

R1066-2 to R1069-12 are transfer points which operate similarly to R1066-1.

Third Line Read-out

R1057, R1060, R1063, R1083 are energized through the MLP fourth station R221AL point so that the information stored in the counter may be released to impulse the print magnets for numerical third line printing as the MLP3 card moves to the fourth station.

R1057-1 is a transfer point which completes a circuit from the 9-10's brush to the print selection exit.

R1057-2 to R1060-12 are transfer points which operate similarly to R1057-1.

R1063-1 to 6 are transfer points which energize the counter exit suppression relays to prevent the counter exit hubs emitting a list impulse through some other control panel wiring.

R1063-7 to 12 are transfer points which energize the counter total relays to cause the storage counters to start turning when the MLP3 card is at the fourth station.

R1083-1 opens and prevents the transfer and SP X control hubs from emitting an impulse through normal wiring at read-out time.

MLP First Line Zone Control

R1072, when impulsed from an MLP1, 2, or 3 card, sets up normal circuits for multiline printing.

R1072-1 is a hold point.

R1072-2 provides a circuit to the transfer zone entry relays R1001, R1004, R1007, and R1010 for first line zone reading.

R1072-3 prevents the PK control R1079 from energizing when an MLP3 card is followed by an MLP card until after the MLP3 card has completed all operations and allows an MLP4 or normal card to advance if R219AL is open.

R1072-4 prevents idle feed tab R234 from energizing when an MLP1 card is passing the second reading station and the MLP control senses that the next card is another MLP card. This eliminates the high speed idling cycle as the MLP1 card passes the third reading station.

R1072-5 N/C provides a circuit to energize card end transfer R229 during normal operations. N/O provides a circuit to card end R1082 and Z1 hub on multiline operation.

R1072-6 provides a circuit to MLP first line zone R1074 to signal that the MLP card held by the first feed rolls, when the PK clutch is latched, is now ready to start multiline operation.

MLP First Line Zone

R1074 controls the sequence of operation so that the MLP second station relay, etc., do not operate until the MLP card is released by the latched picker knife clutch.

R1074-1 is a hold point.

R1074-2 provides a circuit to the MLP second station R211 so that transfer print entry relay R1013, R1016, R1019, R1022 may be energized for first line printing.

R1074-3 N/C allows lower card lever relays R10, R11, R12 to energize when card lever 3 closes with normal cards. N/O causes the card lever relays R10, 11, 12 to energize with card lever 2. These relays complete circuits so that the MLP card may print from the second brush station as a normal card would from the third brush station.

R1074-5 provides a circuit with 1-line card at the second station R212BU to energize 1-line control change R239. This forces the control change recognized between first and second brushes with MLP1 cards to take place immediately rather than delay it as with MLP2 or 3 cards.

Minor 1

R1076 receives an unequal impulse when using MLP cards to provide a delay in control change operation until the multiline printing is completed. The relay is connected to the program start delay minor hub.

R1076-1 is a hold point.

R1076-2 provides a circuit to the minor 2 R601 pick 2 after the multiline operation is completed and the third line zone control has returned to normal.

R1076-3 provides a circuit with minor 2 R601-4 to energize single card group R231 when single card groups are being eliminated.

Intermediate 1

R1077 is picked up by an unequal impulse to program start delay intermediate hub when controlling on multiple-line cards.

R1077-1 is a hold point.

R1077-2 provides circuits on intermediate change to intermediate 2 R603 to set up

programming following the printing of the multiline card or, in conjunction with R236AL N/O, it provides an impulse to machine stop R3 when the control panel is wired for successive feed. See *R235, R236.*

Major 1

R1078 is picked up by an unequal impulse to program start delay major hub when controlling on multiline cards.

R1078-1 is a hold point.

R1078-2 is similar in purpose to R1077-2.

PK Control

R1079 causes the picker knife clutch magnet to be impulsed every cycle with normal cards. With multiline cards it provides a delay in feeding the detail card following an MLP 1, 2, 3, card so that the normal card may be read at the second and third brushes after multiline operation is completed.

R1079-1 is a hold point.

R1079-2 provides a circuit to the transfer zone entry only when cards at the first brush station are moving and may cause zone magnet operation.

R1079-3 provides a circuit to picker knife clutch magnet.

R1079-4 provides a circuit to MLP read delay hubs and for the normal operation of card end transfer R229 when the card held at the first brush station is released.

R1079-5 causes delay in energization of 2-line control R209, 3-line control R207 until net is again energized. This allows the following normal or multiline cards to set after the idle cycle and the PK clutch mag-up their own circuits.

R1079-6 provides a circuit to energize the PK clutch interlock R238 and MLP4 station 2 R210 through the MLP4 control R205AL. See *R238.*

R1079-7 prevents any impulse reaching MLP control 1 R201 except when cards are actually moving. For example, a digit selector might be wired to MLP control PU and would cause MLP control 1 R201 to energize if R1079-7 were not in the circuit.

R1079-8 provides a hold circuit for MLP setup relays so that they may operate on the first cycle after the idling cycle.

R1079-9 provides a hold circuit for card lever 1 R8 and R9 hold until the card following an MLP card, which is held at the first brush station, has been completely read.

R1079-10 provides a circuit with MLP first line zone control R1072-6 to MLP first line zone R1074 so that the transfer print entry relays R1013, R1016, R1019, R1022 will be energized at the correct time.

R1079-11, 12. It is possible that, with an MLP card stopped with the brushes between one and zero, a short strand may make contact with the roll. These points isolate the first reading brushes until the cycle when the PK clutch is again energized.

Card End

R1082 picks through R229B N/O with every normal card, through R1072-5 N/O with an MLP card.

R1082-1 is a hold point.

R1082-2 provides a shunt around CF30 to keep zero elimination relays R246-269 hold energized during the cycles when the PK control relay is not energized and through the last line of an MLP3 card.

R1082-3 prevents head control 2 from energizing until after the last line of heading card 1 is read.

R1082-4 holds feed interlock 2 R63 hold energized during run in for multiple-line operations.

R1082-5 prevents pick of feed interlock R63 until through with the last card of a multiple-line operation during the run out with the feed interlock button.

Third Line Read-out

R1083 energized with 3rd line control and MLP4 station 2 to prevent the transfer SP X control plus N/C point from emitting impulses during MLP operation.

R1083-1 opens to prevent the late all cycles impulses from being available at the transfer and SP X control plus hub during MLP operation, since the control panel wiring may be using the plus hub with normal cards.

CIRCUIT BREAKER CAM CONTACTS

THE circuits have been so designed that the number of relays operated by any one cam contact have been kept to a minimum. In some cases, the purpose for the contact will be repetition or self-evident; however, where an unusual condition exists, the purpose will be explained in detail.

Continuously Running Circuit Breakers

CB1, M9-B19, in conjunction with CB2-3-4, provides a timed impulse for each punching position of the card 9 through 12. M9-B18 for 9 impulse, 18° later for each succeeding position in the card.

CB2 is similar to CB1 in purpose.

CB3 is similar to CB1 in purpose.

CB4 is similar to CB1 in purpose.

CB5, M150-B164, provides a 1 impulse for a net balance correction cycle.

CB6, M114-B128, provides a 3 impulse for a net balance correction cycle.

CB7, M78-B92, provides a 5 impulse for a net balance correction cycle.

CB8, M42-B56, provides a 7 impulse for a net balance correction cycle.

CB9, M6-B20, provides a 9 impulse for a net balance correction cycle.

CB10, M4-B15, in conjunction with CB11-12-13, provides a timed impulse for each cycle point when total printing from 9 through 0. M9-B18 for 9 impulse, 18° later for each succeeding total print impulse. Also provides a carry impulse at 225°.

CB11 is similar to CB10 in purpose and aids in distributing the load.

CB12 is similar to CB10 in purpose and aids in distributing the load.

CB13 is similar to CB10 in purpose and aids in distributing the load.

CB14, M349-B3, in conjunction with CB1-2-3-4, provides 351° impulse to start counters turning on a total reset cycle.

CB15 is similar to CB14 in purpose.

CB16, M7-B21, in conjunction with CB1-2-3-4, provides a 9° impulse to start counters turning when subtracting.

CB17 is similar to CB16 in purpose.

CB18, M45-B18 assures that two speed clutch R5 remains energized past 330° to keep the list speed or high speed control magnets attracted which in turn cause the card feed and print clutch to be moved to the latching point.

CB19, M258-B294, provides a timed impulse to pick list relay R79.

CB20, M277-B291, in conjunction with CB21, provides a fixed duration impulse to energize either card feed clutch control R656 or print clutch control R659 from 282° to 291°.

CB21, M282-B296, works in series with CB20.

CB22, M246-B266, provides a timed impulse to energize exit suppression control R577. When MLP1 cards cause R234 idle feed tab to suppress printing, CB22 and R230B provide the skip to 2 pick circuit since PM11 will not be turning.

CB23, M330-B295, provides a timed impulse for hold of non-print run out R81, and speed change relays R82 etc.

CB24, M252-B225, provides a timed impulse for hold of card feed, print clutch control and list relays.

CB25, M307-B280, provides a timed impulse for the hold of idle cycles R648, R80, R681.

CB26, M288-B338, provides a timed impulse for pick of idle cycle R648 and speed change R82.

CB27, M293-B343, provides a timed impulse for pick of print clutch magnet and card feed clutch magnet.

CB28, M336-B296, provides a pre-energization circuit for the card feed clutch magnet to accelerate the pickup time, also acts as a hold for the clutch magnet once energized.

CB29 is similar to CB28 in purpose.

CB30, M250-B300, provides a timed impulse to pick (R20-R21 in the Type 513 Reproducing Punch) for double balance test punching.

CB31, M270-B300, provides a timed impulse to pick conversion cycle R878 and feed interlock R62.

CB32, M229-B202, provides a timed impulse to hold various relays

CB33, M255-B275, provides a timed impulse to pick all skips R567 after printing is completed.

CB34, M265-B285, provides a timed impulse to carriage start R32 for a skipping operation.

CB35, M249-B285, provides a timed impulse for pick of interlock release R50 when movement of paper is recognized as being less than $3\frac{2}{3}''$ or $2\frac{1}{3}''$ in length.

CB36, M340-B290, provides a timed impulse for hold of skip to control 1 through 11.

CB37, M330-B270, provides a timed impulse for MLP4 control, 3 line setup, 2 line setup and MLP 1st line zone control.

CB38, M330-B270, provides a timed impulse for hold of MLP control circuits.

CB39 (M235-B275) (M305-B185) provides a timed impulse for early and late all cycles pick of R635 and card cycles R638 and R641.

CB40, M358-B218, provides a timed impulse for pick of brush isolation relays R500 to 518.

CB41, M225-B290, provides a timed impulse for pick of early all cycles R642-645.

CB42, M354-B327, provides a timed impulse for hold of total elimination R232-233.

CB43, M235-B265, provides a timed impulse to setup change switches, hammerlock R77, etc.

CB44, M252-B225, provides a timed impulse for hold of pilot and co-selector relays. The break time should be held to + 0° − 1°.

CB45 (M0-B163) (M179-B218) provides a timed impulse so that zero control relays R859 to 868 are energized for 9 through 1 and 11 and 12. The zero control relays are not energized at zero time in order that the hold coils of the comparing relays may have more time to de-energize after comparing numerical punching in an alphabetic control field.

CB46, M18-B30, in conjunction with CB47 provides a test impulse for the unequal condition of the comparing relays, M18-B27 on test for 9. This 9° delay allows a margin of safety when there may be slight variations in brush timing or punching registration which would cause one comparing relay to pick in advance of the other.

CB48 (MO-B172) (M191-B226) provides a timed impulse for the hold coils of the comparing relays for 9 through 1 and 11 and 12.

CB49, M225-B261, provides a timed impulse for pick of single group control R231 and minor, intermediate and major first card relays R16-17-18.

CB50, M317-B290, provides a timed impulse for hold of minor R601, intermediate R603 or major R606 program start relays and program interlock R19.

CB51, M247-B220, provides a timed impulse for hold of program R609-612.

CB52, M225-B245, provides a timed impulse to set up program R609-612 and program level 1 R618. At this time, the circuits are completed so the machine changes from a detail or group printing operation to a total print cycle. Also provides a timed impulse for final total program level.

CB53, M270-B284, provides a timed impulse to allow a program start following a negative balance test for 9 in a counter. Purpose for CB53 is that the Type 402-403 machine with net balance all cycles wired ON allows a test for 9 in a counter to be made each card feed cycle. The control panel may be wired to add a number into the controlling counter from the leader card and to subtract a card count one on each succeeding cycle until the counter returns to 99. On test for a nine, a program start is initiated. As this is too late to also provide for negative balance control, it is best to wire to intermediate program start so that the correction cycle can take place before the intermediate program level.

CB54, M50-B64, provides a timed impulse to pick the program interlock relays R-19-20-21-22-23.

CB56, M235-B271, provides a timed impulse to start negative balance test either following a program start, depression of final total key, or with negative balance all cycles wired ON. Also early all cycles impulse to first card hubs.

CB57, M198-B238, provides a timed impulse to pick the carry relays R485 to 850 and have

the carry circuit completed from the 9-10's brush to the counter start magnet at carry time. It also prevents a 12 impulse from a card column which is wired to a print entry hub and, in turn wired to a counter exit hub, from reaching the counter start magnet.

CB58, M160-B235, provides a timed impulse to hold total relays R403 to R832. The purpose is to keep the total print points in series with the 9-10's brush transferred on programs cycles so there will not be any carry impulse during total cycle operation.

CB59, M272-B245, provides a timed impulse for the hold of conversion cycle relay R878 which in turn keeps all correction relays energized while correction factors are being added.

CB60, M200-B220, provides a timed impulse for pick of conversion cycle interlock R879 and prevents a second correction cycle from starting.

CB61, M255-B267, provides a timed impulse for negative balance test of a counter standing at 9.

CB62, M5-B225, provides a source of timed digit impulse 9 through 12 as well as a hot 9 source.

CB63, M320-B180, provides a timed impulse when program stop R633 may be energized.

CB64, M159-B173, provides a timed impulse for ½ after 1 split column control hub.

CB65, M177-B191, provides an impulse at ½ after 0.

CB66, M195-B209, provides an impulse at ½ after 11.

CB67, M348-B002, provides a timed impulse for the hot 10 impulse for symbol printing and for the credit symbol exit hubs.

CB68, M195-B270, provides a control on the drop out time of 1st card in relays R13-14-15 thus taking the break arc rather than R11AL or R612-9.

CB69, M267-B317, provides a timed impulse to start the summary punch.

CB71, M235-B255, picks R568 and R570 at a definite time in relationship to the machine, since R43 is picked by the 12 brush in the carriage which is not driven by the machine.

CB72 (M235-B255) (M275-B287), controls the pick time of the pilot selector transfer relay R895. The purpose for two impulses is that, through control panel wiring, the negative balance test impulse may be used to energize the digit pickup of the pilot selector. At this same time an early all cycles impulse may be wired through the N/C side of the pilot selector transfer points. Dividing the time when the pilot selector points may transfer, prevents transferring and arcing on the N/C points during 255° to 267° net balance test time. The make time should be held to + 1° − 0°.

CB74, M303-B218, provides a timed impulse to energize the correct zone or print entry relays.

CB75, M240-B300, provides a timed impulse to maintain a hold on summary punch relays R494-853-87, 581, 881, 884, by shunting summary punch end R88BL points.

CB76, M7-B21, acts as a filter for the 9 impulse for MLP control.

CB77, M210-B295, provides a hold for the summary punch relay R86 when it is operated through a pilot selector under the control of a setup change switch.

CB78 supplies the EARLY ALL CYCLES impulse to all cycles, card cycles, program exits, etc.

CB79 supplies the LATE ALL CYCLES impulse as above.

CB81, M75-B86 for a five impulse. It is used in conjunction with CB82 as a means of preventive maintenance check on the machine operation. By placing a piece of paper between the points of CB3 and 4 the impulse circuit is completed through CB1-2-81-82 and is of 6° duration for each impulse 9 through 12.

CB82 is similar in purpose to CB81.

Card Feed Circuit Breakers

CF2, M181-B217, provides a timed impulse for MLP control relays also X-R relay R871, 874 and 1 line control change R239.

CF3, M162-B217, provides a timed impulse for MLP 1st line zone R1074 and zone magnet isolation relays R521 to 530.

CF4, M208-B190, provides a timed impulse for hold of idle feed tab R234 and head control R654.

CF5, M200-B220, provides a timed impulse for multiline cycle R237 and feed interlock R63, idle feed tab R234.

CF7, M7-B340, provides a timed impulse for hold of hammerlock R77, zone suppression R27, and the pilot selector control relays R893 or 894, etc.

CF8, M220-B270, provides a timed impulse to test the card lever relay circuits.

CF9, M4-B220, in conjunction with CF10, allows a circuit to the first, second and third reading brushes from the circuit breakers only when the card feed unit is in operation.

CF10 is similar in purpose to CF9.

CF11, M252-B225, provides a timed impulse to hold card lever relays R10-11-12, first card minor R16, intermediate R17, major R18 hold, etc.

CF12, M252-B225, provides a timed impulse to hold card lever 1 relays R8-9 until the card at that station has been completely read.

CF13, M348-B2, provides a timed impulse to energize 1st card in R13, which is after the 1st card has started to pass the third reading brushes.

CF14, M203-B185, provides a timed impulse to hold the feed interlock relays R62-63-64 and take the arc.

CF15, M190-B265, provides a timed impulse to hold 1st card in R31. If all skips R567 is picked by CB33 from 255° to 275° on a card feed cycle, CF15 takes the arc instead of R567-8.

CF17, M225-B245, provides a timed impulse to pick R654.

CF20, M25-B39, acts as a filter for an 8 impulse for MLP control.

CF21, M97-B111, acts as a filter for a 4 impulse with MLP3 cards.

CF22, M115-B129, acts as a filter for a 3 impulse with MLP3 cards.

CF23, M133-B147, acts as a filter for a 2 impulse with MLP2.

CF24, M115-B165, acts as a filter for a 1-2 or 3 impulse with MLP1-2 or 3 cards.

CF26, M160-B174, provides a timed impulse for out digit impulse of MLP control 1st read delay.

CF27, M135-B171, provides a timed impulse to energize picker knife clutch magnet.

CF28, M120-B140, provides a timed impulse to test for a pick circuit to picker knife control R1079.

CF29, M-252-B225, provides a timed impulse to keep the transfer zone entry R1001 to 1010, transfer print entry R1013 to 1022 energized for all print magnet or zone magnet impulses.

CF30, M217-B190, provides a timed impulse to hold the 0-elimination relays energized until fourth station read-out with MLP3 cards takes place.

CF31, M330-B270, provides a timed impulse for R650 head control read hold.

CF32, M163-B145, provides a timed impulse for card end transfer R229 hold.

CF33, M65-B38, provides a timed impulse for card end R1082 and PK control R1079 hold.

CF34, M214-B187, provides a timed impulse for hold of multiline cycle R237.

CF35, M340-354, provides a timed impulse on the next cycle following the recognition of an unequal condition when using program start delay with MLP cards. This with other circuits provides a delay for program start after all printing operations are completed for the MLP card.

CF36, M15-B357, provides a timed impulse for hold of program start delay relays R1076, R1077, R1078.

CF37, M61-B75, acts as a filter for a 6 impulse wired to the MLP control successive feed which is the signal that a normal card is to be fed directly behind an MLP2 or 3 card.

CF38, M167-B107, in conjunction with R1079-11 and 12 points, provides a circuit to read the 0-11-12 punching in the MLP card held at the first reading brush station.

CF39, M306-B162, in conjunction with R238B, will provide a circuit to read 9 through 1 punching in the MLP card passing the first reading brushes. In MLP card operation, the card following an MLP card will be held at the 165° index point under the first reading brushes while the preceding MLP card completes its printing operation. The first reading brushes should be between the one and zero position of the card; however, a short brush strand may make contact with the contact roll. The purpose for CF38-39 and associated relay points is to prevent a circuit through the first reading brushes while the card is latched in this position at the first reading brush station.

Print Mechanism Circuit Breakers

PM*1, M350-B15,* provides a timed impulse to allow the double space circuit to be established before PM2 closes.

PM2, M0-B15, provides a timed impulse for carriage start R32 and the time of the platen upstroke space.

PM3, M20-B350, provides a timed impulse for the hold of form stop R53. This allows a test to be made once each print cycle for the presence of forms or paper holding the form stop contact closed and the R53 pick circuit energized.

PM4, M250-B185, provides a timed impulse for hold of overflow control indicate R568 and pick of overflow indicate cycle R46 and R47. The IC hubs are used for late all cycles impulse to progressively control the indicate counter.

PM5, M160-B180, provides a timed impulse to pick the overflow brush control circuit.

PM6, M2-B337, provides a timed impulse to cause list speed control magnet to remain energized through the print cycle regardless of the position of R82B.

PM7, M337-B2, provides an interlock to prevent the high speed control magnet from being energized when the print mechanism is in operation.

PM8, M198-B218, provides a timed impulse to energize carriage 1st card R31 after the first card in has printed from third reading bushes.

PM9, M40-B90, provides a timed impulse to energize the hammerlock magnet on printing cycles only.

PM10, M255-B270, provides a timed impulse to establish the overflow skip to circuit after printing has taken place.

PM11, M246-B266, provides a timed impulse to establish the heading control skip to body circuit following the printing of last heading card.

CIRCUIT REVISIONS

WIRING DIAGRAM 210201, TYPES 402-3 AND 419

THE FOLLOWING changes will be found in the wiring diagram 210201 and machine operation will be changed only as indicated below.

C to CS Suffix Change

1. The print mechanism clutch disc has been retimed so that the clutch pawl may engage and disengage at 340°. This improves the operation of the print clutch and type bar mechanism when the machine starts a print cycle operation following a high speed idle cycle.

2. *R25 (Section 4B)* eliminated by redesign of the circuit.

3. *R234BL (Section 5B).* This contact has been moved and placed in series between R2BL and R10BU in section 4B. This change is made to eliminate a condition which locks the machine in an idle cycle when one MLP1 card is printed at the bottom of a form and during the same cycle carriage brush 12 recognizes an overflow condition with the control panel wired from OF to I. The R234BL points formerly picked R662 and R664 which prevented the indicate cycle from taking place following the carriage overflow operation and in turn also prevented PM4 from turning and allowing R568 to de-energize. Since R568-5 remained transferred, CF4 was prevented from turning and allowing R234 to de-energize.

4. *CF15 (Section 24B)* timing changed to M190°-B265°.

CF17 (Section 21A) timing changed to M225°-B245°.

CF30 (Section 22A) timing changed to M217°-B190°.

CB23 (Section 5A) timing changed to M330°-B295°.

CB26 (Section 6A) timing changed to M288°-B338°.

PM1 (Section 9A) timing changed to M350°-B15°.

PM3 (Section 9A) timing changed to M20°-B350°.

PM6 (Section 3B) timing changed to M2°-B337°.

PM7 (Section 3B) timing changed to M337°-B002°.

5. *R662-664 (Section 5B).* The non-print relay circuit is changed by the removal of the 3-coil relays R662-664 and replaced by a double coil 12 point R662. This change was made to eliminate a condition of the non-print feature which allowed the type bars to rise as a result of reversed current through the pick coil of R662. The reverse current was caused by the de-energization of counter plus, minus, total or exit suppression relays which were picked in parallel with the non-print relays by means of all cycles, card cycles, or program cycles impulses.

R662-5 (Section 9B) replaces R664-2.

R662-6 (Section 13B) replaces R664-3.

R662-7 (Section 6B) replaces R664-4.

R577-9 N/C *(Section 4B).* This contact is placed in series with R10BU and R662-4 for the purpose of opening the circuit to R79 and the zone bail control magnet as early as possible on the run in.

R577-10 N/C *(Section 9B).* This contact is placed in series between R31BU and R662-5 to open the circuit as early as possible to the single, double and triple space hold coils on the run in. R662-5 serves the same purpose when operated through control panel wiring.

R577-12 N/O *(Section 6B).* This contact is placed in series with the operating strap of R577-1 and the hold coil of R662, to cause R662 to be energized on the run in control change or when either the feed interlock or non-print run out push button is used.

For machines wired to diagrams prior to 210201D, a field bill of material has been provided to correct this condition by installing a rectifier resistance combination which nullifies the effect of the reverse current.

6. *R568-3 (Section 5B).* This contact is placed in the circuit in series with R2AL to serve the same purpose as R25B to prevent the indicate print cycle from taking place if the carriage runs out of paper and the form stop relay R53 drops. R568-3 N/O energizes the print clutch control relay R659 for the overflow indicate cycle; through R568-3 N/C, the card feed clutch control R656 is energized for normal card feed operation.

7. *Capacitor 17 (Section 7B)* has been added between the N/C side of R88BL and the operating contact of CB75 to protect these points from excessive arc when either point drops out the summary punch relays.

8. *R87A (Section 8B)* is replaced by the R853-11 point, thereby eliminating R87 relay.

9. *R573-9 (Section 9A)* is placed in series with PM3 and R53A, the R660-5 and R609-6 points have been removed. PM3 provides a test circuit for R53 hold circuit when detail printing or on the total cycle when group printing.

When group printing, the machine may run out of forms on the indicate cycle. To prevent the machine from stopping on the indicate cycle, PM2 will close at 0° but the actual space will not take place until after PM3 closes at 20°, thus R53 hold is energized until PM3 opens at 350° on the total print cycle for the indicated group of cards.

R573-9 opens on carriage restore when PM3 is not turning.

10. *R60A (Section 10A)*. These points are added to provide a shunt around R567-2 and prevent a second impulse to R32 in the event R567 is slow in dropping out during a skip operation. The method of wiring R32 has been changed to prevent a repetitive space circuit when operating the machine manually with the crank and with the PM cams turning.

11. *R5BU (Section 10A)*. Opens the circuit to R60 hold in case the machine on completion of an operation coasts to the point where CB34 would be closed. Originally R60 would hold on one depression of the space key and prevent repeated use of the space key.

12. *R665-9 (Section 9A)*. Acts as a shunt around R31BL to provide a circuit to pick carriage start R32 on a final total print operation when the control panel is wired for either single, double or triple space.

R665-11 (Section 9B). Provides a shunt around R31BU so that the single, double or triple space relay may be held if used on a final total operation.

13. *R650 (Section 21B)*. The pick circuit for the head control relays has been changed to prevent a digit impulse sensed at the second reading brushes from causing the R650-4 points to open. This allowed the card cycles relays R638-641 to de-energize while the card passing the third reading brush station was being sensed and amounts were accumulating. R650-4 (section 23B) has been removed for the above reason and R651-8 fills all requirements for suppressing card cycles impulses during heading card operation.

14. *R641 (Section 23B)*. The jumper between R638 and R641 has been removed. The wire to R641 coil is connected to the normally closed side of R651-8 so that the first five hubs in the left row of card cycles are available on all card cycles including head card and multiline card operation.

R641-6 (Section 23A) now makes the hot 10 available on *all* card cycles.

15. *Last Card Auto Total Switch (Section 29A)*. When in the OFF position, the comparing unequal circuit is normal. When in the ON position, the unequal impulse, when comparing, will not be available and a major control change will be forced in both the run in and run out regardless of control panel wiring.

LCPS Hub (Section 29B). This is the lower left unused unequal impulse hub which now becomes the last card program start exit. This hub may be wired to cause any program start following the last card cycle with the last card auto total switch in the OFF position. The LCPS hub, when used with Type 402 machines, may be wired to any program start immediate hub. When the LCPS hubs is used on Type 403 machines, it must be wired to program start delay for both normal and multiple line card operation since the second card lever relay R222BU N/O point in series with *R9BU* N/O provides the program signal.

16. *R16, 17, 18 Hold (Section 32B)*. These relays have been disconnected from CF11 and are now held by CF4 which makes at 208° and breaks at 190°. This change is made to eliminate a condition when group indication elimination is being performed by wiring from minor first card to non-print. If a minor single card group is indicated on machines wired to 210201C, R16 will be energized during the card feed cycle and held by CF11. If during the indicate cycle a major control change is sensed, a parallel path to R16, R17, R18 pick will be set up through R606-2, R606-3, R606-4, before CB49 closes. Because of the inductive load, R16 hold does not drop until 243° even though CF11 is open. This allows CB56 to complete an impulse of short duration through the points of R16AL in error.

17. *R638-12 (Section 35B)* replaces R641-5 since R641 is now active on all card cycles. R638-11 (section 35B) replaces R638-12. R641-5 (section 35B) replaces R641-4.

18. *CB81 and CB82 (Section 42A)* are wired in parallel with CB3 and 4 to allow the customer engineer to check machine operation with a 6° impulse by putting insulating paper between the points of CB3 and 4.

CS to CT Suffix Change

Mechanical changes only.

1. Toggle operating cam 2 is changed slightly. The part number of the cam is changed from 113978 to 120458.

2. Type bar setup pawl release cam 4 is timed 5° earlier.

CT to D Suffix Change

1. Sections 1 and 2. These were redrawn to include rectifier power supply. These sections are spread to a full page so that the others would not have to be remembered.

2. Section 25B. The zone magnet connections to fuse 13 and 14 were corrected to show fuse 14.

3. Sections 35-36, 41-42. All references to CB's 1, 2, 3 and 4 were changed to include the word impulse. The auxiliary CB unit was installed on this change; therefore, these CB's are not in the same location. The charts at the end of the wiring diagram were changed accordingly.

4. Section 43-44. The safety factor of the 9 and 10 impulses is increased by adding jumpers between R80BU and 80BL (operating side) and between CB14 and CB15 (stationary sides).

5. Section 81-82. To clarify the cam tolerances, the ±1 tolerance is added to the charts at the cams.

D to E Suffix Change

1. Section 4A. The start circuit was changed to go through the carriage Jones plug so that the machine could not run when the carriage is removed. R3B is corrected to J27 instead of 10CF and L3.

E to F Suffix Change

1. Section 8A and 27A. C11 and C14 were changed to improve the arc suppression. An internal resistor and an external 22,000-ohm resistor were added.

2. Section 37A. CB55 was removed and two cams were substituted, CB78 for early all cycles and CB79 for late all cycles.

F to G Suffix Change

1. Sections 1 and 2. An additional power transformer was added to provide taps on the primary side to obtain the correct machine voltage.

G to H Suffix Change

This suffix change was made to decrease the time required for summary punching. In general, it provides for an earlier negative balance test and for the starting of the summary punch. The original program was to include changes in the summary punch, which have not been made.

1. Section 3A. R5 is energized through the summary punch interlock (I39), located in section 4A.

2. Section 7A. The CB30 timing was changed to make and break earlier.

3. Section 7A. Conversion cycle R878-3 was removed from the SP start circuit and points of the individual negative balance relays were added. This was necessary because CB69 was changed to make and break earlier. R879-3 was also added in place of R878-3 to complete the circuit for negative totals.

4. Section 8B. R853-10 provides for an earlier pick of R20 and 21 on the summary punch with balance selectors through I3.

5. Section 8A. R494 is picked by CB33 instead of CB31, because its timing was earlier.

6. Section 38A. CB56 was changed to break 5° earlier, because the negative balance is completed earlier.

7. Section 43A. CB61 was retimed to make and break earlier to provide for the earlier negative balance test.

H to J Suffix Change

1. Section 6A. CB80 was added in series with CB26 to insure opening of pick circuit to idle cycles relays. This was removed in the change to suffix K.

2. Section 15A. R567-3 was removed from the hold circuit of the skip to relays. It would cause the relays to hold after a skip when the skip was for a short distance. R567 would pick and drop before CB36 could open; this would then continue to hold the relays, causing incorrect skipping.

3. Section 79 to 90. Sequence charts were added to aid customer engineers in servicing the machines. Start key circuit, programs and MLP3 operations.

4. Section 76. The R771 part number in chart was corrected. It is part number 196186, not 196188.

5. Section 93B. The contact air gap column was added to the chart for the impulse CB's.

6. Section 99 and 100. The platen feed cam on the bill feed machines was changed so that the high dwell at 0° is now at 10°.

J to K Suffix Changes

The major item in this suffix change is the change-over to the rocker type CB. Two other items were

included which do not change the wiring diagram very much. They are the relocating of the fuse panel to be opposite the door in the cover and the moving of the rectifier power supply to make room at the control panel operating mechanism.

The use of rocker type CB's necessitated two changes: First, a number of the cam timings were changed slightly (1° to 3°) because the duration of the two types of cams do not agree. These changes are not listed below. Second, the symbol for the N/C plunger CB's was inverted, because as rocker CB's the common jumpers are put on the other side.

The other items included in the suffix changes are as follows:

1. Section 5A. CB20 break time was changed to correct a drawing error on the wiring diagram.

2. Section 27A. CB72 is same as CB20.

3. Section 41-42-91-92-93. References to impulse CB's were removed. These are now located on same unit with the other CB's.

4. Section 3B. The fuse for I10 is fuse 39.

5. Section 6A. CB80 is removed because of changeover to the rocker type CB.

6. Section 4A. CB70 is connected to the line by way of 648-5 and CB24 to L4 instead of by way of CB19 and L19.

7. Section 8B. The carriage motor resistor is connected to fuse 38, not 41.

8. Section 16-17 and 18. The wiring for CB36 on a 402 connects to CB38 instead of directly to L12.

9. Section 27A. CB73 is removed and CB72 is changed to a two-lobe cam for the two impulses.

K to L Suffix Change

In general this suffix change was made to relocate and substitute components in the circuits and reduce the number of relays or operations in manufacture.

1. Section 2B. Signal fuse R26 has been removed, and the hold of carriage stop R34 has been substituted; R34 now serves two functions. R34AL replaces R26A (4A).

2. Section 3A. Print clutch control R659-6 has been added in the pick circuit of the two-speed clutch control R5 to prevent the type bars from locking up when the stop key is depressed between 18° to 45° on an overflow indicate cycle.

3. Section 4A. In the pick circuit of R19, CB70 has been replaced by CB54 and R609-2 points substituted for R621-2 and R625-2. R19P is now located in 36A.

4. Section 4A. The R10BU in the pick circuit of R79 has been interchanged with R12AL in the final total R65 circuit. This makes possible a change in relays with one of a lesser number of points.

5. Section 3A. The card feed hopper interlock R61 has been removed, and the points of R6 and 7 substituted to perform the same function. Section 23 is also changed accordingly.

6. Section 5B. The lower card lever R12BL is added to the exit suppression control R577 circuit, in order not to pick when programs are forced with a final total impulse.

7. Section 6A. The feed interlock R66AU is added to the non-print run-out key circuit so that the key cannot function if it is mistaken for the feed interlock key.

8. Section 6B. The circuit to the speed change R82 has been revised so that overflow idle cycles, during the skipping, will be at high speed. R659-6 is removed from this circuit and used in two-speed control relay circuit (item 2).

9. Section 7A. The make time of CB31 has been corrected to show the correct make time.

10. Section 8B. R66B has been corrected to R66BL.

11. Section 10B. R36 has been removed and points of R35 substituted to perform the same functions.

12. Section 12-13. Four condensers have been added to improve arc suppression, two of which are mounted on the relays. These are R33BU (12A) and R32B N/C (13A). The other two are mounted in the normal manner. They are C18 around R32B N/O (13A) in parallel with C7 and C19 around R51B (12A).

13. Section 14B. R662-6 is removed as it is not needed. PM5 does not turn on non-print cycles.

14. Section 13B-14B. The R35BL and BU are removed from the two overflow relay circuits, and R35BL is placed in the OF hub circuit to perform the same function. R35BU is used elsewhere to eliminate R36 (item 11).

15. Section 23B. R665-10 is removed as it serves no purpose.

16. Section 33. The program circuits are redesigned to eliminate relays 621, 625 and 629.

17. Section 36B. A symbol hub for final total has been added and replaces one of the final total hubs.

18. Section 42B. The card count hub is moved to CB5 (43A) to eliminate CF16. A brush isolation relay point conditions it for CF cycles.

19. Sections 45 to 64. The counter circuits have been redrawn to show the new wiring which reduces the number of solder connections.

20. Section 67B. The resistors for CB's 10, 11, 12, and 13 are reversed on the chart to correct the numbering.

L to M Suffix Change

This change adds two relay points to the circuits to eliminate circulating current through R82 pick coil due to induced voltage when R82 hold coil de-energized. This corrected printing of asterisks for 9's because of a print cycle starting at high speed.

1. *Section 6B.* The wire from 656-6 O/P to 79BL N/O has been removed, and the circuit is now from 656-6 O/P through new point, 648-6 N/O, to R82P. The wire from 659-4 N/C to 662-6 N/O was removed and replaced by a wire from 659-7 N/C to 662-6 N/O. The circuit from 659 O/P to 79BL N/C was removed and replaced by a wire from 659-4 N/C through new point, 659-7 to 79BL N/C.

M to N Suffix Change

Circuit change to eliminate failure to add a card when the machine was stopped during a tab operation and coasted to a point between 288° and 291°. Failure occurred when the machine was restarted.

1. *Section 6B.* Wire from 656-6 O/P to 648-6 N/O changed to 656-6 N/C to 648-6 N/O.

N to P Suffix Change

This change includes the addition of the portable start key and associated circuit. Also, the following troublesome items were corrected:

Extra carriage space after skip to predetermined total operation.

Loss of final total due to operator error when first card impulse was wired to non-print.

Occasional failure of relay 580 to pick and establish its hold circuit during the 9 millisecond carriage CB impulse.

1. *Section 4A and 5A.* Auxiliary start key circuit added according to supplemental wiring diagram 229456.

2. *Section 6A.* R665-12 N/O (final total level) added in parallel with 662-2 and 662-3.

3. *Section 9B.* Wire from 665-11 N/O to 31BU N/O was removed and replaced by a wire from 665-11 N/O to 662-5 N/C.

4. *Section 10A.* Hold circuit for R60 through 5BU N/O was removed from CB34 and placed on CB35. CB35 timing was changed to M249-B285.

5. *Section 74B.* R580P changed to a faster coil; part number changed from 196208 to 104753.

P to Q Suffix Change

This change was issued to correct circuit diagram symbols and wiring, and to add Note XX.

1. *Section 1.* The ground disconnect symbol was removed from the attachment cord.

2. *Section 1.* The name *Test Light Receptacle* was changed to *Convenience Outlet,* and an auxiliary circuit shown by dotted lines was provided in case the supply voltage was other than 115V AC or DC.

3. *Section 1.* Note XX was added to explain the use of convenience outlet and supplemental wiring.

Q to R Suffix

Relay 196188 was changed to a stronger hold coil relay 255735 on this suffix change. Also, this change released the counter slide chart for easier identification of counter components not shown on the circuit diagram.

ALPHABETIC SUMMARY PUNCHING

THIS DEVICE is an optional feature, which may be ordered by the customer if alphabetic summary punching is necessary. The circuit is designed to store zone information in relays on the same cycle that numerical data are group indicated into counters to provide alphabetic indication summary punching. The location of the Alphabetic Summary Punch control panel hubs is shown in Figure 186.

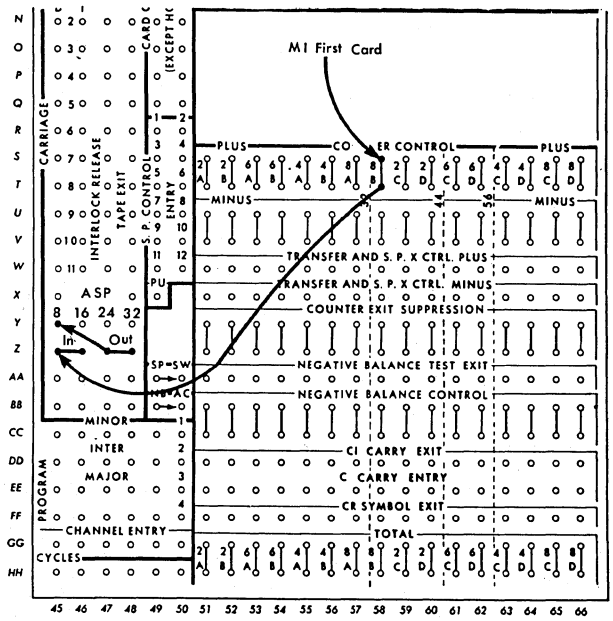


Figure 186. Alphabetic Summary Punch Diagram

Two relays are used to store each zone position. One storage relay is energized for a 12 zone, the other storage relay, for a zero zone, and both are energized for an X- or 11 zone. On the wiring diagram 294621 (Figure 187), the chart shows that position 1 uses ASP3 and ASP4 storage relays.

Storage of zone information is performed as follows: The control panel is wired from the read-in hub to the plus of the counter group that is equipped with alphabetic summary punching. A wire from the first card minor hub to the plus relay of the same counter causes it to accept information from the first card of each new control group at the same time energizing the read in control switch R19. During the same cycle, the impulses from the reading brushes are conducted by control panel wired to the counter entry hubs of the alphabetic summary-punch counter. The numeric portion is added into counters in the normal manner. The zone portion picks one or both of the storage relays and sets up the readout circuit for punching the proper zone digit.

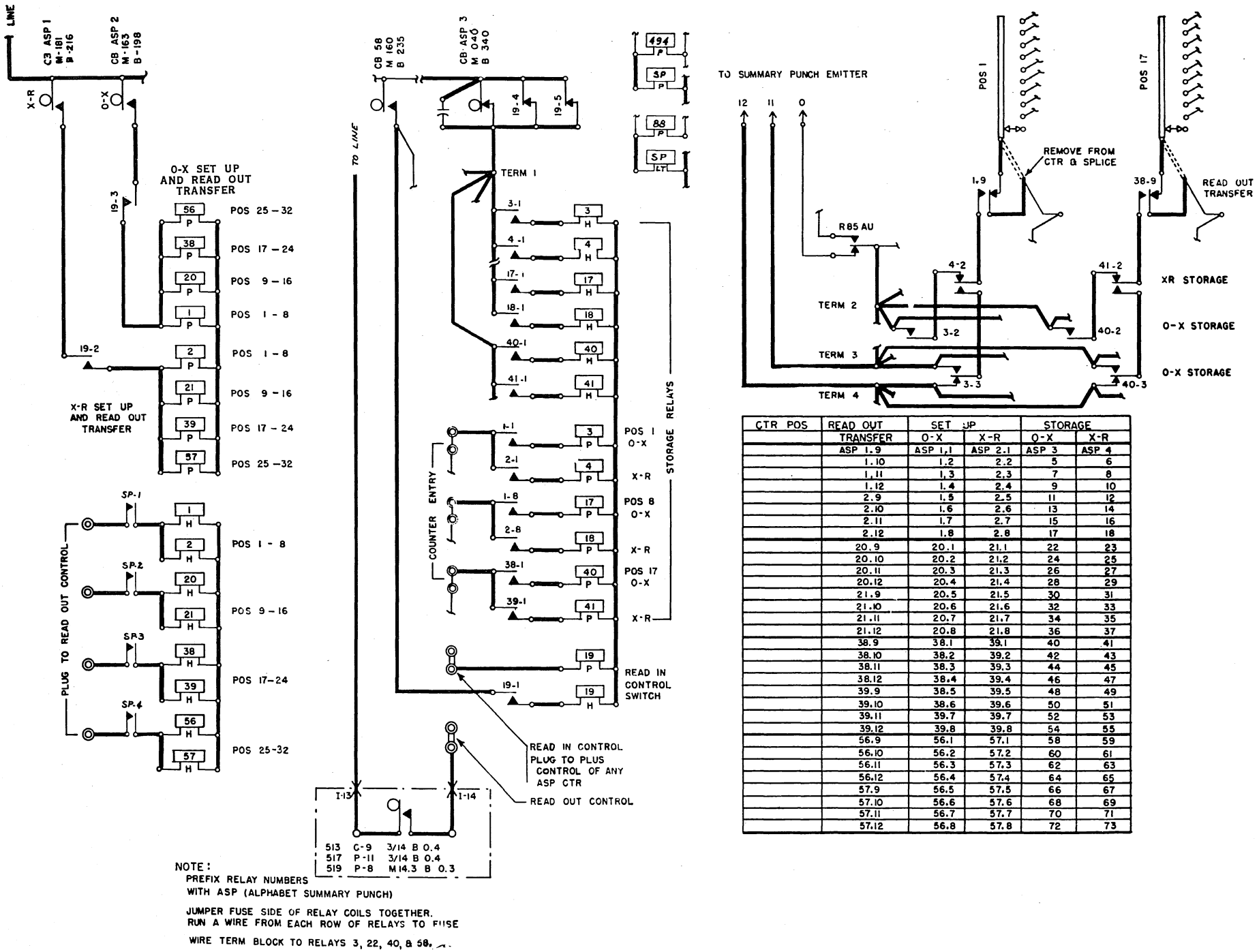
PREPARATION: The control panel is wired for alphabetical summary punching as shown in Figure 186. A card containing S (0-2) is fed through the machine. The wiring diagram of Figure 187 will be used in the following circuit outline.

Read-In Objectives

1. To energize the read-in control switch.
   ASP R19 picks through control panel wire from read-in hub, counter control-plus hub, first card minor hub, CB56 and CB's 78-79.
   R19 holds from CB58.
2. To condition the pick of ASP storage relays for O-X or X-R digits.
   a. ASP R1 picks through 19-3 from CB ASP2.
      No hold.
   b. ASP R2 picks through 19-2 from CB ASP1.
      No hold.
3. To store a *0* zone
   a. ASP R3 picks through ASP 1-1 from the counter entry hub.
      ASP R3 holds through CB ASP3 and later through ASP R19-4 and 5.

Readout Objectives

4. To pick zone readout switch SP1 and readout transfer relays.
   a. SP1 picks and latches transferred in parallel with R494 in the accounting machine.
      SP1 latch trips in parallel with summary-punch end R88.
   b. ASP R1 and 2 hold is energized through SP-1 control panel wire from readout control hub and C9 (located in the Type 513 summary punch).
5. To summary punch the zone zero.
   a. Punch magnet in summary punch energizes through summary punch cable to position 1, ASP R1-9 N/O, 4-2 N/C, 3-2 N/O, 85AU N/C and 0 spot on the summary punch emitter.
      When C9 opens after zone zeros have been punched, the hold for ASP R1 and 2 is broken.
6. To summary punch the numeric 2.
   With readout transfer ASP R1 and 2 de-energized summary punching proceeds in the normal manner.



NOTE:
PREFIX RELAY NUMBERS
WITH ASP (ALPHABET SUMMARY PUNCH)

JUMPER FUSE SIDE OF RELAY COILS TOGETHER.
RUN A WIRE FROM EACH ROW OF RELAYS TO FUSE

WIRE TERM BLOCK TO RELAYS 3, 22, 40, & 58.

CTR POS	READ OUT TRANSFER	SET UP O-X	SET UP X-R	STORAGE O-X	STORAGE X-R
	ASP 1.9	ASP 1.1	ASP 2.1	ASP 3	ASP 4
	1.10	1.2	2.2	5	6
	1.11	1.3	2.3	7	8
	1.12	1.4	2.4	9	10
	2.9	1.5	2.5	11	12
	2.10	1.6	2.6	13	14
	2.11	1.7	2.7	15	16
	2.12	1.8	2.8	17	18
	20.9	20.1	21.1	22	23
	20.10	20.2	21.2	24	25
	20.11	20.3	21.3	26	27
	20.12	20.4	21.4	28	29
	21.9	20.5	21.5	30	31
	21.10	20.6	21.6	32	33
	21.11	20.7	21.7	34	35
	21.12	20.8	21.8	36	37
	38.9	38.1	39.1	40	41
	38.10	38.2	39.2	42	43
	38.11	38.3	39.3	44	45
	38.12	38.4	39.4	46	47
	39.9	38.5	39.5	48	49
	39.10	38.6	39.6	50	51
	39.11	39.7	39.7	52	53
	39.12	39.8	39.8	54	55
	56.9	56.1	57.1	58	59
	56.10	56.2	57.2	60	61
	56.11	56.3	57.3	62	63
	56.12	56.4	57.4	64	65
	57.9	56.5	57.5	66	67
	57.10	56.6	57.6	68	69
	57.11	56.7	57.7	70	71
	57.12	56.8	57.8	72	73

Figure 187. Alphabetic Summary Punching Diagram

AUXILIARY STORAGE DEVICE

PRINCIPLES OF OPERATION

NUMERICAL and alphabetic information can be mechanically stored in the auxiliary storage device used in the Types 402-403 Accounting Machines. The stored data may be read out electrically and used for printing, crossfooting, and summary punching. When it is used for numerical storage, the storage unit releases counters, used previously for storage, for other accumulating operations.

The storage unit is divided into four sections: A, B, C, and D. Each section has a capacity of eight positions, which can store one value, 9 through 12; therefore, when an alphabetic character is stored, one position is needed for the numerical portion and one for the zone.

The unit is available in two capacities: 16 positions using sections A and B, and 32 positions using all four sections.

Control Panel

The control panel hubs are located in panels 1 and 2 and in rows FF, GG, and HH (Figure 188). The purposes of these hubs are described with regard to sections A and B. The hubs for sections C and D serve the same purposes as those for A and B; therefore, they will not be described.

Storage Entry. Two common entry hubs are provided for each position of storage. These hubs will accept information only when that section of the unit is controlled to read-in.

Storage Exit. These hubs are used when the stored information is transferred from the storage unit to some receiving unit in the accounting machine, either a counter, type bars, or another storage unit.

Read-in (RI). This hub is used to control the entry into the storage unit. Restoration of any previously stored information automatically occurs when this hub is impulsed.

Zone (Z). These hubs emit two impulses, one at EAC time to cause restoration of the storage unit and one beginning at half after 1 time to allow storage of zone information only.

Read-out (RO). This hub controls the transfer of information from the storage unit to some receiving unit in the accounting machine.

Summary Punch (SP). Two common hubs emit an impulse for the entire duration of summary punching.

Punch from Storage A (SP-A). This hub accepts impulses to control summary punching from storage.

Alphabetical Punch (AP). This emits an impulse for zone time of the summary punch cycle.

Unit (U). This is wired from the AP hub. It is used when alphabetic summary punching to select internally the zone information stored in section B and direct the zone information out of the exit cable for section A. This allows the zone information from B to combine with the numerical information from A and be available from the exit of section A on the summary punch panel.

APPLICATION

A TYPICAL alphabetic summary punching operation is shown. It is desired to summary punch man name and man number, both of which appear in the first card of each group. For simplicity the name used is John Doe, and his man number is 12345.

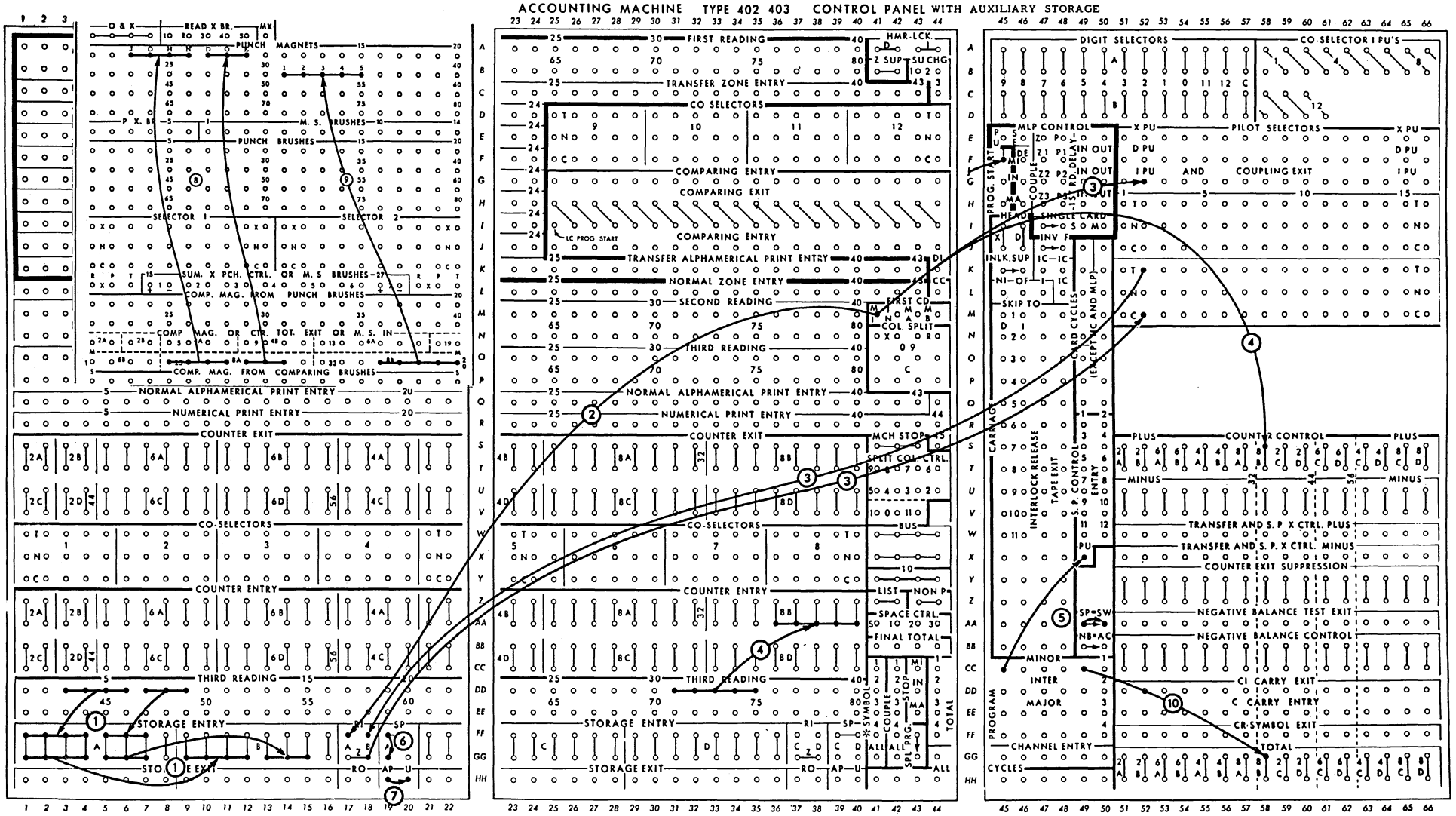


Figure 188. Control Panel

Wiring — Figure 188

1. This is position wiring to allow *man name* to enter storage entry of A and B.

NOTE: When numerical and zone information is stored in A and B, the entry must be wired from one reading station to allow all the data to be stored during one cycle.

2. Section A is impulsed to read-in during the minor first card cycle to allow the numerical data to be stored.

3. Section B is impulsed through a pilot selector during zone time of the minor first card cycle to allow the zone data to be stored.

NOTE: The numerical data *must* be in A, and the zone data *must* be in B. Sections C and D must be used in the same manner when alphabetic summary punching.

4. Counter 8B is impulsed to store *man number* during the minor first card cycle.

5. The summary punch switch is wired ON, and minor totals are directed to punch.

6. Section A is wired to summary punch (A to SP).

7. Section B is wired to summary punch through the same cable as A during zone time only (U to AP).

8. The name is punched from sections A and B through exit for section A into columns 3-9.

9. The man number is punched from counter 8B into columns 31-35.

10. Counter 8B is wired to clear during the minor total cycle.

MECHANICAL PRINCIPLES

IN appearance and operation, the storage unit used with the Type 402-403 is similar to those units used in the Type 77 and 407 in that information is mechanically stored by positioning a ratchet. The storage unit is mounted on rails on the under side of the upper base at the right end of the machine (Figure 189). A means of providing mechanical drive from the continuously running shaft is added directly behind the storage unit (Figure 190). A long cable is provided to facilitate removal of the unit.

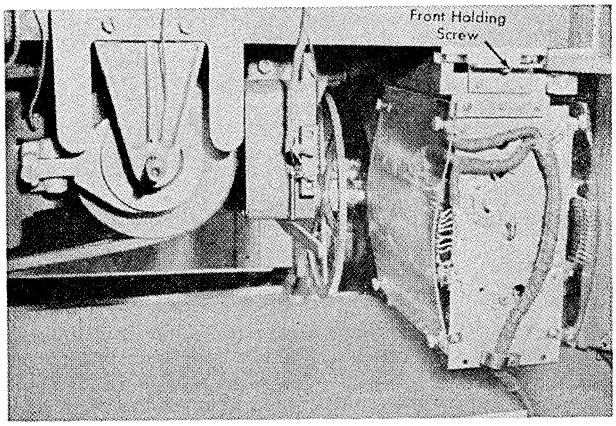


Figure 189. Storage Unit Mounting

Each position of storage consists of a magnet, armature, stop pawl, setup ratchet and contact, and emitter contact assembly (Figure 191). The emitter assembly (Figure 192) contains 14 contact bars located in a horizontal position, one for each possible value to be stored (9-12) and one for the blank position. One additional contact bar is used to keep the contacts from popping out past the 9 emitter when the ratchet is restored. In addition, there are 16 vertical bars for the commons for the 16 positions of one half the unit. The ratchet has 12 teeth, a stop or blank position, and a high portion just past the 9 tooth (Figure 193). The ratchet is driven against its spring tension from the blank position past the 9 tooth by the setup bail. This action is used when restoring or resetting.

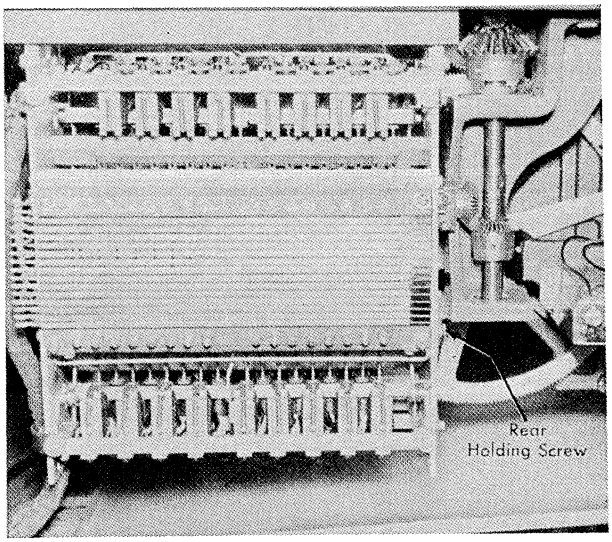


Figure 190. Mechanical Drive Unit

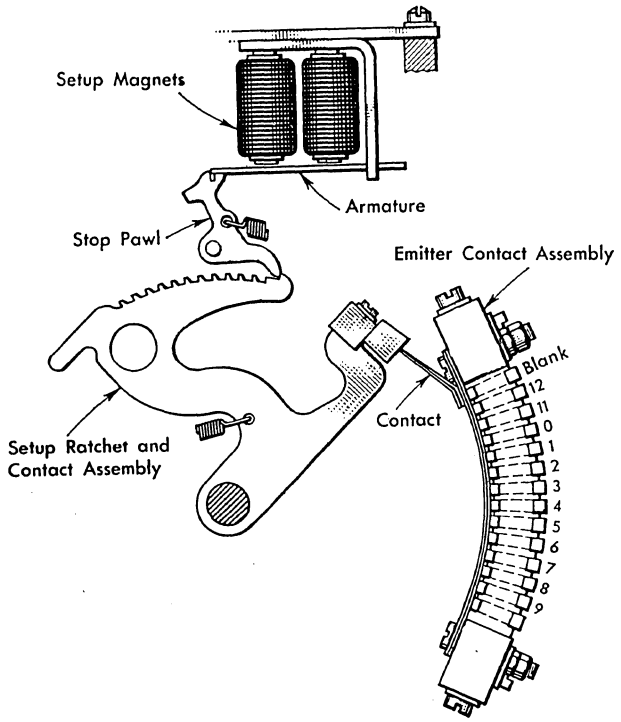


Figure 191. One Position of Storage

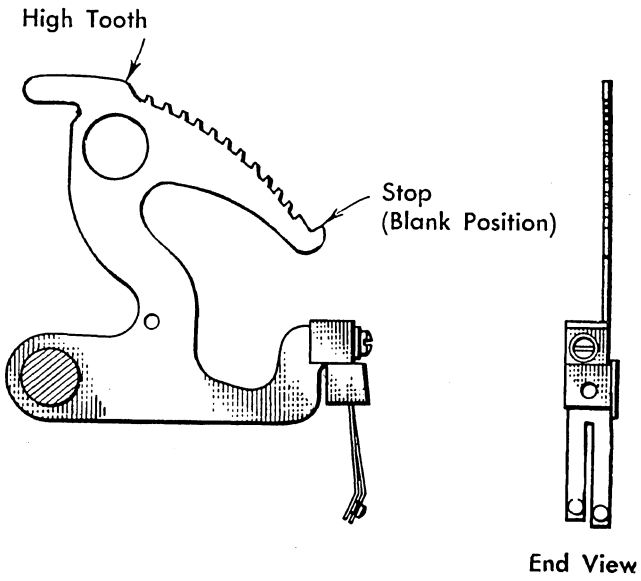


Figure 193. Ratchet and Counter

As the setup bail is cammed back, the spring-driven ratchet rests against the bail. This portion of the cycle is for reading-in.

The setup bail is controlled by a restoring magnet. When the bail is restoring the ratchets, the bail is spring driven, but it is cam driven on the return or read-in portion of the cycle. The home or latched position of the bail occurs when the driving springs are fully extended, and the bail is in a position to allow the ratchets to come to rest at the blank position (Figure 191).

When a section of the unit has been controlled to read-in, the restoring magnet is impulsed, and the setup bail is unlatched. The setup bail springs drive the bail, restoring all the ratchets past 9. The high portions of the ratchets restore the setup pawls to their armatures. As the bail is cammed back, the ratchets follow the bail in synchronism with the

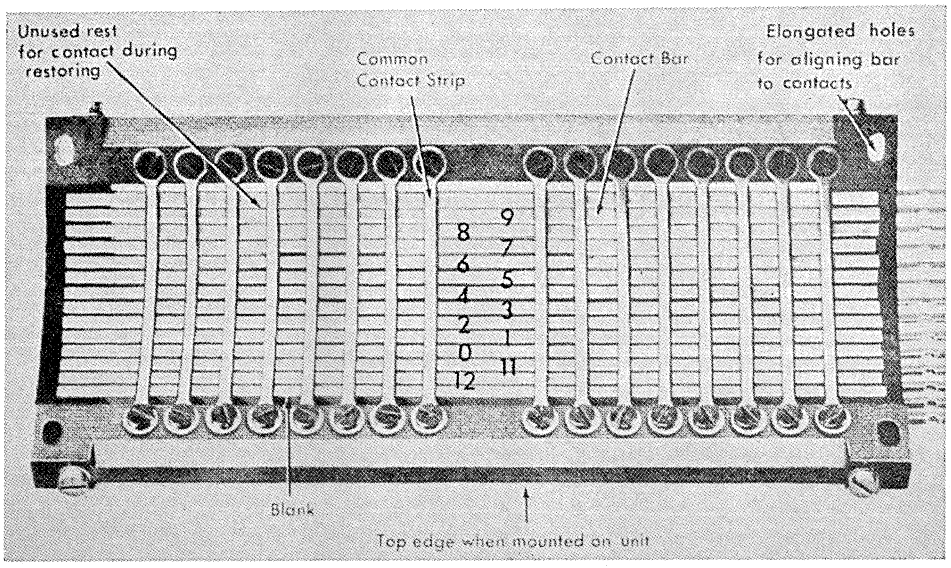


Figure 192. Storage Unit Emitter

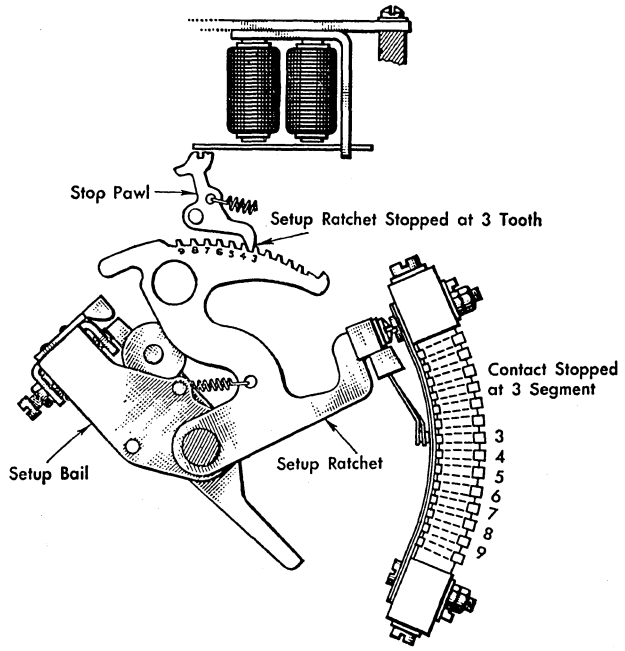


Figure 194. Storing a "3"

machine index. When an impulse reaches a setup magnet, the pawl is released and engages a tooth of the ratchet. The contact on the ratchet now rests on an emitter bar equivalent to the impulse received by the setup magnet (Figure 194). The setup bail continues moving and is relatched at the end of the cycle. In positions where the setup magnets do not receive impulses, the ratchets are free to follow the bail until stopped in the blank position.

As just explained, the setup bail must be operated to clear a previously stored figure and to place a new reading in the unit for storage. One complete operation or cycle of the setup bail will perform both of these functions; therefore, if the restoring magnet is properly controlled, data may be stored for any desired number of cycles.

There are two restoring magnets in the unit. The one located at the top controls sections A and B, and the one on the bottom controls sections C and D. Each magnet controls one setup bail, but both bails are driven from the same cam, cam follower, and arm assembly (Figure 195).

When the ratchets are driven to the point where the high-tooth cams the setup pawls back to a relatching position, a positive knockoff is provided for the armatures (Figure 196). This overcomes any tendency of the armature to hang up because of residual magnetism. This knockoff action takes place as a result of the setup bail camming the knockoff bail.

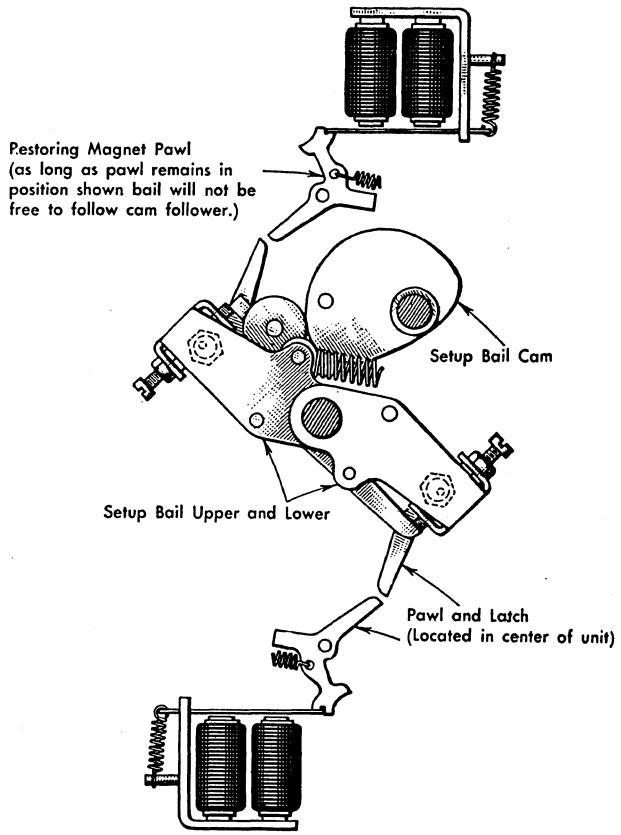


Figure 195. Restoring magnets and Bails

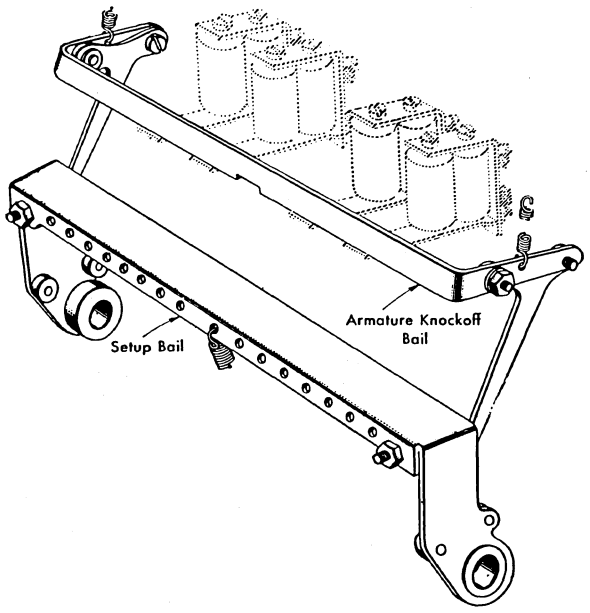


Figure 196. Set Up Magnet Armature Knockoff

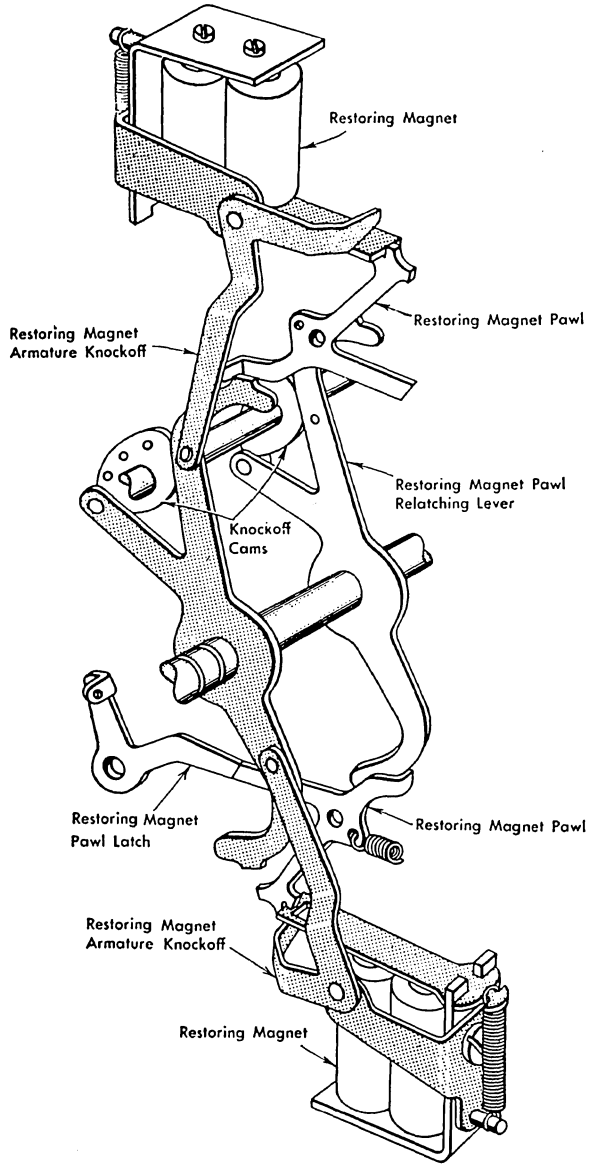


Figure 197. Restoring Magnet Armature and Pawl Knockoff

In like manner, the restoring magnet armatures and pawls have positive knockoffs. The actions result from two cams in the center of the unit. The same pair of cams serve both upper and lower units (Figure 197).

PREVENTIVE MAINTENANCE

Check

1. Operational checks should be run every four months.

2. A complete mechanical inspection at least once every year should be made to check for the following:

a. Magnet armatures for wear at latch point and dirt between armature and core.

b. Setup bail springs for correct strength. It should not be possible to push the setup bail back when the restoring cams are in their low dwell.

c. Setup pawl pivot rods for wear.

d. All unit adjustments. Setup pawl to ratchet overlap, setup armature knockoff, restoring magnet armature knockoff, and relatching clearance of restoring bail.

e. Contact emitter and ratchet contact for good contact and alignment.

Lubrication

IBM 6. Spray all pivot points and setup ratchets.

IBM 9. Cam follower rollers.

IBM 17. Restoring cams and knockoff cams. Bevel gears driving the unit must be kept well lubricated.

REMOVAL AND ADJUSTMENT PROCEDURE

Removal

1. Remove the rear holding screw (Figure 190).
2. Remove the front holding screw (Figure 189).
3. Slide the unit to the front of the machine and place it on the floor.

To replace the unit:

1. Retime the unit following the directions on wiring diagram 296005.

a. Set the machine at 348°.

b. Trip the restoring magnet and allow the bail to rest in the low dwell of the cam.

c. Mesh the drive gear.

2. Replace and tighten the rear holding screw first.
3. Replace the front holding screw.
4. Check for a 1/32″ overlap of the stop pawl on the 9 tooth at 27°.

Adjustments

1. Form the armatures for a .002″ to an .008″ clearance between the attracted armature and the core nearest the pivot (Figure 198).

2. The magnet assembly mounting brackets are located for a .004″ to .010″ unlatching clearance. Form the armature for an individual adjustment (Figure 198).

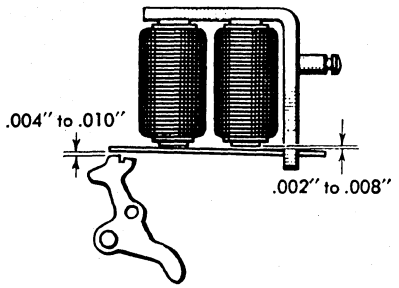


Figure 198. Adjustments 1 and 2

3. Adjust the restoring magnet for a relatching clearance of .005" to .010" when it is on the high dwell of the knockoff cam (Figure 199).

4. Form the knockoff arm for a .002" to .006" clearance between the restoring magnet armature and the knockoff when the knockoff is on the high dwell of the cam (Figure 199).

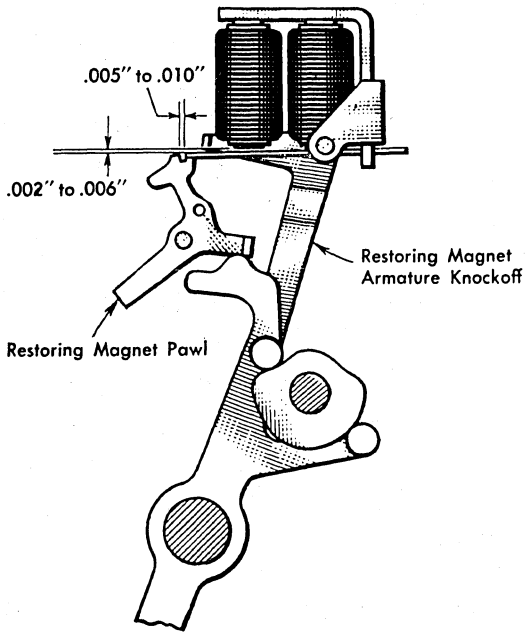


Figure 199. Adjustments 3 and 4

5. Move each magnet to the front or rear to provide a .024" to .028" clearance between the ratchets and the stop pawls (Figure 200). This should provide a relatching clearance of .010" to .014" (Figure 201).

6. Time the unit of the machine. Trip the restoring magnet and allow the cam follower to settle in the low dwell. Insert the unit with the index at 348°. Check for a 1/32" overlap of the pawl on the 9 tooth at 27° (Figure 202).

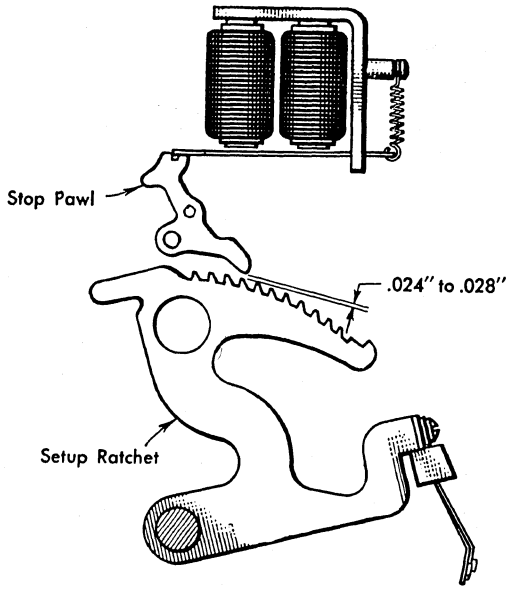


Figure 200. Adjustment 5

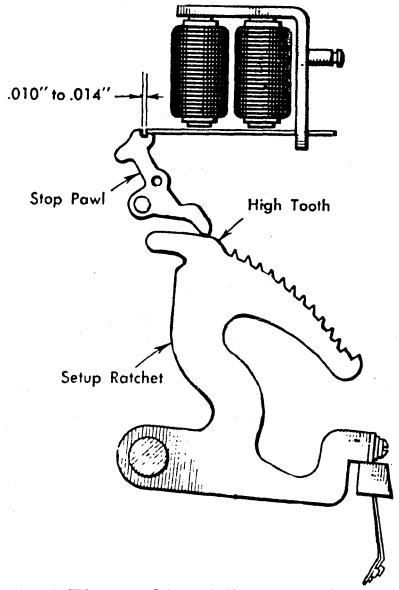


Figure 201. Adjustment 5

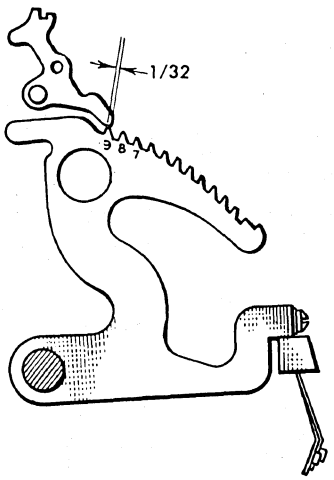


Figure 202. Adjustment 6

If the setup bail adjusting screws have been altered, observe the following procedure:

Turn the setup bail adjusting screws to project 5/64" from the bail at the point where the screw bears against the cam follower. Set the machine at 27°, trip the restoring magnet, and turn the unit until the setup pawl overlaps the 9 tooth by 1/32". Be sure the ratchet is moving from 9 toward 12, and mesh the gears. Adjust the setup bail adjusting screws for an even 1/32" overlap of the pawl on a ratchet tooth across the unit at any impulse time. Both bails may be adjusted with the unit on the machine. If desired, the most easily accessible bail may be adjusted on the machine, the unit may be removed, and the remaining bail may be adjusted using the first bail as a guide. Then re-install the unit.

7. Adjust the restoring bail latch eccentric pivot for a .028" to .032" relatching clearance (Figure 203). Check for at least a .044" clearance of the setup bail to the ratchets with the restoring pawl against its latch (Figure 204).

8. With the setup bail at the low dwell of the cam, adjust the armature knockoff bail eccentric adjusting studs so the armatures will have a .002" to .006" motion (Figure 205).

9. Adjust the ratchet contact assembly so that a contact point is centered on the common bar. Then locate the emitter assembly vertically so that the other contact point is centered on each emitter bar for each position, 9-12, of the ratchet.

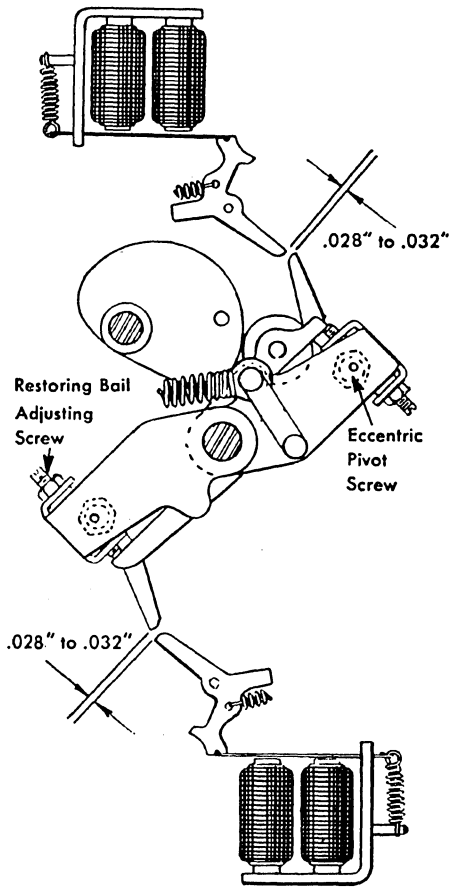


Figure 204. Adjustment 7

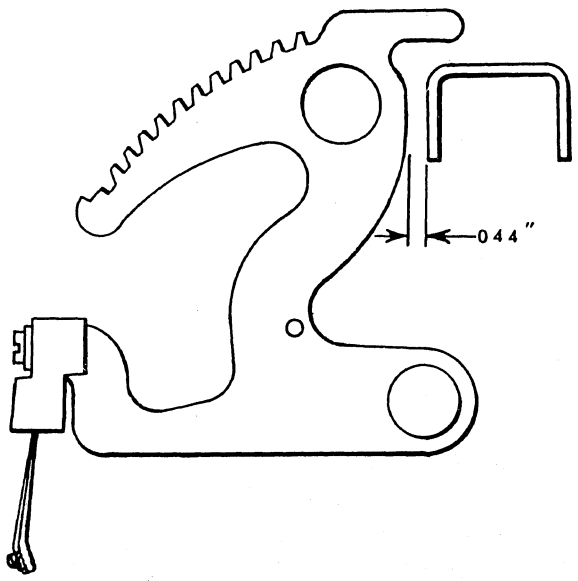


Figure 203. Adjustment 7

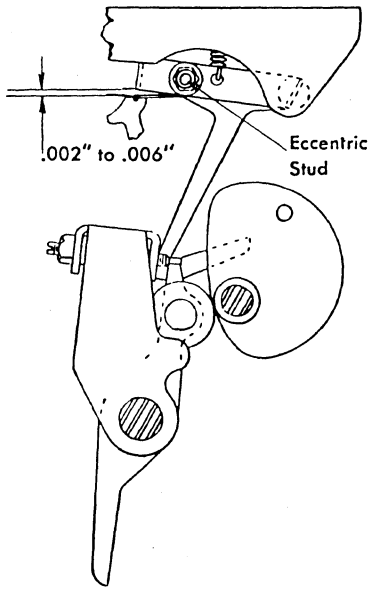


Figure 205. Adjustment 8

CIRCUITS

General

1. Restore control ST10 is picked during the first machine cycle and held until the machine is stopped.

2. Early all cycles ST9 is energized for EAC time every cycle.

3. Wiring change at gang punch switch (2A). Two speed clutch magnets are still controlled by gang punch switch, but R5 and ST10 are by-passed to the line. The machine may be cranked by hand with the gang punch switch ON, and ST10 will be operative. This allows the impulse to reach the restore magnets.

Numerical Read-In, Storage A

The control panel is wired as shown in Figure 188. Wiring diagram 296005D will be used for all circuit outline descriptions. Figure 206 is a sequence of numerical and zone read-in and readout.

OBJECTIVE: To set up the numeric portion of an alphabetical field in storage A.

1. RC1 picks through ST9-1 N/O, control panel wire, first card minor hub EAC impulse. 1A
   RC1 holds through CB ST1. 1A
2. Restore magnet picks through RC1-2, ST10-3, CBST2. 1B
3. RST2 picks through ST9-1 N/C, control panel wire, first card minor hub LAC impulse. 1A
   RST2 holds through CB58. 1B
4. RST1 picks through ST2-11 from CB40; no hold. 1B
   ST1-1 through ST1-6 open to isolate the readout from the read-in circuit. 5A
5. Setup magnets of storage A pick through ST2-3 through ST2-10 by numerical impulses from third reading. 3B

Zone Read-In, Storage B

OBJECTIVE: To set up the zone portion of an alphabetical field in storage B.

1. Storage B read-in hub is impulsed through pilot selector 2 from Read-in Z hub. 1A
   RST3 picks through control panel wire, pilot selector 1 transferred, A and B RIZ hub, ST9-9 N-C, CBST 13.
   RST3 holds through CB58.
2. RST1 picks through ST3-11 from CB40; no hold. 1B
   ST1-1 through ST1-6 open to isolate the readout from the read-in circuit. 5A
3. Setup magnets of storage B pick by zone impulses through ST3-3 through ST3-10 from third reading. 4B

Readout Storage A and B

Because of the many ways in which readout may be controlled, no readout control panel wiring is shown. The time at which storage A and B should read out will be determined by the particular print cycle in which the stored alphabetical information is required. Readout circuits for A and B are identical, and only A will be described.

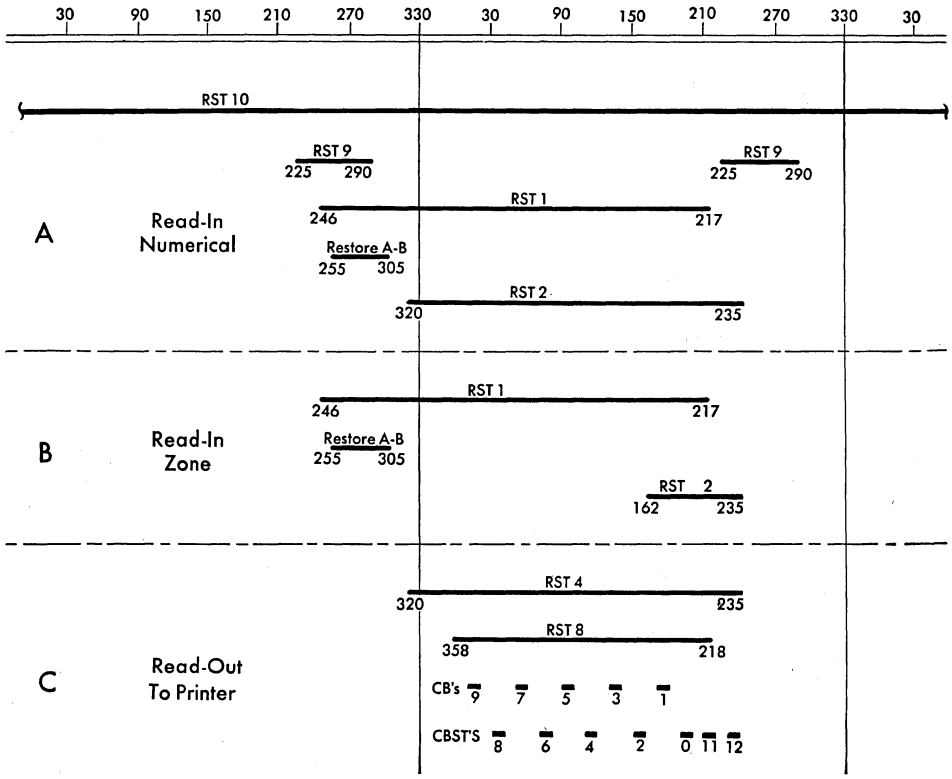


Figure 206. Sequence of Read In and Read Out

OBJECTIVE: To cause storage A to read out for printing the stored numeric information.

1. The read-out hub for storage A is impulsed from any source emitting LAC.
   RST4 picks through ST9-3 N/C, control panel wire to LAC source (card cycles, etc.). 1A
   RST4 holds through CB58. 1B
2. RST8 picks through ST4-2 and CB40; no hold. 1B
3. Storage emitter cams (3A-B) search storage A emitter assembly through ST8-1 to ST8-12. 3-4A
   Impulses are available from storage A exit through ST4-3 to ST4-10. 5-6-7A

SUMMARY PUNCHING FROM STORAGE

General

1. Storage exits and counter exits on the summary punch panel are common. Selection of either one is accomplished by control-panel-operated transfer relays (Figure 207). The association of the storage and counter exits is shown below:

Storage Unit Positions	Designation	Counter Group
1-8	A	8A
9-16	B	8B
17-24	C	8C
25-32	D	8D

2. Zone information, numerical information, or both may be punched from storage with proper control panel wiring.

3. The SP (summary punch) hubs will emit a continuous impulse for the length of summary punching.

4. The AP (alphabet punching) hubs emit an impulse for zone time of the summary punch cycle.

5. The U (unit) hubs control the operation of relays to bring zone information from group B, and numerical information from group A out of the group A summary punch exit hubs.

6. When numerical information is summary-punched from any storage group, the associated counter cannot be used for summary punching.

Alphabetic Summary Punch Using a Counter

OBJECTIVE: To summary punch alphabetic information using storage A for zone digits and associated counter 8A for numeric digits. Assume zone and numerical information previously entered in storage A and counter 8A.

1. The AP hub is wired to punch from storage A. 1-2A
2. Summary punch panel wired from storage A (Ctr 8A) exit to punch magnets. Figure 187.
3. RST11 picks in parallel with summary control R877. 2B
   RST11 holds through CB ST3. 2B
4. RST6 picks through control panel wire from AP (2A) I14, C9 in Type 514, I13, to line in Type 403. 1A
   No hold.
5. RST6-3 to 10, transferred during zone time of the summary punch, complete circuits from the summary emitter, through the storage emitter, to the punch magnets. 5-6-7A
6. RST6, normal during numerical punching time, allows summary punching of digits in the usual manner.

Alphabetic Summary Punch from Storage

OBJECTIVE: To summary punch both zone and numerical information from alphabetical storage. Numerical Information *must be in storage A,* Zone Information *must be in storage B.*

1. SP is wired to PUNCH FROM STORAGE A. 1A
2. AP is wired to U (unit) hub. 1 and 2A
3. R877 and RST11 pick in parallel as before. 2B
   RST11 holds through CB ST3. 2B
4. RST6 picks and holds through control panel wire to SP hub, ST11-3 and 4, line. 1A
5. RST13 is picked by an impulse from AP to U for zone time of the summary-punch cycle. This establishes circuits from the summary-punch emitter, through storage B and out storage A exit for zone punching (Figure 207). 1A
6. RST13, normal during numerical punching time, completes circuits from the summary punch emitter, through storage A emitter to the punch magnets for numerical punching.
7. Counter group 8B can be used for any normal operation during this application including summary punching.

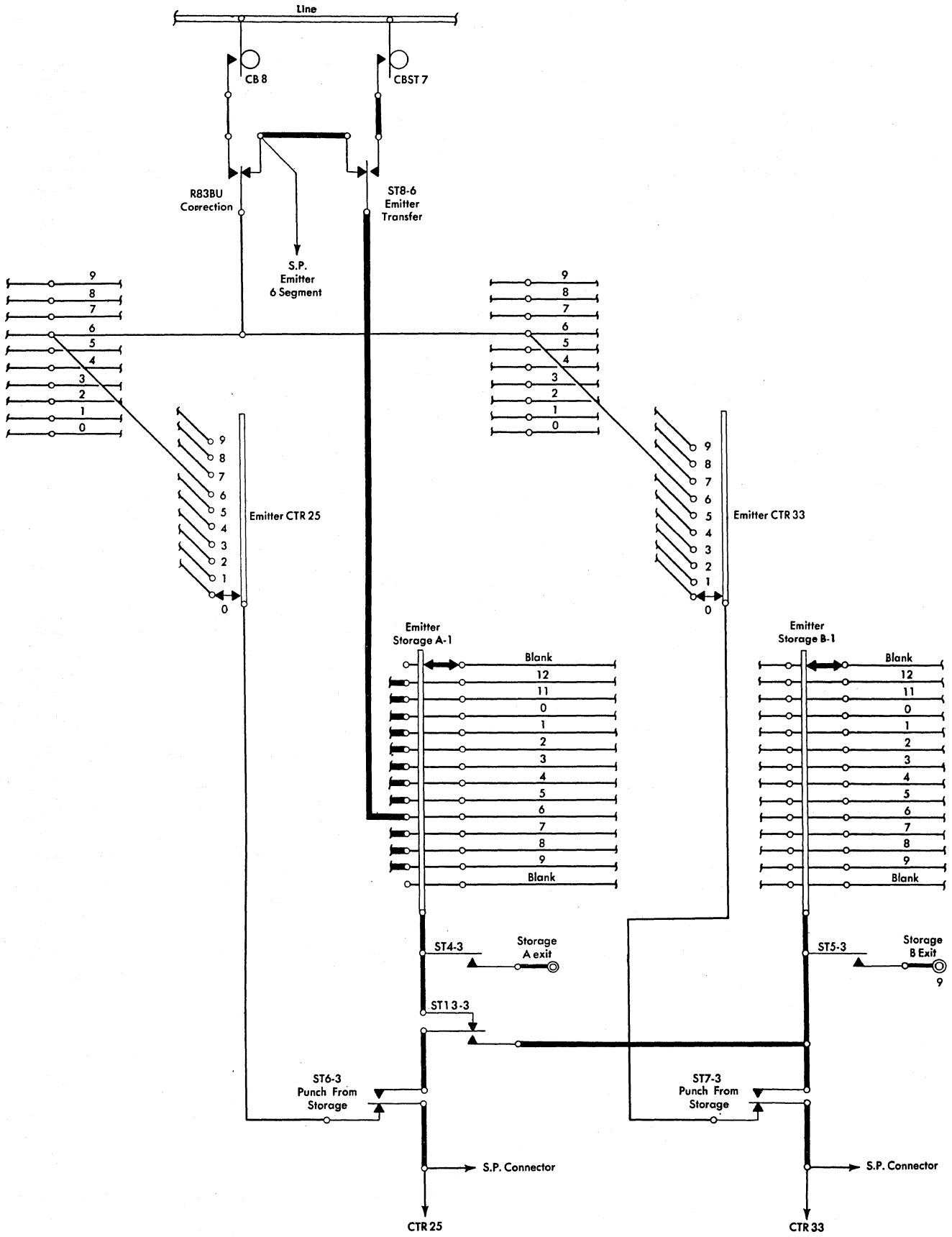


Figure 207. Counter and Storage Association

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