IBM Customer Engineering
Reference Manual

1301 Disk Storage

IBM Machine Record

MACH TYPE	SERIAL NUMBER	VOLTAGE AC ☐ DC ☐	CYCLES	DATE INSTALLED
1301				

SYSTEM DIAGRAMS EC LEVEL

PLANT INSTALLED SPECIAL FEATURES			
DESCRIPTION	QTY	DESCRIPTION	QTY

FIELD INSTALLED SPECIAL FEATURES

CEM NO.	DIAGRAM OR B/M NO.	DESCRIPTION OF FEATURE	INSTALLED		REMOVED	
			MAN NO.	DATE	MAN NO.	DATE

D. J. MIHALIK

Issued to: ~~JOHN SLANEC~~

Branch Office: 422

Department: _____

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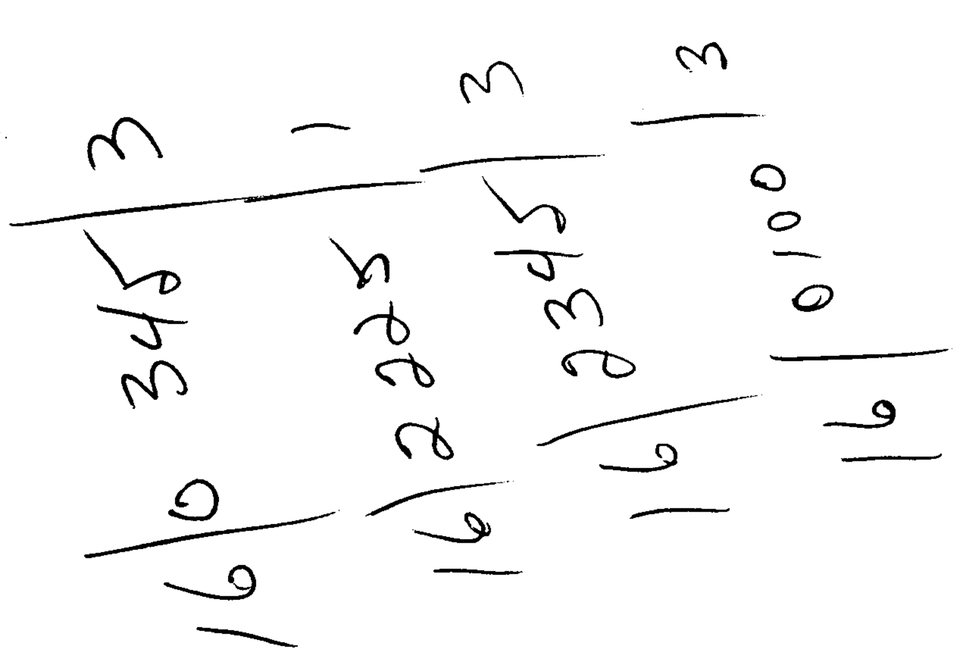

IBM Customer Engineering Reference Manual

1301 Disk Storage

This edition, Form 227-5581-2, incorporates major changes and additions to Form R27-5581-1. The latter form is made obsolete by these changes. Any manuals released at a later date to supplement this manual will carry Form 227-5694.

Address comments regarding this publication to:
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227-5581-2 (11-62)

CONTENTS

SAFETY

Personal safety cannot be overemphasized. To ensure your own safety, make it an every day practice to follow safety precautions at all times. Become familiar with and use the safety practices outlined in IBM pocket-size cards, Forms 124-0002 and MO4-8401, issued to all Customer Engineers.

Exercise caution when working around moving parts of the machine. Parts of the body or clothing near the machine can cause accidents if the machine starts unexpectedly. These accidents can be prevented.

Potential difference within the power contactor gate is -48 v DC to 208 v AC. Potential difference within the electronic gates, printed cards, and display back panel is -48 v DC to +30 v DC. Do not remove or replace circuit cards when DC power is on.

Do not short out or bypass safety features. One such item is the access cover door safety switch. Do not allow the access to run with this door open by manually energizing this cover safety switch. Also note that, although the actuator is electronically interlocked with this door open, if for any reason the solenoid DC power goes off the actuator will attempt to move under hydraulic pressure.

Access Mechanism

Because of the random and sometimes unpredictable motion of the access mechanism, it should be serviced with caution. Shields and guards have been provided and can only be of assistance when firmly in place.

Care should be taken to remove access assembly according to outlined procedures. Two men must be available to handle this unit as it weighs approximately 60 pounds and the mounting screws are accessible only from the rear of the supporting strut.

Power Supplies

When a DC failure is sensed, a DC off sequence is initiated, but power remains on at the gate blowers, convenience outlets, and disk drive motor. Do not depend on this feature as safety protection.

Always use fuse pullers to remove or insert fuses. Replace plastic protective covers over fuses immediately after replacing fuse.

The power supplies are heavy and should be removed with care. Remove line cord from power receptacle and wait at least 15 seconds after power is turned off before attempting any repair or adjustment within any power supply.

High Voltages

High voltage lines and connections exist in many areas within the machine. Such voltages are found on transformers, terminals, convenience outlets, and the like. Contactor relays utilize high voltages at their points. Check these contactor relays with the power on only if absolutely necessary and with extreme caution.

Power On States

Before the file is brought up to running condition from the power sequence panel, it may exist in one of several states of power on. In all cases, the following assumptions are made:

1. The file is plugged into the wall.
2. The wall plug is at the specified potential.
3. An external source of 24 v AC is applied to the file (Emergency Off Power).

Mainline (70 amp C.B.) switch is off.

1. 208-230 volts AC is present at:
   a. input and output of mainline filter.
   b. input to the mainline switch.
2. 24 volts AC is present at:
   a. Coil of K-1.

Mainline switch and CB-2 (30 amp C.B.) on.

1. 208-230 v AC is present at:
   a. input and output of mainline filter.
   b. input and output of mainline switch.
   c. input and output of CB-2.
   d. input and output of K-1.
   e. input to K-2, K-3, K-4.
   f. T1.
2. 110 v AC is present at:
   a. convenience outlet.
   b. TB204, TB203.
   c. T1.
3. 24 v AC is present at:
   a. Coil of K-1.
   b. T1.
   c. TB204.
   d. power sequence panel.

When working in these areas, remove the input power cord or turn off AC power at customer's wall switch.

1. Remove packing material as specified in unpacking instructions. Do not install drawers.
2. Inspect machine for shipping damage especially in the power contactor box, hydraulic power supply, and SMS gates.

WARNING: Applying power to machine with loose or damaged connections in these areas can cause damage to the machine and its surrounding area.

3. Before securing electronic frame to mechanical frame, connect all power cables from mechanical frame to electronic frame. Level electronic frame with mechanical frame. Verify that frame-grounding washers are secured between frames.
4. It is necessary to rearrange some of the components in the I/O area depending upon whether the file is the last one (or only one) of a series of files, or if it is not the last one.
   a. Last File (or only one)
      The End-of-Line Terminators (TCK-), 370334 should be placed in C02, C03, C04, and C05. The dummy biscuit connector (2123269) should be placed in A07.
   b. Not Last File
      The End-of-Line Terminators should be placed in B02, B03, B04, and B05. The dummy biscuit connector should be placed in A01.
5. Swing out the receiver (see Receiver Swing Out, Section 2).
6. Clean the disks. Refer to Disk Cleaning, Section 2.
7. As the drawers are installed (see Drawer Replacement, Section 2), inspect the drawer and clean the heads. These units are adjusted at the plant to be interchangeable with each other.
8. Swing receiver into the array (see Receiver Swing In, Section 2). Check for binds in loading mechanism.
9. Manually load and unload heads to ensure correct alignment. Do not let the heads unload rapidly because this will cause the heads to pivot out of alignment.

WARNING: Never load or unload the heads when they are out of the array.

10. Push access fully into disk array against inner crash stop.
11. Check that the carriage way wipers are not dry and that the way is not dirty.
12. Replace access cover.
13. Before applying power, check that the voltage at outlet agrees with that shown on the nameplate.
14. Set sequence control switches to Local-Manual control then start disk drive motor and check disk rotation as indicated by arrow on filter frame. Turn on electronic DC, gate blowers, solenoid DC, and hydraulic power supply.

WARNING: Do not load the heads.

15. Reinspect drawer profiles.
16. Allow the disk array to run (purge) for 1 1/2 hours before loading the heads.
17. Load heads for 30 minutes.
18. Unload heads and turn machine off. Check run-down time of disk array and compare it to the run down time recorded on the decal in the power sequence gate. Run-down time at installation should not be shorter than recorded time minus four minutes.
19. After the disks have come to a complete stop, remove the access cover and again inspect and clean heads and disks.
20. Manually load and unload heads to ensure correct alignment.
21. Replace access cover.
22. Purge system for 15 minutes before loading heads.
23. Reinspect the heads and disks again at the end of the first, second, and third weeks of operation. After that time, refer to the scheduled Maintenance Routine Chart in Section 1 for correct inspection frequency.

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APPROACH T(

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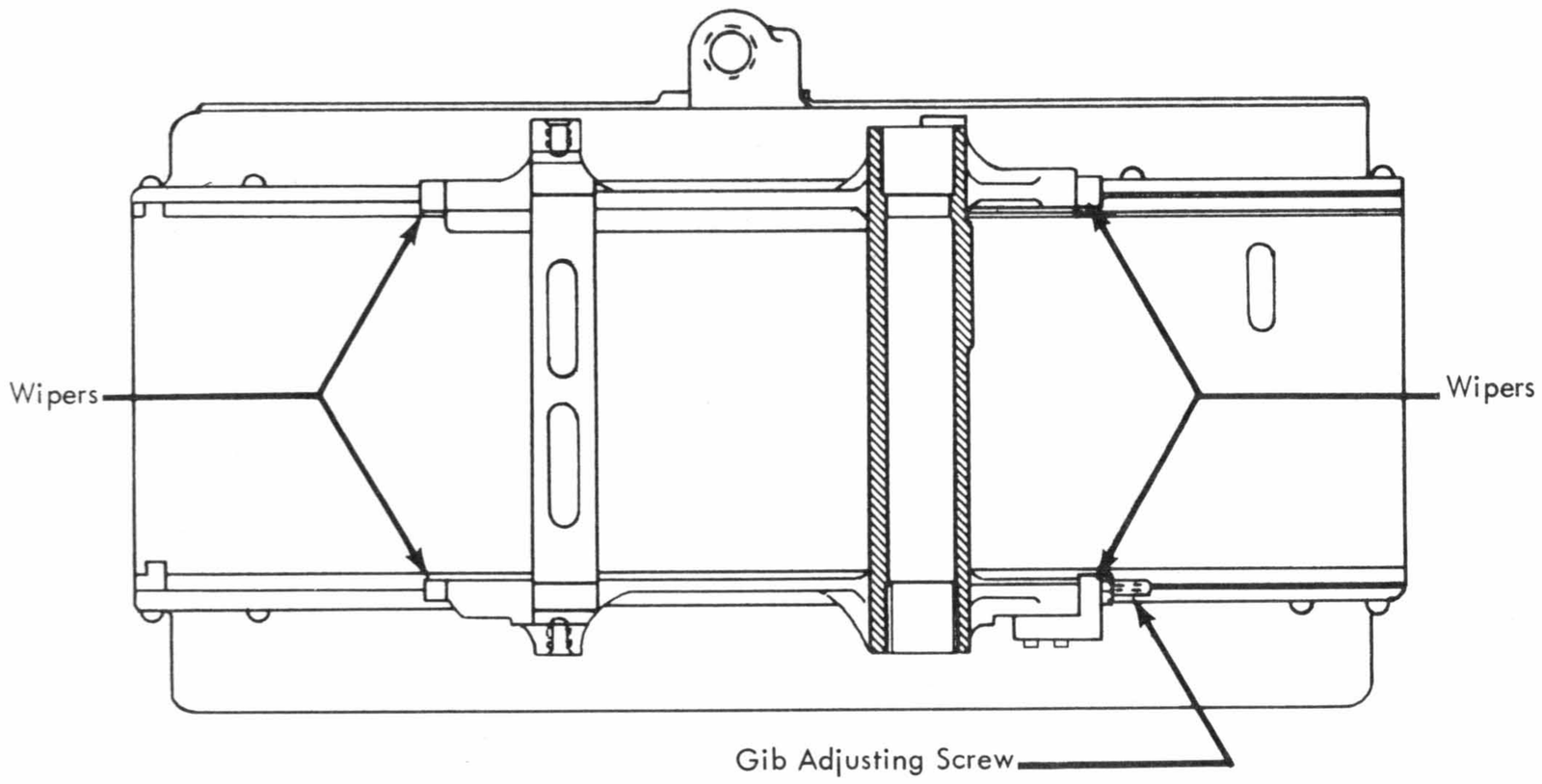


Figure 1-2. Carriage Wiper Locations

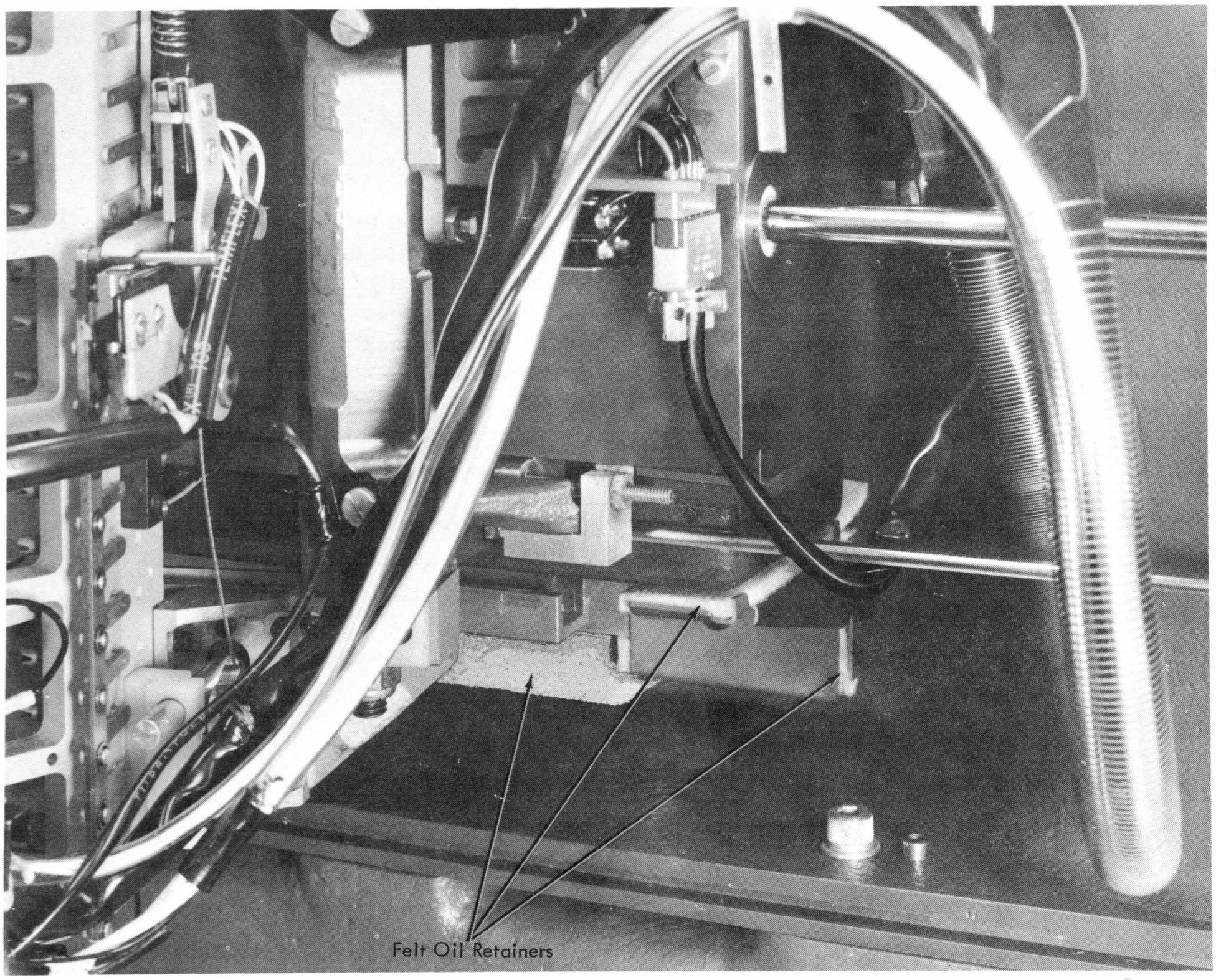


Figure 1-3. Felt Oil Retainers

Adjust Oscillator.

1. Set up a program loop to servo 100 tracks and back.
2. Scope the 33 count trigger at 6C17B and sync on "+ glob got-to-go" at 6B21D. Adjust oscillator at 6C06, so that 6C17B goes plus at 140 ms (±2 ms).
3. Scope "access ready" at 6A16C. Readjust oscillator to obtain 180 ms (+0 ms -2 ms), from "+ glob got-to-go" to "access ready."
4. Set up a program loop to servo 8 tracks and back.
5. Sync on "+ got-to-go" at 6B25A and scope "access ready" at 6A16C to verify 50 ms (+0 -2 ms) from "got-to-go" to "access ready."
6. If greater than 50 ms, reduce oscillator until 50 ms (+0 -2 ms) is obtained.
7. Readjust single shot (6C04) to get 180 ms (+0 -1%). Do not adjust the single shot pulse shorter than 2.0 ms or longer than 5.0 ms.
8. Sync on "+ glob got-to-go" at 6B21D and again scope the 33 count trigger at 6C17B to verify that the time from "glob got-to-go" to the turn off of the 33 count trigger is 140 ms (+2 -2 ms).
9. Scope the 17 count trigger to verify that the time from "glob got-to-go" to the turn off of the 17 count trigger is 115 (+0 -10 ms).

Detent Safety Check — B7.A5.03.1

Detent safety is an indication that the access has slowed enough to allow the detent to be inserted safely.

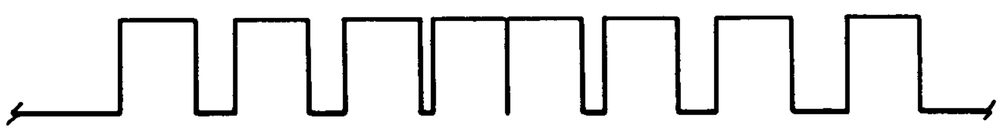


Figure 1-4. Short Stroke

1. Adjust the detent safety integrator (TED - 01A5E12) so a single pulse at the input (pin D) causes a -S pulse out 01A5E12F of at least 7 milliseconds duration.
2. Set address 50 in the access register. Set and reset the register and observe 01A5E12F with an oscilloscope. If the signal looks like Figure 1-4, the integrator pulse is too narrow and should be increased so the picture resembles Figure 1-5.
3. Set and reset different addresses in the access register, detent safety must resemble Figure 1-5 on any address change greater than 50 cylinders. Additional spikes may be seen in the long gap (Figure 1-5) but are of no significance.
4. Address changes from 10 to 49 should also resemble Figure 1-5, but the shorter strokes may begin to resemble Figure 1-4. Changes of less than 10 cylinders will be very erratic about indicating not detent safety condition.

Index Check B7.A5.03.1

Check the time from leading edge of early index (01A5E07B) to leading edge of late index (01A5E07C). This should be 475 ± 15 microseconds. If this time cannot be met by adjusting the late index circumferentially, then check motor speed for possible bearing trouble.

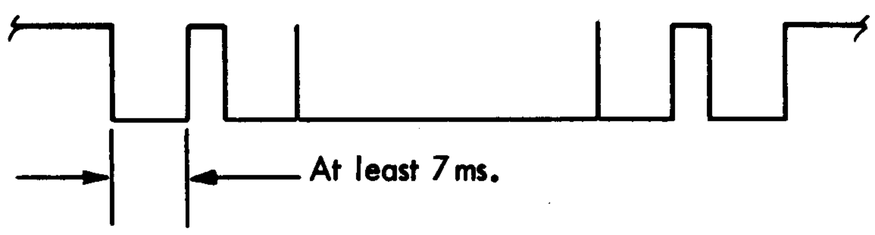


Figure 1-5. Long Stroke

SECTION 2 SERVICING PROCEDURES

CONTENTS

DISK ARRAY

WARNING: If any of the disk array shields are removed, the disks must be cleaned and the disk array must be purged after the shields are re-installed. If the access cover or the access cover door is removed, only purging is necessary. Never run the disk array with shields removed. Never leave the covers off the disk array except when necessary for servicing. The access cover door in the access cover may be opened at any time without stopping the array, but care should be taken to keep out dirt and dust.

Purging

Purging is the process of removing airborn foreign particles from the disk array chamber. These foreign particles are removed by running the array with the heads unloaded thereby replacing the air in the pressurized chamber with filtered air for a prescribed interval of time. The benefit of purging may not be readily apparent, since there is no immediate measurable effect. However, failure to adhere to the process will invite catastrophic consequences. Purging is mandatory.

The purging process will not remove large particles. Therefore, it is essential to maintain extreme cleanliness when the pressurized chamber

or its auxiliary areas are exposed to outside environments during servicing.

Purging is performed by placing the file in a "Local-Manual" mode and manually starting the disk drive motor only. After allowing the disk array chamber to be purged for the prescribed interval, manual sequencing operation may be resumed and the control switches restored to "Remote-Auto."

As a broad guide, purging durations are tabulated below without defining environment. Continued good judgment should be exercised in establishing a sound purging time for each and every occasion.

Service Activity Performed	Purging Time (minutes)	
	Good Environment	Poor Environment
Access Cover Door Removed (with Disk Array stationary)	10	15
Access Cover Removed	15	30
Any Disk Array Shield Removed	30	60
Disk Replaced	45	90
Filter Replaced	45	90
Shaftmotor Replaced	45	90

DISK ARRAY FILTER

Removal

1. Remove AC and DC file power.
2. Remove the canopy over the disk array after it has been vacuumed to remove accumulated dust.
3. Remove filter by loosening the thumb screws and rotating the filter retaining hooks.
4. Lift filter off the filter holder surface, being careful not to allow any loose dirt to drop into the array.
5. Vacuum the machine area under the filter, being careful to vacuum all corners where particles may accumulate.

Replacement

1. Remove the replacement filter from the box and plastic bag in which it is shipped. Handle with care so filter will not be damaged in any way.
2. Check filter by holding it next to a strong light and looking through filter. If any tears or pin holes of light are seen, the filter must not be used.
3. Place the filter in position with the gasket resting on the filter holder. Check that the filter seats all around the holder surface, then tighten the filter retaining hooks by hand as tightly as possible.
4. Run the array with the actuator at track 0 and the heads unloaded for 45 minutes to purge the system and the new filter. Remove the filter after the array has stopped, revacuum as before and re-assemble the filter to the machine.

<u>WARNING:</u> Do not run the array if the filter is not securely in place, as head and disk damage can result.

5. Remove actuator cover and clean disks by using the disk cleaning paddle covered with lint free tissue. If dirt adheres to the disk surface, isopropyl alcohol may be used on the tissue (see Disk Cleaning).
6. Vacuum all areas and surfaces exposed by the actuator cover removal. Replace the actuator cover.
7. Purge array for 15 minutes before loading heads.

DISK ARRAY SHIELDS

<u>Plastic Shields - Front and Rear</u> (Figure 2-1)

Removal

1. Remove AC and DC power.
2. Vacuum false floor and all surfaces surrounding the shields.
3. Remove access cover (see Access Cover).
4. Remove vertical trim (Figure 2-1).

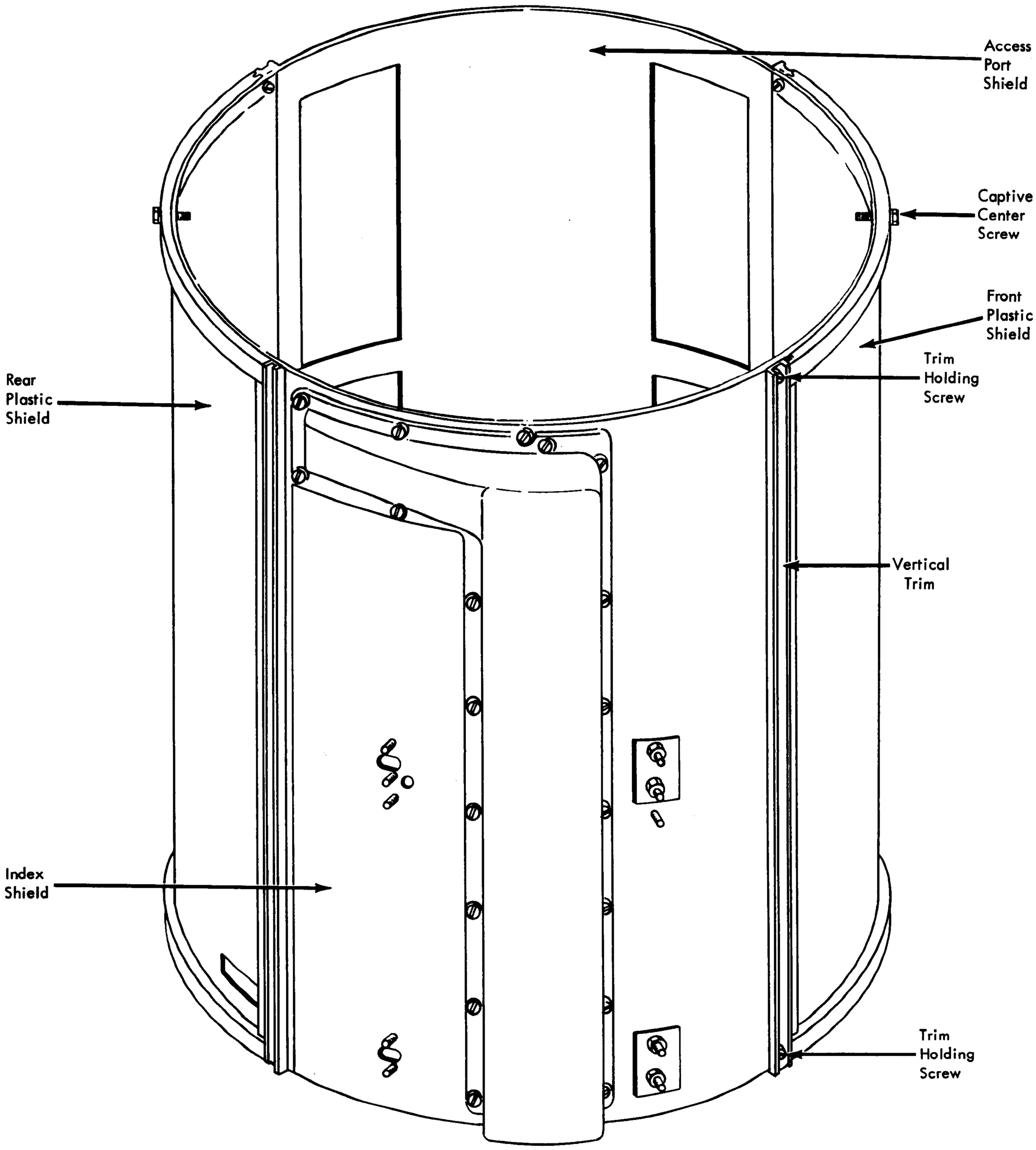


Figure 2-1. Disk Array Shields

5. Loosen the captive center screws and remove the shield.
6. Use a vacuum cleaner to remove any foreign particles from the surfaces and rubber seals exposed by the shield removal. Do not vacuum the disks.

Replacement (Figure 2-1)

1. Clean the plastic shield with isopropyl alcohol and lint free tissue.
2. Secure the shield loosely with the captive center screw.
3. Install the left vertical trim (nearest the index shield) as far as possible toward the plastic shield and tighten trim holding screws.
4. Tighten the center captive screw.
5. Install access cover (see Access Cover).
6. Install and adjust the right vertical trim so that it retains the access cover securely but allows the access cover to be removed without loosening the trim holding screws. Tighten the trim holding screws.
7. Purge the array for 30 minutes.

Index Shield (Figure 2-1)

Removal

1. Remove AC and DC Power.
2. Vacuum false floor and all surfaces around the shield.
3. Remove the two rear most screws from the top and bottom of the front support casting and rotate casting 90° away from the disk array.
4. Remove vertical trim from each side of index shield.
5. Remove shield holding screws and shield. Do not remove the blue air duct from shield.
6. Use a vacuum cleaner to remove any foreign particles from the surfaces and rubber seals exposed by the shield removal. Do not vacuum the disks.

Replacement

WARNING: Back off tranducers one revolution before installing index shield. This is to allow for any difference in compression of the rubber gasket around the disk array when the shield is replaced.

1. Replace index shield and secure with shield holding screws.
2. Place vertical trim as close as possible to plastic shield and secure in place.
3. Adjust transducers (see Index Heads).
4. Purge array for 30 minutes.

Access Port Shield (Figure 2-1)

Removal

1. Remove AC and DC power.
2. Vacuum false floor and all surfaces around the shield.
3. Swing out all receivers (see Receiver Swing Out Procedure).
4. Remove vertical trim from each side of shield.
5. Remove shield holding screws.
6. Lift shield approximately 1/4" and remove from rear of machine.
7. Vacuum all surfaces exposed by shield removal. Do not vacuum disks.

Replacement

1. Replace access port shield and secure with shield holding screws.
2. Install and adjust the vertical trim so that it retains the access cover securely but allows the access cover to be removed without loosening the trim holding screws. Tighten the trim holding screws.
3. Swing in receiver (see Receiver Swing In Procedure).
4. Purge array for 30 minutes.

INDEX HEADS

Service Check

The +S output pulse of the index amplifiers (TEB-01A5E07B and 01A5E07C) should be a minimum of 25 microseconds (Figure 2-2).

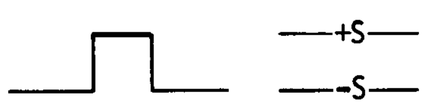


Figure 2-2. Correct Index Pulse

Figure 2-3. Incorrect Index Pulse

If either output resembles Figure 2-3, check the respective index amplifier input for a minimum shift of 1.3 volts. If less than 1.3 volts, adjust the transducer air gap.

The time between the positive leading edges of the outputs at the early and late index amplifiers should be 475 microseconds plus or minus 25 microseconds (Figure 2-4).

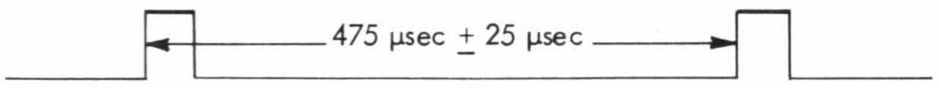


Figure 2-4. Early to Late Index Timing

Adjustment

Adjust the gap between transducer pole tip and disk pole tip by rotating transducer until the required voltage output is obtained (Figure 2-2). Gap should be .015" ± .005".

WARNING: Adjust transducer inward slowly, as contact with disk pole tip can cause serious damage.

Replacement

1. Mount the index-head assembly to the index shield so that both transducer pole tips are in horizontal alignment with the index pole tip on the format disk within .020". Tighten nut to retain the index-head assembly.
2. Locate register plate relative to the bottom surface of the index-head assembly and tighten nut.

DISKS

Cleaning

Any time that any of the disk array shields has been removed, the disks must be cleaned. This cleaning is very important and must be done carefully as outlined below. Cleaning can be done through the access entry port of the disk array shield. Use only isopropyl alcohol for cleaning disks and heads.

CAUTION: Isopropyl alcohol and its vapors are flammable and must be kept away from open flames or lighted cigarettes.

1. Swing out receiver and secure with swing-out brace. If drawers have been removed, it is not necessary to swing out receiver; just return it to the outer crash stop.
2. Wrap the disk cleaning paddle with an approved lint free tissue dampened, not soaked, with isopropyl alcohol. A tissue that is soaked in alcohol can dissolve part of the dirt that is being removed and redeposit the dirt on the surface of of the disk. However, a completely dry tissue should not be used either.
3. Place paddle between disks and rotate the disk array manually (Figure 2-5). If the surfaces of the disks are wet after cleaning, too much alcohol was used on the tissue, and the disks should be cleaned again properly.
4. Clean the disks until the contamination is removed. If the first tissue comes out dirty, reclean the disk. Use clean tissues for each surface of the disk.

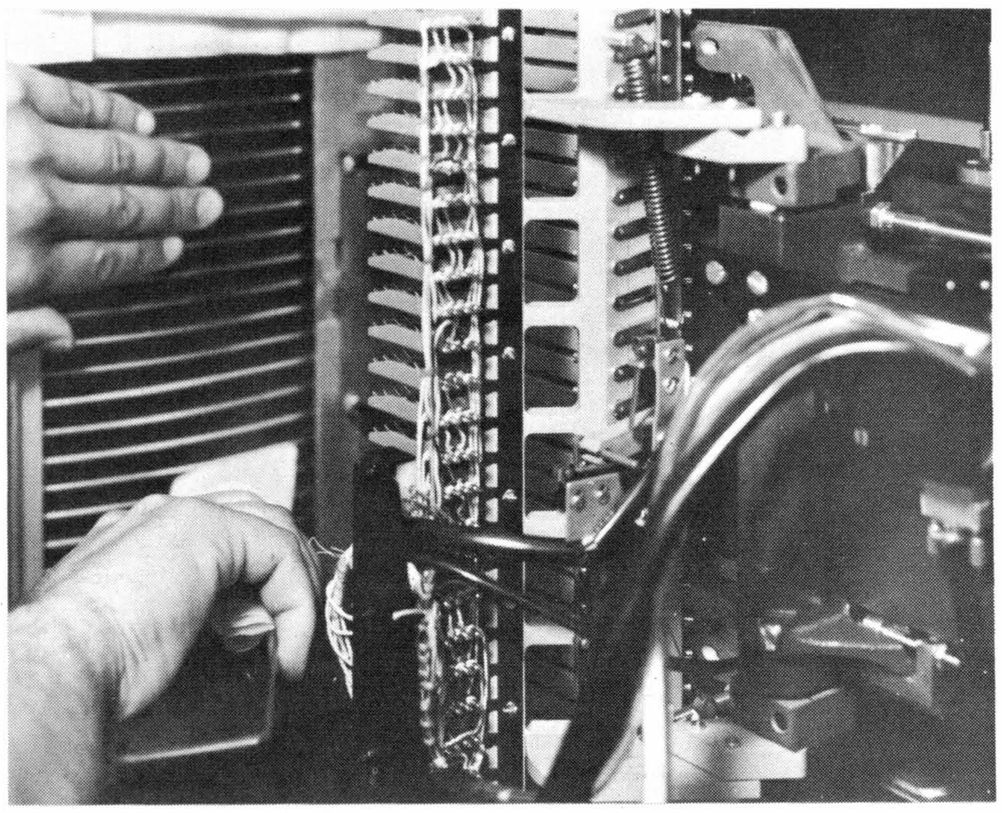


Figure 2-5. Cleaning Disks

When it is necessary to clean individual disks that are not in the file, place the disks on a flat cushioned surface (for example, a desk or table padded with several layers of lint free tissue) to prevent scratching the recording surfaces of the disk.

1. Wipe the top surface of the disk with a tissue dampened with isopropyl alcohol. The surface of the disk should dry shortly after the tissue is removed. Use fresh tissues when the original tissue becomes dirty and for each new disk surface that is cleaned.
2. Turn the disk over and clean the bottom side.
3. Replace any disk that does not clean well or has deep scratches.

WARNING: Handle all disks with nylon gloves to prevent putting fingerprints on the disks.

Removal

1. Obtain disk replacement kit (P/N 2108433) from Emergency Parts Center (E. P. C.).
2. Remove AC and DC file power.
3. Remove glass doors from both sides of the machine.
4. Swing out receiver and remove drawers. After drawers are out, secure receiver with swing-out brace.

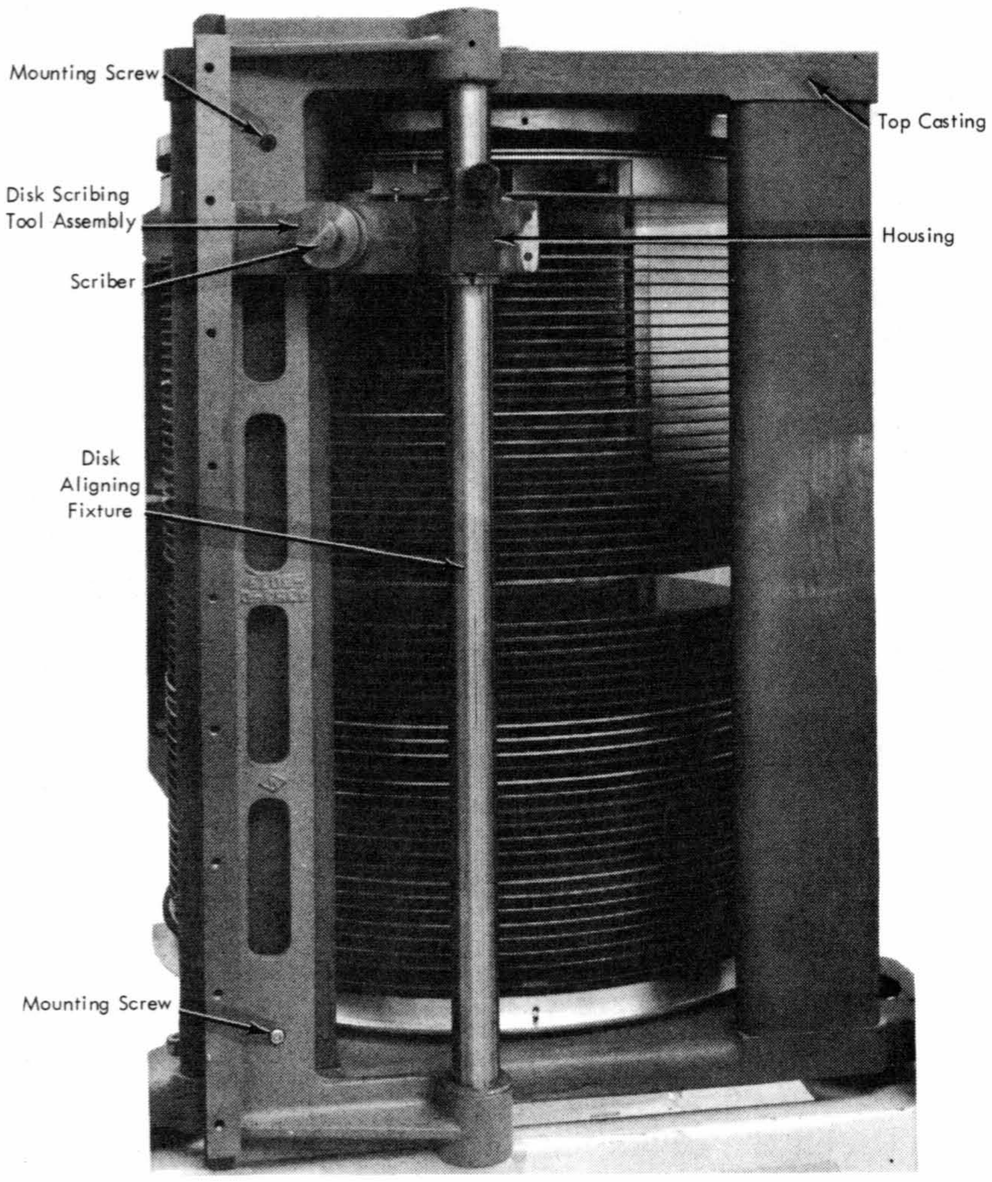


Figure 2-6. Disk Scribing and Aligning Fixture

5. Remove canopy grill and disk array filter.
6. Remove all shields that house the disk array.
7. Mount the disk scribing and aligning fixture assembly (Figure 2-6) to rear support casting and tighten the two screws to 140 ± 10 inch lb torque.

WARNING: Do not loosen these screws until disks have been reinstalled and realigned.

8. Rotate shaft motor until high point arrow (H ↑ P) is at front of machine as shown in Figure 2-7.
9. Lock shaft motor with the shaft motor clamp to keep disks from rotating during the disk scribing operation (Figure 2-8).

NOTE: If the disks have been previously scribed, these scribe marks may be used for realignment, and rescribing is unnecessary; however, verify that all disks are scribed and properly aligned before using any previous marks.

If the previously scribed marks are not to be used, mark them out with a narrow (1/8" to 1/4") ink strip. (A wide strip could be confused with the error free area.)

10. Insert the disk scribing tool assembly into housing (Figure 2-6). Rotate scriber until point is just short of making contact with edge of disk (Figure 2-9). Move scribing tool up and down over the full length of disk edge, while slowly rotating scriber, until disk is scribed. Start with top disk and repeat this sequence until all disks are scribed. Back out scriber while moving from one disk to another. Remove scriber.
11. Remove locking bolt (Figure 2-7). During this removal process, the locking bolt will exert a lifting force on the bottom of the screw retaining plate. This lifting force will raise the screw retaining plate and the shaft support, thereby separating the shaft support from the motor stationary shaft. Do not remove locking bolt or shaft support from top casting, but raise it so that its underside is flush with bottom of top casting. Block in position to prevent its falling and damaging disk surfaces. (Use wooden block from Disk Alignment Kit.)
12. Remove the two rearmost screws from the top and bottom of the front support casting and rotate casting 90° clockwise, away from the disk array (Figure 2-7).
13. Remove the six screws (Item Ⓐ Figure 2-10) which fasten the impeller housing assembly to the top casting.
14. Remove four screws (Item Ⓑ Figure 2-10) which fasten top bowl assembly to top casting. Remove top bowl through front of the machine (Figure 2-11).
15. Remove four screws (Item Ⓒ Figure 2-10) which fasten impeller to top clamping ring. The impeller housing cover, impeller housing, and impeller can be removed through the front of the machine as an assembly (Figure 2-11).
16. Remove the six disk clamping ring screws (Item Ⓓ Figure 2-10) and the clamping ring.
17. As each spacer and disk is removed from the shaft motor, index them numerically on the top side with a brush type ink pen. Mark disks in the uncoated area where the disk part number is stamped. Start numbering spacers and disks with #1.

Replacement

NOTE: Use a vacuum cleaner (approved IBM style) during disassembly and reassembly to remove chips and dirt generated by removal and replacement of screws. Before restacking disks, vacuum disk-array chamber thoroughly and search out all corners and crevices to remove any accumulated dust, dirt, and chips.

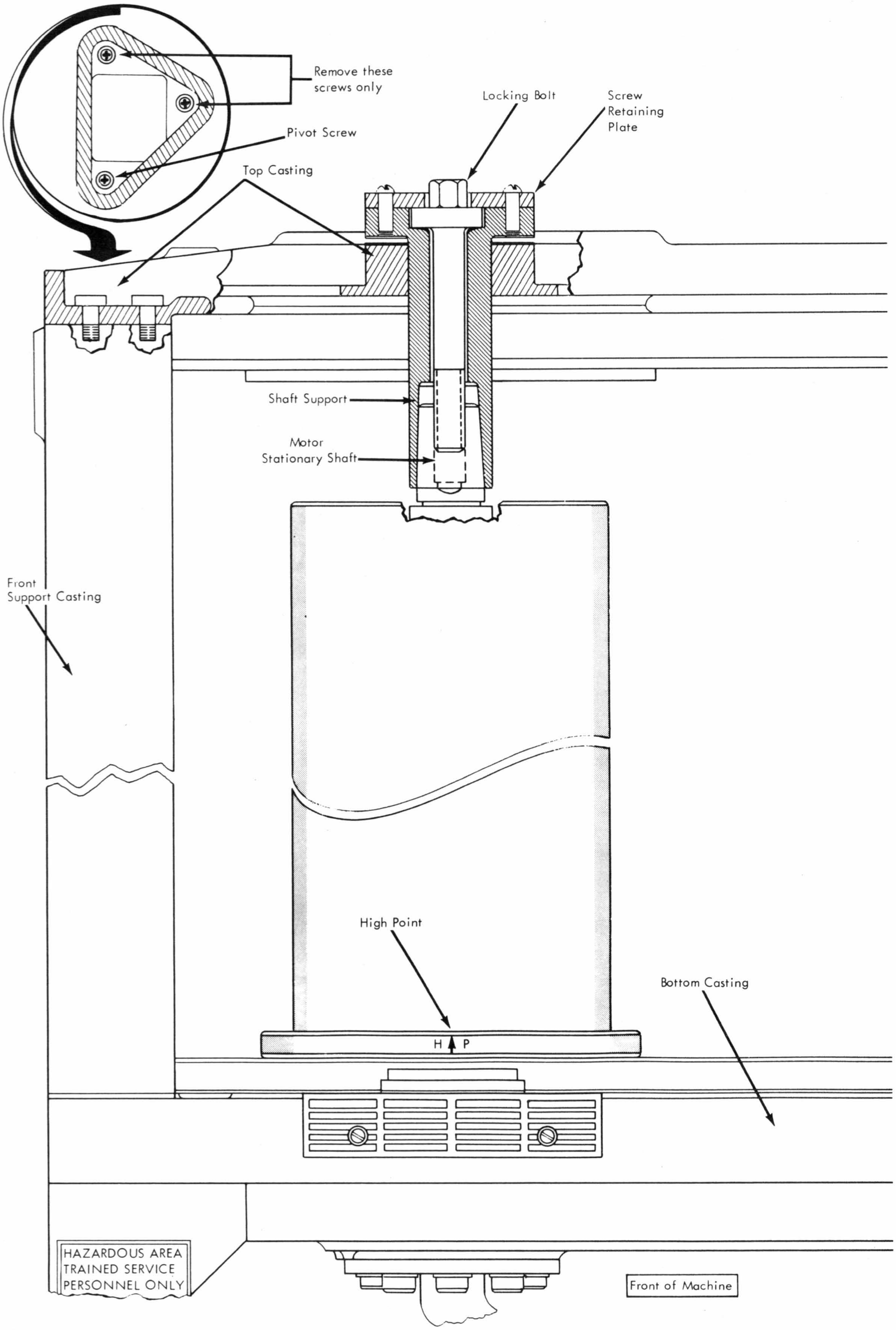


Figure 2-7. Shaft Motor

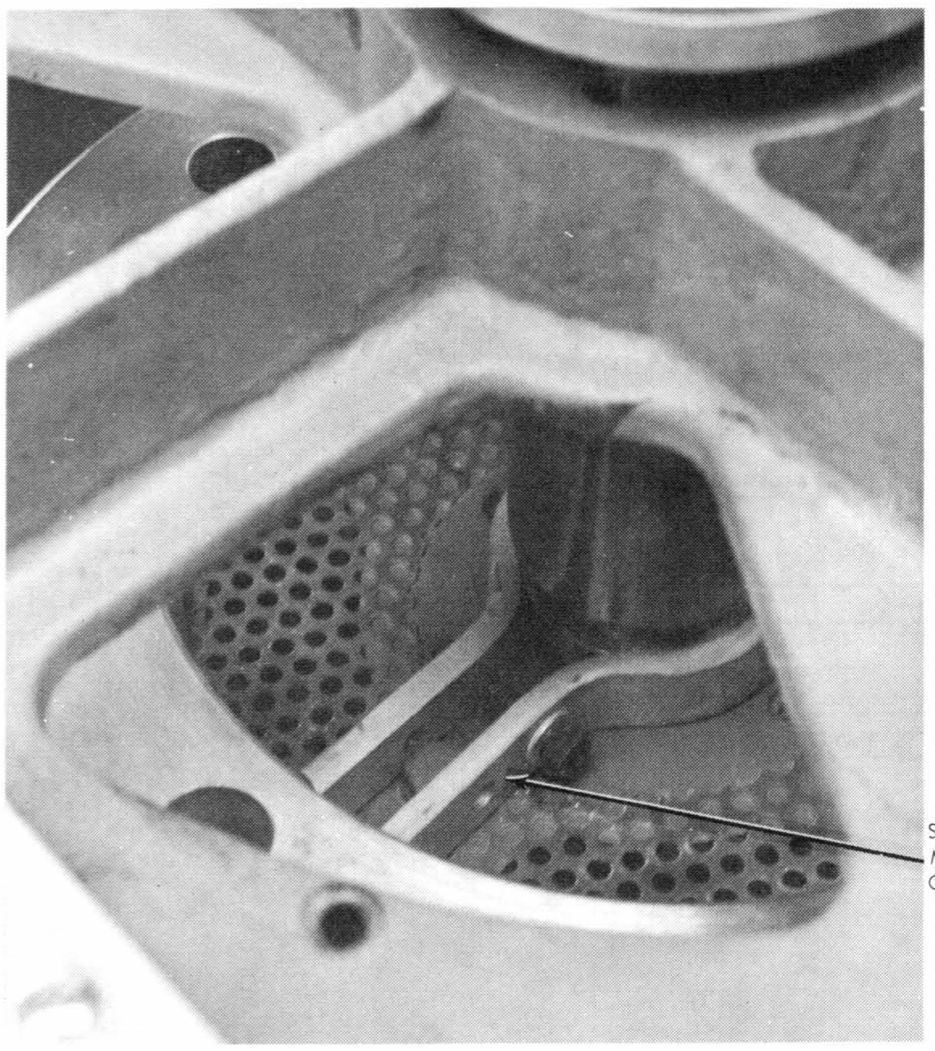


Figure 2-8. Shaft Motor Clamp

WARNING: Precautions should be taken to prevent dropping any metal chips or dirt into the top of the shaft motor or disk array during assembly.

1. If the spacer below the clock disk was removed, install it with its scribed mark aligned within .5" of the shaft motor high point (H↑P). All other spacers are self aligning and must be installed highest numbered spacer first. Check each spacer spring for damage and replace if necessary.
2. Install first disk (highest numbered) with P/N facing upward. The leading edge of error free sector (dimple on edge of disk) must be aligned within .5" of the shaft motor high point (H ↑ P).

WARNING: Do not rotate disks after they are put on the spacer; the spacer aligning blocks can shave the disk inner edge.

3. Install microscope into disk aligning fixture in scriber mounting. Rotate microscope until the vertical cross hair is lined up with the center of the scribe mark (Figure 2-12).
4. Install balance of disks and spacers in numerical sequence. Wipe each disk with isopropyl alcohol and lint free tissue. Replace any scratched disks. Align each disk as it is installed.

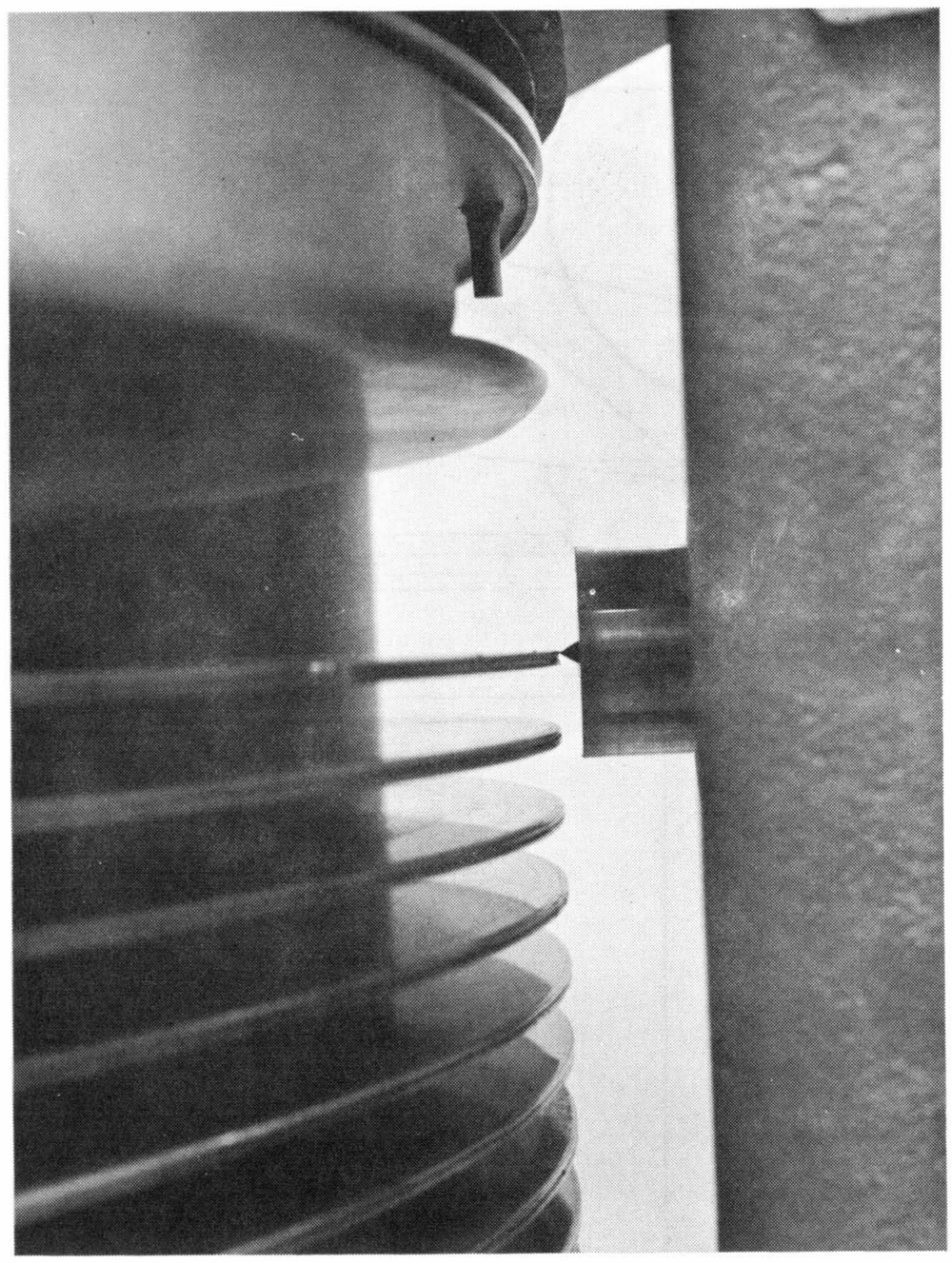


Figure 2-9. Disk Scribing

NOTE T-1301: If the sector disk is replaced align the index scribe mark on sector disk within .010" of the pole tip on format disk (Figure 2-13). If a format disk has been replaced, align the leading edge of the pole tip on format disk in the top module to the leading edge of the pole tip on the format disk in the lower module within .062" measured as viewed in the microscope.

NOTE: Due to the thickness of the rubber gasket on the spacer assembly on the two module file, it is possible that only 49 disks can be installed the first time. It is necessary to install the top spacer assembly and the top clamping ring to compress the array. Use the three long clamping-ring screws to secure the disk-clamping ring to the shaft motor. Tighten the disk-clamping ring screws evenly with 230" ± 10" lb. torque.

5. Remove screws, clamping ring, and top spacer and install last disk and reclamp to 230" ± 10" lb torque. Recheck two or

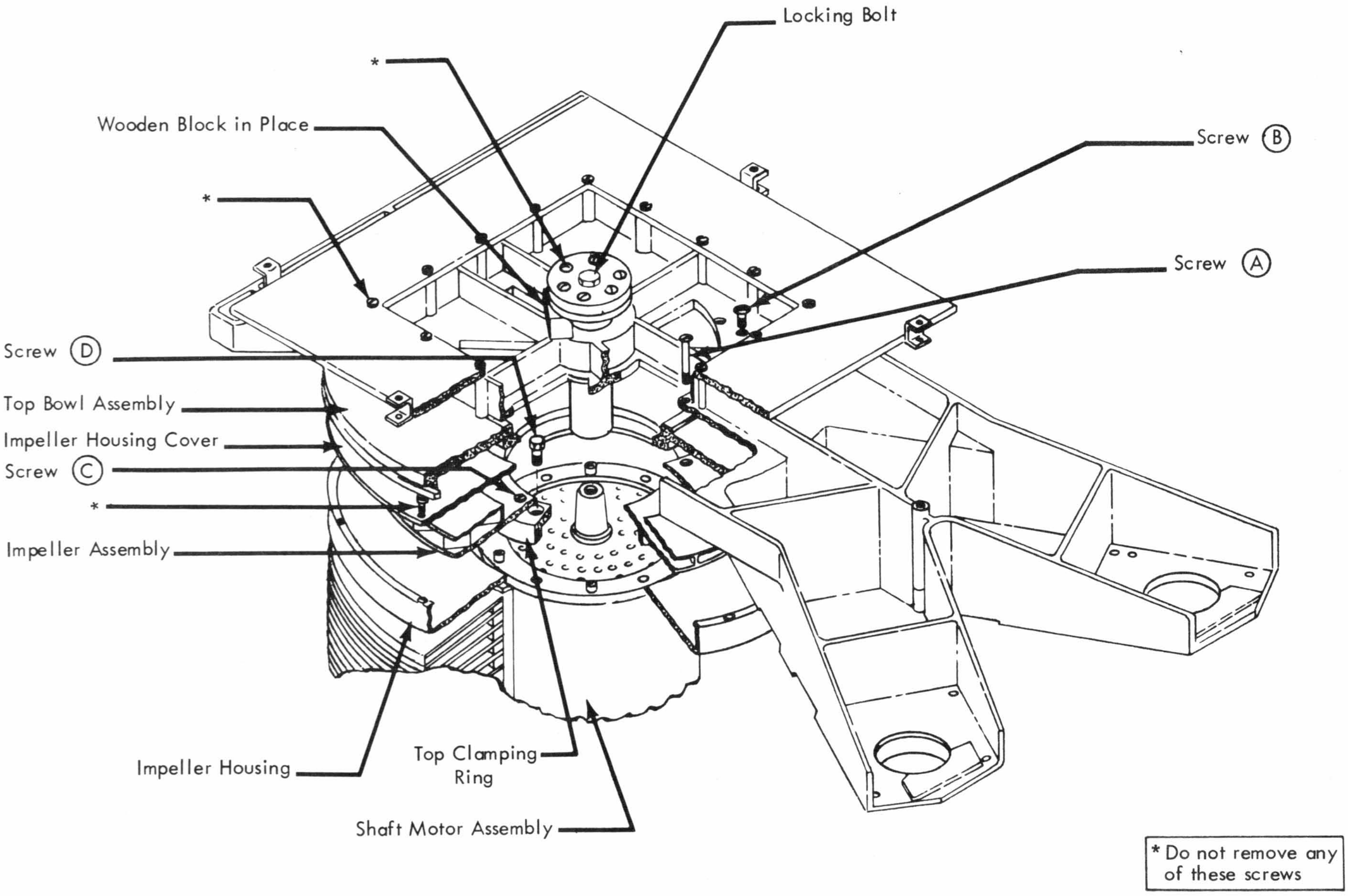


Figure 2-10. Disk Array Disassembly

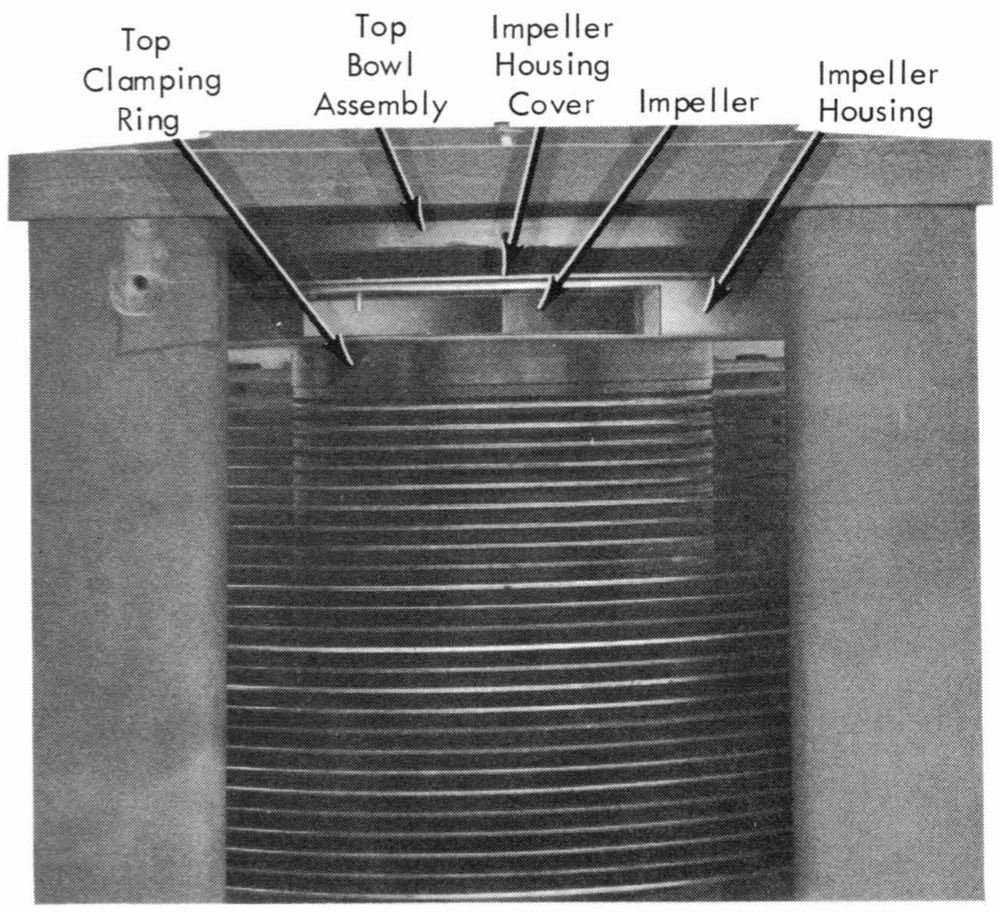


Figure 2-11. Disk Array Assembled

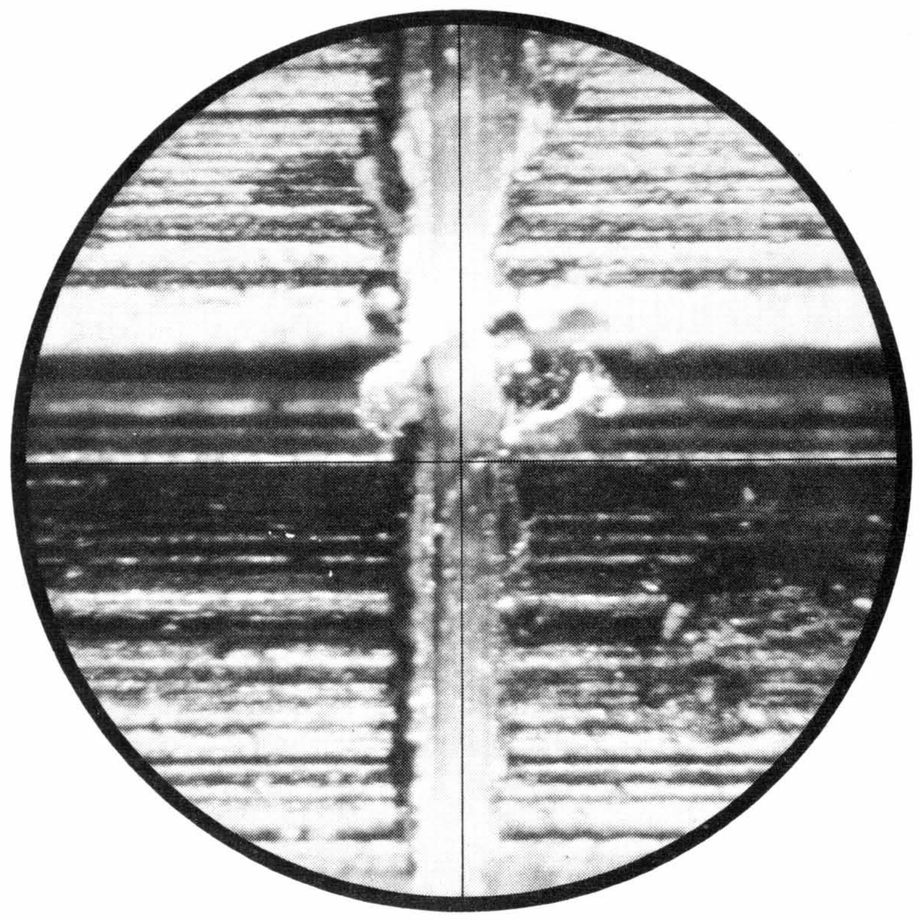
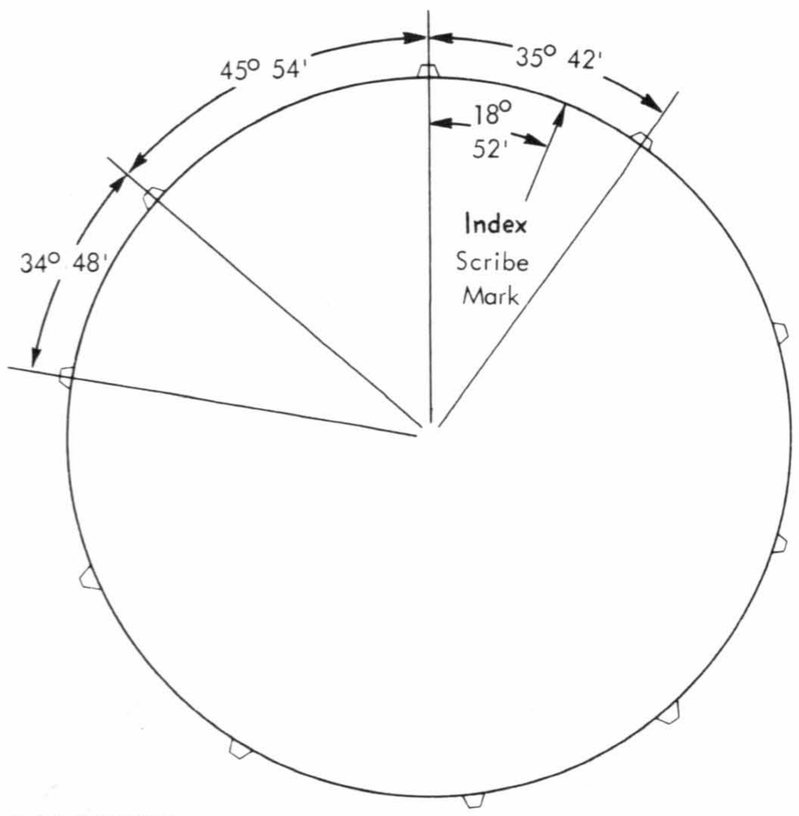


Figure 2-12. Magnified Scribed Line on Disk



P/N 2122923

Figure 2-13. Sector Disk (T 1301)

three disks to verify that the scribe marks have not moved during the clamping operation.

6. Check disk runout of every fifth disk with dial indicator from Disk Aligning Kit. Measure runout at 3/16" ± 1/16" from the edge of the disk while turning the array manually through a full revolution. Runout should not exceed a total indicator reading of .020". Measure runout from the bottom surface of the disk.
7. Remove the disk aligning tool from the rear support casting, place in shipping crate, and return to E. P. C.
8. Install disk array shields.
9. Clean the disks. Refer to Disk Cleaning.
10. Mount the drawer assemblies to the receiver (refer to Drawer Installation), swing in the receiver (refer to Receiver Swing In Procedure), and mount the access cover.
11. Purge the file for at least 45 minutes before loading the heads on the disks under power.
12. Perform a complete read/rewrite of the file to align formats, addresses, and data.

DISK SHAFT MOTOR

Service Check

The start of a shaft motor failure may be indicated by:

1. Noisy bearings
2. Timing problems in the machine
3. Overloads do not stay closed
4. Thermal switch opens on starting
5. Rundown time less than 60% of that recorded on decal.

Removal

Order the following parts from the emergency parts center, B/M 2115248 (Shaft Motor and Instructions), B/M 2108430 (Fixture-Disk Aligning), B/M 2108247 (Shaft Motor Hoist Assembly and Instructions). Special tools required for replacement will be shipped with the shaft motor.

Disk Drive Thermal Overload Switches

Service Hint

A "spare" thermal overload switch is installed on the disk drive motor. Should the switch become defective, the spare switch can be installed by interchanging the leads X2 and X1 located in the contactor cabinet (Figure 2-14). The switch appears on page B7.C1.05.0 of the 1301 system diagrams.

RECEIVER ASSEMBLY

Swing-Out Procedure (Figures 2-15 and 2-16)

1. Remove all power to machine.

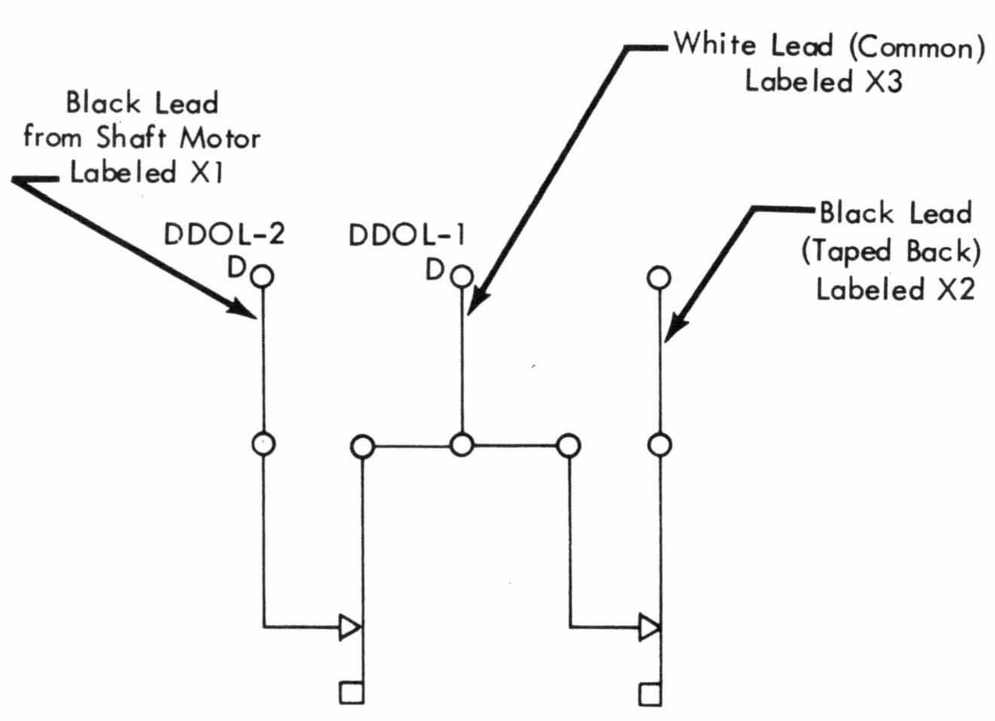


Figure 2-14. Additional Disk-Drive-Motor Thermal

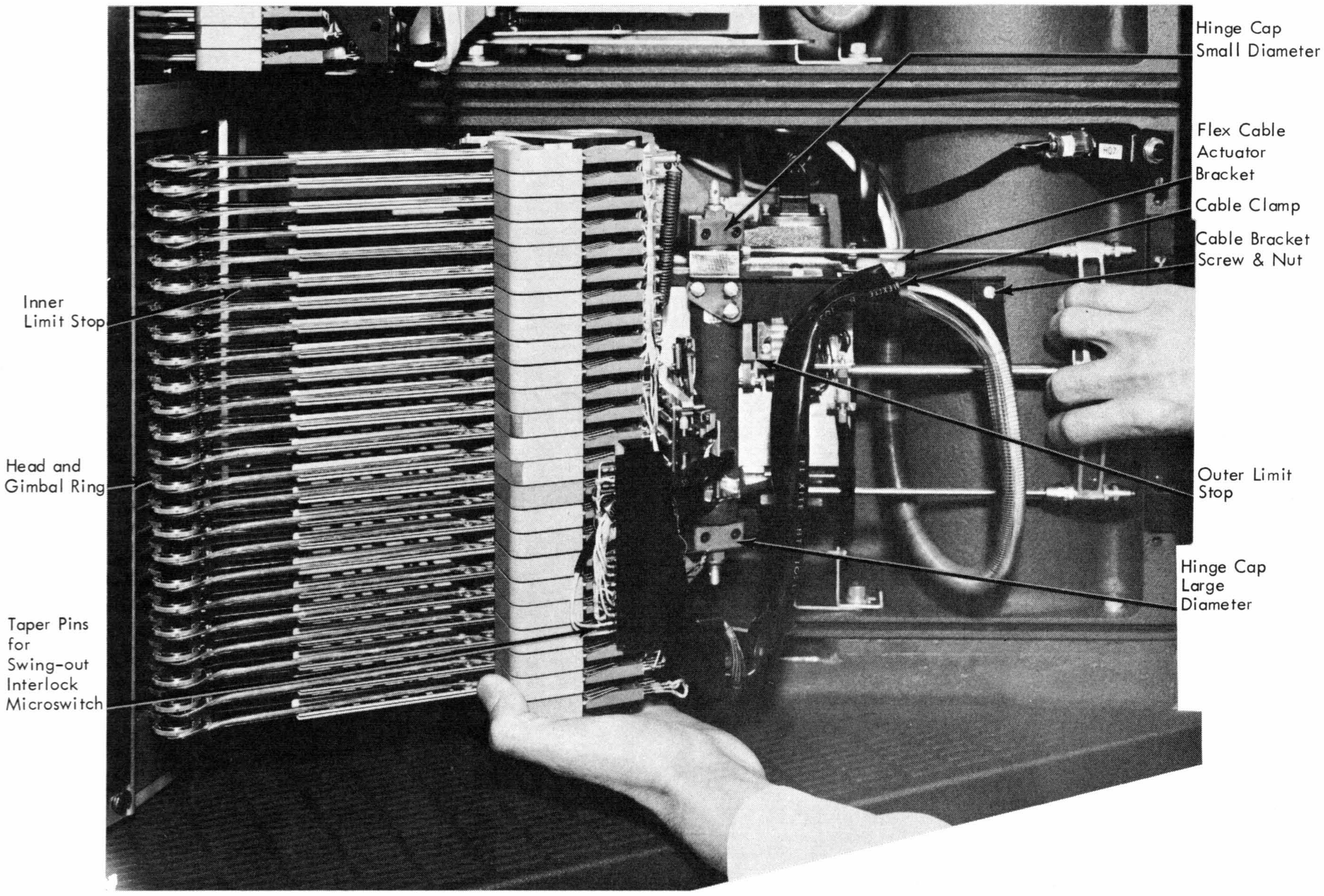


Figure 2-15. Receiver Swing-Out Procedure

2. Release the nylon dowel in the lower left-hand corner of the inner glass-door moulding by moving the dowel retaining slide (under moulding) to the right.
3. Remove access cover.
4. Move carriage to outer limit stop.
5. Retract carriage locking pins. Apply a slight inboard pressure on the receiver to aid retraction. Do not press on arms or stiffeners.
6. Move linkage release lever to unlocked position toward receiver hinge shaft. Move rail linkage so that it clears roller on rack assembly.
7. Swing receiver out carefully. Make sure gimbal rings clear the disk array shields and glass doors.
8. Engage swing-out brace with knob on locking pin.

WARNING: Any time receiver is swung out, drawers and heads are in an extremely vulnerable position. Do not leave the receiver unattended while in this position.

9. Cover access-entry port with a lint-free tissue.

Swing-In Procedure (Figures 2-15, 2-16, and 2-17)

WARNING: Never load heads when they are out of the disk array.

1. Check that all arms are in contact with stiffener ends.
2. Swing in receiver and align heads.
   a. Remove swing-out brace.
   b. Move carriage to outer limit stop.
   c. Move linkage release lever to unlocked position. Move rail linkage so that it clears roller on rack assembly.

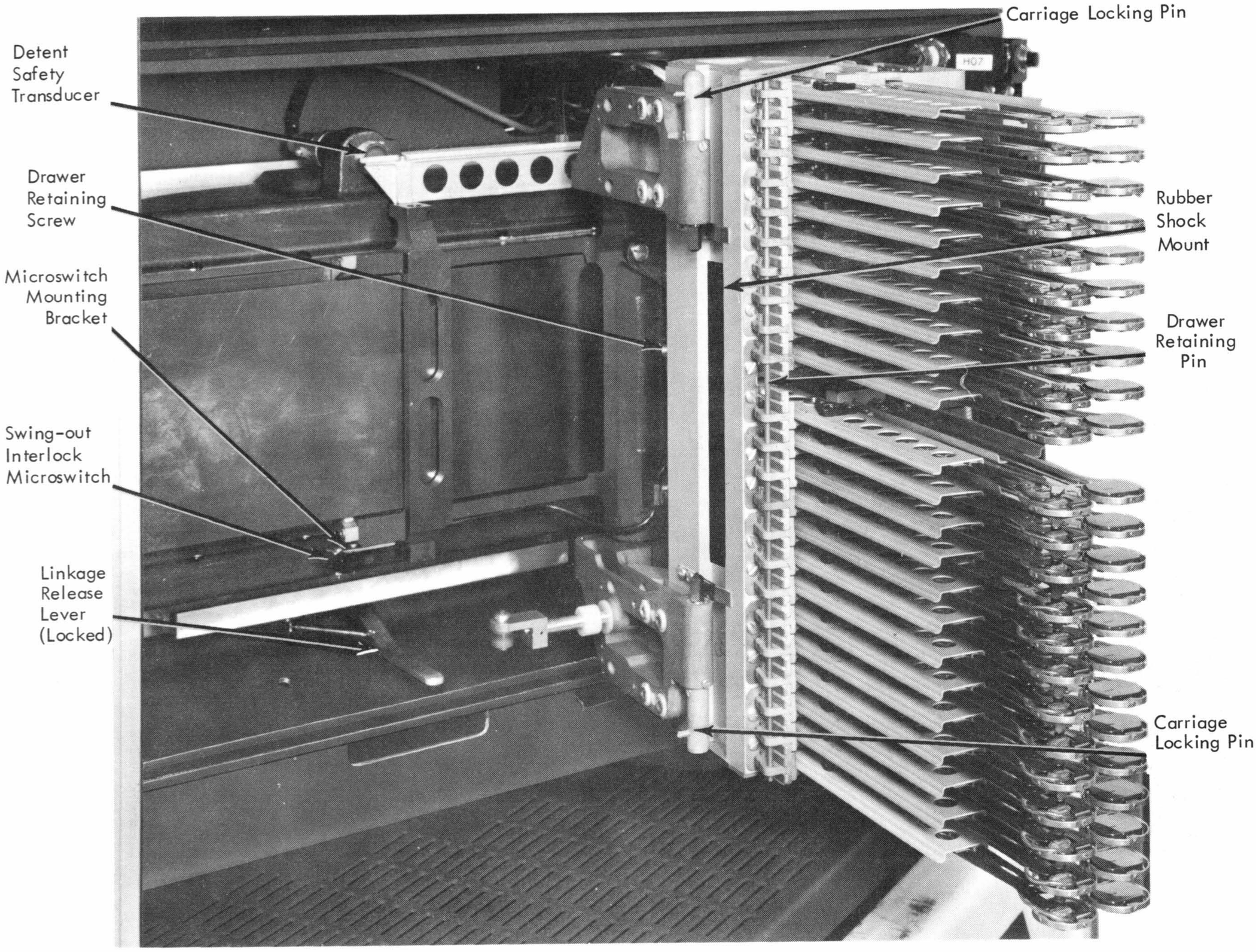


Figure 2-16. Receiver in Servicing Position

d. Swing receiver in carefully. Make sure that carriage is against outer limit stop and channel straddles rack roller.
e. Press on receiver to seat locking pins. Do not put any pressure on arms and stiffeners.
f. Return linkage release lever to locked position - approximately perpendicular to face of strut.
g. Manually rotate main drive link to load and align heads with disk surfaces. Unload the heads.

3. Check head unload and microswitch contact. When in proper adjustment, .090" gage should place main drive link in a horizontal position.
4. Check electrical contact of swing-out interlock microswitch (see Swing-Out-Interlock Microswitch Adjustment).
5. Check drawer assembly profile.
   a. Move carriage to outer limit stop position and check clearance between each head-pair profile and the disk surfaces when the heads are unloaded. The distance between head and disk should be a minimum of .050" on each side of drawer profile (Figure 2-17). Profile should be checked throughout a complete disk revolution by rotating the disks manually. This same procedure should be followed with the carriage positioned against the inner limit stop. To adjust the receiver relative to the disks, add or subtract shims from shim spacers next to small diameter hinge arm (Figure 2-18).
   b. Move carriage to inner limit stop. Sight

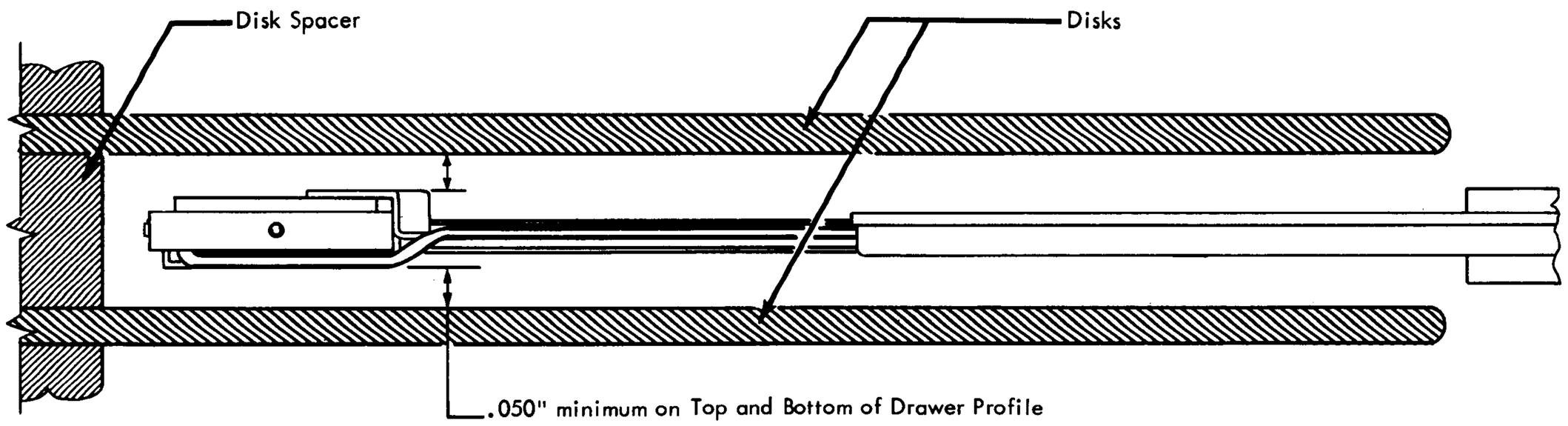


Figure 2-17. Drawer Assembly Profile

along disk spacers as carriage moves in so closing gap between gimbal rings and disk spacers is visible. Pitch pivot screw on gimbal ring should have a visible clearance from spacer when carriage is against properly adjusted inner limit stops.

c. Load heads by picking R-125. (Tie R-125-A coil to ground.)

WARNING: Do not rotate disk array or move carriage while heads are loaded.

6. Check head load and microswitch contact.
   a. Check that cable is within scribed lines on gear surface, which indicates proper over-center position. Be sure there is no gap on rack during measurement (see Gear and Rack Adjustment).
   b. Check for a .110" crank-to-crank spacing and clearance between crank and main drive link (see Cable Adjustment).
   c. Unload heads by releasing R-125.
   d. Return carriage to outer limit stop.
   e. Load heads by picking R-125. (Tie R-125-A coil to ground.)
   f. Check that gear is past top dead center (between the scribed lines). Check for a minimum clearance of .005" between rack roller and rail, when there is no gap on rack (see Air Cylinder Nose Adjustment).
   g. Check that head-load microswitch is made.
7. Check proper engagement of torsion spring fingers with arms.
8. Unload heads by releasing R-125.
9. Reinstall access cover and purge (see Purging).
10. Move carriage to inner limit stop before hydraulic power supply is started. This is necessary because the action of moving the carriage back and forth has "uncalibrated" the hydraulic circuit.

RECEIVER AS AN ASSEMBLY

Removal (Figures 2-15, 2-16, 2-18 and 2-19)

1. Swing out receiver (see Receiver Swing-Out Procedure).
2. Remove drawer retaining pin and drawer assemblies.
3. Loosen but do not remove the screws and nuts that secure adapter to buttress (top and bottom buttress) (Figure 2-19).
4. Remove screws that retain adapter on hinge arm assembly (top and bottom hinge arm) (Figure 2-19).
5. Loosen but do not remove large-diameter hinge cap.
6. Loosen but do not remove hinge shaft nuts.
7. Disconnect two taper pins for swing-out interlock microswitch (use special extraction tool).
8. Remove data and format cable paddles from their corresponding electronics panel. Disconnect interlock switch cable at its connector, H04 (behind strut).
9. Remove flex-cable actuator bracket.
10. Draw cables through casting port.
11. Remove cable-bracket nut and cable clamp.
12. Remove both hinge caps. Remove receiver. This step requires two people.

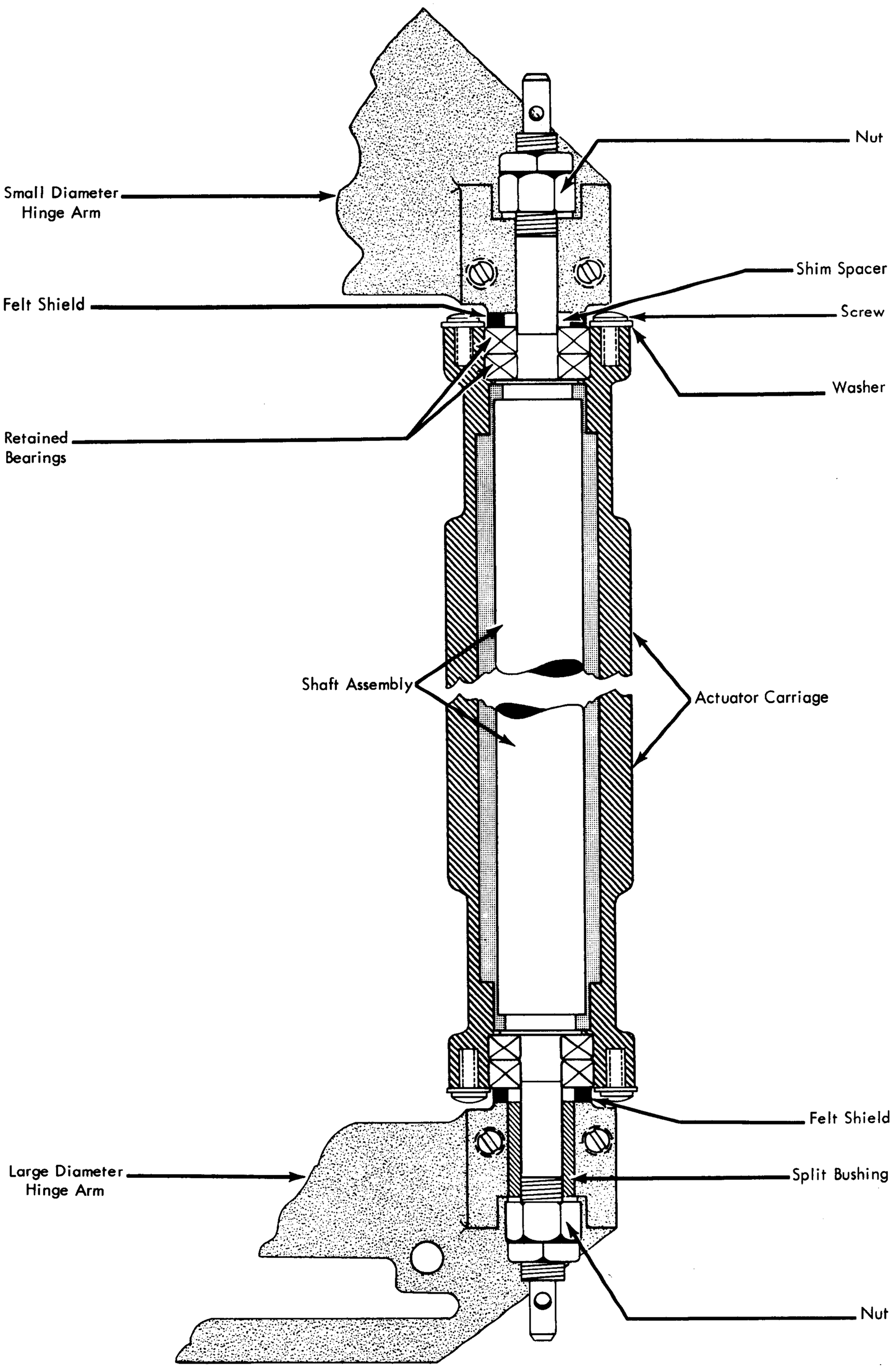


Figure 2-18. Hinge Shaft Assembly

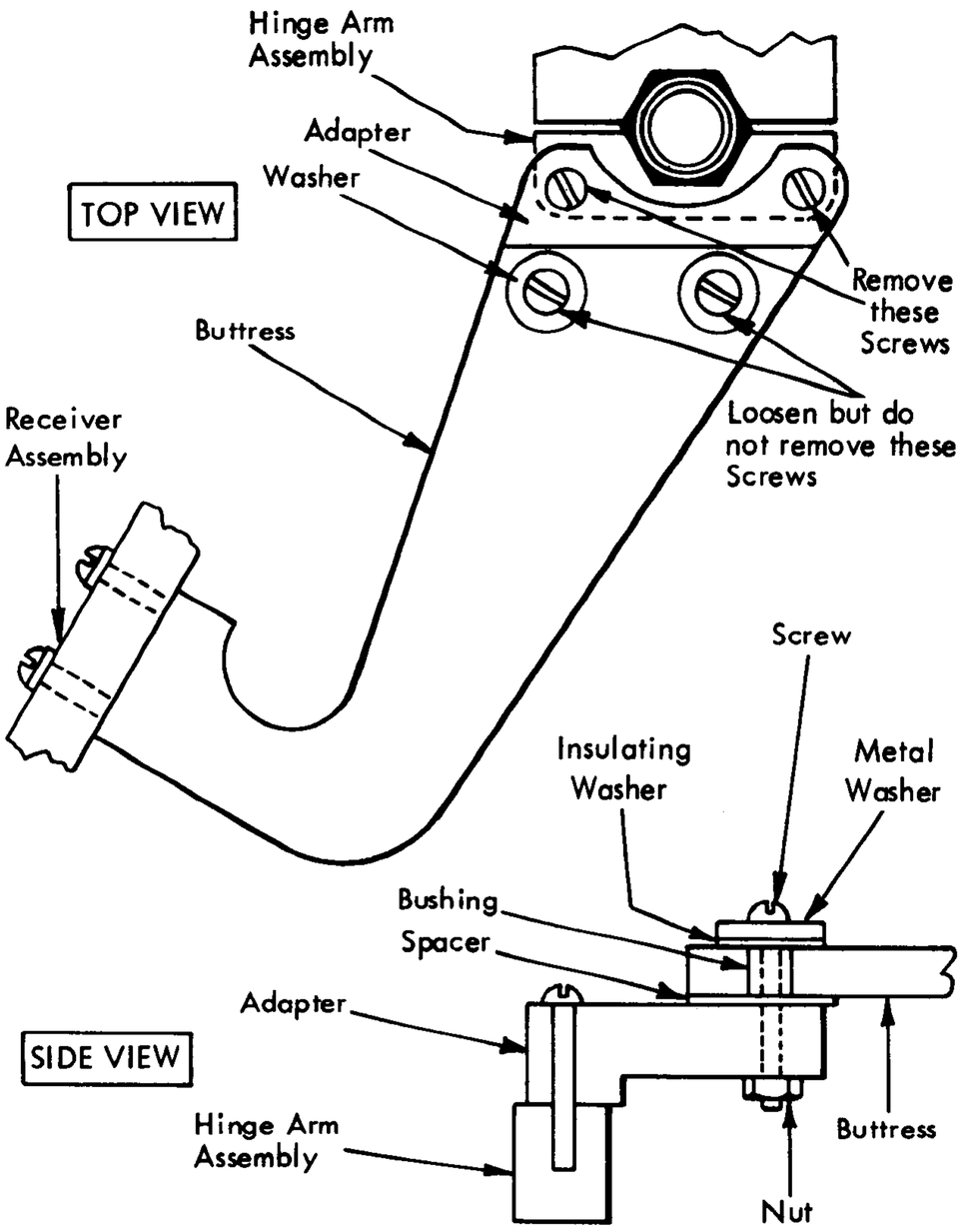


Figure 2-19. Buttress and Adapter Assembly

Replacement (Figures 2-15, 2-16, 2-17, 2-18, and 2-19)

1. Move carriage to outer limit stop.
2. Position receiver hinge arms on shaft assembly. Ensure correct position of washers, felt shields, and spacer during assembly. This step requires two people.
3. Loosely assemble hinge caps to arms.
4. Swing in receiver and press to seat locking pins.
5. Install cable bracket nut and cable clamp.
6. Tighten hinge assembly:
   a. With shaft assembly against retained bearings, tighten hinge cap screws while maintaining an even gap on each side of cap.
   b. Loosen each cap screw by turning it approximately 30°. This allows shaft to move within caps during following step.
   c. Torque nuts to 50" ± 10" lb. Place a set screw wrench in one of the holes provided in ends of the shaft, or use a wrench on the opposing nut to keep shaft from turning.
   d. Tighten cap screws.
   e. Replace the two screws that retain adapter on hinge arm assembly. Tighten screws and nuts that secure adapter to buttress (top and bottom buttress assemblies) (Figure 2-19).
7. Feed cables through casting port.
8. Mount flex-cable actuator bracket.
9. Check that the receiver and cable bracket are electrically isolated from carriage.
10. Connect swing-out interlock microswitch taper pins, (use special insertion tool) data and format cable paddles, and interlock switch cable connector, H04.
11. Swing out receiver and engage swing out brace.
12. Install drawer assemblies and drawer retaining pin.
13. Swing in receiver (see Receiver Swing-In Procedure).

Adjustment

Head Unload. Proper position of unloaded heads requires a .090" distance between the stop screw and main drive link when the main drive link is in a horizontal plane (Figure 2-20). Proper adjustment can be attained in the following manner:

1. Loosen jam nut.
2. Adjust stop screw. The specified distance can be obtained by positioning the link horizontally with the stop screw using either of the following methods and then by turning the screw counterclockwise three turns.
   a. Adjust the stop screw until the ends of the main drive link are equal distances from the top of the receiver.
   b. Place the end of a scale rule against the actuator face as you would a carpenter's square and align link to the edge of the rule.
3. Tighten jam nut.
4. Adjust head unloaded microswitch so that the switch just makes with a .020" gage between the stop and main-drive link.

Head Load. The head load adjustment is done in three steps. These steps must be done in order.

Gear and Rack. Proper over-center relationship of gear and rack exists when there is no gap at rack and cable is within scribed lines on gear surface (Figure 2-21). (Use a 6" scale as a square placed against the gear surface to determine if the cable lies between the scribed lines.) These scribed lines indicate the required .018" to .096" over-center perpendicular distance from pin to a line passing through the gear center and tangent to the outside diameter of roller.

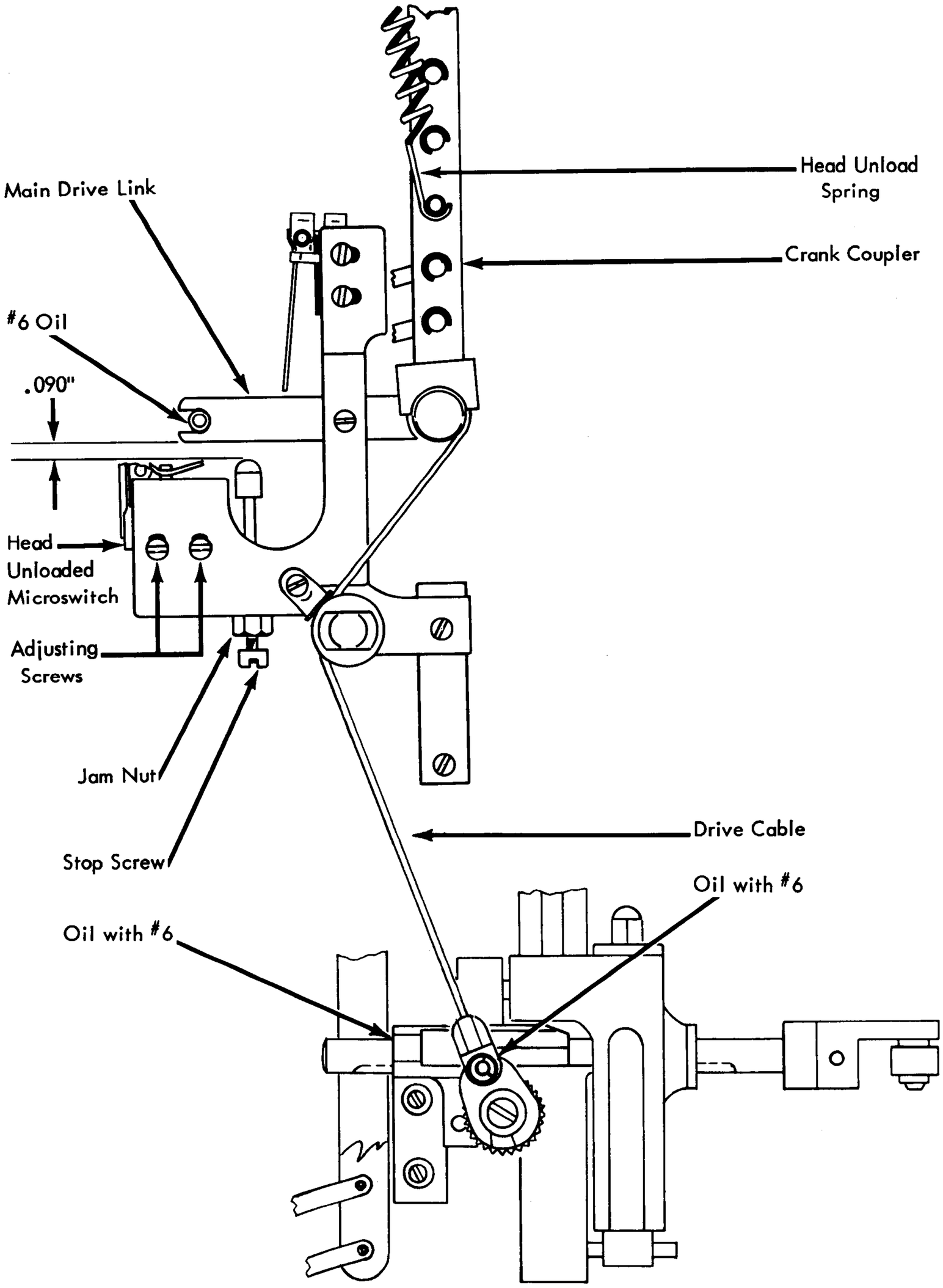


Figure 2-20. Head Unload Adjustment

Proper adjustment can be obtained in the following manner:

1. Unload heads and release head unload spring.
2. Loosen cable keeper screw and move keeper away from roller.
3. Disengage cable from roller.
4. Loosen gear mounting screw sufficiently to allow gear to be disengaged from rack. Check rack freedom in guides. Rotate gear to obtain proper relationship of gear and rack. (One tooth rotation is equivalent to .078" at the pin.)
5. Tighten gear screw and recheck over center position.
6. Engage cable in roller, reset cable keeper, and engage head unload spring.

Cable (Figures 2-21 and 2-22). Proper cable length can be determined only when gear and rack relation-

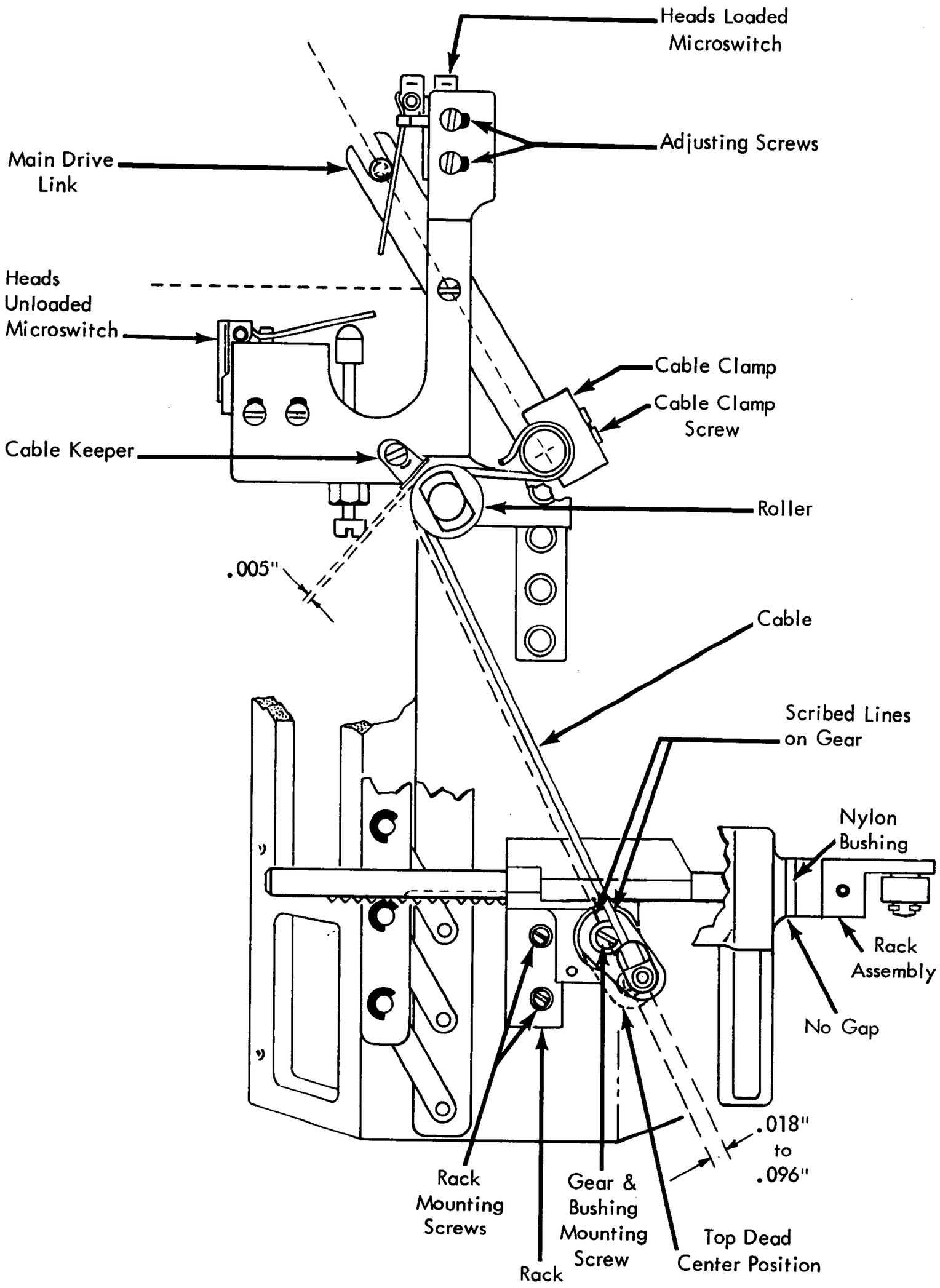


Figure 2-21. Gear & Rack & Cable Adjustment

ship is in proper adjustment.

With heads loaded and no gap at rack, the average distance between the pair of cranks that are opposite the 1/8" square mark on the receiver should not exceed .110" (Figure 2-22). This distance can be measured by using gage P/N 2108577. If .110" is exceeded, the cable is too long. A minimum clearance must also exist between cranks and main-drive-link pivot. If interference is noted, cable is too short (Figure 2-22).

WARNING: Do not rotate disk array or move carriage while heads are loaded.

Proper adjustment can be attained in the following manner:

1. Unload heads and remove head unload spring.
2. Loosen cable clamp screw about one turn.

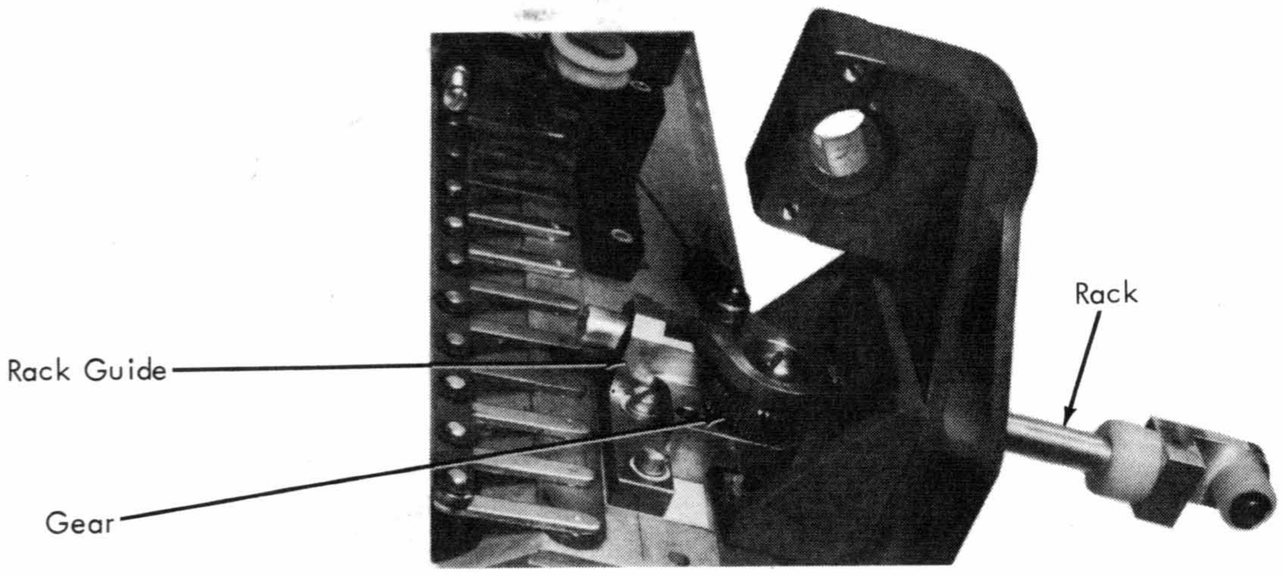


Figure 2-22. Receiver

3. Adjust cable as required.
4. Tighten screw.
5. Load heads and recheck.
6. Adjust head loaded microswitch so that it makes when heads are loaded.
7. Engage head unload spring.

Air Cylinder Nose (Figures 2-23, and 2-24).

Proper air cylinder nose positions can be established only when gear and rack relationship is in proper adjustment. With heads loaded, two conditions must be met (Figure 2-21):

1. The gear must pass top dead center with no gap at the rack.
2. There must be a minimum of .005" clearance between rack roller and rail, with no gap at rack. If the rack roller and rail are in contact with gap at rack, manually move rack assembly to close gap, then check for the specified minimum clearance.

   If clearance is less than .005", rotate nose clockwise in 180° intervals until the proper clearance is obtained.

WARNING: Do not rotate disk array or move carriage while heads are loaded.

DRAWER ASSEMBLY

Drawer As An Assembly

NOTE: Format drawers are not interchangeable with data drawers.

Adjustment

The magnetic elements in the drawer assembly are precisely located during manufacturing. In rare instances, however, adjustment may be necessary. Each head and its arm can be adjusted in a radial direction only, with respect to the disk array. The adjustment is accomplished by rotating the screw which is held captive in the drawer frame (Figure 2-25). Access to these screws is provided through the rear of the receiver.

The operating mode of the machine and the proper terminals from which to pick up the output of the heads are set forth in Read Circuits. While adjusting, bear in mind that one full rotation of the adjusting screw moves the pole tips approximately .018". It is unlikely that more than 1/3 of a turn will be required to obtain maximum head output.

To avoid the effects of friction and backlash, it is important, when adjusting heads, to make sure the final motion of the screw is clockwise as viewed from the rear of the receiver. A clockwise motion of the adjusting screw moves the head radially outward on the disk, i.e., in the direction of the lower numbered tracks. If, in adjusting, a clockwise movement of the screw reduces the signal strength, then the screw must be rotated

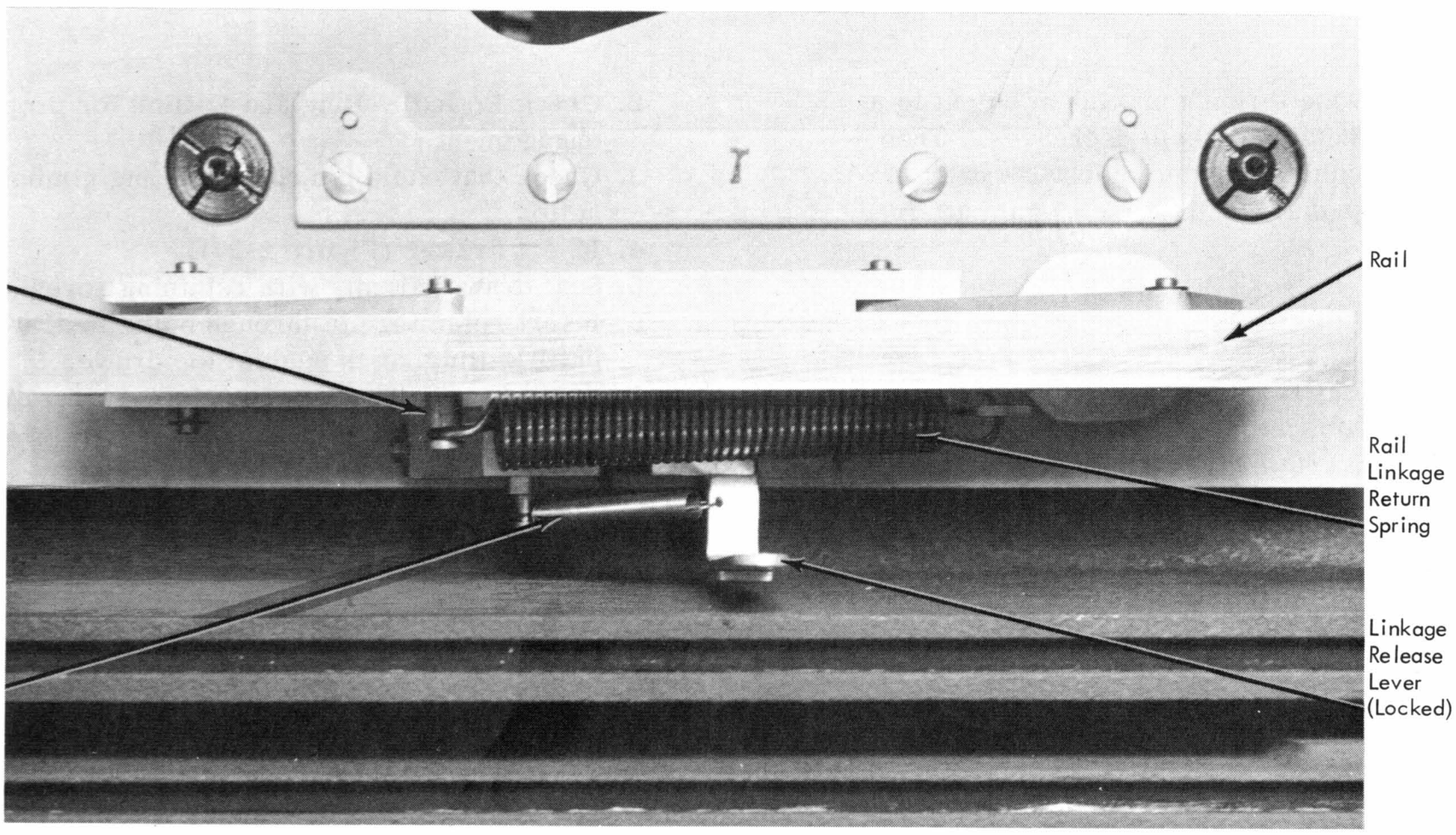


Figure 2-23. Rail Linkage

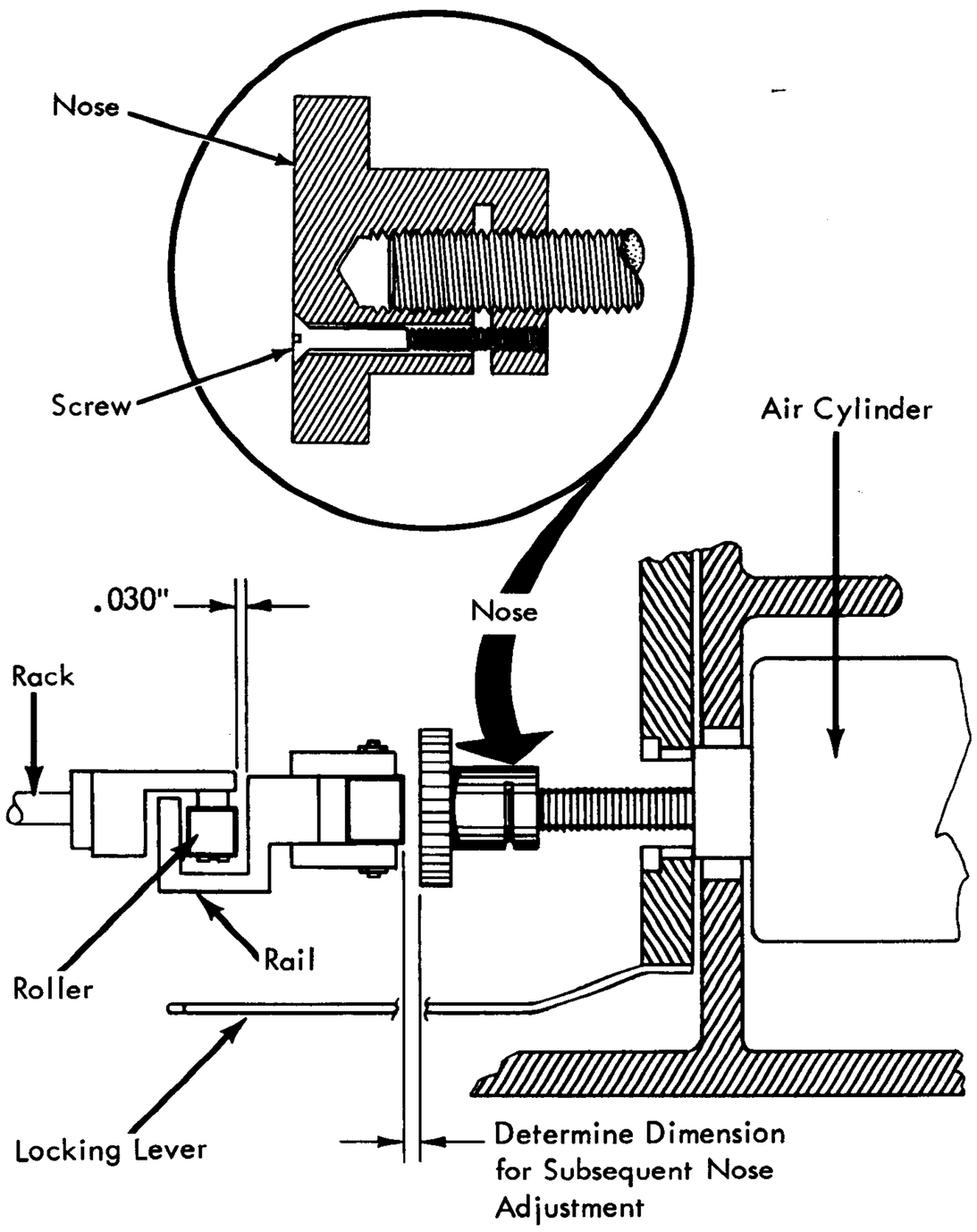


Figure 2-24. Air Cylinder Nose Adjustment

counterclockwise through maximum output to a point where the signal again decreases. Then the screw should be rotated clockwise until the maximum signal strength is once again attained.

Removal

1. Swing out receiver.
2. Remove drawer retaining pin (Figure 2-16).
3. Loosen drawer retaining screw.
4. Remove drawer by applying a clamping force with index fingers and pushing on adjacent drawers with thumbs (Figure 2-26). Drawer assemblies must be handled with care. Never handle assembly by stiffeners or arms.

Replacement

1. Check proper engagement of torsion-spring fingers with arms (Figure 2-25).
2. Check Bowed E-Ring and E-Ring for proper engagement.
3. Check that cable is not restricting gimbal action.
4. Insert drawer (Figure 2-27).
5. Seat drawer firmly with retaining screw.
6. Insert retaining pin through holes in drawers until E-Ring rests against top drawer.
7. Swing in receiver (see Receiver Swing-In Procedure).

Head

WARNING: Electrical arcing between the head and disk can occur if a voltage of about 25 v is applied between the isolated receiver and frame ground. This amount of voltage will cause damage under the following conditions:

1. Assuming AC and DC grounds are isolated, arcing may occur if a DC voltage is shorted

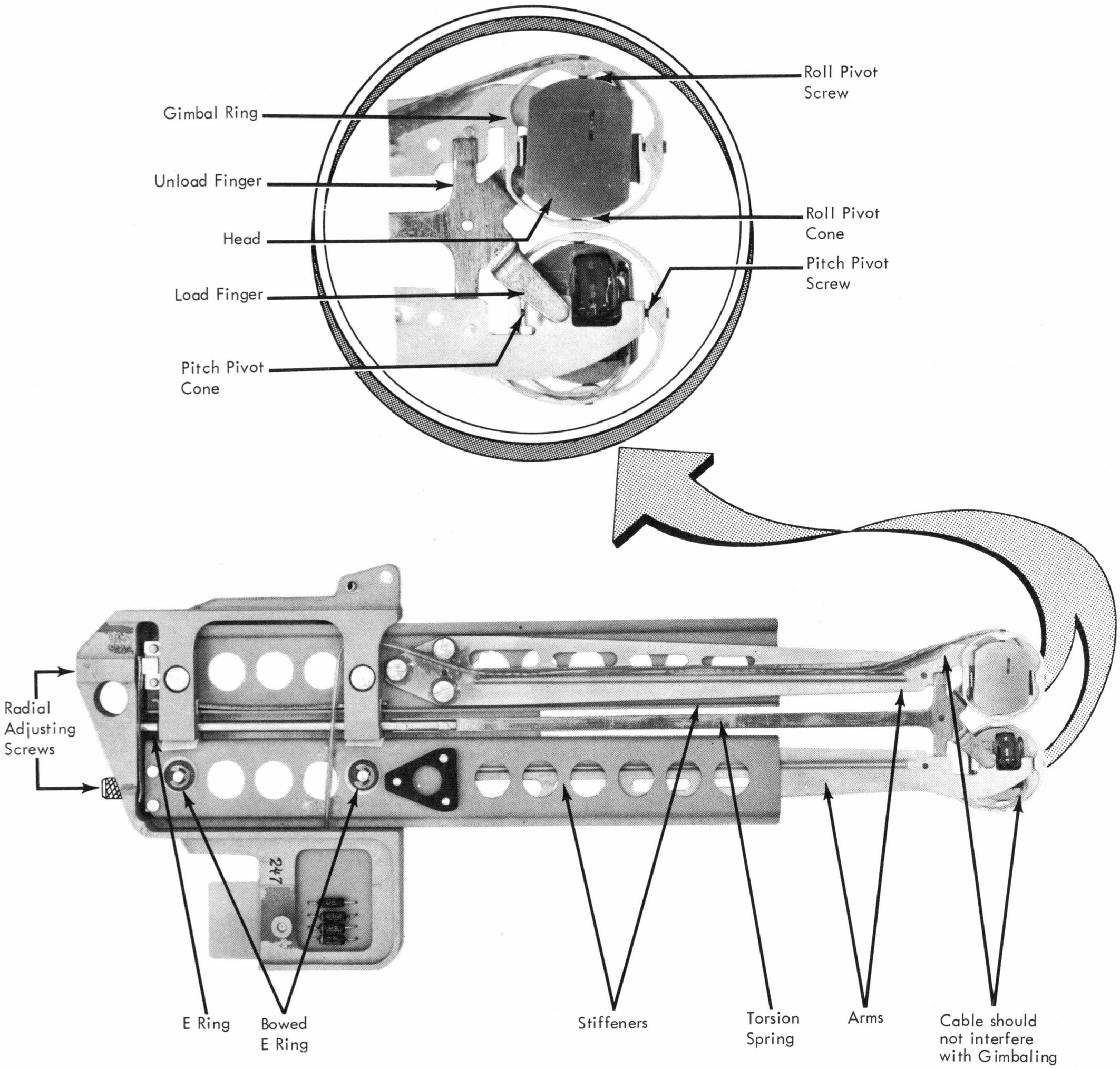


Figure 2-25. Drawer Assembly

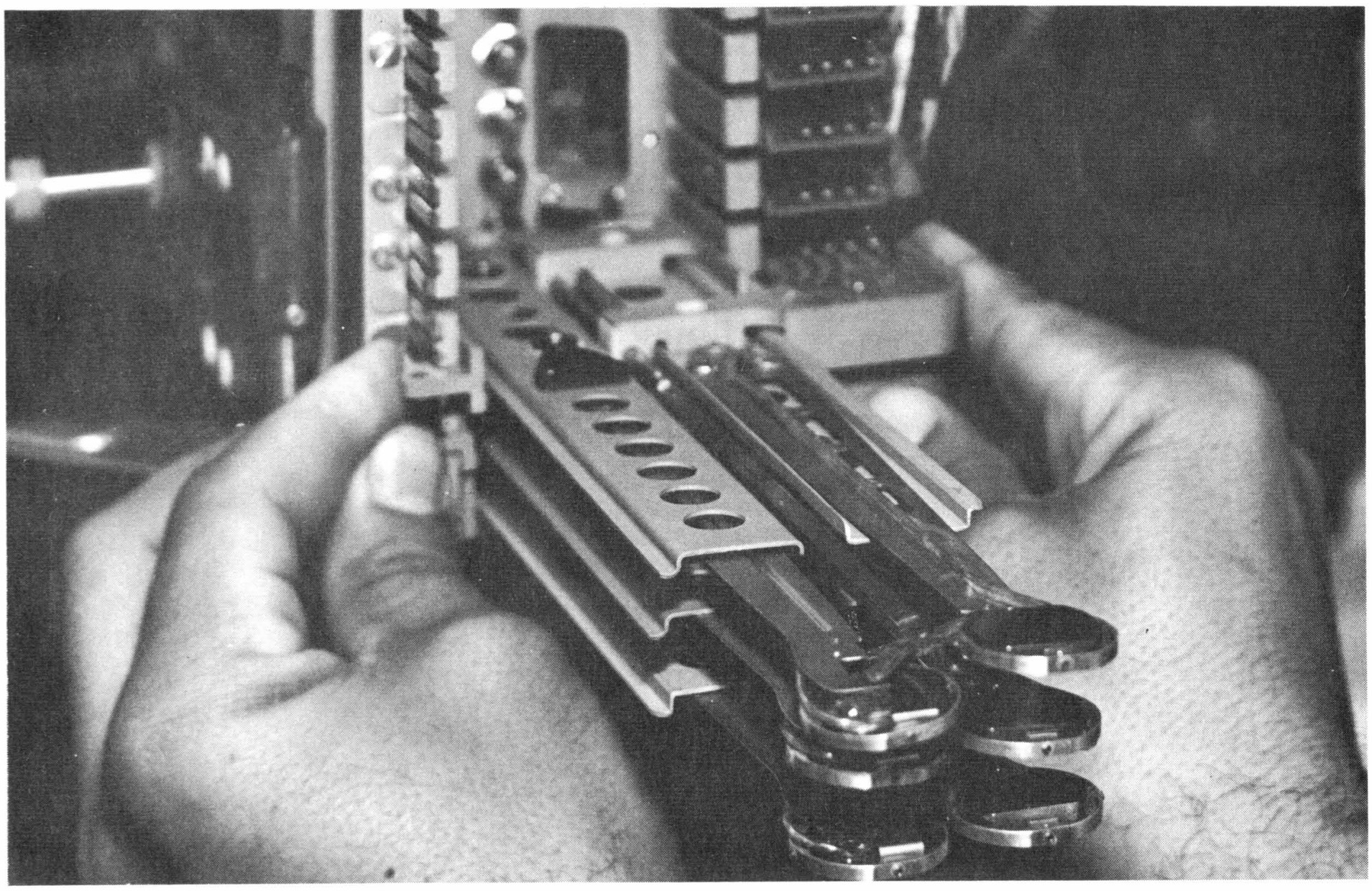


Figure 2-26. Drawer Removal

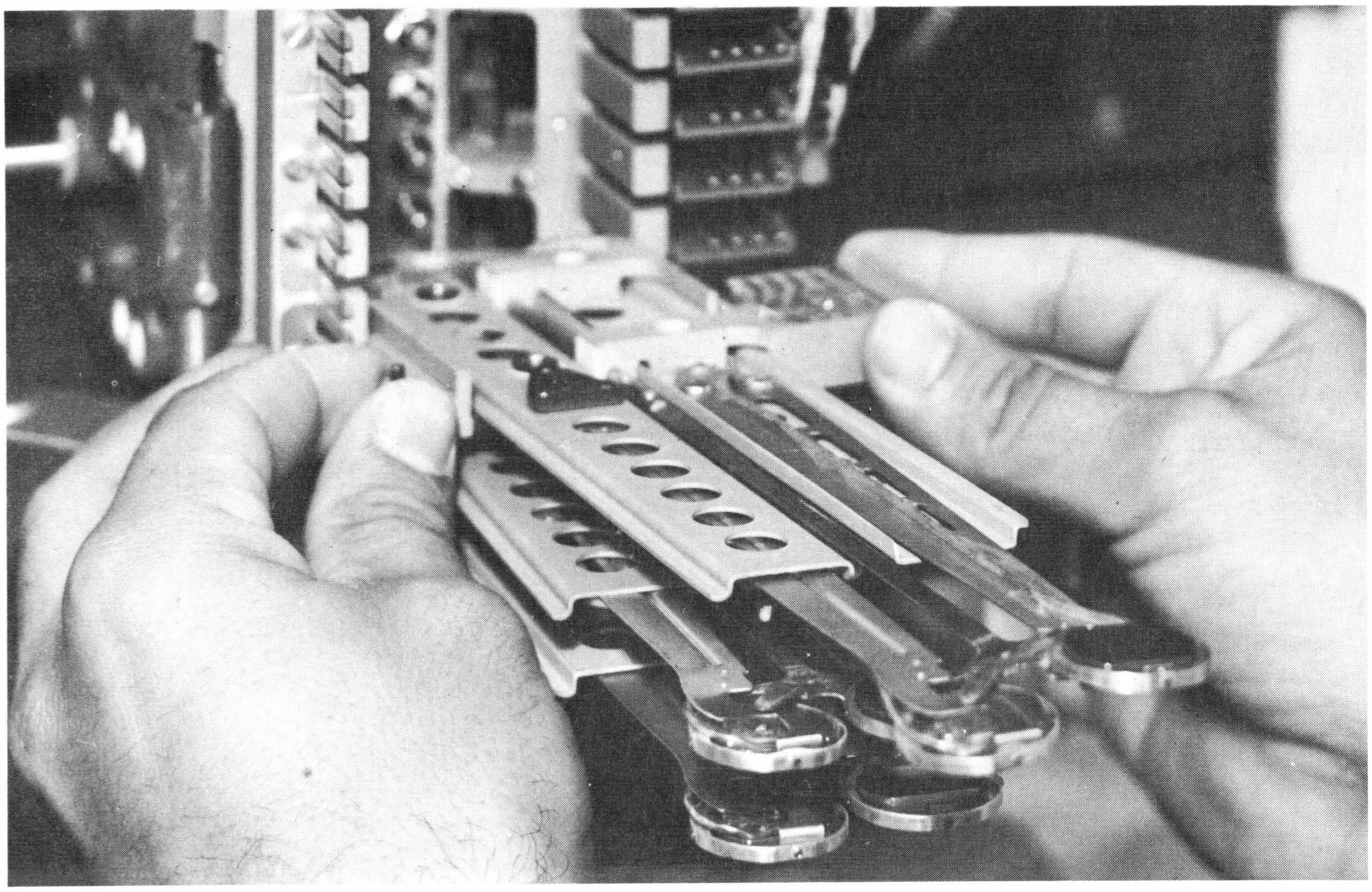


Figure 2-27. Drawer Insertion

to frame ground. The power supply fuse will not blow and damage may result if the head-disk spacing is less than nominal for the voltages under 25 volts and at a nominal spacing for higher voltages. It is very easy to short a DC voltage to frame ground during servicing, e.g. (a) a gate may be opened against a metal object such as a metal stool or an oscilloscope cart. The back panel wiring can then be shorted to frame. (b) Scope leads left dangling etc., can also cause trouble.

2. If AC and DC grounds are tied together at some point in the system, arcing will not occur if a DC voltage is shorted to the receiver or to the frame. However, there exists the possibility of wiring errors or a loose or broken ground wire at the receiver, in which case a DC voltage on the receiver may then cause damage.
3. 24-volts AC is present throughout the machine. A short between one side of the 24-volt line and DC ground would apply 24 volts directly across the receiver and the frame.

NOTE: Remove all drawer assemblies in the receiver if a megger is used to check isolation.

Cleaning

WARNING: Only isopropyl alcohol should be used for disk and head cleaning.

Inspection and routine cleaning of all heads can be easily made without removing them from the receiver. Wrap head-cleaning paddle with lint free tissue moistened with isopropyl alcohol to clean heads. Care should be taken to prevent permanent deformation to the drawer assembly. If a drawer must be removed, refer to Drawer Removal.

Service Check

Gimbal Torque Measurement. Pitch and roll torque measurements are made with a gram gage, P/N 2108473 (Figures 2-28 and 2-29). With a head surface in a horizontal plane, the face of the gage must be in a vertical plane with the arm parallel to the head surface. Gimbal torque measurements must be made with the drawers out of the receiver. A head that does not meet the minimum torque specification, as shown in Figure 2-30, must be replaced. Figure 2-30 indicates the areas where the gage arm must be applied.

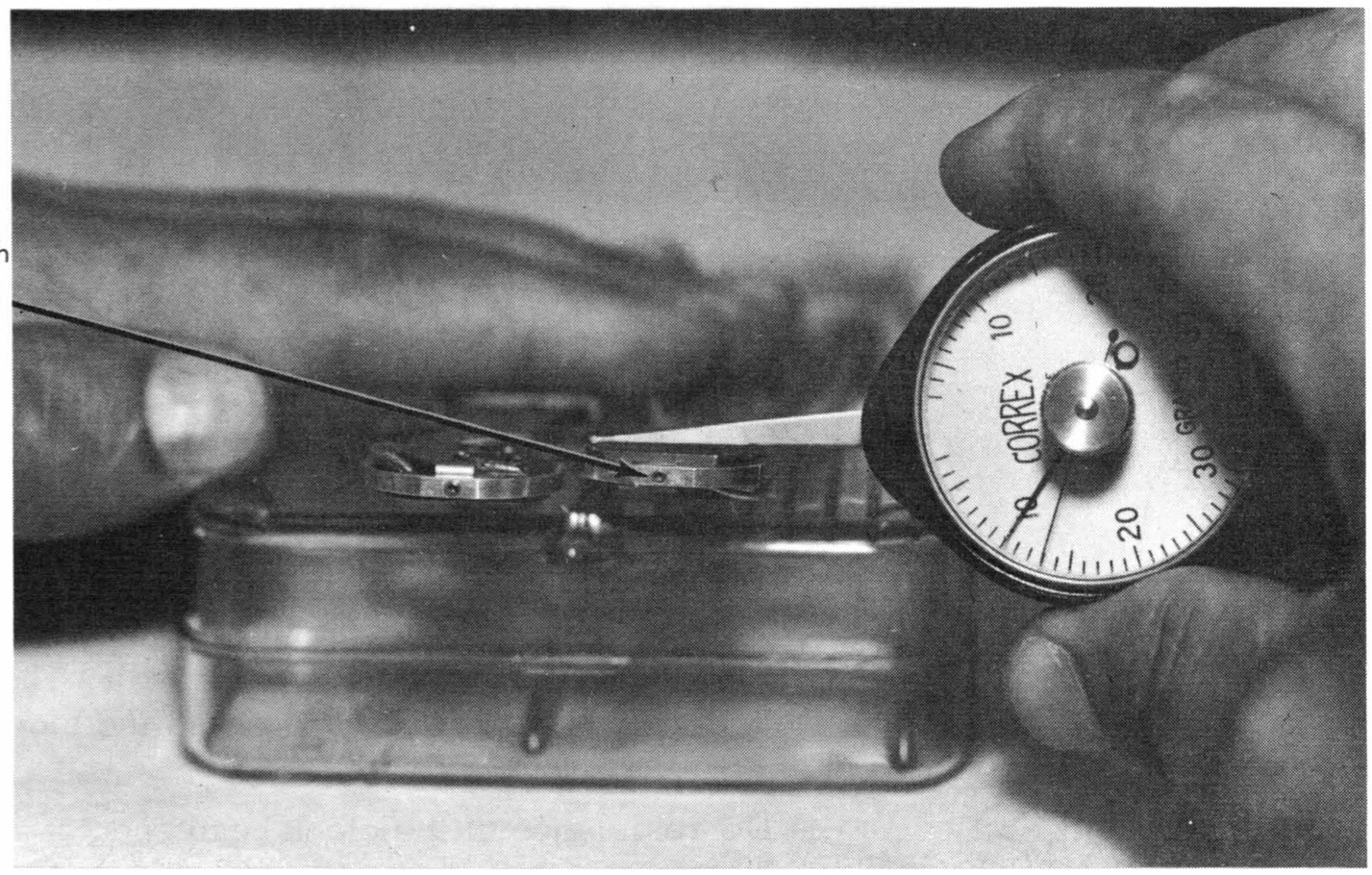


Figure 2-28. Head Gimbal Pitch Torque Measurement

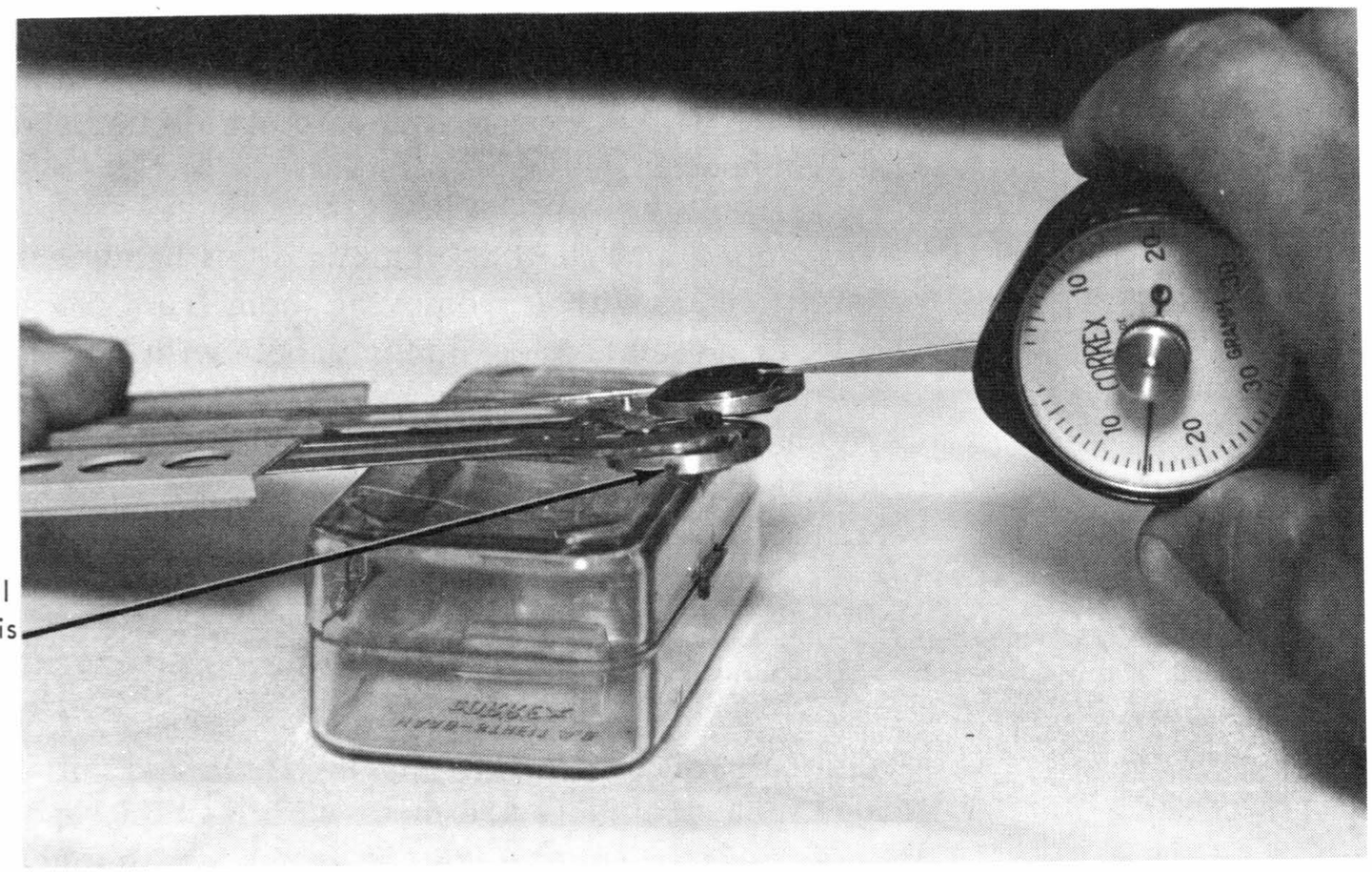


Figure 2-29. Head Gimbal Roll Torque Measurement

Readings must be taken on both sides of the head about the axis concerned and the average computed. The desired reading occurs at the instant head motion is detected. If the averaged pitch or roll reading exceeds 30 grams, the pivots must be lubricated with IBM Lubricant #2 Watch Oil, P/N 173488. The lubricant can be applied with a toothpick that is thinned so it can fit between head and gimbal ring. Apply lubricant sparingly. There should be no excess on gimbal rings, arm, or head.

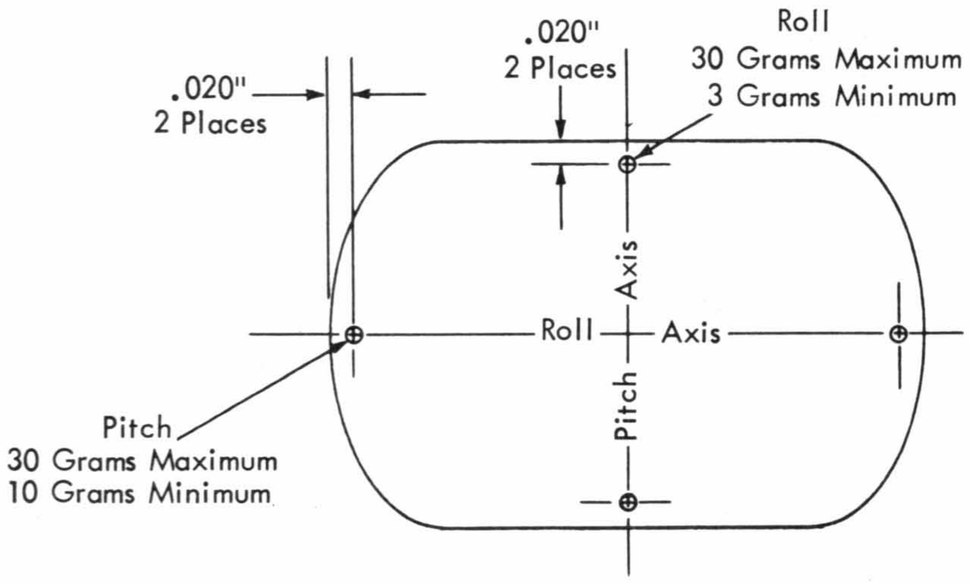


Figure 2-30. Gimbal Torque

SWING-OUT INTERLOCK MICROSWITCH

Adjustment

Adjust mounting bracket so microswitch is made by the drawer retaining pin when access is closed and locking pins are seated (Figure 2-16)

CLOCK HEAD

WARNING: Do not check continuity of the clock head while the head is loaded.

If continuity of the clock head is checked with the head loaded, the clock track can be erased. The potential of a VOM is sufficient to erase the clock track.

The DC resistance of the clock head should measure approximately 4 ohms.

Service Check

The amplitude of the clock-head signal should average 2.0 to 2.5 volts peak-to-peak minimum for any ten cycle period. This should be measured at the output of the second linear amplifier with a CA preamplifier added algebraically.

Three clock tracks are recorded at intervals marked on the clock indexing plate (Figure 2-31).

The 625 KC clock tracks have 20,816 cycles, plus 209 cycles, minus zero cycles.

Each clock track must match the other tracks, cycle for cycle, except at the trailing edge of index time.

A gap or nonsymmetry may occur at the trailing edge of index time if the crossover point does not represent a phase shift greater than 90°.

Clock Head as an Assembly (Figure 2-31)

Adjustment

1. Attach oscilloscope as in the service check.
2. Loosen locking screw.
3. Turn adjusting screw in or out to obtain maximum signal.

Removal

1. Detach cable at plugs G01 and G02.
2. Adjust clock head as far forward as possible and remove rear mounting screw.
3. Back off clock head to its rearmost position and remove front mounting screw.
4. Lift clock-head assembly off locating pins, being careful not to damage disk. A folded IBM card can be placed over the clock disk with the lower flap between the disk and the clock head to protect disk.

Replacement

1. Check plastic shim for damage and replace if necessary. Clean mounting pad of chips and dirt before replacing shim.
2. Replace clock head assembly by slipping over locating pins. By means of the adjusting screw (Figure 2-32), adjust clock head as far in as possible and install rear mounting screw. Check for head to disk interference. Back off clock head to extreme out position and install front mounting screw.
3. With an ohmmeter, check the resistance between the clock-head support and the machine frame. This should exceed 2 megohms.
4. Attach cable at plugs G01 and G02.
5. Perform Clock-Head Service Check. Adjust if necessary.

NOTE: The clock-head assembly is pre-adjusted at the plant and should require no further attention, but failing to obtain the required signal, the following adjustment can be made.

With solenoid energized and head loaded, torsion rod lever (Figure 2-31) should be clamped on torsion rod in such a position that 260 ± 10 grams are required at point "x" to lift it off linkage pin (switch should not be actuated during this time). Adjust switch actuator clamp to close switch.

Clock-Head Arm Assembly (Figure 2-33)

Removal

1. Disconnect cable assembly to head leads.
2. Disconnect jack leads.
3. Remove holding screws.
4. Lift arm assembly from locating pins and at the same time move the head down and toward the electronic frame to free the arm from the torsion spring.

WARNING: There is no interlock on the clock-head arm assembly to prevent loading of the heads with this part removed from the machine. Any energization of the clock loading mechanism will cause the torsion spring to load against the disk.

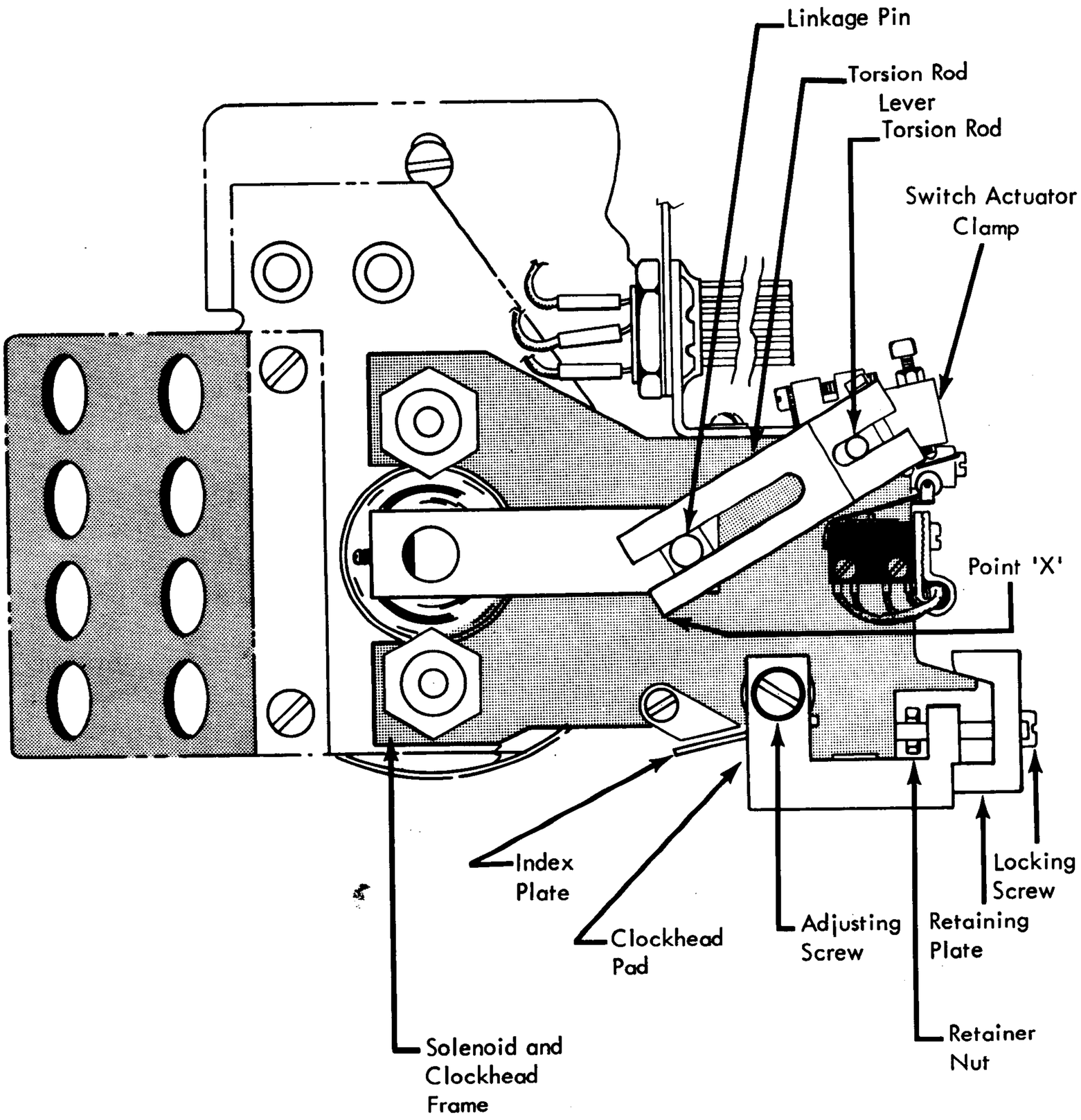


Figure 2-31. Clock Head Assembly

Replacement

1. Engage arm into the torsion spring and into the locating pins.
2. Secure with holding screws.
3. Connect cable assembly to head leads.
4. Check torsion spring for proper engagement.
5. Check head loading and unloading.

HYDRAULIC ACTUATOR

CAUTION: Any time maintenance is to be performed around an actuator with power on, the actuator must be set INOP and the safety circuits which hold the actuator output shaft detented (while the access cover door is removed) must be checked at least once for correct operation before proceeding.

This Safety check is accomplished as follows:

1. Set the desired access inop. This should turn on rezero.
2. From the CE panel, reset rezero.
3. Set in an address of 200 cylinders.
4. Check rezero operation by setting rezero. Check that the detent holds about 1 second while address clears, and is followed by a slow return of carriage to outer limit stop.
5. Reset rezero and set in an address of 20 cylinders.
6. Remove access cover. This should cause rezero to come on. The cylinder address should clear, and the detent should hold.

   For the first second after removal of the cover, the detent will be held, even if the switch is bumped. After that, when switch is bumped or depressed, the carriage will return toward the outer limits at rezero force, but

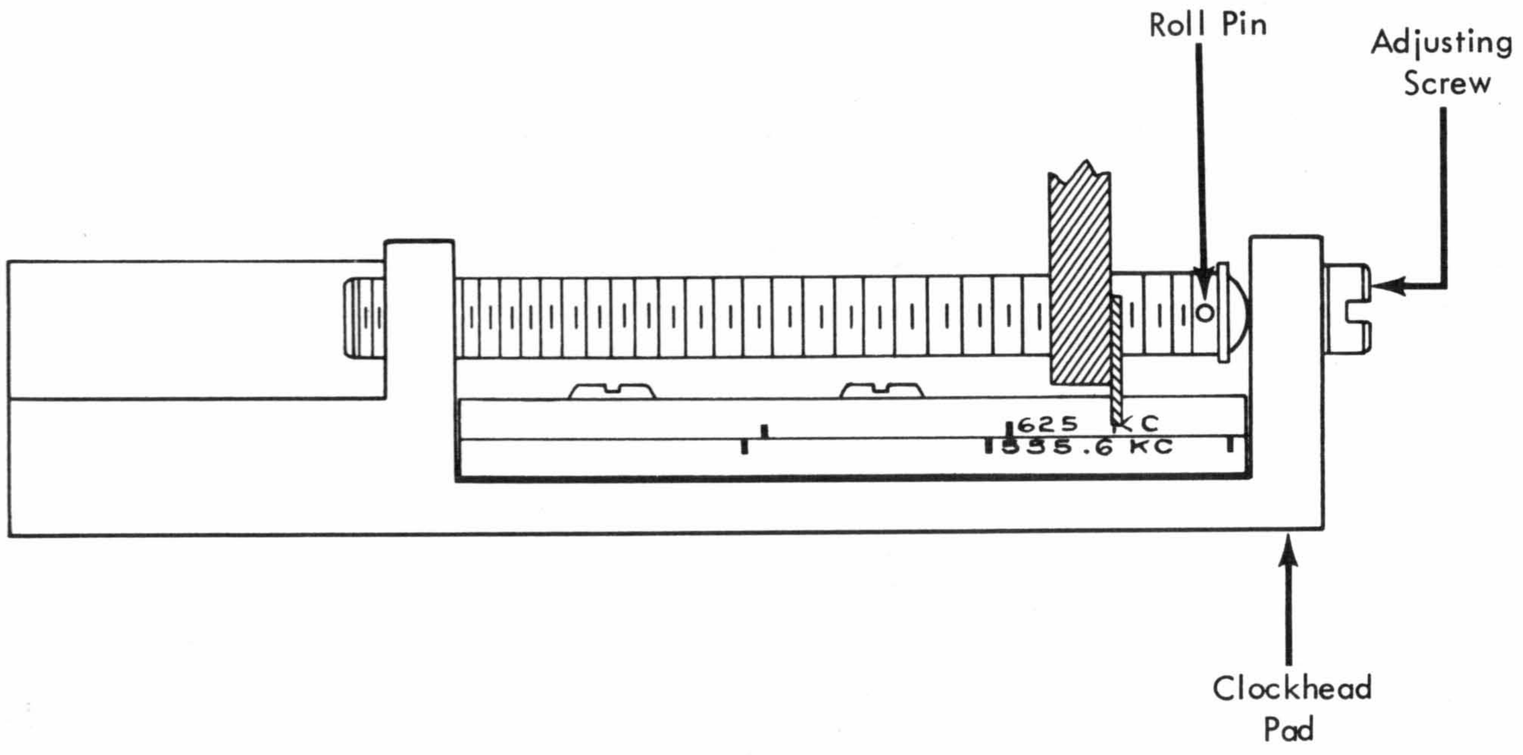


Figure 2-32. Clock-Head Adjustment

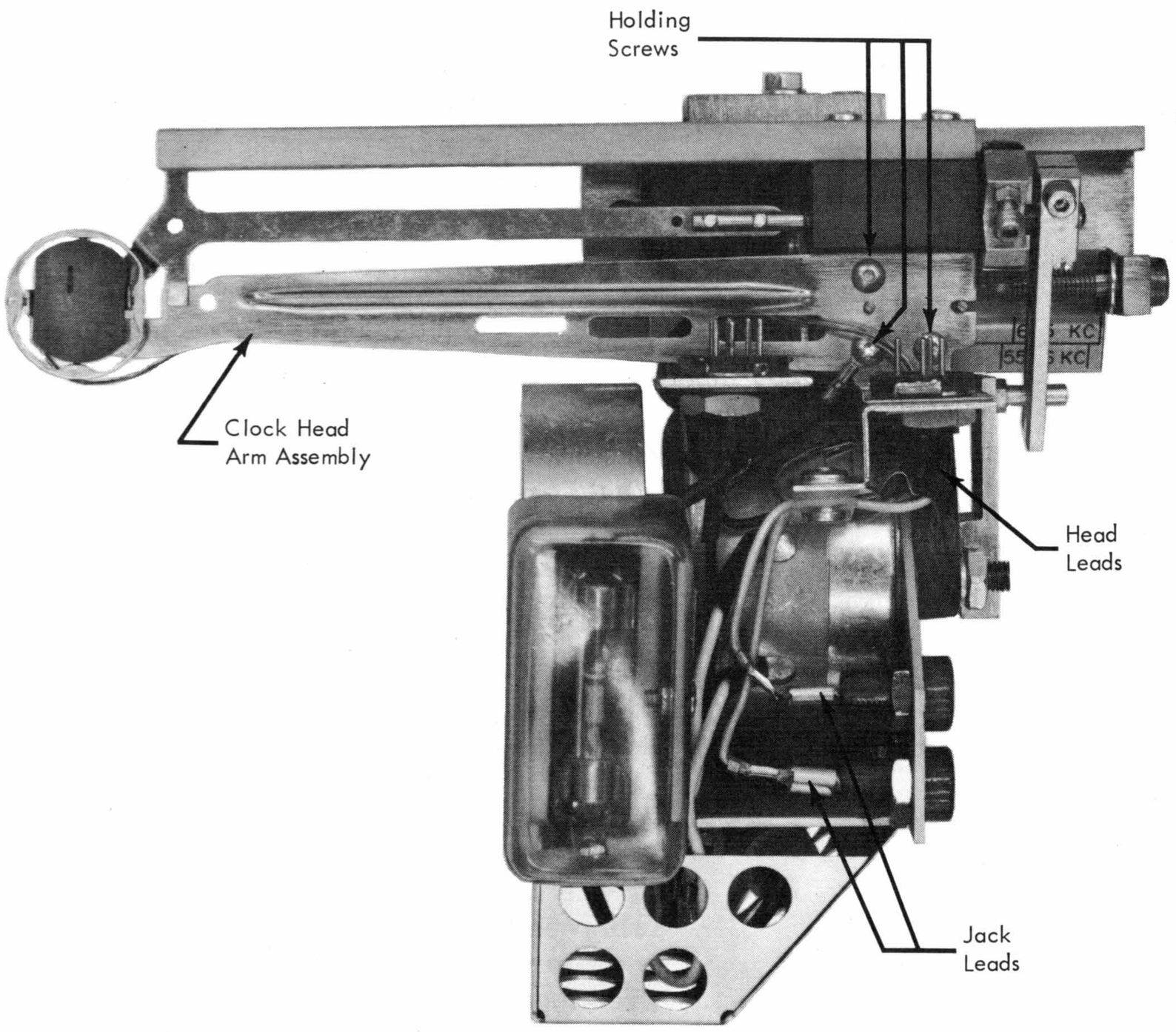


Figure 2-33. Clock Head-Arm Assembly

only while the switch is closed. When it is released, the detent will drive in and hold.

7. With cover off, try to reset rezero from CE panel. Try to set a new address. Both should be impossible. Check an address of over 200 cylinders in the same manner. (Dropping of the piston adders will cause slight movement of the carriage.)
8. After safety check is made, set access to the desired location and proceed.

CAUTION: Although the actuator is electronically interlocked when the access-cover door is open, the actuator may attempt to move under hydraulic pressure if solenoid DC power goes off for any reason.

Service Check

The following technique is to be employed if a stuck hydraulic valve is diagnosed in the actuator.

1. Shift selector valve on hydraulic power supply to circulate - leave at this position for 10 minutes.
2. Shift selector valve to H. P.
3. Turn off hydraulic pump.
4. Manually pick and hold R-64 (file ready) relay in power sequence gate.
5. Set access inop.
6. Pick solenoid of stuck valve from CE panel several times.
7. Remove manual hold of R64.
8. Turn on hydraulic pump.
9. Pick solenoid of stuck valve from CE panel several times.
10. If valve transfers now, pick rezero solenoid and leave in this position for 15 minutes. If valve does not transfer, repeat steps 3 through 9. Steps 3 through 9 should be repeated several times before replacing actuator.
11. Drop rezero solenoid.
12. Shift selector valve on hydraulic power supply to circulate - leave at this position for 10 minutes.
13. Shift selector valve to H. P.
14. From CE panel select solenoids to move carriage to all track positions before returning to normal operation.

Actuator internal repairs and adjustments are not allowed. If actuator proves to be defective, it is to be replaced.

Removal (Figure 2-34)

1. Remove Receiver Assembly including electrical cables. (see Receiver Removal.)
2. Disconnect three electrical connectors to actuator. These are:
   a. One on actuator lid.
   b. One for motion transducer.
   c. One to limit stop plate and switch assembly.
3. Disconnect bleed line from actuator lid and install cap, P/N 2121687, on nipple.

WARNING: Do not start hydraulic power supply with bleed line disconnected.

4. Unlock and back off radial positioning screw.
5. Disconnect pair of hydraulic lines located at back of actuator housing by loosening retaining screw between lines. Catch oil drippings with absorbent cloth or paper. Wrap quick-disconnect with lint free tissue.
6. Remove actuator by removing four actuator mounting screws. This step requires two people. With actuator resting on horizontal positioning key, unit must be held against mounting plate, while screws are being removed. Be certain that two men lift actuator off positioning key. The actuator weighs about 60 pounds.
7. Push carriage full forward.

Replacement

1. Clean actuator mounting surfaces.
2. Make sure that actuator fittings are clean. Do not remove protective caps of new actuator until ready for connection to hydraulic lines.
3. Mount actuator on mounting plate. Make sure that actuator is resting on horizontal positioning key, and that vertical locating keyway is straddling radial register key.
4. Insert and finger tighten four mounting screws.
5. Torque radial positioning screw to 25 ± 2 inch pounds and lock with lock nut. Because of the arm leverage of the actuator-torque-wrench adapter, P/N 2108436, the actuator-torque wrench, P/N 2108435, must be set for 12 inch pounds.

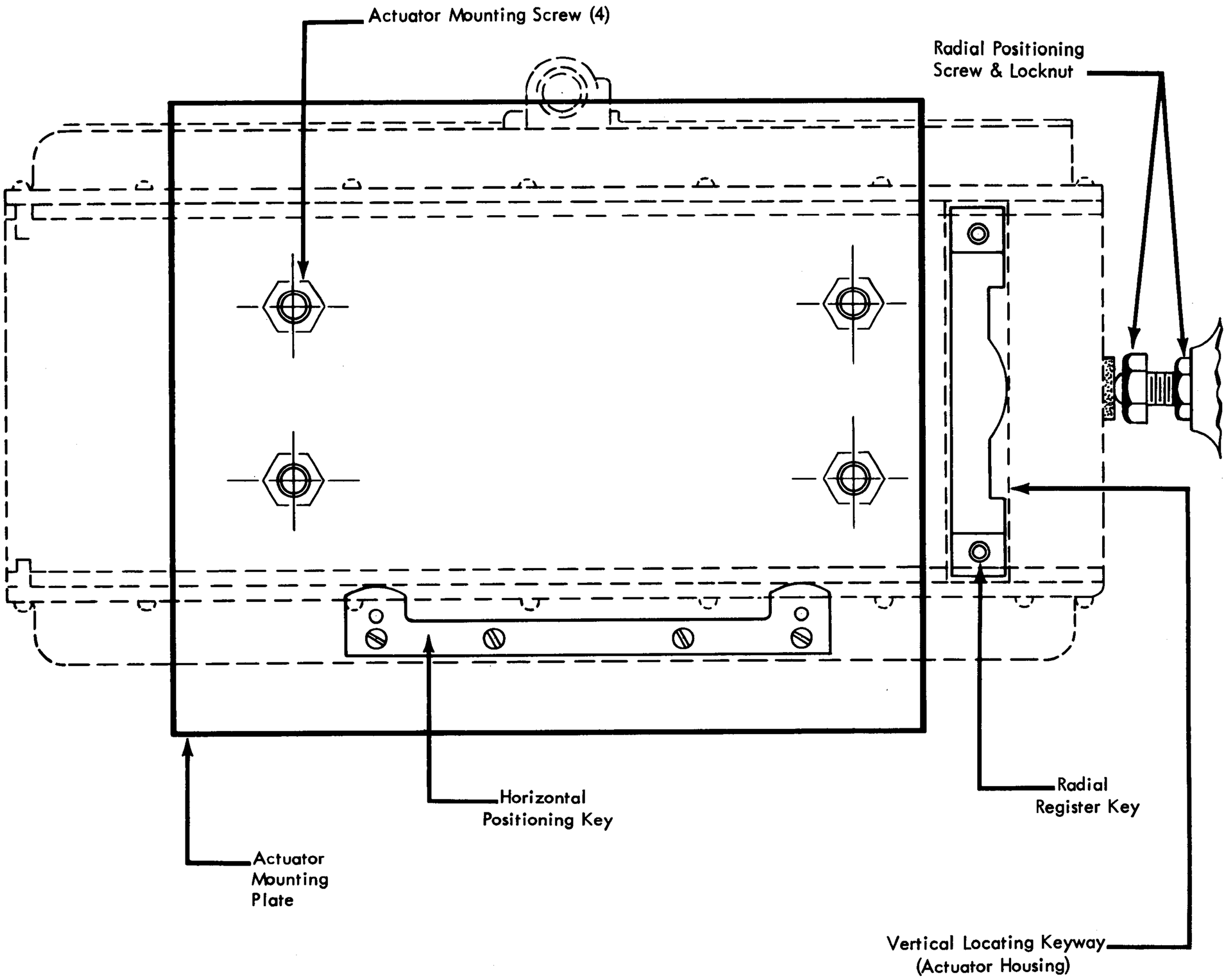


Figure 2-34. Radial and Horizontal Positioning Keys

WARNING: The actuator housing can be damaged in the area where the housing is positioned against the radial locating key if excessive torque is applied to the radial positioning screw. To eliminate the possibility of damaging the actuator housing, the radial positioning screw should be torqued to a setting of 12 inch pounds at the wrench dial. When using the torque wrench and adapter, exercise caution to assure that the wrench is used in the direction which snaps to indicate proper torque (wrench is solid in opposite direction).

6. Torque four actuator mounting screws to 75 ± 10 inch pounds.
7. Remove caps from new actuator.
8. Connect two hydraulic lines, one bleed line and three electrical connectors.
9. Replace Receiver Assembly (see Receiver Replacement).
10. After the receiver is installed to the new actuator, check the force required to snap the diamond pins in their carriage position (Figure 2-35). If the required force is not within the 11 to 14 lb range, add or subtract shims as shown in Figure 2-36.
11. Install a new shock mount when the actuator has been replaced:
    a. With receiver locked to carriage, measure the distance between receiver and carriage with gage P/N 2108576 as shown in Figure 2-35.

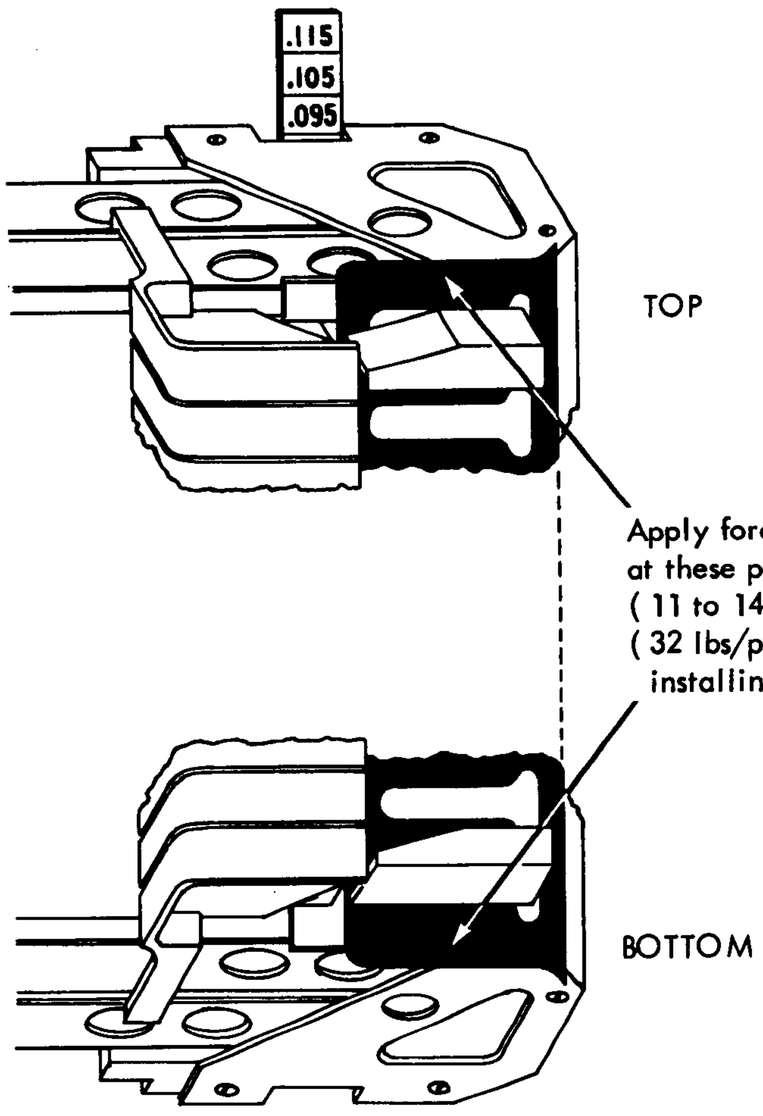


Figure 2-35. Force Measurement

b. Note the number which appears on the gage just above the receiver (.095" as shown in Figure 2-35). This should indicate the shock mount to be used.

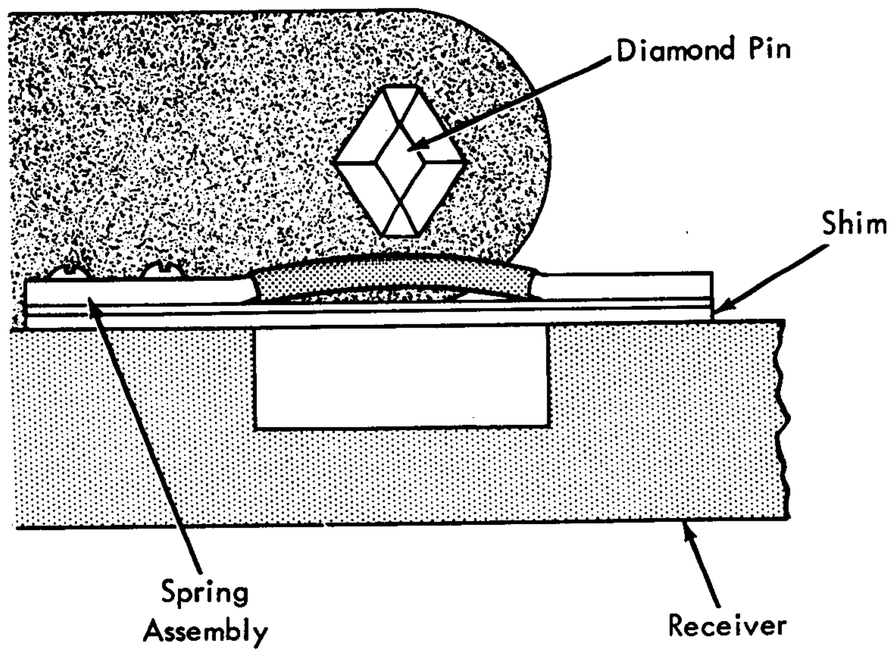
.085" thick P/N 2155709
.095" thick P/N 2155710
.105" thick P/N 2155711
.115" thick P/N 2155712

c. Swing out the receiver and clean the surface of the receiver indicated in Figure 2-37 with isopropyl alcohol.
d. Remove the protective covering from the appropriate shock mount assembly and press it firmly in position (Figure 2-37).
e. Swing receiver in, and with a force gage, measure the force required to freely seat each diamond pin (Figure 2-35). If this force exceeds 32 lb for either diamond pin, use the next lower thickness shock mount.
f. Reinsert drawers and retaining pin, tighten drawer retaining screws, and follow Receiver Swing-In Procedure.

12. Check carriage gib adjustment, yoke inner limit stops, and inner and outer limit switch adjustments (see Limit Switches).
13. Measure the resistance of the primary of the detent detector coil as specified in the note on system diagrams page B7.A5.02.0. Add or remove jumper as required.

ACTUATOR CARRIAGE

The carriage gib and the actuator housing ways are a matched set, lapped for maximum sliding surface contact with minimum friction. Gib adjustment is provided only to compensate for wear. This adjustment should not normally be required at each scheduled maintenance period.



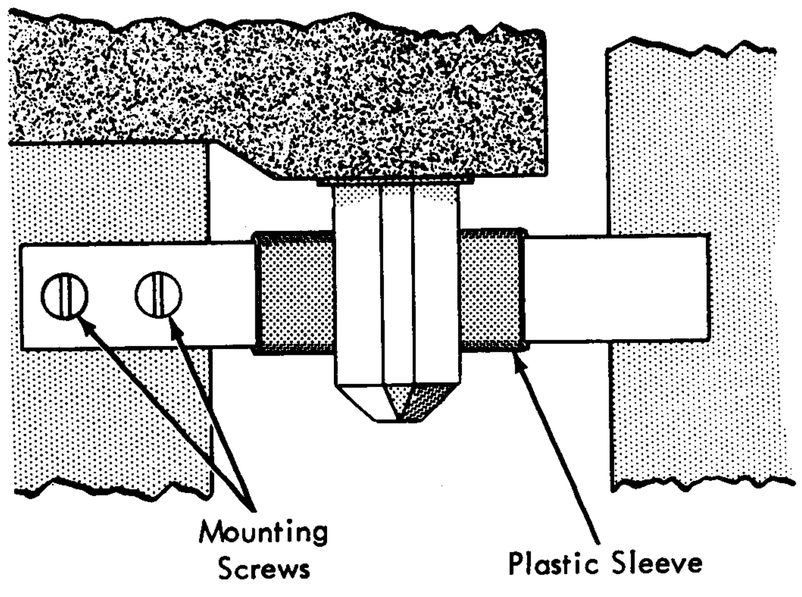


Figure 2-36. Diamond Pin Springs

Carriage Gib (Figure 2-38)

Service Check

The carriage gib adjustment can be accurately checked and corrections made only when machine is at operating temperature and disks are rotating at maximum speed.

1. Properly lubricate ways with a light film of IBM #6 oil.
2. Disconnect tie rods at the yoke.
3. ~~Load the heads.~~ NO!
4. Disengage yoke assembly from both flexure rods by removing outer flexure rod locking nuts and adjusting nuts. Do not disturb setting of inner flexure rod locking nuts and adjusting nuts.
5. Check the gib for a 3 lb ± 1 lb moving drag of the carriage. Check this moving drag at 4" to 8"/sec velocity with the actuator housing at operating temperature after accessing on the fast oscillator for at least one hour.
6. Move carriage assembly slowly and smoothly between inner and outer limit stops. No binds of any nature must exist. Static (break-away) friction of from 6 to 8 lb is considered normal.

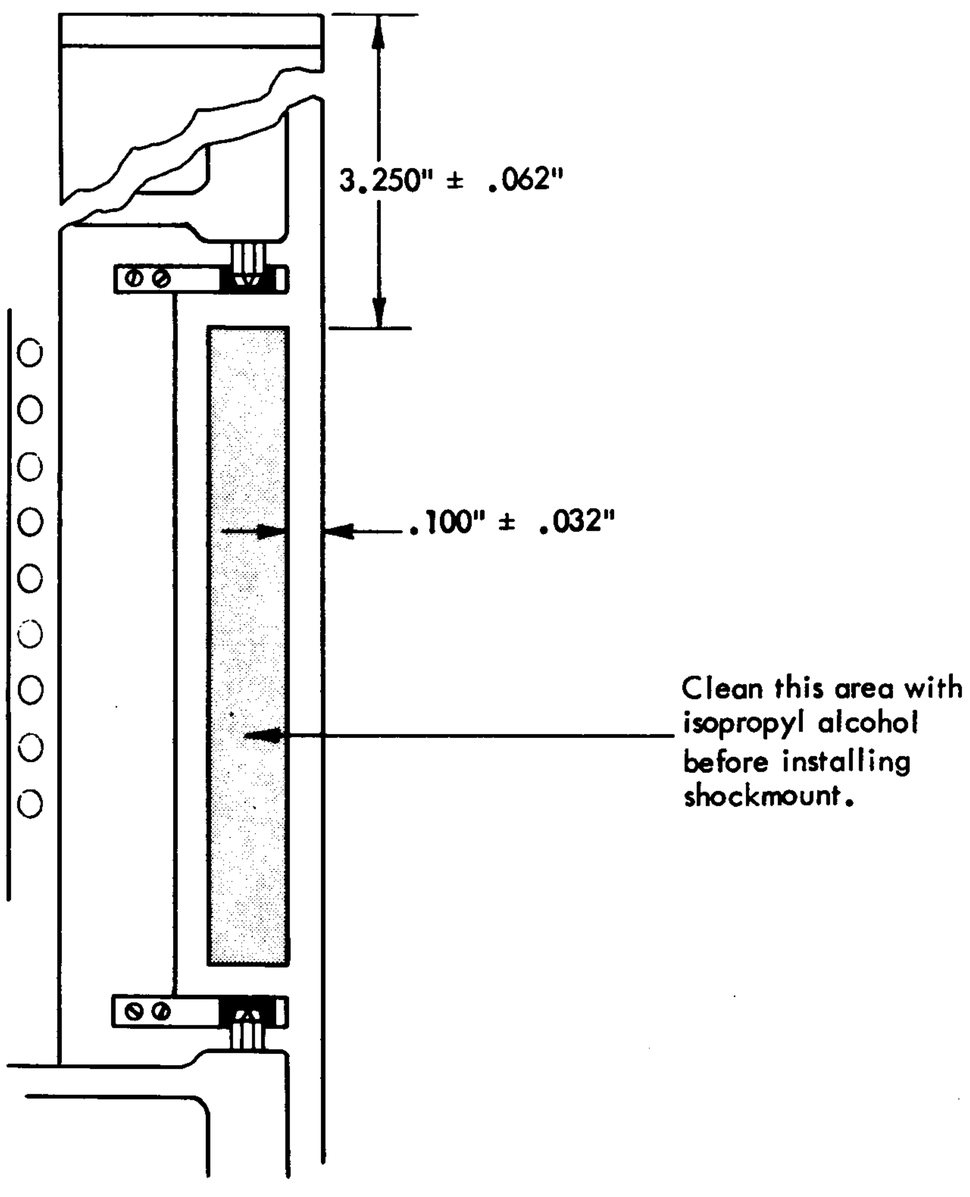


Figure 2-37. Shock Mount Installation

Adjustment

1. Perform Carriage Gib service check.
2. Free locking nut on gib adjusting screw.
3. Turn adjusting screw until conditions 5 and 6 of service check are satisfied. A clockwise movement of the adjusting screw tightens gib and counterclockwise motion loosens gib.
4. Secure locknut on gib adjusting screw.
5. Attach yoke to flexure rods and replace outer flexure rod adjusting and locking nuts.

WARNING: Whenever carriage has been moved manually, it must be placed against inner limit stop before bringing up power. This is necessary because moving the unit back and forth has "uncalibrated" the hydraulic circuit.

Yoke Assembly (Figure 2-39)

The yoke assembly is connected to the actuator output shaft through the use of a differential screw. The differential screw facilitates accurate positioning of the read/write head with respect to previously written information. Thread backlash is taken up by spring-loaded set screws. It is important that the yoke adjusting block projects equal amounts at top and bottom.

Adjustment

1. Alternately loosen yoke set-screws until differential screw is free to turn.
2. Monitor head 20 on oscilloscope and turn differential screw until maximum head signal amplitude is obtained.
3. Lock differential screw in position by alternately "snugging up" both set screws, and torque to approximately 15 in. lb.

Removal (Figure 2-40)

1. While power is still on, position heads at cylinder 0, and:
   a. Measure and record space between actuator outer limit stop and carriage limit stop. This should be .076" ± .001".
   b. Measure and record signal amplitude at head 20.

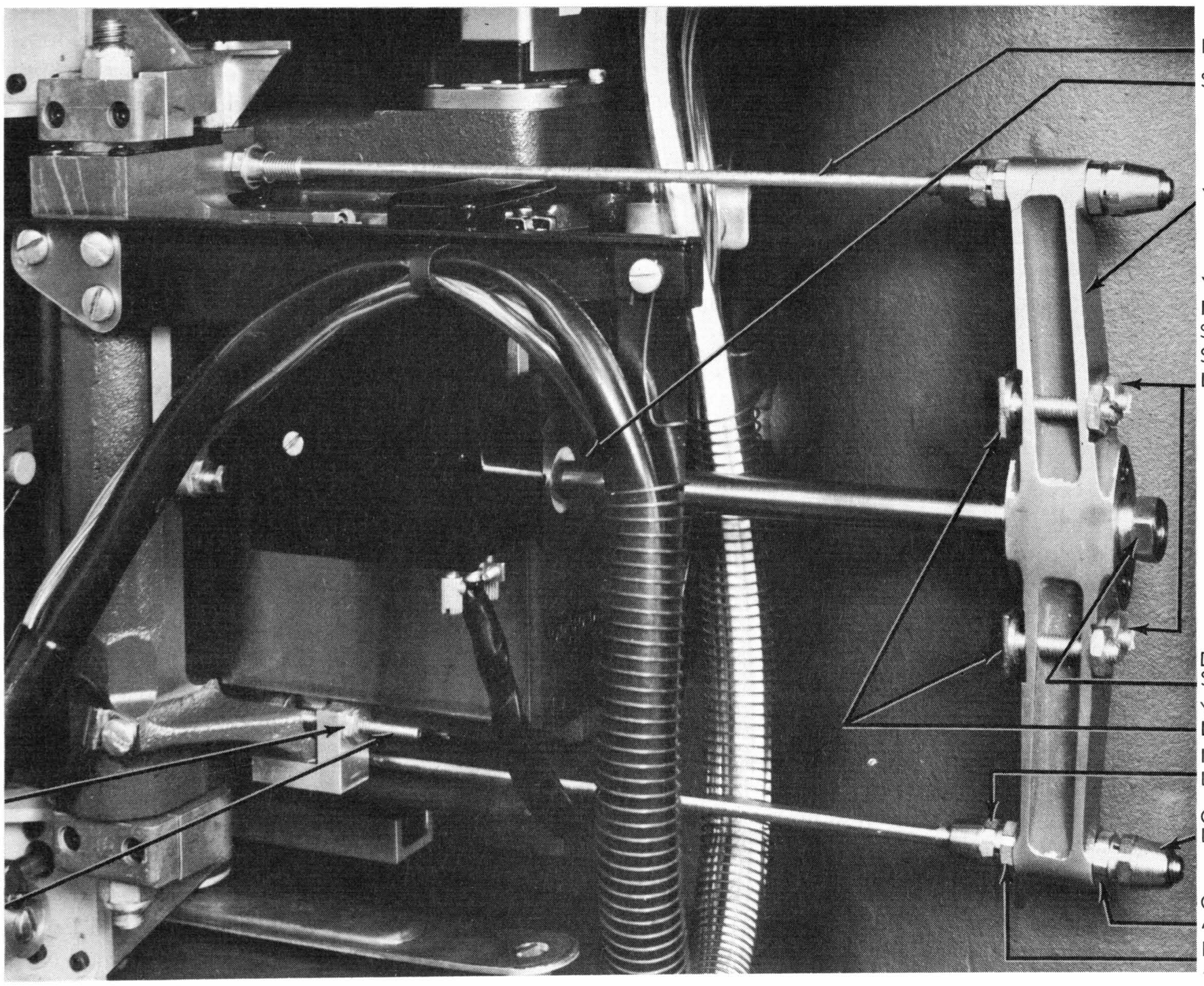


Figure 2-38. Carriage Components

2. Turn power off and proceed:
   a. Remove actuator shield.
   b. Remove yoke set screws.
   c. Remove differential screw.
   d. Remove yoke by sliding output shaft into actuator housing.
   e. Remove yoke adjusting block from output shaft.

Replacement (Figure 2-39)

1. Install yoke adjusting block on output shaft.
2. Align two punch marks (or on some models machined edge) on yoke adjusting block with yoke inner face and carefully engage differential screw. This is to obtain proper relationship for coarse and fine thread engagement.
3. Install set screws and springs with sufficient thread engagment to produce a preloading effect.
4. Continue turning differential screw until yoke adjusting block projects approximately .030" from yoke.
5. Use yoke set screws to maintain an even projection and torque to approximately 15 in-lb.
6. Push carriage in against inner limit stop and start file.
7. Detent output shaft at cylinder zero and measure space between actuator outer limit stop and carriage limit stop. Check value against that obtained in step one of the removal procedure. Compare signal amplitude from head 20 against that obtained in step two of the removal procedure. Obtain agreement by adjusting differential screw (see Yoke Assembly Adjustment).

Carriage Flexure Rods (Figure 2-38)

Motion is transmitted to the carriage from the actuator through its output shaft and the yoke assembly. The carriage is attached to the yoke by means of two flexure rods. It is important that the force presented by the output shaft be evenly distributed between the two flexure rods.

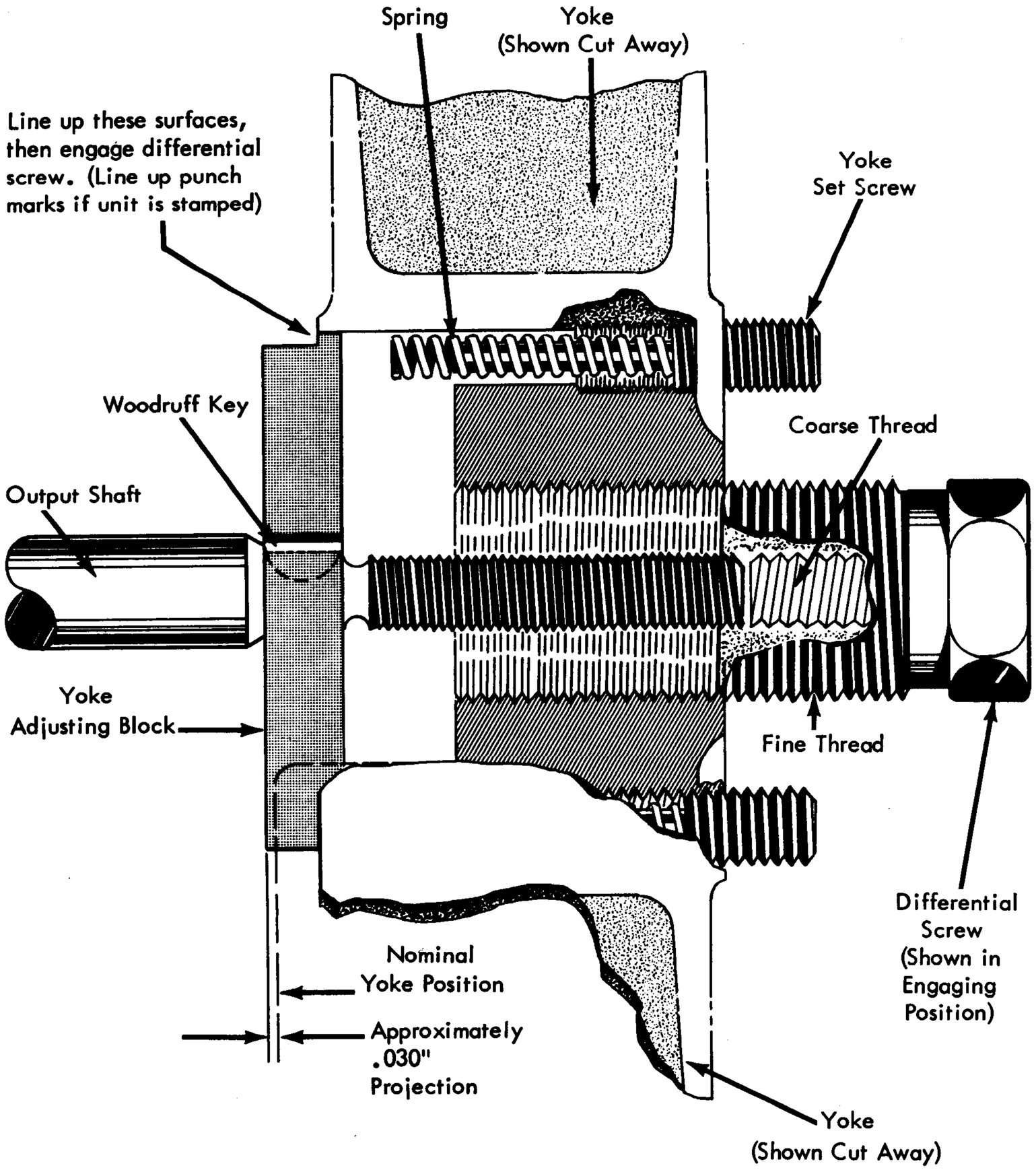


Figure 2-39. Yoke Adjustment

Service Check

1. Check for evenness of projection of yoke adjusting block from inner face of yoke assembly. (See Yoke Assembly Replacement procedure.)
2. Loosen the outer flexure-rod locking and adjusting nuts. Do not disturb the setting of inner flexure-rod locking and adjusting nuts.
3. Move the carriage slowly back and forth with respect to yoke assembly. The top and bottom inner face of yoke must contact top and bottom inner flexure-rod adjusting nuts simultaneously.

Adjustment

1. Position heads at cylinder zero.
2. Loosen outer and inner flexure rod locking and adjusting nuts.
3. Place a .076" shim between carriage limit stop and actuator outer limit stop (see Figure 2-40).
4. Rotate inner flexure rod adjusting nuts until they meet inside face (top and bottom) of yoke assembly simultaneously.
5. "Snug up" outer flexure rod adjusting and lock-

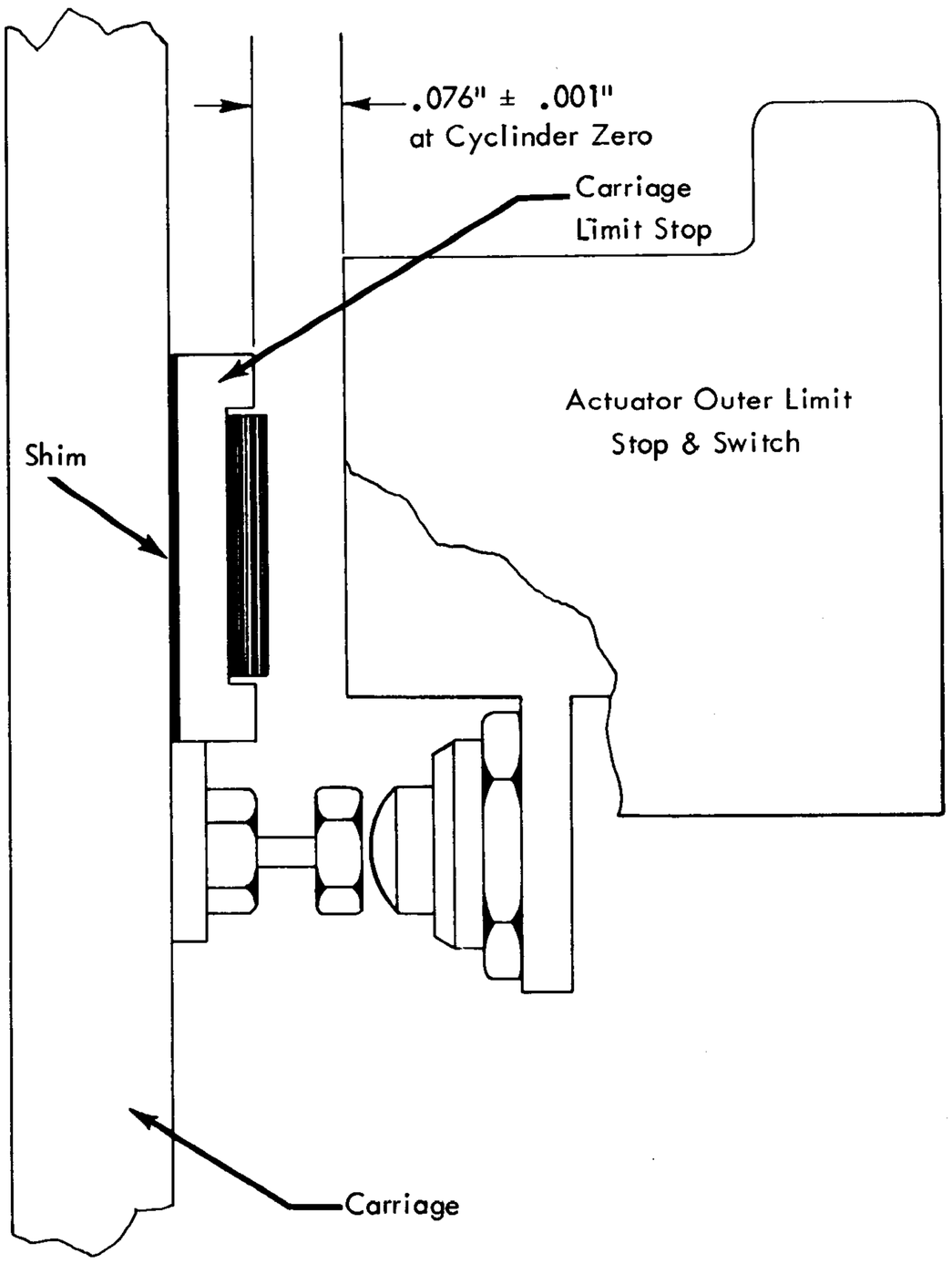


Figure 2-40. Carriage Outer Limit Stop Adjustment

nuts. Care must be taken to avoid putting a torsional strain on actuator output shaft.

6. Without disturbing setting of inner flexure rod adjusting nuts, tighten their respective locking nuts.
7. Monitor head 20 output on oscilloscope and by means of differential screw position carriage for maximum signal amplitude at cylinder zero. (See Yoke Assembly Adjustment.)

Yoke Inner Limit Stops (Figure 2-41)

Two adjustable plastic pads are provided on yoke assembly. These, together with the plastic pads on the inner limit stops, provide a cushioning effect if the carriage overtravels.

Adjustment

1. Swing out receiver assembly and secure receiver by swing-out brace. (See Receiver Assembly Swing-out Procedure.)
2. Place a .070" shim between carriage and inner limit stop (metal-to-metal). (Figure 2-41).
3. Loosen locknuts on yoke inner limit stops. Adjust for a .001" to .005" (metal-to-plastic) clearance between yoke inner limit stops and actuator housing. Tighten locknuts.
4. Swing in receiver assembly. (See Receiver Assembly Swing-in Procedure.)

LIMIT SWITCHES (Figure 2-42)

The inner and outer limit switches indicate extremities of carriage travel (inner CE cylinder and rezero position). They are located on the actuator limit stop and switch plate assembly. They can be checked and adjusted only after the carriage gib, yoke assembly, and flexure rods are in correct adjustment.

Inner Limit Switch

Service Check

The inner limit switch must be made when the carriage is at cylinder 254 and not made when the carriage is at cylinder 253. Check switch operation by alternately setting in the two addresses from the CE panel and observing the CE cylinder indicator.

Adjustment

1. Remove switch cover.
2. Loosen inner limit switch holding screw, and position switch assembly, by means of the eccentric adjusting screw, until the switch is made at cylinder 254 and not made at cylinder 253.
3. Tighten holding screw.
4. Replace switch cover.

Outer Limit Switch

Service Check

This switch must be operated when the carriage is in the rezero position and not operated when it is in cylinder zero position.

1. Alternately set rezero and reset the access register from the CE panel and observe that the CE cylinder indicator comes on only when the actuator is in the rezero position.

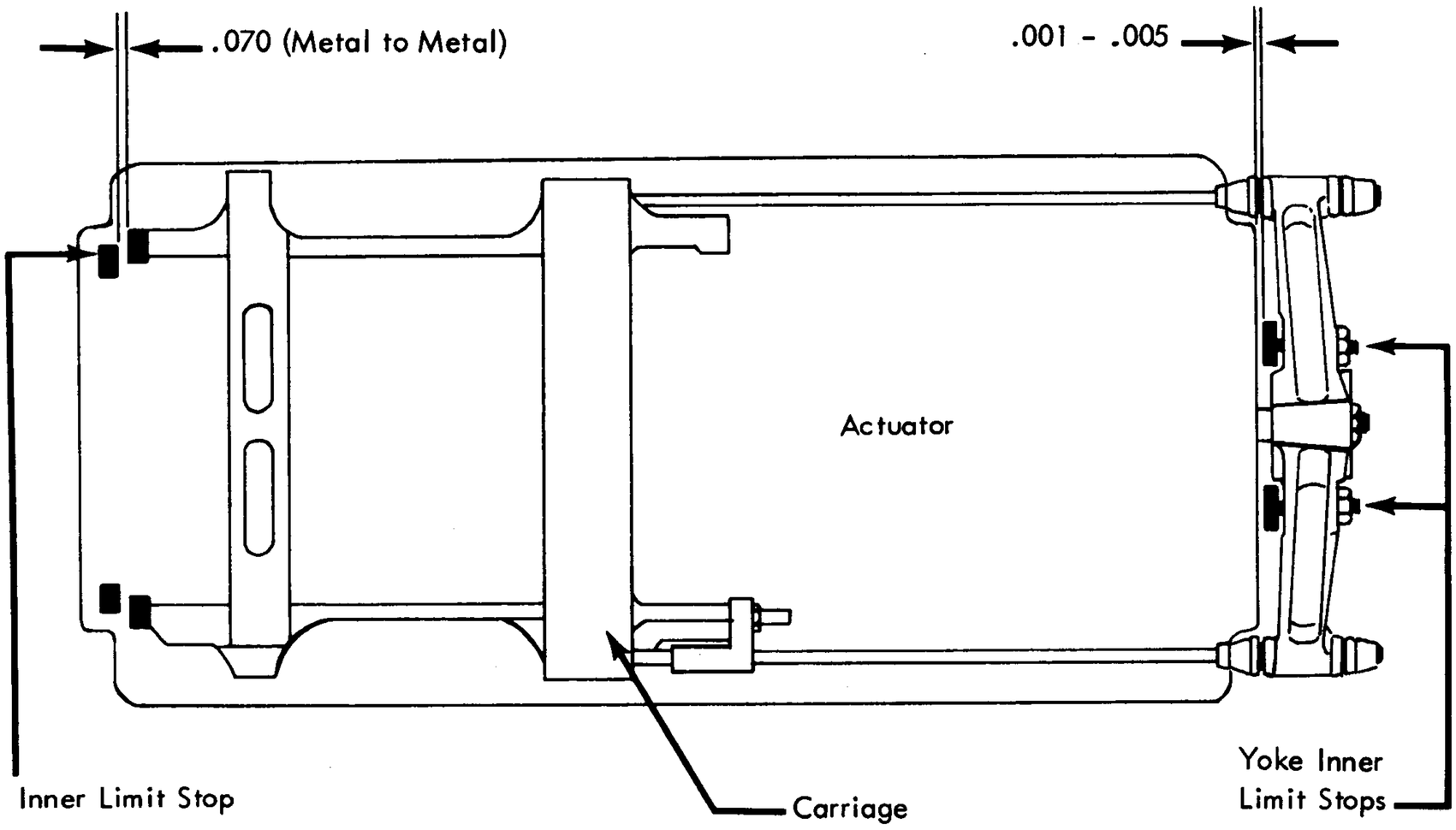


Figure 2-41. Yoke Inner Limit Stop Adjustment

2. Set cylinder 249 into the access register switches and alternately set and reset the access register. There should be no CE cylinder indication. A CE cylinder indication at this time indicates an incorrectly adjusted switch or excessive overtravel of the carriage.

Adjustment (Figure 2-42)

The outer limit switch is set by means of the adjusting screw on the carriage outer limit stop:

1. Reset the access register (Detent at cylinder zero).
2. Loosen locknut on carriage outer-limit switch adjusting screw.
3. Place .024" feeler gage between adjusting screw and switch.
4. Rotate adjusting screw until switch just operates. This can be determined by observing the CE cylinder indicator.
5. Remove .024" feeler gage and place .021" feeler gage between adjusting screw and switch. The switch should not be operated.
6. Tighten locknut on adjusting screw and recheck switch with feeler gages.
7. Repeat Service Check.

ACTUATOR OUTPUT SHAFT SEAL

Removal

WARNING: Cleanliness must be maintained during all steps so that actuators will not be contaminated.

1. Detent output shaft at cylinder 0. Measure and record space between actuator outer limit stop and carriage limit stop (see Figure 2-40).
2. Measure and record signal amplitude at Head 20.
3. Remove oil from actuator:
   a. Depress "Auto Stop" button on CE Power sequence panel.
   b. Open air compressor air pipe shut off valve to bleed air from system, then close shut off valve.
   c. Remove line from air pipe outlet.
   d. Connect larger hose of air filter assembly P/N 2115348 (Figure 2-43) to air pipe outlet.
   e. Position Auto Control Switch on "Local" and Sequence Control on "Manual." Depress Auto Start button. This starts air compressor and purges the line.

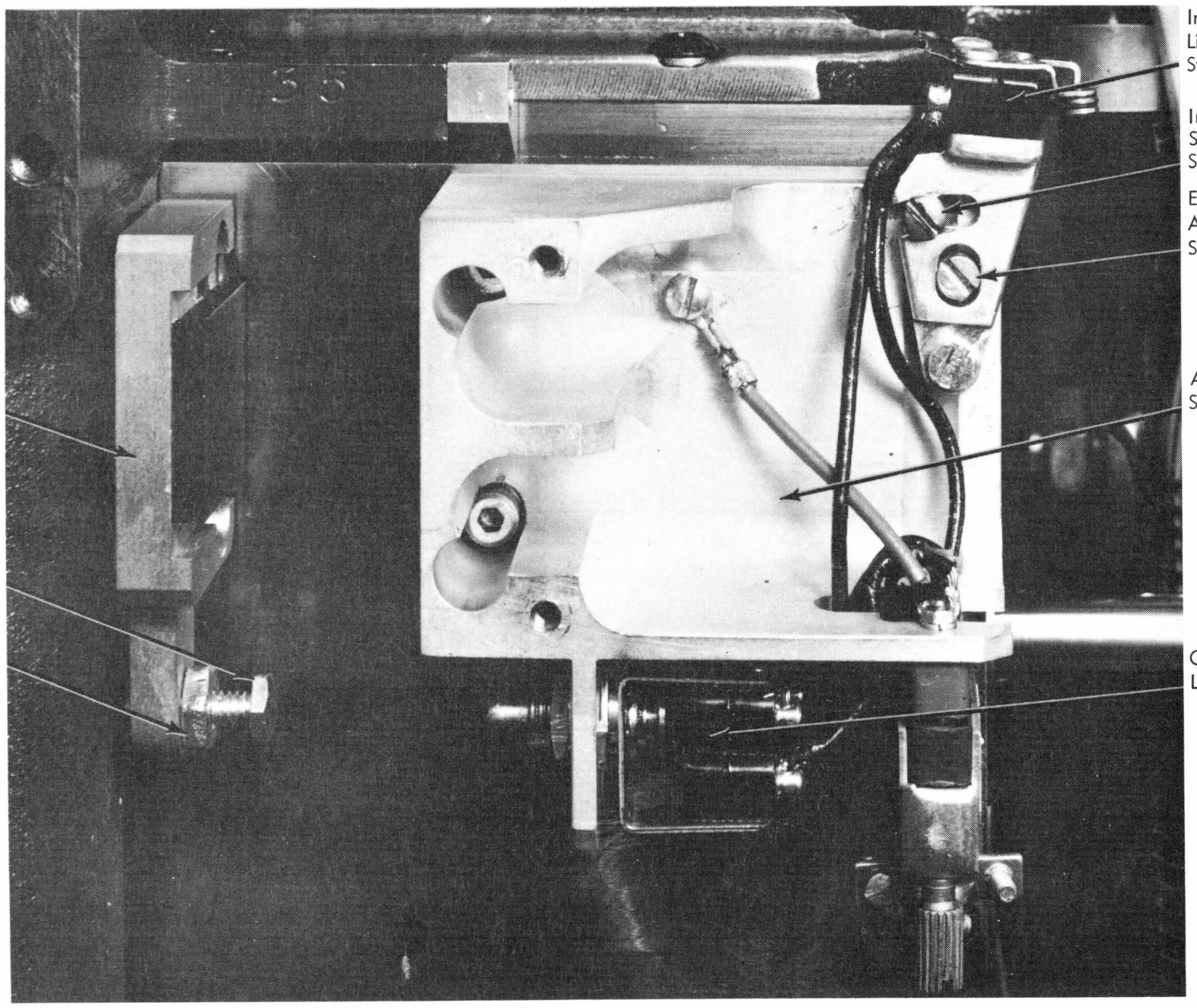


Figure 2-42. Limit Switch Adjustment

f. Run compressor for at least 30 seconds, then depress "Auto Stop" button.
g. Disconnect bleed line from actuator lid and connect smaller hose of air filter assembly in its place.

WARNING: All other bleed lines must be in place.

h. Depress "Auto Start" button.
j. When air is bubbling through hydraulic power supply sump oil, depress "Auto Stop" button.
k. Remove filter line from hydraulic actuator and replace bleed line.

4. Turn off power to machine.
5. Remove yoke, differential screw, and yoke adjusting block (see Yoke Removal).
6. Remove wiper seal cap including rubber support ring and felt wiper (use Tool P/N 2121394). Wrap assembly to ensure cleanliness.
7. Remove seal assembly (use Tool P/N 2121395 & 2121394).

Replacement

WARNING: Parts must be left in their packages for cleanliness.

1. Slide seal assembly over shaft taking care not to damage seal lip (Figure 2-44). Use end of tool (P/N 2121394) without pins to push seal into actuator housing, being careful not to damage "O" ring.
2. Install rubber support ring and the wiper seal cap with new felt wiper. Screw cap into actuator housing until cap is firmly seated. (Use Tool P/N 2121394.)
3. Assemble yoke assembly. (See Yoke Replacement Procedure.)
4. Push carriage against inner limit stop.
5. Start file.
6. Start hydraulic power supply and put actuator in rezero for five minutes.
7. Detent at track zero.
8. With set screws tightened only enough to apply

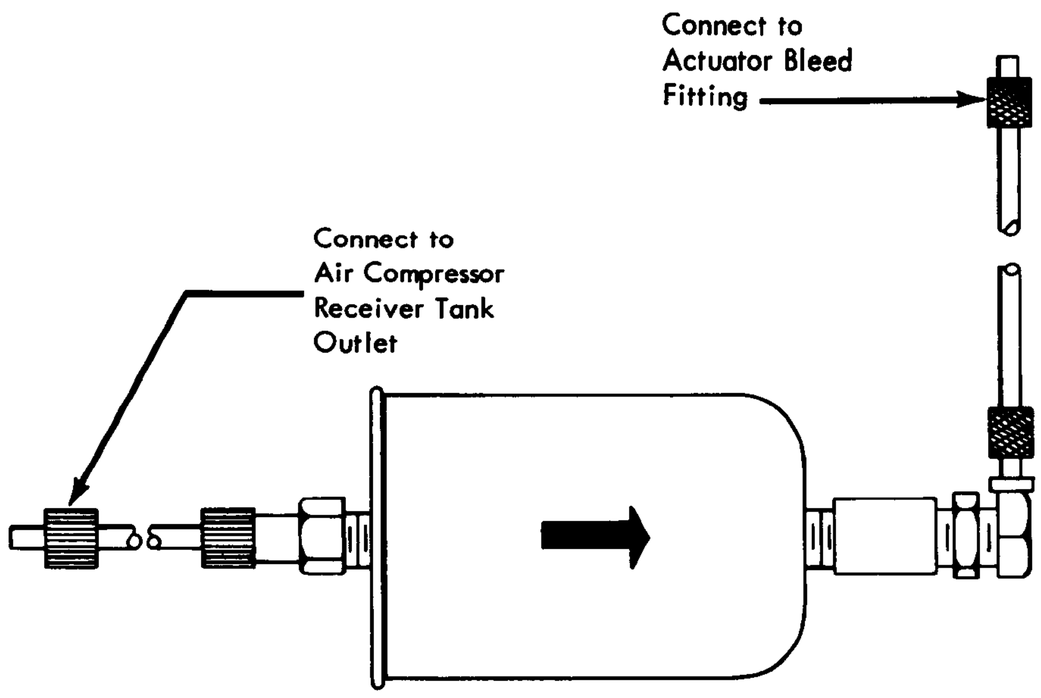


Figure 2-43. Air Filter, P/N 2115348

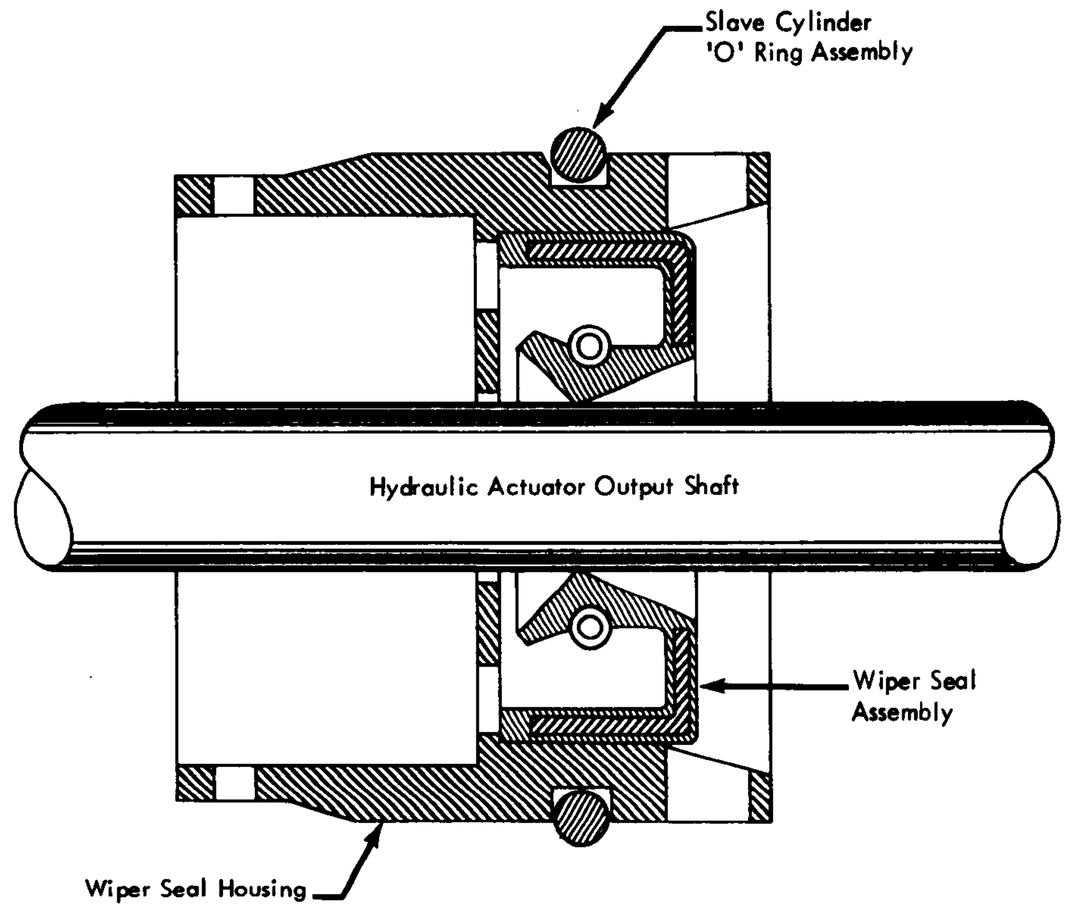
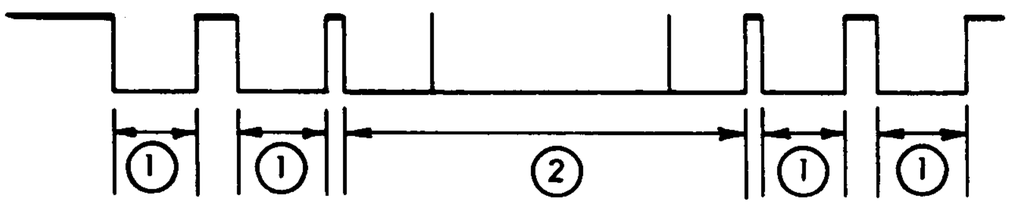


Figure 2-44. Hyraulic Actuator Output Shaft Seal Assembly



(1) 7 ms Down levels

(2) Continuous down level longer than 7 ms

Figure 2-45. Motion Integrator

their spring load, adjust yoke differential screw to give exact value as measured and recorded in Step 1 of the removal procedure.

9. Lock into position with two set screws evenly by going to top and bottom, so as not to bind carriage or output shaft. Do not overtorque. Use approximately 15 in. lbs. Recheck signal amplitude of head 20. If a variation is noted, recheck step 8.

DETENT SAFETY TRANSDUCER

Service Check

When accessing 50 cylinders or more, the motion transducer output should be at least 2 volts peak-to-peak.

Adjustment

1. Adjust the motion detector rack located on the carriage parallel to the carriage way within .002".
2. The pickup transducer mounted on the top lid of the actuator is adjusted to have an air gap to the rack of .006" ± .002". Check this adjustment with an IBM card. This adjustment should result in the minimum output of 2 volts peak-to-peak when accessing 50 cylinders.

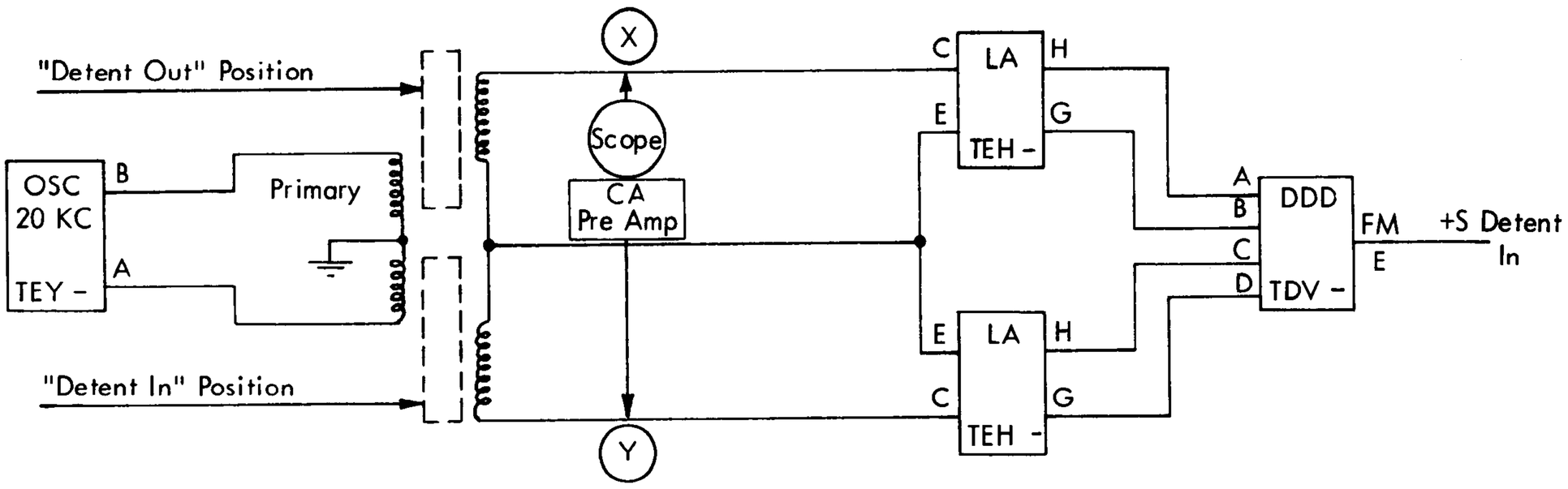
WARNING: The pickup transducer is magnetized, therefore, a non-magnetic material must be used to measure this gap.

3. Check this adjustment at both ends of the rack, to verify rack and actuator alignment.
4. Adjust the motion integrator (TED) to give at least 7 ms of down level, as observed at pin F while performing an access of 50 cylinders (Figure 2-45). Additional spikes may be seen in the long gap but are of no significance.

DETENT DETECTOR

Service Check

The detent detector in the actuator cannot be adjusted or replaced, but it can be checked for normal operation.



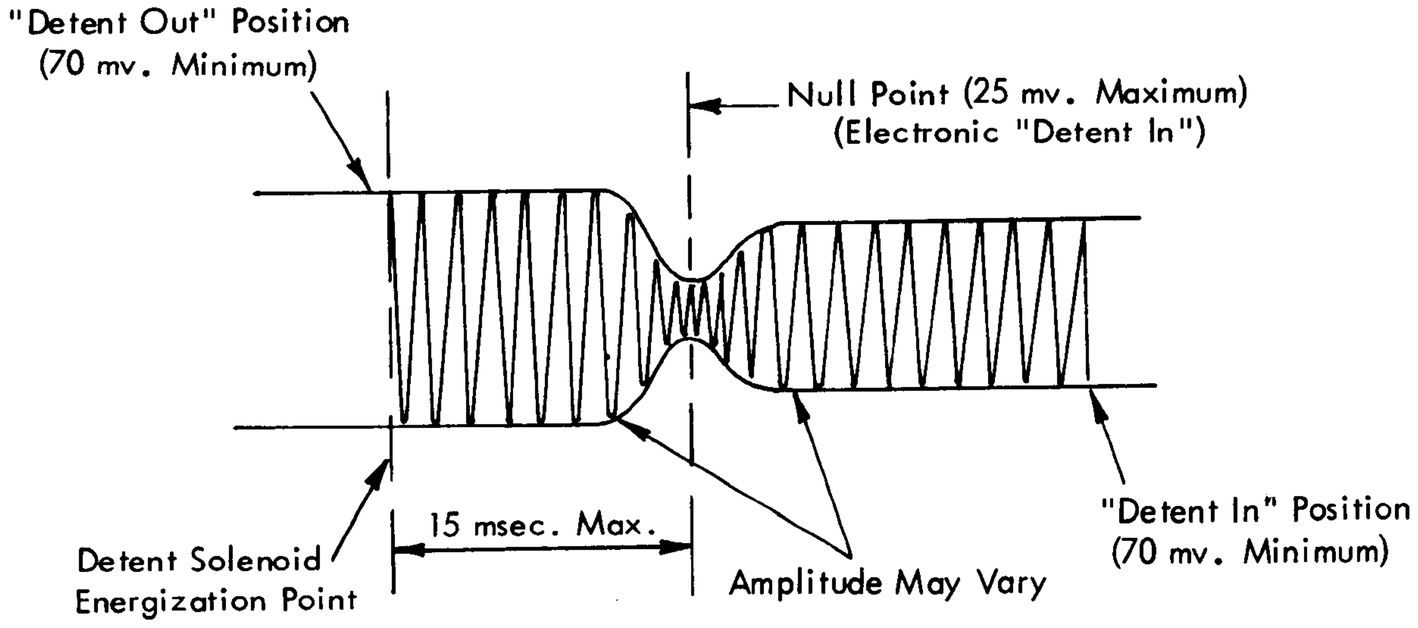


Figure 2-46. Detent Detector

The minimum differential signal as measured at (X) and (Y) of the secondary winding (Figure 2-46) is 70 millivolts. This minimum should be measured after a change in the logic signal of the "Detent In" line. The frequency of the differential signal is 20-25 KC. The differential signal amplitudes at "detent in" and "detent out" positions do not have to be equal.

The null point amplitude should not exceed 25 mv peak-to-peak.

The time between the energization of the detent solenoid and the point at which the null is present should not exceed 15 ms.

If the detent is resting on a land a low-level "detent out" signal (approximately 30 mv. to 65 mv.) is present at (X) and (Y). This low-level "detent out" voltage is lower than the normal 70 mv "detent out" voltage and higher than the null point (25 mv).

MOTION OSCILLATOR

Service Check

The motion oscillator setting is:

Fast range:	4.125 ms ± .100 ms
Slow range:	6.1 ms to 6.8 ms

Adjustment

Adjust the potentiometer on the oscillator card to obtain the fast range of 4.125 msec ± .100 msec.

When the oscillator is set to the fast range value the slow oscillator time should fall between the two limits shown.

ACCESS TIME

Service Check

The maximum access times are for any single operation. These are the times required for the access to become ready after the cylinder portion of the Access Register has changed.

ACCESS TIMES			
Type of Movement	Cylinder Movement of:	Fast Osc. ms(max)	Slow Osc. ms(max)
Piston Adder	Less than 10	50	82
Small Glob	Less than 50	111	170
Large Glob	Less than 250	180	286
Inner CE Cyl	254	180	286

A rezero operation consists of 3 time intervals: (1) the 17 count detent hold; (2) the normal time required for the access to move from any address to the outer CE cylinder; and, (3) the amount of time that the access stays at the outer CE cylinder position before attention status is brought up.

ACCESS COVER

Removal

1. Remove input power.
2. Vacuum the false floor and all surfaces surrounding the cover.
3. Remove access cover door.
4. After the disk array has stopped, loosen the screws on the front of the strut which retain the access cover and remove the cover. If the vertical trim is not properly adjusted it may be necessary to loosen the trim holding screws.

Replacement

1. Clean cover and cover door with isopropyl alcohol and a lint free soft cloth or tissue.
2. Vacuum the actuator, receiver, head loading mechanism, and internal surfaces of the strut to remove any accumulated particles. Be careful to use a light touch on the more delicate parts, such as arm stiffeners, in order to avoid damage.
3. Replace the cover so that it firmly seats on all seals and tighten the retaining screws. Adjust the vertical trim to retain the actuator shield in the proper location.

HYDRAULIC POWER SUPPLY (Figure 2-47)

WARNING: During normal operation and any time the file is left unattended, the Sequence Control switch must be left in the AUTO position. In the MANUAL position, low oil pressure sensing does not shut off the pump. Thus, if the machine is unattended and a hydraulic leak develops, the hydraulic power supply can continue to run, pumping oil out of the hydraulic system.

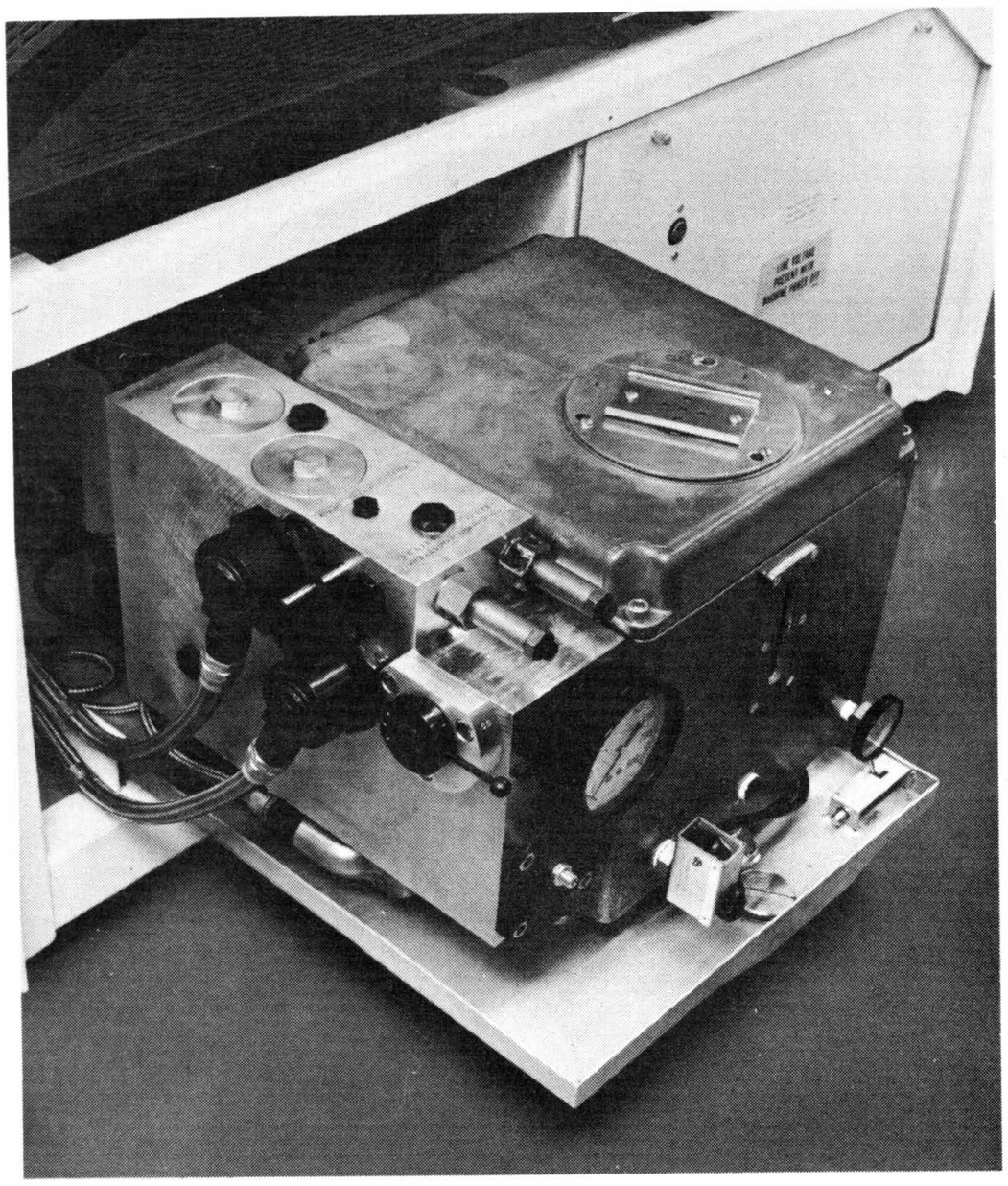


Figure 2-47. Hydraulic Power Supply in Servicing Position

HYDRAULIC POWER SUPPLY AS AN ASSEMBLY

Removal and Replacement

1. Disengage rear stud pin.
2. Slide unit out rear of machine to servicing position (Figure 2-47).
3. Remove electrical connections.
4. Remove actuator air bleed lines and wrap ends in lint free tissue.
5. Place selector valve in CIR position.
6. Remove hydraulic connections after cleaning adjacent area.
7. Slide unit onto receiving platform of crate.
8. Put new unit in machine.
9. Attach electrical and hydraulic connections and actuator air bleed lines.
10. Check reservoir oil level.
11. Check that the direction of rotation of fan is counterclockwise when viewed over the top of the power supply.

OIL LEVEL

Service Check

Check the oil level. Add oil only when level hits ADD line. The quantity of oil needed to raise the level from ADD to FULL is one gallon. Use only IBM P/N 2115252 which is one gallon of pre-filtered oil in a disposable container. Destroy container after initial use.

SYSTEM PRESSURE RELIEF VALVE

Oil must be at normal operating temperature before any checks or adjustments are made.

Service Check

Place all actuators INOP. Check the system pressure (550 psi ± 10 psi). Adjust if necessary.

With the Selector Valve in position SP the system pressure will be registered on the pressure gage.

Adjustment

1. Unlock lock nut.
2. Adjust pressure by turning adjusting screw:
   a. Clockwise rotation will increase pressure.
   b. Counterclockwise rotation will decrease pressure.
3. Lock in place.
4. Return selector valve to HP (Home Position).

Removal and Replacement

1. Turn off hydraulic power supply.
2. Put selector valve in circulate position.
3. Remove system pressure relief valve. Approximately 1 cup of oil will drain from this port.
4. Replace with new valve.
5. Adjust system pressure.

COOLING SYSTEM PRESSURE

Service Check

1. Set all actuator(s) INOP.
2. Check cooling system pressure for 50 psi ± 10 psi.
3. Pressure is read on pressure gage with selector valve at the CS position.

Adjustment

1. Put selector valve in CS position.
2. Use Low Pressure Relief Valve.
3. Unlock locknut.
4. Adjust pressure to 50 psi ± 10 psi by turning adjusting screw:
   a. Clockwise rotation will increase pressure.
   b. Counterclockwise rotation will decrease pressure.
5. Lock in place.
6. Return selector valve to HP (Home Position).

Removal and Replacement

1. Turn off hydraulic power supply.
2. Put selector valve in circulate position.
3. Remove low pressure relief valve. Approximately 1 cup of oil will drain from this port.
4. Replace with new valve.
5. Adjust new valve.

MECHANICAL FILTER

Service Check

1. Check the filter dirt accumulation by determining the pressure drop across the filter. Replace the filter if the pressure drop exceeds 35 psi, or has decreased more than 5 psi in 8 weeks as recorded on chart (see step 3).
2. The pressure drop is determined by the difference in pressure between up stream pressure (USP) and system pressure (SP). Use the selector valve and read the pressures on pressure gage.
3. Record pressure values on chart on Power Sequence Gate.

Removal and Replacement

Field replacement parts of this filter may vary somewhat in physical characteristics, but are interchangeable, i.e., one type may contain a reinforcing coil spring inside the pleated filter media. Others may have a perforated external metal shell. Either type may be used.

An internal "O" ring should always be in place in the filter when replacing this part (Figure 2-48).

1. Turn off the Hydraulic Power Supply.
2. Relieve pressure by turning the Selector Valve to circulate (CIR).
3. After cleaning adjacent area with lint free tissue, unscrew the cap which holds the filter in place.
4. Carefully remove the cap. The filter will normally come out with the cap.
5. Catch any oil drips in absorbent material.
6. Insert new filter element into the cap. Do not touch filter with hands, use plastic packing cover. Make sure that there is an O-ring in the filter.
7. Replace filter and cap into manifold carefully. Tighten cap moderately.
8. With Selector Valve in the Circulate position, run the power supply for 5 minutes. CE power sequence control must be on MANUAL.
9. Return old filter for cleaning. Do not attempt to clean filter in field.
10. Return selector valve to HP (Home Position).

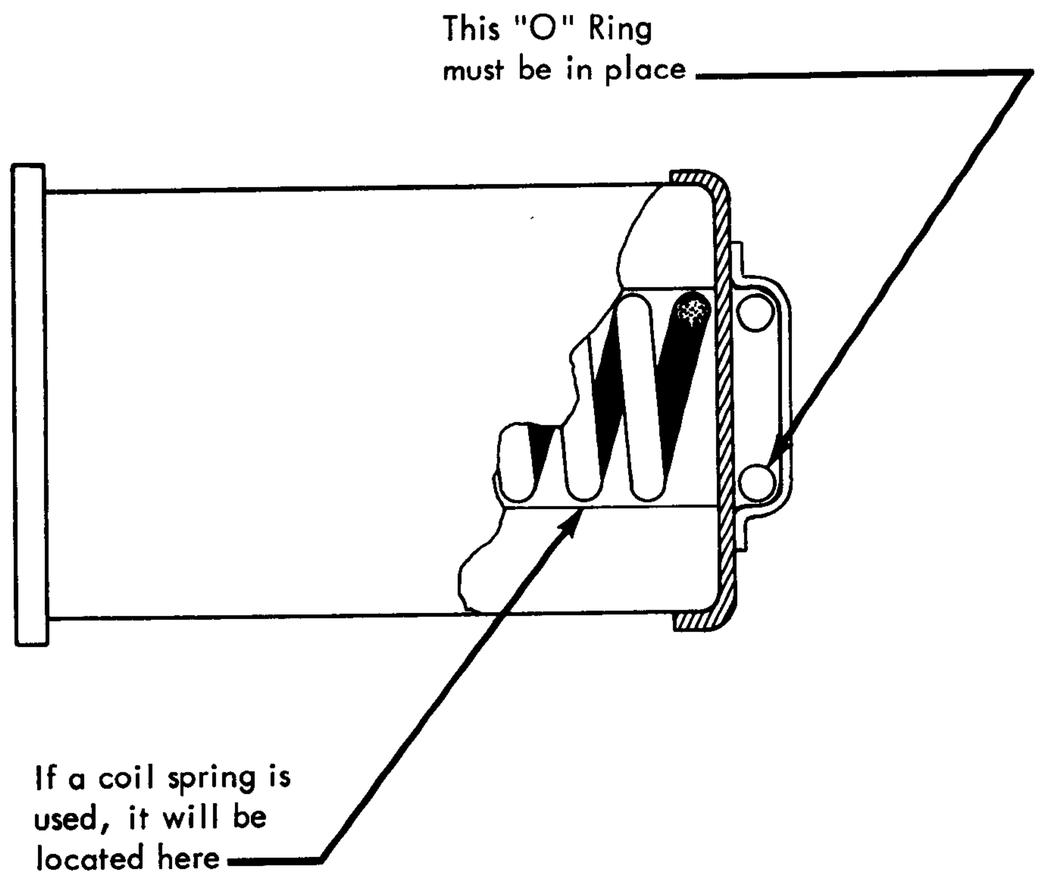


Figure 2-48. Mechanical Filter

OIL TEMPERATURE

Service Check

1. Check the oil temperature indicated on the temperature gage. The oil temperature for a single module, single access machine should be $124^{o} \pm 1^{o}$ F. Oil temperature on all other machines should be $120^{o} \pm 3^{o}$ F.
2. Before making any adjustment, check cleanliness of heat exchanger core. Remove lint collected on core and recheck temperature after 5 minutes.

Adjustment

Place all actuators INOP 5 minutes before adjusting.

1. Check the cooling system pressure as this will have a slight effect on temperature.
2. Adjust the screw on the thermal valve. Clockwise rotation will increase temperature, counterclockwise rotation will decrease temperature. Generally 1/4 turn equals 5^{o} F.

NOTE: Allow 10-15 minutes after each adjustment for stabilization of temperature.

MAGNETIC FILTER

Removal and Replacement

1. Turn off the Hydraulic Power Supply.
2. Relieve pressure by turning hydraulic selector valve to circulate (CIR).
3. Remove cap to magnetic filter, after cleaning adjacent area with lint free tissue.
4. With a pair of clean pliers remove the top magnet, filter element, and bottom magnet. Return these for cleaning. Do not attempt to clean.
5. Insert new filter assembly. Prongs of magnet must be towards the element.
6. Replace cap and tighten moderately.
7. Return selector valve to HP (Home Position).

UNLOADING VALVE

Service Check

This check cannot be made accurately with greater than 5 psi drop across the mechanical filter.

1. Place all actuators INOP.
2. Set selector valve to System Pressure (SP).
3. Unlock system pressure relief valve.
4. Slowly unscrew this adjusting screw while watching the pressure gage. The pressure will drop uniformly, hesitate, then continue to drop uniformly again.
5. The pressure at which the gage hesitates should be 500 psi± 10 psi. This hesitation indicates that the unloading valve is closing and causing more flow over the relief valve.

Adjustment

1. Unlock the unloading-valve adjusting screw.
2. Turn adjusting screw clockwise to increase the pressure at hesitation as described in the service check. Counterclockwise rotation will decrease the pressure at hesitation.
3. Lock adjusting screw in place. Recheck service check.
4. Readjust system pressure relief valve to 550 psi± 10 psi and lock in place.
5. Return selector valve to HP (Home Position).

PRESSURE SWITCH

Service Check

This switch is normally open with no hydraulic pressure present. It is set to close at 500 psi ± 25 psi system pressure.

1. Set power-sequence control to LOCAL-MANUAL; pressure normal light should be on.
2. Set hydraulic selector valve to CIR (circulate); pressure normal light should go out.
3. Return selector valve to HP (Home Position) and power-sequence control to REMOTE-AUTO.

Adjustment

1. Turn power sequence control to Local-Manual.
2. Turn switch adjusting screw counterclockwise until pressure-normal light on power-sequence panel goes out.
3. Reduce system pressure to 500 psi ± 25 psi.
4. Turn switch adjusting screw clockwise until pressure-normal light comes on.
5. Set system pressure at 550 psi ± 10 psi.
6. Return power sequence control to Remote-Auto.

THERMAL SWITCHES

Over Temperature Protection

Adjustment

This microswitch is set to open at 130° F. Adjustments are not normally necessary.

Oil Temperature Thermal

Service Check

This switch is located on the actuator hydraulic disconnect. This switch is set to close at 105° F and is not adjustable.

POWER SEQUENCE CONTROL

Service Check

The proper starting sequence of file components under AUTOMATIC LOCAL and AUTOMATIC-REMOTE operation, after a "heads unloaded" and "Air Pressure Normal" indication is:

1. Cycle start
2. Disk drive and electronic gate blowers
3. Electronic DC; and start next file (remote only)
4. Solenoid DC
5. Oil pump
6. Head load
7. Head load check
8. File ready

An access is set INOP if:

1. The access is not retracted at head load time or,
2. The heads are not loaded at head load check time, or
3. The access cover door is open or off.

POWER SUPPLIES

48 v Supply (Relay and Actuator)

The 48 volt supply must be between 44.6 volts and 50.4 volts. If these values cannot be met and input voltage and input taps are correct, change transformer output taps to obtain desired voltage. Refer to system diagrams for correct taps.

CAUTION: Turn off main-line switch (CB1) in contactor panel prior to changing transformer taps.

DC Supplies

The DC power supplies (-48 not included) must regulate within ± 2% of rated voltage, but are adjustable from +4% to -1%. Measure the voltages at the power supplies. If these values cannot be met and input voltage and input taps are correct, change transformer output taps to obtain desired voltage. Refer to system diagrams for correct taps.

The location of components within the power supplies are shown in the circuit diagrams. These diagrams should be used to find the part number and description of the suspected component. With the part number available, the physical location of the component can be easily located in the parts catalog.

New DC power supplies are available for replacement purposes. The new power supplies are completely interchangeable with the old supplies except for cable length. Therefore, field bill of material No. 2115360 must be obtained when ordering the new supplies. This B/M will include the additional length of cable, fittings and instructions.

Over-voltage sensing and regulator cards are required with the new power supplies and must be ordered separately.

The following is a listing of the old and new power supplies and associated cards:

DC Power Supplies		New Cards	
Old No.	New No.	Over Voltage Sensing	Regulator
207204	473400	370575	370612
207225	473390	370576	370610
208267	472240	370577	370609
207201	473450	370575	370612
208258	473380	370576	370610
207282	473550	370578	370608

ELECTRONIC COMPONENTS

READ CIRCUITS

WARNING: Do not put scope probes, leads or jumpers of any kind on the lines coming directly from the data or format heads. The heads can be damaged and/or data destroyed by possible potential differences.

The peak-to-peak signal at pins A and F of the linear amplifier should be 6.0 to 6.25 volts. This applies to customer and CE cylinders. Wave forms showing input and output signals for special circuit cards are in logic diagrams manual.

The drop in peak-to-peak signal amplitude from a minimum (single) bit pattern to a maximum (all) bit pattern should be no greater than 25%.

The pulse width of the output of the single shot shall be .5 microsecond plus or minus 10%.

Read Amplifier Calibration

Three potentiometers are used in the read amplifier and bit detector to facilitate setting the regulated signal output and the bit detection threshold.

Throughout the following description only the data amplifier (in the B row) points are mentioned, but the format amplifier (in the A row) has a one-to-one relationship for the points concerned. The calibration procedure for both amplifiers is identical (use a 1-to-1 probe or a X10 compensated probe with a wide band (2 megacycle or greater) preamplifier such as a CA or D). Sync on index (01A5E07B). Use an expanded scale of about 50 microseconds/cm and find an all bit pattern such as an AGC burst. Cylinders around 125 should be used as the amplitude difference between single bit and all bit patterns will be slight.

1. Set the machine in a continuous read condition on one head and one track. This can be done by setting the desired access INOP and turning on head select at CE Panel.
2. Balance the DC levels (no signal in) at pins H and G or test point 1 and test point 2 of the Overdriven and Limiter Amplifier (TEN-) at 01A5B17 within .1 volt by means of the potentiometer on card.
3. Adjust the voltage on pins A and F of the linear amplifier (TEH-) at 01A5B12 to 6 to 6.25 volts peak-to-peak by means of the potentiometer on 01A5B09. If this voltage cannot be obtained, the variable gain amplifier (TEV-), the AGC detector (TEQ-), and the two subsequent linear amplifiers (TEH-) should be checked (Figure 2-49).
4. Observe pin A of the OR-AND (ANW-) at 01A5B18 and, by means of the potentiometer on this card, adjust the clipping level to 50%. (Figure 2-50).

   It is very important that the base line reference used for measuring the clipping level be after the recovery time as shown. Any overshoot is to be disregarded in the measurement of the 50% level.

NOTE: This ratio (2-1) is easily accomplished by maintaining E_2 (Figure 2-50) at a constant vertical deflection of one cm (by means of the oscilloscope variable voltage control) and adjusting the potentiometer on the OR-AND (ANW-) to obtain a vertical oscilloscope deflection of two cm for E_1.

Read Amplifier Noise Rejection

If the read amplifier does not reasonably reject conducted line noise, the following conditions should be verified on each access:

1. The receiver assembly is electrically isolated from frame ground and is to be connected to the J pin of the read Preamplifier card (TEL-).
2. The shield of the format head cable is returned to the J pin of the format Preamplifier card (TEL-).

Disk Surface Requirements

A maximum of 5 defects per data disk surface are permitted during manufacturing, including the flag surfaces but not including the CE cylinders.

The disk area in which the first address after index is written must be error-free. This is the marked 2 inch error free area.

There will be no more than 5 defects in any given cylinder location, including the flag surfaces, but not including the CE cylinders, when the 1301 leaves the plant.

The format disk must be defect free.

The following procedure for making a complete surface check is performed at the plant before the machine is shipped. The same procedure can be used to verify or diagnose defective surfaces in the field.

1. Record the format track for single record operation.
2. Record a minimum bit pattern on all disk surfaces at all track locations.

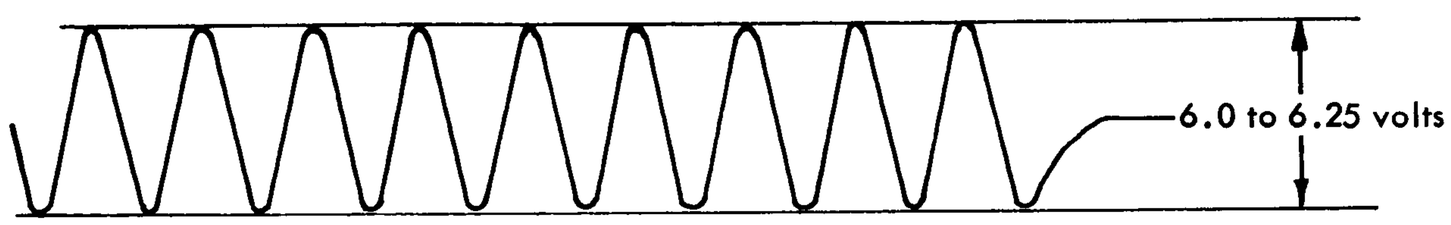


Figure 2-49. Voltage Output of Second Linear Amplifier

3. With the clipping level of the data and format read amplifier set at 40%, read all surfaces and log all defective tracks.
4. Record a maximum bit pattern on all disk surfaces.
5. With the clipping level of the data and format read amplifier set at 60%, read all surfaces and log all defective tracks.
6. Relocate the access to the Track 00 position.
7. With the read amplifier clipping level set to 50%, all data surfaces not designated as defective, and the alternate surfaces to be used in lieu of the defective tracks, must be read without error when written with any 8-bit character combination.

A disk defect log is in the system diagrams of each machine.

GATE VENTILATING SYSTEM

The ventilating system for the SMS gates consists of a motor, a blower assembly, and a set of filters. A complete description of these blowers and their maintenance is contained in Form 223-6900, Standard Modular System.

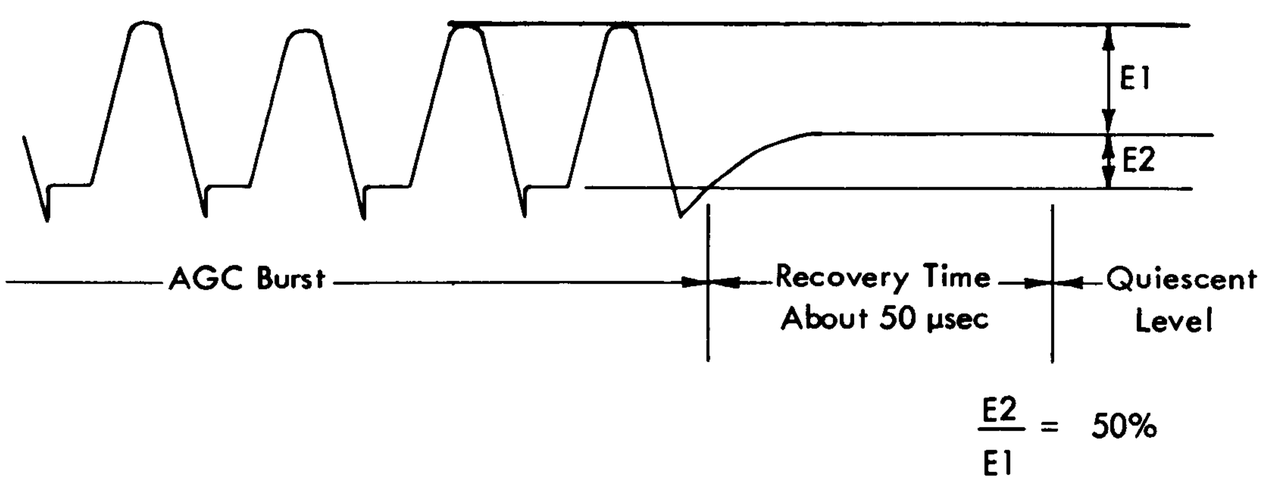


Figure 2-50. Read Amplifier Clipping Level

COMPRESSED AIR SYSTEM

Service Check (Figure 2-51)

Pressure on air pressure gage should be 42-44 psi. Air pressure should remain constant without the air compressor running. Loss of pressure is indicated by frequent starting and stopping of the air compressor. The compressor should start no more often than every 30 minutes.

Adjustment

Air Pressure Normal Switch. Set this switch to close and turn on the Air-Pressure-Normal light on the Power Sequence panel when the air pressure reaches 35 to 38 psi (Figure 2-52).

Air Pressure Control Switch. Set this switch to maintain 42 to 44 psi as indicated on the air pressure gage. The adjusting wheel (Figure 2-53) can be turned with the tip of a screwdriver.

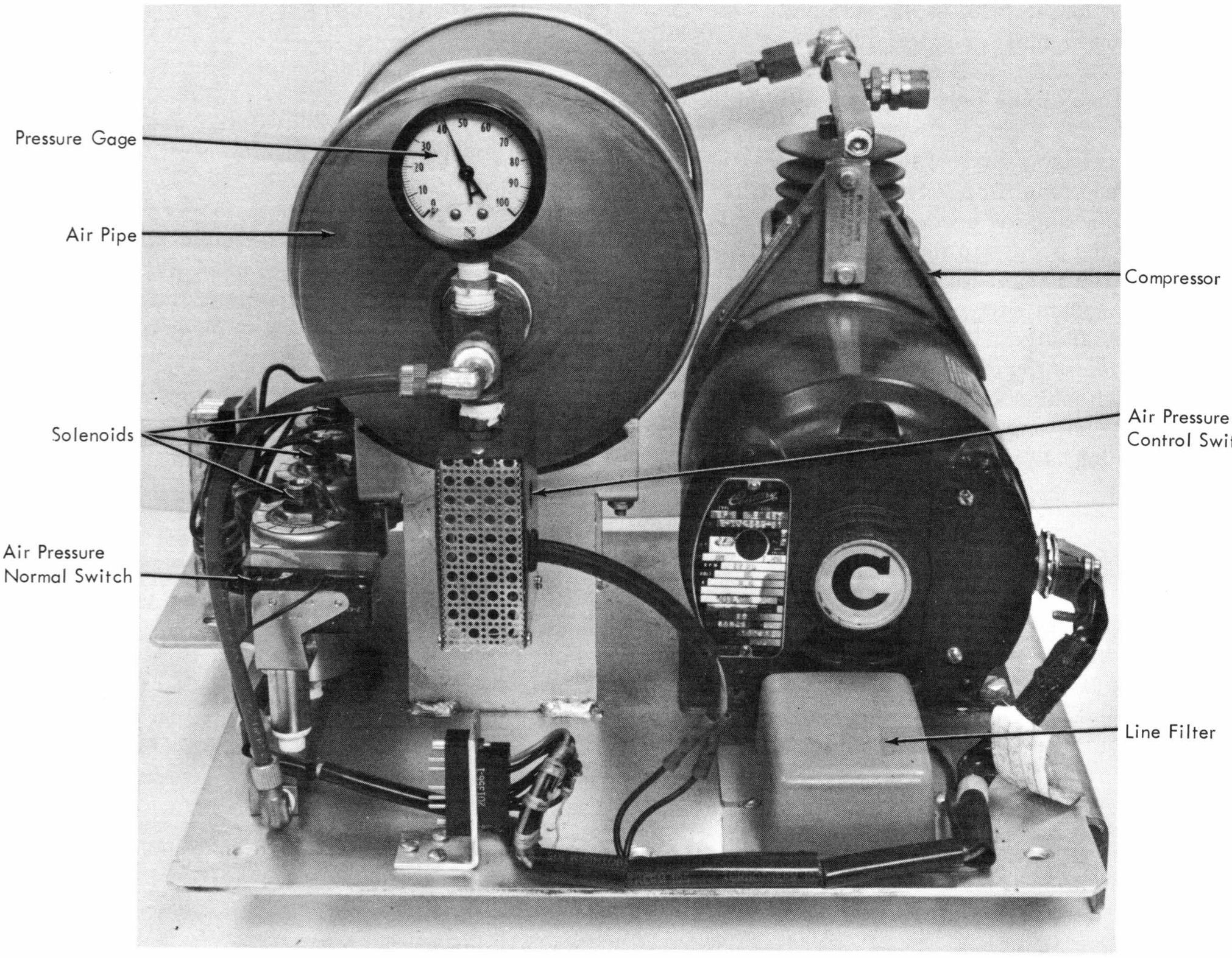


Figure 2-51. Compressed Air Supply

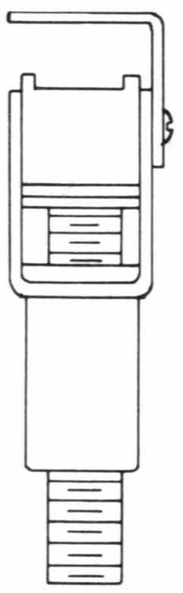


Figure 2-52. Air Pressure Normal Switch

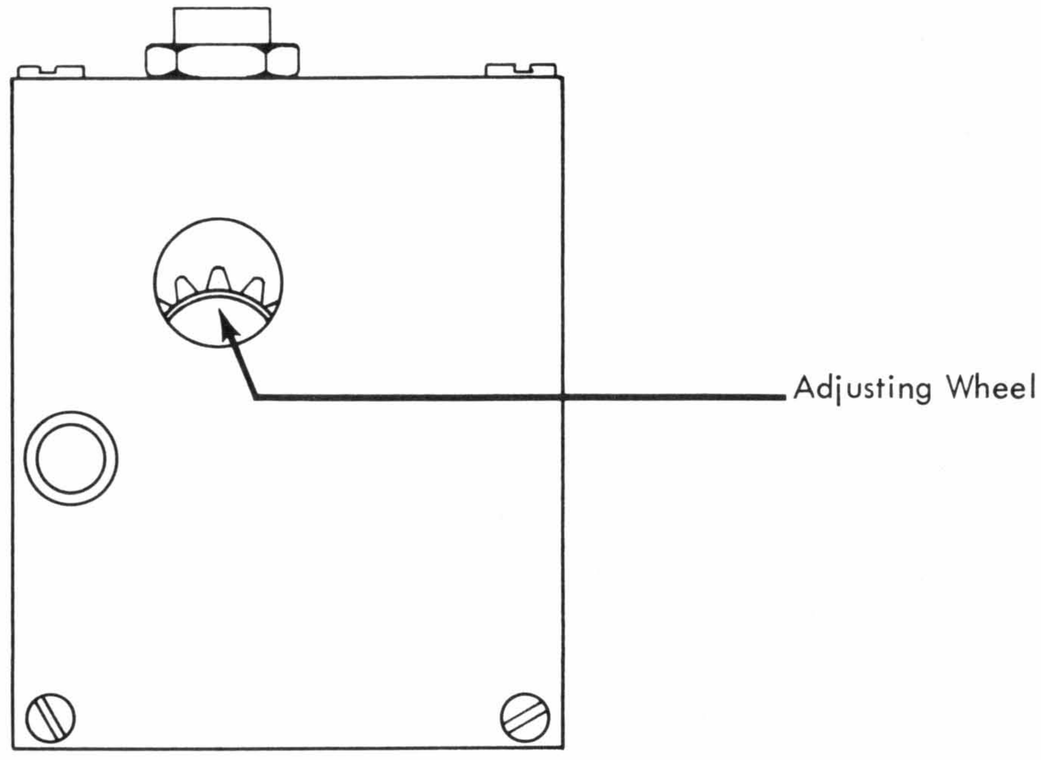


Figure 2-53. Air Pressure Control Switch

SECTION 3 SERVICE AIDS

CONTENTS

TROUBLESHOOTING HINTS

WARNING: Voltage is present on both sides of most circuit cards. Metal caps of transistors are often a part of the circuit. Avoid pulling or replacing cards with the DC on, since a resultant short could damage transistors or other circuit components.

Solenoid Driver No. 2 (TDR-) must never have -48 v on it alone. If this card is removed from gate there is a possibility of having this condition. Solenoid DC and Electronic DC must be turned off prior to removing this card.

Intermittent problems can sometimes be aggravated by vibration. Tapping the edge of the cards with the plastic end of a screw driver in the area suspected should be sufficient. Caution is required since too violent vibrations can cause adjacent card components to short.

There will arise instances where it is desirable to jumper in signals or voltages to specific inputs or outputs to check certain functions. Care should be taken that the logic blocks are not overloaded because of this, as erroneous indications will result. More important is the use of voltages that can damage or destroy the transistors. For the majority of logic block cases, a properly placed ground will create the effect desired. All other cases must be treated individually based on knowledge of the circuits involved.

Special circuit card diagrams are shown in the system diagrams. Also shown are input and output waveforms for most of these cards.

Any S level may be clamped to ground without damage to the circuit card.

READ MALFUNCTIONS

WARNING: Do not put scope probes, leads, or jumpers of any kind on the lines coming directly from the data or format heads. The heads can be damaged and/or data destroyed by possible potential differences.

1. Failure of the read amplifier to reject line noise can be caused if the receiver is not electrically isolated from frame ground. The receiver should be connected to pin J of the read Preamplifier card (TEL-). The shield of the format head cable should be connected to pin J of the format Preamplifier card (TEL-).

2. Read failures can be caused by a non-calibrated read amplifier or a too long or too short single shot pulse. The single shot pulse width should be .5 microseconds ±10%.

3. The average peak-to-peak read signal at the preamplifier for any 300 microsecond period should be not less than 15 millivolts or more than 70 millivolts. Signals beyond this range can cause read failures.

4. Read failures can be caused by heads not being fully loaded. This condition causes all heads of a module to have decreased output. In this case the heads loaded microswitch would also have to be in incorrect adjustment.

WRITE FAILURES

An apparent failure to write can be caused by a write safety circuit malfunction. Check for proper write safety conditions before investigating a write driver or write head for trouble.

A+ S level on pin A of the Write Driver Safety (TDU-) card indicates that one or more Write Drivers (TEF-) are conducting.

A Not Write gate condition or write gate and more than one Write Driver selected will cause output pin B of the Multiple X Select (TDT-) card to be a + S. A -S at pin B indicates write gate and only one write driver selected. The Voltage Safety (TEA-) card prevents any Y selection from being made when the loss of any voltage except + 6 volts occurs.

READ/WRITE FAILURES

1. The voltage safety card protects both read and write circuits. Check this card when neither read nor write operations function.
2. Failure of the clock read circuit will cause read and write failures. Check that the clock line driver (01A1F04, TEJ-) is gating and passing clock signals properly.
3. Incorrect adjustment or loosening of the carriage yoke assembly can cause read or write failures.
4. The input voltage must remain within plus or minus 10%. This tolerance includes any variable combination of steady state and/or short duration transients.

ACCESS MALFUNCTIONS

1. There is no blown fuse indication on the 1301. Failure to go to the correct cylinder can be caused by a blown fuse.
2. Access failure can be caused by the access door being partially open or failure of the interlock.
3. Failure of the motion oscillator to switch to slow speed can cause the access to be set inop when the hydraulic oil is cold.
4. Excessive access time can be caused by failure of the oscillator to switch to high speed.

SERVICE CHECKS

ATTENTION STATUS

Attention status is raised and driven to the system when any of the following conditions occur:

1. Access becomes Ready.
2. End Rezero comes up.
3. 60 count comes up.

REZERO

Rezero can be caused by:

1. CE Rezero
2. Power sequence Rezero
3. Arrival failure
4. Invalid address (all globs)
5. Hitting inner or outer limit switch when not addressed to cylinder 254
6. Opening access cover door

Rezero coming on will:

1. Set the Access Register to 0000.
2. Pull detent (except if access cover door open).
3. Energize Rezero valve.
4. Return to outer CE cylinder (except if access cover door open).
5. Re-calibrate the oil.
6. After the actuator has returned to the outer CE cylinder, the oil is recalibrated for the required length of time, then attention status is raised.

To come out of Rezero, push CE reset. This will turn off Rezero and cause access to detent at cylinder 00.

ACCESS COVER SAFE SWITCH

When the access cover door (B7.A6.15.1) is opened or removed, this switch will open and cause:

1. The access to be set INOP.

2. The Access Register Cylinder Address set pulse to be blocked (from system).
3. Rezero to be held off.
4. Access Register to be held reset.

CAUTION: If solenoid DC is dropped for any reason the actuator may attempt to move under hydraulic pressure.

DC VOLTAGES

1. The 48v relay supply must be a minimum of 44.6v and a maximum of 50.4v.
2. The DC SMS supply voltages must be within ±2% rated output voltage at the laminar bus on the gates.
3. The machine should perform all normal functions with the +12 volt marginal voltages varied between +9 volts and +15 volts.

PULSE WIDTH OF SINGLE SHOTS

WARNING: Adjustment of single shots should only be made while acutator is stationary and under CE control.

T1301 Single Shots

Squelch Single Shot

The pulse width of the output of the single shot should be 375 μsec ±10%.

Record Ready Single Shot

The pulse width of the output of the single shot should be 180 μsec ± 10%.

Record Ready Sample Single Shots

The pulse width of the output of the single shots should be 1 μsec ± 10%.

Write Gate Single Shot

The pulse width of the output of the single shot should be 375 μsec ± 10%.

STANDARD MODULAR SYSTEM MAINTENANCE

All normal maintenance of standard modular system components is found in form 223-6900, Standard Modular System. Included in this form are:

Wrapped Wire Connections
Crimped Connections
Soldered Connections
Wiring Rules
SMS Service Tools
SMS Card Maintenance
Measurements
Ventilating Systems

CE SERVICE AIDS

Many service aids are incorporated into the IBM 1301 Disk Storage. These aids allow the CE to observe or duplicate machine functions.

CE TEST CONTROL PANEL (FIGURE 3-1)

The CE test control panel is located in panel A1. From this panel, the CE can monitor most file functions. However, the respective access must first be set inop and the access cover must be on before most of the switches on this panel are effective.

Head Select

The on-off toggle switch in the upper right corner turns head select on or off.

Cylinder Select Lights

Ten cylinder select lights indicate the contents of the access register and are driven by the outputs of the access register. Above each light is the binary and cylinder equivalent number represented by the light.

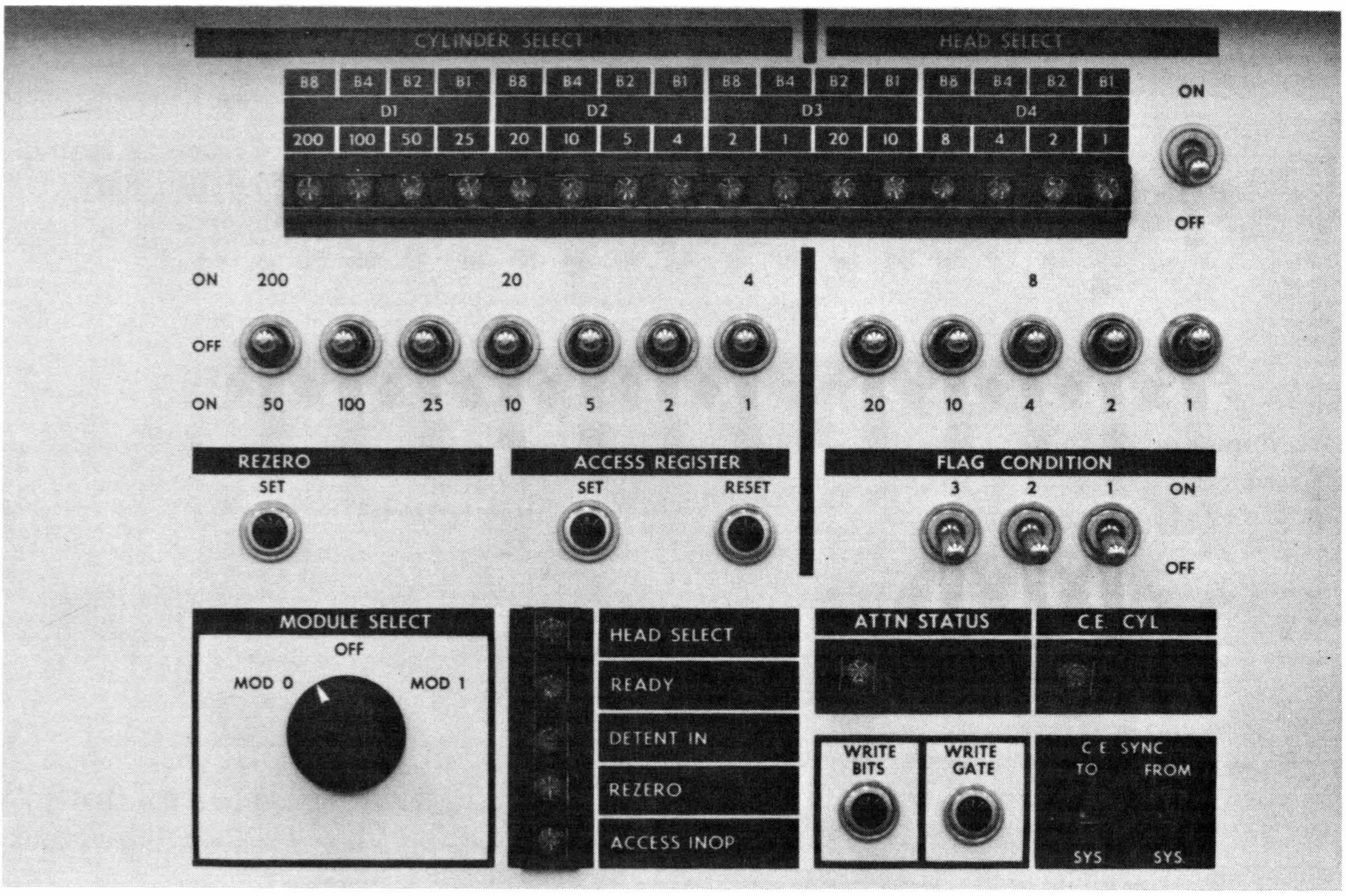


Figure 3-1. CE Test Control Panel

Head-Select Lights

Six head-select lights indicate the head to be selected. These indicators are driven from the access register. Above each light is the binary and decimal equivalent number represented by the light.

Cylinder and Head-Select Switches

These twelve switches can be used to select any cylinder-head address including the inner CE cylinder which is located at cylinder position 254. Certain combinations are considered improper addresses. For example, track 200 and 50, track 20 and 10, track 4 and 1, and head 8 and 4. These combinations are interlocked by the switches. However, there are other improper address combinations that can be selected by the switches. For example, track 200 and 100, track 5, 4, and 2, and head 8 and 2.

Access Register Set-Reset

The address selected by the cylinder and head select switches is set into the access register by depression of the set button. Additional access register latches can be set without a reset. However, none can be turned off without a total reset. The access register is reset by depression of the reset button. This button also resets rezero.

Resetting the access register puts the actuator at cylinder 0 and selects head 00.

Rezero Set Switch

Two functions are performed by this switch: rezero, and locate CE outer cylinder. The outer CE cylinder is 0. Rezero is in the same position. This position is not detented, and as long as the actuator is in rezero, the actuator can be moved manually with a small amount of force. Rezero can be reset by depression of the access register reset switch.

Flag Condition Select Switches

These three switches allow the CE to set the three flag latches which allow selection of any of the six alternate (flag) surfaces.

CE Cylinder Arrival Light

This light indicates that the CE inner or outer cylinder has been located.

Attention Status Light

This light indicates that the access has ended a seek operation. If the access is not inop, a signal is sent to the FCU that indicates an end of seek.

Module Select Switch

This switch selects the module to be monitored or operated from the CE panel. Selection of a module also selects the access for that module.

Condition Indicator Lights

Head select, access ready, detent in, rezero, and access inop are the conditions indicated by lights.

Write Bits—Write Gate Switches

Depression of the write gate button raises the write gate if the access is located at the CE inner or CE outer cylinder. Depression of the write bits button allows raw format data (read from the CE format) to be put on the write data line. This data will then write on the selected head within the CE cylinder.

CE Sync Hubs

These hubs are serviced by convenience wires between the FCU and the 1301. The line from the FCU is terminated in the 1301. The line to the FCU is driven from the 1301.

HYDRAULIC MANUAL SELECTOR VALVE

The hydraulic selector valve is used to check cooler system (CS), upstream (USP), and system pressures (SP). The selector valve can also be used to circulate (CIR) oil through the system. The selector valve should be in HP (home position) when the system is being used.

MARGINAL VOLTAGE CHECK JACK

Marginal voltage checks of the logic circuitry are made by placing the portable marginal voltage supply plug into the jack receptacle. The+ 12 marginal voltage can then be raised to + 15 volts or lowered to + 9 volts.

POWER SEQUENCE CONTROLS

The power sequence control panel (Figure 3-2) provides the facilities for starting and stopping the file during normal operations and ensures proper operation of file components. The sequence control may be either automatic or manual. The manual control of power sequence has been provided for CE manual start or component check. The automatic control of power sequence is under control of a 4-minute timing device. Normally, initiation of start on the first 1301 is under system control. Subsequent files, in remote control, are started on receipt of a timed pulse during the sequencing of a preceding 1301. When the 1301 is ready for normal operation, a "Power sequence complete" signal is sent from file to file. When this line is completed by the last file, the line indicates to the FCU that the file sequence is complete for all files in remote control.

Indicator lights are provided as servicing aids for the Customer Engineer. They indicate both normal and malfunction conditions as long as the mainline 70-amp breaker is closed.

Power Sequence Panel

All power sequence functions are controlled by and monitored at this panel. The red lights indicate unsatisfactory conditions. The white lights indicate satisfactory conditions. Normal sequence is indicated by the small arrow heads next to the lights.

Auto Control Switch

This switch selects the originating point of the start or stop sequence signal. A remote signal originates at the system. A local signal originates with the start or stop switch on the 1301 power sequence panel.

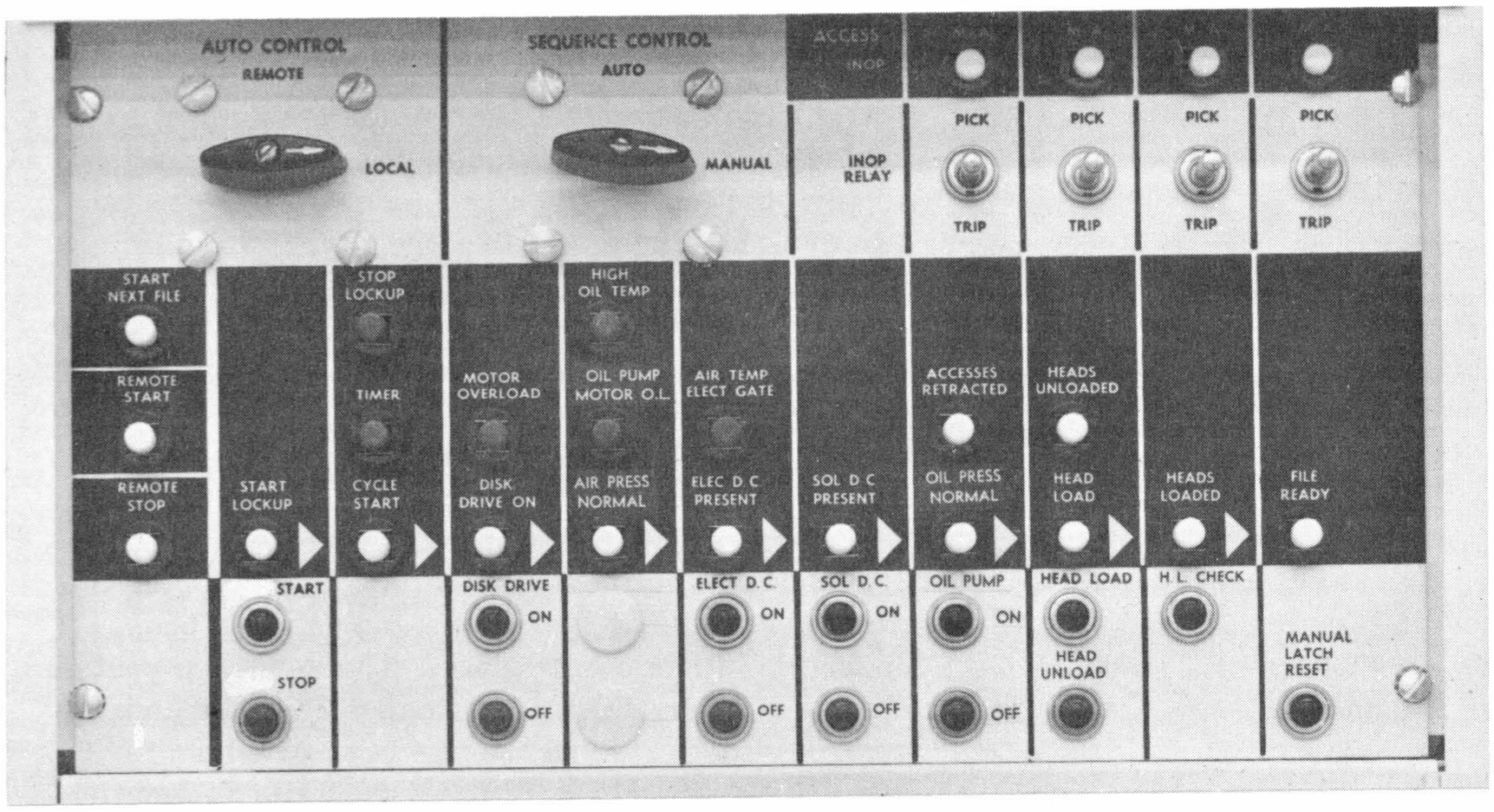


Figure 3-2. Power Sequence Control Panel

Sequence Control Switch

Auto or manual sequence is selected by this switch. Auto sequence puts all functions under control of the sequence timer. Manual sequence allows the CE to select the time and sequence for most functions.

Damage to the heads or disks can result if the heads are loaded before the disks are at operating speed. To prevent this damage, the head load circuit is always directed through the timer 180 second contact. The disks and the timer, therefore, must run for 180 seconds before the heads can be loaded. In a stop sequence, the heads must be unloaded before the disk array is stopped.

System Function Lights

Remote start and remote stop from the FCU to the 1301, and start next file from the 1301 to the next file are indicated by these lights.

Access Inop Lights

If any access is put inop, manually or automatically, the associated inop relay picks, turning on the respective inop light.

Access Inop Switches

Manual operation of any of these switches causes an inop relay to be picked or tripped. Accesses that have been set inop by any method can be reset only by tripping the inop relays with these switches.

Auto Start Stop Controls

Auto local start and auto local stop are initiated with the start or stop switches. The start lock up light comes on with the pick of R10 during an auto start sequence. The timer light is tied in parallel with the timer motor and is on whenever there is power to the timer motor. The cycle start light comes on with the pick of R111 at 15 seconds after the start of an auto power sequence start. During a manual sequence start, the cycle start light does not come on until the disk drive auxiliary (R32) picks. The stop lock up light comes on when R47 picks during any stop sequence.

Disk Drive

The disk drive on and off switches are for manual control of the disk drive motor. The disk drive can

be manually started only if the heads are unloaded and the timer is at the beginning of a cycle. The disk drive light is in parallel with the disk drive contactor (K2). If a disk-drive-motor-overload switch or overtemperature switch opens, R39 picks and turns on the motor overload light. A disk drive overload or overtemperature condition causes a stop sequence to occur.

Electronic DC

The electronic DC on and off switches are for manual control of the electronic DC power. If electronic DC is applied and all access swingout interlocks are closed (access in operating position), R44 picks to turn on the electronic DC present light. An over-temperature condition in an electronic gate causes R48 to drop. R48 picks R36 which turns on the electronic air temperature light.

Solenoid DC

The solenoid DC on and off switches are for manual control of the solenoid DC power. The solenoid DC present light is turned on when R8 is picked by K301. Solenoid DC can come on only when electronic DC is present. Loss of electronic DC results in dropping solenoid DC. This protects the solenoid driver cards from damage caused by having 48 volts without proper biasing voltages.

Oil Pump

The oil pump on and off switches are for manual control of the hydraulic power supply motor. A pressure switch in the hydraulic system picks R7 when operating pressure has been reached. R7 turns on the pressure normal light. Opening an overload in the oil pump drops R2 which in turn picks R40 which turns on the motor overload light. When the temperature of the oil exceeds 130^{0}, R49 drops to pick R38 which turns on the high oil temperature light.

Head Load

The head load switch is for manual loading of the heads. The switch is effective only after the timer has run 180 seconds. This time must be allowed to build pressure in the array and remove particles of dirt. The head unload switch is for manual unloading of the heads. In any stop sequence, the heads must be unloaded before the disk array can be stopped.

Before the heads can be loaded, at least one access must be retracted and air pressure must be normal (above 30 psi). The accesses retracted light is picked by R4. R4 is picked by all the access retracted switches or inop relay points in series. The air pressure normal switch closes to pick R46 which turns on the pressure normal light. The head load light is turned on by R125. R125 also picks the clock head solenoid and the head load air solenoid control (K202). The heads unloaded light is turned on by the pick of R43. R43 will pick only if all the heads, including the clock head, are unloaded. The head load check switch is for manual control of the head check operation. Depression of this switch in manual control will pick the head load check relay (R45). This relay, in series with the head loaded switches on each access and the clock head, will pick R5 if all heads, including the clock head are loaded. R5 turns on the heads loaded light.

File Ready

The file ready light is turned on by the file ready relay (R64) if all of the following conditions are present.

1. Not stop sequence delay
2. Heads loaded
3. Electronic DC present
4. Oil pressure normal
5. Solenoid DC present
6. Solenoid power supply control

Manual Reset

Depression of the manual reset switch is the only way the following conditions can be reset.

1. Disk drive overload
2. Electronic air overtemperature
3. Oil overtemperature
4. Oil pump overload
5. DC failure indication
6. Air pressure normal (after disk drive on)

SECTION 4 LOCATIONS

CONTENTS

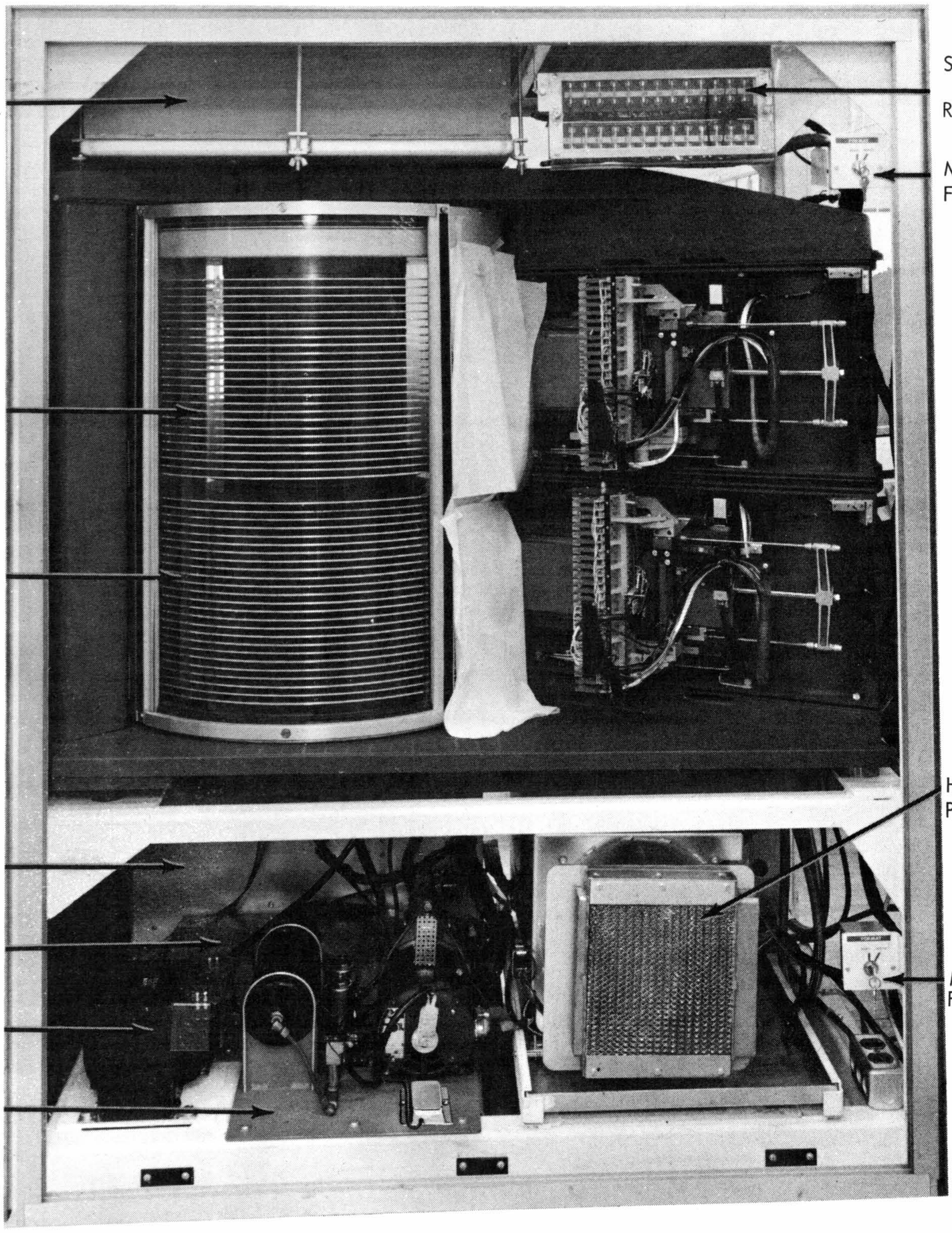


Figure 4-1. Mechanical Frame

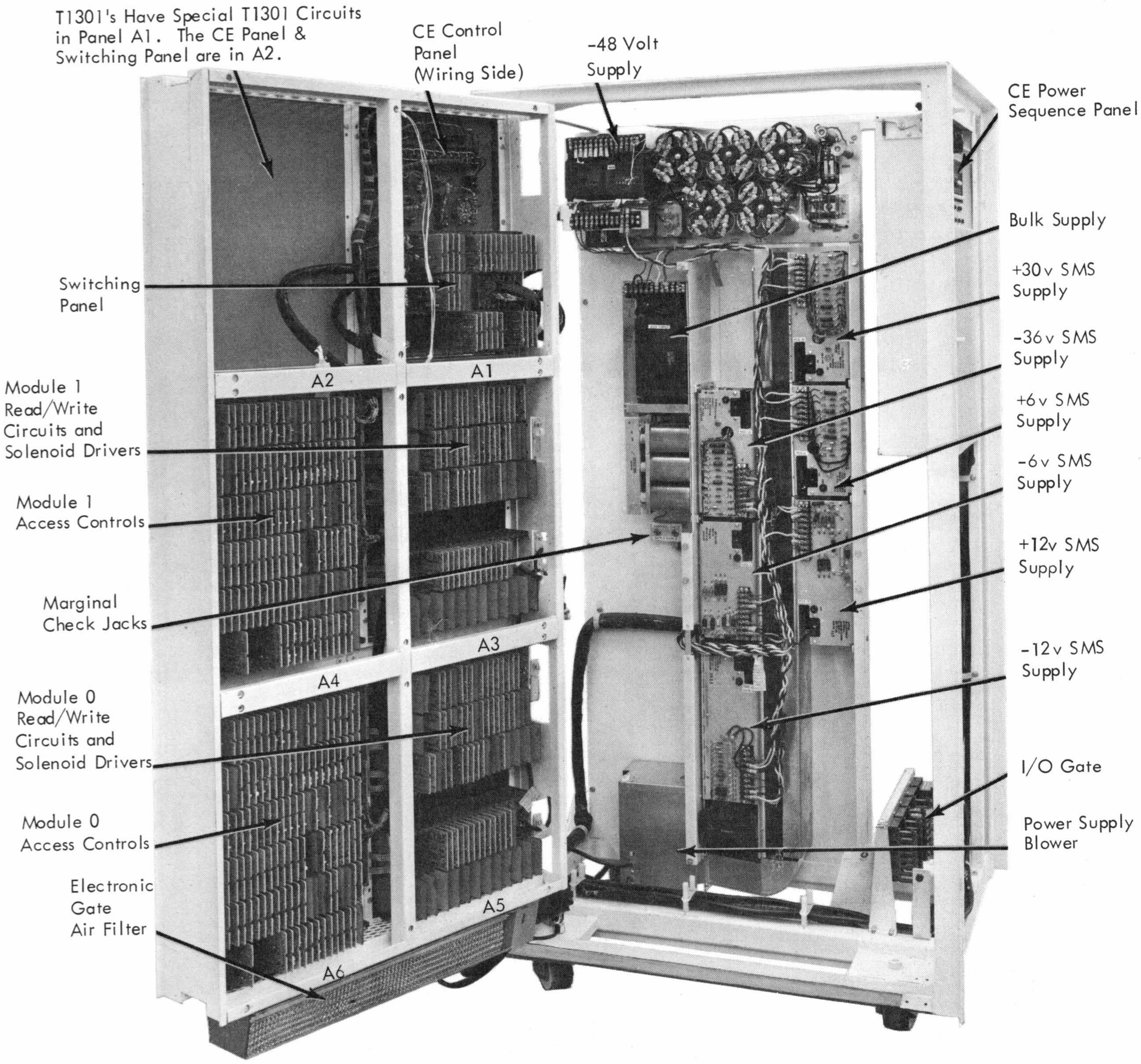


Figure 4-2. Electronic Frame

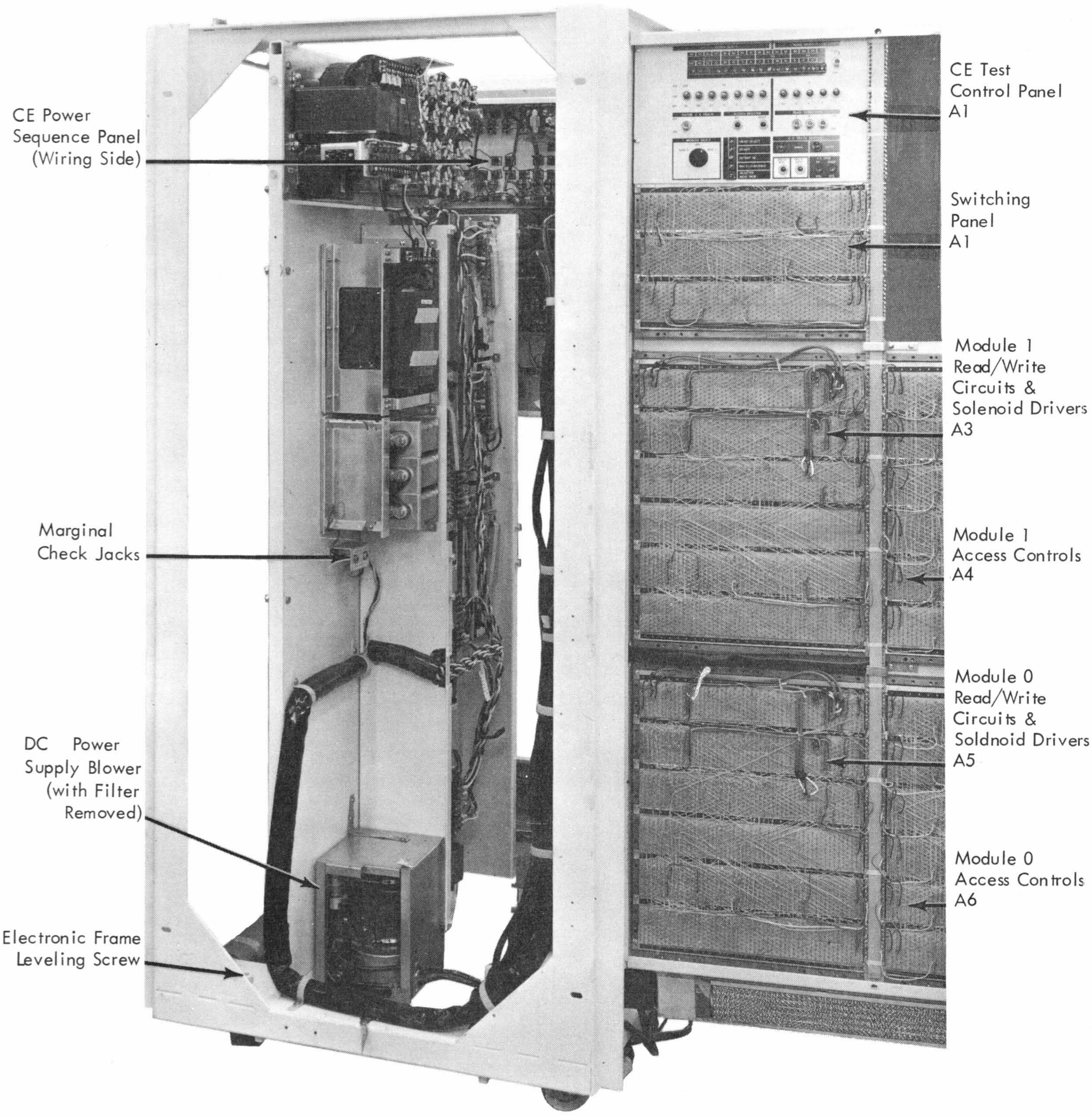


Figure 4-3. Electronic Frame - Left End

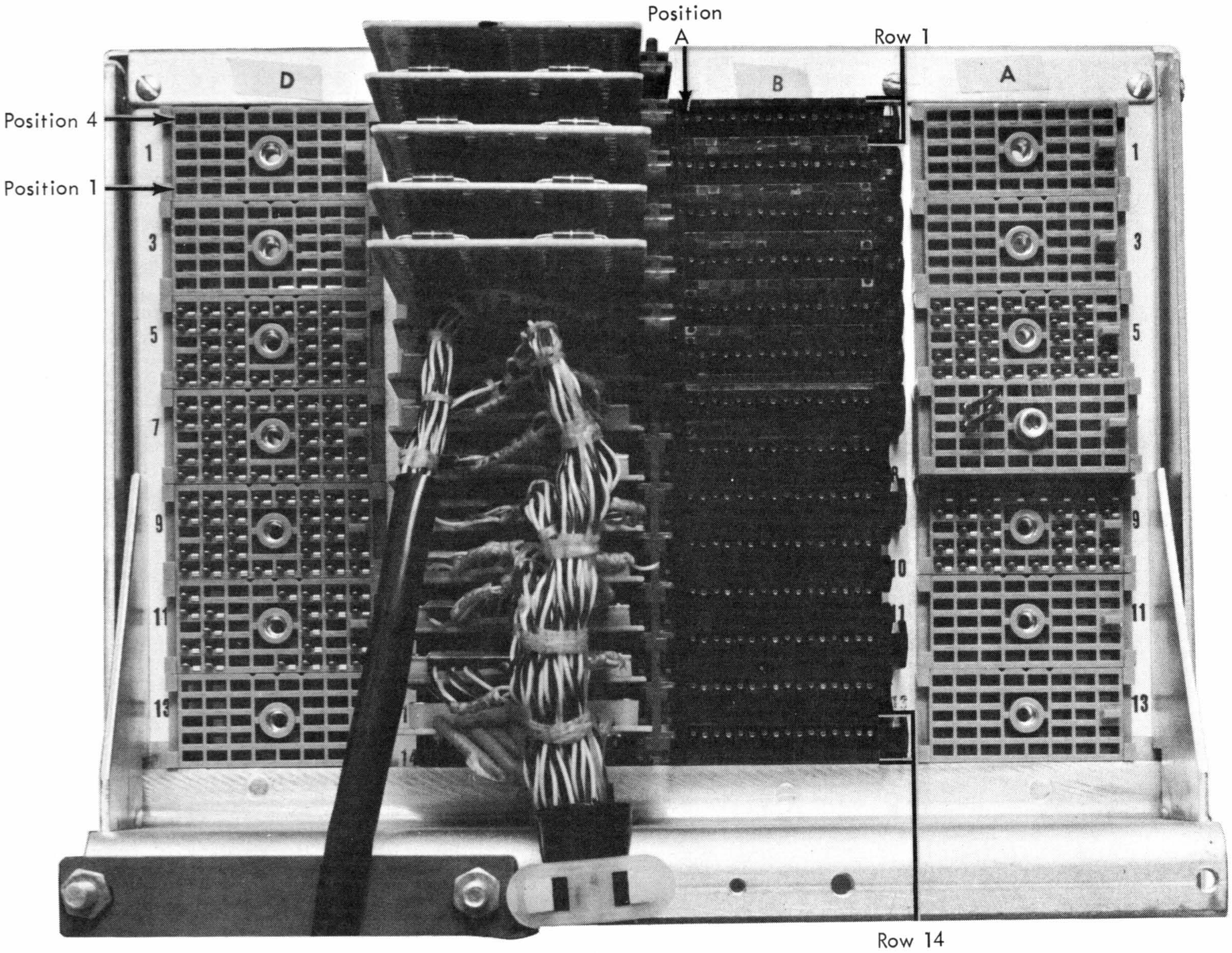


Figure 4-4. I/O Gate

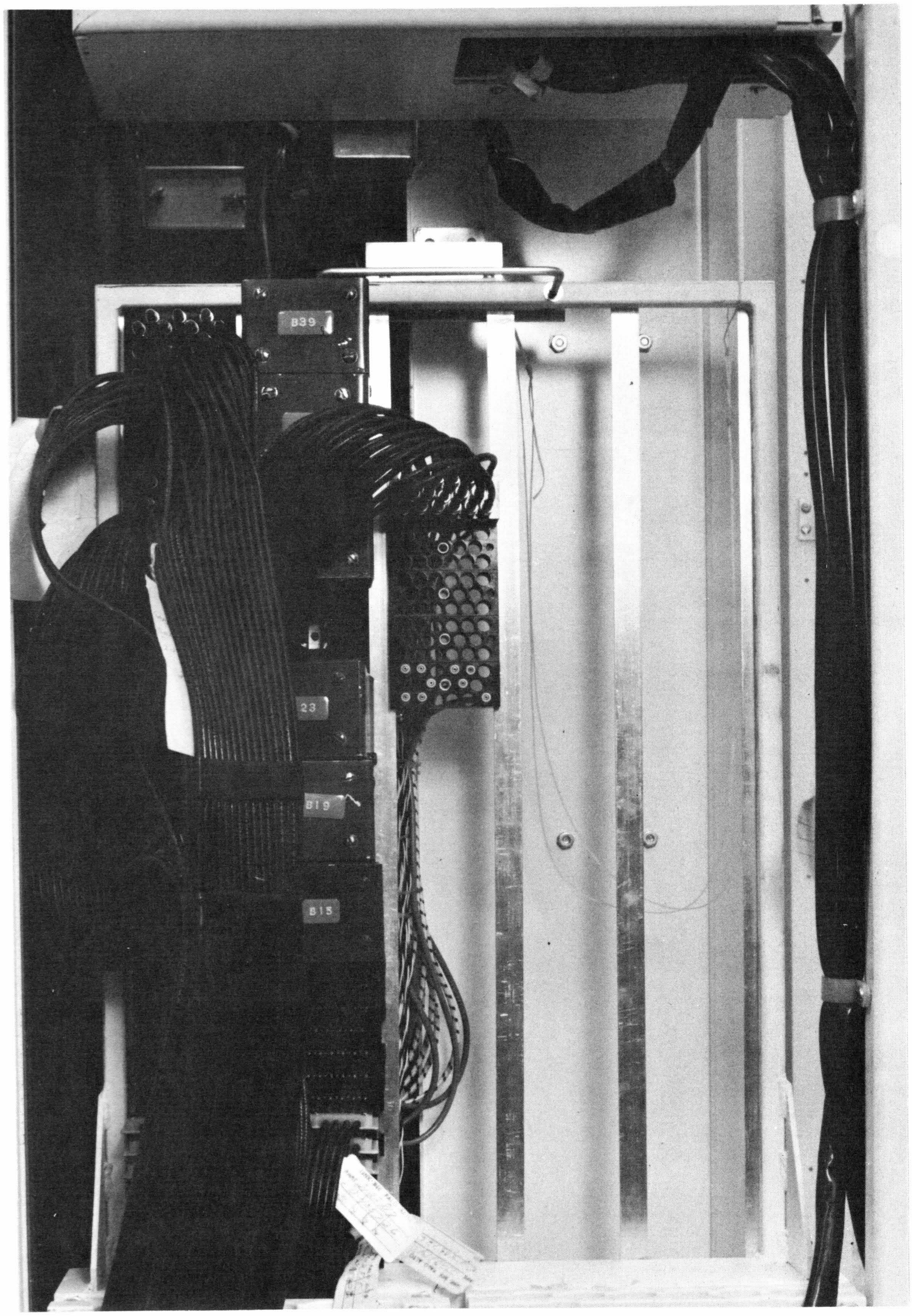


Figure 4-5. I/O Gate - T 1301

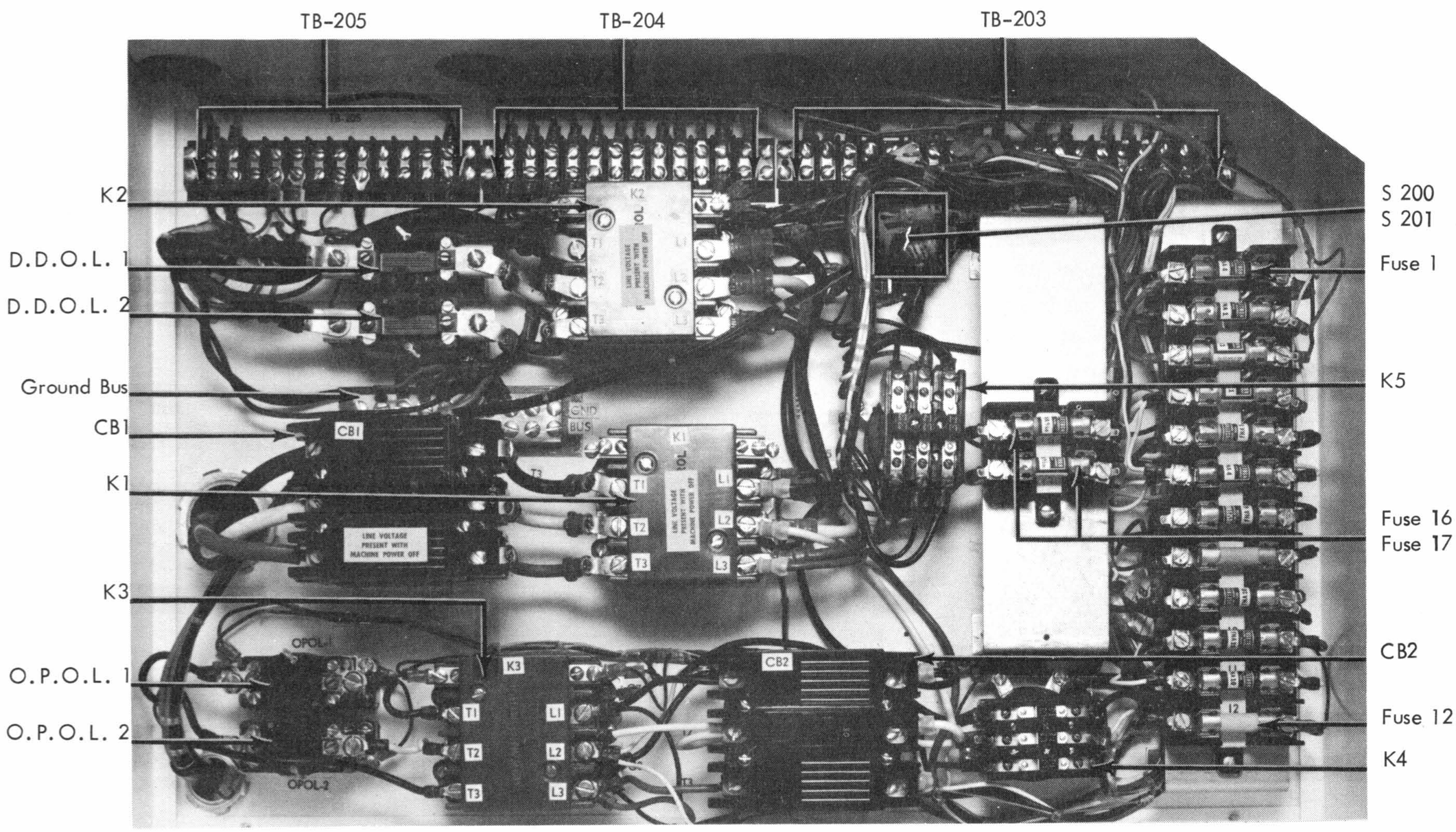


Figure 4-6. Power Contactor Box

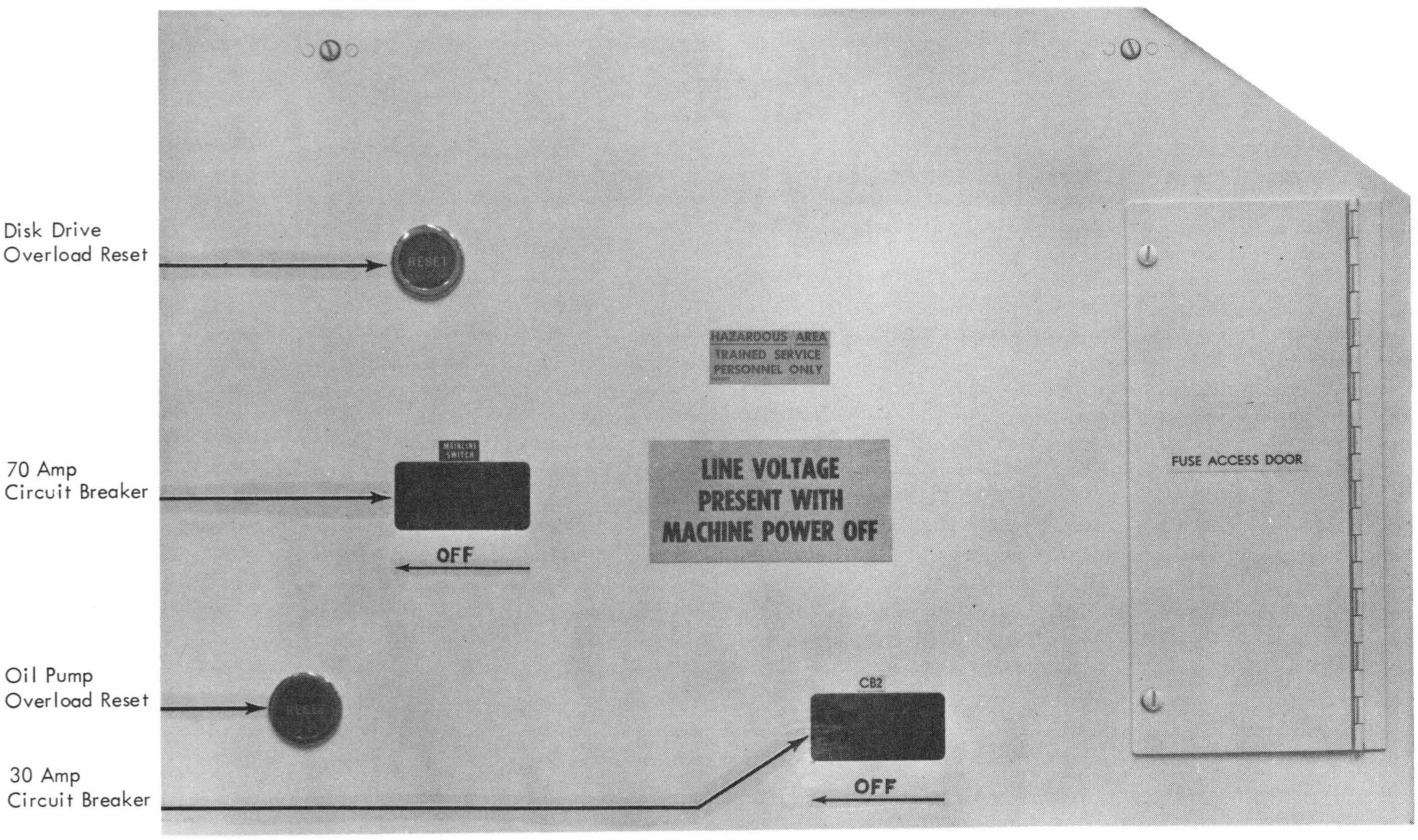
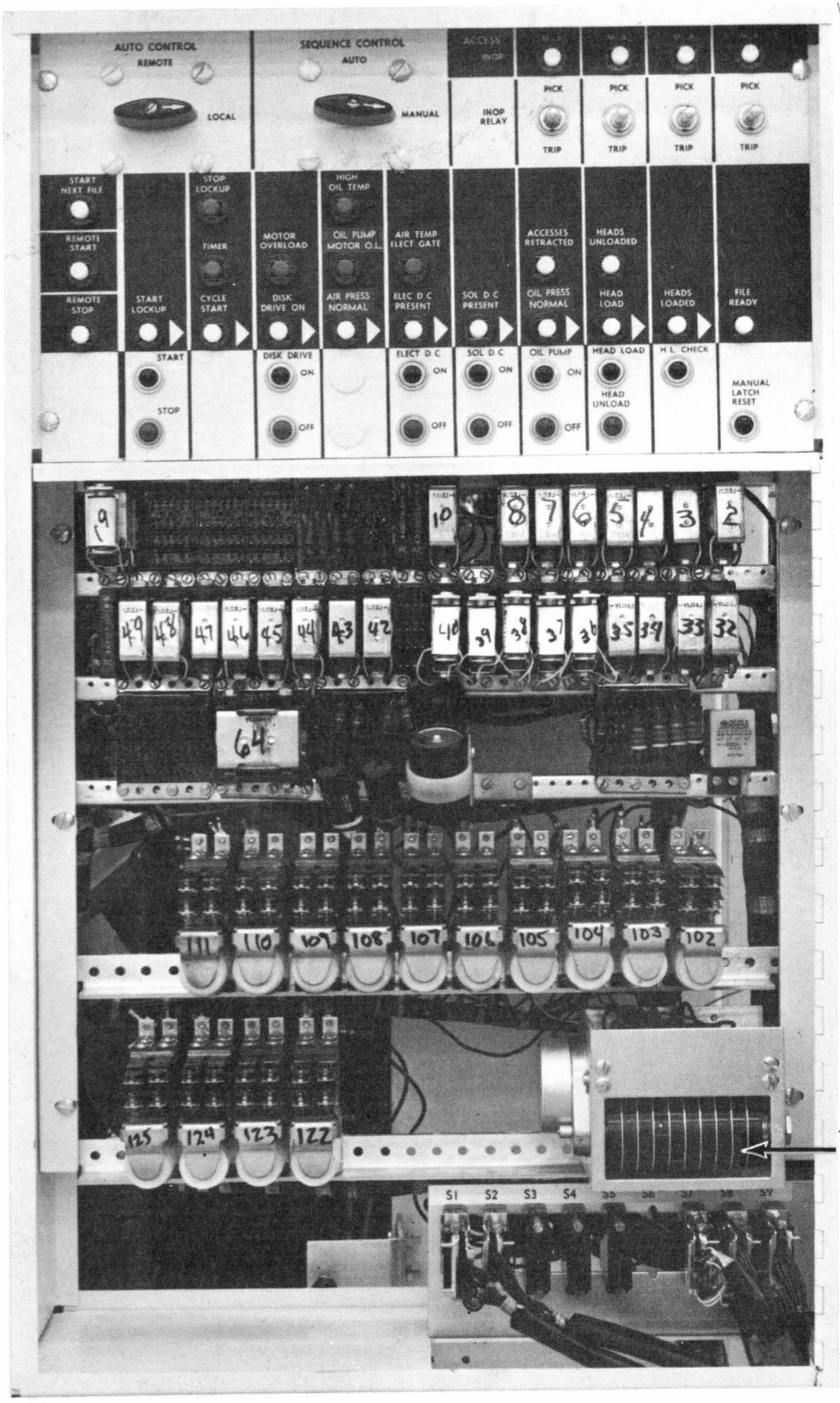


Figure 4-7. Power Contactor Box - Covered



CE Power Sequence Panel

Figure 4-8. Power Sequence Gate

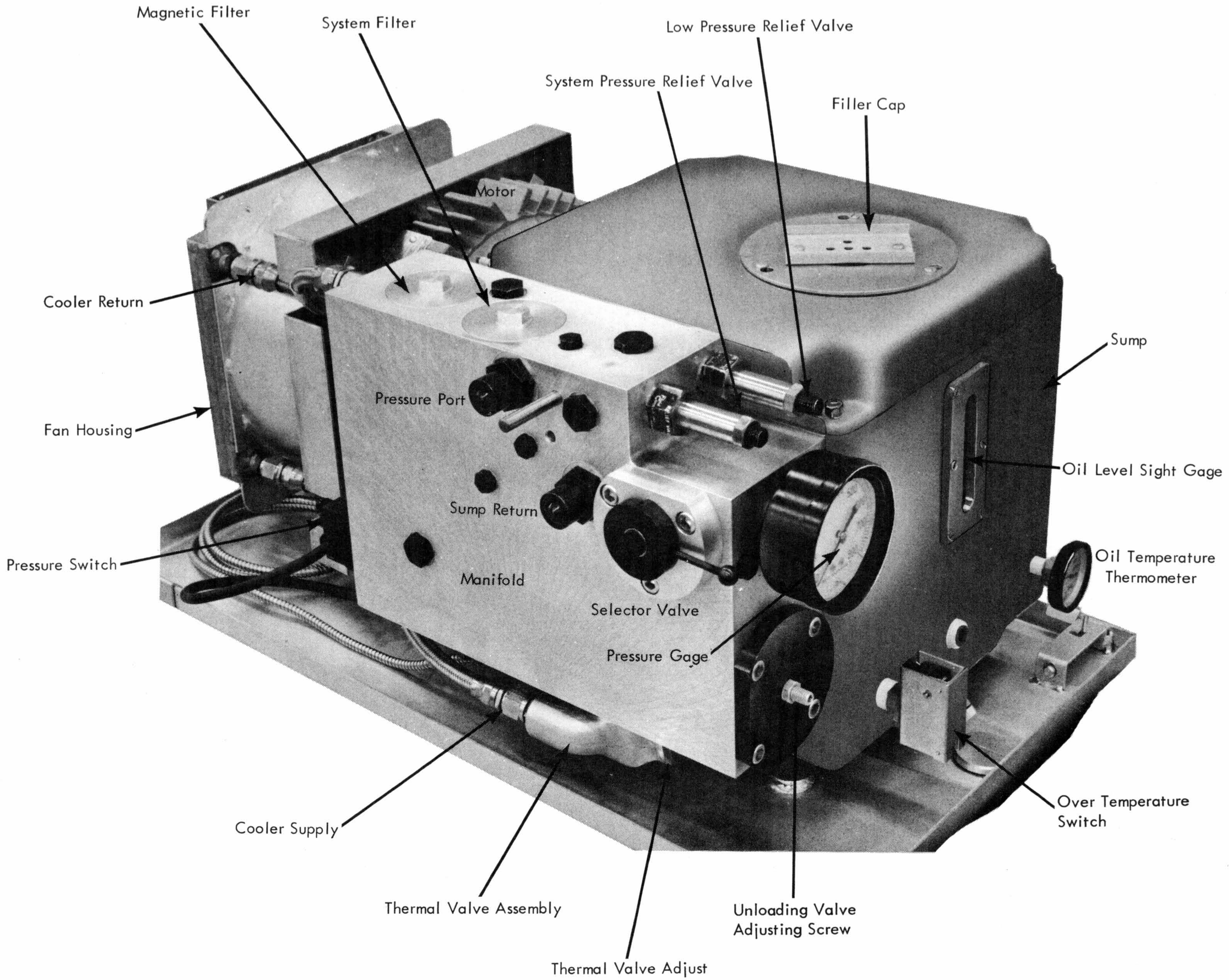


Figure 4-9. Hydraulic Power Supply

SECTION 5 SPECIAL TOOLS AND SUPPLIES

CONTENTS

SHIPPING GROUP

This is a list of special tools and supplies that are sent with the machine from the plant. They should be kept with the machine.

Customer Engineering Reference Manual	Form 227-5581
System Diagrams Manual	P/N 215200
Parts Catalog 1301	Form 127-0772
T1301	Form 127-0767
Hydraulic Actuator Spanner Wrench	P/N 2121394
Seal Puller	P/N 2121395
Disk Cleaning Paddle	P/N 2108010
Head Cleaning Tool	P/N 2108474
Head Roll and Pitch Gram Gage	P/N 2108473
Lint Free Tissue	P/N 2123106
Wrench-Hex Key 7/64	P/N 2108490
Extraction Tool-Connector Pin	P/N 2108398
Insertion Tool - Taper Pin	P/N 2108491
Extraction Tool - Taper Pin	P/N 2108493
Air Filter	P/N 2115348
Wrench - Hex Key	P/N 2108467
Gage - Head Load	P/N 2108577

TOOLS AVAILABLE WITH SYSTEM

The following is a list of tools available for systems which use the 1301 Disk Storage Unit.

Tektronix 535 Oscilloscope and Accessories	P/N 460257
Tektronix Pre-Amp 53/54 CA	P/N 460999
Direct Coaxial Scope Probe (X1)	P/N 460852

OFFICE TOOLS AND SUPPLIES

The following is a list of tools and supplies normally located in the branch office. They can be obtained when needed.

Meter, Simpson	P/N 450497
Force Gage	P/N 2108578
Prefiltered Hydraulic Oil (in one gallon container)	P/N 2115252
Vacuum Cleaner—Hoover Model 86	
10" Adjustable Wrench	P/N 450177
Carriage Spacing Tool	P/N 2108576
Wrapped Wire Pistol Tool	P/N 461012
Torque Wrench and Accessory Kit.	P/N 2108470
(for shaft motor or actuator replacement)	
Wrench - 5 to 150 In/Lbs Torque	P/N 2108435
Adapter - Actuator Torque	P/N 2108436
Socket .500"	P/N 2108464
Socket - Universal.	P/N 2108466
Socket - .375"	P/N 2108478
Roll - Torque Kit Tool.	P/N 2108481
Socket - .125" Hex.	P/N 2108486
Lint Free Tissue	P/N 2123106
Burndy Extractor Tool Rx 20-10	P/N 461043
Solder Iron Tip-SMS Pin Removal	P/N 451111
Replacement Plunger	P/N 451113
Marginal Check Power Supply	P/N 210860
Wrapping Bit, Wire Size #24	P/N 461235
Sleeve, Wire Size #24	P/N 461015
Hand Crimping Tool	P/N 450898
Wire Stripper	P/N 450694
Wire Gage	P/N 461076
#24 Gage Solid Tinned—Copper Wire	P/N 216226

TOOLS FOR SMS SERVICING

The following is a list of tools and supplies that are not shipped with the machine, but are recommended for each installation.

Hand Un-wrap Tool.	P/N 451573
Card Extender—Cable Isolation Tool	P/N 451075
SMS Card Contact Lubricant	P/N 451053
SMS Card Insertion—Extraction Tool. . . .	P/N 451030

TOOLS IN EMERGENCY PARTS CENTERS

The following is a list of tools available in all Emergency Parts Centers. They can be obtained when needed.

Disk Aligning Kit P/N 2108433

This kit contains special disk replacement tools. This kit does not contain replacement disks. Included in this kit is a special flashlight. However, due to the decay factor inherent in dry cell batteries they are not shipped with the light. Obtain two type AA pen light batteries locally.

Hoist for Shaft Motor Kit B/M 2108247

When replacing a shaft motor, the Hoist for Shaft Motor Kit (B/M 2108247), Disk Alignment Kit (B/M 2108433) and Shaft Motor and Instructions (B/M 2115248) must be ordered from the E.P.C. Special tools required for motor replacement will be shipped with the shaft motor.

Hydraulic Power Supply Replacement Kit P/N 2121874

This kit contains a complete hydraulic power supply, including fluid with the equipment necessary to remove the used unit and install the new unit. The container for this unit serves the dual purpose of a shipping crate and a dolly platform to assist in the removal of the used unit and installation of the new unit.

APPLICABLE CUSTOMER ENGINEERING MANUALS

This is a list of CE manuals that contain information that is of value in servicing the IBM 1301 Disk Storage.

Customer Engineering Manuals of Instruction:

Tektronix Oscilloscopes	*Form 223-6725
Transistor Component Circuits	Form 223-6889
Transistor Theory Illustrated	Form 223-6794
Transistor Theory and Application	Form 223-6783
IBM 1301 Disk Storage	*Form 227-5582

Customer Engineering Reference Manuals:

Standard Modular System	*Form 223-6900

*Recommended for each installation.