IBM

Field Engineering

Theory of Operation

83 Sorter

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MAJOR REVISION (APRIL 1962)

This edition, 225-6694-2, is a major revision that obsoletes IBM 83 Sorter Supplement, 225-6829-0, by combining it with 225-6694-1. Other changes in this manual are:

Switches, Keys, and Lights includes the error-retention switch operation.

Circuit Description includes the newer power supply, motor, and tube circuits.

Sorting Circuits is revised to wiring diagram 336001-G.

Special Features is expanded to include card matching, group sorting, length of field, multiple-column selector, sort suppression, zero elimination, and file feed.

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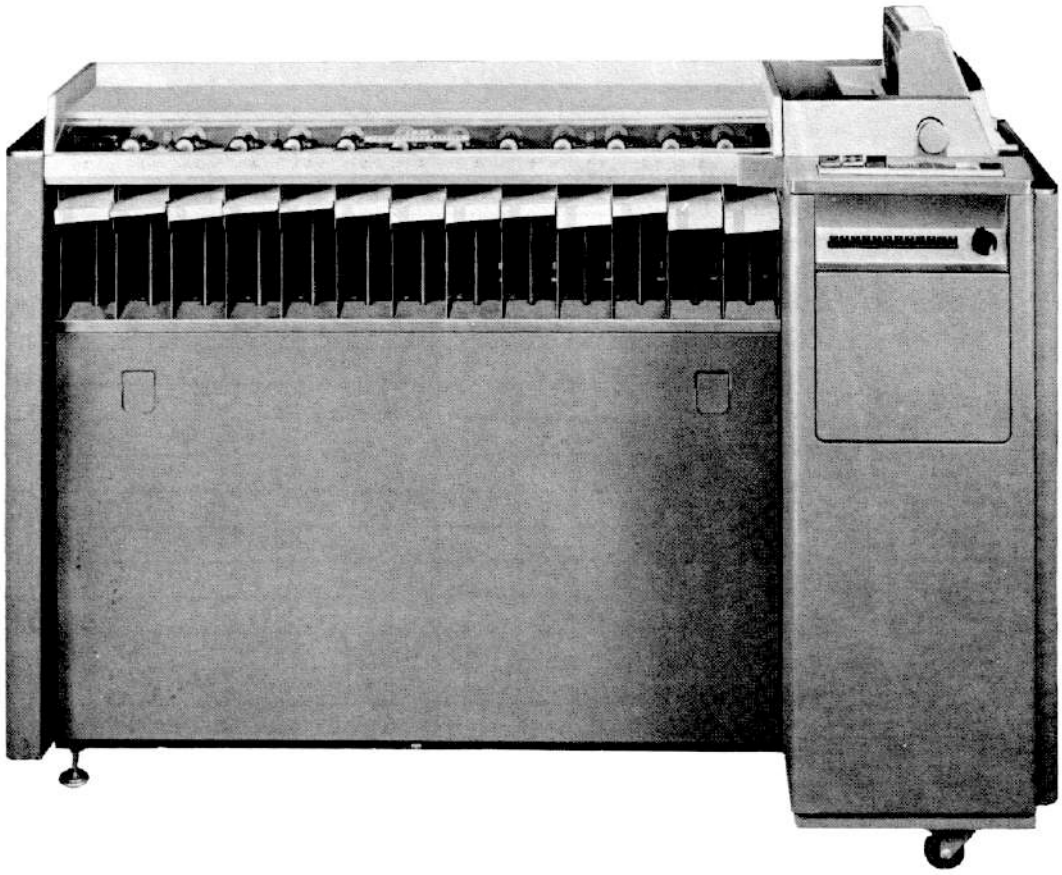


Figure 1. IBM 83 Sorter

Functional Principles

An important part of an accounting system is the sorting of unit records. In the IBM Data Processing System, the IBM 83 Sorter (Figure 1) operates at 1,000 cards per minute to arrange cards quickly and accurately into any desired sequence for the preparation of reports.

Operating Features

Card Feeding

The sorter has a continuous, horizontal card-feed mechanism that permits the operator to refill the hopper while the machine is in operation. The hopper capacity is about 1,200 cards. The cards feed automatically from the bottom of the pack, 9-edge first, through the throat, and past the sort brush. The sort brush reads the holes in a column by causing certain tubes to conduct. The tubes that are in conduction pick relays that select the pockets into which the cards go. Feed rolls carry the cards to the pockets where they are stacked.

Editing

During sorting, cards can be automatically checked to determine that the punching conforms to a selected pattern. This checking feature is called *editing*. It is switch-controlled, and it can be omitted when not desired. The detection of an error by the machine rejects the card and stops the machine, or rejects the card without stopping the machine. The position of the edit-stop switch controls the stopping of the machine in case of error.

Stacker Pocket Capacity

The sorter stops when any one of its 13 pockets is filled with cards. The pocket stops are adjustable, and can be set so that each pocket holds about 400, 565, 735, or 900 cards. To do this, position the handle at the rear of the machine. Moving the handle to the right lowers the stops and increases card capacity before the machine stops. Moving the handle to the left raises the stops and decreases card capacity (Figure 2).

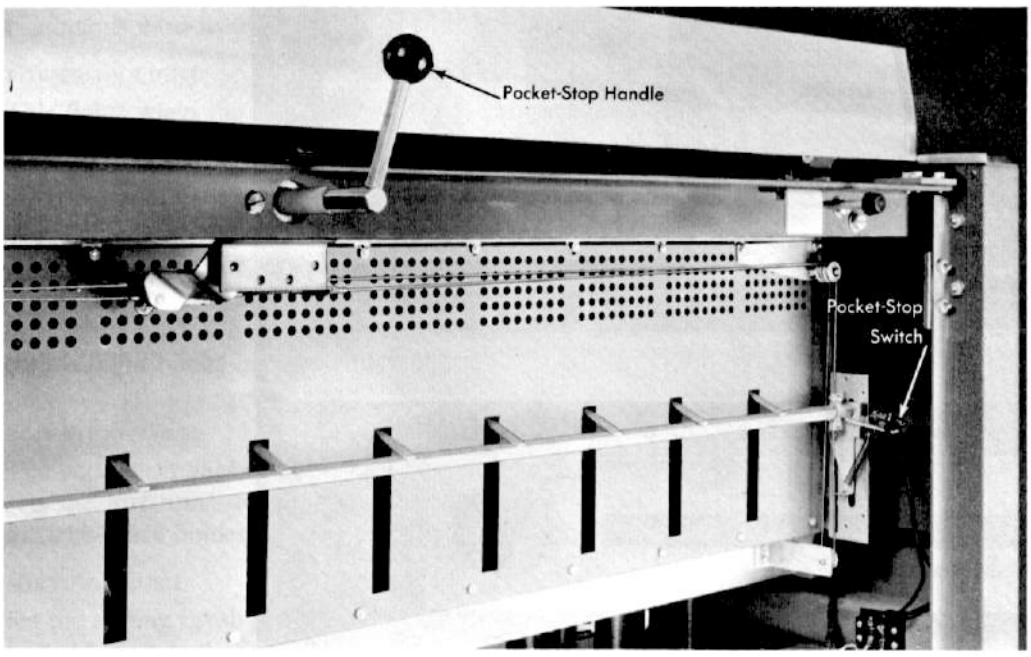


Figure 2. Adjustable Pocket-Stop Mechanism

Jam-Bar Stop Mechanism

There is a jam bar over the length of the machine feed. The bar is a spring steel strip located just above the card travel line. Any card that is bent or damaged enough to flex the metal strip operates a switch that stops the machine within three to five machine cycles.

Switches, Keys, and Lights

MAIN-LINE SWITCH

This switch must be ON to operate the machine. When the switch is first turned on, there is a short delay to allow the tube filaments to heat before the machine operates.

DIGIT-SUPPRESSION KEYS

Twelve digit-suppression keys suppress sorting on specific punches. Each key represents one digit or zone in a column. When a key is pressed, the corresponding punch is disregarded in selecting the sort magnet (Figure 3).

SORT-SELECTION SWITCH

The sort-selection switch governs the pattern into which the cards are sorted. The five settings of this switch are:

1. numerical
2. zone
3. alphabetic 1
4. alphabetic 2
5. alphamerical

Numerical (N). Cards sort on the basis of the first hole read as the cards pass the brush. Blank cards are rejected. Any card with more than one punch in the column being sorted is an error card.

Zone (Z). Cards sort on the zone (0, 11, 12) punches only. The sorter disregards punched holes 1-9. Any card with more than one zone punch in the column is an error card. Cards without a zone punch reject.

Alphabetic Sort 1 (A1). Cards with a 12-zone punched in the column (that is being sorted) sort on the underpunched digit. An 11-zone sorts into the 11-pocket. A 0-zone sorts into the 0-pocket. Any card with multiple-digit punches or with multiple-zone punches is an error card. Cards with one-digit punch (1-9) only or with a 12-zone punch only, and blank cards are rejected.

Alphabetic Sort 2 (A2). Cards with a 0-zone or 11-zone punch sort on the underpunched digit. Error conditions are the same as for *Alphabetic Sort 1*. Blank cards or cards with only one-digit punch are rejected.

Alphamerical (AN). Cards that are punched with a digit punch (0-9) and with no-zone punch sort into the digit pockets. Cards with a 12-zone punch sort into the 12-pocket. Cards with an 11-zone punch sort into the 11-pocket. Blank cards and 0-zone cards (S-Z) sort into the reject pocket. Error conditions are the same as for *Alphabetic Sort 1*.

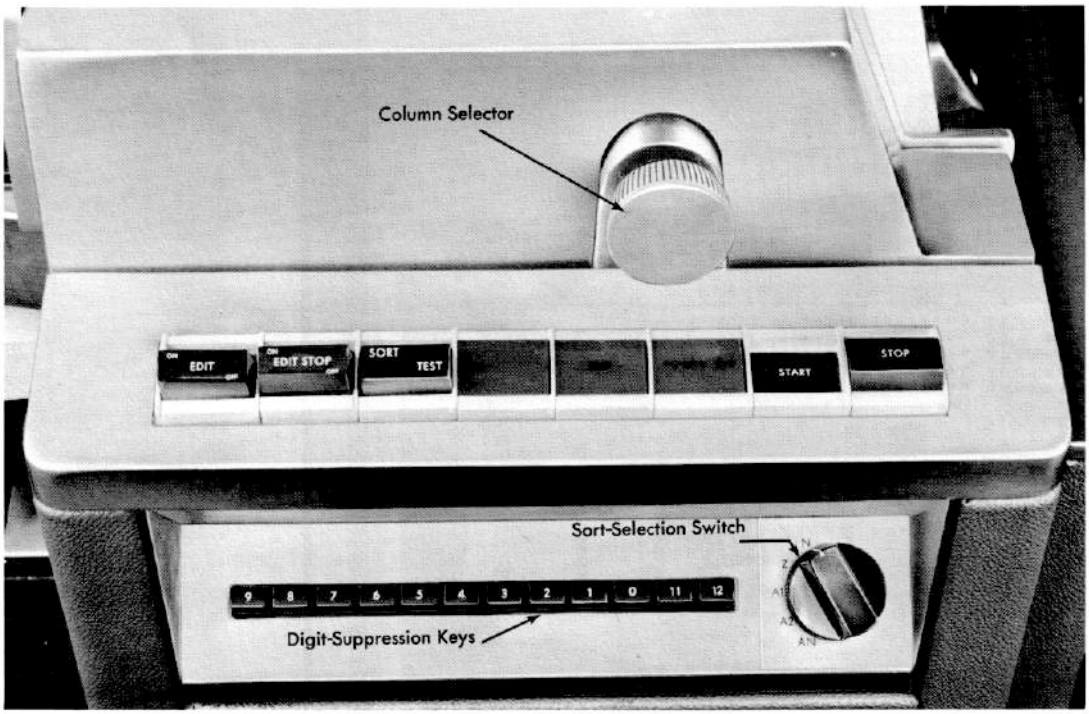


Figure 3. Switches, Keys, and Lights

EDIT SWITCH

Set this switch ON to reject error cards without stopping the machine. With the edit and edit-stop switches OFF, cards sort without editing.

EDIT-STOP SWITCH

When this switch is ON, error cards reject and the machine stops regardless of the position of the edit switch.

ERROR-RETENTION SWITCH

The error-retention switch retains the error conditions that caused an error. With the error retention switch ON, and with the edit-stop switch ON, an error stops the machine. Most important, the tube-transfer relay does not pick, and the sort-control relays that are picked remain up. The error-retention switch is on the relay gate panel (see Figures 23A and 23B).

SORT-TEST SWITCH

Set the sort-test switch to SORT for all sorting operations. Set it to TEST to check the timing of the sort brush.

START KEY

The start key starts the machine.

STOP KEY

This key stops the machine. Also, pressing the stop key opens the error circuit when an error is sensed (with the edit-stop switch ON). There is one exception. Pressing the stop key does not drop out the error circuit. This means that the error light does not go out. It is necessary to press the start key to operate the machine at least one more cycle. Pressing the stop key opens the error circuit. Pressing the start key again allows continuous card-feeding.

POWER-ON LIGHT

This lights when the main-line switch is on, and there is power to the machine circuits.

EDIT LIGHT

This lights when the edit-stop switch is ON and the machine senses an error. It lights when the sort-test switch is set to TEST, and the sort brush is reading through a hole in the card. Whenever the error-retention switch is ON, the light blinks intermittently.

Sort-Brush Gage

The sort-brush gage, located on the contact-roll cover, sets the sort brush for correct projection. This locates the sort-brush holder on the gage (Figure 4).

SORTING BRUSH

Set the sorting brush to any desired column by rotating a round knob at the front of the feed. Each full rotation of the knob moves the brush three columns. A one-third turn of the knob moves the brush one column. To move the brush a number of columns, turn the knob to raise the brush holder, lift the sorter-column pointer, and move the brush holder to the desired column.

Sorting Principles

The IBM 83 sorts by first reading all the holes that are punched in a card column. The machine analyzes all the holes read, and selects the correct sort magnet. The sort magnet energizes in the machine cycle *following* card-reading. The interval between reading the card and energizing a sort magnet allows enough time to analyze the holes read. The sort magnets control the chute-blade operation that selects the cards for the correct pockets.

As shown in Figure 5, cards feed horizonally from the hopper, and pass between the contact roll and the sorting brush. The brush reads the 6-hole in the column by driving a thyratron 2D21 tube (not shown) into conduction. There are twelve tubes of this type. The 6-punch in the card that is read at the contact roll drives the 6-tube into conduction. The tube serves as a storage device and signifies that a 6-hole is read. Each hole read in the card drives a separate tube into conduction. After the card area that contains the holes 1-9 is read, the tubes that are in conduction (in this case, the 6-tube), pick sort-control relays. Storage of the 6-hole that is read in the card is transferred from the 6-tube to a relay. Tube storage is not necessary when holes 0, 11, and 12 are read in the card (in this case the tubes conduct and immediately pick the sort-control relays).

An impulse controlled by the sort-control relays and by the edit key and the sort-selection switch energizes the correct sort magnet. When the sort magnet energizes, the card is entering the third set of feed rolls. Twelve

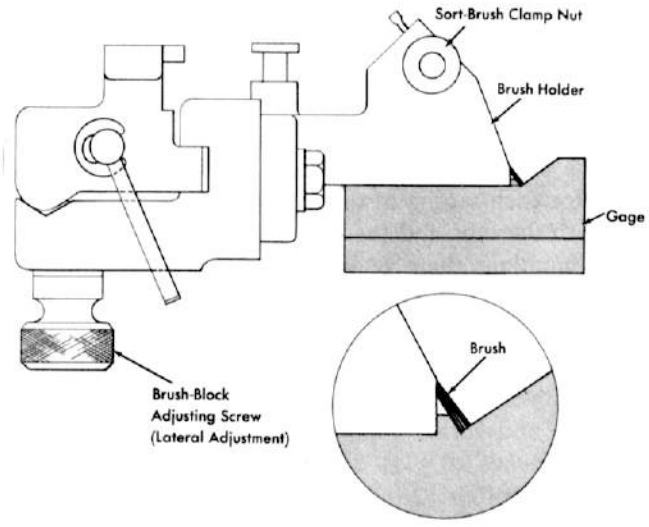


Figure 4. Sort-Brush Holder and Gage

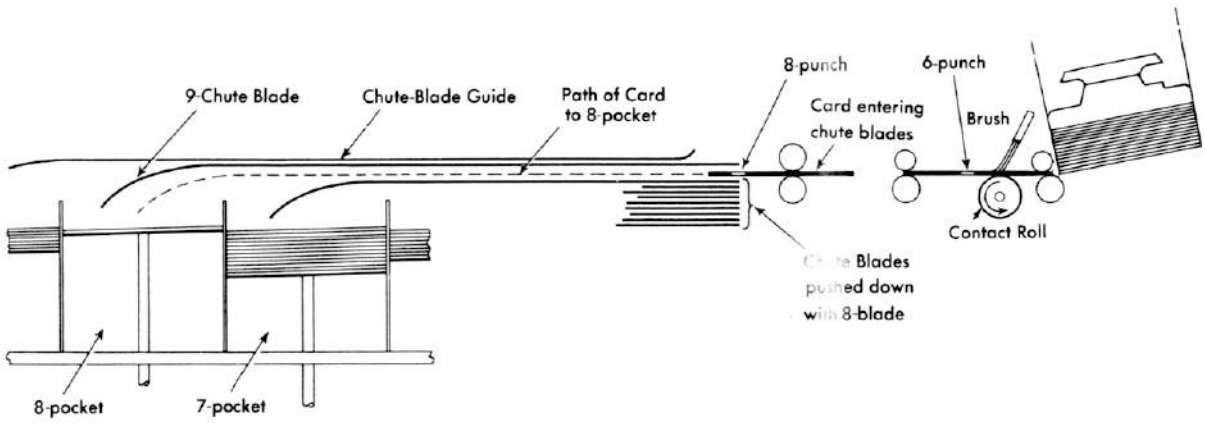


Figure 5. Schematic of Sorter Feed

sort magnets control the twelve chute blades for card sorting. The impulse that picks a sort magnet always occurs at the same time during a machine cycle. The sort magnets control the chute blades that select the cards during the early part of the next machine cycle that follows card-reading. This means that a card can be sorted at the same time that the following card reads at the contact roll.

Assume that the 8-card is selected at the chute blades. The 8-sort control relay energizes the 8-sort magnet (with the sort-selection switch set at N). When the 8-sort magnet energizes, the 8-chute blade and all chute blades located underneath operate to select the card. The clearance between the operated chute blades and those in the normal position provide the card path to select the 8-card.

This system of indirect or selective sorting means that cards are not sorted until the machine analyzes all punches in the column. This makes it possible to pre-edit the sort-control relays before the card sorts. The cards that do not meet the required conditions need not sort, and are rejected.

Example: A card with an 8-punch is not the same as a card with both an 8- and 12-punch. The sort control relays set up the circuits to the sort magnets differently and the cards can be sent to different pockets. Figure 6 shows in tabular form the sort and edit pattern for each setting of the sort-selection switch.

With the edit and the edit-stop keys both off, cards with multiple digit punches (1-9) in a column are analyzed as if only the lower (underpunched) digit were punched.

Example: With the sort-selection switch set to N, a card with a 4 and a 7 in the same column is analyzed as a 7, and sorted accordingly. Cards with multiple-zone punches (0, 11, 12) are analyzed similarly. A card with both a 12- and a 0-punch is analyzed as a 0.

Digit punching (1-9) takes precedence over zone punching (0, 11, 12) when the sort-selection switch is set at the numerical position. At all other positions of the sort-selection switch, zone punching takes precedence.

Numerical Sorting

To begin a numerical sorting operation, set the sort-selection switch to N. Set the edit or edit-stop switch and the digit-suppression keys to the desired positions. Position the sort brush to the column to be sorted. The normal method of sorting is to sort first on the units column, next on the tens column, and so on, until the entire classification field is sorted.

Zone Sorting

The most common use of the zone setting of the selection switch is to select cards with a specific zone punch over a column. The column can also contain a digit punch.

Example: To select all cards punched 11 (X) in column 52, set the sort-selection switch to ZONE and the sort brush to column 52, and sort the cards. If some cards have a 12- or 0-zone punch in column 52, press the 12 and 0 digit-suppression keys so that these zones cannot be selected. Do not press the digit-suppression keys if cards with multiple-punched zones are to be identified. Instead, turn the edit-stop switch on so that cards with multiple-punched zones will be rejected and stop the machine.

Alphabetic Sorting

Alphabetic sorting normally requires two sorts on each column because an alphabetic character is coded as two holes punched in a single column. This is done with the IBM 83 by setting the sort-selection switch to A1, and by positioning the sort brush on the column to be sorted.

On the first pass, the cards with alphabetic characters from A to I sort into pockets 1 to 9, characters J to R sort into the 11-pocket, and characters S to Z sort into

SORT SELECTION SWITCH SETTING	POCKETS												ERRORS (When edit or edit-stop is on)	REJECTS REGARDLESS OF EDIT
	9	8	7	6	5	4	3	2	1	0	11	12		
N	9	8	7	6	5	4	3	2	1	0	11	12	Multiple-punched cards (incl. letters)	Blanks
Z										0	11	12	Any card with more than one zone punch	Any card without a zone punch
A1	I	H	G	F	E	D	C	B	A	0 S-Z,	11 J-R		Any card with more than one zone punch or more than one digit punch	Blanks and cards with a 12 zone punch but no digit punch, digits 1 to 9
A2	R	Q	P	O	N	M	L	K	J				Same as A 1	Cards with 0 or 11 zone only, blanks, letters A to I, digits 1 to 9.
	Z	Y	X	W	V	U	T	S						
AN	9	8	7	6	5	4	3	2	1	0	11 J-R	12 A-I	Same as A 1	Blanks, letters S-Z and 0-1 combination.

This pattern is based on cards fed face down, 9-edge first.

Figure 6. Sort-Pattern Chart for Standard Machine

the 0-pocket. Blank cards or cards punched with digits only in the column sorted are rejected. If cards punched with either alphabetic characters or digits in a column are to be sorted, presort them. Use the AN setting of the sort-selection switch. The edit-stop switch should be on so that any cards with double-punched digits or double-punched zones will reject and stop the machine.

At the end of the sort on A1, place the rejects (cards with no alphabetic punching in the column being sorted) in front of the pack. Remove the cards from pockets 1 to 9 and place them behind the rejects. These cards are the A to I cards that are sorted.

Remove the cards in the 0- and 11-pockets and keep them separated, ready for the second pass. Only the cards punched with characters A to I are sorted completely on the first pass.

Set the sort-selection switch to A2. Do not change the sort-brush setting for the second pass. The 11- and 0-zone cards must be fed through the machine separately on the second pass. Feed the 11's through first to sort the J to R cards. Then remove them and put them behind the A to I cards. The last sort on the 0-zone cards sorts the characters S to Z. Remove these cards and place them at the end of the deck.

Repeat this sorting procedure on each column to be sorted until the field is completed. Normally, alphabetic sorting starts at the right-hand column of a field in the card, and moves to the left until the desired columns are sorted.

Alphamerical Sorting

Use the AN setting of the selection switch to sort card columns that may contain either alphabetic or numerical characters. This setting separates the alphabetic cards from the single-punched numerical cards. The digits 0-9 sort into the 0-9 pockets. The 12- and 11-zone cards sort to the 12- and 11-pockets, respectively. The 0-zone cards sort into the reject pocket. The sorter disregards any digit punch under a zone punch in a column.

This method offers a quick means of separating alphabetic and numerical cards, with the 0-9 digit cards sorted. Sort the 12-zone, 11-zone, and 0-zone cards again; use the sort-selection switch settings A1 and A2.

Covers

Concealed latches secure the front, back, and right end covers of the IBM 83. To remove the covers, press in on the latch-cover plates.

On early machines, the top cover over the feed and selector unit is fastened to the base by four spring catches. Two spring catches fasten the switch cover on the front. To remove the covers, pull upward from the top. On later machines, the cover over the feed and selector unit is different to permit access to the feed without removing the cover. A part of the cover is hinged so that it can be lifted and positioned to the rear of the machine.

Drive

All units of the machine turn continuously, driven by a 1,725-rpm ¼ hp motor. From the adjustable motor pulley, a V-belt turns the card-feed camshaft. Motion from the card-feed camshaft is transmitted to circuit breakers, feed rolls, picker knives, and selector unit. Ball bearings are used extensively.

The first, second, and third sets of feed rolls (upper and lower) are geared together for positive card feeding. A separate timing belt from the card-feed camshaft drives the upper feed rolls for the remaining 13. Lower rolls are driven by friction against the upper rolls. To study this better, run the machine by hand. Figure 7 shows the drive from the motor to the machine units.

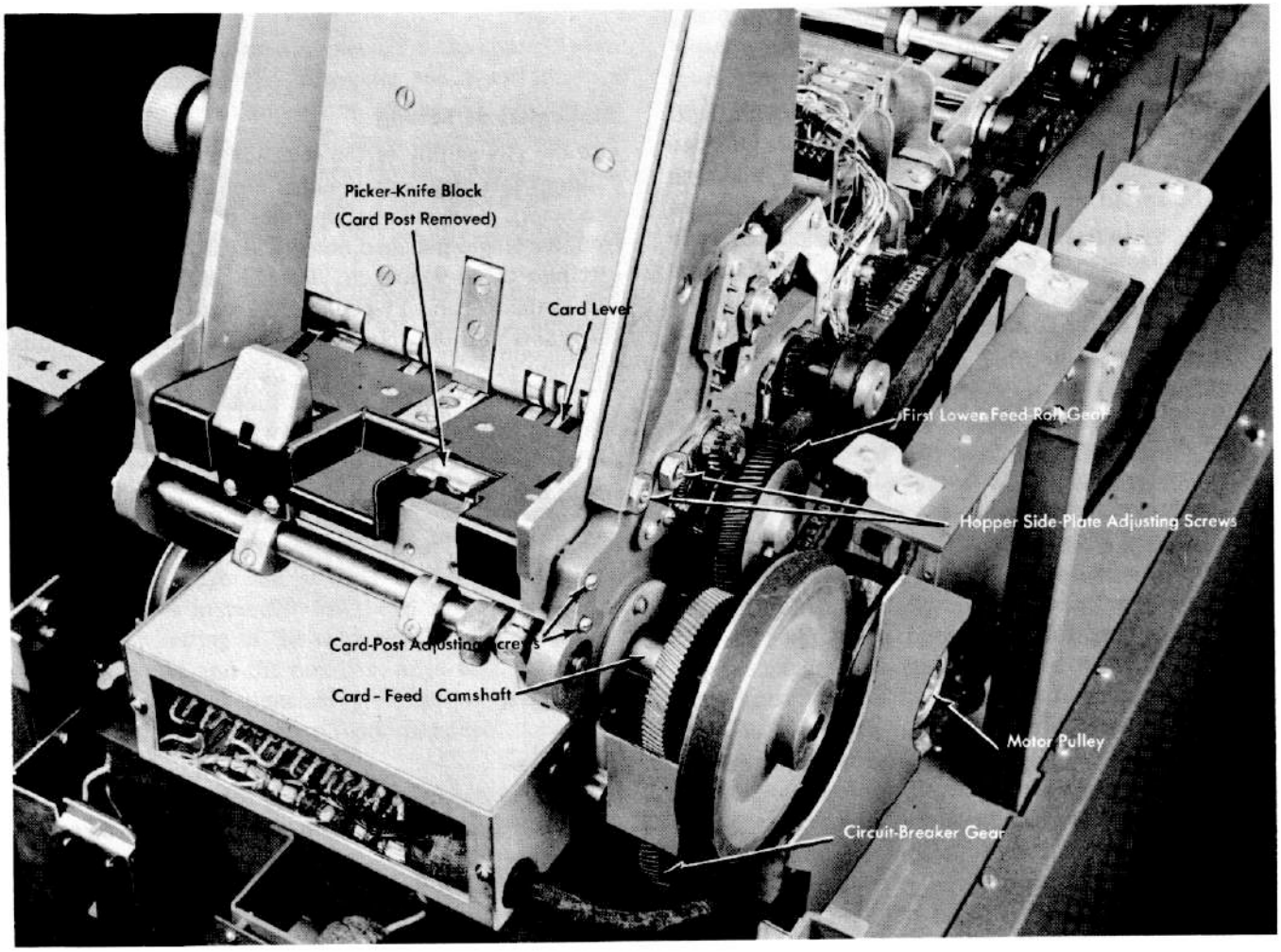


Figure 7. Motor Drive (Rear View of Machine)

On the front of the machine, the selector-unit camshaft is gear-driven from the first lower feed roll. The contact roll is driven from the second lower feed roll by a timing belt, as shown in Figure 8.

Picker Knives

The picker knives move the cards from the hopper into the first feed rolls. Figure 9 shows the picker-knife drive under the hopper. A complementary cam (card-feed cam) is on the shaft that the motor belt drives. Two cam-follower arms clamped to the picker-knife shaft follow the card-feed cam-surfaces and transmit motion to the picker-knife shaft. Two picker-knife arms, also clamped to this shaft, move the picker-knife blocks ⅝ inch through an arc, back and forth.

The picker knives travel in an arc. For this reason, to obtain the best possible feeding condition, the knife blocks must travel evenly through the same arc. To define the picker knife arc, consider the center of the picker-arm shaft as the center of a circle (Figure 10). The distance from the shaft center to the feeding edge of the knife-blocks is comparable to the radius. The card-feed cam-followers move the knife-blocks through the arc of the described circle.

Each picker-knife block is mounted on its arm by an adjustable stud that locks in position with a setscrew. Two Carboloy* inserts are fastened to the block surface to resist wear. The inserts are ground to specifications for knife projection. These inserts cannot be adjusted. This means that when they become worn, the picker-knife block must be replaced.

Sort Brush

The sort brush, together with its timing to the card, establishes the machine reference point for all electrical and mechanical timings. The index on the circuit-breaker unit is already positioned to correspond to this

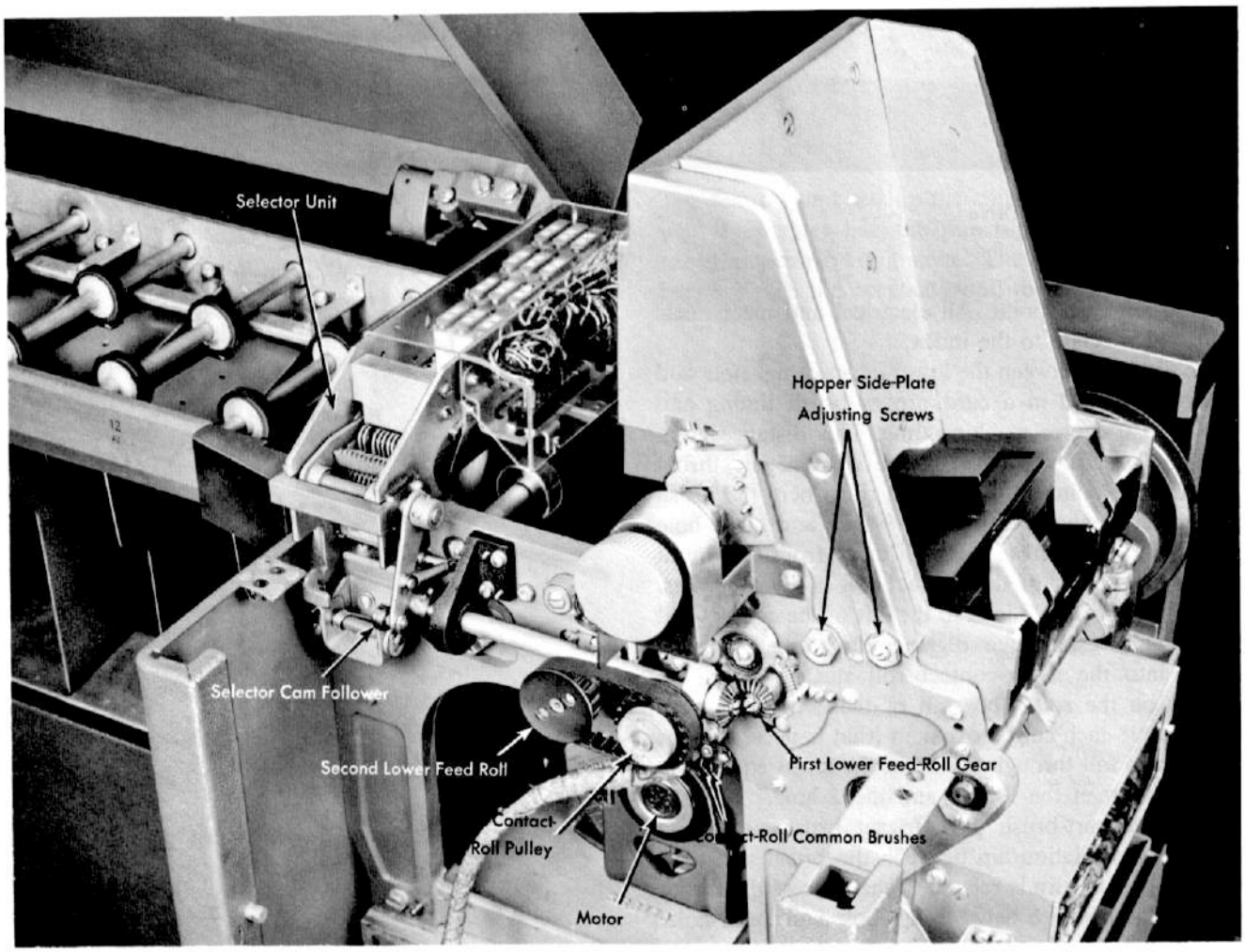


Figure 8. Drive (Front of Machine)

*Trademark of General Electric Co.

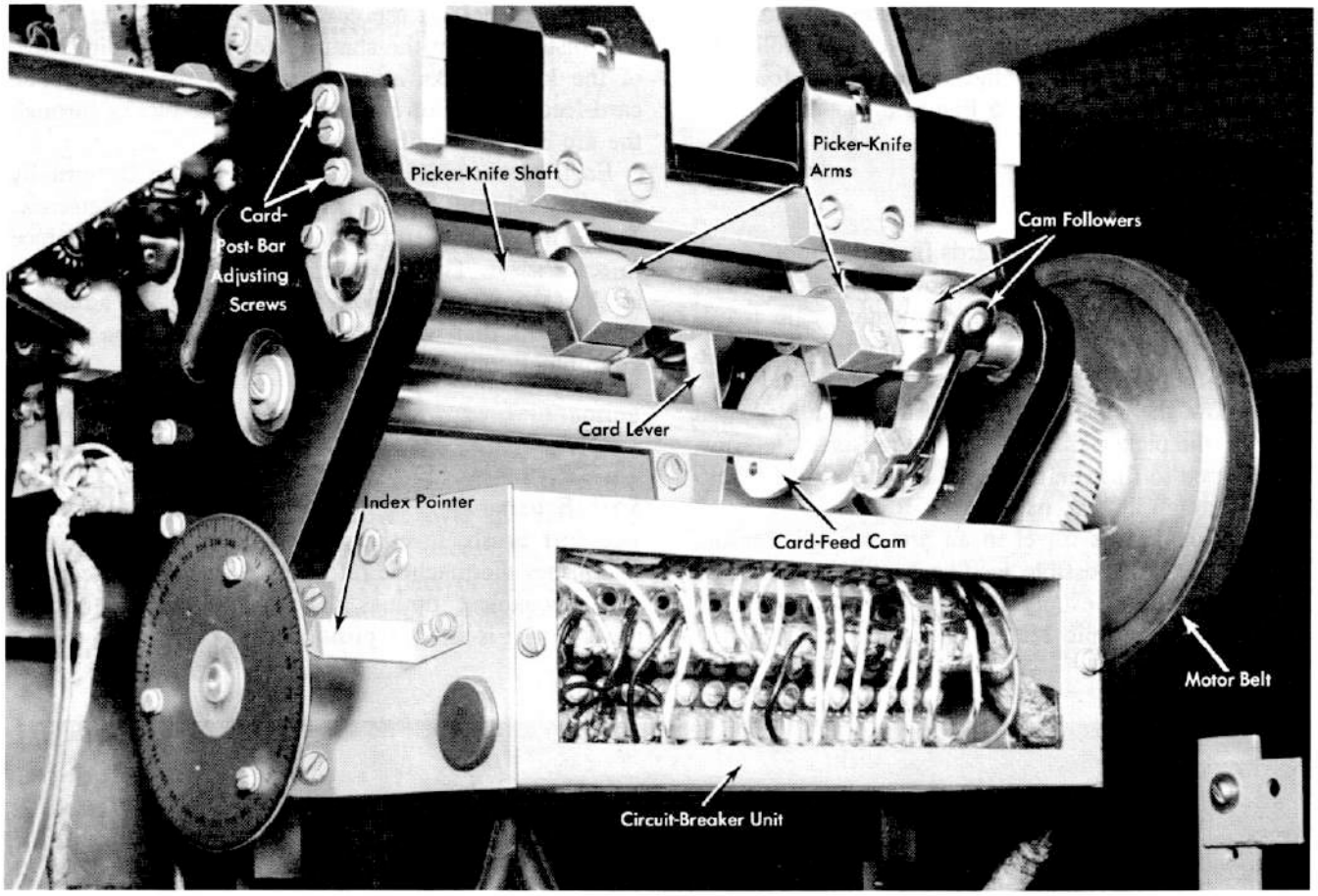


Figure 9. Picker-Knife Drive

machine reference point. All electrical and mechanical timings then relate to the index.

The distance between the lower edges of a 9-hole and a 2-hole punched in a card proves brush timing and establishes 0-degree machine time. This distance compares to the distance between the edge of the throat knife and the point on the contact roll where the brush reads. The distance between the 9-hole and the 2-hole in a card is 1.750 inches. The distance from the throat knife to the center of the contact roll is 1.734 inches. The sort brush is .008 inch to the left of the contact-roll center. This lessens the digging effect of the brush strands into the silver-contact roll surface when the brush is on the roll. The sum of these two distances plus the .008-inch card movement (that is necessary for the brush to fall through a hole in the card) equals the distance between the 9-hole and the 2-hole.

Using the sort-brush gage to set brush projection maintains the relationship between the brush and contact roll. This in turn is related to the edge of the throat knife for the distance between a 9-hole and the 2-hole.

To determine the timing of the brush, position the sort-test switch to the test position and use the edit

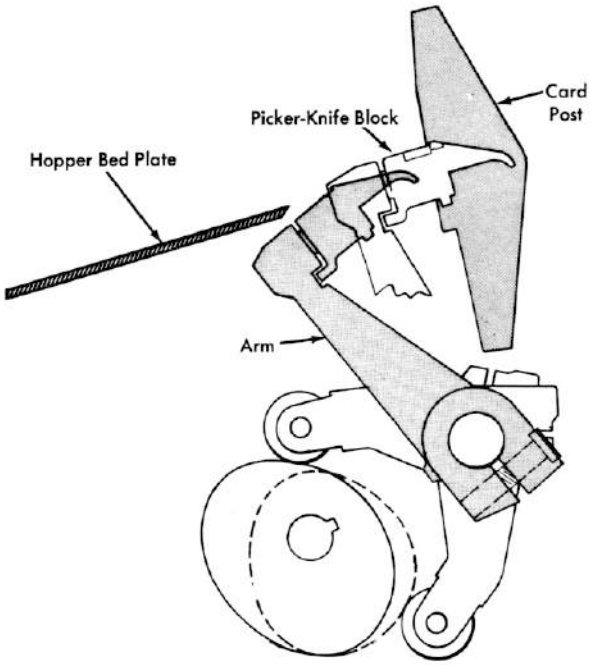


Figure 10. Picker-Knife Arc

light for a meter. Feed a card punched with a 9 and a 2 in column 40 into the machine. When the brush reads the 9-hole, the edit light turns on. At this point, the lower edge of the 2-hole must be even with the edge of the throat knife for correct brush timing. This brush timing establishes zero-degree machine time. Set the index at zero degree.

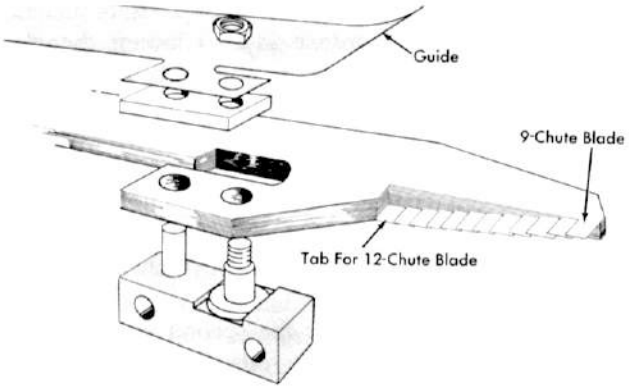


Figure 11. Chute Blades and Mounting Block

Chute Blades

The selector unit operates twelve chute blades to sort cards. The blades are on a stud at the front edge of the feed as shown in Figure 11. A part of each chute blade (called the *tab area)* projects to the front beyond the edge of feeding cards.

The main body of each blade is flat. Part of the chute blade has two holes in it. This part is at an angle of 10 degrees from the main part on all chute blades.

When the blades were fastened down on the mounting block, the formed portions were drawn down flat. This makes the main body of the blades turn up and provide the tension for the chute blades. The blades extend into the feed, bending upward, with the right ends above the card-travel line.

The tab area of the chute blade is the point where the selector pin operates to separate the blades. The tab on the 9-blade (the top blade) overlaps one-third of the tab area of the 8-blade. In the same way, the 8-blade overlaps one-third of the tab area of the 7-blade. The 7-blade overlaps the 6-blade and so on.

When a selector pin is driven down, it drives its corresponding blade down, as well as all blades that are below the operated blade. The blades above the operated blades are not driven down, but remain above the card-travel line. The resulting gap between the blades provides the card path for the card to the selected pocket (Figure 12).

At the stacker pockets, the left end of each chute blade is inserted into position on its corresponding shear plate.

Selector Unit

The selector unit sets up the chute blades for card sorting. It operates like the punch-magnet unit on high-speed punching equipment. The unit consists of 12 magnets with the necessary pull rods, interposer pawls,

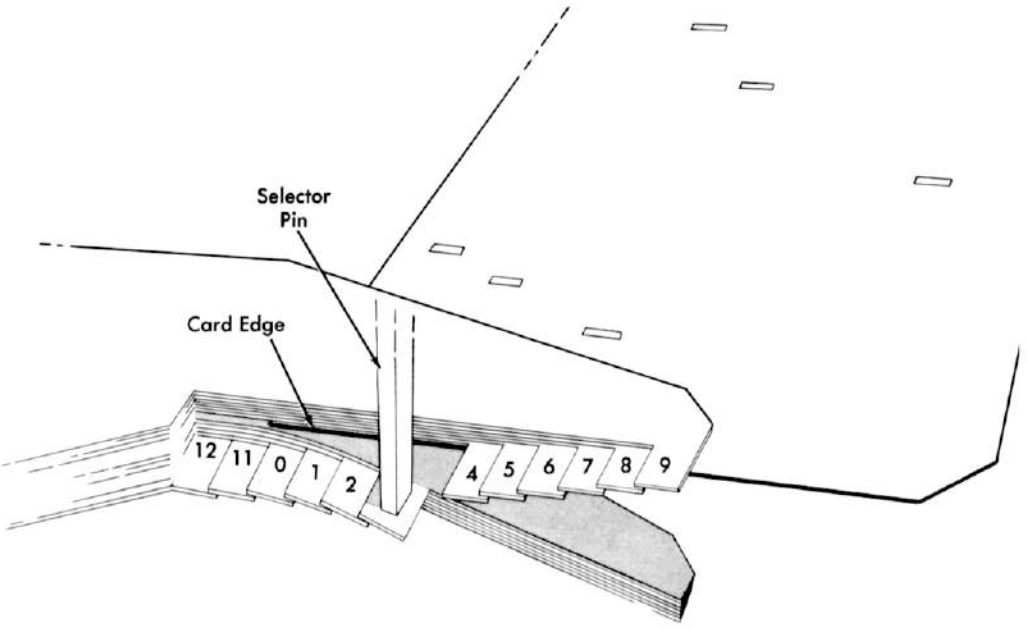


Figure 12. Operated Chute Blades

and selector pins to control the movement imparted to the chute blades. It is mounted on the machine so that the selector pins are beyond the column-one edge of the card (Figure 13). Each selector pin is centered above the exposed portion of its corresponding chute-blade tab. The selector pins used in positions 12, 11, 0, and 1, are .045 inch longer than those used in positions 2-9. The extra length is necessary to fully operate the chute blades in these positions.

When a magnet armature is attracted, its pull rod brings an interposer pawl into the path of the continually operated bail. As the cam follower rides to the high dwell of the cam, the bail pushes down the interposer pawl and the selector pin. The selector pin separates the chute blades. The card is directed to a pocket between the parted blades (Figure 14). As the cam roller comes off the high dwell of the cam, the bail rises. At the upper position of the bail, the interposer pawl strikes the stationary knockoff and is pushed off the bail. The interposer pawl spring keeps the interposer pawl from bouncing and catching on the bail again until its magnet armature is attracted.

Feed Rolls

The picker knives feed cards from the hopper into the first set of feed rolls. The cards then feed from the first feed rolls through the machine by sets of continuously running feed rolls equally spaced apart.

The first upper and lower feed rolls are the only feed rolls that turn steel on steel. This arrangement reduces the cutting effect of feeding cards, and maintains even card feeding. The end sections of the first lower roll have a neoprene layer between the shaft and steel periphery.

This reduces shock and noise because only the outside sections feed the cards. The inner two solid sections of the first lower roll guide the card feeding. The inner sections do not contact the corresponding sections of the upper roll. The first upper roll is under spring tension, and exerts pressure on only the outside end sections of the lower roll.

The steel upper rolls for the second and third sets turn against neoprene lower rolls. Timing belts from the first lower roll (see Figure 7) drive the lower rolls.

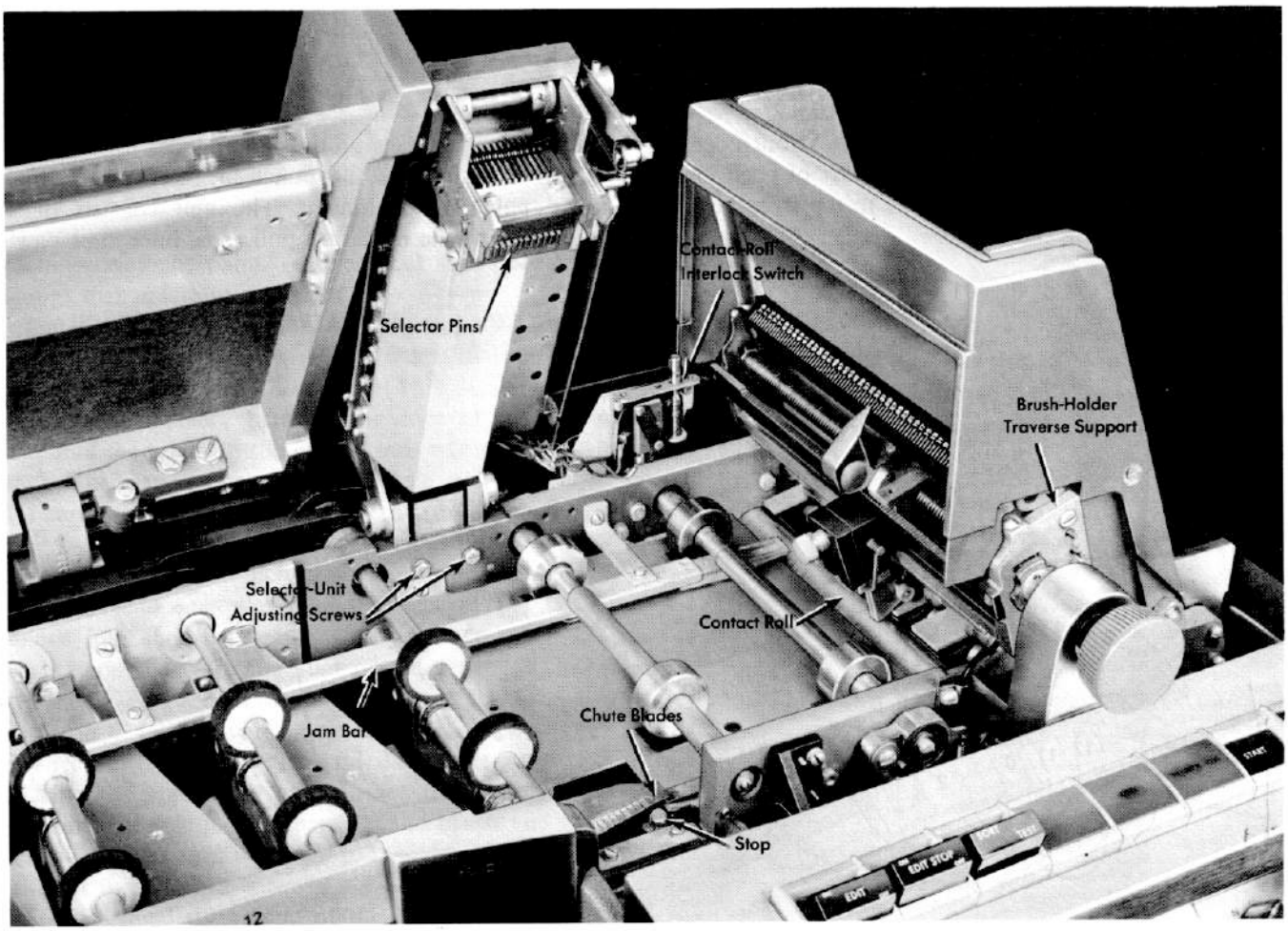


Figure 13. Feed (Selector-Unit Raised)

The lower feed rolls are geared together the same as the first set of feed rolls to prevent the cards from slipping while feeding.

A separate timing belt from the card-feed camshaft drives the fourth upper feed roll. The fourth feed roll transmits motion to the remaining upper feed rolls by belts connected in series.

The lower rolls are friction driven against the upper rolls. The lower feed rolls consist of short shafts, each mounted on a separate shear plate. At the ends of each lower shaft, ball-bearing rollers under spring tension turn against the upper roll. The feed rolls after the fourth set are spaced 3⅜ inches apart to give more room in the stacker pockets for flat card stacking.

Sort-Control Delay

As each card hole is read, a thyratron 2D21 tube conducts. The tubes store the information read from the holes. The card continues on until the next machine cycle before it reaches the chute blades. While the card travels to the chute blades, the tubes that are conducting pick sort-control relays. The relays direct an impulse to the correct sort magnet.

As one card is being read by the sort brush to cause a tube or tubes to conduct, the previous card that was read is being selected at the chute blades. The duration of the impulse for the card that is being selected is from 26½-101½ degrees.

During this time, when the sort magnet is energized, no change occurs in the sort-magnet circuit as controlled by the sort-control relay points. To allow for this, the sort-control relays for the card that is being read are not picked immediately. Thus, only the tubes store the holes that are read.

After the previous card enters the chute blades, the sort-control relays are picked for the card just read. This delay affects the pick time of the sort-control relays for holes 1-9. The sort-control relays for holes 0, 11, and 12, are picked immediately. They are not delayed because the holes are read late in the reading portion of the machine cycle. This is well after the previous card is selected.

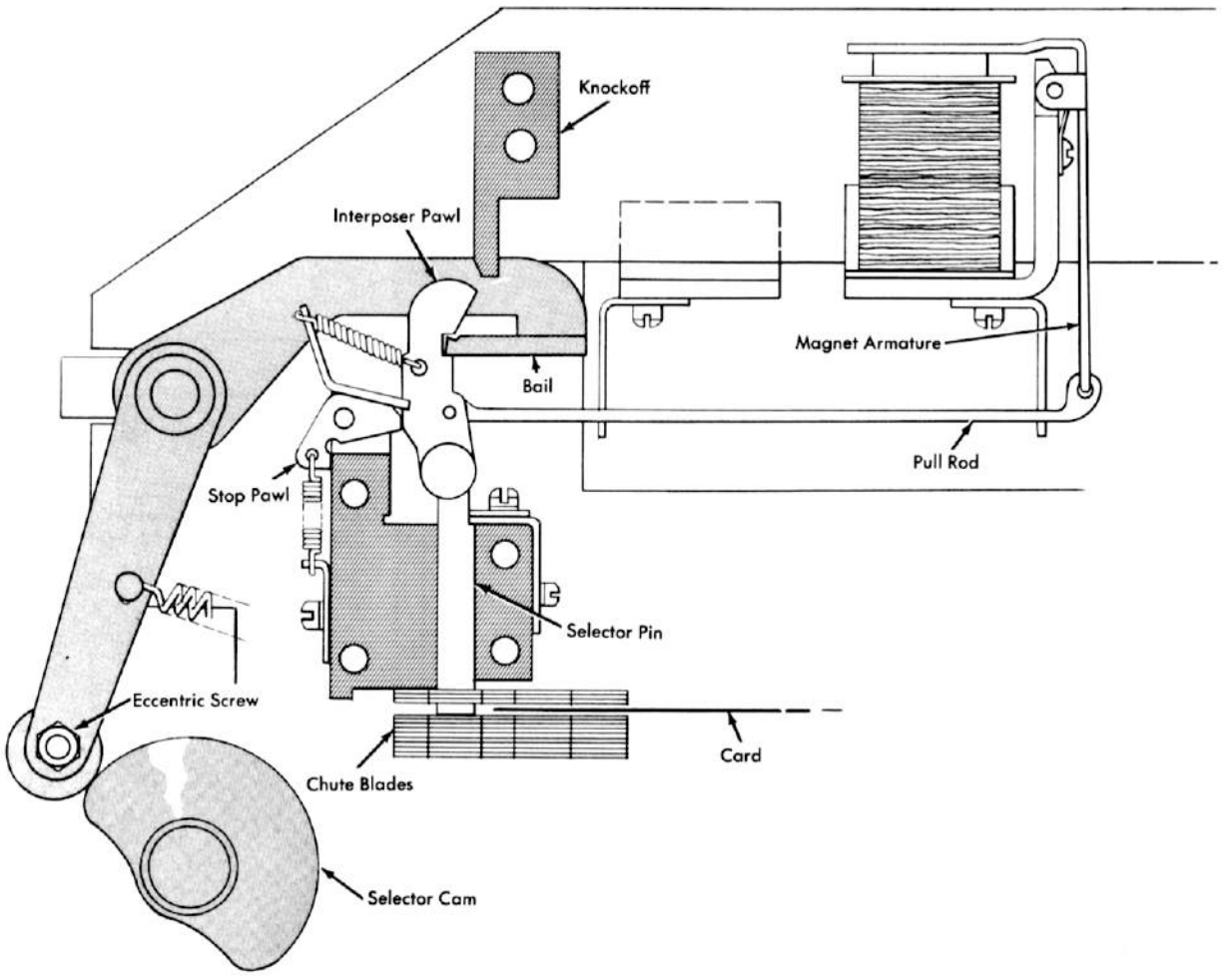


Figure 14. Selector Pin Operated

Tube-Unit Operation

Twelve 2D21 tubes are used in the IBM 83 Sorter. Older models use electronic pluggable units that contain the necessary resistors and capacitors. Later models use a printed-circuit tube panel.

A characteristic of the 2D21 tube is that both grids must be positive at the same time (with respect to the cathode) before the tube can conduct. As soon as conduction starts, the gas within the tube ionizes and increases the flow of electrons. Once ionization starts, it continues either until the cathode or anode circuit opens, or until the difference of potential between the anode and cathode is removed. The grid bias can again be applied and have no effect on conduction because the positive ions neutralize the negative grids.

Figure 15A shows the 2D21 tube and the unit used as a storage device to pick a sort-control relay. There is a similar circuit arrangement for each hole read in the card. With power on, −48V is applied to ET-15 and EP-10, and through the 12K and 15K resistors to both grids. This biases the tube so that it cannot conduct. At pin 6 (10A), +60V is applied to the anode through the anode resistor.

When a hole is read in a card, +60V is applied to grid 1 through pin 1. The +60V potential is applied directly to the grid resistor, and raises the grid potential above the cutoff point. Grid 2 is driven above cutoff by applying +60 volts to its grid resistor through a coding-cam circuit breaker. With both grids conditioned above cutoff, the tube starts conducting. The voltage divides across the tube as shown in Figure 15B.

After C-11 closes (M196° ±1°), C-12 (M198° ±1°) picks the tube-transfer relay (R15). Consequently the tube transfer points complete the sort-control relay circuit. The circuit that picks the sort-control relay goes through the tube in parallel with the anode resistor. The tube-transfer relay points are used in the tube-circuit operation for the holes read. These points prevent back circuits between the tube units and sort-control relays, and allow the tubes and relays to function independently.

The instant that the sort-control relay picks and its point in section 6 makes on the normally open side, the tube anode is connected to T10 and 0V. This reduces the anode potential from +8V to 0V, and the tube stops conducting because the anode and cathode are now at the same potential (Figure 15C).

The sort-control relay holds through the resistor and its own point connected to 0V until C-11 opens at 132 degrees.

Each of the 12 tube units picks one of the 12 sort-control relays. Grid 1 of each tube is common to three other tubes. The entire 12 tubes are grouped (with respect to grid 1) in three separate circuits. Circuit breakers isolate each group. The machine wiring diagram shows this. When the sort brush reads a 12, 1, 4, or 7, all of the 1-grids of the tubes in this group are conditioned above the cutoff. The same holds true of the other groups: 11, 2, 5, and 8; and 0, 3, 6, and 9; when any one of the digits is read for its particular group.

The particular tube of the four that actually conducts is the one that has its 2-grid conditioned above cutoff.

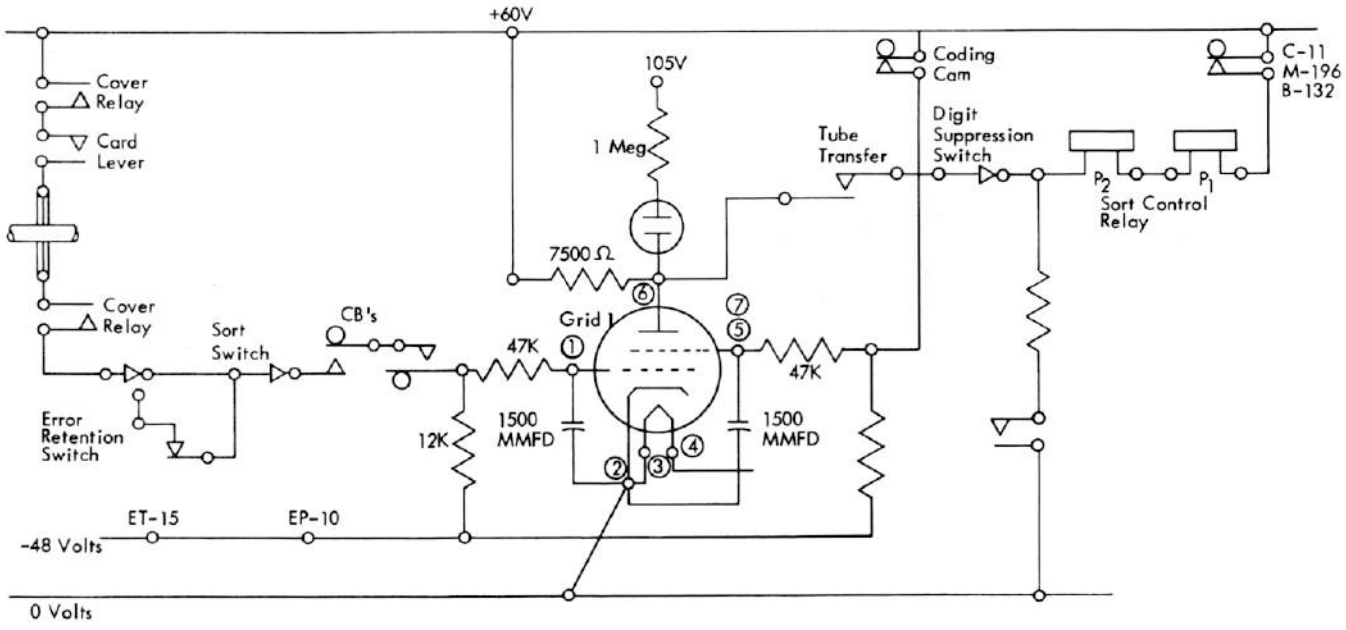


Figure 15A. Tube-Unit Circuit

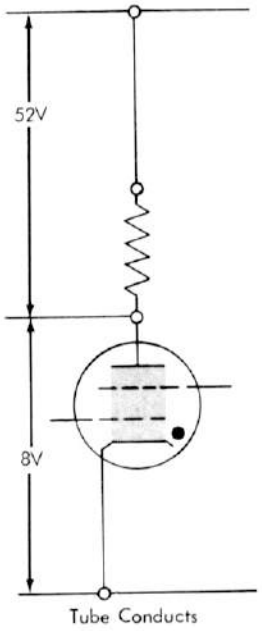


Figure 15B. Tube-Unit Circuit (Tube Conducts)

The timing of coding-cam circuit breakers 7, 8, 9, and 10 controls which tube conducts. These circuit breakers (CB's) condition the 2-grid at the same time the 1-grid is conditioned by reading the hole in the card.

When an 8-hole is read, the 1-grid is conditioned for tubes 11, 2, 5, and 8. As the 8-hole is read, only C-7 is made to condition the 2-grid for tubes 7, 8, and 9.

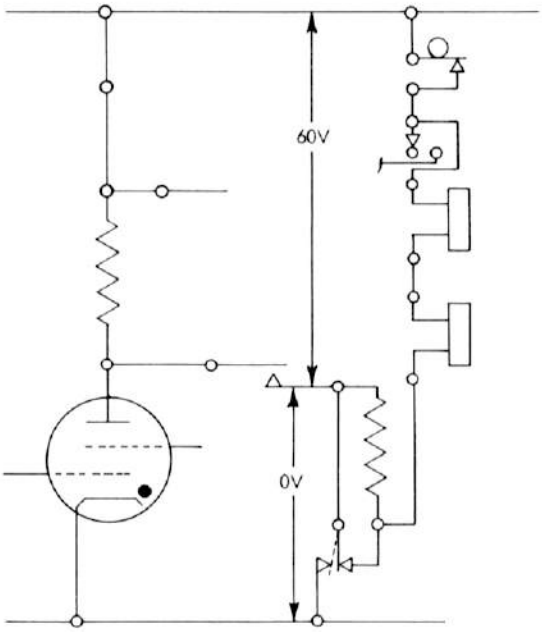


Figure 15C. Tube-Unit Circuit (Tube Cut Off, Sort-Control Relay Holds)

With both grids of the 8-tube above cutoff, only the 8-tube starts conduction.

Circuit Breakers

Circuit breakers control the timing of the electrical circuits. As shown in Figure 9, the circuit-breaker unit is at the right end of the machine. The circuit breaker and cam are similar to those in the IBM 24 punch unit.

Circuit breakers (numbered from C-1 to C-11) control circuits operating with +60V potential. Circuit breakers C-12 to C-15 control −48V potential to the remaining machine circuits. When using a voltmeter, be careful when testing the circuit breakers with the power on.

The machine index is on the same shaft as the circuit-breaker cams. All electrical connections from the circuit breakers to the machine circuits are connected through an Elco receptacle plug. Removing the unit mounting screws and disconnecting the Elco plug at the receptacle enables the circuit-breaker unit to be removed from the machine.

Interlock Switches

The interlock switches prevent machine operation when either the card deck or the cover over the contact roll is raised. The card-deck switch is at the rear of the 9-stacker pocket. The other switch is at the contact roll on the rear casting.

Raising either of these two covers removes the potentials from the contact roll. The switches control a relay. The relay points remove the potentials from the contact roll.

With either cover raised, centering the switch-operating pin and raising the pin through its guide hole make it possible to operate the machine. The switch automatically operates as a safety device when the covers are again in position.

Sort-Selection Switch

The sort-selection switch is a five-position, rotary switch with two sections, as shown in Figure 16. Each section has terminals for two switches. Each switch on a section has six terminals to correspond to the common, N, Z, A1, A2, and AN positions for the sort patterns. The terminals for the 3- and 4-positions are shown with the sort-selection switch at the AN setting. Terminals for the 1- and 2-positions on the second section are the same as for 3 and 4.

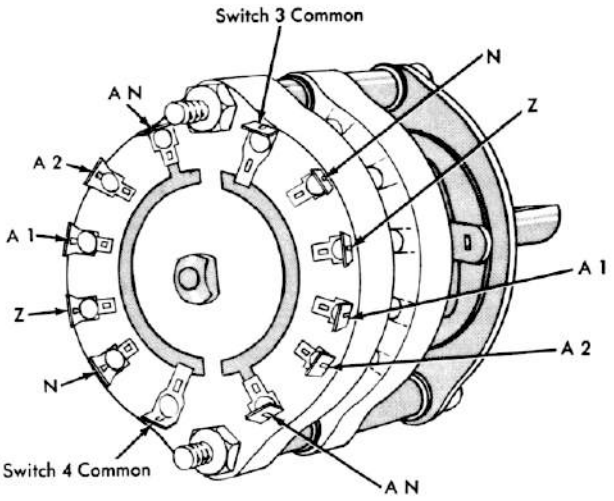


Figure 16. Sort-Selection Switch

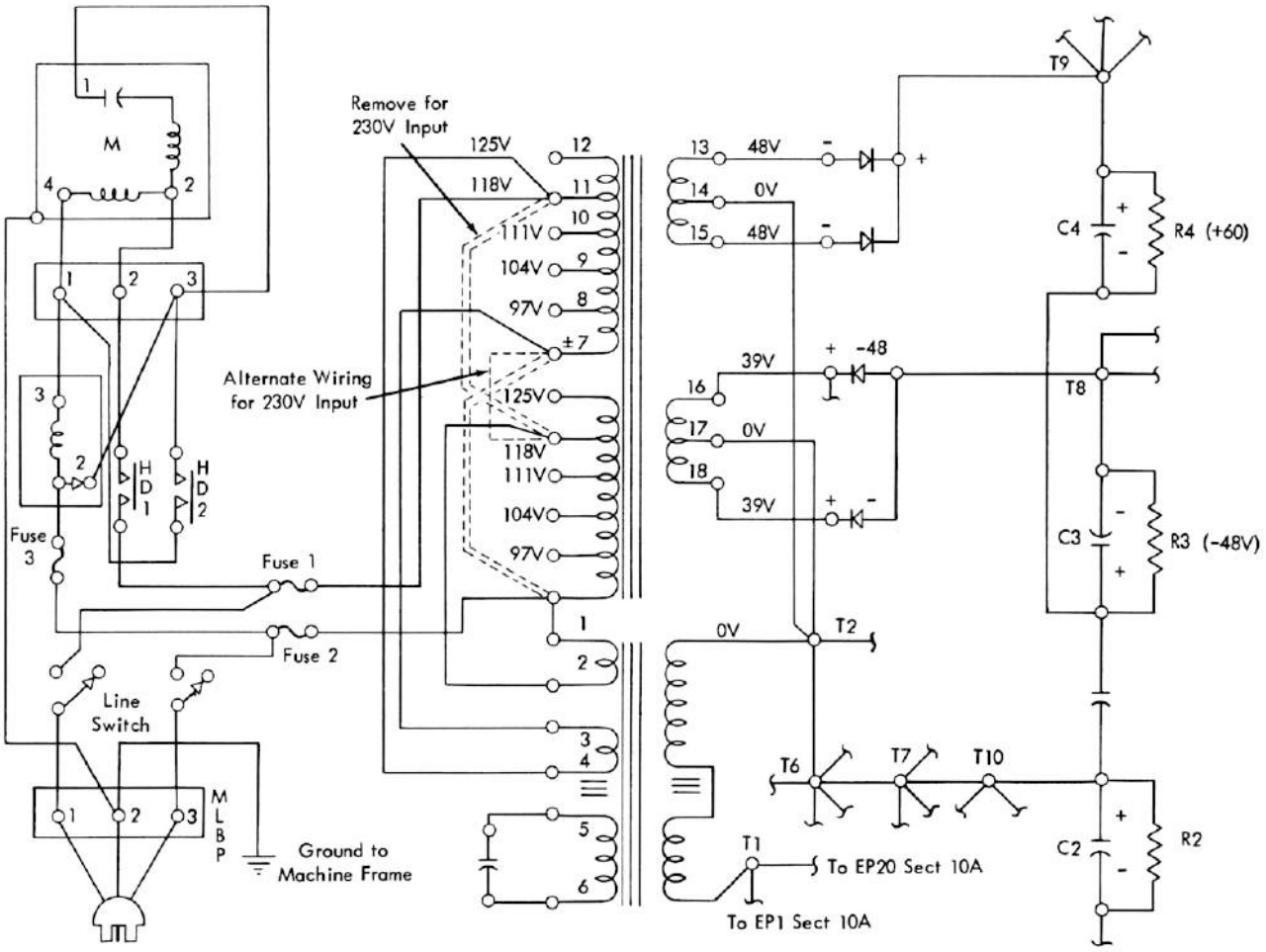


Figure 17. Power-Supply Wiring Diagram

All circuits described in the section *Mechanical and Electrical Principles* refer to wiring diagram 336001-G. The circuits described in this manual are for a 115V ac single-phase machine (most used in the field). Circuits other than for the 115V ac single-phase machines are similar in layout except for various resistors, filter capacitors, or transformer connections in the machine power supply. Direct current is required for the operation of all machine circuits except the motor and tube-filament circuits.

Wiring Diagram Layout

The wiring diagram has ten sections with electrical circuits as follows:

Section	*Circuit*
1	Power Supply
2	Function control relays
3	Sort brush
4	Tube units
5, 6	Sort-control relays
7, 8	Edit and sort magnets
9, 10	Timing and location charts

In section 2, the plus side of the relays is at the left, and the minus side is at the right (the circuits are horizontal). Sections 7 and 8 have the minus side at the top, and the plus side at the bottom of the diagram.

All wire-contact relays in the machine circuits have two pick coils. The two coils are in series in the machine circuits to eliminate excessive heating when the machine stops with the relay energized.

Power Supply

Two transformers in the IBM 83 power supply provide the voltages necessary for machine operation. The transformers can be wired for an input of 115V, 208V, or 230V ac. Both have two primary windings in parallel for an input of 115V ac, or in series for 230V (Figure 17).

Power Transformer

The power transformer provides the voltages for the dc voltage supplies. One secondary winding provides 96V ac for the +60V dc supply. The other winding provides 78V ac for the −48V dc supply.

The 96V (RMS) winding is center-tapped to provide full-wave rectification to produce +60V dc across R4 and C4. The +60V supplies the plate voltage for the 2D21 tubes and operates the sort-control relays.

The 78V (RMS) winding is center-tapped to provide full-wave rectification for the −48V supply across C3 and R3. With 0V coming off post 17 and the −48V at T8, there is a difference of 48V. This supplies the relay circuits for machine functions. The −48V supply also provides the bias voltage for the twelve 2D21 tubes.

With T8 at −48V and T2 at 0V, the circuit for the −48V supply is: T8, C3, C2, T10, T7, T6, T2. From T8, a line comes off to ET-15 (3B) to provide the −48V bias for both grids of all 12 tubes.

As shown in Figure 17, both center taps of the secondary windings and transformer terminal posts, T2, T6, T7, T10 are common and at 0V potential.

Figure 18A shows the arrangements of the −48V supplies in a different form; and presents the relationship of the voltages, rectifiers, and outputs to the transformer center tap.

Figure 18B shows the circuit for the +105V supply that lights the neon lights on the tube unit. C18 is a doubler capacitor that supplies 105V. Assume that on the first cycle, post 16 is negative and post 18 positive; then capacitor 18 charges as shown with the plus side toward ET34. On the second cycle with post 16 positive and post 18 negative, capacitor 19 charges as shown

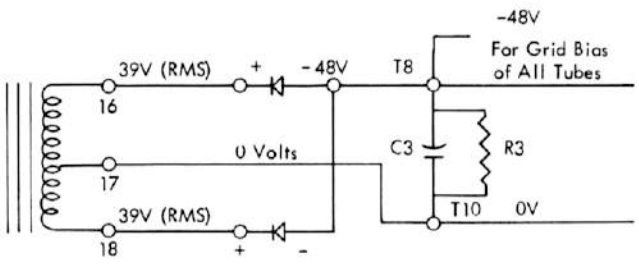


Figure 18A. Schematic of −48V Supply

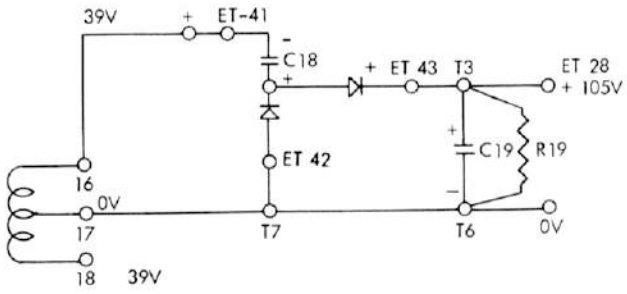


Figure 18B. 105V Power Supply

with C18 acting as a doubler capacitor to increase the charge on C19, and thus to provide the 105V at T3.

Filament Voltage Transformer

A transformer in the power supply regulates voltage for the 2D21 tube filaments (Figure 19). This transformer delivers an output of 6.5V ±5% over a ±10% variation of rated line voltage on the primary. It is specially built with a compensating winding that is wound with the primary at one end of the core (Figure 20). At the other end of the core are the resonant winding and the secondary winding. There is space between the primary and secondary windings to change the reluctance (magnetic resistance) of the transformer.

When input voltage is applied to the primary windings, magnetic lines of flux are set up in the transformer core. The air space in the path of the flux linkages makes the normal magnetic path higher in reluctance than the reluctance of a solid-core arrangement. This design makes the flux lines travel around the core and up through the center of the core instead of across the area with the air spaces.

The flux lines through the lower center of the core induce a voltage into the resonant and secondary windings. A capacitor (matched in rated size to the inductance of the coil) causes a high current (resonant) to flow. The capacitor is connected in series with one of the windings. Only the dc resistance of the circuit opposes the resonating current. The high current flow in the resonant winding causes a magnetic field that saturates the lower core area with magnetic lines of flux.

As the resonant winding saturates the lower core, more lines of flux are available that can pass through the lower part of the core. Thus, not all primary flux linkages can go through the lower core area because it is saturated. Part of the flux crosses the air space because it is a path of less resistance.

Compensating for the resistive losses of the resonant coil maintains saturation at the lower core area. When the losses tend to make the magnetic field fall below saturation, more of the primary flux can enter through the lower core area. The additional primary flux induces voltage into the resonant winding that increases the magnetic field and maintains saturation of the lower core area.

The maintenance of saturation sustains the secondary winding output because the flux changes at the secondary winding are not in proportion to variations in primary voltage. Because of inherent conditions in the transformer, however, there are small changes of output voltage when the input voltage varies. Compensating winding regulates these slight changes.

The compensating winding cancels the slight variations in secondary output voltage. It is wound (positioned) with the primary windings and wired in series with the secondary winding. The compensating winding is wound so that its induced voltage opposes that of the secondary winding (Figure 20).

Within the range of regulation, if the primary input voltage rises, the induced secondary voltage rises slightly. Also, the voltage induced into the compensating coil increases in proportion to the increase over normal output of the secondary winding.

The two voltages oppose each other with the result that 6.5V remains impressed on the filament circuit (Figure 21). When the input voltage on the primary decreases, the induced voltage of the secondary is lower, with a corresponding reduction in the compensating-winding voltage. This produces a 6.5V output because less compensating voltage opposes the secondary-winding voltage.

The location of the filament voltage transformer and capacitor is shown in the power supply (Figure 22).

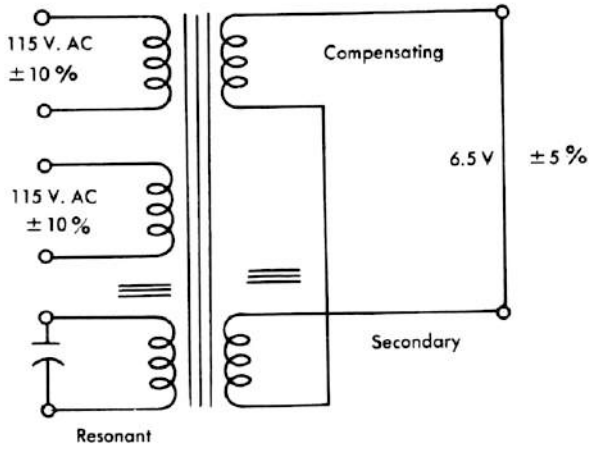


Figure 19. Wiring Diagram —Filament Voltage Transformer

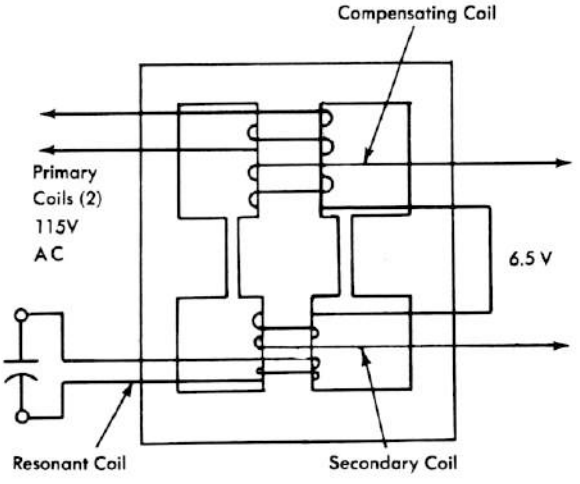


Figure 20. Schematic of Filament Voltage Transformer

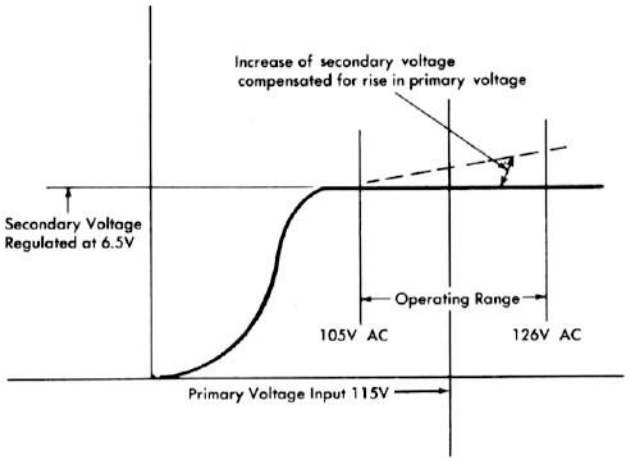


Figure 21. Schematic of Filament Voltage Transformer Output

Rectifiers

The secondary voltages must be full-wave rectified to dc voltages to operate the tubes, relays, and magnets correctly.

Selenium rectifiers are used to rectify ac into dc. When a difference of potential is applied to the rectifier, electrons move readily in only one direction through the rectifier, while offering high resistance in the other direction. With such a device connected in an ac circuit, current can flow in only one direction even though the ac voltage reverses each cycle. Full-wave rectification is obtained by using two sets of plates for each ac voltage. One set of plates rectifies the upper ac wave; the other set rectifies the lower wave.

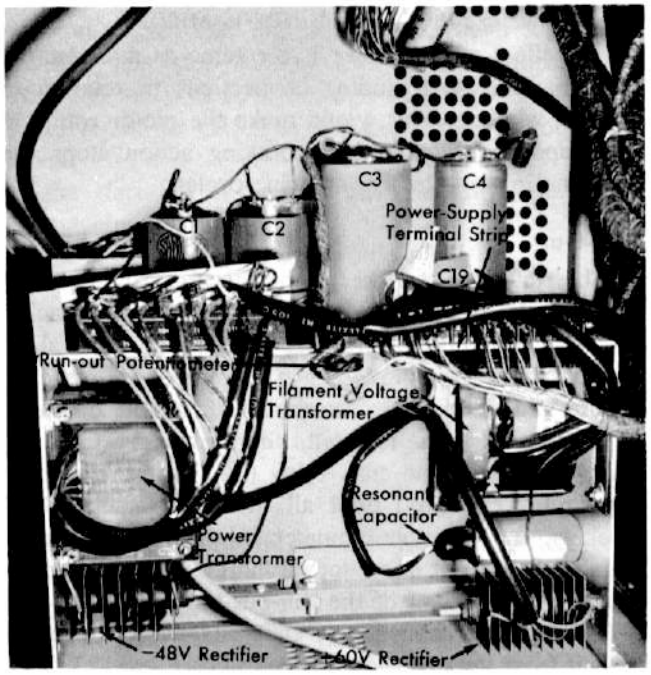


Figure 22. Power Supply

For normal operations, the rectifier supplies power in excess of load requirements. However, if a failure occurs in any one plate of the rectifier, an overload results that damages the remaining plates. It is not safe or practical to rebuild rectifiers.

Function-Control Relay Circuits

Time Delay Relay

The machine must wait 30-40 seconds for the tube filaments to heat before it is ready to operate. A thermal relay causes this delay (Figures 23A and 23B). The relay is controlled by a contact strap wrapped inside a heating element.

As current passes through the element, heat generates to cause the contact strap to bend. When the contact bends enough to touch an adjustable stationary point, there is a circuit for picking the thermal relay.

HEATER-ELEMENT CIRCUIT

The heating-element circuit is: T7 to the heating element, resistor 18, through TH-BL N/C to TH-BU, to T8.

THERMAL-RELAY PICK CIRCUIT

The thermal-relay pick circuit is: T7 to the thermal relay, through TH-AL N/O, to TH-BL, and to T8.

THERMAL-RELAY HOLD CIRCUIT

The thermal-relay hold circuit is: T7 to the thermal relay, through TH-BL N/O, to TH-BU, to T8.

The −48V supply is completed to the machine function circuits through TH-BU N/O.

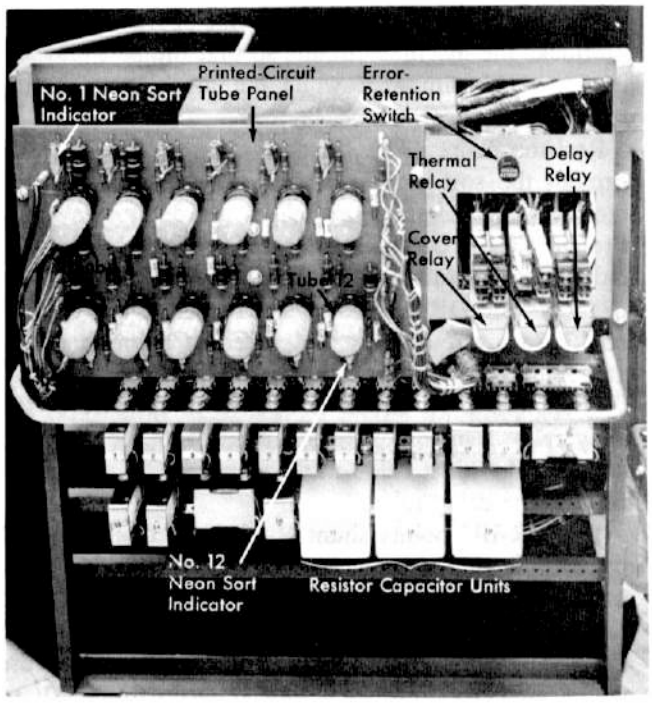


Figure 23A. Relay Gate (Front View)

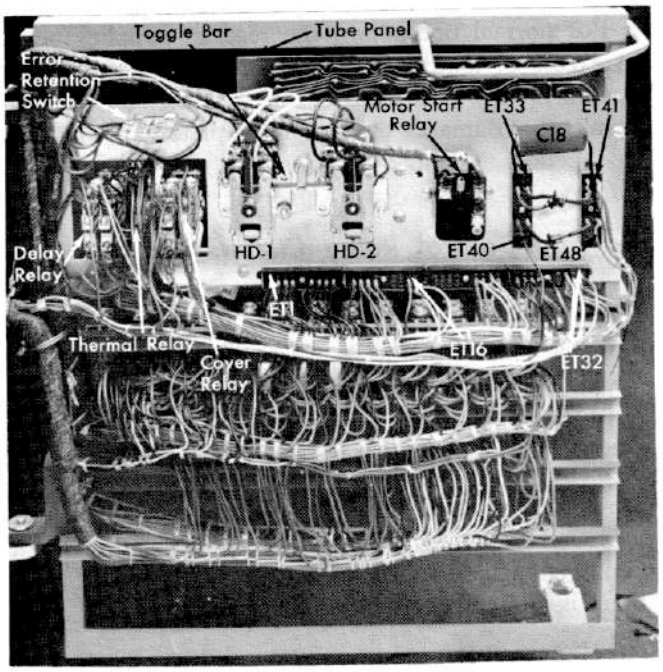


Figure 23B. Relay Gate (Rear View)

Start-Circuit Relay

The start relay (R13) picks when the start key is operated: from T2, to T6, through the stop key, R13 coils, CS-AL N/O, jam stop switch, start key, 13-4, 14-2, 13-3, TH-BU N/O, to T8. Relay 13 holds through CS-AL N/O, jam stop switch, 13-1 N/O, pocket stop switch, 16-2 N/C and 14-2 N/O.

Delay Relay

The delay relay prevents an energized sort magnet from overheating when the machine is not operating. It also interlocks the machine circuits so that the sort magnets are impulsed with 48V while the machine is sorting cards under power.

Resistor R-22 (7A) limits the amount of current through the sort-magnet circuit when the machine is idle. Pressing the start key makes the delay relay pick through 13-4 N/O. The DR-BU N/O points shunt R-22, and allow the full 48V to be impressed on the sort magnets. The DR-AU points interlock the machine so that the delay relay must be picked in addition to the start relay before the machine is operative.

When the R-13 circuit is opened to drop R13, the delay relay remains energized until after the machine stops. To do this a 1,000-mfd capacitor (C2) discharges through the delay relay.

The DR-BU points shunt R-22 from the time R13 drops until after the machine stops. During this time, the full 48V is still used to energize sort magnets. After the delay relay drops out, the DR-BU points open and remove the shunt around R-22. The voltage drop across an energized sort magnet is then reduced from 48V to 13V with 35V dropped across R-22.

Card Lever Relay

The card lever relay (R14) picks at 284 degrees when C-15 closes after the card-lever contacts make at 223°± 5°. C-14 holds R14 until 289 degrees so the sort brush can read the entire last card.

Cover Relay

Because the cover relay has points that control the start- and sort-brush circuits, the machine does not operate until the cover relay energizes. The card-deck and contact-roll cover switches (operated by their respective covers) complete the cover-relay circuit.

Drive Motor Relays

The drive motor is wired to the input lines that enter the primary side of the transformers. Two heavy-duty relays and a start relay control the motor operation (Figure 24). Because the sorter operates at a speed of 1,000 cards per minute, it is necessary that the stopping time be short. To do this, the machine applies dynamic braking to the motor.

1. HD2 picks when the main-line switch is turned on, from T8, to TH-BU, through HD2, 13-2 N/C, to T7.
2. Pressing the start key picks R13, and 13-2 opens the HD2 circuit. HD1 picks from T8, through TH-BU, HD1, DR-AU N/O, 13-2 N/O, to T7.
3. The motor starts and runs counterclockwise in the conventional manner.
4. When the start-relay (R13) circuit is opened, 13-2 drops HD1, and picks HD2. At this instant, the normal run circuit for the run-motor winding is open, but the inductive characteristics of the run winding sustain the current flow through the run coil. The circuit for the run winding is from MBP1 through the run and start windings, the start capacitor to MBP3, through HD2 to MBP1.

The effect on the motor is the same as momentarily reversing the start-winding connections in relation to the run winding. This would make the motor rotate in the opposite direction. The braking action stops the machine in three to five machine cycles.

Run-Out

The run-out circuit keeps the machine running until all cards feed out of the feed and stack in the stacker pockets. The circuit provides a constant interval of run-out time by maintaining a charge on a capacitor before and during the time that the machine operates.

When the cards run out, the capacitor (C1) discharges through the start relay (R13), and keeps the start relay energized until all the cards stack in the pockets. A 10K potentiometer in the run-out circuit adjusts the rate of capacitor discharge. This adjustment controls the amount of the run-out time.

The run-out capacitor (C1) is charged through the circuit from the plus side of C3, to C2, C1, R-23, T11, R-20, T12, 13-3 N/C, TH-BU N/O, to T8.

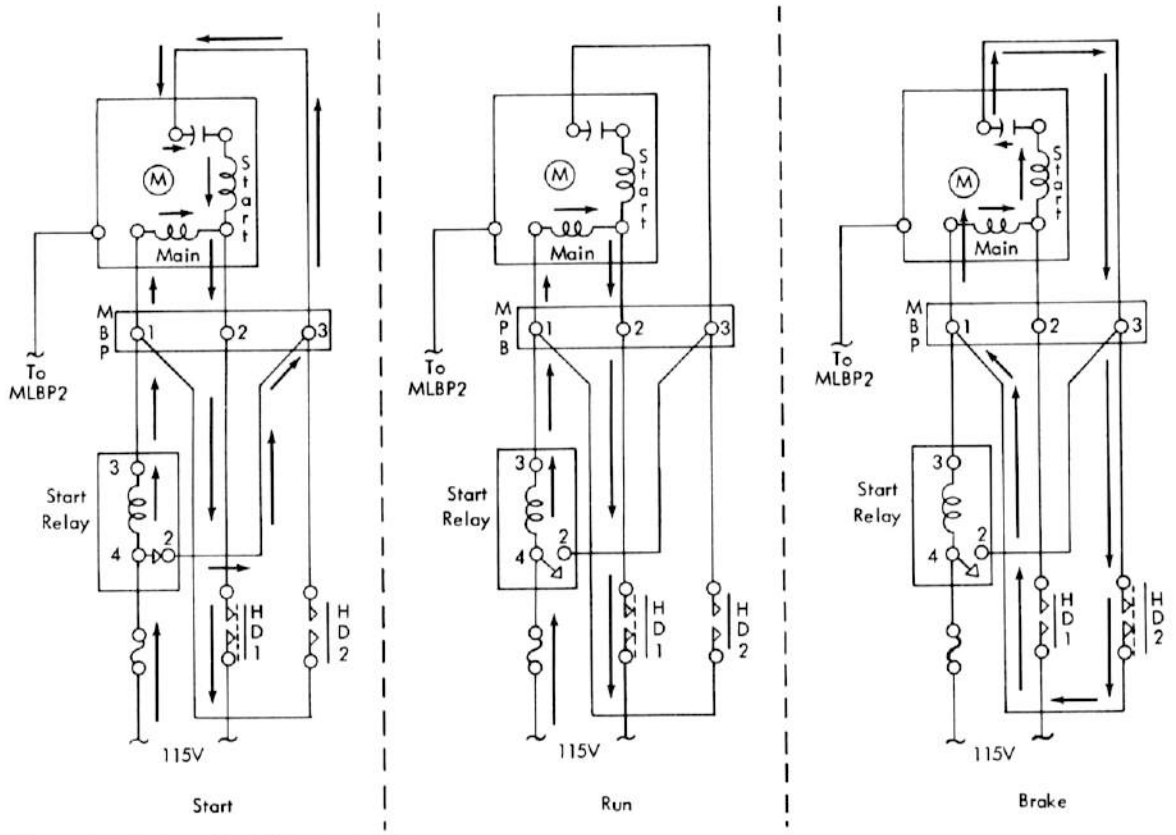


Figure 24. Schematic of Motor Circuits

While cards feed, the capacitor charge is maintained from the plus side of C3, to C2, C1, R-23, T11, R-20, T12, 13-3 N/O, 14-2 N/O, 13-3, TH-BU N/O, to T8.

The run-out capacitor discharges when 14-2 N/O opens to break the charging circuit. The discharge path is from C1, to C2, T6, stop key, through R13 coils, CS-AL, jam stop switch, 13-1, pocket stop switch, 16-2 N/C to 14-2 N/O, through 13-3 N/O, T12, R-20, T11, R-23, to C1. The run-out circuit is operative when:

1. the start key is pressed and no cards are in the machine
2. the card lever (R14) drops out.

Sorting Circuits

Three stages of circuit operation are needed for card sorting. The pattern of sorting is governed by the sort-selection switch.

The stages are:

1. Reading the card and causing tubes to conduct.
2. Picking the sort-control relays and dropping the current in the tubes.
3. Picking the sort-magnet circuits.

The first two stages operate in general the same for all sort-selection switch positions. The third stage changes for each pattern of the sort-selection switch. Circuits are described only for the first two stages. They are omitted in further description. The sort-selection switch is SSS in circuit descriptions.

Card Reading

Assume that a 9-hole is being read:

1. (4B) Grid bias of −48V is applied from T8 (2A), to ET-15, to both grids of tube 9, and all tubes.
2. (4B) Grid 2 of tube unit 9 has +60V applied from T9 (2A) to CS-AU (3A) A-5, C-10, through C-7 to grid 2 of tube 9 (see the *Tube-Unit Operation* section).
3. (4B) Grid 1 has +60V applied from T9, through CS-AU, 14-4 N/O, common brush, contact roll, through the hole in the card, sort brush, CS-BL N/O, sort switch (at SORT) A-12, C-2, C-1, to grid 1 of tube 9.
4. (4B) Tube 9 conducts, electrons flow from the minus side of the +60V supply (2A) C4, C3, C2, T2, EP5 (10A), pin 2, pin 3, cathode to anode, anode resistor pin 6, EP17, ET16, to 16-3 N/O (2A) to T9.

Sort-Control Relay

1. (2B) Relay 15 picks from C3, to T10, through relay 15 coils, S3 (OFF position), A-2, C-12, A-4, through TH-BU N/O to T8.
2. (6B) Relay 9 picks from T9 (2A) to CS-AU, A-5, C-10, through C-11 (6A), R9 coils, through 9-1 N/C, DS9, 15-9 N/O, ET-9, pin 6 of tube unit 9, through the tube to pin 2, EP5, to T2 (0V).

3. Tube current is dropped when R9-1 N/O closes and connects anode resistor pin 6 to 0V through ET-9, 15-9 N/O, DS-9, 9-1 N/O, to T10 (0V). Because the anode and cathode are at the same potential, the tube current is dropped.
4. The relay holds through R6 and 9-1 N/O to T10 until C-11 opens at 132 degrees (Figure 25).

Sort-Magnet Circuits

This section describes the sort-magnet circuits for each position of the sort-selection switch.

SSS AT N

The 9-sort control relay is energized, and sort magnet 9 picks when C-13 closes.

The circuit is from T8 (2A) through TH-BU N/O, A-4, C-13 (6A), A-8, DR-BU N/O, SSS section 1, C to N, 9-2 N/O, 8-3 N/C, 7-3 N/C, 6-3 N/C, 5-3 N/C, 4-3 N/C, 3-3 N/C, 2-3 N/C, 1-3 N/C, SSS section 2, C to N, 12-3 N/C, 11-3 N/C, 10-3 N/C, to 10-2, 11-5, 10-1, 12-1, SSS section 4, zone terminal, through SSS section 3, N to C, 9-4 N/O, sort magnet 9, T6 (2AB), to T2.

Refer to Figure 5. The 9-punched card selects to the 9-pocket only when the sort-selection switch is at N or AN. With the switch at Z, A1, or A2, the card enters the reject pocket. Use the sort pattern chart in tracing circuits for the sort magnets.

Note: Holes in the card pick correspondingly numbered sort-control relays.

SSS AT Z

Assume that a card punched with a 12 is read and R12 picks.

Sort magnet 12 picks through C-13, A-8, DR-BU N/O, SSS section 1, C to Z, SSS section 2, A1, A2 through 12-6 N/O, to 12-3, through 11-3 N/C, 10-3 N/C, to 11-5, 10-1, 12-1, through SSS section 4, Z to C, 10-4 N/C, 11-4 N/C, 12-4 N/O, 12-sort magnet at 26½ degrees.

SSS AT A1

Assume that a card punched with a zero and 7 for the letter X is read and picks relays 10 and 7. The zero-sort magnet picks through C-13, A-8, DR-BU N/O, SSS section 1, C to A-1, 9-2 N/C, 8-2 N/C, 7-2 N/O, 6-3 N/C, 5-3 N/C, 4-3 N-C, 3-3 N/C, 2-3 N/C, 1-3 N/C, SSS section 2, C to A1, 12-6 N/C, 11-5 N/C, 10-1 N/O, to 12-1 N/C, through SSS section 4, A1 to C, 10-4 N/O, zero-sort magnet at 26½ degrees.

On the next alphabetic sort, the sort-selection switch is at A2 to complete the sort for the card column.

SSS AT A2

Relays 10 and 7 pick the same as in *SSS at A1*. The 7-sort magnet picks through C-13, A-8, DR-BU N/O, SSS section 1, C to A2, 9-2 N/C, 8-2 N/C, 7-2 N/O, 6-3 N/C, 5-3 N/C, 4-3 N/C, 3-3 N/C, 2-3 N/C, 1-3 N/C, SSS section 2, C to A2, 12-6 N/C, 11-5 N/C, 10-1 N/O, to 11-1 through SSS section 3, A2 to C, 9-4 N/C, 8-4 N/C, 7-4 N/O, 7-sort magnet at 26½ degrees.

SSS AT AN

Assume that a card punched with 3 and 11 is read, and R11 and R3 picks. The 11-sort magnet picks through C-13, A-8, DR-BU N/O, SSS section 1, C to AN, 9-2 N/C, 8-2 N/C, 7-2 N/C, 6-2 N/C, 5-2 N/C, 4-2 N/C, 3-2 N/O, 2-3 N/C, 1-3 N/C, SSS section 2, C to AN, 12-5 N/C, 11-2 N/O, to 11-3 through 10-3 N/C, to 10-2, 11-5, through 10-1 N/C, 11-1 N/O to 10-1, through 12-1 N/C, SSS section 4, AN to C, 10-4 N/C, 11-4 N/O, 11-sort magnet at 26½ degrees.

Edit

Cards are edited when either the edit or edit-stop switch is ON. Cards that do not conform to the sort pattern being performed are rejected. With only the edit switch ON, the machine continues to operate, but the sort-magnet circuit is not completed. This is because the edit switches are placed in series with the sort magnets by the network of sort-control relay points that are picked from reading the error card. The circuit is open at the edit switches.

Example: If a card punched with 4 and 7 is read, it rejects because 7-2 N/O and 4-3 N/O change the circuit

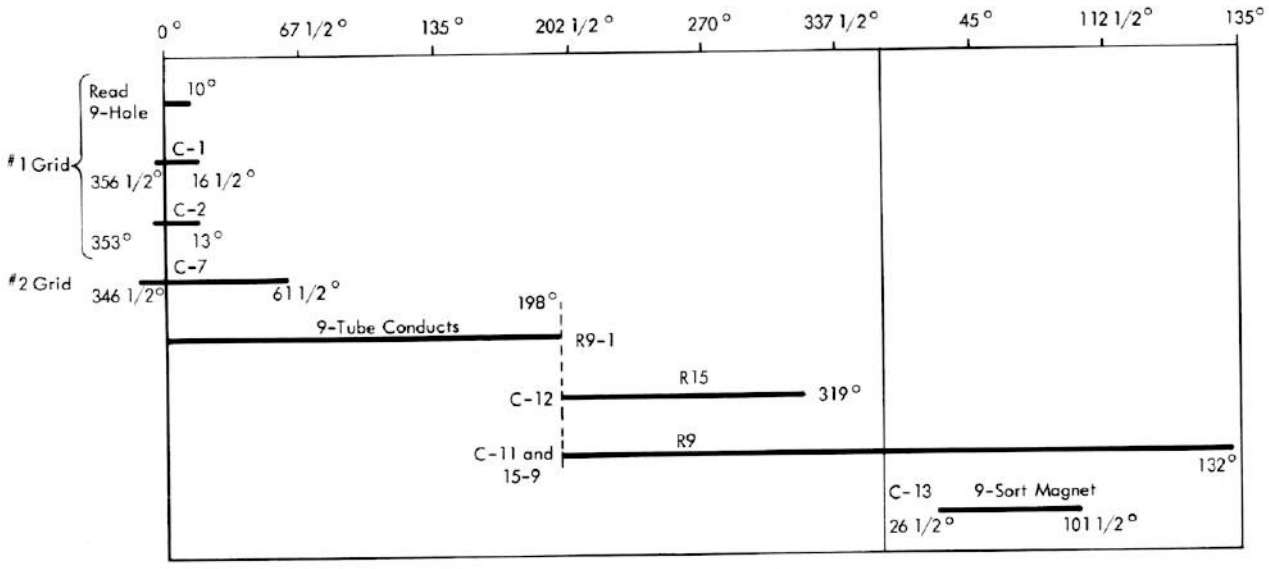


Figure 25. Sequence Chart—Sorting a 9-Card (Sort-Selection Switch on N)

path, and place the edit switches in the sort-magnet circuit. The card enters the reject pocket because no sort magnet energizes.

With both edit switches OFF, a sorting circuit for error cards is complete through the edit switches. The sort magnet that energizes is selected by the lowest punch for the pattern of sorting being performed.

With the edit stop switch ON, an error card rejects, the machine stops, and the error light circuit is completed. The impulse that normally energizes a sort magnet picks R16 instead. R16 picks because too many sort-control relays are energized as the result of reading too many holes in the card:

1. R16 holds through 16-1 N/O and the stop key.
2. R16-2 stops the machine by opening the R13 hold circuit.
3. R16-3 completes the edit light circuit.

General Description (Relays 1-12)

A general description of the purposes of relays 1 through 12 and some component circuits appears in this section.

The edit circuit is part of the sort-magnet circuit. The points or relays 1-12 complete circuits to the sort magnets, and also perform editing purposes. The sorting circuit has three general parts. These consist of:

1. numerical relays (1-9)
2. zone relays (10-12) for editing and sorting
3. part of the circuit controls (by the position of the selection switches 3 and 4) the energization of a particular sort magnet.

The -2 and -3 points of relays 1-8 and the -2 points of relay 9 edit the numerical punches 1-9. These points also complete circuits to the sort magnets.

The network is wired so that if two relays (1-9) are picked, the sort-magnet impulse does not energize a sort magnet when either edit switch is ON. In other words, these relay points edit the numerical punches that read from the card. If a relay (1-9) is picked, its -2 N/O points complete a circuit to the same -3 points for the R1-9 group. The machine checks (by using the -3 points of all relays 1-9) to detect whether a second relay is picked. When two relays (1-9) are picked, the circuit is complete to the edit switches. The position of the edit switches from this point on determines machine operation.

The second part of the circuit checks the zone punches. The numerical relays complete a circuit through the SSS2 section to provide editing either for the combination of zone and numerical punches or for zone punches only. Edit of the zone punches is performed: R12-3, -5 and -6; R11-2, -3, and -5; and R10-3. In this way the relays provide the edit control listed in the sort pattern chart. The second part of the circuit edits for more than one zone and functions to control sorting circuits the same as numerical relays function.

Assume that both edit switches are OFF. Any combination of relays for an error card provides a complete sort-magnet circuit. The third part of the sorting circuit selects which sort magnet energizes. This is controlled by the sort-selection switch.

Relays and Relay Points

R1. When R1 is picked, it serves as a storage device to show that a 1-hole was read in the card.

R1-1. R1-1 provides a circuit to pick relay 1. R1-1 then closes on the normally open side to cut off tube 1 and to provide a hold for relay 1.

R1-2. See *General Description (Relays 1-12).*

R1-3. See *General Description (Relays 1-12).*

R1-4. This is a transfer set of contact points. The N/C points complete a circuit to the N terminal of the sort-selection switch (section 4) for cards with a 0-, 11-, or 12-zone only, to pick the corresponding sort magnet. The N/O points complete a circuit to sort magnet 1.

R2. When R2 is picked, it serves as a storage device to show that a 2-hole was read in the card.

R2-1. R2-1 provides a circuit to pick relay 2. R2-1 then closes on the normally open side to cut off tube 2 and to provide a hold for relay 2.

R2-2. See *General Description (Relays 1-12).*

R2-3. See *General Description (Relays 1-12).*

R2-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnet 1. They also complete a circuit to sort magnets 0, 11, and 12 for the numerical sort pattern. The N/O points complete a circuit to sort magnet 2.

R3. When R3 is picked, it serves as a storage device to show that a 3-hole was read in the card.

R3-1. R3-1 provides a circuit to pick relay 3. R3-1 then closes on the normally open side to cut off tube 3 and to provide a hold for relay 3.

R3-2. See *General Description (Relays 1-12).*

R3-3. See *General Description (Relays 1-12).*

R3-4. This is a transfer set of contact points. The N/C points complete a circuit to pick sort magnets 1 and 2. With the sort selection switch at N, a circuit is completed to sort magnets 0, 11, and 12 through section 4. The N/O points complete a circuit to sort magnet 3.

R4. When R4 is picked, it serves as a storage device to show that a 4-hole was read in the card.

R4-1. R4-1 provides a circuit to pick relay 4 and then closes on the normally open side to cut off tube 4 and to provide a hold for relay 4.

R4-2. See *General Description (Relays 1-12).*

R4-3. See *General Description (Relays 1-12).*

R4-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnet 3 and the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 4.

R5. When R5 is picked, it serves as a storage device to show that a 5-hole was read in the card.

R5-1. R5-1 provides a circuit to pick relay 5. R5-1 then closes on the normally open side to cut off tube 5 and to provide a hold for relay 5.

R5-2. See *General Description (Relays 1-12).*

R5-3. See *General Description (Relays 1-12).*

R5-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 3 and 4 and to the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 5.

R6. When R6 is picked, it serves as a storage device to show that a 6-hole was read in the card.

R6-1. R6-1 provides a circuit to pick relay 6. R6-1 then closes on the normally open side to cut off tube 6 and to provide a hold for relay 6.

R6-2. See *General Description (Relays 1-12).*

R6-3. See *General Description (Relays 1-12).*

R6-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 3, 4, and 5, and to the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 6.

R7. When R7 is picked, it serves as a storage device to show that a 7-hole was read in the card.

R7-1. R7-1 provides a circuit to pick relay 7. R7-1 then closes on the normally open side to cut off tube 7 and to provide a hold for relay 7.

R7-2. See *General Description (Relays 1-12).*

R7-3. See *General Description (Relays 1-12).*

R7-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 3, 4, 5, and 6 and to the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 7.

R8. When R8 is picked, it serves as a storage device to show that an 8-hole was read in the card.

R8-1. R8-1 provides a circuit to pick relay 8. R8-1 then closes on the normally open side to cut off tube 8 and to provide a hold for relay 8.

R8-2. See *General Description (Relays 1-12).*

R8-3. See *General Description (Relays 1-12).*

R8-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 3, 4, 5, 6, and 7 and to the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 8.

R9. When R9 is picked, it serves as a storage device to show that a 9-hole was read in the card.

R9-1. R9-1 provides a circuit to pick relay 9. R9-1 then closes on the normally open side to cut off tube 9 and to provide a hold for relay 9.

R9-2. See *General Description (Relays 1-12).*

R9-3. This is not used.

R9-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 3, 4, 5, 6, 7, and 8 and to the sort magnets controlled by R3-4 N/C. The N/O points complete a circuit to sort magnet 9.

R10. This picks when a zero hole is read in the card.

R10-1. This is a transfer set of contact points. The N/C points complete a circuit to the sort magnets for the following conditions:

1. The sort-selection switch is set at A1. Cards punched A through I energize sort magnets 1 through 9 respectively. Cards punched with an X energize sort magnet 11.

2. The sort-selection switch is set at A2. Cards punched J through R energize sort magnets 1 through 9 respectively.

3. The sort-selection switch is set at AN. Cards with one punch (1-9 or 11) energize the corresponding sort magnet.

The N/O points complete a circuit to the sort magnets for the following conditions:

1. The sort-selection switch is set at A1. Cards punched with zero-only energize the zero sort magnet.

2. The sort-selection switch is set at A2. Cards punched S through Z energize sort magnets 2 through 9 respectively.

3. The sort-selection switch is set at AN. Cards punched with zero-only energize the zero sort magnet.

R10-2. This completes the sorting circuit when the sort-selection switch is set at AN, except for alphabetic cards S through Z which are rejected.

R10-3. See *General Description (Relays 1-12).*

R10-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 11 and 12. The N/O points complete a circuit to the zero sort magnet.

R10-5. R10-5 provides a circuit to pick relay 10. R10-5 then closes on the normally open side to cut off tube 10 and to provide a hold for relay 10.

R11. R11 picks when an 11 (X) hole is read in the card.

R11-1. This is a transfer set of contact points. The N/C points complete a circuit to sort magnets 1 through 9 for the following conditions:

1. The sort-selection switch is set at A1. Cards punched A to I respectively are sorted.

2. The sort-selection switch is set at AN. Cards with one punch (1-9) are sorted.

The N/O points complete a circuit to the sort magnets under the following conditions:

1. The sort-selection switch is set at A1. Cards punched with an X-zone or X-zone-only energize sort magnet 11.

2. The sort-selection switch is set at A2. Cards punched J through R energize sort magnets 1 through 9 respectively.

3. The sort-selection switch is set at AN. Cards punched with an X-zone or X-zone-only energize sort magnet 11.

R11-2. This is a transfer set of contact points. The N/C points complete a circuit for cards with one punch (1-9) to energize sort magnets for the AN sort pattern. The N/O points complete a sorting circuit for cards with an X-punch. They edit as in *General Description (Relays 1-12)* when the AN sort pattern is used.

R11-3. See *General Description (Relays 1-12).*

R11-4. This is a transfer set of contact points. The N/C points complete a circuit to sort magnet 12. The N/O points complete a circuit to sort magnet 11.

R11-5. This is a transfer set of contact points. The N/C points complete a sort-magnet circuit for the following conditions: cards with a zero punch only, (N, Z, A1 and AN sort patterns), cards punched S through Z (A1 and A2 sort patterns).

The N/O points complete sort-magnet circuits for cards with an X-punch-only or for cards punched with an X as for N/C points.

R11-6. R11-6 provides a circuit to pick relay 11. R11-6 then closes on the normally open side to cut off tube 11 and to provide a hold for relay 11.

R12. This picks when a 12-hole is read in the card.

R12-1. This is a transfer set of contact points. The N/C points complete a sort-magnet circuit for cards with a zero or X-only, (AN sort pattern). The N/O points complete a circuit to sort magnet 12 for cards with a 12-punch only (AN sort pattern).

R12-2. This is a transfer set of contact points. The N/C points complete a sort-magnet circuit (1-9) for cards with one punch (1-9) when the AN sort pattern is used. The N/O points complete a sort-magnet circuit (1-9) for alphabetic cards (A-I) when the A1 sort pattern is used.

R12-3. See *General Description (Relays 1-12).*

R12-4. This completes a circuit to sort magnet 12.

R12-5. This is a transfer set of contact points. The N/C points complete a sort-magnet circuit for cards with one punch (1-9) or for cards punched J-R when the AN sort pattern is used. The N/O points perform editing as in *General Description (Relays 1-12).*

R12-6. This is a transfer set of contact points. The N/C points complete a sort-magnet circuit for the following conditions: cards punched with zero or X-only for sort patterns N, Z, or AN; letter-coded cards J-Z for the A1 or A2 sort patterns. The N/O points complete a sort-magnet circuit for cards with a 12-punch only. The N/O points perform editing as in *General Description (Relays 1-12).*

R12-7. R12-7 provides a circuit to pick relay 12. R12-7 then closes on the normally open side to cut off tube 12 and to provide a hold for relay 12.

R13. This relay controls the start and running operation of the machine.

R13-1. R13-1 provides a hold circuit for R13.

R13-2. This is a transfer set of contact points. The N/C points complete a circuit to pick HD2 and to dynamically stop the machine. The N/O points complete a circuit to pick HD1 to start the motor.

R13-3. This is a transfer set of contact points. The N/C points provide a circuit to charge the run-out capacitor when the machine is not in operation. The N/O points complete a charging circuit for the run-out capacitor while the machine is operating.

R13-4. This provides a circuit to pick the delay relay.

R14. This relay picks when cards are feeding to control machine operation.

R14-1. R14-1 provides a hold circuit for R14.

R14-2. This provides a hold circuit for R13 as long as cards are in the feed.

R14-3. This completes the card-counter circuit for the auxiliary card counter when cards are in the feed.

R14-4. This completes the sort-brush circuit for card reading.

R15. This relay controls the time at which the storage of holes read in a card transfers from the tubes into the relays.

R15-1. This completes the circuit from the plate of tube 1 to pick sort-control relay 1.

R15 (2-9). These points serve the same purpose as R15-1, but for sort-control relays 2 through 9 respectively.

R15-10. This completes the circuit from the plate of tube 10 to pick sort-control relay 10. This point prevents false neon indication of tube conduction.

R15-11, R15-12. These points serve the same purpose as 15-10 but for tubes 11 and 12 respectively.

R16. This relay is picked to indicate an error card when the edit-stop key is ON.

R16-1. This provides a hold circuit for R16.

R16-2. This opens the start-relay circuit (R13) to stop the machine for an error card with the edit-stop switch on.

R16-3. R16-3 completes a circuit to light the edit light. Also, with the error-retention switch ON, it provides a circuit to supply 60V to hold the relays that caused the error condition.

R16-5. With the error-retention switch ON, this point opens to prevent repicking the tube-transfer relay in case of an error. This prevents any other relays from picking except those that caused the error condition.

R16-6. With the error-retention switch ON, this point opens to prevent any more tubes from energizing in case of an error condition.

HD1. This relay controls the motor circuit for machine operation.

HD1-1. This completes the motor circuit.

HD2. This relay controls the motor operation to stop dynamically.

HD2-1. This completes a circuit to use the stored energy in the run-winding to dynamically stop the machine.

Thermal Relay. This relay adjusts for an interval of delay that is needed to heat the tube filaments before the machine can be operated.

TH-AL. This provides a circuit to pick the thermal relay when the heating element closes the points.

TH-BU. This completes a circuit to supply the potential of −48V for relay operation.

TH-BL. This is a transfer set of contact points. The N/C points open the circuit to the heating element when the thermal picks. The N/O points provide a hold circuit for the thermal relay.

CS Relay. This relay is a safety device to make sure that the cover switches are operated by their respective covers before the machine can be operated.

CS-AU. This completes the circuit for the +60V potential to the contact roll.

CS-AL. This completes the start-and-hold circuit for R13.

CS-BL. This completes the sort-brush circuit to the tube units. When open, it removes the −48V potential from the contact roll that is present if any pair of CB's (1-6) is closed.

DR Relay. This relay interlocks the machine circuits. It provides that the sort magnets must be operated with −48V when the machine is sorting under power.

DR-AU. This prevents machine operation if the delay relay is not picked.

DR-BU. This shunts the resistor (R-22) in the sort-magnet circuit when the machine is sorting under power so that the sort magnets operate with full voltage of 48V.

Circuit Breakers

On newer machines the cams are timed 4 degrees later than before. Check the machine wiring diagram for timings.

C-1. This establishes the earliest time that holes 0, 3, 6, and 9 in the card can condition grid 1 of tubes 10, 3, 6, and 9. Along with CB2, CB1 isolates grid 1 of these four tubes for the other holes that can be read in the card.

C-2. This establishes the latest possible time that holes 0, 3, 6, and 9 in the card can condition grid 1 of tubes 10, 3, 6, and 9.

C-3. This has the same purpose as CB1 but for card holes 8, 5, 2, and 11.

C-4. This has the same purpose as CB2 but for card holes 8, 5, 2, and 11.

C-5. This has the same purpose as CB1 but for card holes 7, 4, 1, and 12.

C-6. This has the same purpose as CB2 but for card holes 7, 4, 1, and 12.

C-7. This provides 60V for grid 2 of tubes 7, 8, and 9.

C-8. This has the same purpose as CB7 but for tubes 4, 5, and 6.

C-9. This has the same purpose as CB7 but for tubes 1, 2, and 3.

C-10. This has the same purpose as C-7 but for tubes 12, 11, and 0.

C-11. This provides a hold circuit for the sort-control relays until after the sort magnet for each card energizes. Also, by picking the relay, it cuts off the tubes.

C-12. This picks R15 to transfer (from tubes to relays) storage of the holes (9-1) read in the card.

C-13. This provides a timed impulse to energize a sort magnet.

C-14. This provides a hold circuit for the card lever so the sort brush can read the entire last card.

C-15. This picks the card-lever relay (R14).

C-16. This provides a timed impulse to operate the auxiliary card counter.

Resistors

Resistor 1. R-1 discharges the run-out capacitor (C1) when power is removed.

Resistor 2. R-2 discharges C2 when power is removed.

Resistor 3. This provides voltage regulation by maintaining a load on the −48V supply.

Resistor 4. This provides voltage regulation by maintaining a load on the +60V supply.

Resistor 6-17. These provide voltage regulation on their respective sort-control relays. When the tubes are dropped the relays are being held.

Resistor 18. This limits the amount of current through the heating element to provide enough time for the tube filaments to heat before the contact picks the thermal relay.

Resistor 19. This resistor provides a load on C19 to regulate the 105V supply for the neon lights on the tube unit.

Resistor 20. This resistor limits the maximum rate at which the run-out capacitor (C1) can discharge.

Resistor 21. This limits the maximum rate at which C2 can discharge.

Resistor 22. This limits the amount of current that passes through the sort magnets when the machine is stopped or operated by hand.

Resistor 23. This provides an adjustment for the amount of run-out time.

Capacitors

C1. C1 provides run-out time to stack all cards in the pockets when it discharges, by delaying the drop of relay 13.

C2. C2 provides that the sort magnets operate with 48V potential until the machine stops, by discharging through the delay relay.

C3. This capacitor filters the rectified voltage for the −48V supply.

C4. This capacitor filters the rectified voltage for the +60V supply.

C18. This is a doubler capacitor. It provides the 105V supply for the neon lights on the tube unit.

C19. This capacitor filters the rectified voltage for the 105V supply for the neon lights on the tube unit.

Alphabetic Sorting

When the alphabetic sorting feature is installed, the sorting patterns for settings A1, A2, and AN are permanently changed. A card column can be sorted alphabetically by passing all the cards through the machine on the selected column once, and a part of the cards a second time. It is not necessary to remove any *sorted* cards from the machine until the column is completely sorted.

Figure 26 shows the sorting pattern for a machine equipped with the alphabetic sorting feature. With the sort-selection switch set to A1, the first pass of the cards on a column sorts all the cards punched A, C, E, G, I, L, O, R, U, and X into pockets 0 to 9. Cards punched B, D, F, H, J, M, P, S, V, and Y sort into the 12-pocket. Cards punched K, N, Q, T, W, and Z sort into the 11-pocket. Blanks and cards punched 0-1 and those without alphabetic coding reject.

The selection switch is changed to A2 for the second pass and the cards in the 12-pocket, followed by the cards in the 11-pocket, are fed without removing any cards from the 0 to 9 pockets. At the end of the second pass, the column is completely sorted.

This method of alphabetic sorting is superior to others because ten characters, including all the vowels, are sorted in one pass. It is not necessary to remove sorted cards from the pockets until the sort is completed.

This feature adds relays 17, 18, 19, 20, and 21 to the machine circuits. The relays operate in combinations for the new purposes of the sort patterns A1, A2, and AN. The added relay points are in the sort-magnet circuits.

With the alphabetic sorting feature, three factors control the selection of a card: the holes in the card, the position of sort-selection switch, and the points for relays 17, 18, 19, 20, and 21.

Auxiliary Card Counter

The auxiliary card counter on the IBM 83 Sorter counts all cards that pass through the machine. The counter operates at the speed of 1,000 cards per minute (cpm). The counter does not affect machine speed. All normal functions can be performed regardless of the position of the card-count switch. The capacity of the counter is 999,999. To reset to 000,000 turn the knurled handwheel.

The actual counting and accumulating is done mechanically by a unit entry counter. Each time the shaft of the counter rotates sufficiently, a 1 adds into the

SORT SELECTION SWITCH SETTING	POCKETS												ERRORS (When edit or edit-stop is on)	REJECTS REGARDLESS OF EDIT
	9	8	7	6	5	4	3	2	1	0	11	12		
A1	X	U	R	O	L	I	G	E	C	A	KN QT WZ	BD FH JM PS VY	Any card with more than one zone punch or more than one digit punch	Cards punched with digits only, or with zones only, blanks or 0-1 combination.
A2	Z Y X	W V U	T S R	Q P O	N M L	K J I	H G	F E	D C	B A			Same as A 1	Same as A 1
A N	9	8	7	6	5	4	3	2	1	0	KN QT WZ 11	BD FH JM PS VY 12	Same as A 1	Blanks A, C, E, G, I, L, O, R, U, X and the combination 0-1.

This pattern is based on cards fed face down, 9-edge first

Figure 26. Sort-Pattern Chart using Alphabetic Sorting

units position of the counter. The mechanical carry from one position of the counter to another is internal in the counter.

As cards enter the feed, they operate the card lever. This picks R14 to provide a circuit for the card-counter magnets to count 1 each card cycle. The operation of the card counter begins (if the card counter switch is ON), when C-16 completes the card-count circuit. The card count magnets energize with 60V and rotate the rotor counterclockwise. This is because of the magnetic effect by the pole pieces to line up the rotor.

The total movement of the rotor is limited by bumper stops that help to insure silent operation (Figure 27). In Figure 27 the end support sections are not completely shown. One magnet and pole piece are shown in dotted lines.

As the rotor rotates, the drive pawl (which is clamped to the same shaft to which the rotor is fastened) drives the counter ratchet wheel. The movement in this direction moves the ratchet wheel one-half the distance necessary to add 1 in the counter. The impulse provided by C-16 ends at 184 degrees to allow the rotor to be spring-returned to home position. As the rotor returns to rest position, the detent pawl drives the ratchet wheel, and completes the necessary movement to add 1 in the counter.

Two actions on the ratchet wheel perform the mechanical action of counting a digit of 1.

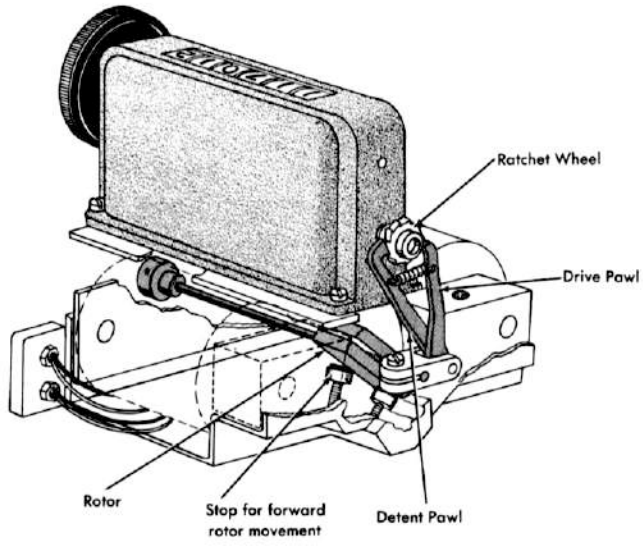


Figure 27. Auxiliary Card Counter

Card Counting Unit

Functional Principles

The card counting unit is used with, and is under the control of, the IBM 83 Sorter to count cards. The counter unit performs a pocket distribution count for all cards with or without card sorting.

In normal operation, the unit counts cards that enter each pocket and shows this total in the subtotal counter. If cards have multiple punches, the counters count each hole in the card column. The subtotal counter accumulates the total number of cards and not the number of holes read.

Two keys (see Figure 33) control the counting unit. They are on the front cover below the digit-suppression keys. Set the counter key ON to count cards. When the key is ON, the counting unit must be connected to the sorter. The cable from the counting unit connects into an Elco receptacle in the back of the auxiliary card-counter cover. If the cable is not connected to the sorter, and the counter key is ON, the sorter does not operate.

Set the count-only key ON to suppress sorting while cards are counted. Digit suppression suppresses the sorting of cards with specific punches without suppressing the count of the respective punches.

The counter unit is electrically connected to the sorter through an Elco plug and receptacle. Normally, the counting unit is on the rear rail of the machine. It can be used away from the sorter within the limits of the cable. It can be disconnected and removed from the machine entirely when not in use.

The counting unit consists of 14 separate counters: 12 counters to count the punches in the card, one counter to count rejected cards, and one counter to accumulate a total of all cards. The counters are in two rows across the length of the counting unit. The counters are numbered to correspond with the particular hole counted. The counters in the top row consist of 0 through 5 and reject. The counters in the lower row consist of 6 through 12 and subtotal. Each has a capacity of 99,999.

Reset the counters manually by turning the crank at the right side of the counting unit. Press the detent lever on the front of the unit before turning the crank. The detent lever is an interlock to prevent machine operation when the counters are not fully reset to zero. Pressing the detent lever operates a switch that opens the machine start circuit.

The reset crank resets the counters by turning a shaft to which all the counters are geared. At the completion of the second crank revolution, a detent lever engages in the counter-reset shaft. This prevents further movement of the reset mechanism until the detent lever is again pressed.

Actual counting and accumulating in the counters is mechanical. Each hole impulses the correct counter magnet to be counted. As the magnet armature is attracted, point A engages the counter ratchet and moves the unit counter wheel (Figure 28). This provides half the ratchet movement needed to add 1. The armature is spring-returned when the counter magnet is de-energized.

As the armature returns, point B drives the counter ratchet to complete the action of counting 1 (Figure 29). The carry from one position of the counter to the next higher position is internal. When the counter wheel passes from 9 to 0, it engages the next (higher) counter wheel to carry a 1.

Circuits

To count cards, the count key must be ON. This provides a circuit to pick R51 (Figure 30). The points of R51 electrically connect the counting unit into the circuits of the IBM 83. The 51AL points transfer and cause C-12 to pick R115 instead of R15, which is disconnected. The R115 points complete circuits to pick relays 101-112 when their respective tubes conduct. The sort-control relays (1-12) are not picked first because R15 did not pick. R101-112 relays pick. Their 1 and 2 points complete a hold circuit, and pick R1-12 respectively.

The 51BL provides a circuit to the counter magnets. The 51AU points open the normal circuit for the delay relay and relay 13 to interlock these relays under the control of the counter-unit reset switch. When ON, the count-only key opens the sort-magnet circuits to suppress sorting.

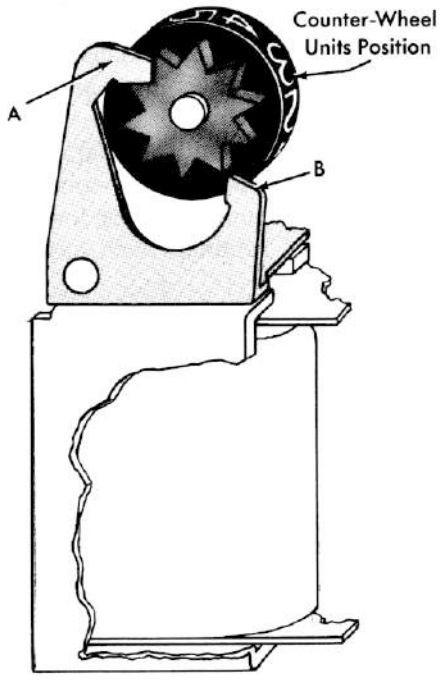


Figure 28. Counter Magnet Energized

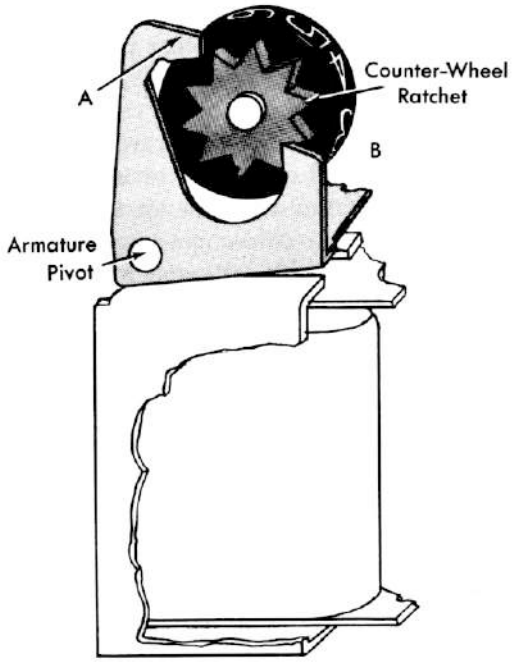


Figure 29. Counter Magnet Normal

Relay 52, is picked when the stop key is pressed during machine operation, and the DR-AL points close. The 52AL points make on the normally open side, and prevent any more counter magnets from working. The 52BU points suppress the auxiliary counter.

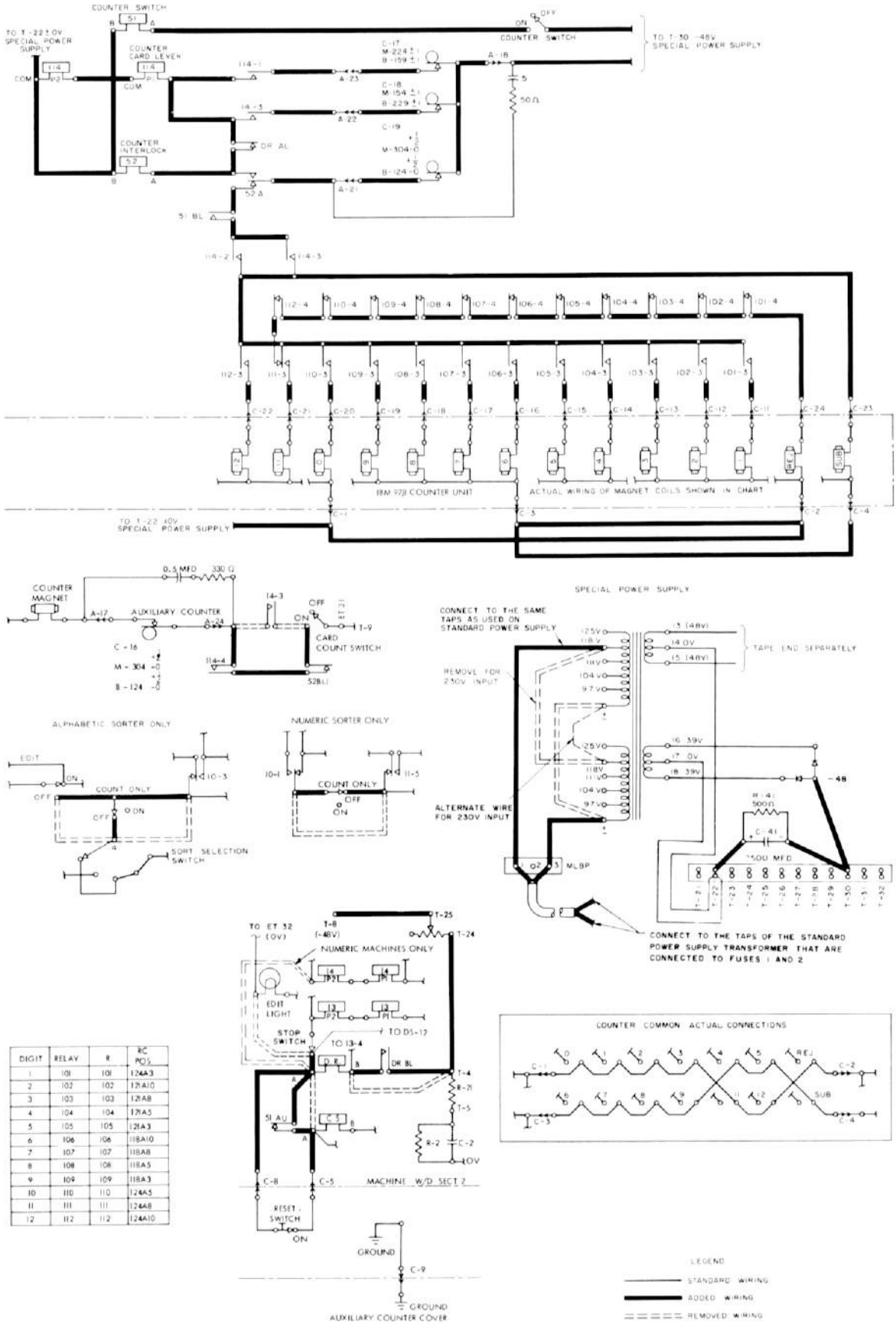
There is a separate power supply for the card-counter unit circuits. A transformer (located under the stacker pockets) provides —48V for circuit operation of the counters and additional relays. The primary windings have adjustment taps to obtain the proper secondary output voltage. The secondary output is rectified and filtered across the T22 and T30 terminals.

The sequence chart (Figure 31), illustrates the sequence of relay and counter operation for two cards from the time the cards enter the reading station until they are sorted. The first card is punched 8, and the second 12. If the count-only switch is ON, the operation is the same except that no sort magnets are energized.

Card Matching

The card matching feature compares a merged file of master and detail cards. It separates card files into matched and unmatched groups. Such a file could consist of three types of cards:

1. detail cards (identified by a corner cut, a 9-punch, or an equivalent 9-punch in columns 1 or 80). An



DIGIT	RELAY	R	RC POS.
1	101	101	124A3
2	102	102	121A10
3	103	103	121A8
4	104	104	121A5
5	105	105	121A3
6	106	106	118A10
7	107	107	118A8
8	108	108	118A5
9	109	109	118A3
10	110	110	124A5
11	111	111	124A8
12	112	112	124A10

Figure 30. Wiring Diagram—Card-Counter Unit Circuits

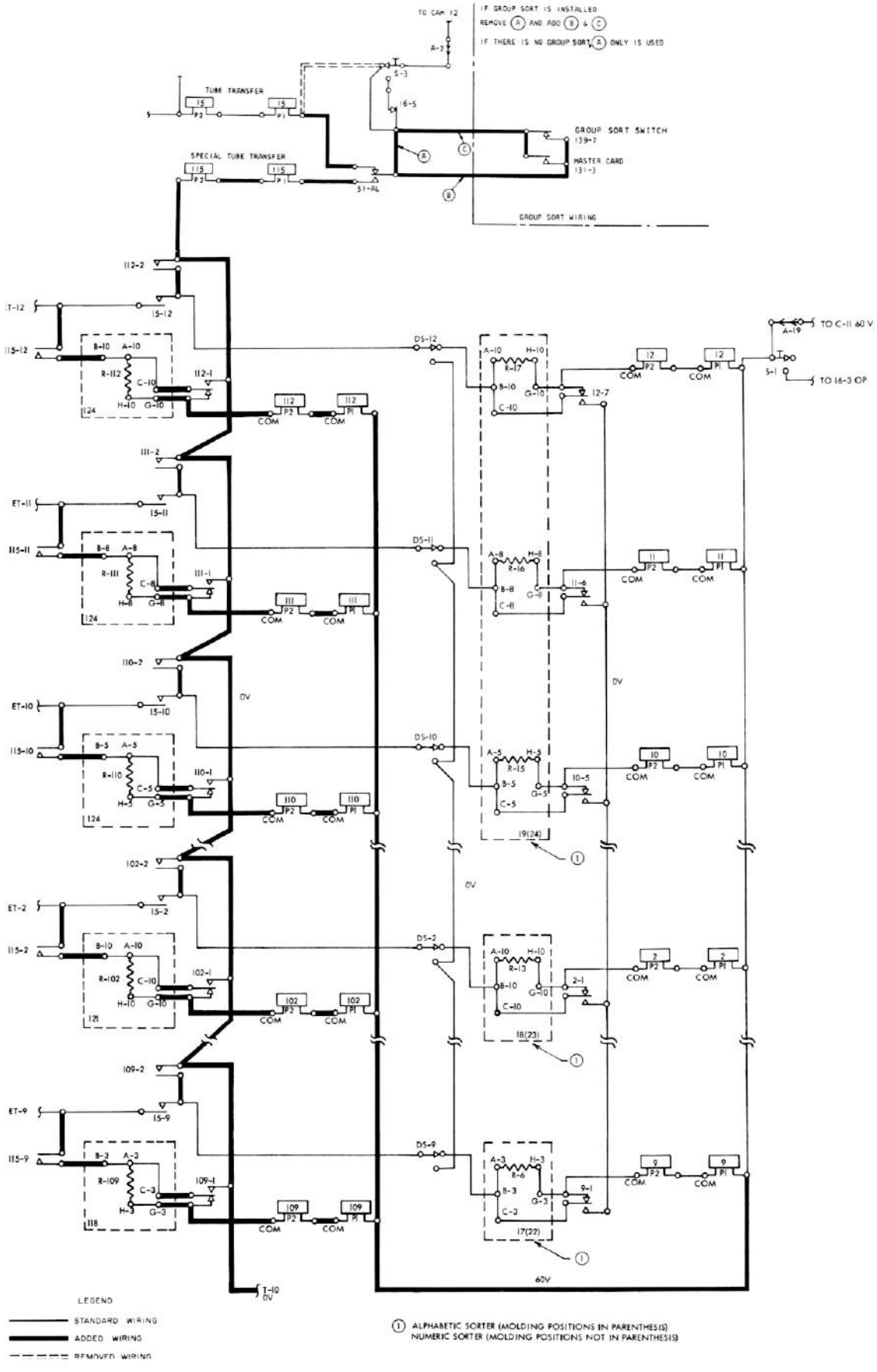


Figure 30. (Continued)

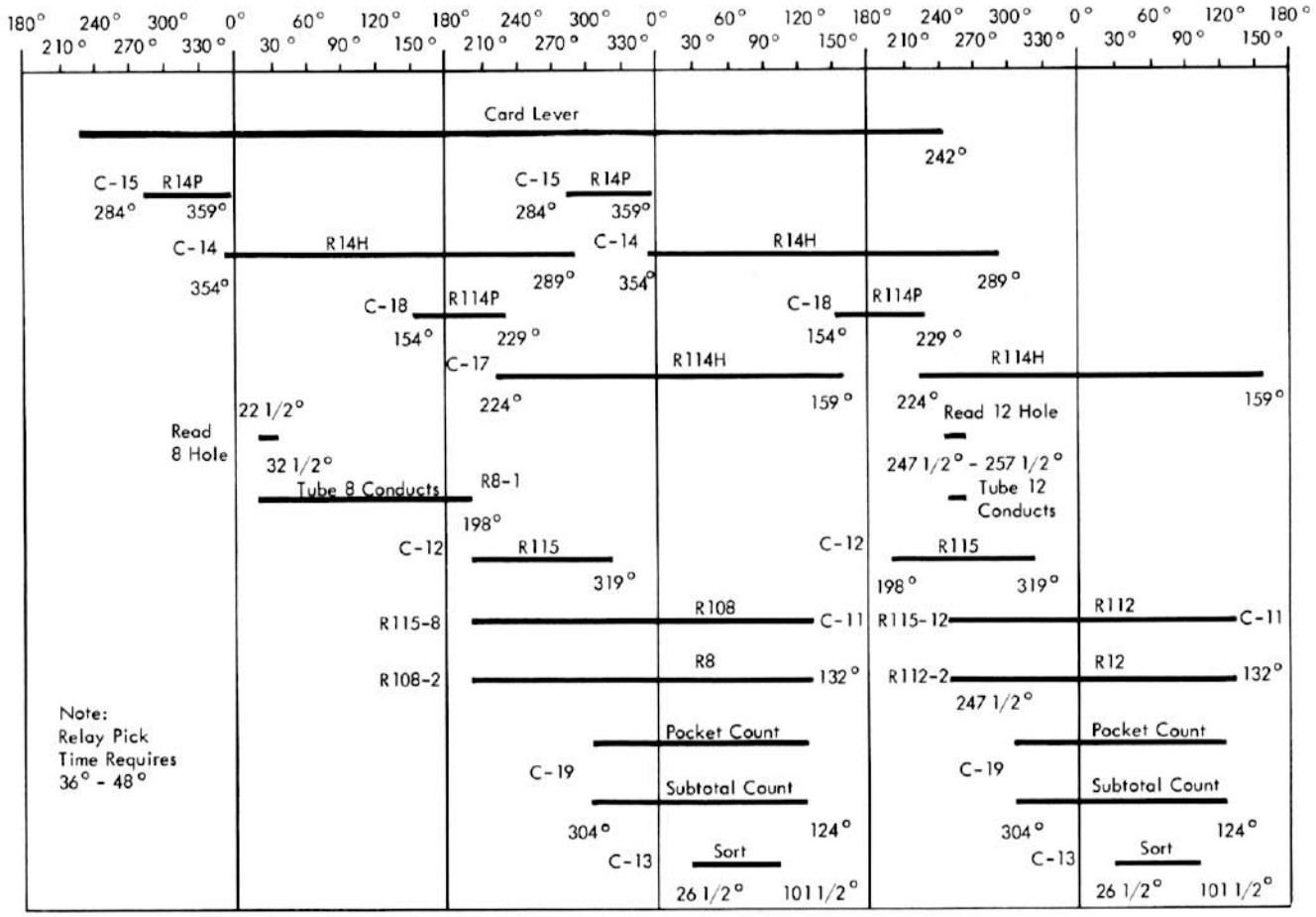


Figure 31. Sequence Chart—Card-Counter Unit

equivalent 9-punch is a 12-punch when cards are fed 12-edge first.

2. master cards, (identified by a significant punch in an assigned column, or by a corner cut opposite to that of the detail cards).
3. unidentified cards, (not recognized as either detail or master cards).

Detail cards are read by either a front or rear rail brush (Figure 32). A front rail brush reads a left-hand or an equivalent left-hand corner cut. A rear rail brush reads a right-hand or an equivalent right-hand corner cut. The term *equivalent corner cut* means this feature permits the card to be reversed so that card column 80 passes sort column 1. A spacer added to the front rail brush reads sort column 1, and one added to the rear rail brush reads sort column 80. Only one rail brush is used at a time.

Master cards that contain a significant punch are read by the regular sort brush. Digit-suppression keys are pressed to eliminate reading unwanted punches. Replace the normal sort-brush assembly by an offset-brush assembly when master cards are to be identified by a corner cut.

To operate this feature, set the card-match key ON (Figure 33), and turn the sort-selection switch to N. The file must be arranged so that detail cards precede master cards of the same group, and corner cuts must be on the leading edge. The card-matching sort circuits direct the cards either to the 11-pocket or to the reject pocket. The first detail card read sets up a sort-to-11 circuit, which once picked holds itself up.

When a master card reads, the circuit sorts the master card into the 11-pocket, but drops out the sort-to-11 circuit for the succeeding cards. Therefore, a sort-to-11 sequence directs these cards into the 11-pocket: the first detail card, the following cards, and the first master card read.

Because a master card drops out the sort-to-11 circuit, only the last master of a multiple master group is identified. When a master card is followed by a detail card, the sort-to-11 circuit is signalled to drop out by the master card, and to pick up by the detail card. In this case, the detail card takes precedence and the sort-to-11 circuit is maintained.

This feature permits cards to be fed 9-edge, face up or down; and 12-edge, face up or down. There are 16

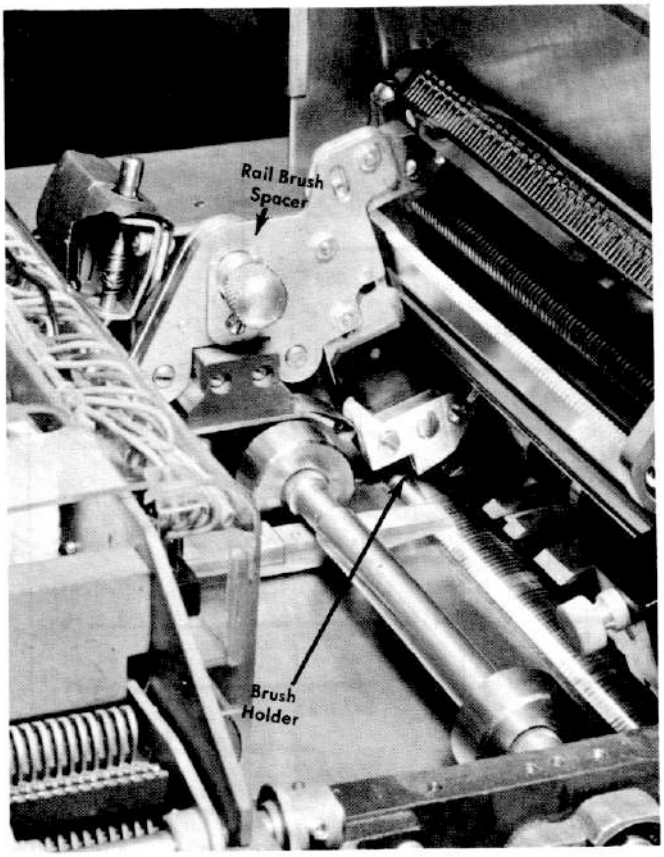


Figure 32. Rear Rail Brush

possible sort arrangements (see Figure 34). The left chart in Figure 34 lists the detail and master card order and identification. The right chart lists the card relationship to the feed bed, and the brush-reading assemblies required.

The card-match switch picks R142 (Figure 35). This relay conditions other circuits for card matching. The points are arranged so that the sort impulse is directed to tube 2 (master tube) instead of to a specific sort magnet.

R142-1 is used only on alphabetic machines. It routes the sort impulse past the edit-stop switch, edit switch, and sort-selection switch 3. This prevents the sort impulse from picking a sort magnet incorrectly by way of the edit switches.

R142-2 directs the sort impulse to the -3 points of all sort control relays except 9. When one of these relays is picked by a master card, the sort impulse reaches tube 2 through the transferred -3 points.

R142-3 directs the sort impulse to tube 2 when sort-control relay 9 is picked.

R142-4 transfers the sort impulse from normal sort circuits to tube 2.

R142-5 picks R138.

OBJECTIVE

Read a detail card and set up a sort-to-11 circuit. Read a master card, sort it into the 11-pocket, and drop out the sort-to-11 circuit. The detail card has a right-hand corner cut. The master card has an 8-punch in column 30. See the sequence chart in Figure 36.

CIRCUIT DETAILS

Detail card read:

1. The corner cut of the detail card is read by the rail brush. Both grids of detail tube 1 (see Figure 37 for assembly) are driven positively and the tube conducts.
2. R132 is picked by tube 1, C-26.
3. R132 is held by 132-1, C-26.
4. Tube 1 cuts off when its plate potential is brought below the extinguishing potential by the 10-mfd charge current through its load resistor.
5. R134 is picked by 132-4.
6. Sort magnet is 11 picked by 134-2, DR-BU, C-13.
7. The detail card and all cards following continue to sort into the 11-pocket until R134 is released.

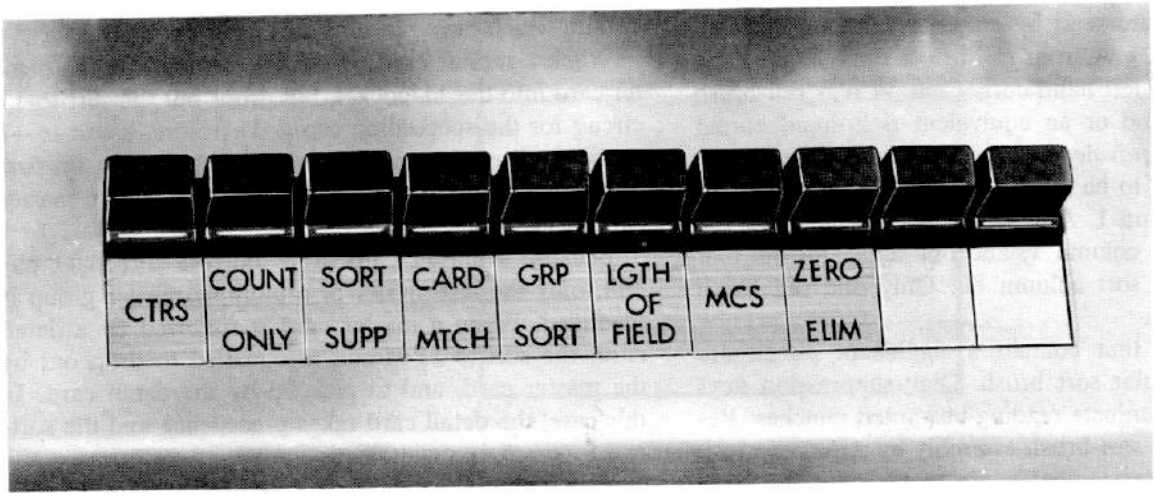
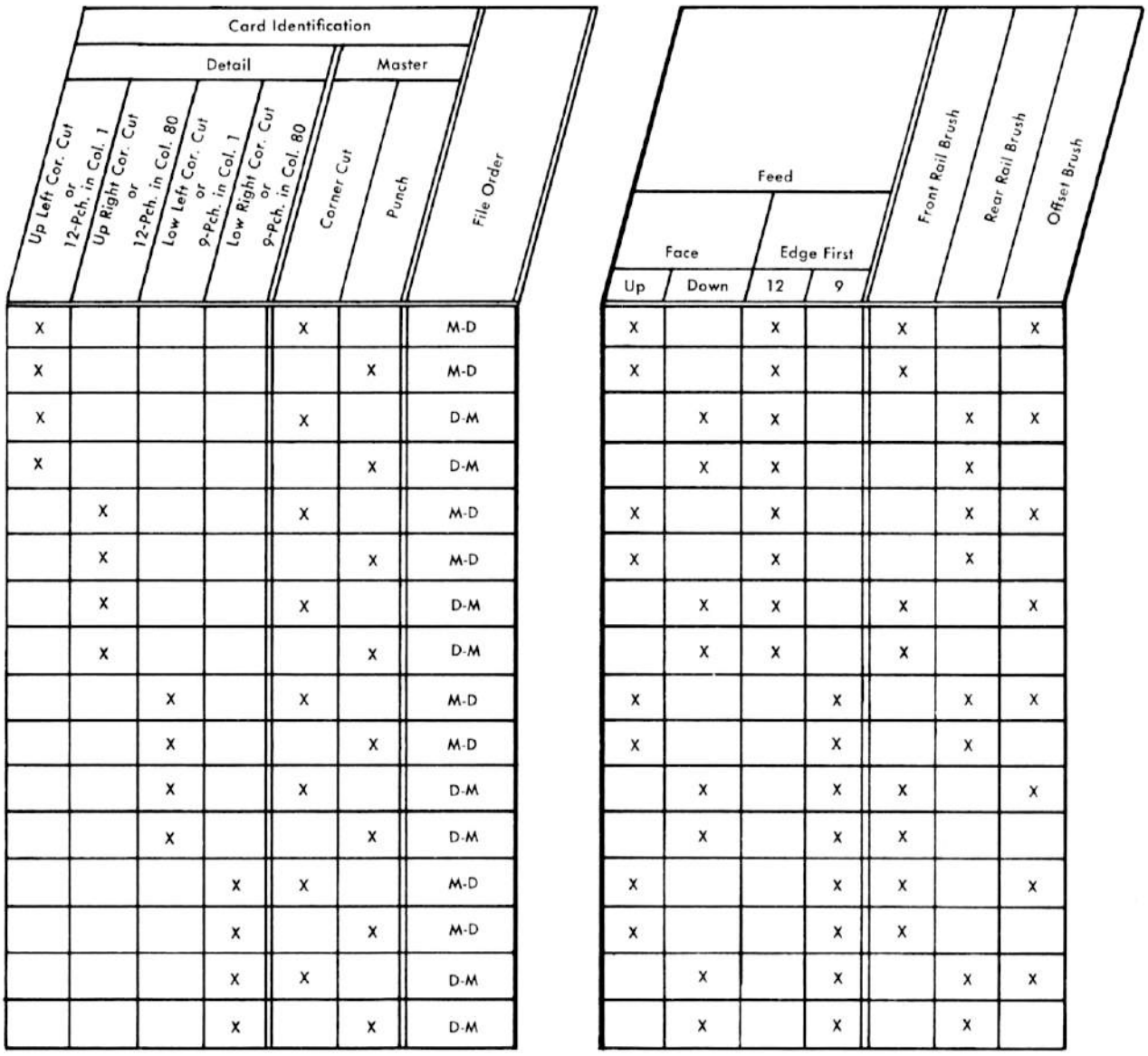


Figure 33. Special Features Keys



Card Identification								Feed						
Detail						Master		Face		Edge First				
Up Left Cor. Cut or 12-Pch. in Col. 1	Up Right Cor. Cut or 12-Pch. in Col. 80	Low Left Cor. Cut or 9-Pch. in Col. 1	Low Right Cor. Cut or 9-Pch. in Col. 80	Corner Cut	Punch	File Order	Up	Down	12	9	Front Rail Brush	Rear Rail Brush	Offset Brush
X				X		M-D	X		X		X		X
X					X	M-D	X		X		X		
X				X		D-M		X	X			X	X
X					X	D-M		X	X			X	
	X			X		M-D	X		X			X	X
	X				X	M-D	X		X			X	
	X			X		D-M		X	X		X		X
	X				X	D-M		X	X		X		
		X		X		M-D	X			X		X	X
		X			X	M-D	X			X		X	
		X		X		D-M		X		X	X		X
		X			X	D-M		X		X	X		
			X	X		M-D	X			X	X		X
			X		X	M-D	X			X	X		
			X	X		D-M		X		X		X	X
			X		X	D-M		X		X		X	

Figure 34. Detail-Master Card Identification

Master card read:

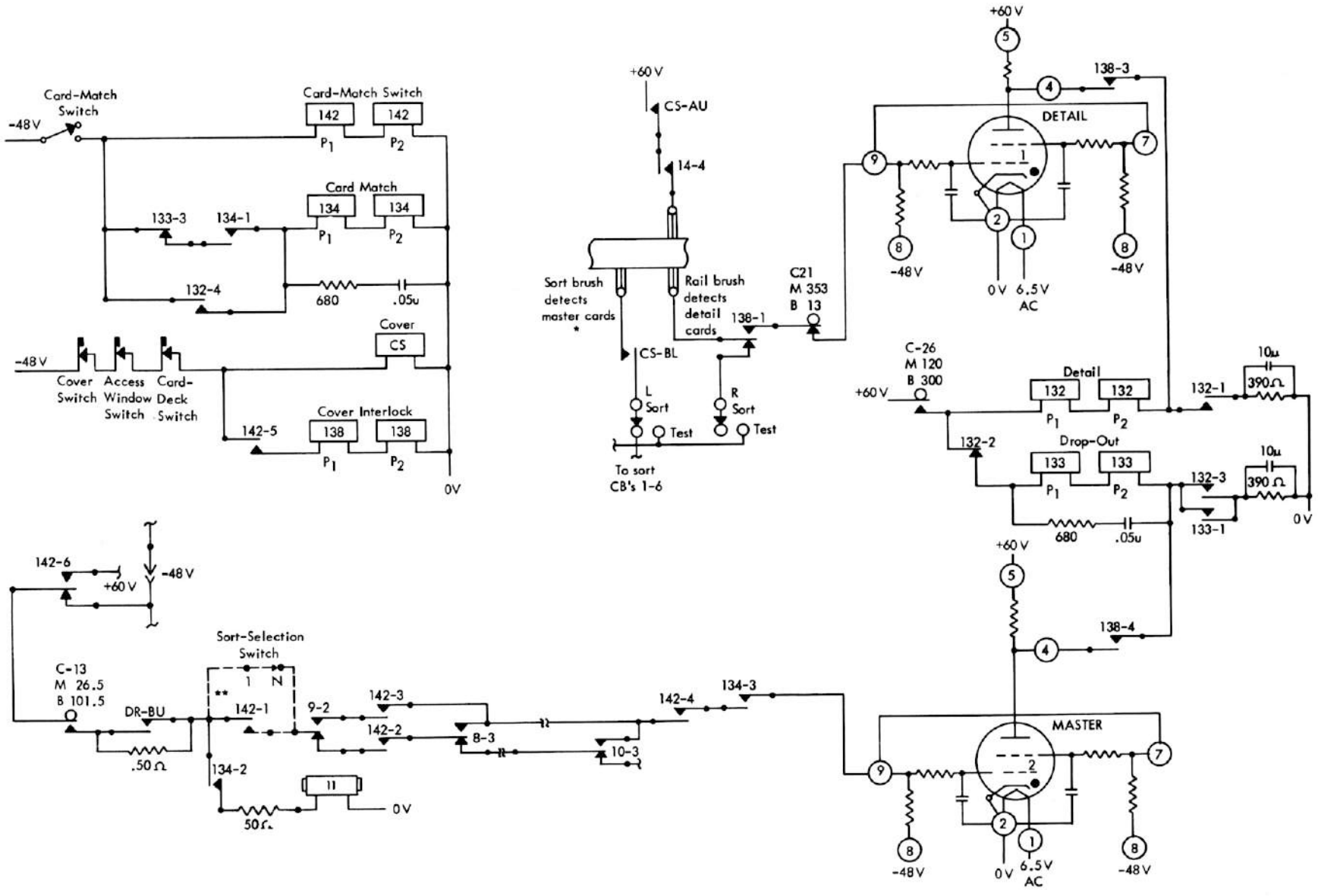
1. Sort-tube 8 conducts when the 8-punch in the master card reads.
2. Sort-control relay 8 is picked in the normal manner.
3. Tube 2 is picked by 134-3, 142-4, 8-3, 142-2, 9-2, 142-1 or the sort-selection switch, DR-BU, C-13.
4. The sort magnet 11 is picked by 134-2, DR-BU, C-13. The master card sorts into the 11-pocket.
5. R133 is picked by tube 2, 132-2, C-26.
6. Tube 2 is cut off by the 10-mfd charge through 133-1, 138-4, and the plate load resistor of tube 2.
7. R134 is dropped by 133-3.
8. The cards following the master card reject until another detail card reads.

Note: When a detail card directly follows a master card, R132 and R133 both establish pick circuits. Once R132 is picked, its 2-points open the pick of R133, its 3-points cut off tube 2, and its 4-points re-establish a pick for R134. In this case both master and detail sort into the 11-pocket.

Card Racks

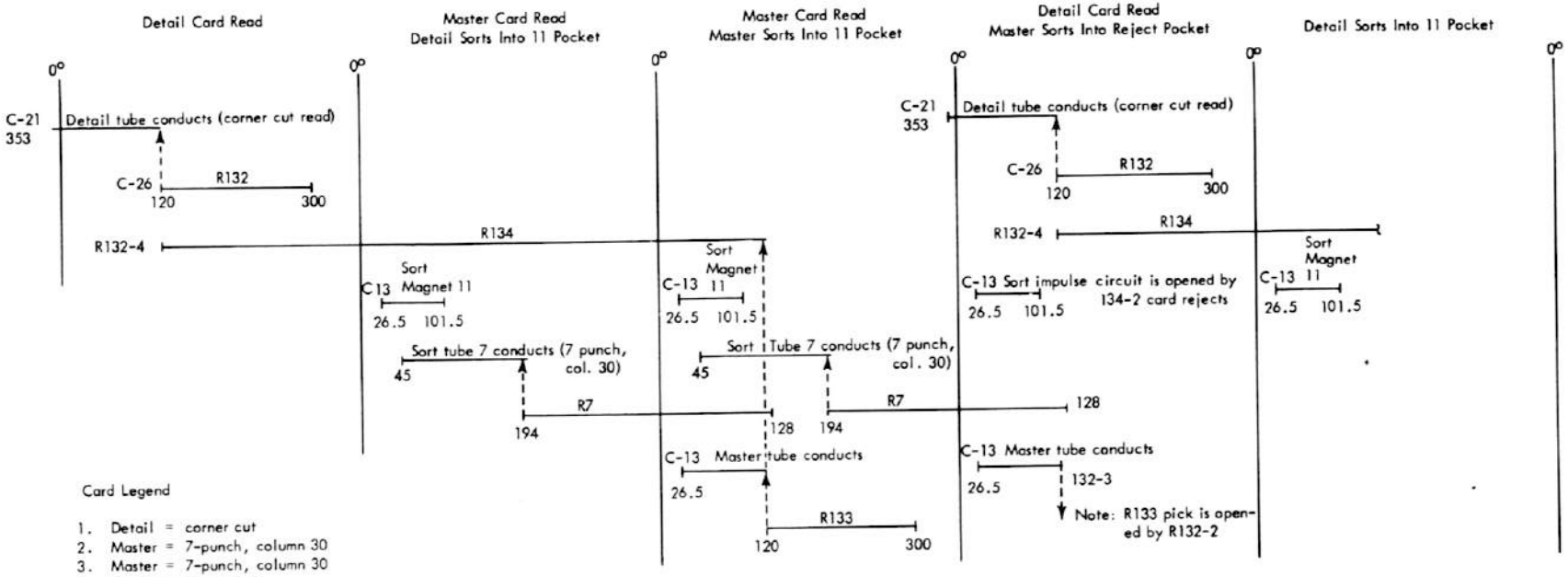
Two different card racks can be used with the IBM 83 Sorter. The upper card rack is used behind the sorter. It is supported on a stand and is not attached to the base of the sorter. It has a pocket capacity of 3,000 cards for each of 13 pockets. The lower card rack is attached to the front cover of the machine below the stacker pockets. It does not require a stand. It has a capacity of 2,500 cards per pocket.

Figure 35. Card Matching



* Offset brush is used instead of sort brush when the master card is read from column 00, 0, 81, or 82.

** R 142-1 is used with alphabetic machines only. Sort-selection switch 1 is used with numerical machines.



Card Legend

1. Detail = corner cut
2. Master = 7-punch, column 30
3. Master = 7-punch, column 30
4. Detail = corner cut

Note: Cards 1 and 2 are of the same group and sort into the 11-pocket.
Card 3 has no preceding detail card and it rejects.
Card 4 is a detail card not followed by a master, and it sorts into the 11-pocket

On groups containing more than one master card, only the last master card has an identifying punch.

Figure 36. Card-Matching Sequence Chart

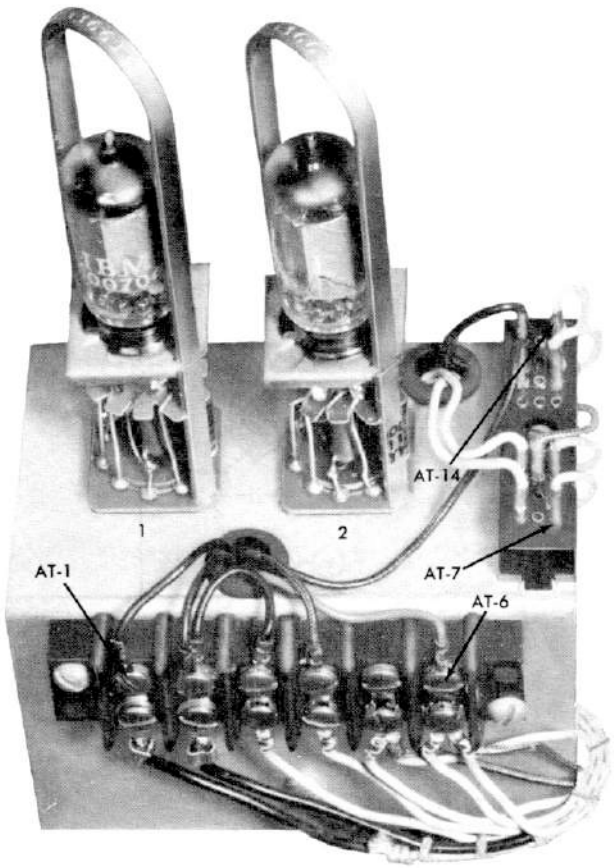


Figure 37. Card-Matching and/or Group-Sorting Tube Chassis

Group Sorting

The group sorting feature permits sorting a card group into a pocket selected by a master card. A master card is identified by a corner cut on the leading edge, or by a 9-punch or an equivalent 9-punch in columns 1 or 80. An equivalent 9-punch is a 12-punch when cards are fed 12-edge first. Detail cards do not require identification, and they cannot contain master card identification.

Master cards are read by either a front or rear rail brush, or both. A front rail brush reads a left-hand corner cut, and a rear rail brush reads a right-hand corner cut. A spacer added to the front rail brush reads sort column 1, and one added to the rear rail brush reads sort column 80.

The group-sort key (see Figure 33) controls the operation of this feature. No sorting is performed until a master card is sensed. Once a master card is sensed, it sorts normally (the tube storage transfers into the relay storage-sort control relays). The setting of the sort selection and edit switches determines where the master card sorts. The reading of the master card is retained by preventing the picked sort-control relays from dropping out. All detail cards that follow sort into the same pocket as the master card. The status of the sort-control relays is not affected by any detail card readings. The relays are held until the next master card is sensed.

A trailer-card feature can be used with the group sorting feature. A corner-cut read at the trailing edge of a card by the rail brush breaks the control of the preceding master card. The trailer card sorts into the same pocket as the master and detail cards. All following detail cards reject until another master card is sensed.

Group sorting with the IBM 83 requires the addition of two 2D21 tubes (see Figure 37), five circuit breakers (C-21, C-22, C-23, C-24, C-25), and four relays (R131, R133, R138, R139). The circuit is designed to use these components for special features other than group sorting. This is done with switching circuits controlled by the special-feature keys.

The group-sorting switch (Figure 38) picks group-sorting relay 139.

R139-1 N/C opens the direct +60V plate supply for tubes 1-9. The plate supply is thus controlled by C-24. This permits any sort tube 1-9 that is picked by a detail card to drop out at 293 degrees when C-24 breaks. Sort tubes 1-9 (picked by master cards), drop out in the normal manner; that is, by sort-tube transfer to sort-control relays.

R139-1 N/O supplies +60V to a relay-point-controlled common return of the sort-control relays. C-11 is thus effective only during master-card reading cycles; that is, it provides a timed dropout for the sort-control relay picked by the previous master card.

R139-2 N/C opens the normal pick of the tube transfer relay R15. R15 picks through 131-3, which is up on master-card cycles only.

R139-3 removes positive bias from the G2 grids of sort tubes 0, 11, and 12. These tubes can now conduct only on master-card cycles when positive bias is established by 131-4.

R139-4 connects the rail brush to the input circuit of tube 2.

R139-5 picks R138.

OBJECTIVE 1

Sort a master card containing a 9-punch in column 30 into the 9-pocket. Sort all detail cards following the master into the 9-pocket. Sort a second master card that contains a 12-punch in column 30 into the 12-pocket. Master cards have a lower right-hand corner cut. Detail cards do not have a lower right-hand corner cut.

CIRCUIT DETAILS 1

Master card read:

1. The rail brush reads the master-card corner cut. Both grids of master tube 1 are driven to positive and the tube conducts.
2. R131 is picked by tube 1, C-23.

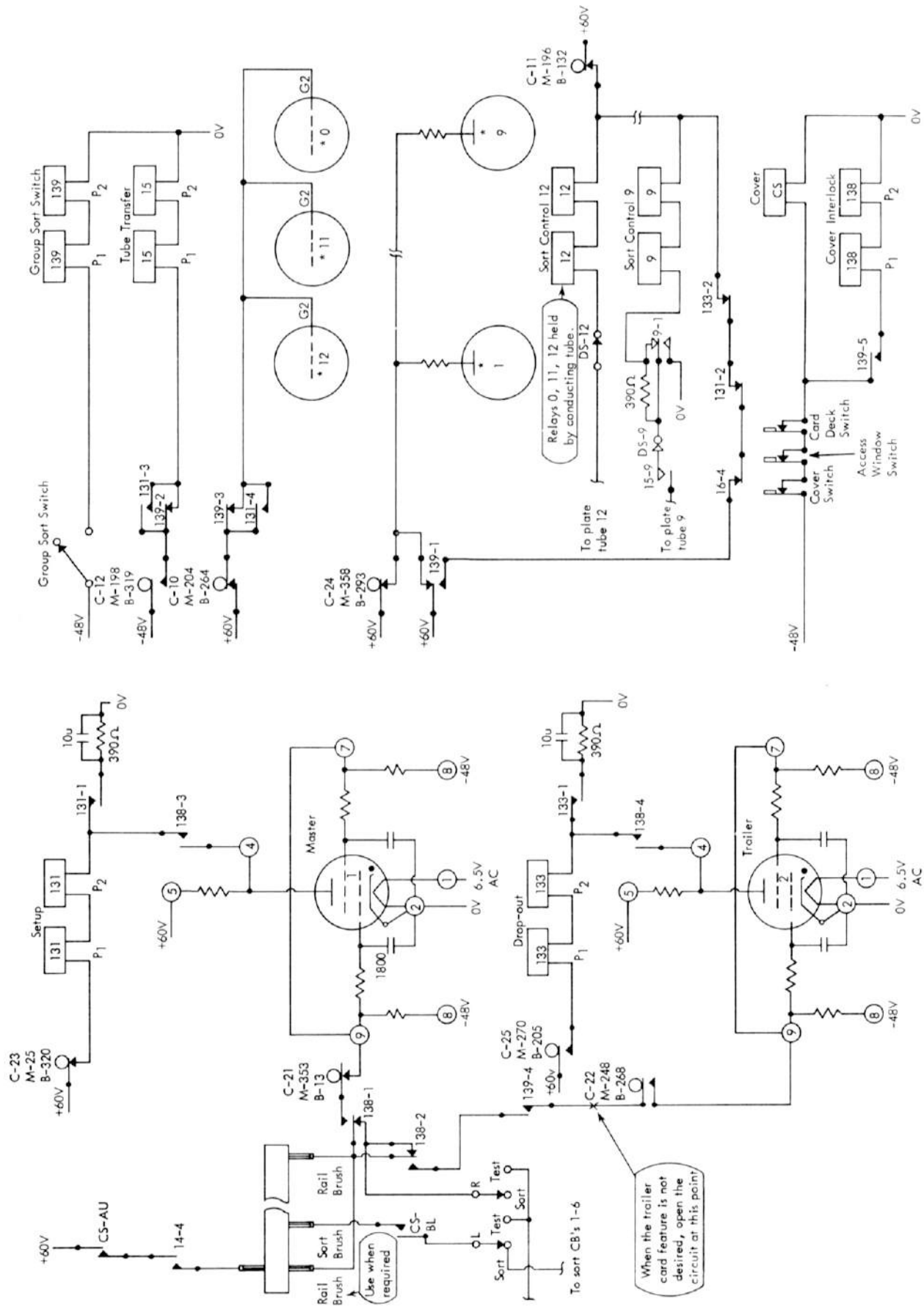


Figure 38. Group Sorting

3. R131 is held by 131-1, C-23.
4. Tube 1 cuts off when its plate potential is brought below the extinguishing potential by the 10-mfd charge current through its load resistor.
5. Sort tube 9 conducts by the 9-punch in column 30.
6. R15 is picked by 131-3, C-12.
7. Positive bias is fed to G2 grids of sort tube 0, 11, and 12 by 131-4, C-10.
8. Sort control R9 is picked, and tube 9 cuts off in the normal manner; that is, sort-tube transfer to sort-control relays.
9. R131 is dropped at 320 degrees when C-23 breaks.
10. Sort control R9 is held by 9-1, 133-2, 131-2, 16-4, 139-1.

Note: Until a new master card reads, R15 cannot pick and sort-control R9 cannot drop. Therefore, all following cards sort into the 9-pocket.

Detail card read:

1. Punching that is read in column 30 enters into sort tubes 1-9. Tubes 0, 11, 12 cannot pick because their G2 grids are negatively biased.
2. Any sort tube in conduction cuts off at 293 degrees when C-24 breaks.

Second master card read:

1-4. Items 1-4 are the same as for master card read.
5. Sort-control R9 drops at 132 degrees when C-11 breaks (131-2 is open).
6. Positive bias is fed to G2 grid of sort tubes 0, 11, 12 by 131-4, C-10.
7. Sort tube 12 conducts by the 12-punch in column 30.
8. R12 picked by sort tube 12.
9. R12 held by sort tube 12, 133-2, 131-2, 16-4, 139-1.
10. Cards continue to sort into the 12-pocket until a new master card is read.

OBJECTIVE 2

Detect an upper right-hand corner cut as a trailer card. Sort the trailer card into the same pocket as the preceding master card (assume the 9-pocket). Drop out the sort-control relay so that cards following the trailer reject.

CIRCUIT DETAILS 2

1. The rail brush reads the trailer-card corner cut.
2. Both grids of tube 2 are driven to positive by C-22, 139-4, 138-2, and the rail brush. Tube 2 conducts.
3. R133 is picked by tube 2, C-25.
4. R133 is held by 133-1, C-25.
5. Tube 2 is cut off when its plate potential is brought below the extinguishing potential by the 10-mfd charge current through its load resistor.
6. The trailer card sorts into the 9-pocket.
7. Sort-control R9 drops at 132 degrees when C-11 breaks (133-2 is open).
8. The detail cards that follow the trailer reject.

Note: To nullify the trailer card feature, break the circuit between 139-4 and C-22.

Length of Field

The length-of-field feature saves sort time on alphabetic sort operations. To use this feature, replace the regular sort-brush assembly by a ten-column brush assembly, and set the length-of-field switch ON. The length-of-field key sets up a circuit that opens the run circuit until a thermal delay relay picks. This delay period is required so that the filaments of ten 2D21 gas tubes are heated only when this circuit is used.

The operation consists of an initial sort that groups cards into as many as eleven pockets. The initial sort detects the last right-hand column punched from a predetermined left-hand position, and directs this card to a specific pocket.

Examples of card grouping (as shown in Figure 39) are as follows:

1. Card 12 sorts into the 11-pocket because the right-hand punch (N in column 17) is read by brush 10. This picks tube 10, which picks R163. R163 directs the impulse to sort magnet 11.
2. Card 4 sorts into the 7-pocket because the right-hand punch (A in column 9) is read by brush 2. This picks tube 2, which picks R152. R152 directs the impulse to sort magnet 7.
3. Card 2 sorts into the 9-pocket because no punching is read in columns 8-17. The length-of-field feature circuit directs blank cards to the 9-pocket.

This one sort completes the length-of-field operation. To resume normal sorting: the operator places the groups in the card rack, turns off the length-of-field key, and replaces the ten-position brush assembly with the

Card Col→ / Card	1 2 3 4 5 6 7 Brush Position	8 9 10 11 12 13 14 15 16 17 1 2 3 4 5 6 7 8 9 10	Right-Hand Brush	Picks Tube	Picks Relay	Sort Pocket
1	(BLANK)					9
2	RYE N Y					9
3	MACON GA		1	1	151	8
4	MONROE	LA	2	2	152	7
5	LEBANON	MO	3	3	153	6
6	COSHOCT	ON O	4	4	154	5
7	CARLSBA	D N M	5	5	155	4
8	FAIRMONT	MINN	6	6	156	3
9	WINNEMU	CCA NEV	7	7	157	2
10	THERMOP	OLIS WYO	8	8	158	1
11	WALLA W	ALLA WASH	9	9	159	0
12	ARKANSA	S CITY KAN	10	10	163	11
Column Control Keys	UP (Select) DOWN (Sort)	1 2 3 4 5 6 7 8 9 10				

Figure 39. Length-of-Field Operation Chart

normal sort brush. Cards that were grouped in the 11-pocket now sort on column 17. Cards that were grouped in the 0-pocket add, and column 16 is sorted. This operation continues until sort completion.

Length-of-field circuits (Figure 40) are as follows:

1. R167 is picked by the length-of-field switch.
2. R54, R145 are picked by 167-1.
3. R13 cannot pick because the —48V controlled line is opened by 54BU.
4. The filament supply to control tubes 1-10 is completed by 54AL, 54BL.
5. R53 is picked by 53AL after the filament warm-up delay.
6. R53 is held by 53BL.
7. R13 can pick because the —48V controlled line is closed by 53BU.
8. Press the start key and the machine runs in normal manner.

This completes the setup of the circuit. A step-by-step circuit operations of cards 12, 4, and 2 appears in Figure 39.

OBJECTIVE 1

Read the N-punch in column 17 of card 12. Sort card 12 into the 11-pocket. Column-control keys 1-10 are set to select.

CIRCUIT DETAILS 1

1. Grid 1 of tubes 1-10 is biased positively at 5-time by 145-2, C-3, C-4, the sort switch, CS-BL, 145-4.
2. Tube 10 is picked by select switch 10L, brush 10, the 5-hole in the card.
3. R160 is picked by 167-2, C-12.
4. R163 is picked by tube 10, 160-10, C-30.
5. R163 is held by 163-1, C-30.
6. Tube 10 cuts off by C-31.
7. Sort magnet 11 is picked by 163-2, 167-3, DR-BU, C-13.
8. The card is directed to the 11-pocket.

Note: Card 12 also contains punching that makes tubes 1, 3-6, 8, and 9 along with tube 10 conduct. Each tube picks a control relay. The 2-points of the control relays are arranged in the sort-impulse circuit so that the highest numbered tube that is conducted controls the pocket selection.

Example: If the highest numbered tube that conducts is:

1. 10, then 163-2 directs the card to the 11-pocket.
2. 9, then 159-2 directs the card to the 0-pocket.
3. 1, then 151-2 directs the card to the 8-pocket.

OBJECTIVE 2

Read the A-punch in column 9 or card 4. Sort card 4 into the 7-pocket. Column-control keys 1-10 are set to select.

CIRCUIT DETAILS 2

1. Grid 1 of tubes 1-10 is biased positively at 1-time by 145-3, C-5, C-6, the sort switch, CS-BL, 145-4.
2. Tube 2 conducts by select switch 2L, brush 2, 1-hole in card.
3. R160 is picked by 167-2, C-12.
4. R152 is picked by tube 2, 160-2, C-30.
5. R152 is held by 2-1, 152-1, C-30.
6. Tube 2 cuts off when its plate potential is brought below the extinguishing potential by the 10-mfd charge current through 2-1, 152-1, 160-2, tube 2 load resistor, C-31.
7. Sort magnet 7 is picked by 152-2, 167-3, DR-BU, C-13.
8. The card is directed to the 7-pocket.

OBJECTIVE 3

Sort card 2 into the 9-pocket. Column-control keys 1-10 are set to select.

CIRCUIT DETAILS 3

1. No control tube conducts because brushes 1-10 read blank columns 8-17.
2. Sort magnet 9 is picked by 151-2, 167-3, DR-BU, C-13.
3. The card is directed to the 9-pocket.

Multiple-Column Selector

A multiple-column selector is used for:

1. Multiple-column selection. This permits selecting on one pass through the machine all cards punched with a prewired numerical or alphabetic code. Ten or less consecutive card columns can be checked.
2. Common digit selection. This permits sorting out all cards that have one or more common-digit punches in any one of a multiple number of columns. Ten or less consecutive card columns can be processed in one pass of the cards through the machine.

Multiple-Column Selection

Multiple-column selection (MCS) compares card information with control-panel wired information. An equal comparison directs the card to the zero pocket. An unequal comparison directs the card to the reject pocket. To do multiple-column selecting, an operator must:

1. Determine the specific card punching to compare. These punched columns must not exceed a field of ten columns, the capacity of the brush-reading assembly.
2. Determine that all information is comparable within the limits of this feature. Comparing card columns containing three or more digits can cause back circuits.
3. Wire the control panel.
4. Press the MCS key to turn on the MCS feature. This disconnects the normal sort circuit.

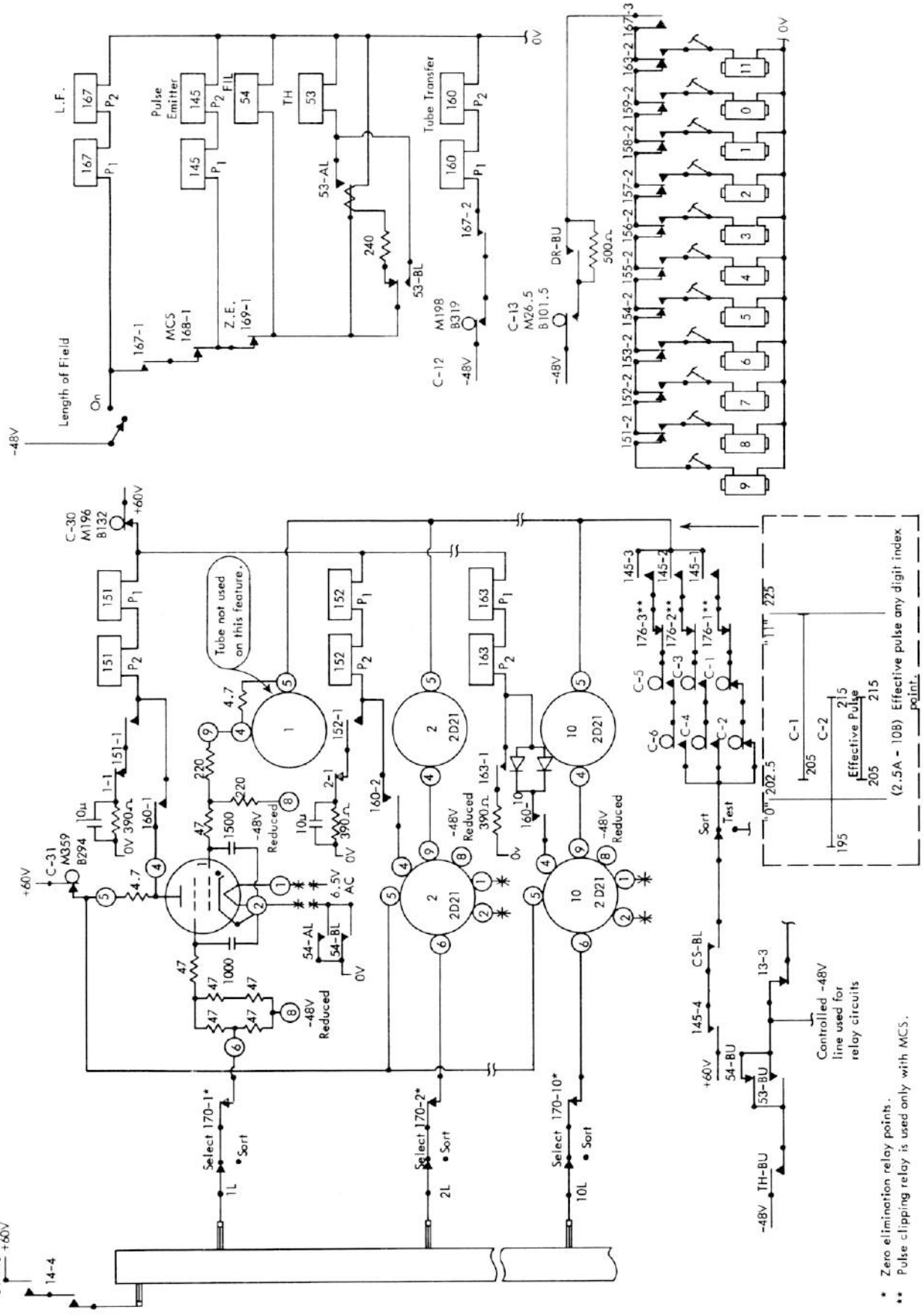


Figure 40. Length of Field

5. Run the cards through the feed. On this sort, cards that compare with the control-panel wiring go to the zero pocket. All other cards reject.

The feature consists of a ten-column brush assembly, ten-column-control keys, and a multiple-column-selector key. With this feature the ten-column brush assembly replaces the regular sort-brush assembly. Pressing the MCS key opens the run circuit until a thermal relay picks. The delay period is required to heat the filaments of twenty 2D21 gas tubes that are necessary for the MCS feature but are not used for normal sorting.

Because the MCS operation is a comparing feature, the operator should make a chart of the card information to check for reference purposes. A typical MCS operation chart is shown in Figure 41A.

The control-panel wiring required for this operation is shown in Figure 41B. This panel consists primarily of a digit emitter and brush-entry positions. Each brush entry has four hubs. The hubs are grouped; that is, the upper hubs are common and the lower hubs are common. Internally, the upper and lower hubs are brought through filters to a common point. This minimizes split wiring and decreases the possibility of back circuits.

Although the feature has ten brush positions, it is only necessary to study one brush position to understand how comparing is done. Figure 42 is a simplified schematic of the electronic compare-circuit used. The theory of this circuit is discussed in detail. The circuit has three inputs A, B, and C. Input C is fed the 12-digit impulses by sort-coding cams. Input A is a card-reading brush. Selected digit-emitter impulses are control-panel wired to input B. Possible combinations of inputs A and B follow:

1. Coincidence of A and B (an equal compare)
2. A-only (an unequal compare)
3. B-only (an unequal compare)

Because this is a comparing feature, the circuit description must show the results of two conditions: an equal compare and an unequal compare. Therefore, the first objective is to describe how the electronic compare-circuit detects a coincidence of inputs A and B as equal. Also the make-and-break timings of inputs A, B, and C must be known. Figure 42 shows that B and A make on the line of index, and C makes 6.5 degrees later.

Card Column		1	2	3	4	5	6	7	8	9	10
Information selected		1	2	3	4	5	6	7	8	9	10
Punching selected		D	B	K	Z		6,5	2	1	$	-
Card Punching		12 4	12 2	11 2	0 9		6 5	2	1	11 3 8	11
Column Control Keys	Up (Select)	10	9	8	7		5	4	3	2	1
	Down (Sort)					6					

Figure 41A. Multiple-Column Selection—Operation Chart

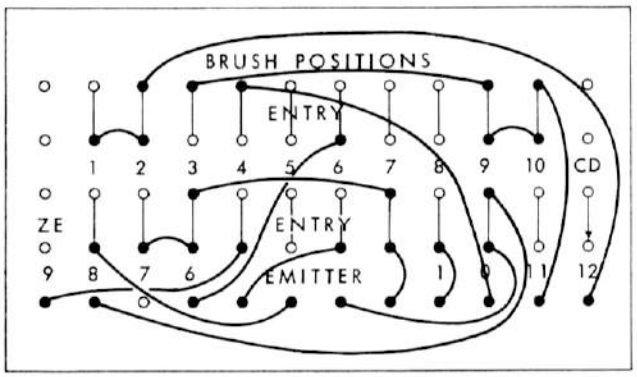


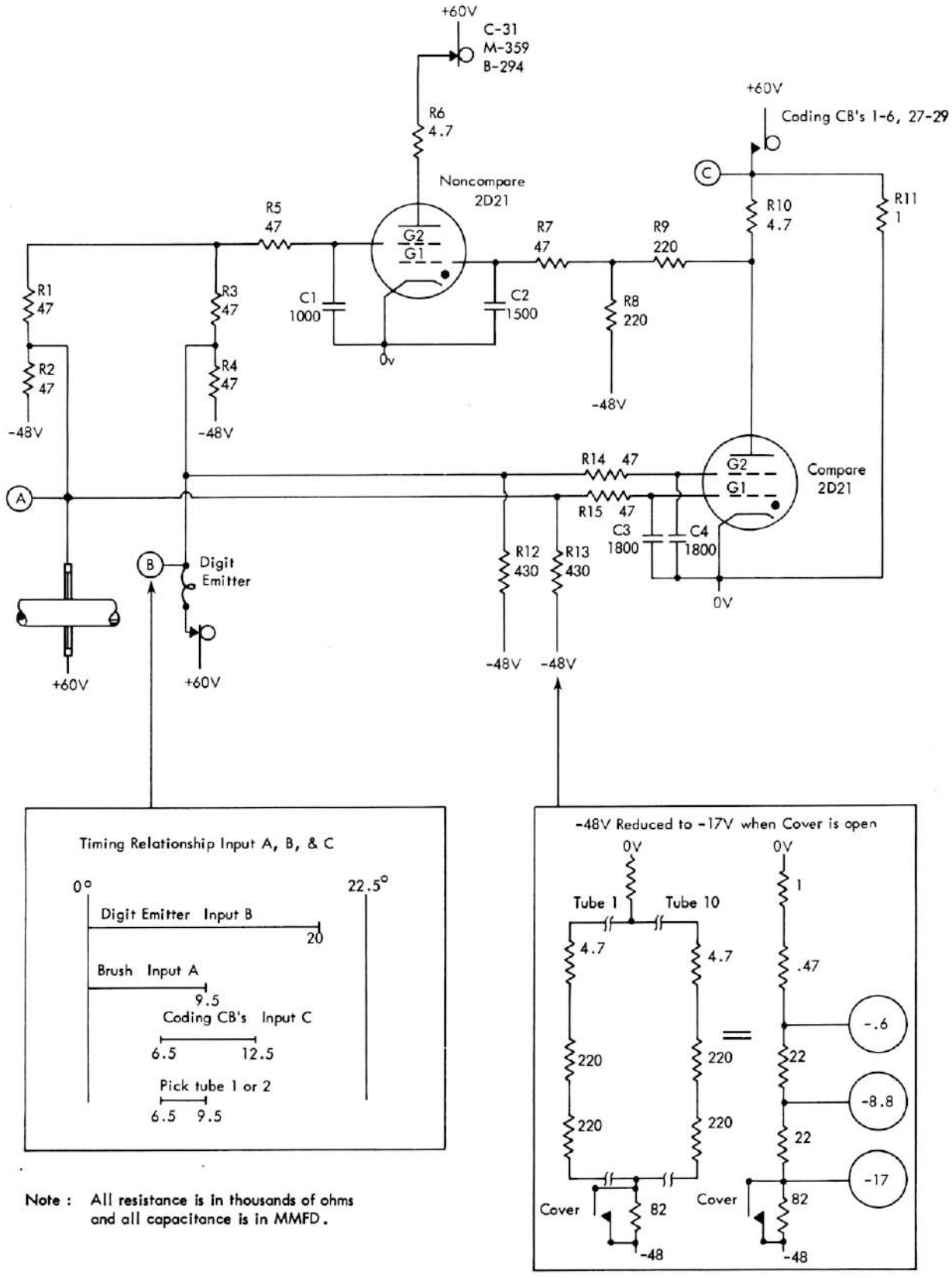
Figure 41B. Multiple-Column Selection—Control-Panel Wiring

The static circuit conditions follow:

1. The grid bias voltage is −48V. On the wiring diagram this is −48V reduced. The circuit is arranged so that the bias supply is normally −48V but is reduced whenever an interlocked cover is opened. The purpose of the circuit is to reduce the terminal voltage at the brush assembly (input A) to less than 25V as required by Underwriters' Laboratory standards. In this way possible shock hazard to an operator is eliminated.
2. Capacitors C1, C3, and C4 charge to the −48V bias supply. Divider current through R-8, R-9, R-10, and R-11 puts the junction of R-8 and R-9 at about −25V and C2 charges to this level. Thus, both grids of the compare and the noncompare tubes are biased negatively.

Input B causes both C1 and C4 to start rising from −48V to +60V. Neither C1 nor C4 actually rises much above zero because of the cathode to the G2 preionization current. Figure 43 is a cross section of a 2D21 looking down from the top. It explains preionization current. Note that grid G2 completely surrounds the cathode control grid G1, and the anode. The divider sections 1, 2, and 3, have a cutout portion represented by parallel lines. As G2 goes above the cathode potential, ionization in section 1 occurs. The preionization current maintains G2 at about the cathode potential, and is limited to section 1. This construction permits G2 to act as a gate and compares to the pre-energizing of a relay. In this way, the tube conducts almost instantaneously under control of G1.

Input A causes both C1 and C3 to start rising from −48V to +60V. Preionization currents establish the charge level of C1 and C4 at slightly above 0V. The coincidence of inputs A and B parallels R-1 and R-3 to the +60V supply and has no active effect, although it



Note : All resistance is in thousands of ohms and all capacitance is in MMFD.

Figure 42. Electronic Compare Schematic

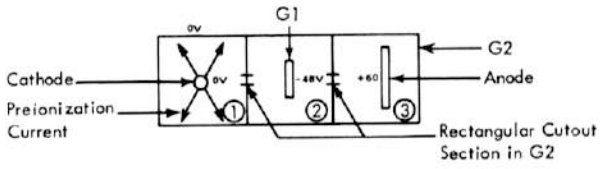


Figure 43. 2D21 Cross Section

does reduce the time constant required to bring grid G2 of the noncompare tube to zero.

Grids G1 and G2 of the compare tube, and G2 of the noncompare tube have an RC time delay on their inputs so that they cannot reach cutoff falsely on transient pulses or line noise. The time required to swing G1 and G2 of the compare tube to 0V is about .05 milliseconds. The time to swing G2 of the noncompare tube to 0V is from about .04-.06 milliseconds. The circuit is timed so that input C (coding CB's) makes about 1 millisecond after A and B. This permits the grids controlled by inputs A and B to reach a stable level before input C is applied.

The coincidence of input A and B causes the compare tube to conduct when input C makes. This puts its anode at 8V. Divider current through R-8 and R-9 now places the junction of R-8 and R-9 at −20V, and C2 charges to this level. Thus, the noncompare tube cannot conduct because its grid G1 is biased negatively. The compare tube cuts off at 12.5 degrees after the digit index, when input C breaks.

An input of only A or B, biases positively G2 of the noncompare tube, and a grid of the compare tube. The compare tube cannot conduct when input C makes because both grids are not biased positively. Divider current through R-8, R-9, and R-10 to +60V at input C, puts the junction of R-8 and R-9 at +5V, and C2 attempts to charge to this level. When G1 of the noncompare tube reaches about 0V, the tube conducts. It cuts off at 294 degrees when C-31 breaks.

The circuit is summarized as follows:

1. The compare tube makes a test every index point for an equal or an unequal compare. It conducts for an equal compare, and does not conduct for an unequal compare.
2. The noncompare tube conducts at the first digit index point that an unequal compare is detected; that is, it conducts when input A or B is detected and the compare tube does not conduct. Because the noncompare tube does not cut off until the end of the reading cycle, it effectively acts as a storage device to store an unequal compare detected during digit reading.

The operation chart in Figure 41A shows that when brush 1 reads a D, it compares equally with digit-emitter wiring. Each card through the feed compares column 1 against a 12- and 4-emitted impulse. A card containing a 12- and a 4-punch is an equal compare, and is directed to the 0-pocket. A card missing a 12- or 4-punch, or containing other punches, is an unequal compare and is directed to the reject pocket.

Refer to Figures 44 and 45 for multiple-column-selection circuitry and component location.

1. R146 is picked by the cover switches and the ten-column brush contact.
2. R168 is picked by the MCS switch. R54, R145 are picked by 168-1.
3. R13 (coil not shown) cannot pick because the −48V controlled line is opened by 54BU (located lower left).
4. The filament supply to twenty 2D21 tubes is completed by 54AL, 54BL (see pin 2 of compare tube 10).
5. R53 is picked by 53AL after the heater delay, and R53 is held by 53BL.
6. R13 (coil not shown) can pick because the −48V controlled line is closed by 53BU.
7. C-33 to C-38 provide digit-emitter impulses that are distributed by emitter-control relays 143 and 144.
8. R143 is picked by C-40, and R144 is picked by C-39.

OBJECTIVE 1

Detect a D in column 1 as an equal compare and direct this card to the 0-pocket. Wire emitter exits 12 and 4 to brush entry 1. Key 1 is set to select. Keys 2-10 are set to sort.

CIRCUIT DETAILS 1

1. G2 of compare and noncompare tubes is biased positively at 4-time by entry 1, control-panel wire to emitter hub 4, 144-3, C-38, 146-2.
2. G1 of compare tube is biased positively at 4-time by 170-1, select switch 1L, brush 1, the hole in the card, to the live contact roll.
3. The compare tube conducts by pin 5, 145-3, C-29, C-5, C-6, the sort switch, CS-BL, 145-4.
4. Noncompare grid G1 is biased negatively by the conducting compare tube.
5. The compare tube is cut off by C-6 at 12.5 degrees after 4-index time.
6. The sequence of circuit operation for checking digit 12 is similar to digit 4; that is, the compare tube conducts and off-biases the noncompare tube.
7. The 0-sort magnet is picked by 168-3, 163-3, DR-BU, C-13.
8. The card is directed to the 0-pocket.

OBJECTIVE 2

Detect a blank column 1 as an unequal compare, and direct this card to the reject pocket. Wire emitter exits 12 and 4 to brush entry 1. Key 1 is set to select. Keys 2-10 are set to sort.

CIRCUIT DETAILS 2

1. G2 of compare and noncompare tubes is biased positively at 4-time by entry 1, control-panel wire to emitter hub 4, 144-3, C-38, 146-2.

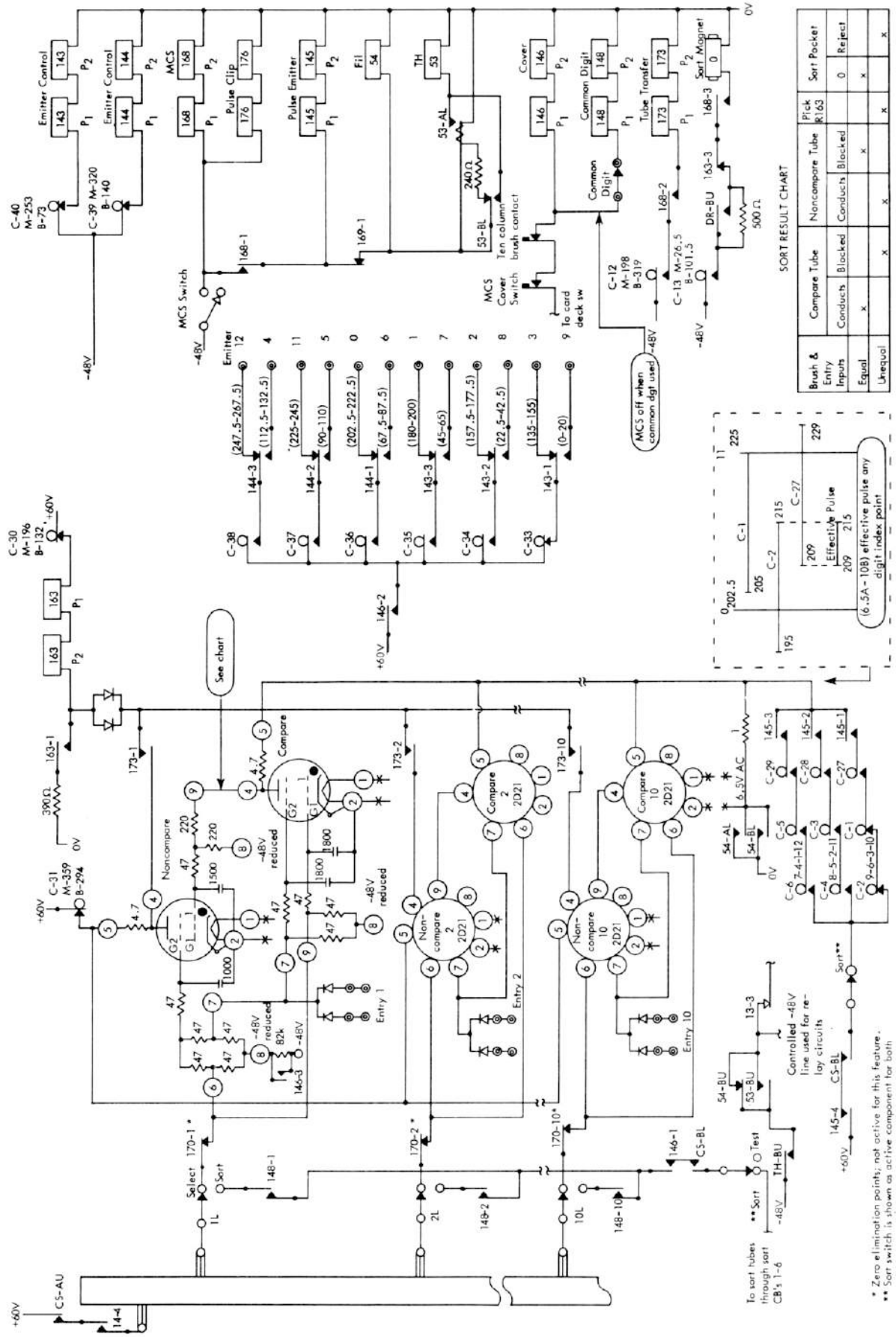


Figure 44. Multiple-Column-Selection Circuitry

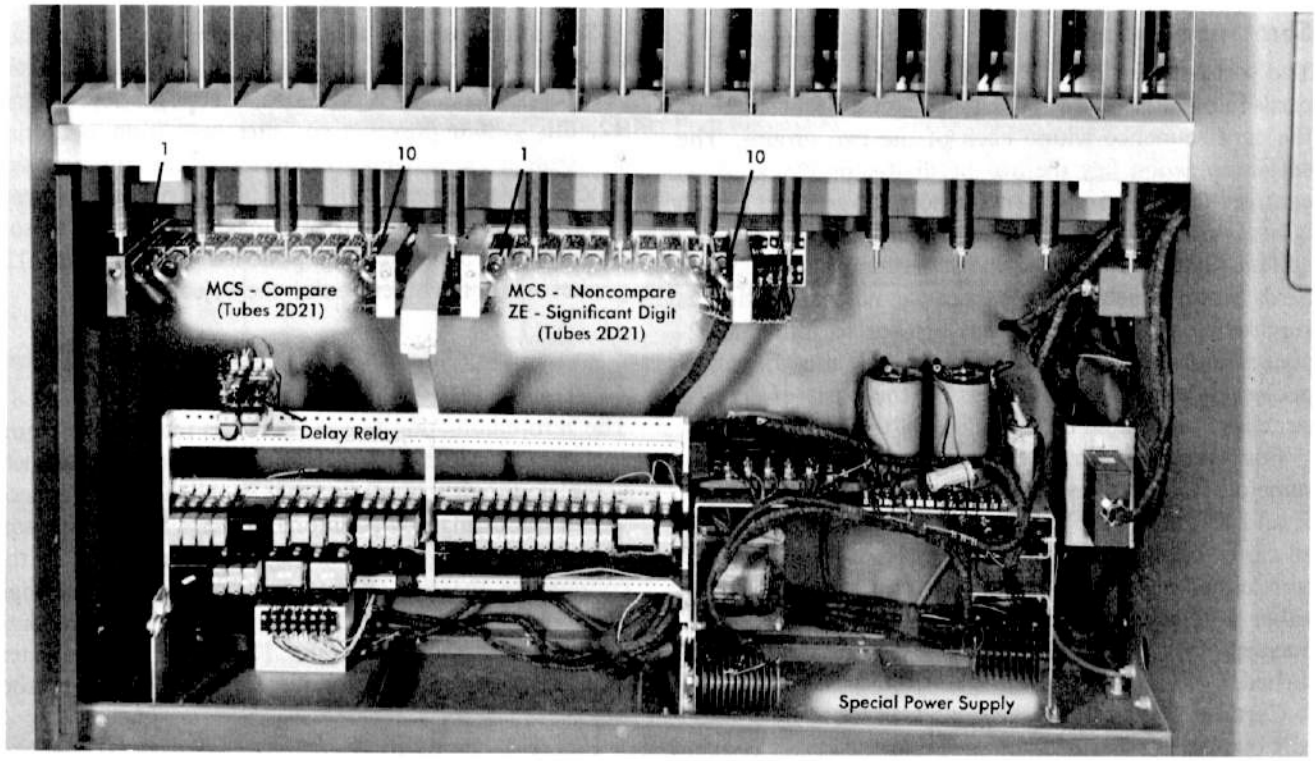


Figure 45. Component Location MCS, Length of Field

2. The compare tube cannot conduct because the brush input is not available at 4-time.
3. G1 of the noncompare tube is biased positively by pin 9, 145-3, C-29, C-5, C-6, the sort switch, CS-BL, 145-4.
4. The noncompare tube conducts by C-31.
5. R163 is picked by the noncompare tube, 173-1, C-30.
6. R163 is held by 163-1, C-30.
7. The noncompare tube is cut off by C-31.
8. The 0-sort magnet circuit is opened by 163-3.
9. The card is directed to the reject pocket.

Common Digit Selection

Common digit selection permits checking up to ten consecutive card columns for specific card punching. For example, ten consecutive columns can be checked for a 7-punch. If a 7-punch appears in any of these columns the card is directed to the 7-pocket. To use this feature:

1. Remove the regular sort-brush assembly, and install the ten-column brush assembly in the card columns read.
2. Determine the sort requirements; that is, which card columns to search for what common punching.
3. Press the digit suppression keys for all digits that are not part of the common punching. For example, if 7's and 3's are the common digits, press all suppression keys except 7 and 3.
4. Press the column-control keys for each brush position read. For example, if the brush assembly is in card columns 1-10 and all columns except 5 are read, then all column-control keys except 5 are pressed.
5. Jackplug the common digit hubs (CD) on the control panel.
6. Although common digit selection is considered part of the MCS feature, the MCS key is OFF for this feature.

Figure 44 shows that any column-control key that is pressed (set to sort) directs its brush to the input of sort tubes 1-12. For example, assume that column-control key 10 is set to sort, and brush 10 reads a 7-punch. Then a circuit is established from the contact roll, brush 10, column-control switch 10L set to sort, 148-10, 146-1, CS-BL, the sort switch, sort CB's 1-6 to grid 1 of tube 7. This causes tube 7 to pick in the normal manner, and the card is directed to the 7-pocket. A similar circuit is established through any column-control key that is set to sort. When more than one column-control key is set to sort, the associated reading brushes are connected in parallel. Thus, up to ten brushes can be searched for common digits.

Sort Suppression

The sort-suppression feature permits the segregation of cards into either the reject or 12-pocket without changing the card sequence within each of the two groups. The sort-suppression key (below the digit-suppression keys) controls this feature. When the sort-suppression switch is OFF, sorting is in the normal manner.

This feature is useful in the separation of unpunched cards from punched cards because normal sorting is suppressed. All punched cards are sorted into the 12-pocket and the blank cards are sorted into the reject pocket. It also separates cards on the basis of specific punches in a column by using the digit-suppression keys.

For example, using the sort-suppression feature, assume all digit-suppression keys are pressed except 2, 4, 6, and 8. The sort-selection switch is at N. This causes all cards to enter the reject pocket except those punched with either a 2, 4, 6, or 8. The cards punched with either a 2, 4, 6, or 8 sort into the 12-pocket. The sequence of the cards in both pockets remains undisturbed.

Cards can be edited in the same manner as for normal sort operations. Error cards sort into the reject pocket. Figure 46 shows the sort patterns for the five positions of the sort-selection switch when the sort suppression feature is used. The pattern of card sorting is shown for a standard machine. The sort patterns are the same when using the alphabetic-sorting feature, except for the patterns A1 and A2. The patterns A1 and A2 cause cards to sort the same as the AN position for a standard machine.

Sort Selection Switch Positions	POCKETS		
	12	Reject	
		Normal	Edit
N	Punched Cards	Blanks	Cards with more than one punch
Z	0, 11, 12	Cards without a zone punch	Cards with 2 zone punches
A1 and A2	Alphabetical Coded Cards (A-Z); Zones 0, 11 or 12; 0-1 code combination	Blank Cards and those with only 1 numerical punch (1-9)	Cards with 2 zones or 2 numerical punches
AN	Punched Cards	Blanks	Same as A1
This pattern is based on cards being fed face down, 9 edge first with no digit suppression used.			

Figure 46. Sort-Pattern Chart—Standard Machine using Sort Suppression

Sort suppression is done by adding one 12-position relay to the machine. The relay is picked when the sort-suppression key is ON. Also, except for sort magnet 12, this switch prevents sort magnets from operating by opening the sort-magnet circuit at the common side of the coils (Figure 47). The points of the suppress relay connect the normal sort magnet impulses to sort magnet 12. This selects the punched cards into the 12-pocket while all others enter the reject pocket.

Zero Elimination

The zero-elimination feature shortens the time for some sort operations. It does this by rejecting cards that have completed their major sort; that is, when their sequence would not change by additional sorting. The major sort column is the highest order digit of a field; that is, the columns to the left do not contain a significant digit (1-9). A blank column that contains a significant digit to the left is directed to the 12-pocket. The rejected cards are stacked as a completed sort. This saves sort time.

Figure 48 shows the value of this feature by comparing a normal sort sequence with a zero-elimination sort. A summary follows:

1. Six cards are punched 1 to 100,000 in multiples of ten.
2. Conventional sorting requires six passes of six cards, or a total of 36 cards.
3. Zero elimination rejects a card which has completed its major sort so that card 1 is rejected on sort column 15, card 2 is rejected on sort column 14, and so on.
4. Rejected cards are stacked as a finished sort so that the card volume is continually reduced. Only five cards sort on column 14, four on column 13, and so on. The sum of the six passes using zero elimination is only 26 (6 + 6 + 5 + 4 + 3 + 2) as compared with 36 for conventional sorting.

Note: No time is saved if all cards have significant digits in the highest order of the field. Time is saved when the major sort column is spread over several columns. For example, if cards with values of 1 to 100 are mixed with cards with values of a million.

From an operating standpoint, this feature consists of a ten-column brush assembly, ten column-control keys, a zero-elimination key, and a control panel. To operate the operator must:

1. Replace the sort brush with the ten-column brush assembly.
2. Wire the control panel as required.
3. Set the zero-elimination key ON.
4. Operate the column-control keys as required.

Operating the zero-elimination key opens the IBM 83 run circuit until a thermal relay picks. This delay period

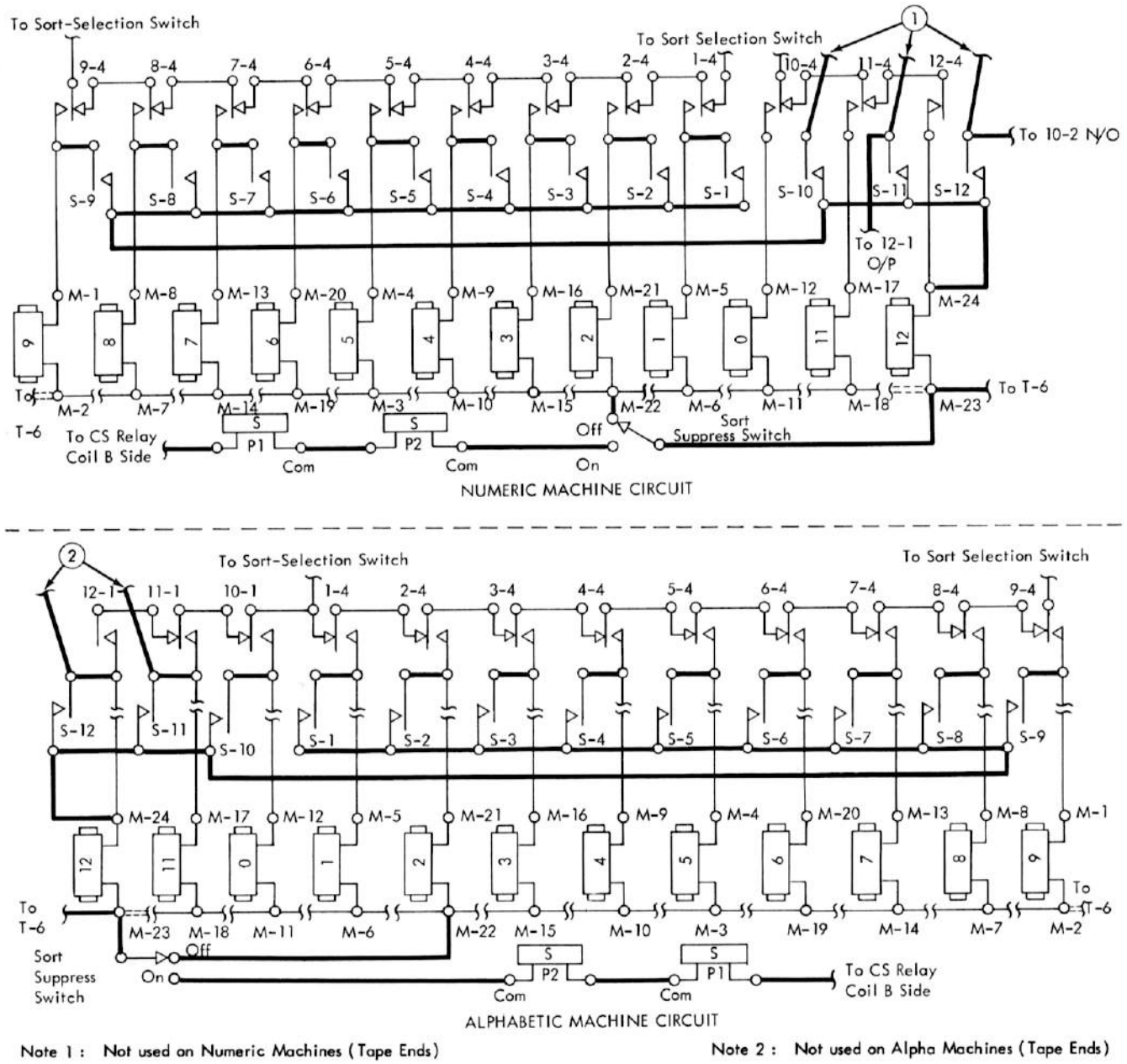


Figure 47. Wiring Diagram—Sort Suppression

is needed to heat the filaments of ten 2D21 gas tubes.

To explain card reading, assume that the ten-column brush assembly is located in columns 1-10 (see Figure 49 for schematic). To sort on column:

1. 10, set column-control key 10 to sort, and column-control keys 1-9 to select.
2. 9, set keys 10 and 9 to sort, and keys 1-8 to select.
3. 2, set keys 2-10 to sort, and key 1 to select.

Note: The lowest numbered column-control key that is set to sort determines which column sorts.

The zero-eliminate hub on the control panel (Figure 50) emits a gate from 1-9 time. It is wired to the entry hubs of the brush positions that read the sort field; that is, if columns 1-5 are read, entry positions 1-5 are wired. The circuits are arranged so that an entry hub connects to the G2 grid of a gas tube, and the associated brush input connects to the G1 grid. Therefore, coincidence of the brush and entry input picks the associated gas tube. The operation is such that only the brush positions to the left of the sort column are directed to gas tubes (one tube for each position). Thus, these gas tubes become storage devices that detect a significant digit to the left of the column sorted. This circuitry performs no useful purpose if the column be-

Card	Card Punched	Sort Column	Cards through Feed per Sort Column		Reject Card
			Normal Sort	Zero Elimination	
1	000,001	16	6	6	
2	000,010	15	6	6	1
3	000,100	14	6	5	2
4	001,000	13	6	4	3
5	010,000	12	6	3	4
6	100,000	11	6	2	5
			(36)	(26)	

Figure 48. Sort Sequence—Conventional Sort vs. Zero Elimination

ing sorted contains a significant digit. If the column sorted is blank, the storage device is active and sets up a circuit to direct the card to the 12-pocket. If the column sorted contains a zone punch, the storage device is active, and sets up a circuit to direct the card to the zone pocket selected.

The circuits are designed so that the column sorted is directed to a sort pocket according to one of four types of sort possibilities as shown in Figure 51. The four types follow:

1. When the sort column contains any digit 1-9, the card sorts into the selected pocket regardless of the reading from the left.
2. When the sort column contains 0, 11, or 12 and a significant digit is read from the left, the card sorts into the selected pocket.
3. When the sort column contains a 0, 11, 12, or blank; and a zone punch or blank is read from the left, the card rejects.
4. When the sort column is blank, and a significant digit is read from the left, the card sorts into the 12-pocket.

Note: Only type 3 represents cards that require no additional sorting because only they have completed their major sort.

To see how to use this feature, assume that the six cards shown in Figure 48 are sorted. The brush assembly is positioned with brush 10 in column 16. Column-control key 10 is set to sort. Column-control keys 1-9 are set to select. The control panel is wired ZE to entry 5, and is jackplugged to positions 6-10.

The first pass sorts cards on column 16. Set column-control key 9 to SORT to allow the second pass to sort column 15. On this sort, card 000,001 rejects and is put aside as a completed sort. Set column-control key 8 to SORT to allow the third pass to sort column 14. On this sort, card 000,010 rejects and is put behind card 000,001 previously rejected. This procedure continues until the sort is completed.

Refer to Figure 49 for zero elimination circuitry:

1. R146 is picked by the cover switches and the ten-column contact.
2. R169 is picked by the zero-elimination switch.
3. R54 is picked by 169-1.
4. R13 (coil not shown) cannot pick because the —48V controlled line is opened by 54BU.
5. The filament supply is completed by 54AL, 54BL, (see tube 1).
6. R53 is picked by 53AL after the heater delay.
7. R53 is held by 53BL.
8. R13 can now pick because the —48V controlled line is closed by 53BU.
9. The machine runs in the normal manner when the start key is pressed.

Further circuit analysis requires a step-by-step operation of the four sort types shown in Figure 49.

OBJECTIVE — TYPE 1

Sort column 16, and direct card 000,001 into the 1-pocket. Set column-control key 10 to sort. Set keys 1-9 to select.

CIRCUIT DETAILS — TYPE 1

1. Standard sort tube 1 conducts, by CB's 1-6, the sort switch, CS-BL, 146-1, switches 1-9 select, switch 10-R sort, 10-L sort, brush 10, 1-hole, live contact roll.
2. The card is directed to the 1-pocket in normal manner.

OBJECTIVE — TYPE 2

Sort column 16, and direct card 000,010 into the 0-pocket. Controls are the same as in *Objective — Type 1.*

CIRCUIT DETAILS — TYPE 2

1. Standard sort tube 10 conducts, by CB's 1-6, the sort switch, CS-BL, 146-1, switches 1-9 select, switch 10-R sort, 10-L sort, brush 10, 0-hole, contact roll.
2. Significant-digit tube 9 grid G1 is biased positively by 170-9, switch 9-L select, 1-hole, contact roll.
3. Significant-digit tube 9 grid G2 is biased positively by entry 9, control-panel wiring to ZE hub, 146-2, C-32.
4. Significant-digit tube 9 conducts by 2 and 3, C-31.
5. R173 is picked by 169-2, C-12.
6. R163 is picked by tube 9, 173-9, C-30.
7. R163 is held by 163-1, C-30.
8. Tube 9 is cut off by C-31.
9. The 0-sort magnet is picked in the normal manner by IBM 83 sort circuits.
10. The 12-sort magnet is picked by 163-4, 169-4, through sort-impulse circuit to C-13.
11. Although sort magnets 0 and 12 are both picked, the card is directed to the 0-pocket because the 0-chute blade also forces down the 11- and 12-blades. The 12-magnet circuit is effective only when the column sorted is blank as in Figure 49, type 4.

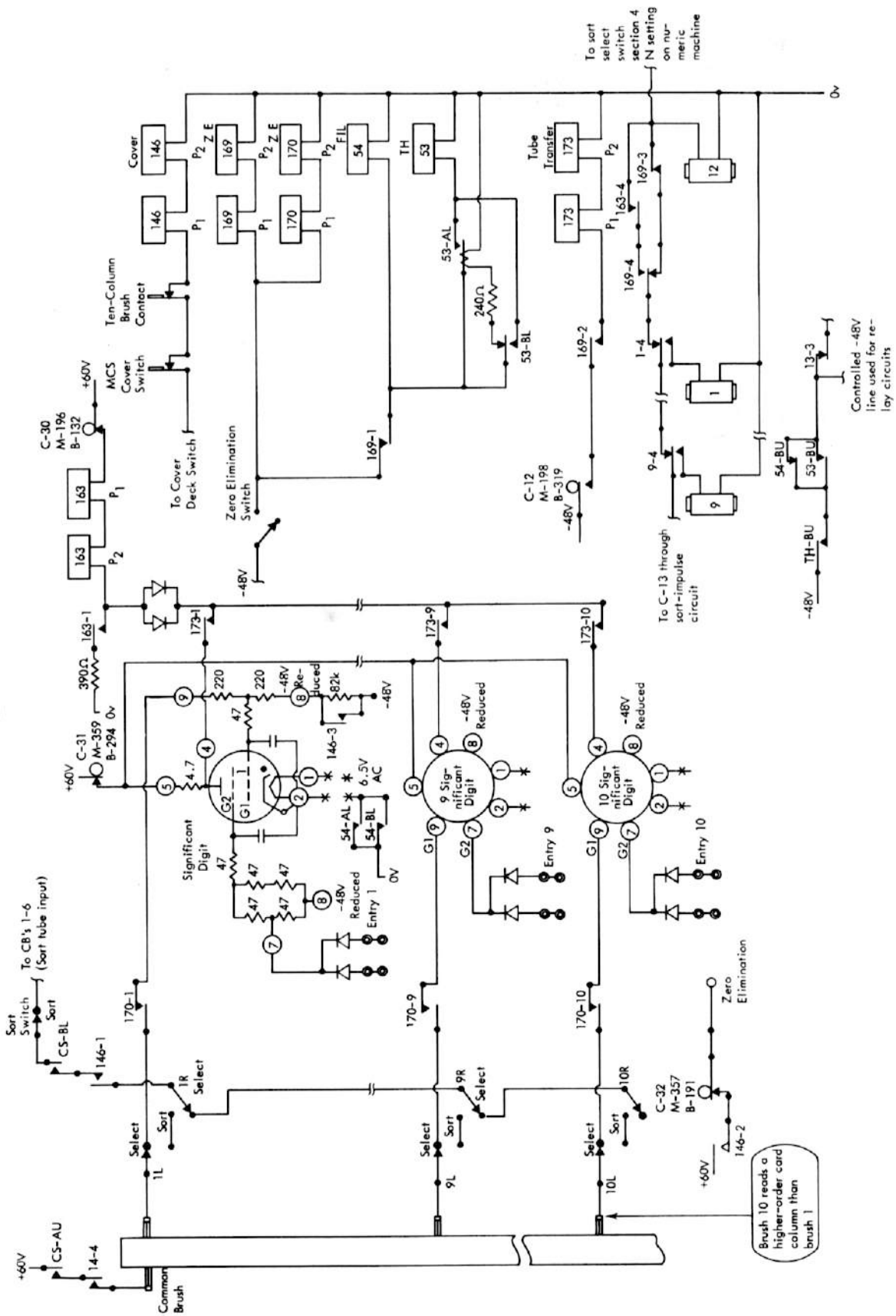


Figure 49. Zero-Elimination Schematic

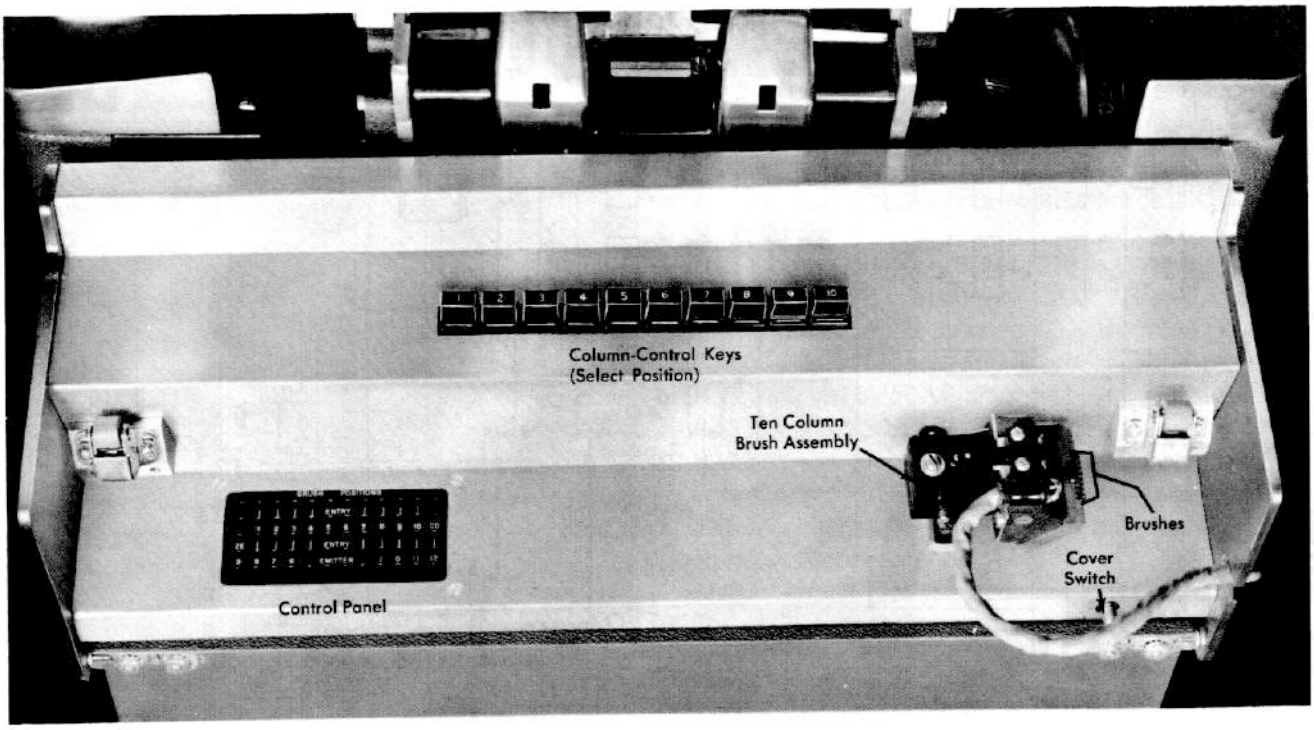


Figure 50. Multiple-Column Selection and Zero-Elimination Controls

OBJECTIVE — TYPE 3

Sort column 15, and direct card 000,001 into the reject pocket. Set column control keys 9 and 10 to sort. Set keys 1-8 to select.

CIRCUIT DETAILS — TYPE 3

1. Standard-sort tube 10 conducts by CB's 1-6, the sort switch, CS-BL, 146-1, switches 1-8 select, switch 9-R sort, 9-L sort, brush 10, 0-hole, contact roll.
2. 0-sort magnet is not impulsed because 163-4 is open.
3. Card rejects.

OBJECTIVE — TYPE 4

Sort column 15, and direct a card punched 000,6()0 to the 12-pocket. Controls are the same as in *Objective — Type 3*.

CIRCUIT DETAILS — TYPE 4

1. No standard sort tube is picked because column 15 is blank.
2. Significant-digit tube 8 (not shown) grid G1 is biased positively by 170-8, switch 8-L select, 6-hole, contact roll.
3. Significant-digit tube 8 grid G2 is biased positively by entry 8, control-panel wiring to ZE hub, 146-2, C-32.
4. Significant-digit tube 8 is picked by 2 and 3, C-31.
5. R173 is picked by 169-2, C-12.
6. R163 is picked by tube 8, 173-8, C-30.
7. R163 is held by 163-1, C-30.
8. The 12-sort magnet is picked by 163-4, 169-4, through sort-impulse circuit to C-13.
9. The card is directed to the 12-pocket.

Type	Column Sorted Contains	Positions to the Left Contain	Sort into Pocket
1	1-9	1-12, Blank	1, 9
2	0, 11, 12	Any digit 1-9	0, 11, 12
3	0, 11, 12, Blank	0, 11, 12, Blank	Reject
4	Blank	Any digit 1-9	12

Figure 51. Zero-Elimination Sort Types

File Feed

The file feed consists of two basic units: the upper and lower magazines.

The upper magazine is a tray that holds up to 3,600 cards to feed into the hopper. Place cards in the feed 9-edge first, face down. This magazine is hinged and can be locked at a 12-degree angle to make the sensing area more accessible.

The lower magazine contains clutch-controlled feed rolls that feed the cards into the hopper. The level of the cards in the hopper (Figure 52) controls operation of the helical-spring feed-roll clutch. Under spring tension, the front joggler (Figure 53) applies pressure on the joggler-operating lever. This makes the lever follow the contour of the front-joggler cam. As the front-joggler cam rotates, the front joggler oscillates to joggle the cards into position.

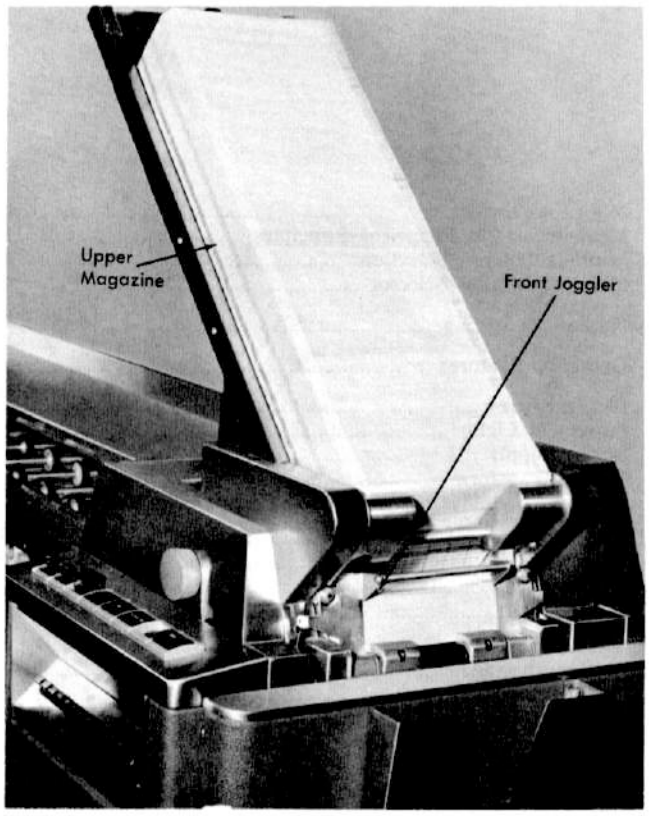


Figure 52. File Feed

On the front-joggler plate are two protrusions called sensing pads. If there are sufficient cards in the hopper to cover the sensing pads, the inward travel of the joggler is limited, and the joggler control lever is not allowed to follow into the low dwell of the cam. There is no clutch action or card feed at this time.

When the card level drops below the sensing pads, the additional travel of the front joggler forces the joggler-operating lever to follow the low dwell of the front joggler cam.

At this time, the tab on the joggler-operating lever causes the clutch-operating lever to rotate counterclockwise to pivot the clutch latch out of the step in the clutch sleeve. The helical spring grips the shaft, and the feed rolls are driven. Cards feed until the card level in the hopper again reaches the sensing pads. Cards are automatically front-and-side joggled in the hopper. Correctly operating jogglers produce a deck with almost perfectly straight sides. Open the front joggler to insert or remove cards.

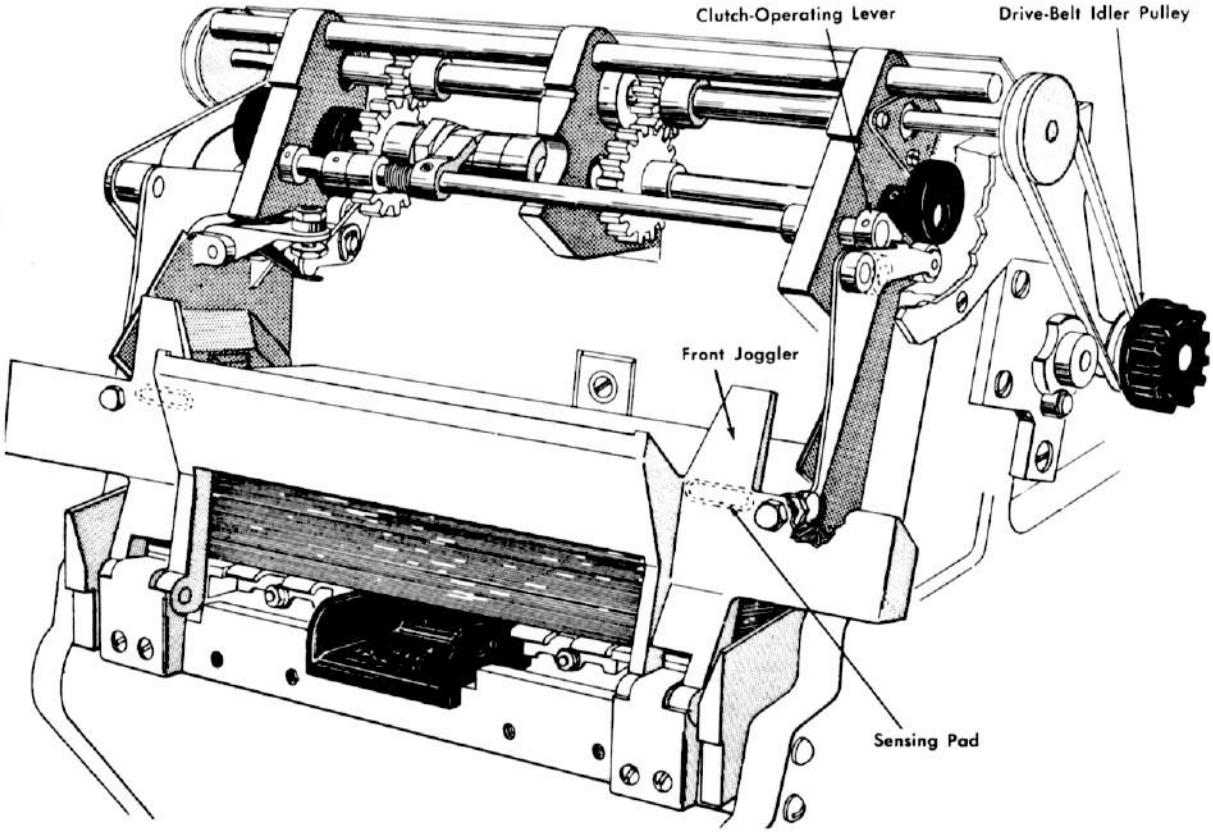


Figure 53. File-Feed Drive Unit

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Wiring Diagram

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TYPE- 083

MACHINE SERIAL NO.-

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