

## TRANSPORT MAINTENANCE

### 4.1 ROUTINE MAINTENANCE

#### 4.1.1 Cleaning

Cleaning the heads, and other components in the tape path, is described in Section 6. It is important that such cleaning be accomplished after each eight-hour operating period, or oftener if visual inspection indicates the need.

Visually inspect all components at the back of the transport each month. Use a brush, or a small vacuum cleaner, to remove any accumulations of dirt or dust. If more comprehensive cleaning is required, Iso-Propyl alcohol may be used.



Do not use the blower action of a vacuum cleaner, or any other compressed air device, to clean the transport. Dust might be blown into bearings or other rotating parts. Also, if alcohol is used, do not allow it to drip or spray into such critical areas.

#### 4.1.2 Head Demagnetization

Demagnetization of the heads, explained in Section 6, must be accomplished on a daily basis, or oftener if there is any suspicion that such action is necessary.

#### 4.1.3 Lubrication

Lubrication of certain components in the tape transport is required after each 2000 hours of operation, or once a year (whichever occurs first). Use Ampex oil 4010825.

The two drive motor bearings (one at each end of the motor) require 5 or 6 drops of oil. Lubrication requires that the drive motor assembly be removed from the transport, and that the flywheel be removed from the motor assembly (refer to Disassembly, paragraph 4.3.2).

Both capstan bearings are lubricated through a spring loaded ball to the right of the capstan. Press down on this ball and insert 5 drops of oil. A hypodermic needle is ideal for this purpose.

The clutch belt separator pulley, the drive belt idler pulley, the capstan idler, and the

front bearings of the turntable clutch assemblies require lubrication at the time interval previously specified, or oftener if they become noisy. Lubrication of these components requires that they be removed from the transport. Use not more than one drop of oil or the rotating parts will throw oil. If oil should spill or be thrown on the rubber tires or belts, clean them immediately with Iso-Propyl alcohol. Any oil which contaminates the brakes will require replacement of the brake lining.

If the shaft on the speed change assembly starts to bind, lubricate it with a general purpose grease such as Ampex 4010829. Apply the grease to each end of the shaft and move the shaft back and forth several times to work the grease into the bearings. Wipe off any excess grease.

## 4.2 CHECKOUT AND ADJUSTMENTS

### 4.2.1 Test Equipment Required

Spring Scale, 0 to 32 ounces  
Length of cord, approximately 30 inches, with loop tied in one end.  
Empty EIA reel (2-1/4-inch hub diameter)  
Feeler gauges, .015 to .045 inch extreme measurements.  
Length of 1-1/2 mil magnetic tape, approximately 24 inches  
Ampex Flutter Test Tapes as applicable:  
15 ips: Catalog No. 01-31316-01  
7-1/2 ips: Catalog No. 01-31326-01  
3-3/4 ips: Catalog No. 01-31336-01  
1-7/8 ips: Catalog No. 4690108-01  
15/16 ips: Catalog No. 4690107-01  
Flutter Meter, D and R Model FL3-d or equivalent  
Normal tools used by technician

### 4.2.2 Tape Tension

Tape tension is measured indirectly by determining the torque supplied by the turntable clutches. This torque is adjusted by positioning sliders on two resistors -- R106 for supply, R107 for takeup -- located in the transport control box assembly. If the following procedure is performed when the equipment is cold, set the tensions on the high side of the tolerances quoted; if the recorder has been operating for 30 minutes or longer, set them on the low side.

Step 1: Place the empty 7-inch EIA reel (hub diameter 2-1/4 inches) on the supply turntable.

Step 2: Apply power to the recorder.

Step 3: Use a rubber band or piece of masking tape to hold the takeup tension arm away from its rest position, so that it does not contact the safety switch.

Step 4: Wind the length of cord on the reel in a counterclockwise direction, leaving the loop at the free end of the cord.

Step 5: Insert the hook on the spring scale in the loop on the cord. Hold the scale stationary, and press the PLAY pushbutton.

Step 6: Tap lightly on the reel, to ensure a true reading, and note the scale indication. Correct indications are shown in Table 4-1.

Step 7: If the indication in Step 6 is incorrect, remove power from the equipment and adjust the shorting slider on resistor R106 (see Fig. 4-1). Shorting more of this resistor will increase torque indication, shorting less will decrease.

Step 8: Repeat Steps 4 through 7 as required to obtain a scale indication within tolerance.

Step 9: Repeat the entire procedure at the takeup turntable, except wrap the cord on the reel in a clockwise direction. Adjustment is made at R107. Correct indications are shown on Table 4-1.

### 4.2.3 Brakes

Any required adjustment of braking force must be preceded by checking certain clearances. Steps 1 through 5 of the following procedure describe how to determine if brake adjustment is required; Steps through 12 describe how to check clearances and make the final adjustment.

Step 1: Place the empty EIA reel (hub diameter 2-1/4 inches) on the supply turntable.

Step 2: Wind the length of cord on the reel in a counterclockwise direction, leaving the loop in the cord at the free end.

TAPE SPEEDS AVAILABLE	SUPPLY TORQUE	TAKEUP TORQUE
15/16 - 1-7/8 ips	3-4 ozs.	4-5 ozs.
1-7/8 - 3-3/4 ips	3-4 ozs.	4-5 ozs.
3-3/4 - 7-1/2 ips	4-5 ozs.	4-6 ozs.
7-1/2 - 15 ips	4-5 ozs.	5-1/2 - 6-1/2 ozs.

Table 4-1. Correct Torque Indications

Step 3: Insert the hook on the spring scale in the loop on the cord.

Step 4: Pull on the scale, making certain that the cord does not touch either flange of the reel (the turntable will rotate counterclockwise). Note the scale indication when the turntable is rotating slowly and steadily (the initial force required to start the rotation will be excessively high). The scale should indicate from 8 ounces (minimum) to 10 ounces (maximum).

#### NOTE

The scale indication may vary during each rotation of the reel. Consider only the highest indication when making the measurement. (The variation will have no effect under dynamic operating conditions.)

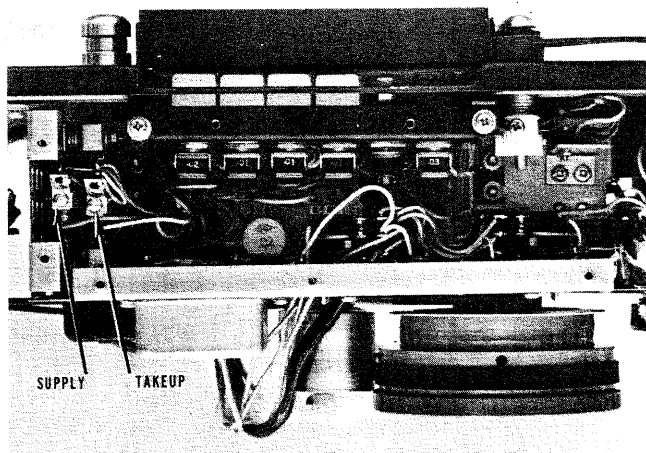


Fig. 4-1. Tension Adjusting Resistors

Step 5: Repeat Steps 1 through 4 at the takeup turntable, except wind the cord on the reel in a clockwise direction in Step 2 so that the turntable will rotate clockwise for the measurement). The scale indication should be the same as that at the supply turntable.

#### NOTE

If the scale indications are correct at both turntables, and brake operation has been normal, no adjustment is required. If either indication is incorrect, or if braking has been intermittent, proceed with the following steps.

Step 6: Use masking tape, or a rubber band, to hold the takeup tension arm away from its rest position (so it does not contact the safety switch).

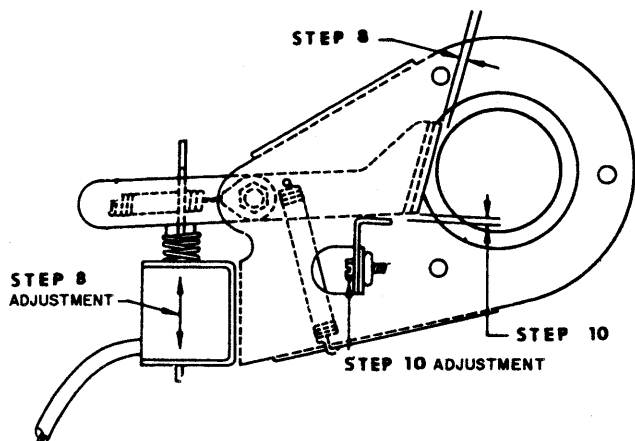
Step 7: Apply power to the equipment, and press the PLAY pushbutton. This will energize the brake solenoid.

Step 8: Using the feeler gauge, check the clearance between the brake lining (on the brake arm, see Fig. 4-2) and the brake drum. It should be from .015 to .025 inch. If necessary, adjust this clearance by moving the brake solenoid up or down on its mounting bracket. Be sure that there is clearance between the brake actuator and the solenoid if this adjustment is made.

**Step 9:** Press the STOP pushbutton to de-energize the brake solenoid.

**Step 10:** Check the clearance between the brake arm and the brake stop (see Fig. 4-2). It should be from .030 to .045 inch. If necessary, adjust this clearance by repositioning the brake stop.

**Step 11:** Recheck that the brake actuator is not binding against the solenoid. If any binding is noted, repeat Steps 7 through 10, positioning the components so that the actuator clears the solenoid.



*Fig. 4-2. Brake Assembly Clearances and Adjustment*

**Step 12:** Check the braking force as described in Steps 1 through 5. If necessary, adjust this force by moving the end of the high tension spring (see Fig. 4-2) to different holes on the brake arm until proper braking force is achieved.

#### 4.2.4 Capstan Idler Pressure

In the record or reproduce modes, the capstan idler holds the tape in firm contact with the capstan. Idler pressure is adjusted by means of a locknut on the capstan solenoid spade bolt (see Fig. 4-3). Running this nut in will increase idler pressure up to the point where the solenoid can no longer bottom. At that point, insufficient pressure is exerted and tape slippage will occur between the capstan and idler unless the nut is backed off. If the idler pressure is too high, an undue strain will be placed on the upper bearings in the capstan assembly.

An increase of temperature in the capstan solenoid will cause an increase in the d-c resistance presented by the coil. Therefore, allow a 30 minute warm-up period, with the equipment operating in the reproduce mode, before attempting any capstan idler pressure adjustment.

**Step 1:** Remove power from the equipment, and check the clearance between the capstan idler and the capstan. It should be 1/8 inch ( $\pm 1/64$  inch). If not, the capstan solenoid stop (item 3, Fig. 7-15) must be repositioned on the solenoid to achieve this condition.

**Step 2:** Thoroughly clean the capstan and capstan idler (refer to Section 6).

**Step 3:** Remove the capstan drive belt from the drive motor pulley.

**Step 4:** Use masking tape or a rubber band to hold the takeup tension arm away from its rest position (so it does not contact the safety switch).

**Step 5:** Thread an approximate 2 foot length of 1-1/2 mil magnetic tape between the capstan and the capstan idler, with the oxide-coated (dull) side of the tape next to the capstan.

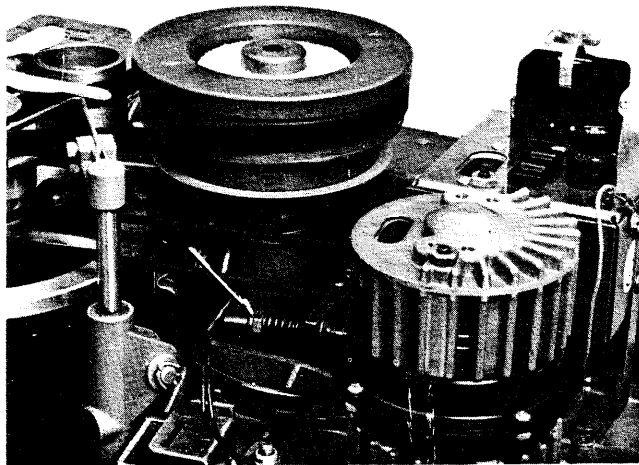
**Step 6:** Apply power and press the PLAY pushbutton. The capstan will not rotate, but the capstan idler will engage.

**Step 7:** Form a loop, or punch a hole, in the end of the tape on the takeup side of the capstan. Insert the hook on the spring scale through this loop.

**Step 8:** Noting the indication, pull on the scale in the direction of normal record/reproduce tape travel. The tape should start to slip between the idler and capstan when the indication is 26 ounces ( $\pm 4$  ounces).

**Step 9:** If the indication in Step 8 is incorrect, adjust the solenoid locknut (see Fig. 4-3) as required. Running the nut in will increase pressure; running it out will decrease pressure.

**Step 10:** Check that the capstan solenoid is bottomed (if not, the idler can be easily



*Fig. 4-3. Capstan Idler Adjustment*

pushed away from the capstan). If necessary, back off the locknut until the solenoid bottoms, then recheck the idler pressure.

### CAUTION

Do not leave the capstan idler pressed against the stationary capstan any longer than necessary, or a dent may be impressed in the idler. Be sure to press the STOP pushbutton when the test is concluded.

Step 11: Reinstall the drive belt removed in Step 3. Be sure that the correct face of the belt is against the drive motor pulley (see Fig. 4-4).

#### 4.2.5 Turntable Height

In the play mode, the magnetic tape should leave the supply reel and enter the takeup reel without touching the flanges. Molded plastic reels are not precision devices, and variations sometimes occur from one to another. Tape guiding on this transport is such that the center-line of the tape is 1/2-inch from the top plate, and turntable height is adjusted for reels with an overall thickness of 0.500 inch ( $\pm 0.005$  inch). However, this height can be adjusted to accommodate the specific type of reel being used.

Step 1: From the back of the transport, loosen the two setscrews which hold the turntable assembly.

Step 2: Raise or lower the turntable as required, and re-tighten the two setscrews.

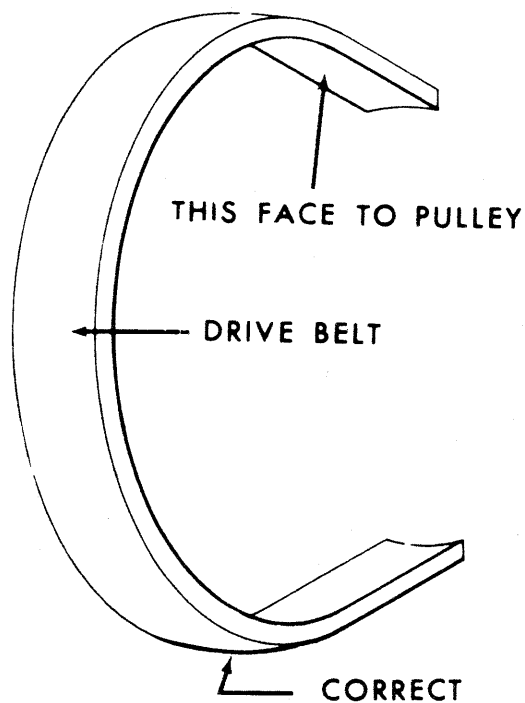
Step 3: Check by running tape in the play mode. Readjust turntable height as required until the tape moves from reel to reel without touching the flanges.

#### 4.2.6 Speed Change Mechanism

Do not attempt any adjustment to this mechanism as long as it functions normally. If the speed change operation becomes intermittent, or fails, it can usually be corrected by one of the following procedures.

(a) Visually inspect the capstan drive belt. Correct positioning is shown in Fig. 4-4. If incorrect, reverse the belt (face for-face) and recheck speed change operation.

(b) Check the tracking of the capstan drive belt. It should track in the middle of the capstan flywheel and drive motor pulley. If not,



*Fig. 4-4. Positioning Drive Belt*

check the clearance between the inner face of the drive motor pulley and the end of the motor. It should be  $1/32$  inch; if not, loosen the two set screws and slide the pulley in or out on the shaft to achieve this clearance. When the clearance is correct, loosen the two setscrews on the capstan flywheel and position the flywheel for correct drive belt tracking.

#### NOTE

If the position of the drive motor pulley is changed, check the separation of the supply clutch belt at the crossover point. It should be approximately  $1/16$  inch; if not, reposition the belt separator pulley in the slotted mounting hole to achieve this separation.

(c) The edges of the drive belt should be parallel with the guide holes in the speed shift fork (item 5, Fig. 7-11) and should run through the center of those holes. The fork can be moved slightly by loosening the two socket-head screws (item 14, Fig. 7-11), repositioning the fork as required, and tightening the screws.

(d) The clearance between the shift fork and the closest part of the drive motor pulley should be approximately  $1/32$ -inch. Clearance can be checked by pulling down on the shift fork (see Fig. 4-5a) and measuring the clearance. Adjustment can be made by loosening the nut at the base of the speed change assembly, (item 97, Fig. 7-10) moving the assembly in the slotted hole to achieve correct clearance, and tightening the nut. Check that there is no interference between the fork and the motor pulley in either position of the speed change mechanism.

#### NOTE

If proper fork clearance cannot be achieved as explained, it is permissible to bend the fork slightly, as shown in Fig. 4-5b).

(e) If the fork has been bent across the width (see Fig. 4-5c) it could cause the drive belt to come off the motor pulley or capstan flywheel. Check and correct if necessary.

(f) The shift fork for 15/16-1-7/8 ips and 3-3/4 - 7-1/2 ips recorders has a twist at the end of the fork (see Fig. 4-6). Check that this twist is as shown, and correct if necessary.

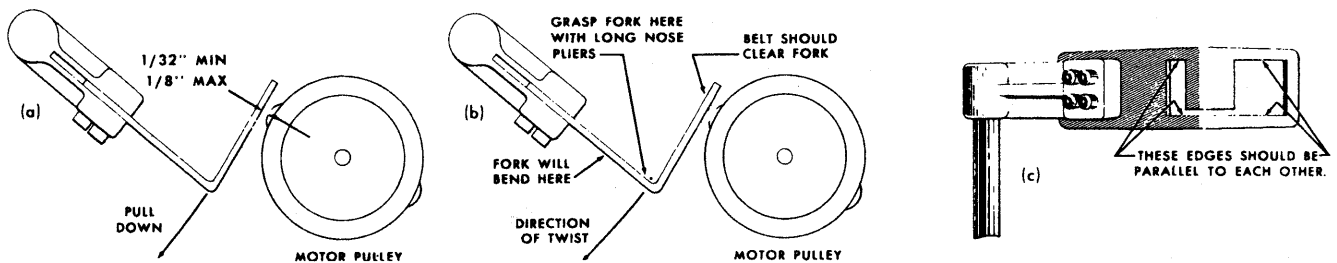
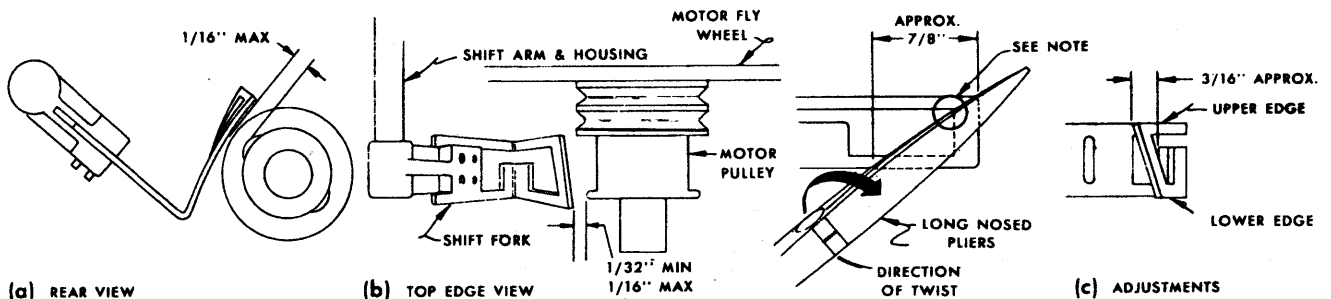


Fig. 4-5. Speed Change Mechanism



NOTE: THE EDGE OF THE LONG NOSED PLIERS MUST CROSS THE SHIFT FORK LEVER AT THIS POINT.

Fig. 4-6. Shift Fork

#### 4.2.7 Checking Flutter and Wow

This check requires an aligned electronics, the applicable Ampex Standard Flutter tape, and a flutter meter such as the D and R Model FL3-D or equivalent.

Ampex Standard Flutter Tapes are prepared on precise equipment for each tape speed. The rms flutter content of these tapes is less than .03%, which for all practical purposes can be disregarded when flutter measurements are taken. Flutter tapes are prepared for specific tape speeds, and ---since flutter meters will accept only 3,000 cycle signals ---cannot be used at other speeds.

Flutter meters are sensitive, to some extent, to amplitude modulation, which can occur if poor head-to-tape contact exists or if drop-outs of signal occur. Heads must, therefore, be cleaned and demagnetized before flutter measurements are taken.

As a flutter tape is used over a long period of time the flutter indication will rise, although the flutter on the equipment may remain constant. This is caused by increased drop-outs, demagnetization of the signal in the repeated passes over the heads, and physical deformation of the tape by tensions, changes in temperature and humidity, etc.

Standard tapes are not to be rewound before storage, because the tape pack and tension within the reel might cause physical deformation such as edge damage, stretching, etc. Extremes in temperature and humidity must also be avoided in storage areas. Finally, standard tapes must not be stored near sources of magnetic fields, such as motors, generators, permanent magnet loudspeakers, etc., or partial erasure of the signal may result.

Flutter measurement is made as follows:

Step 1: Thread the applicable standard flutter tape on the equipment, by putting the flutter tape on the takeup turntable and rewinding to an empty reel on the supply turntable (using the tape lifters while rewinding).



Whenever the standard flutter tape is threaded on the equipment place the record selector switch on the electronic assembly in the safe position.

Step 2: Apply power, and select tape speed and equalization in conformance with the standard flutter tape.

Step 3: Connect the flutter meter to the OUTPUT connector.

Step 4: Start tape in motion in the reproduce mode. Adjust the REPRODUCE LEVEL control to achieve a 0 indication on the vu meter.

Step 5: Adjust the level on the flutter meter as instructed in the applicable manual.

Step 6: Switch the flutter meter to the discriminator adjustment, and adjust the trimmer for a minimum reading on the flutter meter.

Step 7: Switch the flutter meter to readout at 0.5 to 250 Hz, and read the flutter as indicated on the flutter meter.

Step 8: When the flutter measurement is completed, allow tape motion to continue in the play mode until the tape is completely wound on the takeup reel. Mark the reel "Rewind Before Using" and store it in a safe place.

Flutter can be caused by any component in the transport that affects tape motion. It is manifestly impossible in this manual, therefore, to delineate specific causes and remedies.

However, possible causes of excess flutter include:

Excessive or erratic play holdback tension.

Drivemotor not synchronized--This can be caused by low line voltage (less than 105 volts); excessive play takeup tension; a dragging belt tensioning idler; defective drive motor

starting capacitor; bearings in drive motor or in capstan in need of lubrication; or a defective drive motor.

**Brakes** -- the brakes may drag on the drum if they are incorrectly installed or adjusted.

**Capstan Idler** -- The idler tire may be dented by being allowed to engage the capstan for an extended period when the equipment is not operating. Running the recorder in the play mode for two or three hours will usually restore the tire to normal. If not, or if the bearing is defective, replace the idler.

**Drive Belt** -- The drive belt may be dirty or worn.

**Tape Scrape** -- Can be caused by warped or damaged reels, or incorrect turntable height.

If a tunable filter (e.g., General Radio Model 1564A Sound Vibration Meter) is available, excessive flutter can be isolated to certain frequencies. This is accomplished by connecting the filter to the output of the flutter meter. Starting at (for example) 2 Hz, tune both the low frequency and high frequency cutoff controls to the same frequency. Measure and make a note of the flutter. Proceed in this manner in one octave steps to 256 Hz. Comparing the results with ro-

tational periods shown in Table 4-2 may then isolate the offending assembly.

Note that if flutter disturbance is introduced by components in the supply turntable assembly, the frequency of the flutter will vary -- being low when the supply reel is full of tape and progressively increasing with reel rotation as the tape pack diminishes.

## 4.3 DISASSEMBLY

### 4.3.1 General

Disassembly of the tape transport for lubrication or replacement of parts, requires careful attention to detail. The assembly drawings in Section 7 are included to aid in disassembly and assembly procedures, and also to help in determining part numbers.

Do not attempt to disassemble components beyond the point quoted in the following procedures. In some instances, disassembly is described but part numbers are not supplied; such parts are specially fitted and, though they can be removed and reinstalled, cannot be ordered separately (the entire subassembly must be replaced).

### 4.3.2 Removal of Drive Motor

Individual parts of the drive motor assembly are not available as separate items (in

COMPONENT	15/16 ips	1-7/8 ips	3-3/4 ips	7-1/2 ips	15 ips
Capstan		3.8 Hz	7.6 Hz	15.3 Hz	
Capstan Idler		.68 Hz	1.35 Hz	2.7 Hz	
Drive Motor		30 Hz	30 Hz	30 Hz	
Drive Belt		2.8 Hz	4.7 Hz	9.4 Hz	
Drive Belt Tension Idler		10.9 Hz	18.2 Hz	36.3 Hz	
Clutch Belts		5.5 Hz	5.5 Hz	5.5 Hz	
Belt Separator Pulley		19.5 Hz	19.5 Hz	19.5 Hz	

Table 4-2. Rotational Periods of Components



this respect, the fan is not considered part of the assembly).

Step 1: At the back of the transport, remove the fan (item 49, Fig. 7-10) from the drive motor by loosening the setscrew and sliding the fan from the motor shaft.

Step 2: Remove the nut, flat washer, and lockwasher (items 97, 98, and 100, Fig. 7-10) at the base of the speed change assembly.

Step 3: At the front of the transport, remove the speed change knob (item 31, Fig. 7-9) by loosening the setscrew and sliding the knob off the shaft.

Step 4: At the front of the transport, remove the threaded bushing from the speed change mechanism, using long nose pliers. That mechanism will now be free and can be removed.

Step 5: Remove the capstan drive belt, and both clutch drive belts, from the drive motor pulley.

Step 6: Disconnect the drive motor connector from the receptacle on the transport control box assembly.

Step 7: Open the head cover, and remove the two motor mounting screws and washers (items 83 and 102, Fig. 7-9). The head cover will be free.

Step 8: Pry the escutcheon (item 33, Fig. 7-9) from the transport.

Step 9: Manually support the drive motor, and remove the two motor mounting screws and washers (items 83 and 102, Fig. 7-9) which were exposed when the escutcheon was removed. This frees the drive motor from the transport (the leads to the motor capacitor will still be connected).

If the drive motor was removed for lubrication, loosen the two setscrews in the flywheel and remove the flywheel. Both oil holes in the motor will now be accessible. If the drive assembly is to be replaced, disconnect the capacitor leads. Reassemble in the reverse order of disassembly.

#### 4.3.3 Disassembly of Speed Change Mechanism

Step 1: Remove the speed change mechanism (refer to Steps 2, 3, and 4, paragraph 4.3.2).

Step 2: Remove the shift fork (item 5, Fig. 7-11) by removing the two screws (item 14, Fig. 7-11).

Step 3: To remove the speed shift arm (item 1, Fig. 7-11), grasp the roller (item 8, Fig. 7-11) with long nose pliers; pull the roller away from the slot in the speed shift arm and pivot it free from the assembly. (The spring, item 9, will also come free.) Remove the drive pin (item 13, Fig. 7-11) and the speed shift arm can be removed.



Do not remove the bearing (item 3, Fig. 7-11) from the housing. If the bearing becomes defective the entire speed change assembly must be replaced.

Step 4: To remove the bearings (item 4, Fig. 7-11), remove the cotter pin at the end of the clevis pin (item 7, Fig. 7-11) and slide the clevis pin out (the washers, items 10 and 11 will also come free). The nylon bearings can now be compressed and removed.

Reassemble in the reverse order of disassembly.

#### 4.3.4 Removal of Clutch and Brake Assemblies

Step 1: At the back of the transport, loosen the two setscrews which secure the turntable. Slide the turntable assembly up and off from the front of the transport.

Step 2: Disconnect the clutch and brake connectors from the receptacles on the transport control box assembly.

Step 3: Remove the clutch drive belt from the drive motor pulley.

**Step 4:** Manually support the clutch and remove the three screws and washers (items 65 and 81, Fig. 7-9). The clutch and brake will both be free of the transport.



Do not attempt any disassembly of the clutch. If the clutch becomes defective, the entire assembly must be replaced.

Remount the clutch and brake in the reverse order of removal.

#### 4.3.5 Disassembly of Brake

With the brake assembly removed from the transport (refer to paragraph 4.3.4), proceed as follows to replace the brake arm (which includes the brake lining as an integral part).

**Step 1:** Remove the low tension and high tension springs (items 10 and 11, Fig. 7-13).

**Step 2:** Remove the locknut (item 29, Fig. 7-13); the spring anchor and thrust washer will also come free. The brake arm (item 2, Fig. 7-13) can now be replaced.

Reassemble in the reverse order. When installing the locknut (item 29, Fig. 7-13), tighten it until it is snug, then back it off 1/4 turn. Check brake clearances and tension (refer to paragraph 4.2.3) when the assembly is remounted on the transport.

To replace the brake solenoid, proceed as follows:

**Step 1:** Remove the screw, washer, and locknut (items 25, 28, and 30, Fig. 7-13). The solenoid plunger and return spring will come free.

**Step 2:** Remove the two screws, lockwashers, and washers (items 26, 32, and 34, Fig. 7-13). This frees the solenoid.

Reassemble in the reverse order. Check brake clearances and tension (refer to

paragraph 4.2.3) when the assembly is remounted on the transport.

#### 4.3.6 Removal of Clutch Drive Belt

To replace a clutch drive belt, simply remove the two nuts and lockwashers which secure the end bell. The clutch drive belt can then be replaced.

#### 4.3.7 Removal of Capstan Assembly

Removal of the capstan assembly is required only when the capstan solenoid, or one of its associated parts, is to be replaced. Removal is not necessary to lubricate the capstan or to take off any other replaceable part. Note that the transport control box assembly must first be removed before it is possible to remove the capstan assembly.

**Step 1:** Disconnect all cables from the receptacles on the transport control box assembly.

**Step 2:** Remove the three nuts, lockwashers, and washers that secure the top edge of the control box to the transport.

**Step 3:** Remove the two screws, lockwashers, and washers which secure the lower edge of the control box to the transport. The control box assembly is now free except for the leads to the capacitor.

**Step 4:** Remove the capstan drive belt (item 70, Fig. 7-10).

**Step 5:** Manually support the capstan assembly, and remove the three screws and washers (items 65 and 85, Fig. 7-9). The capstan assembly is now free and can be removed. Replace in the reverse order of removal.

To remove the solenoid from the capstan assembly, proceed as follows:

**Step 1:** Remove the cotter key and clevis pin (items 5 and 4, Fig. 7-15).

**Step 2:** Remove the two screws and lockwashers (items 16 and 19, Fig. 7-15). This frees the solenoid stop bracket (item 3, Fig. 7-15).

**Step 3:** Remove the two screws, lock-washers, and washers (items 15, 35, and 18, Fig. 7-15) to free the solenoid.

**Step 4:** To replace the adjustment spring or eyebolt (items 8 and 6, Fig. 7-15) remove the nut (item 7, Fig. 7-15).

When reassembling, adjust the solenoid stop so that the capstan idler clears the capstan by 1/8 inch ( $\pm 1/64$  inch).

There should be no need to remove the flywheel or belt tension idler; if it becomes necessary, refer to Fig. 7-15.

## 4.4 PRINCIPLES OF OPERATION

### 4.4.1 General

The tape transport mechanism provides tape motion for all modes of operation. Smooth, positive movement of the tape across the head assembly, and proper tape tension, is provided by four basic systems; the tape supply system, the tape takeup system, the tape drive system, and the control circuits.

### 4.4.2 Supply and Takeup Systems

Both the supply and takeup assemblies are composed of eddy current clutches, a turntable (mounted directly on each clutch shaft), and a brake assembly. The brake mountings are mirror images of each other, so the brake assemblies are not interchangeable. The brakes are solenoid operated, remaining in the braking position until the brake solenoids are energized.

The supply (rewind) and takeup eddy current clutches are so connected that if power is applied with no tape threaded, the turntables will rotate in opposite directions --the supply turntable, clockwise; and the takeup turntable, counterclockwise.

In the fast forward mode, the takeup clutch operates at full torque, and no torque is applied to the supply (rewind) clutch. The tape is held under tension by friction.

In the rewind mode, the supply clutch operates at full torque and no torque is applied

to the takeup clutch. Again, the tape is held under tension by friction.

In the reproduce or record modes, both clutches operate at reduced torque. The capstan then determines tape speed, and the tensioning system supplies tape or takes it up as metered by the capstan drive. The capstan exerts sufficient pull on the tape to overcome the opposing torque of the supply clutch, which constitutes the holdback tension. The capstan feeds the tape to the takeup turntable, under tension provided by the takeup torque.

If a tape loop is thrown, or tape breaks, the takeup tension arm actuates the safety switch (S104) and stops the equipment. The takeup tension arm is not a part of the tape tension system. Its function is to remove tape slack, especially when starting, and to operate the safety switch.

### 4.4.3 Tape Drive System

The tape drive system is composed of the drive motor, the capstan assembly, and the capstan idler assembly. The purpose of the drive system is to transport the tape across the heads at a uniform speed during the record and reproduce modes. A hysteresis synchronous capstan drive motor is employed.

The drive motor operates continuously whenever the POWER switch (S106) is in the ON position and tape is properly threaded. When the PLAY button is pressed, the capstan solenoid and the brake solenoids are energized. The capstan solenoid pulls the rubber tired capstan idler wheel against the tape, causing it to make firm contact with the capstan. The tape is then driven at a constant speed across the head assembly.

### 4.4.4 Eddy Current Clutch

A conductive disc, subjected to a normal magnetic force, has the property of resisting an applied force which tends to move the disc in its own plane. The magnitude of this resistance is directly proportional to the velocity of the conductor with respect to the magnetic field.

This resisting, or braking effect is produced by the interaction between the applied magnetic field and a family of circulating currents

induced in the disc by conventional d-c generator action. The direction of the induced current produces a component of force opposite to the applied force, and proportional to the strength of the magnetic field. The disc is essentially an infinite number of short-circuited turns moving through a magnetic field.

The eddy current clutch makes use of the above-described braking principle, but applies the braking between a constantly moving magnetic field and a loaded current sheet. A copper cup serves as the disc. It is secured to a shaft which, in turn, drives the load. A fluted slug, made of sintered iron, is fastened directly to the drive pulley, and the slug/pulley assembly is free to rotate about the shaft. The coil, cup, and slug are assembled coaxially with the cup between the coil and the flutes of the slug.

In operation, the fluted slug is belt-driven at constant speed by the drive motor. The output shaft remains motionless, or substantially so, until a current is fed through the coil. When current is applied, the fluted slug becomes magnetized, and a constant-angular-velocity magnetic field passes through the copper cup, producing an eddy-current drag, and thus applying torque to the shaft.

#### 4.4.5 Brake Operation

Smooth brake operation is extremely important in maintaining proper tape tension when stopping the tape. Holdback tension, supplied by the trailing turntable, is lost when the STOP button is pressed, and maintenance of tape tension then becomes a function of brake operation. The braking force acting on the turntable from which the tape is being pulled (trailing turntable) in any mode of operation must exceed the braking force acting on the turntable taking up the tape (the leading turntable) to prevent the formation of tape loops.

The brake assembly is mounted on a bracket which, in turn, is mounted between the turntable clutch and the top plate. The brake pad is affixed to the brake arm, which operates on a pivot.

A low-tension spring holds the brake pad in contact with the brake drum. One direct-

ion of rotation of the drum tends to release the brake. The spring tension holds the pad against the drum and provides the "low side" of the brake differential.

Rotation of the drum in the opposite direction causes the brake pad to exert more pressure against the drum. This moves the brake arm against the brake stop. Adjustment of this spring therefore determines the "high side" of the brake differential.

Rotation of the drum in the opposite direction causes the brake pad to exert more pressure against the drum. This moves the brake arm against the brake stop. Any further movement of the brake arm must act against the high-tension spring. Adjustment of this spring therefore determines the "high side" of the brake differential.

The ratio of the braking force in one direction to the braking force in the other--the brake differential--is approximately two to one on this equipment.

Brakes are released when the brake solenoids are energized in any operating mode.

#### 4.4.6 Control Circuit

##### 4.4.6.1 General

The drive motor capacitor, capstan solenoid, and brake solenoid are mounted on the assemblies which they serve. All other components of the transport control circuit are located in the control box assembly at the back of the transport.

Receptacles on the control box provide plug-in connection facilities for the drive motor, turntable clutches, brake solenoids, capstan solenoid, a-c line power, and the electronic assemblies. A receptacle and dummy plug (cable not supplied) is also supplied for connecting a remote control unit (refer to Section 1). If a remote control is not used, the dummy plug must be inserted in this receptacle or the transport will not operate.

All tape motion is controlled by five pushbuttons -- STOP, REW (rewind), FWD (fast

forward), PLAY, and REC (record) -- which are mounted on the control box (they protrude through the front of the transport). Application or removal of power is controlled by a toggle switch.

The following descriptions of circuit actions can be followed most easily by referring to the simplified schematic diagrams of Figs. 7-2 and 7-4. In these descriptions, it is assumed that tape is properly threaded and power is applied.

#### 4.4.6.2 Play Circuit

When PLAY pushbutton S107 is pressed, capstan solenoid K105 is energized, power is applied to the takeup and supply turntable clutches, and both brake solenoids are energized.

Capstan solenoid K105 incorporates a set of contacts which is closed when that solenoid is energized. A holding circuit is formed to the capstan and brake solenoids, and to the turntable clutches, through normally closed relay contact sets K102-3, K101-3, and solenoid contact K105A in the energized position.

The capstan solenoid moves the capstan idler to clamp the tape against the capstan, the brake solenoids release the brakes, and the turntables provide correct holdback and takeup tension. Tape is thus placed in motion in the reproduce (play) mode.

Note that the play mode cannot be initiated when tape is in motion in another mode, without first pressing the STOP pushbutton.

#### 4.4.6.3 Record Circuit

In a strict sense, this circuit does not function as a tape motion control. It becomes operative only when tape motion is started in the play mode. Thus all actions described in paragraph 4.4.6.2 must be completed before recording can begin.

After the play mode is initiated, d-c power is available (through relay contact sets K102-3, K101-3, and solenoid contact set K105A) to pin 3 of J110S, and also to RECord pushbutton S102 (which is connected to pin 4 of J110S). When the REC pushbutton is pressed, the record relay

in the electronics assembly is energized through pin 4. The potential at pin 3 then serves to hold that relay energized (a description of record relay action is provided in Section 5, paragraph 5.5.2).

#### 4.4.6.4 Fast Forward Circuit

When FWD pushbutton S103 is pressed, fast forward relay K102 is energized. Contact set K102-1 applies full available d-c power to the takeup clutch, and opens the circuit from the d-c line to the capstan solenoid. Contact set K102-2 forms a holding circuit for the relay, in series with normally closed contact set K101-2. Contact set K102-3 applies d-c power to the brake solenoids, and opens the d-c paths to the play and the rewind circuits.

Thus, full power is applied to the takeup clutch, the brakes are released, and the capstan solenoid is deenergized. Since no power is applied to the supply clutch, tape is simply pulled at fast speed from the supply reel to the takeup reel.

Note that fast forward operation can be initiated when tape is at a standstill or in motion in any other mode (reproduce, record, or rewind modes will drop out when the FWD pushbutton is pressed).

#### 4.4.6.5 Rewind Circuit

This circuit is similar to the fast forward circuit previously described. When the REW pushbutton S101 is pressed, rewind relay K101 is energized. Contact set K101-1 applies full available d-c power to the supply clutch, and opens the d-c line to the capstan solenoid. Contact set K101-2 applies d-c power to the brake solenoids, and opens the circuit to the fast forward relay. Contact set K101-3 forms a holding circuit for the rewind relay (in series with normally closed contact set K102-3), and opens the d-c path to the play circuit.

Full power is thus applied to the supply clutch, the brakes are released, and the capstan

#### 4.4.6.6 Stop Circuit

STOP pushbutton switch S105 is a normally closed switch inserted in series with the negative return lead from all relays and solenoids. When this pushbutton is pressed, the negative return is opened. Any mode of operation will be dropped out, and the brakes will be applied to stop tape motion.

solenoid is deenergized. Since no power is applied to the takeup clutch, tape is pulled at fast speed from the takeup to the supply reel.

Similarly to fast forward, the record mode can be initiated when tape is at a standstill or in motion in any other mode (reproduce, record, or fast forward modes will drop out when the REW pushbutton is pressed).