IBM

Customer Engineering Reference Manual

88 Collator

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IBM

Customer Engineering Reference Manual

88 Collator

IBM MACHINE RECORD

88 TYPE	SERIAL	SUFFIX	3 2 1	DIAGRAM NUMBER SUFFIX	BASE NUMBER	ORDER NUMBER
SPECIAL FEATURES ENGINEERING CHANGES B/M						

M.E.S NUMBER	DESCRIPTION AND QUANTITY	DIAGRAM OR B/M NUMBER	CEM NUMBER	INSTALLED		REMOVED	
				MAN NUMBER	DATE	MAN NUMBER	DATE
	Primary Sequence Split						
	Secondary Sequence Split						
	Compare Split						
	Group of 5 Selectors						
	Primary Digit Selector						
	Secondary Digit Selector						
	Card Count Device						
	Alphabetic Collating Device						
	Auxiliary Card Counter (s)						
	Secondary File Feed						
	Alteration Switch (s)						
	51-Column Interchangeable Secondary Feed						

This manual, Form 225-6494-3, is a minor revision to, but does not obsolete Form 225-6494-2. Power supply tolerances have been added. Adjustments for the redesigned clutch, the brush units, and the file feed side joggler have been revised. The CEM listing by category has been updated. Revisions in the text are indicated by a vertical line to the left of that portion of the text which has been changed. Changes to illustrations are denoted by a bullet (●) to the left of the caption.

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IBM, Product Publications Department, Rochester, Minn. 55901.

Contents

Code	Unit	Freq. Weeks	Lubricate - Clean	Observe
1	Primary and Secondary Feeds	17	IBM 17: Gears, mechanical cams, and extension spring pivots. IBM 6: Ball-bearing hanger pivots, hopper contact and card lever pivots, picker knife stud.	Condition of belts. Brushes for wear, damage, and alignment. Brush timing.
1	File Feed	17	IBM 20: Drive clutch spring (grease fitting). IBM 17: Gears, cams, upper magazine latch slot, drive clutch operating lever, side joggler leaf spring, joggler adjusting screw heads and spring ends. IBM 6: Upper magazine shaft pivots, drive clutch detent shaft pivot, joggler cam follower hubs, joggler pivots, drive belt idler pulley hub. Contact lever pivots.	Feed rolls for glaze. Condition of belts. Clutch overthrow.
1	Clutches	17	IBM 20: Reverse lock. IBM 17: Clutch grease fitting, gears. Latch and keeper surfaces. IBM 9: Intermediate arm pivot. IBM 6: Keeper, latch and armature pivots, dog and detent pivots.	Check for loose drive dog pivot stud and excessive play between clutch pulley and clutch drive arm.
1	Transport & Stackers	17	IBM 17: Nylon cams and follower bearings. IBM 6: Jam bar contact operating lever pivot, selector magnet armature pivots.	Jam bar for binds and correct operation. Pusher and card support slide free of binds. Card restraining and retaining lever free and clean.
3	CB's-CR Primary-Secondary	17		Contact condition. Check for loose stack screws and proper air gap. Check timing of cams connected to CE aid panel.
7	Duo Relays	As necessary	IBM 6: Armature pivots.	Dirt behind armature. Check stack screws. Contact rise.
0	Blowers Filters	17		Replace filter as necessary. Do not clean filters.
5	Motors	17	IBM 9: Motors	Condition of belts.
1	Machines equipped with 51 column device.	17	IBM 17: Upper ledge stud, 51 column radial guide detent spring and slide.	51 column select magnet assembly for wear.
8	Tubes, Relays, and Auxiliary Electrical Components	52	Check oscilloscope patterns against those in IBM 88 Service Index. Make certain that dummy fuse is removed before test and replaced after test. If not replaced, intermittemt trouble will result.	

SCHEDULED MAINTENANCE ROUTINE CHART

Scheduled Maintenance

Installation Procedures

1. Remove the collator from the packing crate following directions suplied with the crate.
2. Install the upper magazine (file feed tray).
3. Examine all relays (without removing) for misplaced armatures.
4. Check power supply voltage at CE aid panel.
5. Run operational test to verify proper machine operation.

Machine Specifications

Length—57½″ Depth—28″ Height—44¾″

	BTU/HR		WEIGHT UNPACKED	WEIGHT PACKED
	TUBE	TSTR		
Model 1	5310	3560	1075	1329
Model 2	4560	3000	1055	1309
Model 3	3880	2440	1035	1289

Current Requirements

		1 PHASE						3 PHASE				
		115v		208v		230v		115v	208v		230v	
		50 Cy	60 Cy	50 Cy	60 Cy	50 Cy	60 Cy	50 Cy	50 Cy	60 Cy	50 Cy	60 Cy
TUBE MODEL	1	15.9	14.2	8.8	7.9	7.9	7.1	12.1	6.6	5.9	6.0	5.4
	2	13.8	12.3	7.7	6.9	6.9	6.2	10.4	5.7	5.1	5.2	4.7
	3	11.9	10.6	5.7	5.1	5.9	5.3	8.9	4.9	4.4	4.5	4.0
TSTR MODEL	1	10.7	9.5	5.9	5.3	5.4	4.8	8.3	4.7	4.1	4.2	3.7
	2	9.0	8.0	5.0	4.4	4.5	4.0	6.5	3.8	3.2	3.3	2.9
	3	7.2	6.5	4.0	3.6	3.6	3.3	4.8	2.8	2.4	2.4	2.2

Approach to Scheduled Maintenance

The prime objective of any maintenance activity is to

1. provide increased machine availability to the customer and
2. reduce machine down time.

Do not adjust, disassemble, or spend time checking adjustments on any unit that is working properly.

Scheduled Maintenance Procedures

Specific items for scheduled maintenance are scheduled on punched cards processed by the local IBM Branch Office. Details of scheduled maintenance operations are listed in the *Scheduled Maintenance Routine Chart*. Do only those operations listed on the chart for that maintenance period. Details on adjustments, service checks, removal and replacements are found on the pages as listed in the table of contents.

Visual Inspection

Visual inspection is the first step in every scheduled maintenance operation. A visual check for corrosion,

dirt, wear, binds, burnt contacts and loose parts will save later machine down time. Rusty surfaces usually indicate a loose pin, a loose setscrew, or a lack of lubrication.

Electronic Circuits

Scheduled maintenance of electronic components can be accomplished in a short time by the use of oscilloscope procedures and patterns. This information is available in the IBM 88 Collator Service Index, Form No. 229-4002-2.

During the life span of a tube, conduction is high for a period of two or three months and then settles down to a steady state conduction. In this latter period, such items as sluggish relays, weak capacitors, and faulty terminal connections will show up. Repeated replacement of a tube in any one position would indicate weak or faulty electrical components in series with the tube, faulty grid control to the tube, or a marginal component of the tube unit.

Mechanical Units

Cleaning, lubricating, and observing are the three basic steps to be performed on mechanical units. Do no more than the recommended scheduled maintenance on equipment that is operating properly. However, anything observed that needs attention should be corrected.

Service Procedures

Card Feeds

Feed and Hopper

SERVICE CHECKS

1. The feed knives are adjusted to obtain proper brush timing. If feed knife timing is changed, the P or S cams will need retiming.
2. Feed roll bearings do not require lubrication; the bearing hanger pivots do.
3. Follow the *Scheduled Maintenance Routine Chart* for proper lubricant and lubrication points.

ADJUSTMENTS

1. Adjust picker knife lower cam follower arm so that there is a clearance of .006″ between cam and cam followers at point of maximum looseness.
2. The inside faces of the primary and secondary card posts should have .010″ to .015″ clearance to a card held against the throat knife. Use shims Nos. 369384 or 369385 to obtain this clearance.
3. With a clearance of .062±.015″ between the secondary feed rear side plate and the frame, adjust the front side plate for .006″—.011″ clearance over the length of the card.
4. With a clearance of .062±.005″ between the primary feed rear side plate and the side frame, adjust the front side plate for .016″—.021″ over the length of the card. NOTE: Adjustments 3 and 4 should result in cards centered between the rails in transport section ($\frac{5}{16}$″± $\frac{1}{32}$″ from front rail).
5. There must be .020″ to .050″ clearance between the fingers of the hopper back plate and the hopper bed plate (Figure 1).
6. The picker knives must be parallel to the first set of feed rolls within .003″.
7. At their extreme rear travel, the picker knives should be .030″—.035″ behind a card held against the throat knife.

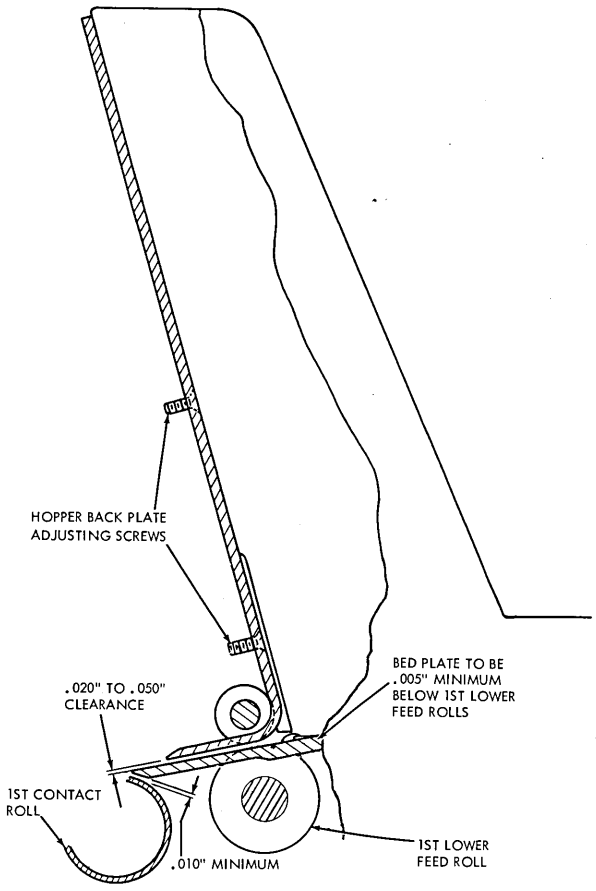


Figure 1. Hopper Backplate

8. The throat roller must be positioned so that the step indicating the center line of the roller is lined up with the throat knife face.

9. The throat opening should be .0095 go—.0105 no go.

10. The picker knife cams are timed to feed a card so proper sequence-brush timing is obtained when sequence-brush heel strands are on scribed line. This should result in the trailing edge of the card feeding past the throat knife face at 70° ±3°. Also, the timing holes in the picker knife cams should align with a hole in the side frame at 303° ±3°. As a final check observe CB S-3 or P-3 for being within timing tolerance.

NOTE: Code plate aligning tool (Part No. 460028) is used to align picker knives on early "88" models. A 1/8" hex wrench (Part No. 450050) is used on later "88" models.

11. Clearance between removable upper card guide and the lower card guide should be .020" to .050".

Card Levers

SERVICE CHECKS

1. Card levers should be free of binds.

2. Check timing according to timing chart (see wiring diagram).

ADJUSTMENTS

1. The card levers must be positioned to give a minimum of .020" travel of both contacts together, when a card lever is operated by a card.

2. Position the card levers and contacts to provide a minimum of 1/64" rise of the N/O contact strap off the support strap when operated by a card.

3. A minimum of 1/32" air gap must be present when the card levers are in their normal unoperated position.

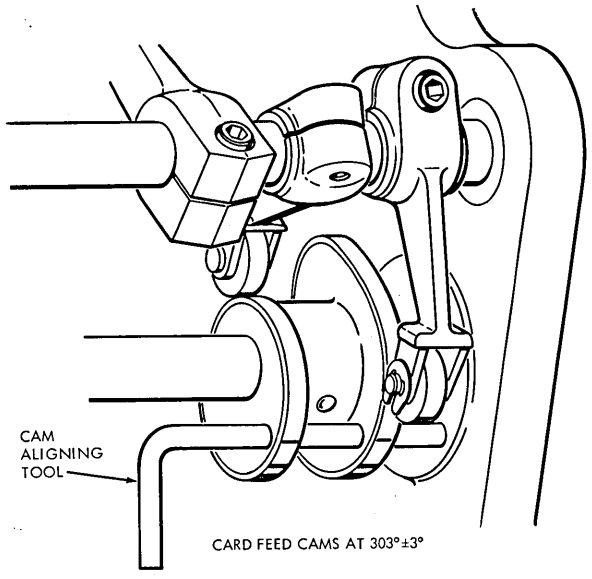


Figure 2. Feed Knife Cam Timing

Brushes (Figure 3)

SERVICE CHECKS

1. The hopper side plates are not adjusted for proper brush tracking. The tracking is obtained by shifting the holder assembly within the side frames.

2. When reinserting brushes, strand breakage will be minimized if the machine is turned over by hand while latching the brushes down. A maximum of three splayed or bent brushes may be broken (not pulled) from each brush during adjustment. However, not more than two strands should be broken from any one group of strands.

3. Brushes should be centered in separator and should not touch either side of slot.

4. Sequence brushes are timed with their heels on the scribed line by shifting the picker knife cam timing.

5. Check for wax build-up between the brushes and brush separators when reading failures occur. This is evidenced by strands or groups of strands failing to project out of the separator properly.

ADJUSTMENTS

1. Insert the brush unit until the plunger locating pins have seated in the side frame holes. There should be .012" — .040" clearance between the brush separator and the contact roll. This is adjusted by moving the separator, which is secured with four screws to the brush separator mounting bar (Figure 3).

2. Recheck service check 3 under *Brushes.*

3. The brushes should track through the center of the holes in a properly fed card. To adjust tracking:

a. Center the brush block assembly in the holder assembly using the screws on the holder assembly. NOTE: The retractable style brush holder assembly uses two allen setscrews with nylon insert to hold adjustment (setscrews, P/N 477037). Be certain the inner brush holder assembly pivots freely within the outer brush holder frame assembly after adjusting the setscrews. With zero clearance between one set screw and the pivot frame, there should be .001"—.003" clearance between the other set screw and pivot frame.

b. With the brush holder in place, adjust tracking by using the adjusting screws in the machine side frames. On some machines, remove the brush unit for access to screwheads. On all other machines, adjust tracking from outside the feed.

c. Allow .005" maximum clearance between side frame and brush holder to prevent binding when removing or replacing brush assembly.

4. Scribed-line-to-brush-heel settings provide the best brush-to-contact-roll relationship. Because the correct relationship will help to eliminate brush and card-feeding troubles, always keep sequence-brush heel strands on the scribed line, and follow the timing pro-

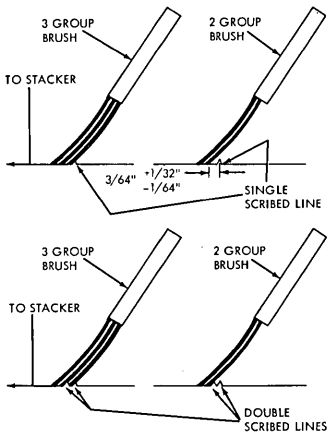
cedure in this manual. (See Figure 3.)

Scribed-line-to-brush-heel settings differ because there are four combinations of brushes and brush separators. The adjustments are:

a. Three group brush; one scribed line: set brush heels to scribed line.

b. Three group brush; two scribed lines: set brush heels to scribed line nearest hopper.

c. Two group brush; one scribed line: set brush heels 3/64" + 1/32" - 1/64" from scribed line, toward stacker. (Plus is toward stacker.)



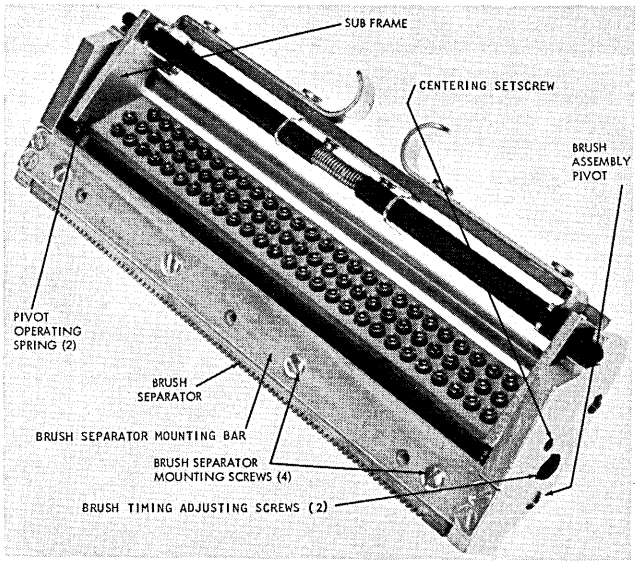


Figure 3. Brush Assembly

d. Two group brush; two scribed lines: set brush heels to scribed line nearest stacker.

5. Sequence-brush timing is obtained by shifting the picker knife cam to obtain correct timing. Sequence-brush heel strands must be left on the scribed line.

Correct compare-brush timing is obtained, after sequence-brush timing is correct, by moving brushes from scribed line if necessary. To avoid timing variations, latch sequence brushes in position; then time primary or secondary brushes.

The two type of brushes, and the dynamic timings for each are:

a. Three-group brushes: Time brushes to make within 1 1/2° of each other. All brushes should make by 3° before line of index; no brush should make until 7° before line of index; no brush should break before 10° after line of index.

b. Two-group brushes: Time brushes to make within 1 1/2° of each other. All brushes should break by 10° after the line of index, but none should break before 8° after the line. All brushes should be made at 1° before line of index. Check impulse CBs, and correct if necessary.

This timing procedure should result in the picker knife cam timing holes aligning with the side-frame hole at 303° ±3°.

Contact Roll Installation (Figure 4)

When installing new contact roll assembly, P/N 602252, be certain that the flat portion of hub, P/N 602216 (Figure 8), 88 Parts Catalog, is horizontal and up. If the hub is not horizontal with the flat side up, the brush block assembly will not seat properly.

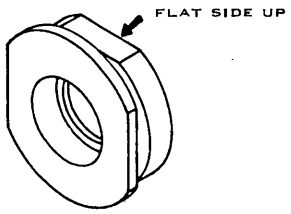


Figure 4. Contact Roll Hub

Clutches (Figure 5)

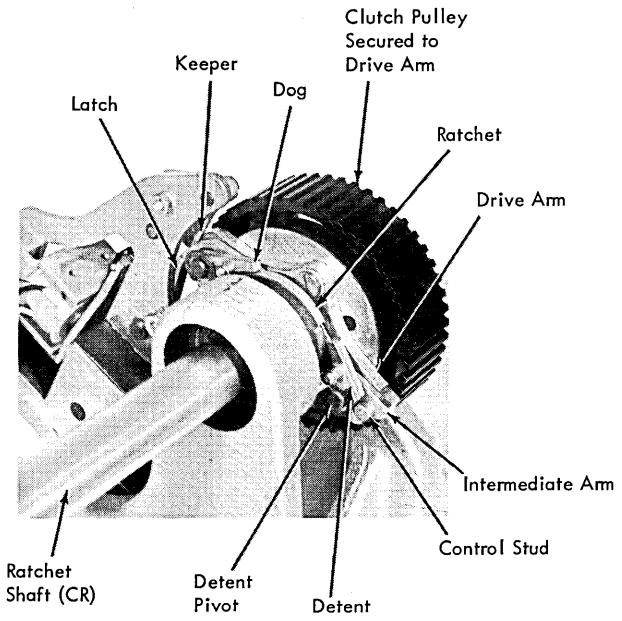
Primary and Secondary Clutches

SERVICE CHECKS

1. Armature and latch assembly must be free of binds.
2. Check for loose screws in the clutch pulley assembly.

WARNING: Be sure the clutch is latched up when you finish working on it. Nipping and possible machine damage will result if the clutch is not latched.

The clutches can be adjusted either in or out of the machine. Steps 1 - 4 should be performed only when a new clutch assembly is installed, or when complete adjustment is to be made to center plate assembly and clutch magnet assembly. When a complete adjustment



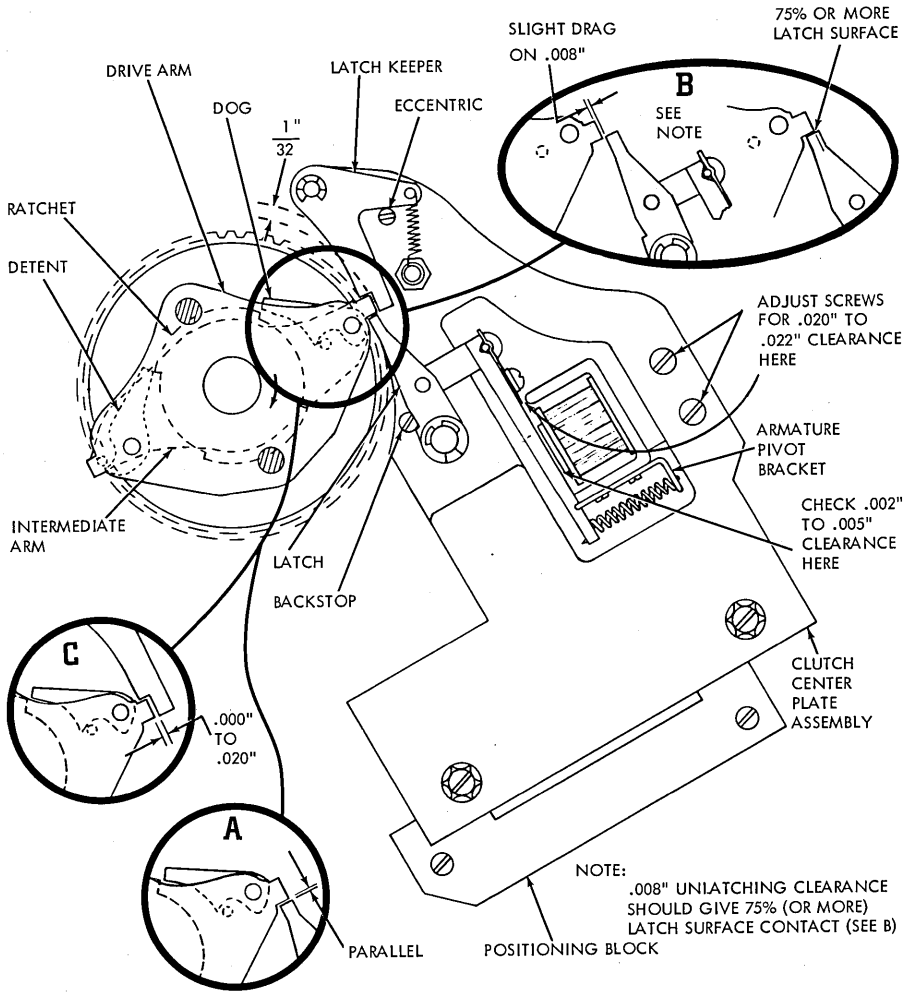
● Figure 5. Clutch Breakdown

is to be made, the clutch locating plate gage 610147 should be used.

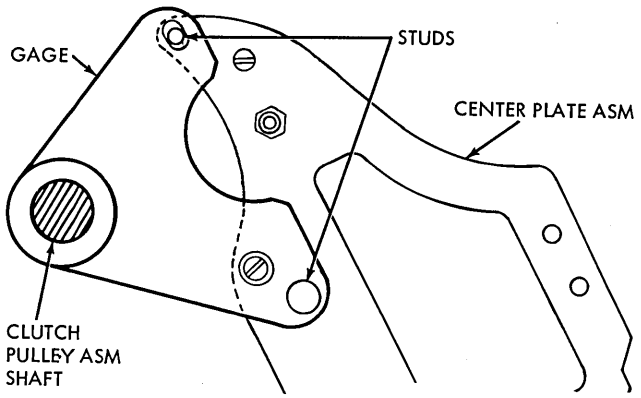
NOTE: Use of this gage will ensure a parallel condition, at latch-up time, between the latch surface of the drive arm and the latch. If adjustments are to be made only to the armature, latch, and magnet, begin at Step 5.

ADJUSTMENTS

1. Remove clutch pulley assembly.
2. Remove latch keeper and latch from center plate assembly. (See Figure 6.)
3. Position locating gage on center plate assembly studs and clutch pulley shaft, with positioning block loose. Secure positioning block against bottom of center plate assembly as far to left as possible (Figure 6). Remove gage.



● Figure 6. Magnet Assembly and Latch Adjustments



4. Reinstall latch keeper, spring, latch, and clutch-pulley assembly.

5. Adjust armature pivot bracket to maintain .002" to .005" clearance between armature and core. (See Figure 6.)

6. A .020" to .022" clearance should be allowed between armature and yoke with latch against backstop. (See Figure 6.)

7. Hold armature attracted, and remove slack from linkage by pushing latch toward drive arm. Position center plate assembly on positioning block to get slight drag on .008" feeler gage between latch and clutch drive arm. (Figure 6B.) Tighten center plate assembly mounting screws. At least 75% of the latch should be in contact with drive arm assembly in latched condition. (See Figure 6B.)

NOTE: Be sure to keep center plate against positioning block.

8. Loosen positioning block mounting screws and move block as far to the right (ear of positioning block against plate) as possible. Lock mounting screws.

9. Adjust eccentric keeper stop stud to obtain .000" to .020" between clutch drive arm and latch keeper at latch time. (See Figure 6C.)

Clutch Timing

1. If all timing is lost, the general timing sequence is:
   a. time index to secondary clutch.
   b. time secondary feed knives to index.
   c. primary clutch to index.
   d. primary feed knives to index.

2. Clutches are to latch at 310° ±1°. Latch time is determined by the time the keeper (Figure 6) falls behind the drive arm. With clutch engaged, turn the clutch over until the drive arm is near the keeper. While putting finger pressure on the clutch-driven pulley, in direction of rotation, continue to rotate clutch until keeper snaps behind drive arm. This is to occur at 310° ±1°.

3. Only four belts on the IBM 88 will affect basic machine timing: the two motor drive belts; primary and secondary clutch driven belts.

4. If either motor drive belt breaks or comes off, the only timing lost is the primary feed end. This can be regained by aligning the primary feed knife cam shaft with the aligning tool at 303°. NOTE: Primary clutch must be engaged. Check primary-clutch time, impulse CBs, and brush timings; correct if necessary. Be sure sequence-brush heel-strands are on scribed line.

WARNING: Remove the tool before cranking machine.

5. If the secondary clutch drive belt breaks, engage secondary clutch; crank index to 303°; rotate feed knife camshaft to align holes in feed knife cam and side frames; replace belt. *WARNING:* Remove tool before cranking machine. Check secondary impulse CBs and secondary-brush timings; correct if necessary. (One tooth on picker knife pulley is approximately 7°.)

6. The procedure on the primary clutch drive belt is the same as on the secondary except that the primary clutch is engaged instead of the secondary clutch.

Primary Clutch Drive Removal (Figure 7)

1. Locate the positioning blocks firmly against the drive assembly.

2. Trip the clutch and turn to 303°; spot mark the gear on the CR input shaft, the CR idler gear (2 marks) and the CR drive gear to retain the CRCB timing (Figure 8).

3. Insert the timing tool in the feed knife cam and the hole in the feed side casting.

4. Remove four drive belts.
   a. Contact roll drive (front of primary).
   b. File feed drive (rear of primary).
   c. Motor drive (rear of primary).
   d. Clutched feed roll drive (rear of primary).

Loosen the belt take-up pulley bracket.

5. Remove the clutch magnet leads at the terminal block.

6. Remove the four hex-head clutch-drive assembly mounting screws.

7. Remove the assembly to the rear.

Primary Clutch Drive Installation

1. Set the drive assembly in position with the clutch engaged.

2. Mesh the CRCB drive gears using spot marks.

3. Install four drive asembly mounting screws; do not tighten.

4. Square the assembly to feed by laying a straight edge across the front of the feed and clutch drive castings just below the gears. This is for belt and gear alignment. NOTE: Use machined surfaces.

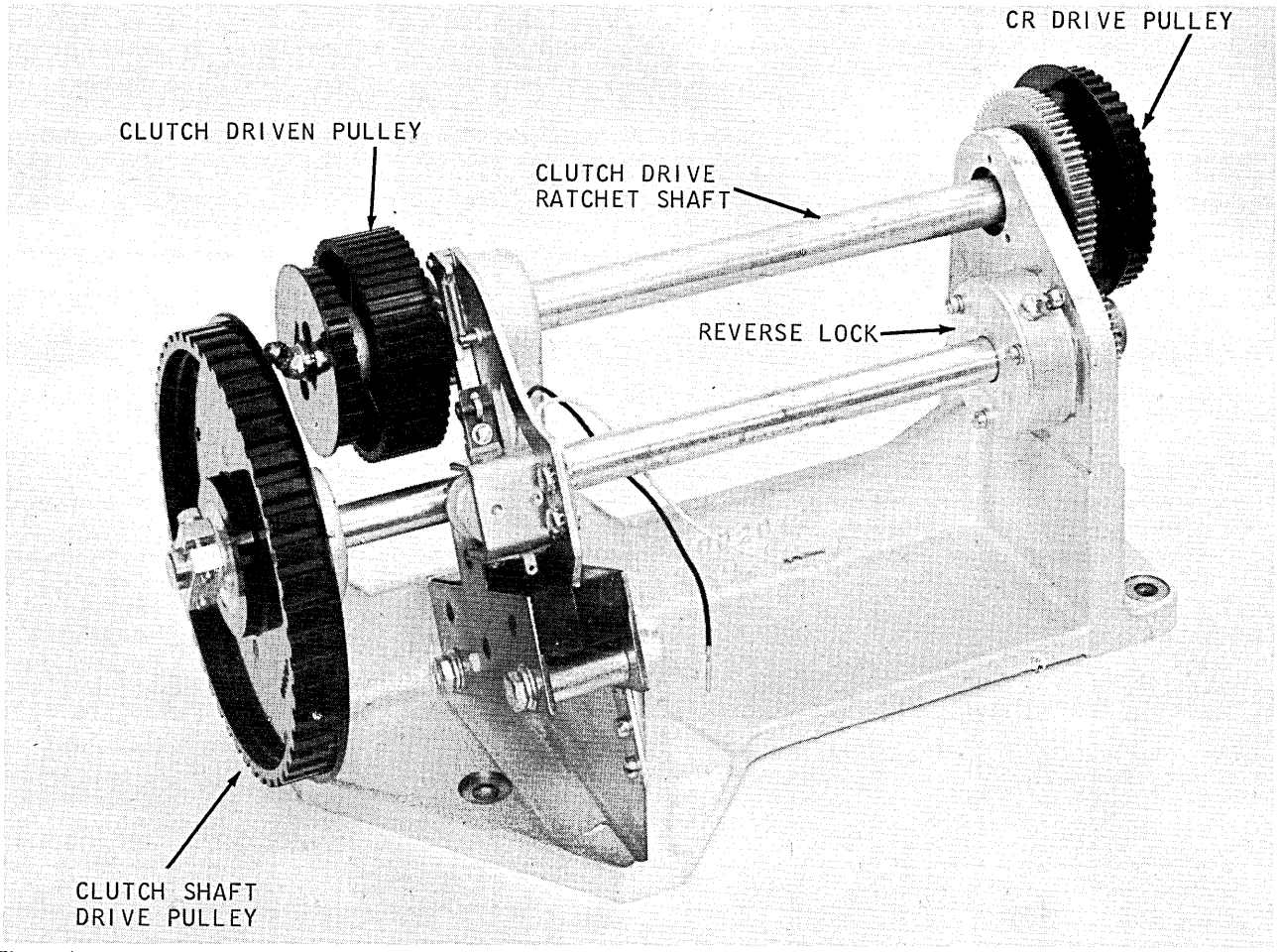


Figure 7. Clutch Assembly

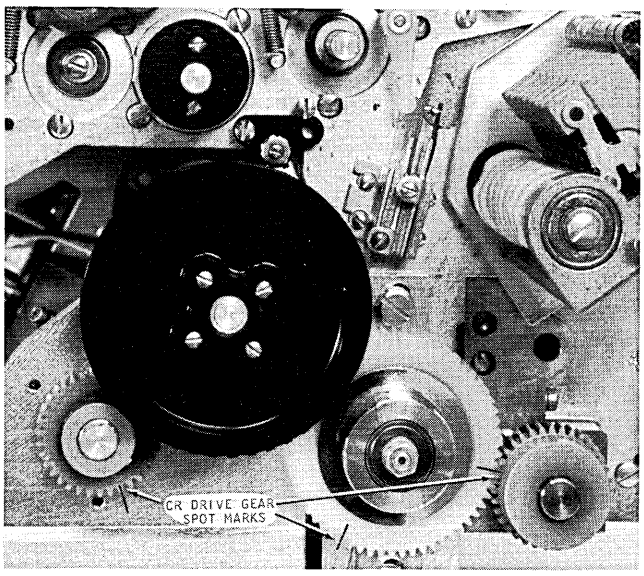


Figure 8. CR Drive Gear Spot Marks

5. Check the wink at the idler gear and tighten the mounting screws.

6. Install the clutched feed-roll-drive belt with the timing tool in the feed knife cams and with spot marks lined up. Set belt tension with the adjustable idler pulley bracket.

7. Keeping the spot marks aligned and the index at 303°, install the motor drive belt.

8. Plug the clutch magnet leads into the terminal block.

9. Replace contact roll drive belt. Adjust tension in accordance with figure 9. *Warning:* Before running machine, remove timing tool and make certain keeper is behind arm.

10. Check the following timing:

a. Primary clutch engagement time (310° ± 1°).

b. Trailing edge of the card feeding in should align with the face of the throat knife at 70° ±3°.

c. Primary brush impulse CB timing; use CE aid panel.

d. Timing of the CRCB's at the primary end of the machine.

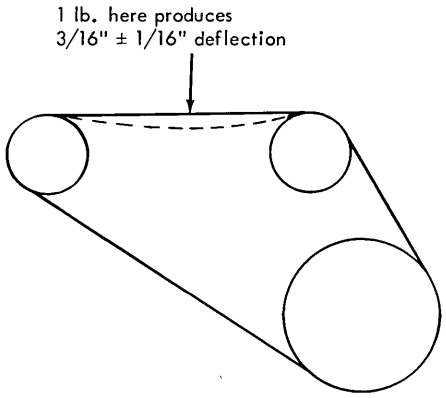


Figure 9. Contact Roll Belt Tension

11. With feed knives all the way back and front joggler forward but just starting back, replace file feed belt.

Primary Clutch Component Replacement

Primary clutch components may be removed by removing clutch pulley only.

1. Engage both clutches.
2. Crank machine to 303°, install timing pins through picker knife cams and into sideframe holes (both feeds).
3. Remove grease fitting from clutch shaft.
4. Mark file feed belt-to-pulley relationship.
5. Remove file feed belt and drive pulley.
6. Mark clutch drive pulley-to-shaft relationship drive (Figure 7); slide pulley out so clutch-driven pulley will clear end of ratchet shaft.
7. Loosen wide clutch drive belt idler.
8. Loosen clutch retaining collar; slide clutch pulley off shaft.
9. Reinstallation is the reverse of removal.
   WARNING: Remove timing pins from both feeds before cranking machine.
10. Check clutch latch time.
11. Check brush timings and impulse CB timings; correct as needed.

Secondary Clutch Drive Removal

1. Check that the positioning blocks are against the unit and tightened.
2. Engage the primary and secondary clutches and turn to 303°.
3. Spot-mark the secondary gears on the CR input shaft, the idler gear, and the CR drive shaft to keep correct CB timing (Figure 8).
4. Insert timing tools in both primary and secondary feed knife cams and side casting; note timer reading.
5. Remove the dynamic timer and the hand wheel.
6. Remove three belts:
   a. Clutched feed roll drive belt; loosen take-up pulley.
   b. Contact roll drive.
   c. Motor drive.
7. Remove two clutch magnet leads at the terminal block.
8. Remove four hex head clutch assembly mounting screws.
9. The clutch assembly can be removed from the front.

Secondary Clutch Component Replacement

It is not necessary to remove the entire secondary clutch assembly to replace defective clutch components. Replacement of clutch parts can be accomplished as follows:

1. Remove secondary clutch drive belt, grease fitting from end of shaft, and split collar.

NOTE: Machines after 88-12734MO have a threaded angular grease fitting installed. Machines prior to approximately 88-10472AO employ a driven or pressed straight grease fitting.

2. Remove two screws and lockwashers securing pulley to clutch drive arm.
3. Remove pulley from end of shaft. There is adequate room for removal between end of shaft and dynamic timer.
4. Remove clutch from end of shaft.
5. Reinstallation is the reverse of removal.
6. Time feed: engage clutch; crank index to 303°; insert timing tool in feed knife cam; install belt. *WARNING:* Remove tool before cranking machine.
7. Check brush timings and impulse CB timings; correct if necessary.

Secondary Clutch Drive Installation

1. Set the assembly in position with the clutch engaged.
2. Mesh the CRCB drive gears using spot marks.
3. Install four assembly mounting screws; do not tighten.
4. Square the assembly to feed by laying a straight edge across the rear of the feed and the clutch drive assembly castings just below the gear. NOTE: Use machined surfaces.
5. Check wink between the CR idler gear and the CR drive gear and tighten the mounting screws.
6. With spot marks aligned and timing tool in place in both feeds, install all three belts. NOTE: The primary clutch should be engaged.
7. Mount the dynamic timer and the hand wheel; leave the split hub on the timer hub loose.
8. Again checking the spot marks and the timing tools, set index as noted in removal and tighten index

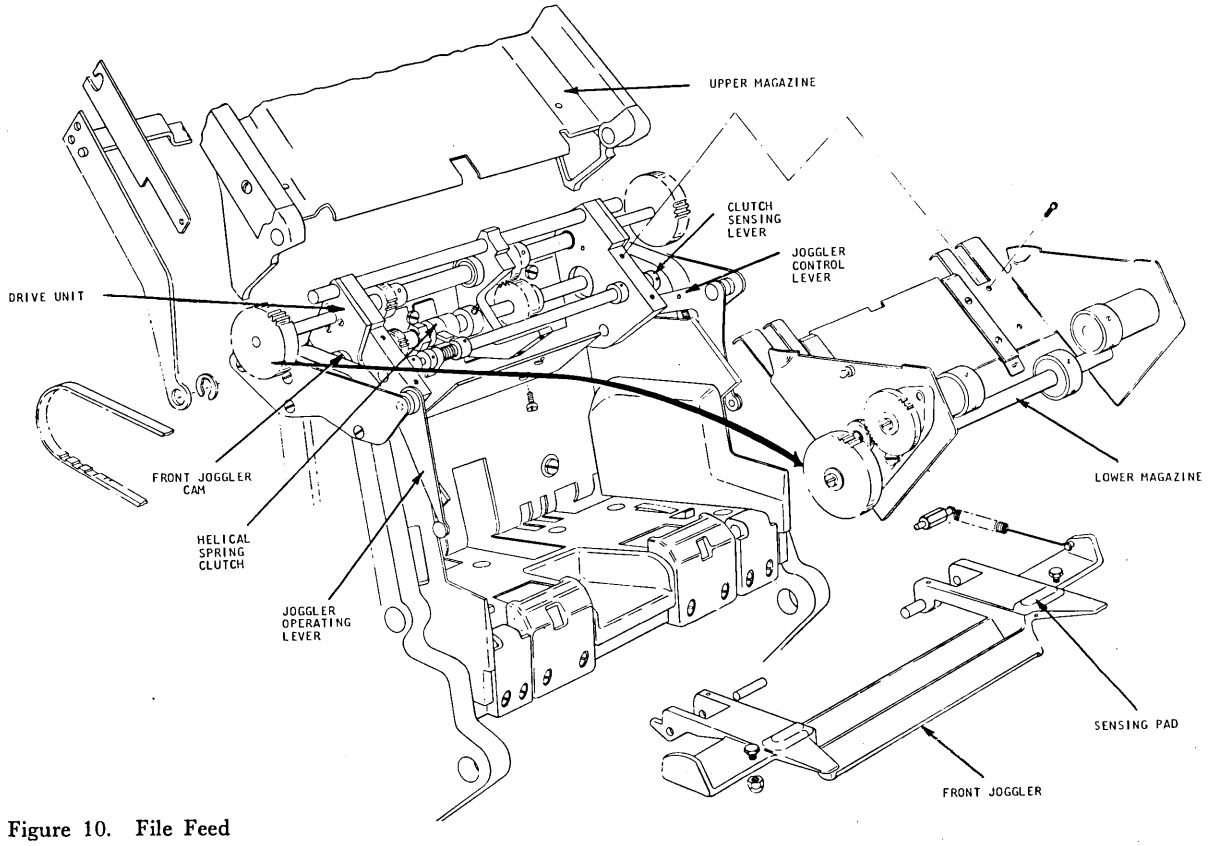


Figure 10. File Feed

split hub. *WARNING:* Remove both timing tools.

9. Plug in clutch magnet leads.
10. Check the following timings in both feeds:
    a. Clutch engagement time (310° ±1°).
    b. The trailing edge of the card feeding in should align with the face of the throat knife at 70° ±3°.
    c. Brush impulse CB timings; use the CE aid panel.
    d. Timing of the CRCB's.

File Feed (Figure 10)

The file feed mechanism consists of four basic components: upper magazine, drive assembly, joggler assemblies, and lower magazine.

Upper Magazine

The upper magazine is secured to the drive assembly by two sliding studs on the main tray and by two studs on the feeds which hold the upper magazine struts.

Drive Assembly

This unit consists of the pulleys, gears, file feed clutch, and joggler operating cams. To make adjustments, remove the lower magazine and the drive belts.

CLUTCH ADJUSTMENT

With the clutch latch against the latch step on the sleeve, loosen the split collar and rotate the collar backwards (opposite normal rotation) until stopped by the spring fully uncoiled inside sleeve. While holding the split collar in this position, rotate the detent and gear 1/16" past detent position. This should result in 1/16" overthrow (Figure 11).

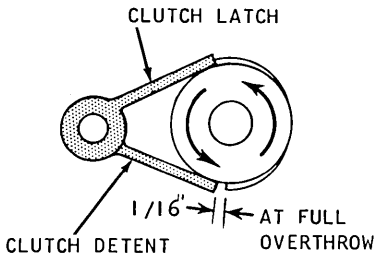


Figure 11. File Feed Clutch Adjustment

JOGGLER ADJUSTMENTS (FIGURE 12)

1. Turn the drive unit until the front joggler cam followers are on the low dwells of the cams. Fill the hopper to just below the sensing pads on the front joggler and close joggler. With the cam followers against the cams, adjust screws so that there is a .002"

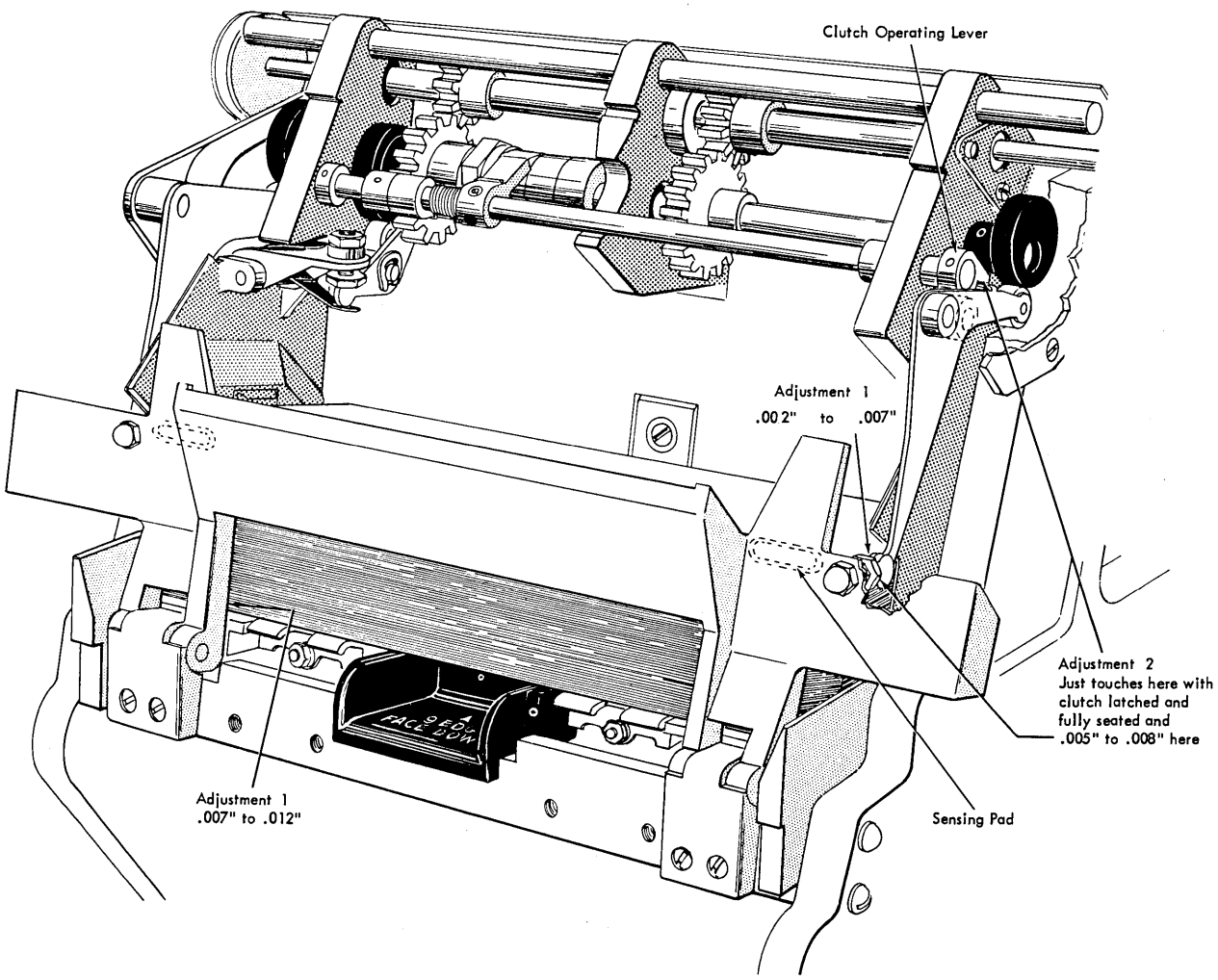


Figure 12. Drive Unit and Front Joggler

to .007″ clearance between screws and levers. Screws and levers should be parallel within .002″. Under stated conditions, there should be a .007″-.012″ clearance between the cards and the lower end of the joggling surfaces (the lower end of the joggling surfaces is in line with the top of the card feed knife posts).

2. Turn the drive unit until the front joggler cam followers are on the high dwell of the cams. Fill the hopper with cards to a level even with the top of the sensing pads and close the joggler. Hold the cam follower (rear one for primary; front one for secondary) against the cam and continue to operate the unit. Stop when .005″ — .008″ clearance appears between the cam follower arm and the adjusting screw. Loosen the clutch operating lever on its pivot shaft and fully seat the clutch latch. With the cam follower against the cam, position the clutch operating lever so that it just touches the turned over ear on the cam follower arm (Figure 12). Tighten the setscrews in the clutch operating lever, securing it to its pivot shaft.

3. Adjust the side joggler: place a two-inch deck of cards in hopper; crank file feed drive until hopper-joggler cam-follower is on high dwell of cam; set adjusting screw (Figure 13) for 0.000″ to 0.005″ clearance between upper left corner of deck and joggler arm. Remove cards from hopper, fully extend side joggler by means of cam; lift side joggler arm at operating arm (Figure 13). There should be further extension of joggler. If interference exists, check distance between hopper side plates. See *Card Feeds, Feed and Hopper, Adjustments.*

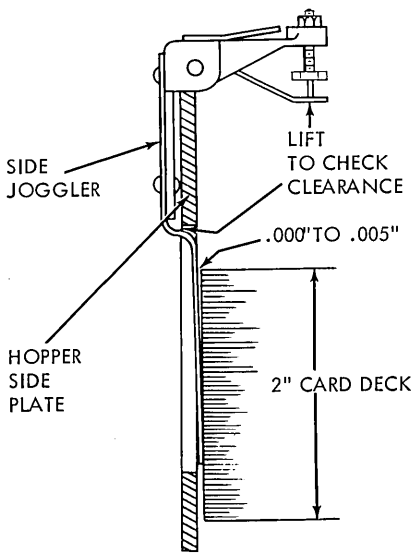
4. The feed knives and the jogglers should be timed about 180° out of phase so that the jogglers move away from the cards just before the feed knives start forward.

DRIVE CLUTCH REMOVAL

1. Remove the covers and the upper and lower magazines.

2. Remove the drive unit from machine.

3. Remove the rear pulley and the front and rear joggler cams. NOTE: Mark the cams and shaft to maintain relationship.



● Figure 13. Side Joggler

4. Remove the rear bearing retainer plate.

5. Loosen the side joggler cam, clutch hub (with grease fitting), and the clutch drive gear on the joggler cam shaft. These setscrews are seated in undercuts on the shaft and must be loosened a full turn. Slide the shaft out of the rear of the unit.

6. Remove the clutch assembly through the bottom of the unit. The clutch can now be disassembled and the spring removed.

7. Reassemble in the reverse order. Be careful to have the clutch latch and the detent in their correct positions, and the grease fittings over the slot in the shaft. The clutch drive sleeve and the side joggler cam should hold the clutch together, with the clutch in full mesh. The sleeve and the side joggler cam should not squeeze the clutch so tightly as to cause binding when the clutch is latched. Check all drive unit adjustments after the unit is replaced in the machine. NOTE: The feed knives and the jogglers should be about 180° out of phase so that the jogglers move away from the cards just before the feed knives start forward to relieve pressure on cards.

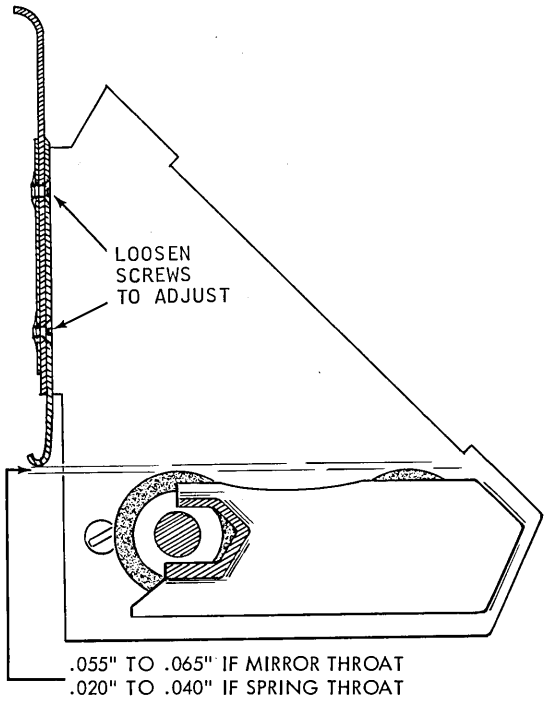
Lower Magazine Unit (Figure 14)

SERVICE CHECK

All four feeds rolls should be in the same plane so that a flat surface placed across them would rest on all four feed rolls at the same time.

ADJUSTMENTS

Adjust the lower magazine throat guides so that they are .020" to .040" (.055" to .065" for mirror-plated throat) above an imaginary plane across the tops of the four feed rolls.



● Figure 14. Lower Magazine Throat

Transport and Stackers

Chute Blades and Selector Magnets (Figure 15)

ADJUSTMENTS

1. Lower the control key and indicator light panel by loosening two holding screws and pivoting (Figure 17).

2. Adjust the selector magnet armature stops so that the air gap between the upper part of the armature and the armature stop is .035" ± .003" (for pocket 3 magnet) and .040" ± .003" (for pocket 2 and 4 magnet).

3. The selector magnets and chute blades should be positioned so that the chute blades are 1/32" to 3/64" above the card line when the magnets are not energized, and 1/32" to 3/64" below the card line when magnets are energized.

4. Horizontal adjustment of chute blades is shown in Figure 16.

5. Chute blade tension should be such that a force of 150-350 grams (3/8 - 3/4 lb.) applied to the 3 select magnet armature just under the backstop is necessary to hold the armature fully attracted. For pockets 2 and 4 use 75 - 200 grams (3/16 - 7/16 lb.) See Figure 15.

6. Select magnet deflector spring should be .005" to .010" above lower card guide. (Figure 15.)

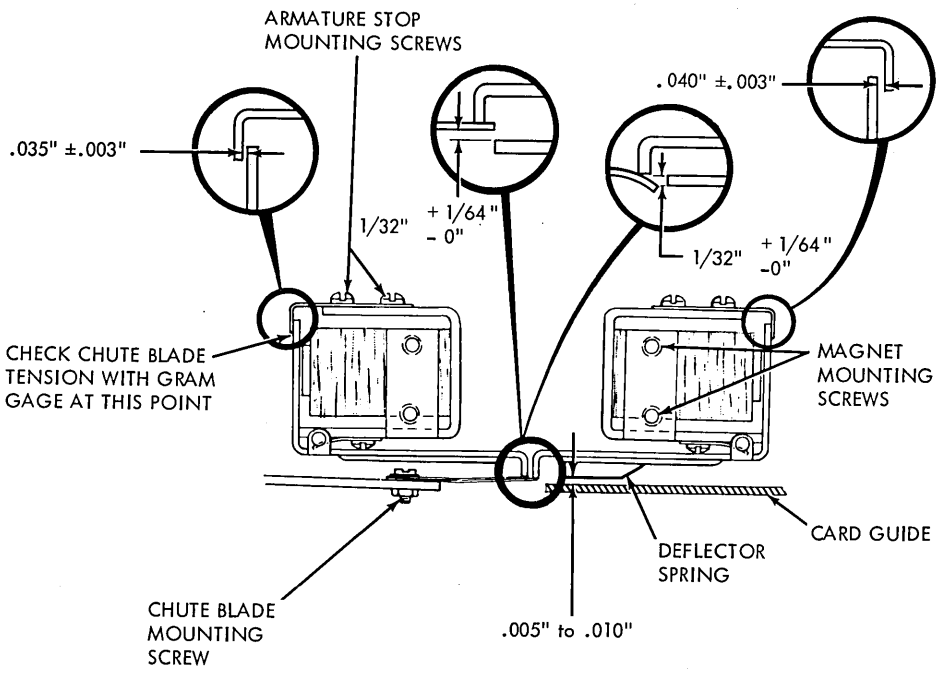


Figure 15. Chute Blade and Selector Magnet Adjustment

NOTE: With the chute blade removed, the tab containing the chute blade mounting screw hole should project $\frac{1}{8}'' \pm \frac{1}{64}''$ above a flat surface when chute blade is held flat with the mounting tab up.

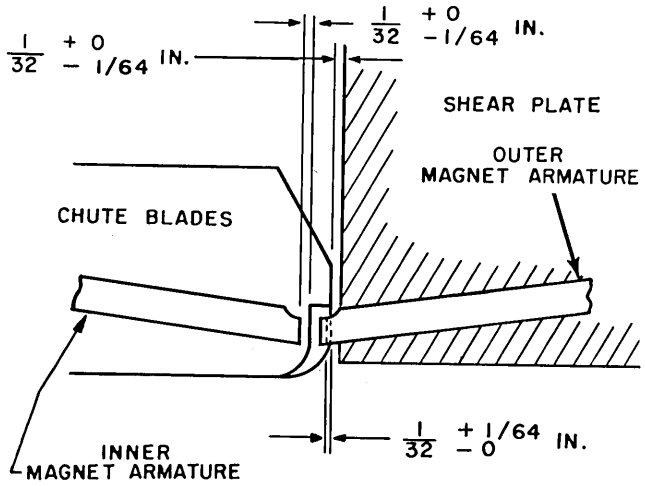


Figure 16. Chute Blade (Top View)

CHUTE BLADE REMOVAL

1. Loosen two screws securing control key and indicator light panel bracket to frame and pivot bracket. Lift and pivot panel out and down until panel bracket rests against stops (Figure 17).
2. Remove the covers at each side of stackers.
3. Remove the card retainer assembly.
4. Note how chute blades are positioned on deflector plate.

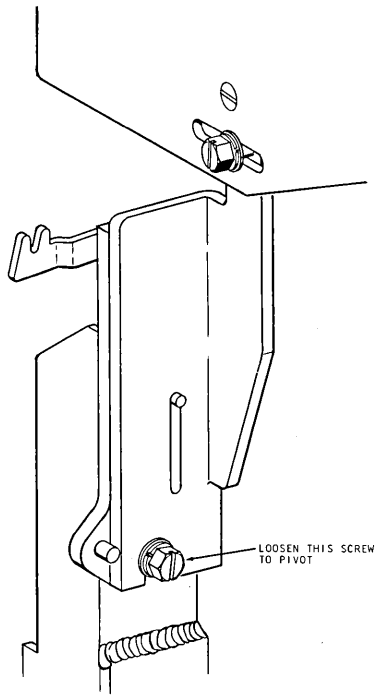


Figure 17. Control Key and Indicating Light Panel Bracket

5. Remove the nut from the chute blade mounting screw and remove chute blade.

CHUTE BLADE INSTALLATION

Reverse the above procedure, positioning the chute blade tips to clear the lower card guide plate (Figure 16).

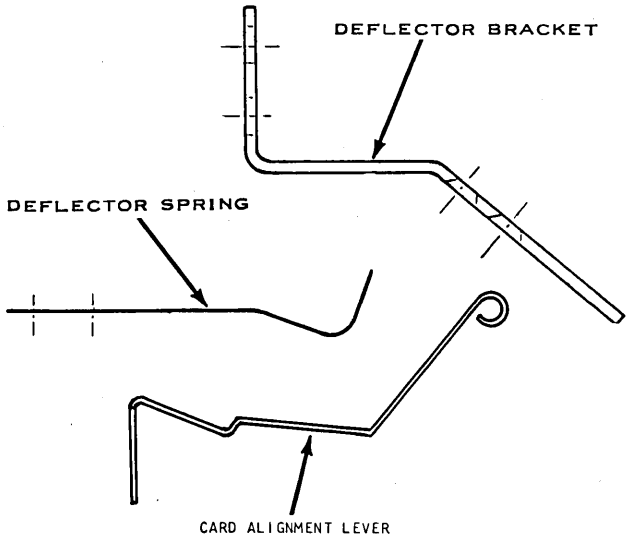


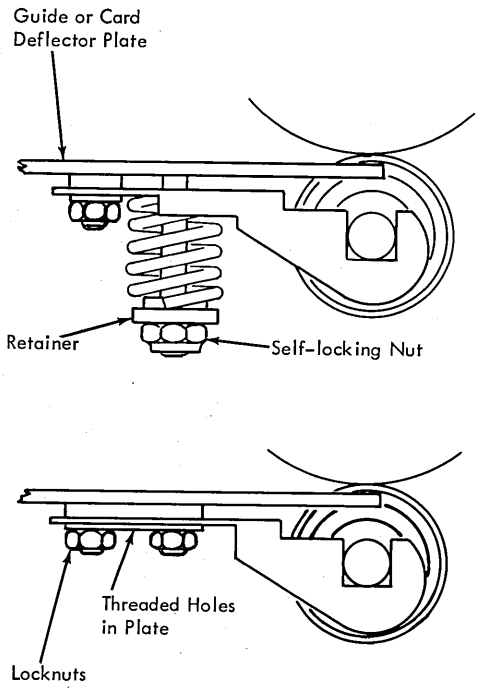
Figure 18. Pocket Deflecting Spring, Deflector Bracket and Card Alignment Lever

Transport Rolls

ADJUSTMENTS

1. The lower pressure rolls should be centered directly below the upper rolls. This can be accomplished by inserting a .010″ feeler gage leaf between the upper and lower rolls and adjusting the lower roll mounting brackets until the feeler gage leaf is parallel to card line.

2. Tension on the pressure rolls is adjusted by varying the feed roll shaft mounting bracket screws so that a pull of 1.5 lbs. to 2.5 lbs. is required to pull a card strip from between rolls (upper roll not turning). Tension on the front and rear rolls should be within ¼ lb. of each other. The card is pulled in the same direction as it is fed. NOTE: Push-pull scale, P/N 9900012, may be used.



UPPER FEED ROLL REMOVAL

1. Lower the key and indicator light panel. Remove the top and rear covers (Figure 17).

2. Remove the necessary belts from the rear drive pulley.

3. Remove the pulley (s) by loosening two setscrews per pulley.

4. Remove the rear bearing retainer.

5. Move the feed roll to the rear until the front end of the shaft clears the front rail. Lift the front end and remove the feed roll over the front rail.

6. Assemble in reverse order.

Stackers

SERVICE CHECKS

1. (Figure 19) Check jam bar for binds and correct operation. Inspect jam tape hanger for burrs. Round off if necessary. Access may be gained by removing shear plate.

2. The stacker card restraining and retaining levers must be clean and free of binds. Card alignment levers should hold 5 to 30 cards before cards slip onto card pusher slide.

3. The pusher and card support slides must be free of binds.

4. Check for loose lock nuts on the lower feed roll mounting screws.

5. Check for .005″ to .010″ between the tips of the spring deflectors (mounted on pockets 2 and 4 selector magnets) and the lower card guide.

6. Primary and secondary cards should be $\frac{5}{16}$″ ± $\frac{1}{32}$″ from the front rail and should align within $\frac{1}{32}$″ of each other at the merge pocket.

7. Deflector springs and brackets should be formed as shown in Figure 18 for proper card action into pocket 3.

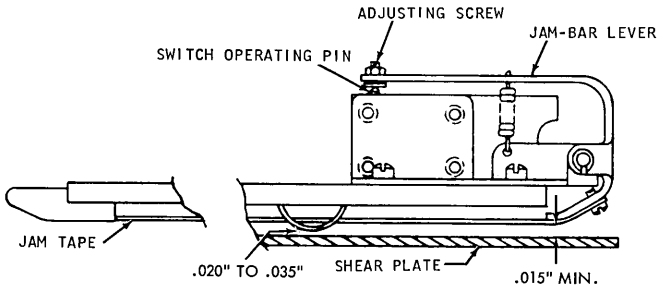
ADJUSTMENTS

1. The space between the pocket separators should be 3 $\frac{5}{16}$″ ± $\frac{1}{64}$″.

2. The pocket separators should be square with transport rails within .015″.

3. The radial guides should be square with pocket separators within .010″ and formed as shown in Figure 20.

4. The jam bar must be positioned for .020″ to .035″ clearance between the formed points and the card guides over the entire length of the card transport; however, the ends of the jam bar must be at least .015″ above the card guides. (Figure 19.)



● Figure 19. Jam Bar

5. The tape must be adjusted so that the switch will be operated with a tape deflection of 1/16".

6. The merge pocket jam tape lever should be adjusted so that a card just touches when a card is fed into the merge pocket.

7. If card alignment lever fails to hold five to thirty cards, check configuration of card alignment lever with configuration shown in Figure 18. If configuration is correct and card alignment still does not hold five to thirty cards, bend tab on card alignment lever to obtain proper spring tension. *WARNING:* Do not bend tab on radial guide.

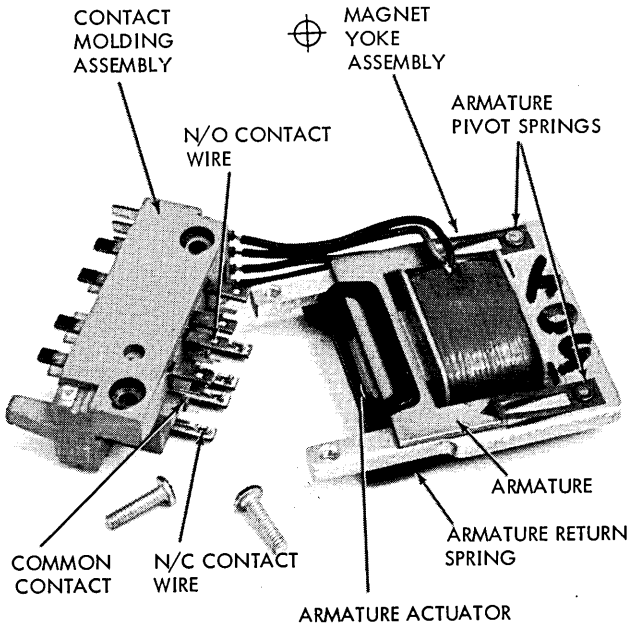
Permissive Make Relays

Disassembly

1. When a PM relay is the cause of a machine malfunction, it may not be necessary to replace the entire relay. Disassemble as follows:

a. (Figure 21.) Remove two relay yoke mounting screws and separate contact molding from yoke assembly. Use care to prevent breakage of coil wires from relay molding.

b. With a screwdriver, press contacts free of locating hole.



● Figure 21. Permissive Make Relay

Service Checks

1. Inspect common contact point for dust or corrosion film. If necessary, burnish the point lightly. If common contact is burned or pitted, discard relay. Excessive cleaning will result in an increased air gap and loss of contact wire tension.

2. Check for corroded or burned contact wires. Check for proper contact wire configuration (Figure 23). Do not bend contact wires to meet requirements. Discard faulty contact wire and install new part.

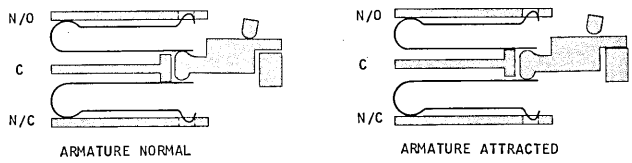
Reassembly

1. Check new contact wires for correct configuration (Figure 23).

2. Install new contact wires one at a time from armature side of contact molding assembly. Make certain that contact wires do not become twisted.

3. Secure magnet yoke assembly to contact molding assembly with two screws. Center armature on yoke so that the ears of the armature actuator are equidistant from the end contact wires.

4. Make certain that the yoke is held tight against the mounting pads. Check for freedom of armature movement. Check coil leads and proper seating of armature pivot springs. Check operation of relay contacts with dynamic timer or oscilloscope.



● Figure 22. PM Relay Schematic

Circuit Breakers

Service Checks and Adjustments

1. Changing the timing of the primary or secondary feed knife cam shaft will also change the timing of the respective clutched CB's.

2. Check the timings, dynamically, of critical CB's using the CE aid panel.

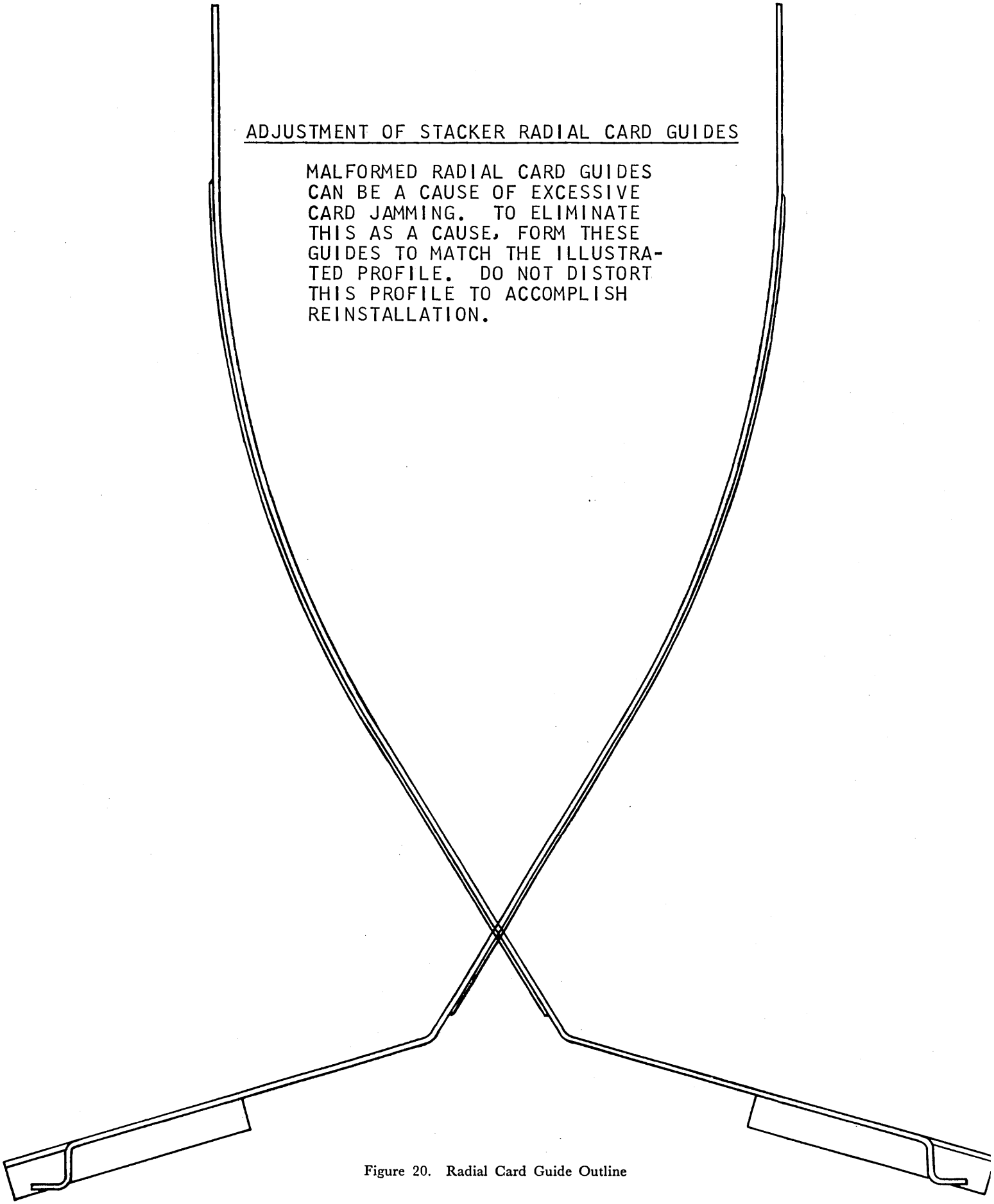


Figure 20. Radial Card Guide Outline

3. For maximum reliability of brush impulse CB's, P2 - P5 and S2 - S5, check air gap after correct duration is set (see Wiring Diagram). The air gap should be .018" to .022". If this air gap cannot be obtained with the correct duration, and if reading failures persist, replace the cam. Make certain that the timing relationship between the impulse CB timings and the code cam timings is adjusted for maximum overlap. See Wiring Diagram.

4. Loose contact stack screws, caused by shrinkage of phenolic insulators, can contribute to loss of duration as well as reduced contact pressure.

5. Contact point bounce can easily be seen by using the dynamic timer. A break in the impulse approximately 3 degrees after make will usually occur if the contact point bounces. If tightening the stack screws and adjusting the air gap does not correct trouble, replace the CB.

6. Tightening one setscrew too tight in the nylon cam can cause timing variations. Tighten both screws together and equally tight.

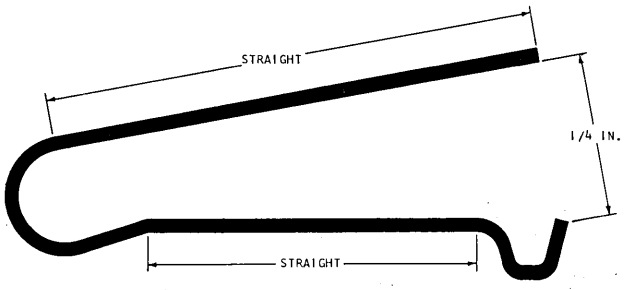


Figure 23. PM Relay Contact Wire

Cam Replacement

1. If cam replacement is necessary, cams may be removed from either end of shaft. Proceed as follows:

a. Remove collar or input gear, whichever is closest to cam being replaced. Remove two screws securing bearing to side plate.

b. Loosen cam adjacent to side plate. Drive cam against bearing washer and drive out bearing. Remove as many cams as necessary from shaft.

c. Reassembly is the reverse of disassembly.

2. To remove cams P2 through P10 and S2 through S10, remove entire circuit breaker mounting bracket. Proceed as follows:

a. Remove two screws securing CB mounting bracket to front frame assembly. Remove screw securing washer to shaft and remove CB mounting bracket from frame.

b. Remove and reinstall cams on shaft as necessary.

3. Reinstall CB mounting bracket as follows:

a. Remove bearing from mounting bracket.

b. Secure mounting bracket to frame with two screws.

c. Install bearing. Bearing must slip freely into place. If it does not, mounting bracket must be shifted or shimmed to attain proper alignment. *WARNING:* A broken picker knife shaft or bearing damage can result from improper alignment of outboard bearing.

51 Column Feature

The 51 column feature makes it possible to adapt a standard machine to 51 column cards. The 51 column cards can be fed from the secondary feed only. Cards may be selected into select pockets 4 and 5 or merge pocket 3.

Card arrester tapes mounted on the sides of pocket 3 hold a maximum of 100 cards until a control change causes the release of the tape control magnet. When the tape control magnet is released, the cards drop as a group into the stacker. The control change is recognized by an equal compare and a high or low secondary sequence output. The control change also causes the interruption of the clutch circuits for two cycles to allow time for cards on the arrestor tapes to fall before cards are again fed into pocket 3.

Conversion from 80 to 51 Column Operation

1. Install auxiliary side plates to regular side plates with knurled thumb screws. Secure by tightening locknuts against regular side plates. (Figure 24.)

2. Interchange 80 and 51 column card weights.

3. Reach into pockets 4 and 5 and pull recessed radial guide forward to front limit. Slide end of guide down until it latches.

4. Lift the auxiliary stacker ledge cover and pull each auxiliary ledge from its upper locked position. Push each upper ledge toward the rear of the machine to a locked position. Swing the auxiliary ledges into respective pockets. (Figure 25.)

5. Open top sliding cover. Pivot into ledge hole the card hold down spring located over pocket 3 in the transport. Close cover. (Figure 26.)

6. Install hopper liner assembly into upper secondary magazine assembly. The liner assembly snaps into place.

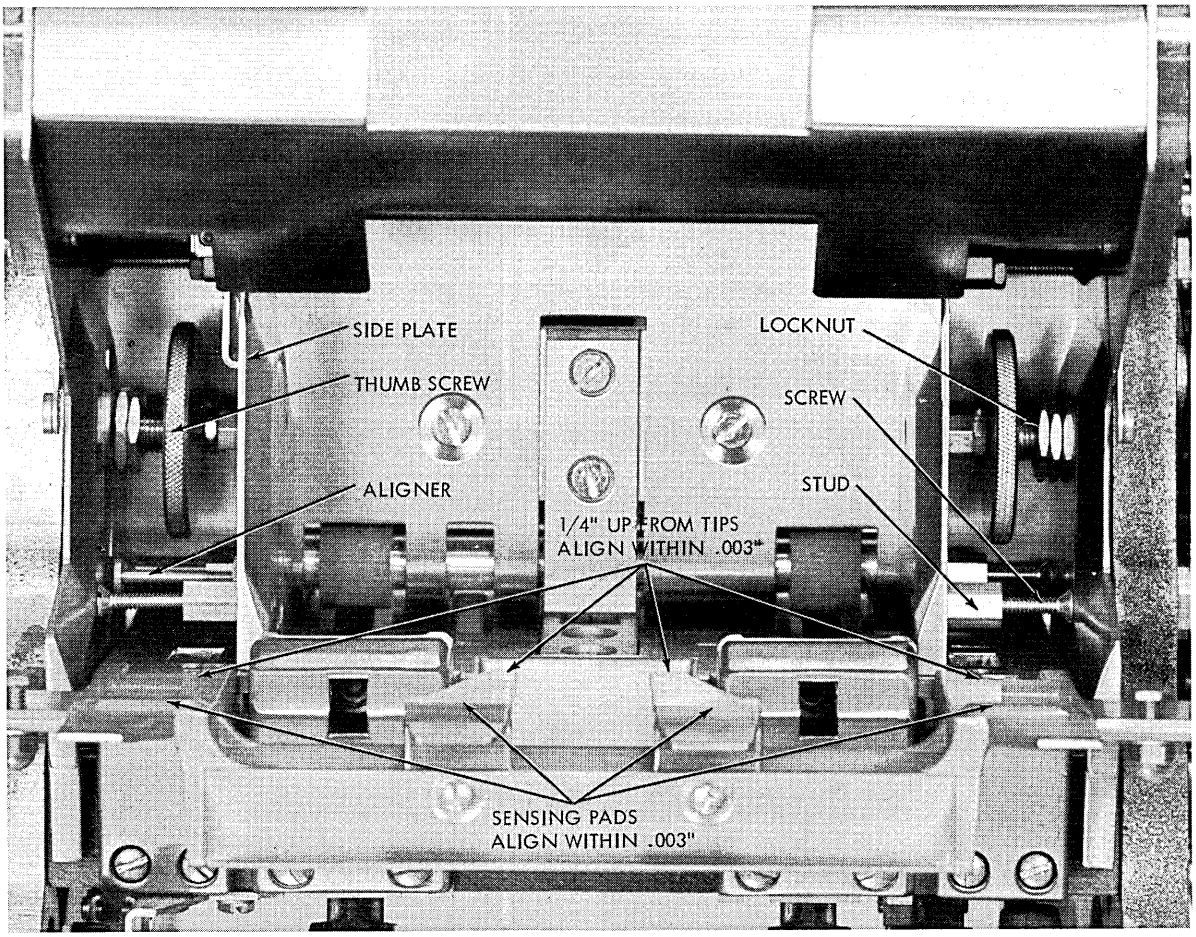
7. Wire 51 column switch on control panel with jack plug.

Adjustments

SECONDARY FEED ADJUSTMENTS

All adjustments same as standard feed with the following exceptions:

1. The hopper contact is adjusted to make when top



● Figure 24. 51 Column Hopper

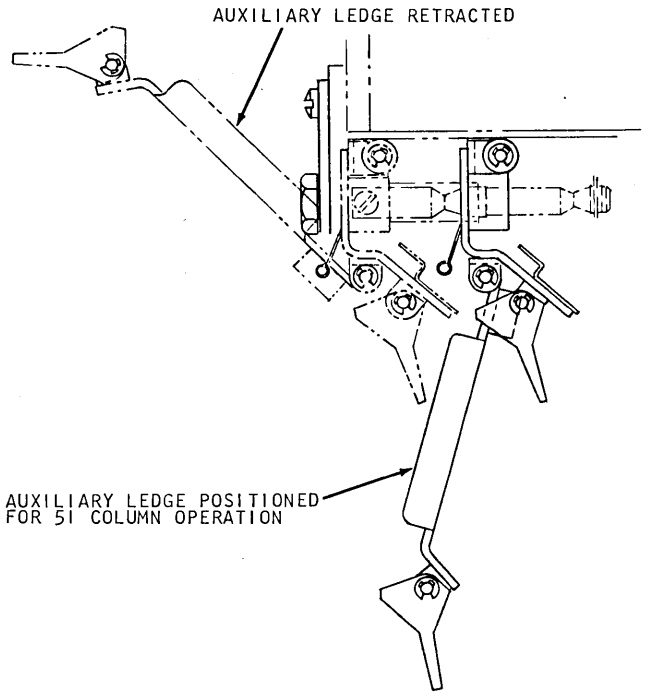


Figure 25. Auxiliary Ledge

card lever is $\frac{1}{16}$" above surface of the picker knife. Card lever must pivot freely with no binds.

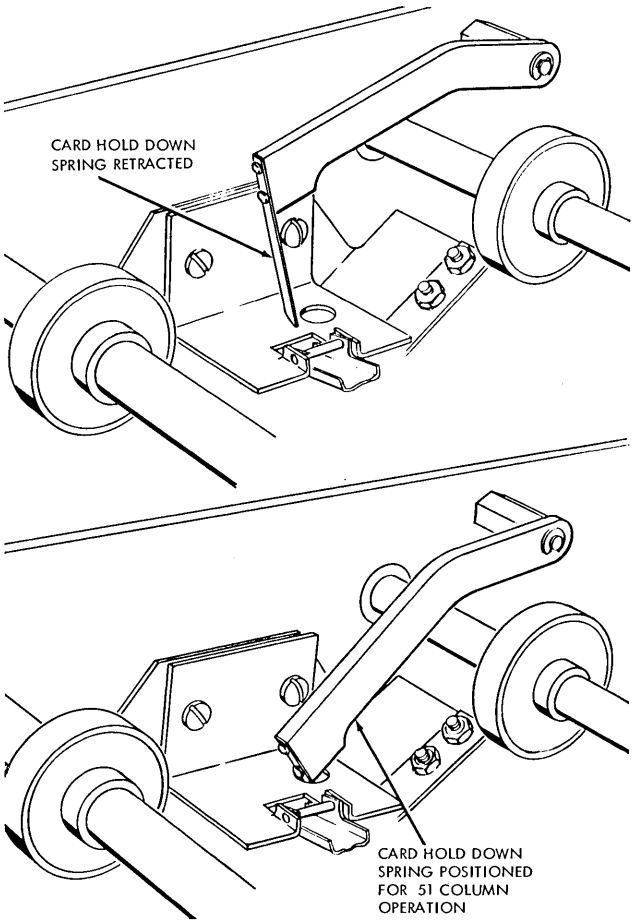
2. The side plates must be positioned for two conditions:

a. Set for reading of columns 15 through 65.

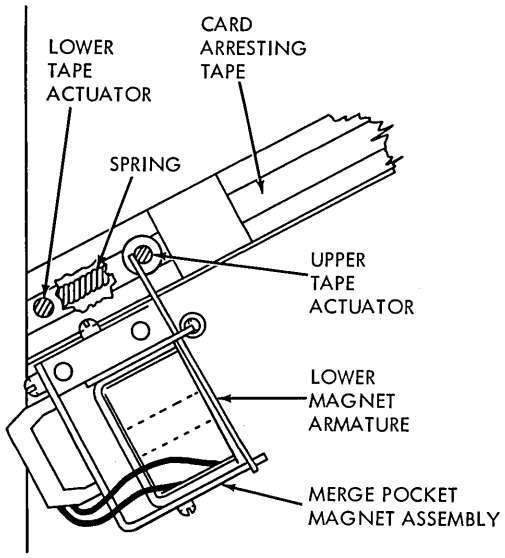
b. Opening between side plates should be 4.861 $^{+\ .005}_{-\ .000}$ at point just above bed plate. Check by placing deck in hopper. If opening between side plates is proper, a single card placed on edge between side plate and deck will be loose, two cards will not fit.

3. The 51 column part of the front joggler gate must be aligned with the standard gate within .003" at the sensing pads, and for a distance of 1/4" up from the tips on the joggling surface. (Figure 24.)

4. Throat-knife to roller alignment is more critical on 51-column feeds. Align, using a .010" feeler gage, so feeler is parallel to card line.



● Figure 26. Card Hold Down Spring



● Figure 27. 51 Column Merge Pocket Magnet

TRANSPORT AND STACKER ADJUSTMENTS

All adjustments are same as standard machine with the following exceptions:

1. (Figure 27.) In the merge pocket, remove the springs connecting the actuator rods and center the upper tape actuator rod in the separator plate clearance holes. Position the tape arrestor magnet (non-energized) so that the armature just touches the rod. Replace the springs connecting the actuator rods and tighten the tape clamps on the front of the separator plates. Energizing the magnet should produce approximately $\frac{1}{4}''$ buckle of the tape into the pocket.

2. The deck support dampening springs should just touch the channels as the deck support is inserted.

3. The deck support return spring (coil) should exert a force of approximately .5 lb. at a point just before pocket stop operates. This is checked with no cards in the stacker.

4. The pocket 3 deck arrestor levers should be adjusted by means of the adjustable stop screw so that it projects $\frac{3}{8}'' \pm \frac{1}{16}''$ above the guide surface when in its upward position and flush with the guide surface $\pm \frac{1}{16}''$ when in the down position.

5. The deck arrestors in pockets 4 and 5 should be adjusted for $\frac{3}{16}'' \pm \frac{1}{64}''$ above guide surface when in the up position.

6. The radial guide deck arrestor for 51 column card must be adjusted to drop cards in groups $\frac{1}{8}''$ to $\frac{1}{4}''$ thick.

7. Position selector magnets so that the deflector spring tip is $\frac{1}{16}''$ to $\frac{5}{64}''$ above shear plate when de-energized and $\frac{1}{32}''$ to $\frac{3}{64}''$ below shear plate surface when energized.

8. There should be .010″ to .020″ clearance between the armature and the armature pivot with the magnet energized.

9. The rear edge guide surface should be .015″ ± .010″ from edge of incoming primary card.

10. The vibrator should move approximately $\frac{1}{8}''$.

11. The upper ledge in pockets 4 and 5 should be adjusted for minimum looseness to its rollers and be free to slide with no binds.

12. Pocket separator plates for pockets 3, 4, and 5 should be set to 3.312 ± .005″ apart. Top is adjusted by shifting shear plate left or right as needed.

13. The lower feed rolls at pocket 3 are offset towards the 3 pocket so that a plumb line over the upper rolls would miss the lower primary roll by $\frac{3}{16}''$ and the lower secondary roll by $\frac{1}{4}''$. The lower rolls must be parallel to the upper rolls within .010″.

14. Radial card guide outline must be in accordance with configuration shown in Figure 28.

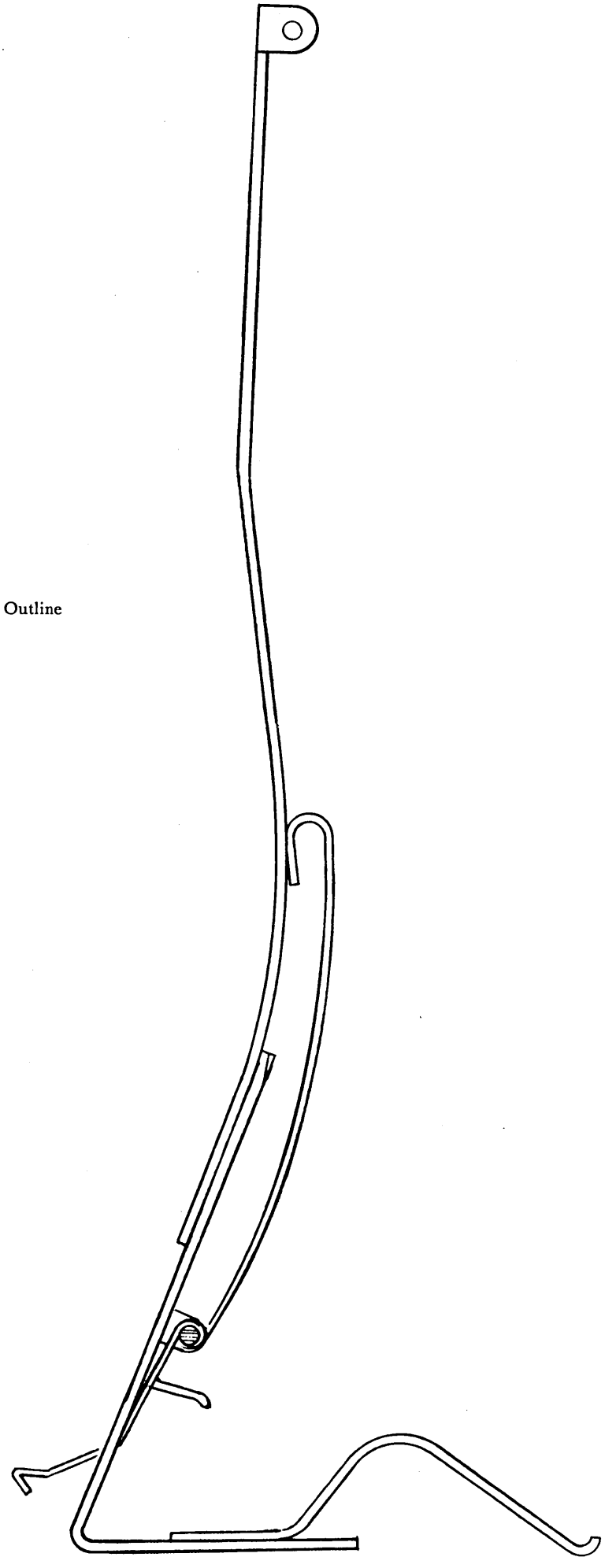


Figure 28. 51 Feature Radial Card Guide Outline

Electrical Circuits

Service Checks

1. Check for proper card lever action and freedom from binds. Bouncing card levers can be detected by using the dynamic timer on the pick of the card lever check relays. NOTE: You should never see the dynamic timer light.

2. Intermittent control stop lights can be detected or narrowed down by jumpering diagnostic panel test hubs to localize the failure.

3. Repeated or intermittent failures may be caused by broken edge connectors on the resistor-capacitor panel or tube gate.

4. *WARNING:* Make certain brush selection switch is off before using dynamic timer leads. Failure to do so will result in blown fuses and possible shock to the customer engineer.

Power Supply Tolerances

Input voltage (115v, 208v, and 230v, single phase, ac) tolerances for tube or transistor machines are ±10%.

Transistor 88 output voltage tolerances are:

Supply	Tolerance
+48v	±10%
—12v	±12%
—70v	±10%

Tube 88 with non-regulated supplies; output voltages under no-load conditions are:

Supply	Voltage (no-load)
+48v	+52 ±1v
+70v	+80 ±2v
—70v	—80 ±2v

The voltage difference between adjacent taps on the transformer is approximately 0.7v.

Tube 88 with regulated supplies; output voltage tolerances under no-load conditions are:

+48v	±2%
+70v	±1%
—70v	±1%

There is approximately a two-volt difference between adjacent taps on the transformer.

Tube 88 regulated filament supply (for all tube 88s) should be set at 6.5vac measured between terminals 34 and 49 at the filament supply output. This voltage may differ from that at the CE Panel 6.3v test hub. Adjust at the taps on the buck-boost transformer. Voltage difference between adjacent taps is 0.1v.

Service Aids

General

Service Checks

1. Check all belts and pulleys for wear and tension (Figures 9 and 29).

2. Air filter should be changed as necessary. Do not clean. Loss of the fiber glass adhesive will result.

3. The thermal delay relay must be adjusted to give a time delay of 30 seconds before points transfer. Insufficient time delay can damage or reduce tube life. NOTE: There is no time delay relay on thyratron transistor IBM 88's.

4. The dynamic timer dial must be concentric with timer shaft to insure reading accuracy.

5. Check all ground connections to be certain all parts of machine will be at ground potential. CAUTION: Keep in mind that the frame and base of the machine are at 0 volts and not isolated from machine power supplies.

6. Timing variations of over 3° may occur in clutched CB and read brush pulses. The variations should be held to a maximum of 3°. Oscillation should only occur immediately following feed clutch engagement. To detect, observe the brush impulse CB timing while operating the clutch engagement switch on the CE aid panel. Observe primary 9 digit and secondary 12 digit timing for any variation which may be caused by the following:

a. Loose motor drive belts.

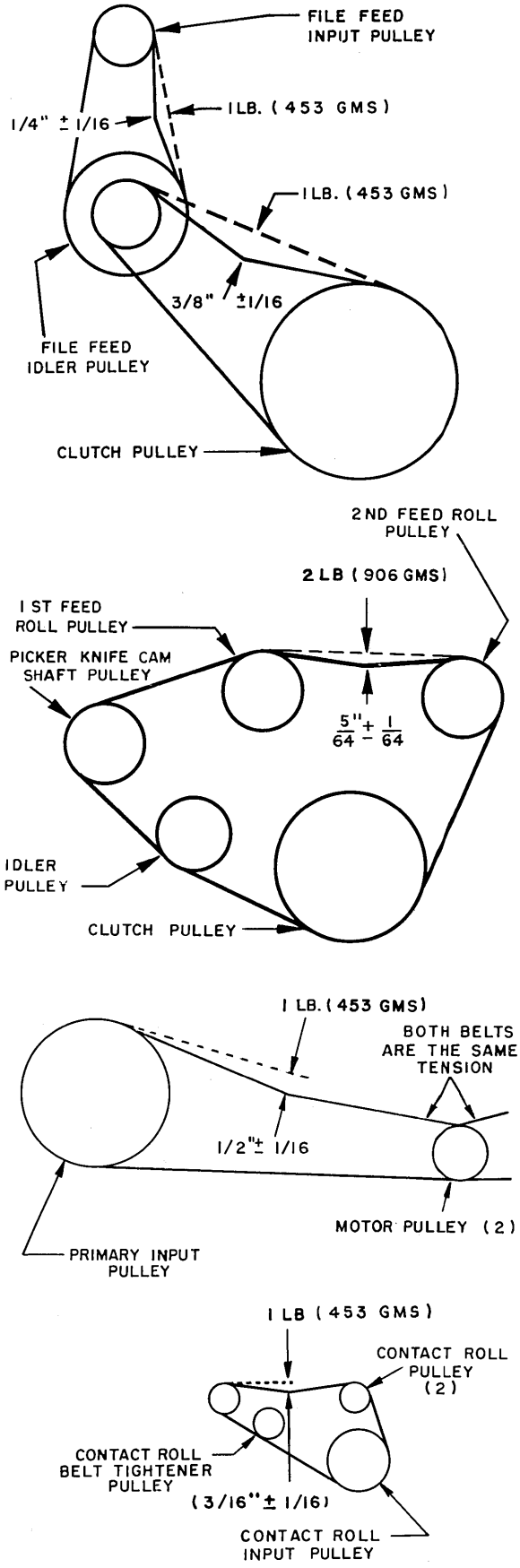
b. Loose clutched feed roll belts. Belts should be kept very taut by means of the idler pulley brackets.

c. Loose screws in the clutch pulley assembly (P/N 602013, Item A, Figure 13, IBM 88 Parts Catalog). Four screws are involved. Two screws fasten the drive arm assembly to the shock mount and two screws fasten the pulley to shock mount.

d. Secondary feed, idler gear (P/N 602078, Item A4, Figure 14, IBM 88 Parts Catalog) may be worn.

e. Excessive flexibility due to defective bonding of the clutch pulley shock mount (Item A3, Figure 13, IBM 88 Parts Catalog). If the timing variance is traced to this point, replace the shockmount assembly.

f. Wear of keyway in aluminum hub of pulleys can cause intermittent timing variations. If a timing pul-



● Figure 29. Belt Tensions

ley is replaced due to wear in the keyway, the key should also be replaced.

g. Breakage of picker knife cam shafts on either feed may be caused by misalignment of the associated primary or secondary CB unit to the machine frame. This may be caused by molding ridges on the CB unit on the surface to which it attaches to the side frame.

h. PM relays "failure to seal" may be caused by contamination between the armature and yoke. This results in a higher voltage requirement to maintain armature seal. Weak tubes, low plate supply voltage or high resistance connections may also cause relay seal failures.

Control Panels

Control Panel Adjustments (See Figure 30)

A control panel that is not aligned properly may cause damaged or shorted contacts and/or failure of contacts to make. To correct control panel alignment, proceed as follows:

1. Remove control panel door from frame.
2. Remove control panel and insert panel gage assembly, P/N 450323, into control panel retainer. Insert alignment bar, P/N 450307, into slots and make certain that all stationary contacts are flush with the top surface.
3. Adjust roller adjusting screw, P/N 75717 for the best over-all condition and form individual contacts if out of alignment with the majority of contacts.
4. As the mechanism is closed, check for 1/8" rise of control panel. If amount of rise is improper, adjust two eccentric studs, P/N 186881 at top of mechanism to obtain the 1/8" travel.

Quick Test Control Panel (Figure 31)

Wire a control panel to stop the machine with any condition other than equal compare output and equal primary and secondary sequence outputs. Sequence and compare entries are to be wired to columns commonly used by the customer. DPBC is OFF. Cards punched with a 2 and a 9 in even-numbered columns and a 5 and a 7 in odd-numbered columns will pick all code and sequence relays. A failure of any code or sequence relay to pick will result in an unequal output. A short between the brushes or in brush circuitry will result in an unequal sequence output. Running blank cards with the same control panel will test for erroneous picking of code or sequence relays. Running blank cards with DPBC wired ON will check all BC circuits and/or lights.

Clutch Check Control Panel

Wire the control panel as follows. Running blank cards in both feeds with this control panel wiring should

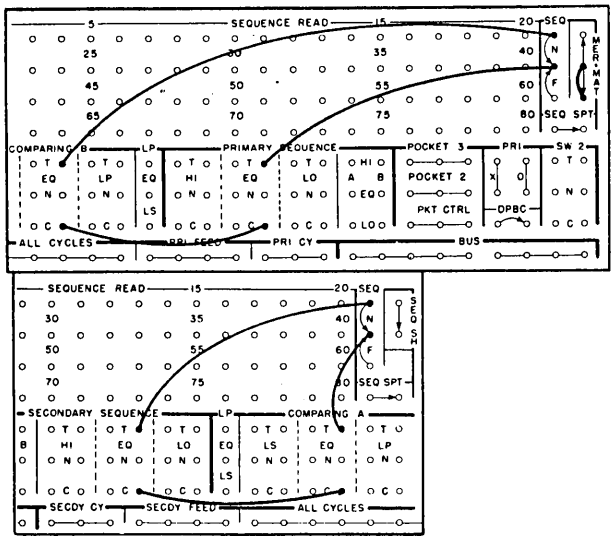


Figure 31. Quick Test Control Panel

aid in analyzing clutch troubles of any nature.

1. Jackplug secondary sequence OFF.
2. Jackplug primary sequence OFF.
3. Pick selector one from PRI CY hub.
4. Jackplug first and second picks of selector one together.
5. Wire from transfer hubs of selector one to secondary feed.
6. Wire from normal hubs of selector one to primary feed.
7. Wire from common hubs of selector one to all cycles.
8. Wire from secondary exit to selector assignment entry of selector one.

Operational Test Control Panel

The testing procedure is designed to give the IBM 88 a quick operational check. It is divided into four separate tests which may be used individually or together. The complete procedure should be used when installing an IBM 88. It is recommended that at least *the merge test* be used after an inspection. Columns 3 and 78 have a 12, 5 and 9 punch for use in conjunction with CE aid panel to check brush timing.

TEST DECKS (B/M 602573)

The two test decks used are identical, except that one has an X punched in column 41. The testing fields are punched in columns 4 through 25, and 56 through 77. Columns 38 through 40 contain card number sequence. Each column of the testing field is tested with each digit three times. The first of the three like cards are identified by an X in column 79 so that every third card has an X in 79. The control panel is shown for a 22-position machine.

For a 16-position machine, the units position of the testing field would be wired to B8 with the eighth position wired to A8. For a 10-position machine, the units position of the testing field would be wired to B5, and so forth. Use the first 273 cards for a 10-position machine, the first 435 cards for a 16-position machine, and all 597 cards for a 22-position machine.

The X-punch in column 79, by picking selectors 1 and/or 2, forces the wiring to the "SEQ ON" hubs to go through the high sequence answer relay picks. When selectors 1 and/or 2 is not picked the N/C points of the selector forces the wiring to go through the equal answer relay points. This wiring checks for high sequence on the step-up card and equal sequence on the two following cards of each group.

TEST PROCEDURES

Wire the control panel as shown in Figure 32. Unnumbered wires apply to all tests. Wire only those numbered wires called for in the individual test. Each test will check:

a. Card feeding.
b. Card reading.
c. Stacking.
d. Running circuits.
e. DPBC
f. Control stop circuit (one and only one answer).
g. Check circuits.

When errors are indicated, see the trouble analysis charts in this section. NOTE: Certain number combinations may cause equal compare or equal sequence neons to glow on the diagnostic panel even though the indicated position is not equal. For example: An 84 in primary position A1 and A2, and a 95 in secondary position A1 and A2 will cause a low primary compare answer. However, the equal neon for position A1 and A2 will glow indicating postion A3 as column of decision.

Sequence Test. Wire 1 to L. H. bus hub of primary side from upper SEQUENCE ON hub. Wire 2 to MATCH. Using one deck only, run cards through primary and then through secondary feeds.

1. Primary test detects:
   a. Erroneous feeding or pocket 1 stacking troubles.
   b. Tube (or transistor) capacitor, or brush reading failures in either the primary or primary sequence station.
   c. Low secondary answer failure
   d. Erroneous high, equal or low sequence answers
   e. Selector 1 failure

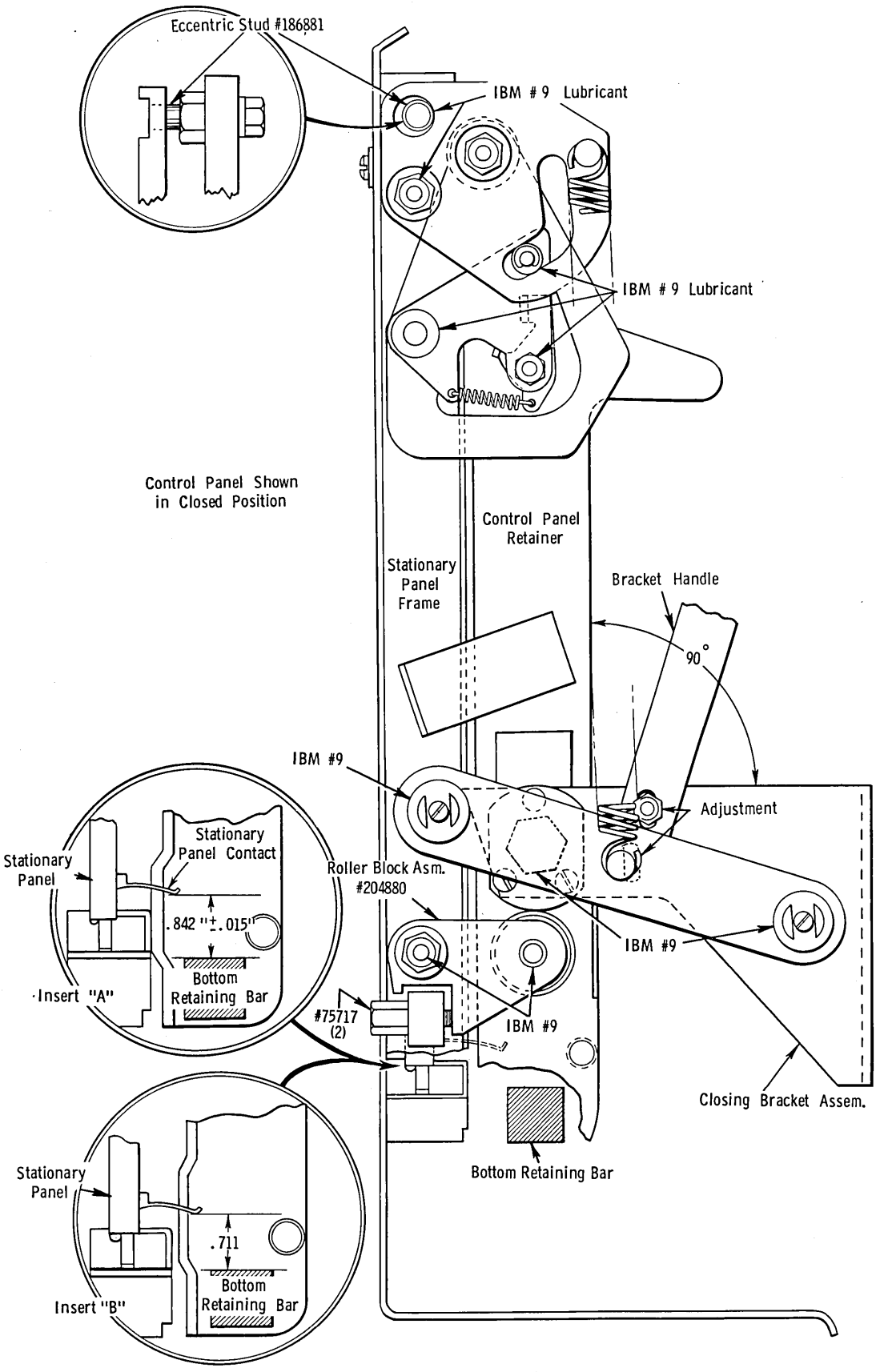
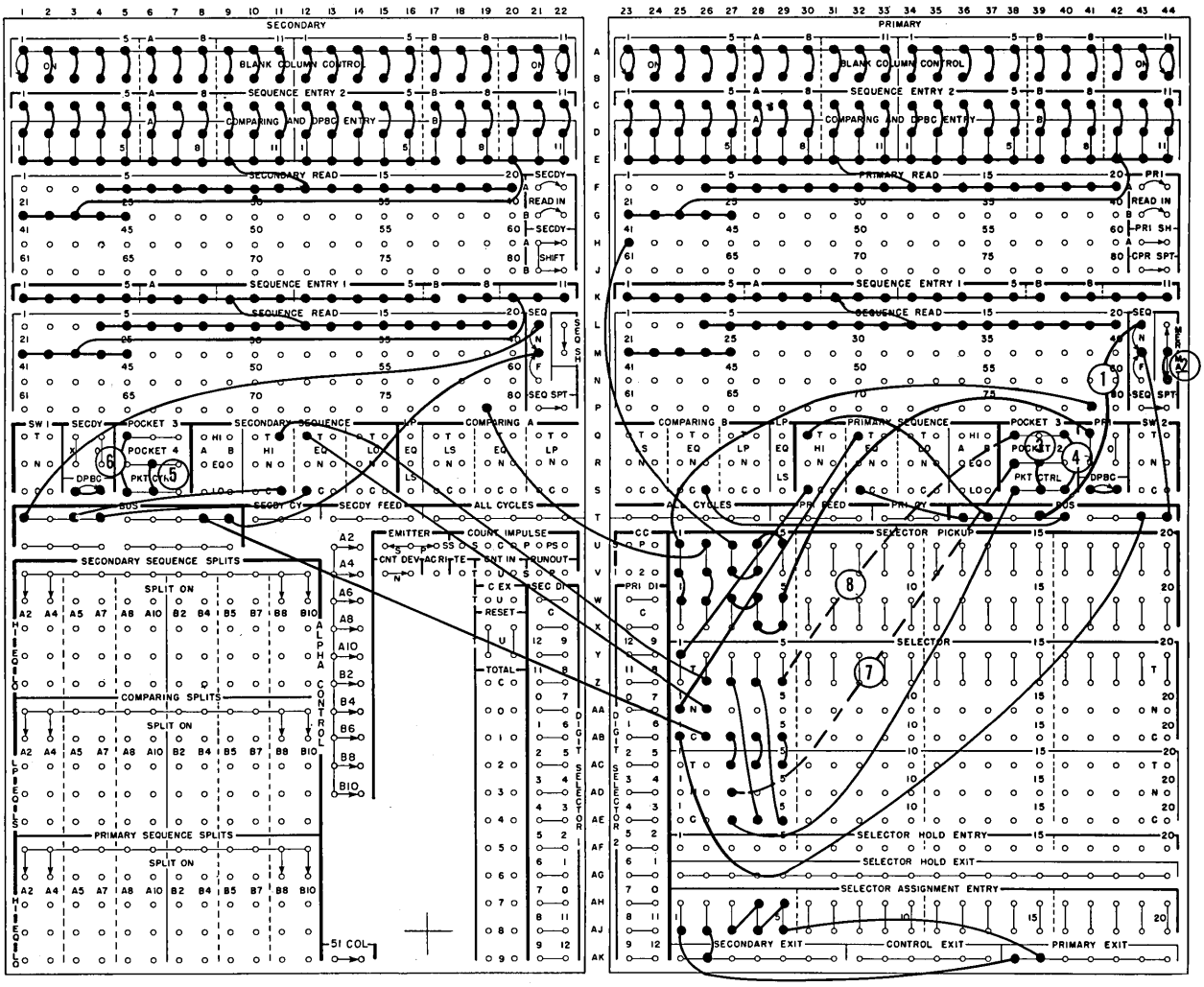


Figure 30. Control Panel Closure Mechanism



● **Figure 32. Operation Test Control Panel**

2. Secondary test detects:
   a. Erroneous feeding or pocket 5 stacking troubles
   b. Tube (or transistor), capacitor, or brush reading failures in either the secondary or secondary sequence stations.
   c. Low primary answer failure
   d. Erroneous high, equal or low secondary sequence answers
   e. Selector 2 failure.

NOTE: Selector 1 and/or 2 will pick on run-out and a control stop will result.

Match Test. Move wire 1 to equal compare selector transferred hub and add wires 3 and 5. Wire 2 to MATCH. Place a complete test deck in each feed. Primary cards will fall in pocket 2 and secondary cards in pocket 4. Because both decks are equal, the equal compare answer relay circuit will be tested each card. Two out of the three equal cards of each equal card group will further test the equal sequence circuit. A failure in either compare or primary equal sequence will result in a primary control stop. A failure at the secondary sequence brushes or a tube or transistor failure in the secondary sequence unit will cause a secondary control stop. Match test detects:

1. Code relay failures.
2. Equal compare answer failures.
3. High and equal secondary sequence and primary sequence answer failures.
4. Pocket 2 and 4 stacking failures.

NOTE: Primary and secondary control stops will occur on run-out because of selectors 1 and 2 picking from bare contact roll. The last cards of both feeds will fall into pockets 1 and 5 respectively.

Merge Test. Wire 2 for MERGE instead of MATCH. Add wires 4 and 6. Remove pocket select wires 3 and 5.

Place a complete deck in each feed. Cards will merge in pocket 3. Merge test detects:

1. Code relay failures.
2. Equal compare answer failures.
3. High and equal secondary sequence and primary sequence answer failures.
4. Compare interlock failures.
5. Selector 1 and 2 failures.
6. Stacking failures in pocket 3.

NOTE: As each feed runs out on run-out, a control stop will occur and the last card in each feed will fall into pockets 1 and 5 respectively.

Selector Test to Pull Merged Cards Apart

1. Wiring Instructions: Move wire 1 from equal compare transferred hub to R. H. Pri. bus hub. Add wires 7 and 8. Remove wires 3, 4, 5, and 6. NOTE: All available selectors in each machine should be tested.

2. Operation: Place the cards in the primary feed when selectors 3 through 5 are wired as shown. X-cards will fall in pocket 3; NX-cards will fall in pocket 2. Any selector transferred point or individual selector failure will cause card or cards to fall into pocket 1. An X-card in pocket 2 indicates selector 3 failed to pick or that its points failed to transfer. A NX-card in pocket 1 indicates selector 3 normally closed point failed to make. For control stops or primary check stops see *Trouble Analysis Charts, Figures* 37 *and* 38.

3. Selector Test Detects:
   a. Failure of X to read.
   b. Hot X failure.
   c. Selector failures.
   d. Any brush, tube, or relay failure associated with feed being run.

Alphabetic Tests

Testing of IBM 88's with an alphabetic device installed can be done by use of the standard 88 field test decks (B/M 602573). Two fields separate from the numeric fields are used; columns 26 through 35 and columns 46 through 55. One deck has an X in column 41 which may be used to separate the two decks after they have been merged. Each deck is punched in two card groups with each succeeding group one digit higher in value than the one it follows. The first card of the two card group has an X in column 43. The X in column 43 is used to pick a selector so that a high primary sequence answer may be checked.

The "SEQ" on hubs are wired through equal compare and equal sequence in series. When the X 43 card is at the sequence brushes the "SEQ" on hubs are wired through equal compare and high sequence - selector 2 or 4 in series. Any reading other than equal when the card at primary or secondary read brushes is equal to the card at the corresponding sequence brushes will cause a control stop. By the same token, when the card at the sequence brushes is higher than the card at the read brushes, a control stop will occur if either the selector (2 or 4) fails to pick or if the answer is other than high sequence.

	Card Columns									
	26	27	28	29	30	31	32	33	34	35
Card Number	46	47	48	49	50	51	52	53	54	55
001-002	1	1	1	1	1	1	1	1	1	1
003-004	2	2	2	2	2	2	2	2	2	2
005-006	3	3	3	3	3	3	3	3	3	3
007-008	4	4	4	4	4	4	4	4	4	4
009-010	5	5	5	5	5	5	5	5	5	5
011-012	6	6	6	6	6	6	6	6	6	6
013-014	7	7	7	7	7	7	7	7	7	7
015-016	8	8	8	8	8	8	8	8	8	8
017-018	9	9	9	9	9	9	9	9	9	9
019-020	12	12	12	12	12	12	12	12	12	12
021-022	A	A	A	A	A	A	A	A	A	A
023-024	A	A	A	A	A	A	A	A	A	B
025-026	A	A	A	A	A	A	A	A	A	C
027-028	A	A	A	A	A	A	A	A	A	D
029-030	A	A	A	A	A	A	A	A	A	E
031-032	A	A	A	A	A	A	A	A	A	F
033-034	A	A	A	A	A	A	A	A	A	G
035-036	A	A	A	A	A	A	A	A	A	H
037-038	A	A	A	A	A	A	A	A	A	I
039-040	A	A	A	A	A	A	A	A	A	J
041-042	A	A	A	A	A	A	A	A	A	K
043-044	A	A	A	A	A	A	A	A	A	L
045-046	A	A	A	A	A	A	A	A	A	M
047-048	A	A	A	A	A	A	A	A	A	N
049-050	A	A	A	A	A	A	A	A	A	O
051-052	A	A	A	A	A	A	A	A	A	P
053-054	A	A	A	A	A	A	A	A	A	Q
055-056	A	A	A	A	A	A	A	A	A	R
057-058	A	A	A	A	A	A	A	A	A	S
059-060	A	A	A	A	A	A	A	A	A	T
061-062	A	A	A	A	A	A	A	A	A	U
063-064	A	A	A	A	A	A	A	A	A	V
065-066	A	A	A	A	A	A	A	A	A	W
067-068	A	A	A	A	A	A	A	A	A	X
069-070	A	A	A	A	A	A	A	A	A	Y
071-072	A	A	A	A	A	A	A	A	A	Z
073-074	A	A	A	A	A	A	A	A	B	Z
121-122	A	A	A	A	A -etc-	A	A	A	Z	Z
171-172	A	A	A	A	A -etc-	A	A	Z	Z	Z
221-222	A	A	A	A	A -etc-	A	Z	Z	Z	Z
271-272	A	A	A	A	A -etc-	Z	Z	Z	Z	Z
321-322	A	A	A	A	Z -etc-	Z	Z	Z	Z	Z
371-372	A	A	A	Z	Z -etc-	Z	Z	Z	Z	Z
421-422	A	A	Z	Z	Z -etc-	Z	Z	Z	Z	Z
471-472	A	Z	Z	Z	Z -etc-	Z	Z	Z	Z	Z
521-522	Z	Z	Z	Z	Z -etc-	Z	Z	Z	Z	Z
523-597	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

Figure 33. Alphabetic Test Deck Punching

Punching of the field test deck for alphabetic testing is shown in Figure 33.

ALPHABETIC MATCH TEST

For an eight position alphabetic machine, wire the control panel as shown in Figure 34. For a four position alphabetic machine, wire columns 32 (52) through 35 (55) to A-2, A-4, B-2 and B-4 respectively. For a ten-position alphabetic machine, wire column 35 into the B-10 position as the units position.

During this test secondary cards will be checked for equal or high sequence. All secondary cards will fall into pocket 4.

Primary cards will be checked for equal or high sequence and for equal compare. Primary cards will fall into pocket 2.

NOTE: Cards 223 through 597 may be eliminated if the machine is a four-position alphabetic machine. On

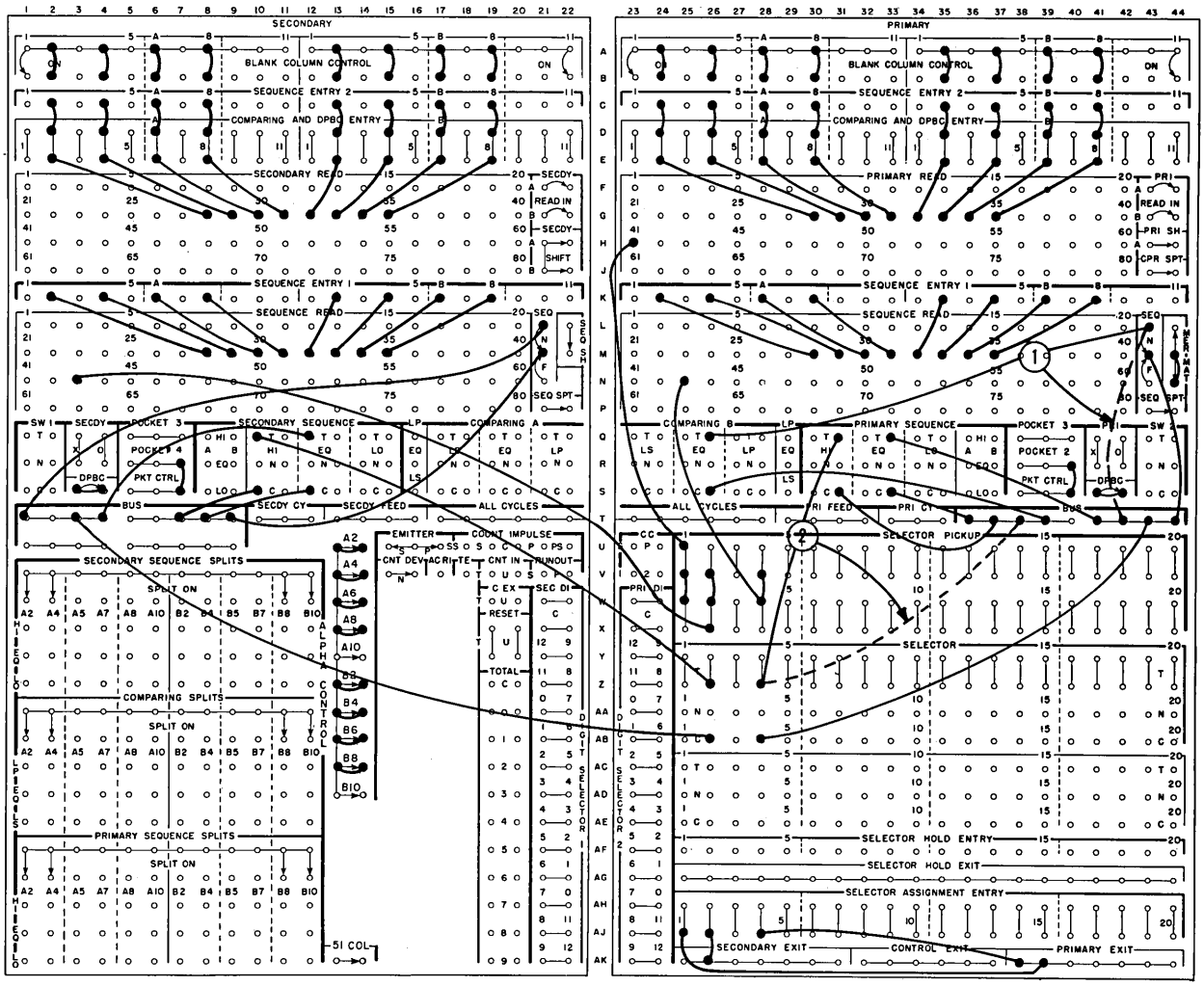


Figure 34. Alphabetic Test Control Panel

an eight-position machine, cards 423 through 597 may be eliminated. On a ten-position machine, cards 523 through 597 may be eliminated. DPBC stops will occur on cards 19 and 20 because no numeric digits are punched.

ALPHABETIC MERGE TEST #1

For this test all wiring is as shown in Figure 34 except the jackplug is moved from MAT to MER. This run will test clutch operations and merge functions without merging cards wrong in case of a malfunctioning machine. Wires 1 and 2 are wired as shown in their solid line positions.

ALPHABETIC MERGE TEST #2

Wiring for this run is same as shown in Figure 34 except that both secondary and primary pocket selection controls are wired as shown in Figure 35.

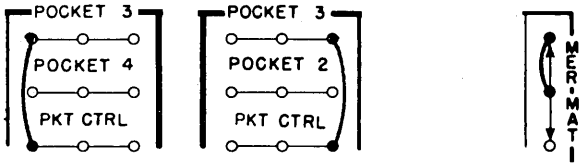


Figure 35. Merge Test #2

ALPHABETIC SEQUENCE AND DECK SEPARATION TEST

This run is used to check for proper merging and to separate the two decks. Wiring changes to Figure 34 are as follows:

1. Move wires 1 and 2 to their dotted positions.
2. Wire pocket selection as shown in Figure 36.

Trouble Analysis

Whenever a machine fails to perform an operation, the customer engineer must develop a method for de-

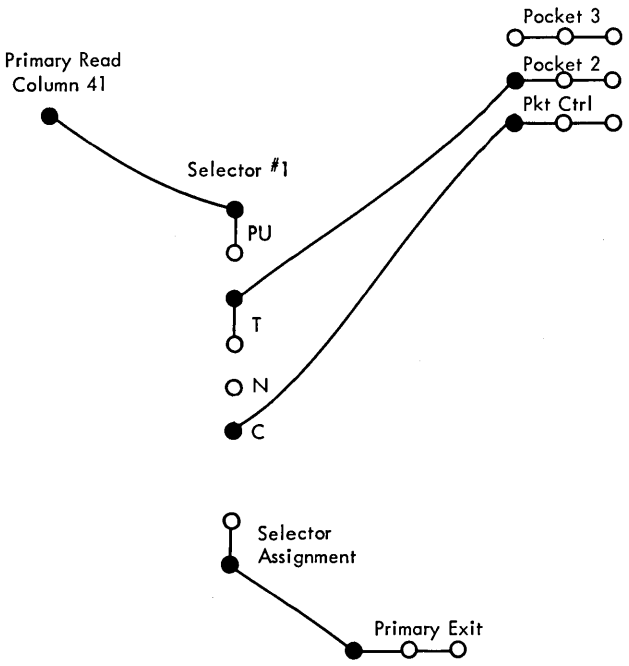


Figure 36. Alpha Sequence Pocket Selection Wiring.

termining the cause of failure. The cause must be located quickly, so that the machine can be returned to the customer with a minimum loss of time. Therefore, it is necessary that every customer engineer develop a diagnostic technique to include interpretation of all error indications, recognition of certain failures as being due to particular component failures, and a complete understanding of diagnostic procedures, test control panels, and how to use them.

When diagnosing trouble on the IBM 88, it is very convenient and helpful to turn the machine by hand with the power on. Unplug the drive motor and depress the appropriate keys before turning by hand. DPBC lights will occur if the DPBC hub is wired.

WARNING: Do not leave the machine at any one point in the cycle for extended periods of time, because overheating and consequent burning out of unit resistors may result.

The flow charts (Figures 37 and 38) are helpful in determining the cause of check and control stops.

In addition to pulse checking, test hubs located on the CE aid panel and on feed side frame terminal blocks can be conveniently used to shunt out points and groups of points when analyzing trouble in the brush, card lever, control stop, or clutch circuitry. Turn brush selection switch OFF for normal use.

The use of the CE aid panel can be helpful in detecting crooked feeding. Observing the time at which brushes 3 and 78 fall off the trailing edge of cards will eliminate a possible false indication due to varying punching registration.

CEM's should not be overlooked as a source of valuable assistance in resolving machine problems. Following is a list of all customer engineering memorandums.

CUSTOMER ENGINEERING MEMORANDUMS BY CATEGORY

Category	88 CEM Number
Brushes	23, 51, 84, 87, 92, 93; Gen. CEM 71
Card Count	44, 50
Circuit Breakers	21, 28, 30
Clutch	37, 84, 95
DPBC	21, 30, 84
Drive, Base	27, 37, 49, 66, 67, 86, 87, 88
Dynamic Timer	18, 65, 84, 92
Feed	14, 24, 52, 65, 84, 86, 87, 88, 89, 96; Gen. CEM's 10, 59
File Feed	26, 27, 67, 68, 73, 84, 89; Gen. CEM's 48, 59
Indicators	90
Power Supply	1, 42, 43, 53, 63, 92
Reading-Coding	20, 23, 38, 48, 50, 58, 61, 62, 64 65, 84, 93
Relay	16, 84, 87; Gen. CEM's 12, 13, 14
Resistor or Diode	50, 62, 84, 92
Safety	56; Gen./Saf. CEM's 19, 20, 23, 28, 30
Service Aids	33, 48, 84, 87, 92
Sequence Errors	13, 35, 84, 87, 93
Shorting-Grounding	63, 84, 92
Special Features	57, 61, 68, 84, 87, 96
Stacking	24, 52, 84, 92, 96, 97
Timing	28, 65, 84
Tube-Transistor	18, 60, 84, 87

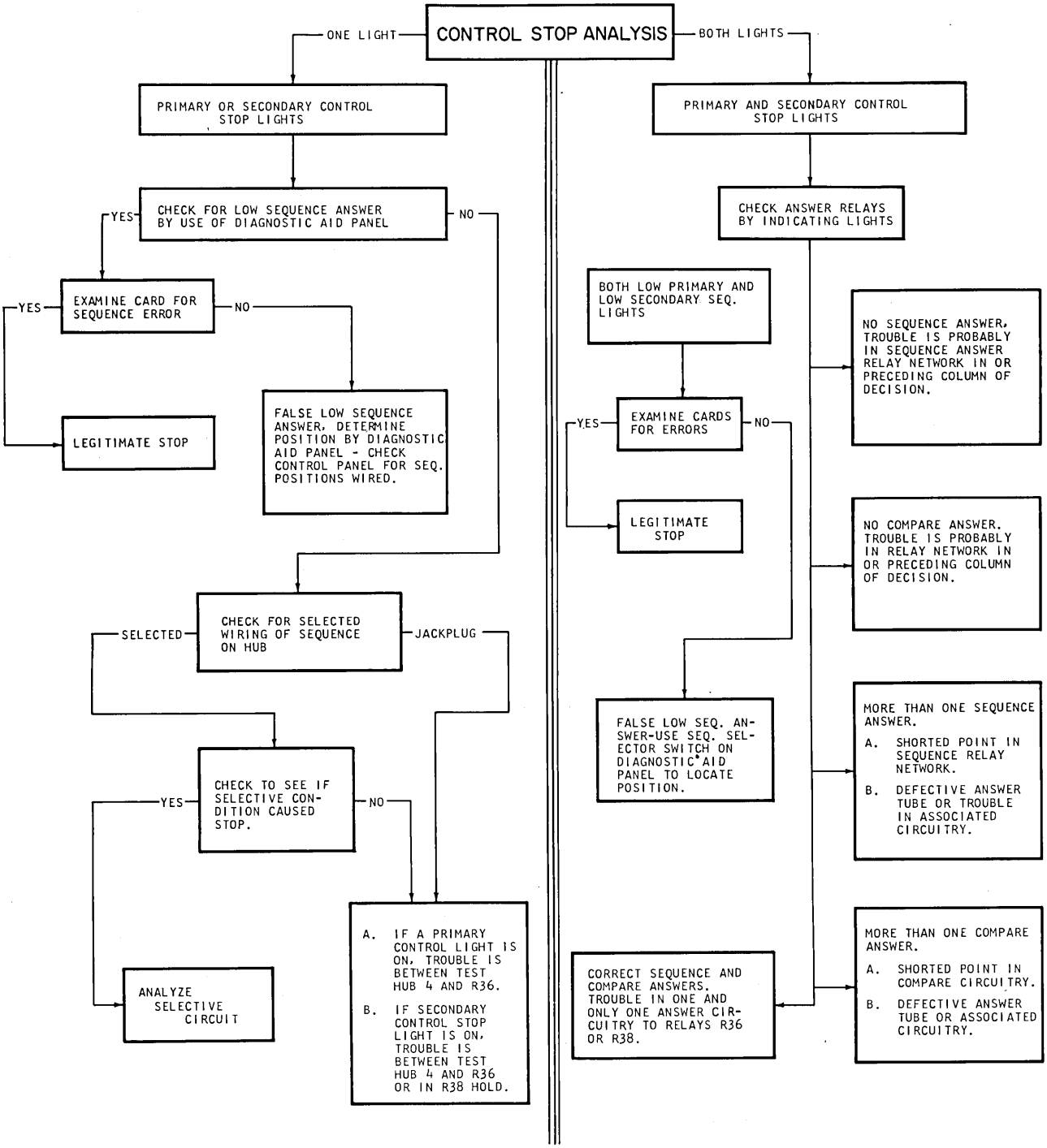
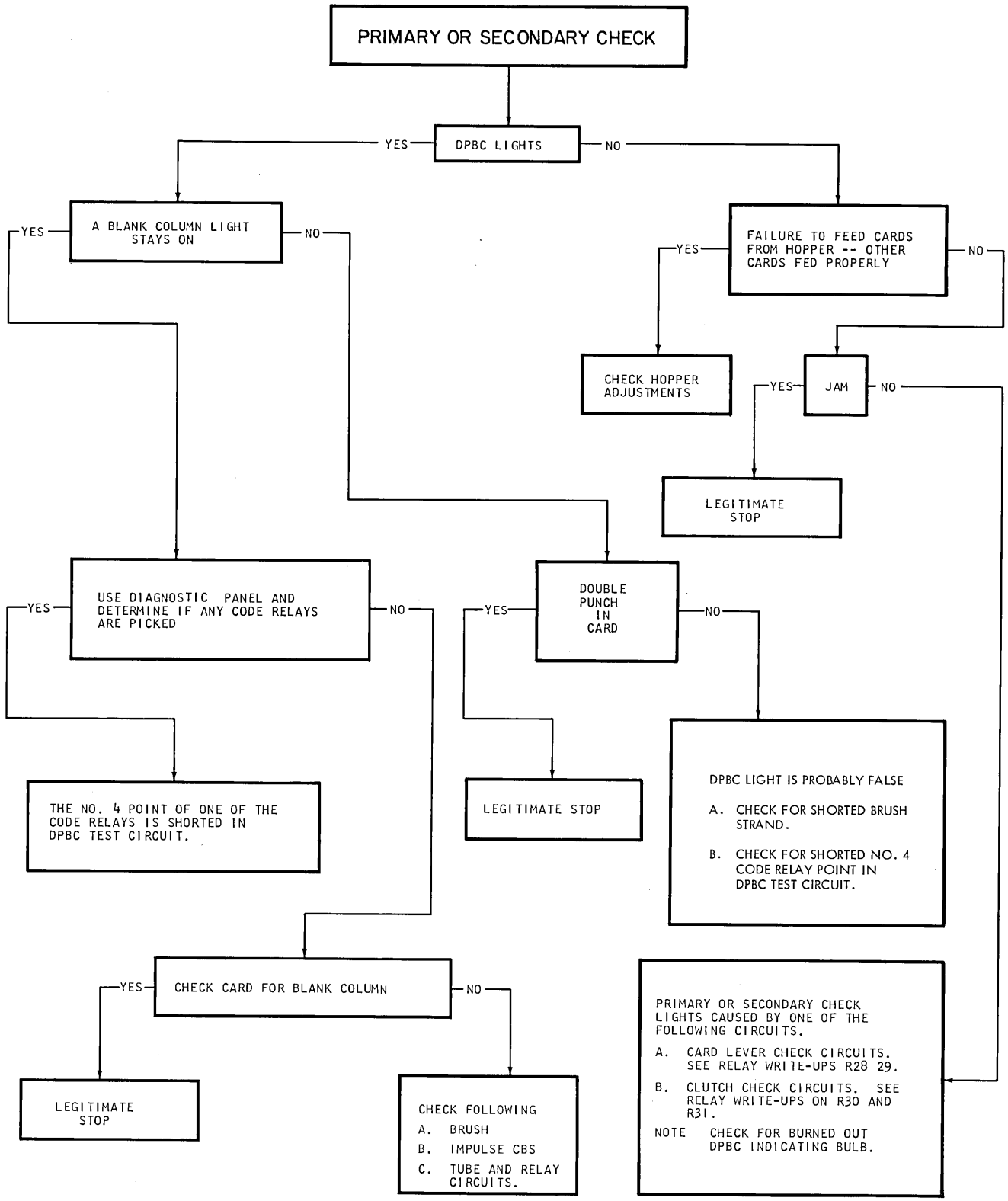


Figure 37. Control Stop Analysis



● Figure 38. Primary and Secondary Check Light Analysis

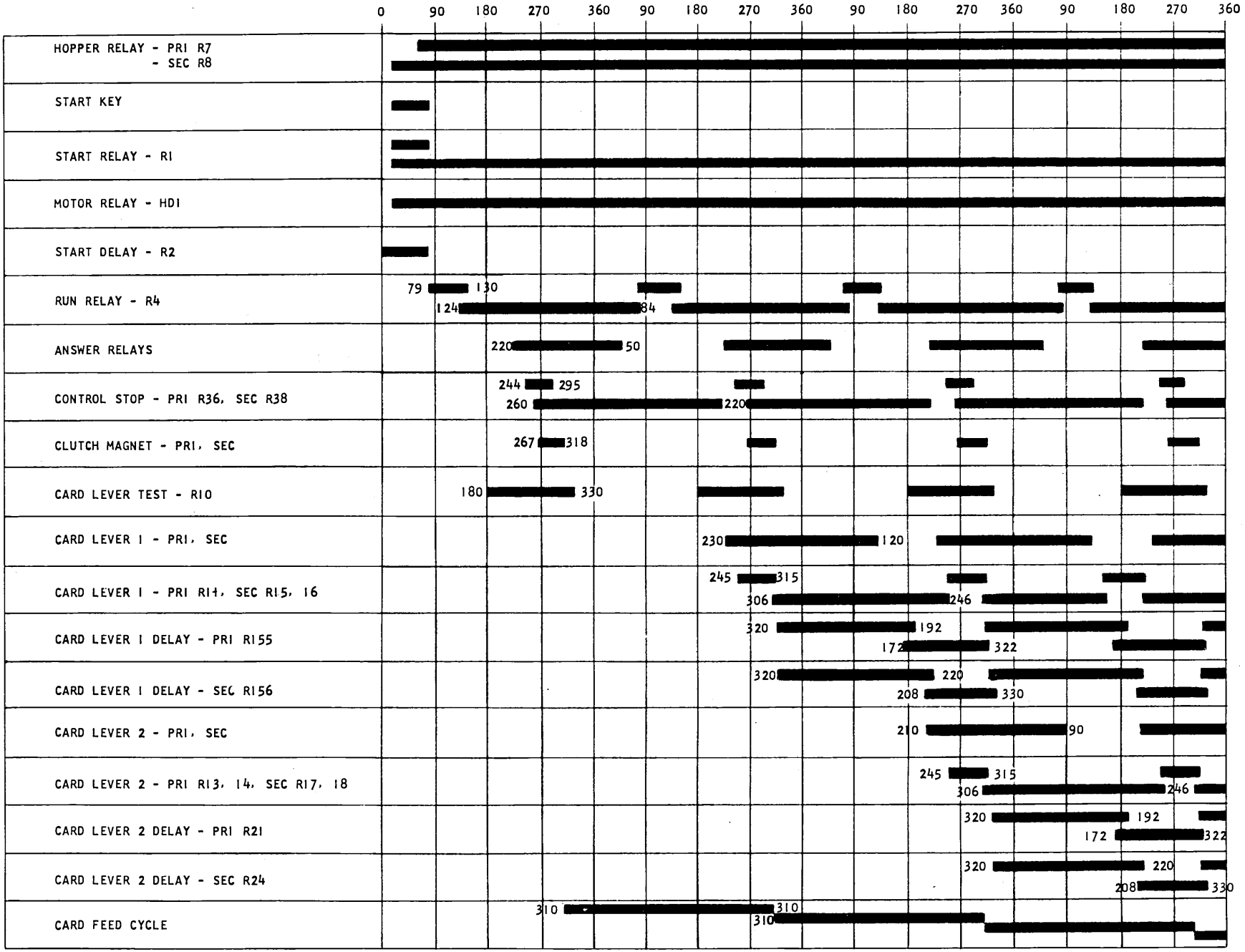


Figure 39. Three Cycles of Run-In

BASIC SET UP WIRED TO MERGE (SEQ CHECKING ON - CARDS IN ALL STATIONS)				
COMPARE OUTPUT	PRI SEQUENCE OUTPUT	SEC SEQUENCE OUTPUT	COMP INLK RELAY	ACTION RESULTING
LOW PRI	EQUAL OR HIGH	EQUAL OR HIGH	DOWN	PRI FEED
LOW SEC	EQUAL OR HIGH	EQUAL OR HIGH	DOWN	SEC FEED
* EQUAL	EQUAL	EQUAL OR HIGH	DOWN	PRI FEED
EQUAL	HIGH	HIGH	DOWN	PRI FEED SEC FEED
EQUAL	HIGH	EQUAL	DOWN	PRI FEED SEC FEED PICK INLK RLY
EQUAL (FORCED BY) (INLK RELAY)	EQUAL OR HIGH	EQUAL	UP	SEC FEED HOLD INLK RLY
EQUAL (FORCED BY) (INLK RELAY)	EQUAL OR HIGH	HIGH	UP	SEC FEED DROP INLK RLY
* BASIC SETUP WIRED TO MATCH (MERGE RULES APPLY EXCEPT FOR FOLLOWING)				
EQUAL	EQUAL	EQUAL	DOWN	PRI FEED SEC FEED

Figure 40. Merging and Matching Rules

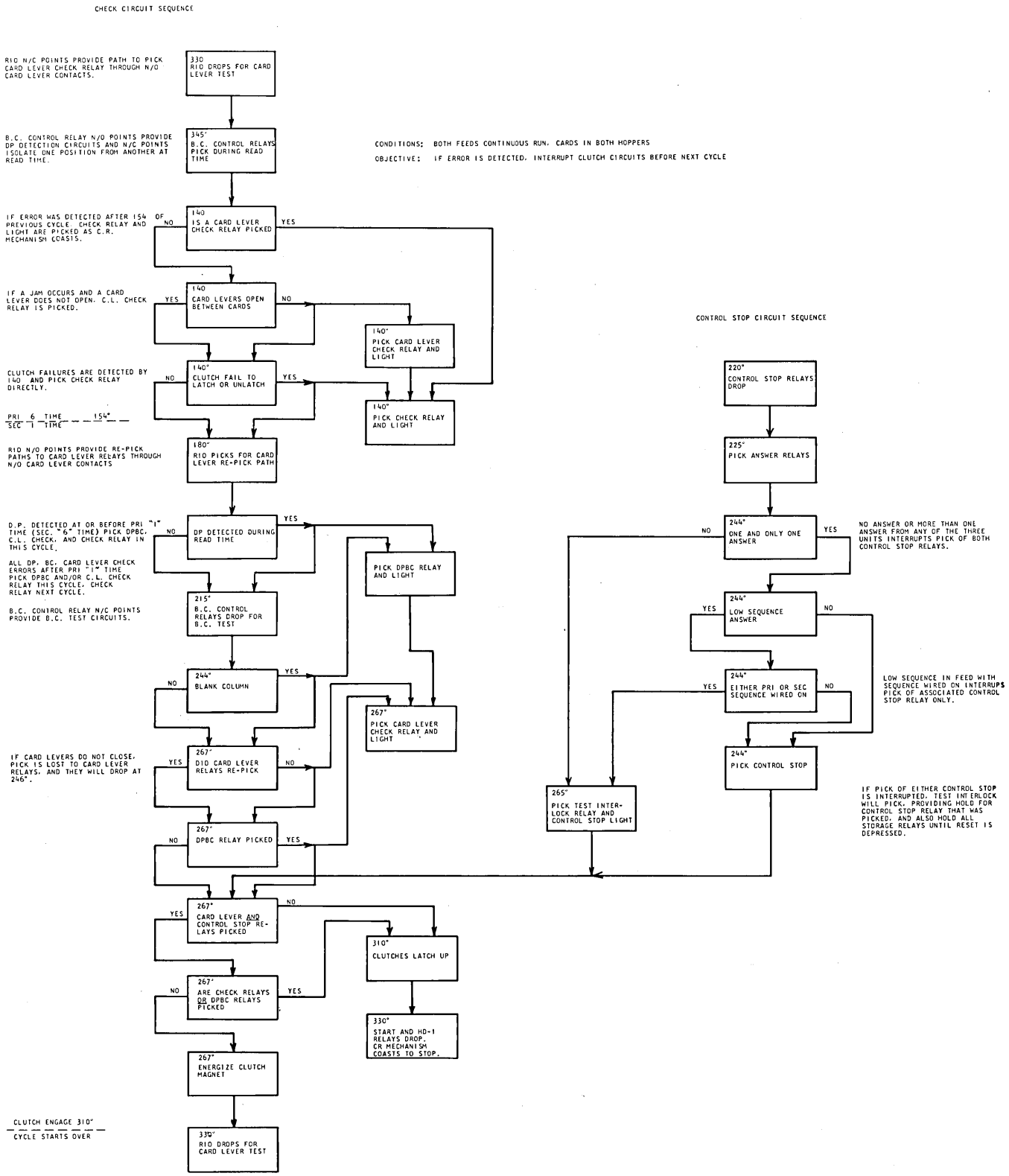


Figure **41.** Check and Control Stop Circuit Sequence

Purpose of Relays and Relay Points for Tube Type Machine, WD 602700B

R1. Start relay. This relay picks on depression of either the start key or runout key. If the power supply relay has not picked, the blown fuse relay energized; or if the cover interlock, the jam contact, the pocket stop, the joggle contact, or the stop key is open, the start relay cannot be energized.

R1-1 N/C. Provides a pick circuit for R2, the delay relay, when there are no cards in the hopper and no control stop error condition exists.

R1-1 N/O. Provides a hold circuit for R1 coil while the machine is running. It can hold through C48, 19-5, 23-1, or 4-2, any one of which provides the circuit at different times.

R1-2 N/O. Provides a pick circuit for R4 (run relay) when C1 makes, and the delay relay R2 is de-energized.

R1-3 N/O. Provides a circuit to energize the motor-start heavy-duty relay.

R1-4 N/C. Controls the ready light through the R1 hold circuit.

R2 Pick. Delay Relay. Provides a delay of approximately 3 seconds before the machine can feed cards, if the primary hopper is empty. This delay allows cards to drop from the file feed to the hopper.

R2-1 N/C. Provides the circuit to pick the run relay R4 through R1-2 N/O, C1, and the interlock switches.

R3 Pick. Single Cycle Relay. Allows only single cycle operation when machine is being run from the auxiliary start key.

R3-1 N/O. Provides hold circuit for R3 through the hold circuit of R1.

R3-2 N/O. Opens the circuit to the clutch thyratrons when R3 picks. This prevents more than one clutch-cycle operation per depression of the auxiliary start key.

R4 Pick. Run Relay. Picks when relay R1 is picked and the delay relay is not energized.

R4-1 N/O. Provides hold for R4 through C2.

R4-2 N/C. Provides pick circuit to R2 (delay relay), the hold of R1 start relay, and the hold of R3 single cycle, until the delay relay allows R4 to pick.

R4-3 N/C. Provides a path on machine start to ascertain that feeds are latched prior to run-in by allowing a path from C4 through R10-5 N/C card lever test and on through primary and/or secondary feed relays to the check relays.

R4-3 N/O. Provides a pick circuit to the card lever relays from C5. It also provides a path from C4 through the R10 N/C card lever test points to pick R28 (primary check) and R29 (secondary check) if the card levers fail to open between cards.

R4-4 N/C. This point in the pick of the reset relays R26 and R27 insures against picking the reset relays except when the machine is stopped.

R4-5 N/C. Provides a hold circuit for the primary and secondary control stop relays, R36 and R38, if the machine should stop with C37 open.

R4-6 N/O. Prevents all cycles impulses and operation of the primary and secondary clutches until R4 picks. This may be delayed if there are no cards in the primary hopper.

R5 Pick. Runout Relay. Picked by runout key B contact and C1 through the interlock contacts.

R5-1 N/O. Provides the hold for R5 through C2.

R5-2 N/O. Provides a circuit around the primary and secondary hopper and CL1 contacts to operate the primary and secondary clutches under runout conditions.

R5-3 N/O. Provides a circuit to the primary clutch for runout under error conditions which pick R30 or fail to pick R36.

R5-4 N/O. Provides a circuit to the secondary clutch for runout under error conditions which pick R31 or fail to pick R38.

R5-6 N/O. Provides a pick circuit for the storage clear relay when the runout key is depressed.

R7 Pick. Primary Hopper Relay. Energized when cards are in hopper.

R7-1 N/O. Provides a circuit with R11-4 N/C (primary CL1) to pick the primary check relay R28 with the error condition in which a card fails to feed from the primary feed.

R7-2 N/C. Provides a circuit with R11 N/C and C8 to provide hot 9's and 0's to the primary sequence and read brushes to insure valid primary sequence conditions during runout operation.

R7-3 N/C. Provides circuit for primary clutch under primary runout conditions and also a circuit for secondary clutch impulses with no cards in the primary hopper.

R7-3 N/O. Used in clutch thyratron circuit to interrupt clutch impulses if cards run out of the primary hopper while machine is running.

R7-4 N/C. Provides a runout circuit to the primary clutch thyratron under primary check or primary control stop error conditions. This point insures cards being removed from primary hopper before runout will function.

R7-4 N/O. Provides a circuit to the primary clutch on run-in until R21-5, (primary CL2 delay) is energized.

R7-5 N/C. Used in the secondary clutch circuit to allow secondary feeding with no cards in the primary. It also functions with R21-4 N/O (primary CL2 delay) to interrupt the normal secondary clutch circuit when cards are put into the primary hopper but have

*Refer to TSTR Relay Point section.

not run into the primary feed. This condition would exist after a primary error when cards are being re-entered into the primary.

R7-6 N/C. This point prevents pick of delay relay R2 with cards in the hopper.

R8 Pick. Secondary Hopper Relay. Is energized when cards are in the secondary hopper.

R8-1 N/O. Provides a circuit with R15-4 N/C and R23-3 N/O to pick secondary card lever check relay R29 when a card fails to feed from the secondary feed.

R8-2 N/C. Provides a circuit with R17-2 N/C and C21 to provide hot 9's and 0's to the secondary read brushes to insure valid secondary sequence conditions during runout operation.

R8-3 N/C. Provides a circuit for the secondary clutch under secondary runout conditions and also a circuit for primary clutch impulses with no cards in the secondary hopper.

R8-3 N/O*. Used in the clutch thyratron circuit to interrupt clutch impulses if cards run out of the secondary hopper while the machine is running.

R8-4 N/C*. Provides a runout circuit to the secondary clutch thyratron under secondary check or secondary control stop conditions. This point insures cards being removed from secondary hopper before runout will function.

R8-4 N/O*. Provides a circuit to the secondary clutch on run-in until R25-1 (secondary CL2 delay) is energized.

R8-5 N/C. Used in the primary clutch circuit to allow primary feeding with no cards in the secondary. It also functions with R24-4 N/O (secondary CL2 delay) to interrupt the normal primary clutch circuit when cards are put into the secondary hopper but have not been run into the secondary feed. This condition would exist after a secondary error when cards are being re-entered into the secondary.

R8-6 N/C. This point prevents pick of delay relay R2 with cards in the hopper.

R10 Pick. Card lever test relay picks every machine cycle through C7.

R10-1 N/C. Provides a path to pick the primary check relay R28 from C4 if the primary CL1 fails to open between cards.

R10-1 N/O. Provides a path to pick the primary CL1 relay R11 from C5 when the primary CL1 closes.

R10-2 N/C. Provides a circuit to pick the primary check relay R28 from C4 if the primary CL2 fails to open between cards.

R10-2 N/O. Provides a path to pick the primary CL2 relays R13 and R14 from C5 when the primary CL2 closes.

R10-3 N/C. Provides a path to pick the secondary check relay R29 from C4 if secondary CL1 fails to open between cards.

R10-3 N/O. Provides a circuit to pick the secondary CL1 relays R15 and R16 from C5 when secondary CL1 closes.

R10-4 N/C. Provides a path to pick the secondary check relay R29 from C4 if secondary CL2 fails to open between cards.

R10-4 N/O. Provides a circuit to pick the secondary CL2 relays R17 and R18 from C5 when secondary CL2 closes

R10-5 N/C. Allows the C4 pulse through either R22-4 N/O (secondary feed), or R19-4 N/O (primary feed), and R4-3 N/O (Run) to test the card levers for incorrect operation.

R10-5 N/O. Provides a circuit to pick the single cycle relay R3 from C5 when the auxiliary start key is being used.

R11 Pick. Primary card lever 1 picks through C5 when the first card closes CL1. This relay stays energized as long as cards are closing CL1 each feed cycle.

R11-1 N/O. Provides hold circuit for R11 from C6.

R11-2 N/C. Provides circuit from C8 through the primary hopper relay R7-2 N/C to allow hot 9's and 0's to the primary sequence and read brushes on runout for valid sequence check operation.

R11-2 N/O. Allows a circuit from the primary impulse cams to the primary sequence brushes when the 1 card lever indicates a card in that position.

R11-3 N/C*. Provides a circuit for the secondary clutch thyratron if no cards are in the primary feed.

R11-3 N/O*. Provides a circuit from C43 to the clutch thyratrons after the first primary feed cycle when this point closes.

R11-4 N/C. Operates with primary hopper relay R7-1 N/O and primary feed relay R19-6 N/O to energize the primary check relay R28 from C3 if a card fails to feed from the primary hopper.

R11-5 N/O. Provides a circuit to the primary clutch thyratron through R7-4 N/C and R21-5 N/C on the second cycle when a single card is being processed in the primary.

R11-6 N/O. Provides a circuit to the pick of primary card lever 1 delay R155.

R13 Pick. Primary card lever 2 relay is energized on the second feed cycle when the first card closes the 2 card lever. R13 stays energized as long as the card keeps closing the 2 card lever each cycle.

R13-1 N/O. Hold R13 and R14 through C6.

R13-2 N/C. Provides circuit from C8 through the primary hopper relay R7-2 N/C and primary card lever 1 N/C to allow hot 9's and 0's to the primary read brushes on runout for valid sequence check operation.

R13-2 N/O. Provides a circuit from the primary impulse cams to the primary common brush when cards are in position to be read by primary brushes.

R13-3 N/C. Provides a circuit to clutches on the second cycle of run-in.

R13-3 N/O. Provides a circuit to clutches after the second cycle for continuous running.

R13-4 N/O. Provides a circuit to pick the primary card lever 2 delay, R21 through P8.

R14. Picked with R13 as primary card lever 2.

R14-2. Provides a circuit to the primary clutch through R7-4 N/C and R21-5 N/C on the third cycle when a single card is being processed through the primary feed.

R14-3. Opens to prevent energizing the storage clear relay until last cycle of runout.

R14-4 N/C. Allows circuit to pick primary CL check relay 28 through 19-6 N/O and C3 if card fails to feed from first read station.

R15 Pick. Secondary CL1. Picks with R16 through C5, secondary CL1 and card lever test relay R10-3 N/O. R15 remains energized as long as cards feed past secondary CL1.

R15-1 N/O. Holds R15 and R16 through C6.

R15-2 N/C. Allows "Z" reading to secondary sequence on runout to eliminate false control stop on runout.

R15-2 N/O. Allows a circuit from the secondary impulse cams to the secondary sequence brushes when the 1 card lever indicates a card in that position.

R15-3 N/C. Works with secondary CL2, R17-3, secondary feed relay R22-3 N/C, and secondary CL2 delay R24-3 N/C to provide a path to the clutch thyratrons on the first cycle of run-in with cards in the secondary hopper only.

R15-3 N/O. Functions after the first run-in cycle of secondary feed. It works with the secondary hopper relay R8-3 N/O to provide the second and third run-in clutch impulses and all following normal clutch impulses.

R15-4 N/C. Operates with the secondary hopper relay R8-1 N/O and the secondary feed relay R23-3 N/O to energize the secondary check relay R29 from C3 if a card fails to feed from the secondary hopper.

R16 Pick. Picks and holds under same conditions as R15.

R16-1. Provides a circuit to the secondary clutch through R8-4 N/C and R25-1 N/C on the second cycle when a single card is being processed in the secondary.

R16-2. Completes circuit from S8 to pick R156 secondary card lever 1 delay.

R16-3. Shunts C40 for normal secondary sequence reading except on runout.

R17. Picks with R18 through C5, secondary CL2 and card lever test relay R10-4 N/O. R17 is energized on the second feed cycle and remains energized as long as cards feed past secondary CL2.

R17-1 N/O. Holds R17 and R18 through C6.

R17-2 N/C. Provides circuit from C21 through secondary hopper relay R8-2 and secondary card lever 1 N/C to allow hot 9's and 0's to the secondary read brushes on runout for valid sequence operation.

R17-2 N/O. Provides a circuit from the secondary impulse cams to the secondary common brush when cards are in position to be read by the secondary read brushes.

R17-3 N/C. Used with the secondary CL2 delay R156-3 N/C to provide the circuit for the first clutch impulse on secondary run-in.

R17-3 N/O. Completes circuit for continuous running after cycle 2 is completed.

R17-4 N/O*. Provides a circuit to pick the secondary CL2 delay relays R24 and R25 through S8.

R18. Secondary card lever 2. Picks and holds under same conditions as R17.

R18-2 N/C. Provides a circuit to secondary clutch through R8-4 N/C and R25-1 N/C on third cycle when a single card is being processed in the secondary.

R18-3 N/C. Opens circuits to storage clear until cards run out.

R18-4 N/C. Completes circuit to secondary check relay R29 if card fails to feed to second read station.

R19 Pick. Primary feed relay picks from P8 every primary feed cycle. If the primary keeps running, R19 does not drop out.

R19-1 N/O. Holds R19 through C7.

R19-2 N/C. Works in conjunction with the primary clutch relay R39-2 N/O and C4 to energize the primary check relay R30 if R39 picks and R19 does not pick. For this error condition, the clutch was impulsed but failed to operate.

R19-2 N/O. Picks check relay R30 if feed cycle is taken and R39-2 is not energized by clutch impulse.

R19-3 N/C. Opens the circuit for the first run-in clutch impulse through the primary CL2 delay R21-3 N/C. This forces the clutch impulse to go through the hopper R7-3 N/O and primary CL1 R11-3 N/O points which should be available after one cycle.

R19-4 N/O. Provides a circuit, on a primary feed cycle, to check for card levers failing to open between cards. The check pulse is from C4 through card lever test R10-5 N/C, run relay R4-3 N/O, the card levers if closed, another CL test point and either primary or secondary feed relay points to the primary or secondary check relays R28 or R29.

R19-5 N/O. Holds the start relay R1 energized on a primary feed cycle during the time C48 is open. This allows the machine to keep running.

R19-6 N/O. Operates in the various primary check error circuits to energize the primary check relay R28 on a failure to feed, card lever failing to open between cards, or a primary DPBC error.

R21 Pick. Primary card lever 2 delay is picked through P8 and primary CL2 R13-4 N/O on the cycle following the pick of R13. R21 stays up until the cycle following the drop out of R13. The points of R21 simulate a 3rd card lever station relay.

R21-1 N/O. Holds R21 through P7 which is closed at clutch latch time keeping R21 energized over latch time.

R21-2 N/O. Controls the circuit from C46 to the primary blank column check pulse exit. This keeps the blank column check inactive until the first card has been read by primary read brushes.

R21-3 N/C. In the circuit for the first cycle of run-in, this point insures the circuit is inoperative from the time R21 picks (third feed cycle) until all cards have been run out of the primary feed.

R21-4 N/C. Provides continuous running operation for the secondary feed when basic merge is wired ON and cards are being processed only in the secondary.

R21-4 N/O. Used in the normal secondary clutch circuit to interrupt the secondary clutch impulse if the primary hopper contains cards but there is no card at the third station. This would occur on running the cards into the primary after a primary, error runout. This circuit allows the primary to "catch up" with the secondary which was not run out.

R21-5 N/C. Provides a circuit for the first three run-in primary clutch cycles. It opens on the third cycle, forcing subsequent clutch impulses to come through control panel wiring.

R21-5 N/O. Provides the circuit for control of primary clutch operation through control panel wiring on cycles following the third run-in cycle.

R21-6 N/O. Opens on the last cycle of runout to prevent hot 9's and 0's reaching the primary DPBC thyratron and being recognized as a double punch.

R22 Pick. Secondary feed relay picks from S8 every secondary feed cycle. If the secondary keeps running, R22 does not drop out.

R22-1 N/O. Holds relays R22 and R23 through C7.

R22-2 N/C. Works in conjunction with the secondary clutch relay R41-2 N/O and C4 to energize the secondary check relay R31 if R41 picks and R22 failed to operate.

R22-2 N/O. Works with R41-2 N/C to pick R31 if feed cycle is taken without a clutch impulse.

R22-3 N/C. Opens the circuit after the first run-in clutch impulses through the secondary CL2 delay R24-3 N/C. This forces the clutch impulse to go through the hopper R8-3 N/O and secondary CL1 R15-3 N/O points which should be available after one cycle.

R22-4 N/O. Provides a circuit, on a secondary feed cycle, to check for card levers failing to open between cards. The check impulse is from C4 through card lever test R10-5 N/C, run relay R4-3 N/O, the card levers if closed, another CL test point and either primary or secondary feed relay points to the primary card lever or secondary card lever check relays R28 or R31.

R23. Secondary feed relay picks with R22.

R23-1 N/O. Holds the start relay R1 on a secondary feed cycle during the time C48 is open. This allows the machine to keep running.

R23-2. Holds the compare interlock R35 around C41 if machine operation is interrupted while R35 is energized.

R23-3 N/O. Works in conjunction with secondary card lever 1 relay R15-4 N/C and secondary card lever 2 R18-4 N/C to pick secondary card lever check relay R29 in case of feed failure.

R24 Pick. Secondary card lever 2 delay relays are picked through S8 and secondary CL2 R17-4 N/O on the cycle following the pick of R17. R24 and R25 stay energized until the cycle following the drop out of R17. The points of these relays simulate a third card lever station relay.

R24-1 N/O*. Holds R24 and R25 from S7.

R24-2 N/O. Controls the circuit from C46 to the secondary blank column pulse exit. This keeps the blank column check inactive until the first card has been read by the secondary brushes.

R24-3 N/C. In the circuit for the first cycle of run-in, this point insures the circuit is inoperative from the time R24 picks (third feed cycle) until all cards have been run out of the secondary feed.

R24-4 N/C. Provides a continuous operation for the primary feed when basic merge is wired ON and cards are being processed only in the primary.

R24-4 N/O. Used in the normal primary clutch circuit to interrupt the primary clutch impulse if the secondary hopper contains cards but there is no card at the third station. This would occur on running the cards into the secondary after a secondary error runout. This circuit allows the secondary to catch up with the primary which was not run out.

R24-5 N/C*.

R24-5 N/O*.

*R24-6**.

R25 Pick*. Secondary card lever 2 delay (see R24 pick).

R25-1 N/C. Provides a circuit for the first three secondary run-in cycles. It opens on the third cycle, forcing subsequent clutch impulses through control panel wiring.

R25-1 N/O. Provides the circuit for control of the secondary clutch operation through control panel wiring on cycles following the third run-in cycle.

R25-4 N/O. Opens on the last cycle of runout to prevent hot 9's and 0's reaching the secondary DPBC thyratron and being recognized as a double punch.

R26 Pick. Primary reset relay. R26 is energized by depressing the reset key. This can only be done after a primary control stop error (R36-5 N/C made) and with the machine stopped. R26 energizes control stop relay R36 and eliminates the error indication.

R26-1 N/O. Holds R26 through P7 which will hold until the first primary feed cycle.

R26-2 N/O. Protects the run relay R4-4 N/C points in case the start or runout keys are depressed, which would pick R4, while the reset key is held down.

R26-4 N/O. Picks the primary control stop relay R36 from C46 when the reset key is depressed to eliminate the error stop condition. This point keeps R36 picking each machine cycle until a primary feed cycle restores the original sequence or compare error condition and also drops R26.

R27 Pick. Secondary reset relay R27 is energized by depressing the reset key. This can only be done after a secondary control stop error (R38-5 N/C made) and with the machine stopped. R27 energizes control stop relay R38 and eliminates the error indication.

R27-1 N/O. Holds R27 through S7 which will hold until the first secondary feed cycle.

R27-2 N/O. Protects the run relay R4-4 N/C points in case the start or runout keys are depressed, which would pick R4, while the reset key is held down.

R27-4 N/O. Picks the secondary control stop relay R38 from C46, when the reset key is depressed, to eliminate the error stop condition. This point keeps R38 picking each machine cycle until a secondary feed cycle restores the original sequence or compare error condition and also drops R27.

R28. Primary card lever check relay. Picks with primary DPBC or failure to feed from hopper.

R28-1. Provides hold for R28 through reset key A and parallel to hold of R1.

R28-2 N/O. Completes circuit from C4 to pick R30 to operate primary check light on feeding failure.

R28-3 N/C. Prevents pick of R29 when primary card lever check relay R28 picks.

R29. Secondary card lever check relay.

R29-1. Provides hold for R29 through reset A and R1 hold.

R29-2. Provides pick of R31 secondary check relay on feeding failure.

R29-3. Prevents pick of R28 when secondary card lever check relay R29 picks.

R30. Primary check relay. Picks to stop machine and indicate error.

R30-1. Holds R30 through reset A and R1 hold circuit.

R30-2 N/C. Opens clutch and all-cycles circuit on primary check stop.

R30-3 N/C. Opens primary clutch circuit under primary check condition.

R30-3 N/O. Provides circuit to primary clutch to run out under primary check error condition.

R30-4. Opens circuit to pocket control on machine primary feed malfunction.

R31. Secondary check relay.

R31-1. Holds R31 through reset A and R1 hold circuit.

R31-2. Opens clutch and all-cycles hub circuits on secondary check conditions.

R31-3 N/C. Opens secondary clutch circuit under secondary check conditions.

R31-3 N/O. Provides circuit to secondary clutch to run out under primary check error condition.

R31-4. Opens circuit to pocket control on secondary feed malfunction.

R32 Pick. Basic relay is energized from the control panel basic switch plugged to either MERGE or MATCH.

R32-1 N/O. Provides a circuit to automatically pulse the secondary read-in relays when basic is wired.

R32-2 N/O. Provides a circuit to automatically pulse the primary read-in relays when basic is wired.

R32-4 N/O. Forces the basic switch to be wired before the compare interlock relay R35 can be energized. Circuit changes caused by R35 make this necessary.

R32-5 N/C. Provides a circuit from the control panel primary feed hubs to the primary clutch thyratron grid for other than basic wiring.

R32-5 N/O. Transfers control of the primary clutch to internal wiring, using answer relay points when the basic switch is plugged to MERGE or MATCH.

R32-6 N/C. Provides a circuit from the control panel secondary feed hubs to the secondary clutch thyratron grid for other than basic wiring.

R32-6 N/O. Transfers control of the secondary clutch to internal wiring, using answer relay points, when the basic switch is plugged to MERGE or MATCH.

R34 Coil. Match relay is energized in conjunction with the basic relay R32 when the basic switch is plugged to MATCH. R34 modifies basic wiring to allow a variation in the secondary feed control for a match operation.

R34-1 N/O. Changes the secondary feed control to allow simultaneous primary and secondary feed operation on an equal compare answer and equal secondary sequence indication. This saves machine cycles when there is no need for the primary to feed ahead of the secondary cards.

R34-2. Provides pick of R32 when MATCH is wired.

R35 Coil. Compare interlock relay picks only if the basic switch is wired, the primary and secondary are equal, there are multiple equal cards in the secondary, and the last card of the primary group is being sensed. Its points control circuits that allow the last primary card to be fed but forces an equal answer and secondary feeding until the matching equal cards have been fed from the secondary. These circuits allow proper selection on a merge operation.

R35-1 N/O. Holds R35 through C41.

R35-2 N/O. Allows the pick coil to re-energize from C42 as long as the equal secondary sequence answer exists.

R35-3 N/O. Prevents a primary control stop from occurring, due to a low primary sequence condition, until the compare interlock condition no longer exists.

R35-4 N/C*. Provides the normal circuit to the primary clutch thyratron grid when the basic relay is wired ON.

R35-4 N/O. Forces the secondary to feed (the primary circuit is interrupted) under compare interlock condition.

R35-5 N/C. Provides normal test pulse circuit to the low primary answer relay thyratron.

R35-5 N/O. Changes the test pulse circuit so the pulse to pick the low primary answer relay is forced to pick the equal answer relay.

R35-6 N/C. Provides the normal test pulse circuit to the low secondary answer relay thyratron.

R35-6 N/O. Changes the test pulse circuit so the pulse to pick the secondary answer relay is forced to pick the equal answer relay.

R36 Coil. Primary control stop relay is energized every cycle if one and no more than one answer is developed in each of the sequence and compare circuits and no low primary sequence error condition exists. Failure to energize R36 will stop the machine and indicate a primary control stop error.

R36-1 N/O*. Provides a hold circuit for R36 through C37 for normal use; run relay R4-5 N/C, when the machine is stopped; or through the test interlock R63-2 N/O during a secondary error runout procedure.

R36-2 N/C. Picks the test interlock relay R62 through C45 if the primary control stop relay R36 is not energized.

R36-2 N/O. Interrupts the circuit to the pocket exit hubs if a primary control stop condition exists.

R36-3 N/O. Interrupts the circuit to all-cycles hubs and the primary and secondary clutches if a primary control stop condition exists.

R36-4 N/C. Provides a circuit from C43 through the runout relay R5-3 N/O to the primary clutch thyratron for running the cards out of the primary feed on a primary control stop error condition.

R36-4 N/O. Provides the circuit for the primary clutch impulse as long as R36 is energized each cycle.

R36-5 N/C. Prevents the reset key A from energizing the primary reset relay R26 except when a primary control stop condition exists.

R36-6 N/C. Provides the circuit to turn on the primary control stop indicating light under error conditions.

R38 Coil. Secondary control stop relay is energized every cycle if one and no more than one answer is developed in each of the sequence and compare circuits and no low secondary sequence error condition exists. Failure to energize R38 will stop the machine and indicate a secondary control stop error.

*R38-1**. Provides a hold circuit for R38 through C37 for normal use; run relay R4-5 N/C, when the machine is stopped; or through the test interlock R36-2 N/O during a primary error runout procedure.

R38-2 N/C. Picks the test interlock relay R62 through C45 if the secondary control stop relay R38 is not energized.

R38-2 N/O. Interrupts the circuit to the pocket exit hubs if a secondary control stop condition exists.

R38-3 N/O. Interrupts the circuit to the all-cycles hubs and the feed clutches if a secondary control stop condition exists.

R38-4 N/C*. Provides a circuit from C43 through the runout relay R5-4 N/O to the secondary clutch thyratron for running the cards out of the secondary feed on a secondary control stop error condition.

R38-4 N/O. Provides the circuit for the secondary clutch impulse as long as R38 is energized each cycle.

R38-5 N/C. Prevents the reset key A from energizing the secondary reset relay R27 except when a secondary control stop condition exists.

R38-6 N/C. Provides the circuit to turn on the secondary control stop indicating light under error conditions.

R39 Coil*. Primary clutch relay is energized by the impulse to the primary clutch thyratron grid. Its points are used in the clutch-checking circuit and for control of some primary circuits.

R39-1 N/O. Holds R39 through C6.

R39-2 N/C. Used with primary feed relay R19-2 N/O to pick the primary check relay R28 through C4 if the primary feed should run without the clutch being impulsed.

R39-2 N/O. Used with primary feed relay R19-2 N/C to pick the primary check relay R28 through C4 if the primary clutch is impulsed but the feed fails to run.

R39-3 N/O. Provides a circuit from C42 to the primary cycles hubs following a primary clutch impulse.

R39-4 N/O. Controls the circuit from C35 to the primary read in relays R74-R77. This insures the primary restore circuits will function only on a primary feed cycle.

R39-5. Provides hold circuit for primary sequence relays when the primary feed is not running.

R39-6.*

R41 Coil*. Secondary clutch relay is energized by the impulse for the secondary clutch thyratron grid. Its points are used in the clutch-checking circuit and for control of some secondary circuits.

R41-1 N/O. Holds R41 through C6.

R41-2 N/C. Used with the secondary feed relay R22-2 N/O to pick the secondary check relay R31 through C4 if the secondary feed should run without the clutch being impulsed.

R41-2 N/O. Used with the secondary feed relay R22-2 N/C to pick the secondary check relay R31 through C4 if the primary clutch is impulsed but the feed fails to run.

R41-3 N/O. Provides a circuit from C42 to the secondary cycle hubs following a secondary clutch impulse.

R41-4 N/O*. Controls the circuit from C35 to the secondary read-in relays R78-R81. This insures the secondary restore circuits will function only on a secondary feed cycle.

R41-5. Provides hold for secondary sequence relays when secondary feed is not running.

R41-6.*

R43 Coil. Primary double punch blank column relay is energized whenever the machine detects either type of error in the primary feed. R43 stops the machine and turns on both the primary DPBC light and the primary check light.

R43-1 N/O. Holds R43 through the reset key A or the hold circuit of relay R1.

R43-2 N/O. Turns on the DPBC indicator light.

R43-3 N/O. Provides a circuit from C3 through the primary feed relay R19-6 N/O to pick the primary check relay R28 on a DPBC error.

R43-4 N/C. Provides the normal circuit to the primary blank column hubs from C46.

R43-4 N/O. Closes on a primary DPBC error to provide a continuous voltage to the primary blank column hubs. This allows the individual column indicator neons to remain on, showing the column containing the blank column.

R43-5 N/C. Interrupts the all-cycles and clutch impulses on a primary DPBC error.

R43-6 N/C*. Interrupts the primary and secondary read-in relay circuit from C35. This insures the error readings will be retained, and nothing new will be read into the circuits on error runout cycles.

R45 Coil. Secondary double punch blank column relay is energized whenever the machine detects either type of error in the secondary feed. R45 stops the machine and turns on both the secondary DPBC light and the secondary check light.

R45-1 N/O. Holds R45 through the reset key A.

R45-2 N/O. Turns on the DPBC indicator light.

R45-3 N/O. Provides a circuit from C3 through the secondary feed relay R23-3 N/O to pick the secondary check relay R29 on a DPBC error.

R45-4 N/C. Provides the normal circuit to the secondary blank column hubs from C46.

R45-4 N/O. Closes on a secondary DPBC error to provide a continuous voltage to the secondary blank column hubs. This allows the individual column indicator neons to remain on, showing the column containing the blank column.

R45-5 N/C. Interrupts the all-cycles and clutch impulses on a secondary DPBC error.

R45-6 N/C*. Interrupts the primary and secondary read-in relay circuits from C35. This insures the error readings will be retained, and nothing new will be read into the circuits on error runout cycles.

R46 Coil. Low secondary sequence answer relay is energized as a result of a secondary sequence test. Its points control machine functions.

R46-1, R46-2. Are wired to control panel hubs for use in functional wiring.

R46-3. Both the N/O and N/C points are used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R46-4 N/C. Works with the secondary sequence switch plugged ON to interrupt the circuit to the secondary control stop relay R38 if a low secondary sequence error occurs.

R47 Coil. Equal secondary sequence answer relay is energized as a result of a secondary sequence test. Its points control machine functions.

R47-1, R47-2. Are wired to control panel hubs for use in functional wiring.

R47-3, R47-4. Are used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R47-5 N/O. Functions with the basic match relay R34-1 N/O to provide a circuit to the secondary clutch which allows simultaneous running of the primary and secondary feeds with equal compare conditions.

R47-6 N/O. Conditions the circuit to energize the compare interlock relay R35.

R49 Coil. High secondary sequence answer relay is energized as a result of a secondary sequence test. Its points control machine functions.

R49-1, R49-2. Are wired to control panel hubs for use in functional wiring.

R49-3. Used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R50 Coil. Low primary sequence answer relay is energized as a result of a primary sequence test. Its points control machine functions.

R50-1, R50-2. Wired to control panel hubs for use in functional wiring.

R50-3. Used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R50-4 N/C. Works with the primary sequence switch plugged ON to interrupt the circuit to the primary control stop relay R36 if a low primary sequence error occurs.

R51 Coil. Equal primary sequence answer relay is energized as a result of a primary sequence test. Its points control machine functions.

R52-1, R52-2. Are wired to control panel hubs for use in functional wiring.

R51-3, R51-4. Are used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R52 Coil. High primary sequence answer relay is energized as a result of a primary sequence test. Its points control machine functions.

R51-1, R52-2. Are wired to control panel hubs for use in functional wiring.

R52-3. Used in the one and only one answer circuits. These interrupt the circuit to the control stop relays R36 and R38 if improper answers are indicated.

R52-4. Provides a circuit, with basic wired, to allow the secondary clutch to energize on an equal compare condition if a high primary sequence is sensed.

R52-5 N/O. Conditions the circuit to pick the compare interlock relay R35.

R54 Coil. Low primary A compare answer relay is energized as a result of a test of the A half of the compare circuits if COMPARE SPLIT is wired. R54 picks in parallel with low primary B compare R57 if compare split is not wired.

R54-1, R54-2. Are wired to control panel hubs for use in functional wiring.

R54-3. Used in the one and only one answer circuits.

R55 Coil. Equal compare answer relay is energized as a result of a test of the A half of the compare circuits if COMPARE SPLIT is wired. R55 picks in parallel with compare B R58 if COMPARE SPLIT is not wired.

R55-1, R55-2. Are wired to control panel hubs for use in functional wiring.

R55-3. Used in the one and only one answer circuits.

R56 Coil. Low secondary A compare answer relay is energized as a result of a test of the A half of the compare circuits *if* COMPARE SPLIT is wired. R56 picks in parallel with low secondary B relay if COMPARE SPLIT is not wired.

R56-1, R56-2. Are wired to control panel hubs for use in functional wiring.

R56-3, R56-4. Are used in the one and only one answer circuits.

R57 Coil. Low primary B compare answer relay is energized as a result of a test of the B half of the compare circuits only when COMPARE SPLIT is wired. Without COMPARE SPLIT wired, the primary B answer relays are controlled by a test of the complete compare network.

R57-1, R57-2. Are wired to control panel hubs for use in functional wiring.

R57-3. Used in the one and only one answer circuits.

R57-4 N/C. Conditions the basic clutch control circuit to provide a secondary clutch impulse if there is an equal compare with high primary sequence answer or if, with MATCH wired, there is an equal compare with an equal secondary sequence answer.

R57-4 N/O. Conditions the basic clutch control circuit to provide a primary clutch impulse on a low primary answer.

R58 Coil. Equal B compare answer relay is energized as a result of a test of the B half of the compare circuits only when COMPARE SPLIT is wired. Without COMPARE SPLIT wired, the primary B answer relays are controlled by a test of the complete compare network.

R58-1, R58-2. Are wired to control panel hubs for use in functional wiring.

R58-3. Used in one and only one answer circuit.

R58-4. Conditions the basic clutch control circuit to provide a primary feed cycle on any equal compare answer and a secondary feed cycle if other conditions are met.

R58-5 N/O. Conditions the circuit to energize the compare interlock relay R-35.

R59 Coil. Low secondary B compare answer is energized as a result of a test of the B half of the compare circuits only when COMPARE SPLIT is wired. Without COMPARE SPLIT wired, the Primary B answer relays are controlled by a test of the complete compare network.

R59-1, R59-2. Are wired to control panel hubs for use in functional wiring.

R59-3, R59-4. Are used in the one and only one answer circuits.

R59-5 N/C. Conditions the basic clutch control circuits to provide a secondary feed cycle if there is no low secondary answer but other conditions are met.

R59-5 N/O. Control the secondary clutch circuit to provide a secondary feed cycle if BASIC is wired and a low secondary answer is developed.

R62 Coil*. Test interlock relay is energized on a primary or secondary control stop error condition. R62 causes R63 and R64 to pick and together they provide circuits to retain the error conditions and isolate circuits to aid in diagnosing the cause of the error. They drop out when the reset key is depressed.

R62-1 N/O*. Provides a hold circuit through reset A for R62 and the hold coils of R63 and R64. Test interlock R63 and R64 have no pick coil so this circuit energizes R63 and R64. R62-1 N/O also provides the circuit to turn on the primary or secondary control stop lights if R36 or R38 are not picked.

R62-2 N/C*. Opens the circuit from C35 to the read-in relays on control stop errors. This prevents restoring the compare relays and thereby losing the error conditions.

*R62-3**.

R62-4 N/O*. Connects the secondary sequence plates directly to the line as long as the test interlock relays are energized. This retains the sequence indication throughout the error runout procedure.

R62-5 N/C, *R62-6* N/C*. Open the grid conditioning circuit for the primary and secondary sequence checking circuitry. This prevents additional sequence relays being energized as cards are sensed during the error runout procedure.

R63 Coil. Test interlock relay uses only the hold coil. It is controlled by and holds in parallel with test interlock R62.

R63-1. Opens the circuit to energize the delay relay R2. This makes the clutch delay circuit inoperative on control stop error runout conditions.

R63-2 N/O. Provides a circuit to hold the control stop relays R36, R38 directly to the line when the test interlock relays are energized. This keeps R36 or R38, whichever has been picked, from dropping out during an error runout procedure.

R63-4 N/O*. Connects the primary sequence plates directly to the line as long as the test interlock relays are energized. This retains the sequence indication throughout the test procedure.

*R63-5**.

*R63-6**.

R64. Test interlock relay.

R64-1. Opens the circuit to storage clear relay R72 under error condition.

R64-2 N/C, *R64-3* N/C. Interrupts the pick circuits of the primary and secondary control stop relays. This insures that their status will not change during the error runout procedure.

*R65**.

*R65-2**.

*R65-3**.

R66 Coil. Primary A compare shift relays are energized from fuse 12 through control panel wiring. They change the control of the primary A compare and DPBC circuits to allow them to function properly with cards read by the secondary brushes.

R66-1 N/C. Provides the normal circuit for the primary A blank column control test exit pulse.

R66-1 N/O. Transfers the primary A blank column exit pulse from primary feed control to secondary feed control when primary A shift is wired ON.

R66-2 N/C. Provides the normal circuit from the primary A DPBC network to the primary DPBC error indication circuit.

R66-2 N/O. Transfers the primary A DPBC network from the primary DPBC error indication circuit to the secondary DPBC error indication circuit. This keeps the error indication compatible with the card sensing when compare units are shifted.

R66-3 N/C. Used in the normal circuit to pick the primary A BCT relays R83, R85, R93, R99, from P6 used to asign primary A blank column test relays to the primary feed.

R66-3 N/O. Transfers the control of primary A BCT relays from P6 to S6 for use with secondary card sensing when primary A shift is wired ON.

R66-4 N/C. Provides normal impulse from primary clutch relay R39-4 to primary A read-in.

R66-4 N/O. Transfers control of the primary A read-in relays from the primary clutch R39-4 to the secondary clutch R41-4 for use with the secondary card sensing when primary A shift is wired ON.

R67 Coil. See R66 coil.

R67-1 N/C*. Works in conjunction with R67-2 N/C, R67-3 N/C and R67-4 N/C to provide the proper A, B, C, D code conditioning to the grid of the corresponding primary A compare relay thyratrons. These normal circuits condition the grid from C11 for A code, C12 for B code, C13 for C code and C14 for D code.

R67-1 N/O*. With R67-2 N/O, R67-3 N/O and R67-4 N/O transfers the grid conditioning of the primary A compare code relay thyratrons to C24 for A code, C25 for B code, C26 for C code, and C27 for D code. These cams condition the thyratrons for secondary read code timing.

R67-2, 3, 4. See R67-1.

R68 Coil. Secondary A compare shift relays are energized from fuse 12 through control panel wiring. They change the control of the secondary A compare and DPBC circuits to allow them to function properly with cards read by the primary brushes.

R68-1 N/C. Provides the normal circuit for the secondary A blank column control test exit pulse.

R68-1 N/O. Transfers the secondary A blank column exit pulse from secondary feed control to primary feed control when secondary A shift is wired ON.

R68-2 N/C*. Works in conjunction with R68-3 N/C, R68-4 N/C, to provide the proper A, B, C, or D code conditioning to the grid of the corresponding secondary A compare relay thyratrons. These normal circuits condition the grid from C24 for A code, C25 for B code, C26 for C code and C27 for D code.

R68-2 N/O*. With R68-3 N/O and R69-1 N/O transfers the grid condition of the secondary A compare relays to C11, C12, C13 and C14, which condition the thyratrons for primary read code timing.

R68-3. See R68-2.

R68-4. See R68-2.

R69 Coil. See R68 Coil.

R69-1. See R68-2.

R69-2 N/C. Provides the normal circuit from the secondary A DPBC network to the secondary DPBC error indication circuits.

R69-2 N/O. Transfers the circuit from the secondary A DPBC network to the primary DPBC error indication circuit. This keeps the error indication compatible with the card sensing.

R69-3 N/C. Used in the normal circuit to pick the secondary A BCT relays R88 and R90 through S6.

R69-3 N/O. Transfers the control of secondary A BCT relays R88, R90, R96, R102 from S6 to P6 for use with primary card sensing.

R69-4 N/C. Used in the normal circuit to secondary A read-in relays R78 and R79 from C35 if basic is not wired.

R69-4 N/O. Transfers control of the secondary A restore relays from the secondary clutch R41-4 to the primary clutch R39-4 for use with primary card sensing.

R70 Coil, *R71* Coil. Function for section B as R68 and R69 do for section A.

R70-1. Same function for Section B as R68-1 for section A. See R68-2.

R70-2. Same function for section B as R68-2 for section A. See R68-2.

R70-3. Same function for section B as R68-3 for section A. See R68-2.

R70-4. Same function for section B as R68-4 for section A. See R68-2.

R71 Coil. See R70 Coil.

R71-1. Same functions for section B as R69-1 for section A. See R69-1.

R71-2. Same function for section B as R69-2 for section A. See R69-2.

R71-3. Same function for section B as R69-3 for section A. See R69-3.

R71-4. Same function for section B as R69-4 for section A. See R69-3.

R72 Coil. Storage clear relay is energized to clear all sequence and compare readings when both feeds are empty.

R72-1 N/C*. Opens to allow the primary compare A tube plates to be controlled by C15. Because the point opens after both feeds are empty, when C15 operates, no new readings will be read in and the storage unit is cleared.

R72-2 N/C*. Same function for primary compare B as R72-1 N/C (using C16). See R72-1.

R72-3 N/C*. Same function for secondary compare A as R72-1 N/C (using C28). See R72-1.

R72-4 N/C*. Same function for secondary compare B as R72-1 N/C (using C29). See R72-1.

R72-5 N/C*. Same function for primary sequence as R72-1 (using C17). See R72-1.

R72-6 N/C*. Same function for secondary sequence as R72-1 (using C30). See R72-1.

R74 Coil, *R75* Coil. Primary A read-in relays.

R76 Coil, *R77* Coil. Primary B read-in relays.

R78 Coil, *R79* Coil. Secondary A read-in relays.

R80 Coil, *R81* Coil. Secondary B read-in relays.

The read-in relays work in pairs in each section of the compare circuitry. They are energized just before the feed cluch engages and then de-energize shortly before the clutch latches. They allow the compare relays to energize and control how long they are held.

R74-1 N/O*, *R76-1* N/O, *R78-1* N/O, *R80-1* N/O. These relays hold their pairs of relays through C36.

R74-2 N/C, *R76-2* N/C, *R78-2* N/C, *R80-2* N/C. Control the hold of compare relays. These short around the hold cam keeping the compare relays energized until the read-in relays pick to allow the hold cam to open the circuit.

R74-3 N/O, *R76-3* N/O, *R78-3* N/O, *R80-3* N/O. Control the pick of the blank column test relays. These insure a double punch check is made only if a new card is being read into the corresponding section of compare.

R74-4 N/O, *R76-4* N/O, *R78-4* N/O, *R80-4* N/O. Control the circuit from the DPBC test network to the error circuits. These insure that no blank column indication is possible unless a card is being read by the corresponding feed.

R75, R77, R79, R81. All points of R75, R77, R79, and R81 control the conditioning of the grids of the code relay thyratrons in their respective area of compare circuitry. They insure the thyratrons can fire only during a cycle in which a card is being read.

R82 Coil. Fuse relay is energized if a fuse blows in either the +48v or the +70v circuits. R82 stops the machine and indicates a fuse has blown.

R82-2 N/C. Interlocks the start and run circuits to interrupt machine operation if a fuse blows. It also keeps the ready light from coming on.

R82-3 N/O. Turns on the fuse light to indicate that a fuse has blown.

R83 through *R104*. Blank column test relays. There are two BC test relay points associated with each position of compare entry. They all function as described for R83-1 and R83-2. The BCT relays are picked up on each feed cycle before card read time and dropped out after read time but before the end of the cycle.

R83-1 N/O. While the card is being read, this point allows any card read pulse to test the associated code relay points for a double punch condition.

R83-1 N/C, *R83-2* N/C. These test points provide a blank column test path from the primary BC test hub to the DPBC relay thyratron after card read time. If no code relays have energized, a blank column condition is indicated.

R107 through *R148**. Primary A and secondary A positions 1-5 compare code relays. The odd-numbered relays are associated with the primary feed. The even-numbered relays are associated with the secondary feed. They are energized by thyratrons controlled by the card reading and conditioning cams.

All 1 points are used in the code lamp rotary switch circuit.

All 2 and 3 points, when used, are in the primary-secondary cross-compare circuits for the A half of the compare network.

All 4 points are used in the DPBC detection circuits to sense the presence of multiple punches or absence of any punch.

R151. Primary sequence split relay. Picked from control panel wiring. Its function is to separate A and B halves of the primary sequence circuit and make them operate independent of one another.

R151-1. Transfers the low primary A sequence test pulse from primary B sequence points to a control panel hub marked LOW PRIMARY A SEQUENCE.

R151-2. Opens the test pulse between the equal points of the last position of A primary sequence and the first primary B sequence position. The transferred point brings a test pulse from C44 into the first position of primary B sequence test circuits.

R151-3 N/O. Provides a circuit from the equal primary sequence A points to a control panel hub marked EQUAL PRIMARY A SEQUENCE.

R151-4. Transfers the high primary A sequence test pulse from primary B sequence points to a control panel hub marked HIGH PRIMARY A SEQUENCE.

R152. Secondary sequence split relay is energized from control panel wiring. Its function is to separate the A and B halves of the secondary sequence circuits and make them operate independent of one another.

R152-1. Transfers the low secondary A sequence test pulse from secondary B sequence points to a control panel hub marked LOW SECONDARY A SEQUENCE.

R152-2. Opens the test pulse circuit between the equal points of the last position of A secondary sequence and the first position of secondary B sequence. The transferred point brings a test pulse from C44 into the first position of secondary B sequence.

R152-3. Provides a circuit from equal secondary sequence A points to a control panel hub marked EQUAL SECONDARY A SEQUENCE.

R152-4. Transfers the high secondary sequence A test pulse from secondary sequence B points to a control panel hub marked HIGH SECONDARY A SEQUENCE.

R153 Coil, *R154* Coil. Compare split relays are energized through control panel wiring to divide the compare circuits into A and B halves. Each half is made independent of the other and utilizes its own answer relays.

R153-1. Isolates the primary B read-in from the primary A read-in so they may be independently controlled.

R153-2. Isolates the secondary B read-in from the secondary A read-in so they may be independently controlled.

*R153-3**. Transfers the test pulse circuit for low primary indication of primary A from the entry to the primary B half of the compare circuits to the low primary A answer relay thyratron grid.

R153-4. Opens the circuit from the last position of equal compare A points to the first position of the B half of the circuit. When it transfers, R153-4 brings a test pulse to the first position of compare B circuitry, so an independent answer can be developed in the B half.

R154 Coil. See R153 Coil.

R154-1. Performs two functions. It opens the circuit from equal compare B answer test points to the equal compare A answer test points which normally forces the A answer to agree with the B answer. It then provides the circuit from the equal points of the last position of compare A to control the equal compare A answer relay.

R154-2. Isolates the A and B compare low secondary test points and provides the circuit to control the low secondary A answer relay from the A test points.

R154-3. Isolates the control circuit for the low secondary A answer relay from the low secondary B answer relay circuits.

R154-4. Isolates the control circuit for the low primary A answer relay from the low primary B answer relay circuits.

R155. Primary card lever 1 delay. Picks from R11-6 point and P8 on cycle after R11 picks.

R155-1. Holds R155 through P7.

R155-2. Works in conjunction with R14-4 N/C point and R19-6 N/O point to pick card lever check R28 in case R14 fails to pick.

R155-3. Works in conjunction with R13-3 to take care of run-in and continuous running pulses to clutches.

R156. Secondary card lever 1 delay. Picks through R16-2 and S8 on cycle following pick of R16.

R156-1. Holds R156 through S7.

R156-2. Works in conjunction with R18-4 N/C to pick secondary card lever check relay R29 if R18 fails to pick.

R156-3. Works in conjunction with R17-3 for secondary run-in and continuously running conditions to operate clutches from C43.

R160 through *R209.* Primary A and secondary A positions 6-11 compare code relays are identical in operation to R107-R148. See R107-R148.

R210, R210-1*, R210-2*.*

R213 through *R254*.* Primary B and secondary B positions 1-5 compare code relays. Function in B half of compare circuitry the same as R107-R148 in primary A circuits. See R107-R148.

R256 through *R260*.* Selector relays are energized by coincident pulses wired to control panel hubs. The points are used to control machine functions.

All 1 points are used in the hold circuits.

All 2 points are used to provide a re-pick of the relay if it is being held over multiple of cycles.

All 3 and 4 points are wired to control panel hubs for use in functional control of the machine.

R260.*

R263.*

R266 through *R315, R316*.* Primary B and secondary B positions 6-11 compare code relays. Function the same as R107-R148. See R107-R148.

R319 through *R343.* Primary sequence check relays position A1-A11.

R345 through *R369*.* Primary sequence check relays positions B1-B11.

These relays are energized from brush impulses sensed by primary or primary sequence brushes. The odd-numbered relays from the primary sequence and the even by the primary brushes. Their points provide circuits for the test pulse to energize primary sequence answer relays.

All 1 points are used in the code lamp rotary switch circuit.

All 2 points of even-numbered relays are in the pick circuit of the corresponding odd-numbered relays, and the 2 points of the odd-numbered relays are in the pick circuit of the corresponding even-numbered relays. They sense which brush reads a punch first.

All 3 and 4 points, when used, are in the primary sequence test circuits to energize the high, equal, or low primary sequence answer relays.

R372 through *R396.* Secondary sequence check relays positions A1-A11.

R398 through *R422.* Secondary sequence check relays positions B1-B11.

These relays are energized from brush impulses sensed by secondary or secondary sequence brushes. The odd-numbered relays from the secondary brushes and the even-numbered relays from the secondary sequence brushes. Their points provide circuits for the test pulse to energize secondary sequence answer relays.

The points of R372-R422 are the same as those of the primary sequence check relays R319-R369. See R319-R369.

R465. Sequence shift relay. Shifts secondary sequence to work with primary readings.

R465-1. Shifts the secondary sequence tube plate circuits from C30 to C17 for use with the primary feed sequence checking.

R465-2. Shifts the secondary sequence grid conditioning circuits from C31 to C18 to work with primary feed.

R465-3-12, R468-474, 1-12 points. When normal test points, in conjunction with the RC network between two tube plates of one position, cause the higher digit position to turn lower reading tube OFF. This results in the higher digit value being recognized. With the sequence shift relay points transferred, the first reading is recognized.

*Purpose of these points is different for thyratron transistor IBM 88.

Purpose of Relays and Relay Points in Thyratron Transistor Type Machine

R24-5 N/C. Same as R25-1 on 602700B WD.

R24-6 N/O. Same as R25-4 on 602700B WD.

R25 Pick. No R25 used.

R28-3 N/O. Provides pick to card lever check light.

R29-3 N/O. Provides pick to card lever check light.

R32-6 N/C. Provides a circuit from the control panel secondary feed hubs to the secondary clutch for other than basic wiring.

R35-4 N/C. Provides the normal circuit to the primary clutch when BASIC is wired ON.

R36-1 N/O. Provides a hold circuit for R36 through C36 for normal use; run relay R4-5 N/C, when the machine is stopped, or through R63-2 N/O during a secondary error runout procedure.

R38-1 N/O. Provides a hold circuit for R38 through C36, for normal use; run relay R4-5 N/O, when the

machine is stopped, or through R63-2 N/O during a primary error runout procedure.

R38-4 N/C. Provides a circuit from C43 through the runout relay R5-4 N/O to the secondary clutch for running the cards out of the secondary feed on a secondary control stop error condition.

R39 Coil. Primary clutch relay is energized by the impulse to the primary clutch. Its points are used in the clutch-checking circuit and for control of some primary circuits.

R39-4 N/O. Control the circuit from C34 to the primary read-in relays. This insures the restore circuits will function only on a primary feed cycle.

R39-6 N/C. Used to shunt C20 to enable reading code relays and code lights when machine is stopped.

R41 Coil. Secondary clutch relay is energized by the impulse for the secondary clutch. Its points are used in the clutch-checking circuit and for control of some secondary circuits.

R41-4 N/O. Controls the circuit from C34 to the secondary read-in relays. This insures the secondary restore circuits will function only on a secondary feed cycle.

R41-6 N/C. Same as R39-6 N/C.

R43-6 N/C. Interrupts the primary and secondary read-in relay circuit from C34. This insures the error readings will be retained and nothing new read into the circuits on error runout cycles.

R45-6 N/C. Same as R43-6 N/C.

R62 Coil. Test interlock relay is energized on a primary or secondary control stop. R62 causes R63 to pick and provides circuits to retain the error condition and isolate circuits to aid in diagnosing the cause of the error. They drop out when reset key is depressed.

R62-1 N/O. Provides a hold circuit through reset A for R62 and hold of R63. R62-1 N/O also provides a circuit to turn on primary or secondary control stop lights if R36 or R38 is not picked.

R62-2 N/C. Opens circuit from C34 to read-in relays on control stop errors. This prevents restoring the compare relays and, thereby, losing the error conditions.

R62-3. See R64-1 on WD 602700B.

R62-4 N/O. Connects the secondary sequence hold coils directly to the line as long as the test interlock relays are energized. This retains the sequence indication throughout the error condition.

R62-5 N/C, *R62-6* N/C. Open the collector circuits for the primary and secondary sequence checking circuitry. This prevents additional sequence relays being energized as cards are sensed during the error runout procedure.

R63-4 N/O. Connects the primary sequence hold coils directly to the line as long as the test interlock relays are energized. This retains the sequence indication throughout the test procedure.

R63-5, R63-6. See R64-2 and R64-3 on WD 602700B.

R65-2 N/C. Same as R82-2 N/C on WD 602700B.

R65-3 N/O. Turns on the fuse light to indicate fuse has blown.

R67-1 N/C. Works in conjunction with R67-2 N/C, R67-3 N/C and R67-4 N/C to provide the proper A, B, C, or D code bias to the collectors of the transistors controlling the corresponding primary A compare relays. These normal points provide bias to the transistor collectors from C11, 12 for A code, C13, 14 for B code, C15, 16 for C code, and C17 for D code.

R67-1 N/O. Same as above except bias is put under control of CB24-30 to read with secondary feed.

R68-2 N/C. Works in conjunction with R68-3 N/C, R68-4 N/C, and R69-1 N/C to provide the proper A, B, C, or D code bias to the collector of the transistor controlling the corresponding secondary A compare relays. The normal points provide bias to the transistor collectors from C24, 25 for A code, C26, 27 for B code, C28, 29 for C code, and C30 for D code.

R68-2 N/O. Same as just mentioned except bias is under control of C11, 17.

R72-1 N/C. Opens to allow the primary compare B transistor collectors to be controlled by C52. Because the point opens after both feeds are empty when C52 operates, no new readings will be read in and the storage unit is cleared.

R72-2 N/C. Same function for primary compare A as R72-1 N/C using C51 instead of C52.

R72-3 N/C. Same function for secondary compare B as R72-1 N/C using C38.

R72-4 N/C. Same function for secondary compare A as R72-1 N/C using C37.

R72-5 N/C. Same function for primary sequence as R72-1 N/C using C19.

R72-6 N/C. Same function for secondary sequence as R72-1 N/C using C33.

R74-1 N/O, *R76-1* N/O, *R78-1* N/O, *R80-1* N/O. These points hold their pairs of relays through C35.

R75, 77, 79, 81. All points of these relays control the biasing of the collectors of the code relay transistors in their respective area of compare circuitry. They insure that the transistors will be active only during a cycle in which a card is being read.

R107-148 N/O. All 1 points are used in the code lamp rotary switch circuit and to maintain code relay hold circuits.

R153-3. Transfers the test pulse circuit for low primary indication of primary A from the entry to the B half of compare circuits to the low primary A answer relay transistor base.

R255, R259. Same as R256-R260 on WD 602700B.

R319 to *R422* N/O. All 1 points are used in code lamp rotary switch circuits and are used to maintain hold circuit through relay hold coils.

R210. Same as R465 on WD 602700B.

R210-1. Shifts the secondary sequence pick circuits from C32 to C18 for use with the primary feed sequence checking.

R210-2. Shifts the secondary sequence relay hold circuits from C33 to C19 to work with primary feed.

R260. Same as relay 468 used with WD 602700B.

R263. Same as relay 471 used with WD 602700B.

R316. Same as relay 474 used with WD 602700B.

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