<u>MCI JH-110 Capstan Motor Disassembly</u>

The two key items of a tape recorder are the condition of the heads and the stability of the tape path. Without a faithful transfer of the sound to and from the tape at a stable and accurate speed, the results can be unacceptable. The MCI JH-110 capstan motor (MCI PN ASA2500-0129-03 for high speed and ASA2500-0129-04 for low speed) was an excellent solution for its day, but has not fared well in aging compared to many simpler AC synchronous motors on decks such as the Ampex 350 and 440. As the MCI captain motor is no longer available, I feel it is the Achilles-heel of these tape machines.

The MCI model ASA2500-0129-03 capstan motor is really a Torque Systems MH-3210-040A PM field DC servomotor, designed some 40 years ago and with no direct substitution available today. On the rear of this motor are an added tachometer disk, two optical sensors and an IC for tachometer signal shaping.

In good condition, the original captain motor provides very accurate tape speed control that was state-of-the-art in the late 1970s. As these motors are no longer made, we must either keep our old motor in good operating condition, or experiment and replace the motor with something new. Both solutions can be difficult.

This paper discusses the disassembly of the MCI capstan motor with the goal of replacing worn parts for improved performance. These ideas possibly can also be applied to the JH16, JH24 and Sony APR capstan motors that have similar motors with ceramic shafts (but I have not worked on these motors). The MCI JH-110 reel motors are Motronics SP7000 series, similar to that used in the Ampex ATR102, and also no longer available.

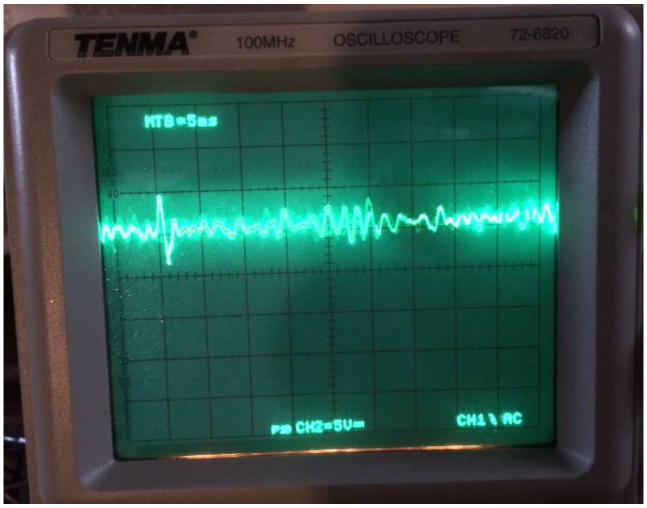
An MCI JH110 capstan motor

As there have been advances in servomotor design, possibly a better motor might be incorporated with substantial effort. A possible substitute motor for the original MH-3210-040A could be the ITT/CMC Torque Systems 3505 series (http://www.torquesystems.com/brush_servo_motor_platform3500.cfm). However, the mount is different (requiring a re-drilling of the deck plate for NEMA spacing) and the motor shaft is both shorter (one inch, we need about 1.75 inches shaft length for the JH110 2 or 4-track deck) and the new motor's shaft is not ceramic. Also tachometer data may need to be modified to create the correct feedback signal. Here, modern PIC microcontrollers such as an Arduino possibly could be incorporated to create just about any speed. This option needs further research to determine if it is viable.

To refresh your existing motor, there are motor refurbishing services such as provided by ITT Torque Systems, Servotech (http://www.servotechusa.com) and Athan Corp (http://www.athan.com/cgi-local/store.cgi?sid=36644716&product=1413). Torque Systems will evaluate a motor for $150, but not guarantee a repair. Right now, Athan looks to be the best option as they have refurbished MCI captain motors.

The MCI high-speed capstan motor passes tape on a JH110 deck at 7.5, 15 and 30 inches per second. The shaft diameter on a unit I measured using a vernier micrometer was 0.4775 inches diameter (a hair under ½ inch). Below the motor where the tach is mounted measured slightly larger at 0.4778 inches diameter-a little larger.

The voltages fed to the motor for each speed were measured on a sample deck to be 3VDC for 7.5IPS, 4.82VDC for 15IPS and 8.25VDC for 30IPS.The current drawn is under one amp for normal use and about ½ amp while being fed from a bench supply at 13VDC under no load. In an MCI deck, the DC drive to the motor has correction signals added by the feedback system as seen below.



Peak "correction" modulation on the 5V DC drive voltage at the motor appears as waves and a 10V spike once per revolution.

As the motor wears performance can be affected, resulting in instability of rotation and flutter in the tape path. There are two reasons for a noisy motor. One is bearing wear, the other is brush and/or commutator wear. Bearings and brushes can be relatively easily replaced. Commutator refurbishment or replacement is quite extensive, but it is worth investigating a home-based process.

The original bearings used in the MCI capstan motor are model R8-Z (1/2" x 1-1/8" x 5/16" shielded, one side, deep groove bearings) made by GMN in Germany (http://www.gmn.de/en/ball-bearings/service/downloads-catalogues.html). A possible replacement is made by NSK of Japan. Bearings can often be sourced locally, or via US mail order. Amazon and eBay even have them. They cost somewhere around $18.

An NSK bearing

I purchased a set of two bearings via eBay from Locate Ball Bearings of Palm Desert, CA. 800-409-3632. http://www.locateballbearings.com

I have yet to determine the make and model of the brushes, or whether they can be sourced locally.

To replace bearings and brushes in an MCI capstan motor, perform the following steps. Be sure to clean the used parts carefully as you go. Wash your hands frequently to avoid polluting the capstan shaft with dirt, carbon dust and oil. This procedure will take about four hours. It is a good idea to take photos and log the dis-assembly process.

Disassembly:

1. Power down and unplug your tape deck from the mains. Let the power supply drain.

2. Unplug the motor and tach connectors from the transport motherboard.
3. Remove the top deck escutcheon. This requires that you remove all of the tape guide rollers, pinch roller and the head stack. Then unscrew the small black Allen screws to free the painted cover plate.
4. You will then see three flat-head screws near the capstan shaft. Mark the screw positions with a pencil. Carefully remove these screws while holding the motor from underneath. Carefully remove the motor to not damage the shaft. Slip off the mu-metal magnetic shield.
5. On a well-lit table or bench, place the motor on its side with a towel under it.
6. Remove the tachometer cover end bell.

7. Unscrew the tach PC board.
8. Note how the photo-sensors sit within the encoder disk. Unscrew the two photo sensors and slip off the PC board with the sensors.
9. Remove the six small flat head screws and the pewter cover of the optical disk.

10. Carefully remove the optical disk and place in a safe place.

11. 
12. Measure the distance (or mark the motor shaft with the location) of the lower pewter disk plate.
13. Loosen the Allen screw that clamps the disk plate to the motor shaft.

14. Using a heat gun or hair dryer, heat up the disk plate and remove the plate.
15. Mark the tach housing, magnet housing and aluminum cover plates for re-assembly orientation.
16. Unscrew the two black allen screws holding the tach adjustment assembly and the tach housing. Remove the housing plate.
17. Remove the felt capstan dust guard.
18. Unscrew the four Allen screws securing the top and bottom cover plates.
19. Unscrew the four black plastic brush covers. Remove the brushes, but note the location and position of each brush for re-assembly. This will allow the armature to slip out without damaging the brushes.
20. Lay out fresh paper towels under the motor. This will catch the large amount of carbon dust from the worn brushes that will fall out of the motor. Using a hair dryer or heat gun warm up the top and bottom aluminum covers.
21. Using a soft hammer or end of a screwdriver, tap the top of the capstan shaft. The shaft should move down over time. You will eventually be able

to very carefully remove the top cover plate from the bearing.

22. Heat and remove the bottom cover plate. Notice the pressure spring washer in the well of the bottom cover.

23. Carefully remove the armature from the magnet assembly.
24. Carefully clean all parts. Keep the shaft clean.

25. Heat and remove the bearings. You may need a bearing puller to do this. Install the replacement bearings.

Re-assembly:

26. Carefully slide the bottom of the armature assembly into the bottom cover/brush assembly. Re-install brushes, but do not tighten plastic covers. Look at each brush and verify that each is seated well on the commutator.
27. Carefully slide the magnet assembly over armature (the magnets will try to grab the armature, so resist this to not break any wires).

28. Carefully slide top cover onto bearing. Oil the cover bearing wells with a Q-Tip and heat the covers to make it easy to slide on. Slide the covers on.
29. Start the screws. Slowly tighten each screw a bit in a circular motion around the covers until the covers are evenly seated. It helps to oil each screw.
30. Rotate the capstan manually shaft manually to seat the brushes and then tighten the brush covers.
31. Re-assemble tach assembly in reverse order of disassembly. Be very careful with the slotted disk. Center the disk before seating all five screws.
32. Clean the capstan shaft with alcohol while holding the motor upside down to not get any alcohol into the bearing.
33. Power the motor up with a bench supply to verify operation. A variable supply allows one to see any motor cogging while running slowly. Reverse the voltage polarity to cause the motor to rotate in the opposite direction. If good, re-install in tape transport. Perform pinch pressure and tach optical sensor adjustment.

I am interested in any comments and suggestions to make this procedure a better one. Let me know if you use this procedure successfully.

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