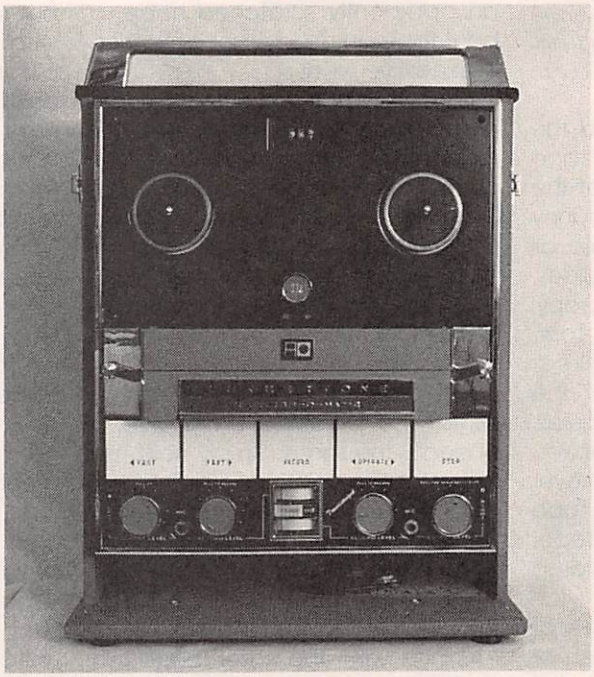
RESTORING A "REEL" RECORDER



This month we take the first steps towards bringing our "golden oldie" back to its original splendor

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In the first part of this series (**Electronics Now,** February 1998) we explored some of the issues you should consider before beginning the repair or restoration of a vintage open-reel tape recorder. This month, we'll begin the actual restoration process. While we can't begin to cover each of the thousands of makes and models individually, the procedures we present are generally applicable to almost all machines. Where fundamental differences exist—such as tube *vs.* transistor or single-motor *vs.* three-motor designs, we'll point out any different approaches that might be necessary.

But before we get too much further, there are a few things we need to warn you about:

• Electricity can be dangerous. Do not attempt any electrical inspection or repair if you do not have the necessary general knowledge, experience, and tools. While low-voltage, battery-operated, all-transistor equipment, like the unit pictured in Fig. 1, might be relatively safe, anything with vacuum tubes, high-voltage batteries, or AC-line cords should be considered dangerous—with potentially lethal consequences.

• Mechanical inspection, troubleshooting, repair, and restoration attempts can also be dangerous. Many people have sustained permanent injury as a result of improper mechanical technique. Clothing and fingers get caught, eyes get hit with various projectiles, *etc.* Don't let that happen to you! Do not attempt any mechanical work if you do not have the necessary knowledge, experience, and tools.

• Never, ever succumb to the temptation of plugging in your newly-acquired vintage recorder "just to see if it works," if it has not been used for months or years and has not gone through the preliminary restoration steps described below. In short, doing so is just about the worst thing you could do! Okay, maybe not the worst thing; after all, you could bounce it down a flight of 30 concrete steps or use it as a boat anchor on your next ocean fishing trip! But, seriously, plugging in a tape recorder without first doing the necessary work could irreparably damage electrolytic capacitors, permanently bend or break "frozen" brake bands, cause totally unnecessary bearing wear, destroy what may still be some potential life in drive belts, or jam/seize-up mechanical levers, pulleys, or shafts.

On a different but related subject, as with any repair or restoration job, it is important to keep scrupulous notes. Don't rely on memory—write down every abnormality or questionable area you find as you go through the recorder. You may be amazed at the number of observations you have recorded by the time you are finished. Those notes, together with details of actual repairs, should become a permanent log for this particular machine, and it will be an invaluable future reference.

Initial Preparations. Before you begin, prepare your work area with the appropriate tools, lighting, cleaning stuff, lubricating stuff, a magnifying glass, a pencil and paper, and a "Variac" (variable-voltage AC transformer). The cleaners I use are: "Fantastik," any mild glass cleaner, isopropyl (rubbing) alcohol, "Endust," a good quality spray "tuner cleaner" (such as GC Electronics 19-634), and mineral spirits. (For brevity, I have not included any wood-working or wood-cleaning considerations here.) You will also want to have a supply of paper towels and "Q-tips" handy, along with inexpensive ½- and 1-inch soft paint brushes.

Lubricants should include both oil and grease. The oil, for everything other than motors, should be a light machine oil housed in a small plastic vial—preferably with a telescopic-style nozzle. For motors, use a quality 20-weight motor oil. For very light grease applications, where no significant heat is present, "Vaseline" works remarkably well. For average or heavy-duty use, automotive-suspension grease will do the job.

Exterior Cleaning. The first step is to thoroughly clean and inspect all exterior surfaces of the recorder, beginning with the tape path. The tape path (see Fig. 2) must be meticulously cleaned from the first

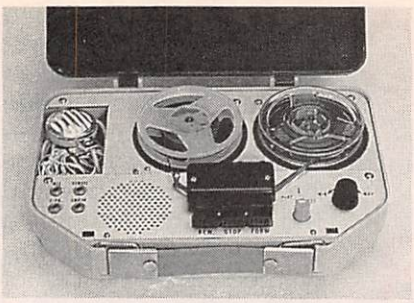

Fig. 1. A small, battery-operated tape recorder like this one might not produce dangerous internal voltages, but be very careful when working with AC-powered units as high, or even lethal, voltages could be present inside.

point of tape contact beyond the supply reel to the final point of tape contact, which is just ahead of the take-up reel. Every nook and cranny must be spotless. That includes all edges and corners of tape guides, posts, and heads. Use only isopropyl alcohol and Q-tips for this task. Never use abrasives of any kind; and, whatever you do, resist the temptation to scrape those guide edges with a small screwdriver. You will scratch the metal and forever cause abrasion against the tape (which not only wears out the tape, but also makes future oxide build-up an even greater problem).

I must confess I've been guilty of using my fingernails on occasion, or even breaking off a Q-tip end and using the paper Q-tip shaft, but that's the limit. This job might seem to take forever; it may appear as if the tape oxide has been deviously epoxied to the metal. That is normal; just keep at it. One other word of warning here: Don't use excessive force during the cleaning process. Heads can be pushed out of alignment and tape guides can be bent if you are not careful. Also, as you go through the cleaning process, be sure to note any abnormality or questionable area such as an apparently scratched head, a bent tape-guide lever, or potentially excessive wear.

By the way, it's okay to use isopropyl alcohol on the pinch roller. This roller is typically located to the right of the tape heads, as pictured in Fig. 3, though it might also be centered within the head assembly. Such a setup is occasionally found on auto-reversing machines. Also, a small number of models contained two pinch rollers, one on each side of the head assembly. Regardless of the setup, the cleaning procedure is basically the same: Simply hold the roller stationary with one hand, and clean the tape contact surface with the other using an alcohol-moistened paper towel.

Note: Do not attempt to clean the pinch roller when the machine is running—with the roller engaged against the capstan shaft—as this can be dangerous. I have never found isopropyl alcohol to damage the rubber (even after many applications over many years) if used only as the roller is being wiped clean.

Next, thoroughly clean the remaining front-panel area, using glass cleaner if it's only dusty, or a stronger cleaner (such as Fantastik) if it's dirty. As you do this, be careful not to wipe off old lettering. Mineral spirits is handy for removing household-tape adhesive remnants. Note that Fantastik sometimes leaves a film residue; that can be removed with an application of glass cleaner. Then clean the rear panel and/or compartment area. Take note of any broken connectors, frayed cables, missing "remote" plugs, etc. Now finish cleaning the remainder of the exterior cabinet.

As a last step, go back and take one more careful look at the tape path, using the magnifying glass this time to note any imperfections or oxide clumps you might have missed the first time. Also "sight down" the heads and guides to take note of any gross misalignments. By sighting down, I mean get your head down to the tape path area to gain a view similar to that shown in Fig. 4. Close one eye and visually bring adjacent tape contact points into view—carefully watching to see that surfaces are parallel or perpendicular where they should be. Don't bend or otherwise adjust anything at this time.

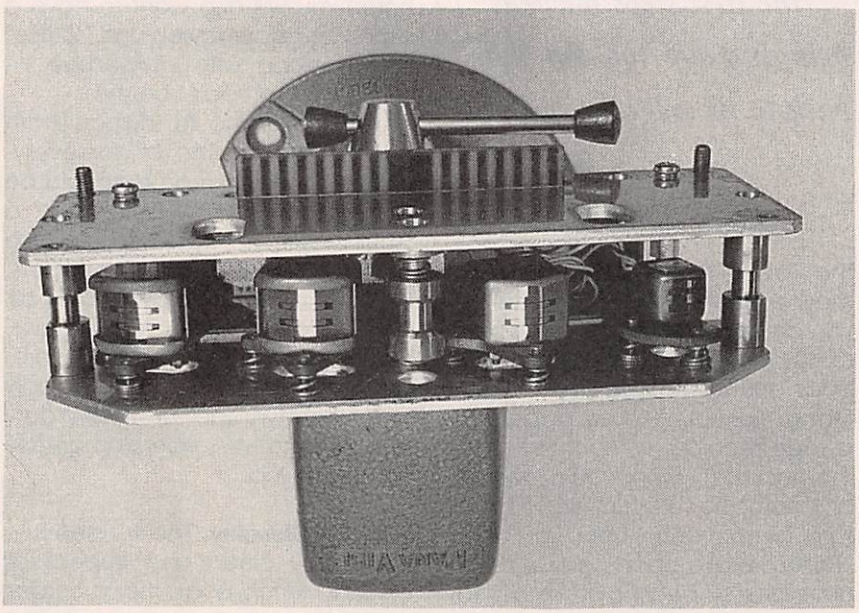

Fig. 2. The various tape heads and guides found in the tape path of a typical audio-tape recorder. This particular head assembly is from an auto-reverse machine. It contains four heads: one each for erase and record, plus two play heads—one for each playback direction.

General Interior Cleaning. Now let's tackle the interior cleaning and inspection. The goal of this step is to determine the overall state of the "internals" and perform some minor cleaning and lubrication in an attempt to condition the machine to the point where it can be safely powered up. It's only after power application that you will be able to determine, in detail, the extent of work needed to complete the restoration.

At this point, remove enough of the cabinetry to gain access to the major mechanical and electronic sections. Make sure you keep track of the disassembly sequence and all of the hardware you remove in the process. Using Endust or something similar sprayed onto a paint brush (just a little will do nicely), carefully brush out the interior—

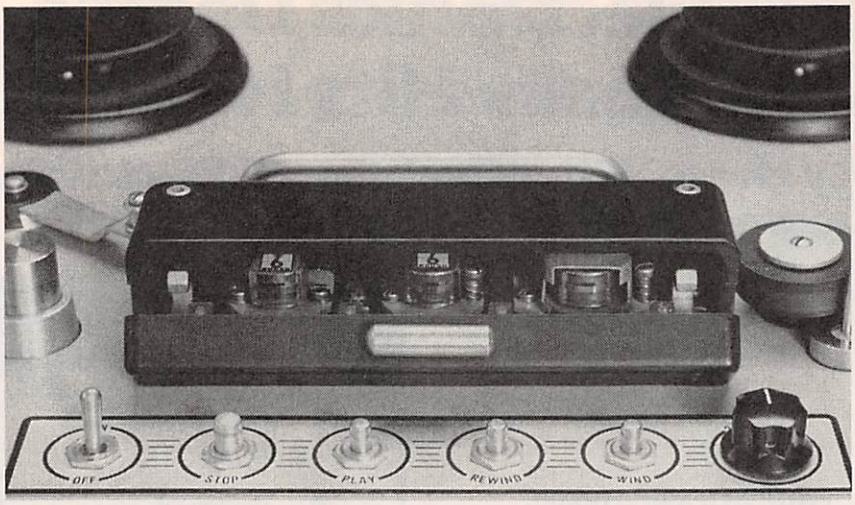

Fig. 3. In a typical type path, the pinch roller is located to the right of the tape heads, as shown here, though it might also be centered within the head assembly.

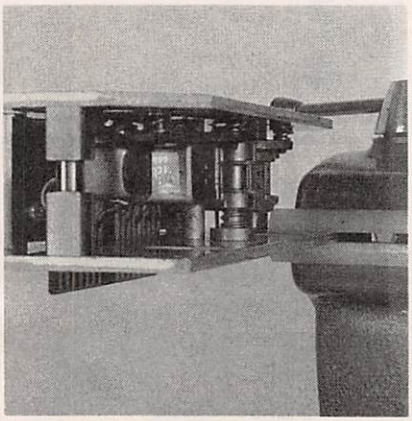

Fig. 4. One preliminary step when checking head alignment is to "sight down" the tape path as an initial check to ensure all tape contact surfaces are parallel to each other.

removing major clumps of dust and grit. Be very careful of the following as you do this:

- Do not dislodge or otherwise stress wires or components; transistors, for example, are often plugged in (as opposed to being soldered in place). If you brush too hard, you may inadvertently dislodge them.
- Do not brush areas containing grease; use Q-tips for those areas.
- Do not brush "into" mechanical components; doing so might cause dirt clumps to become lodged inside bearing surfaces.

A small vacuum cleaner could also be used here, but it would be most effective if used together with the brush. You might as well clean the inside of the cabinet as long as it's removed at this time.

Follow this with Fantastik-dampened paper towels to finish the cleanup task. Once again, be careful to observe the above warnings. The idea here is not to produce a "spit shine" but rather to do a general cleaning, removing dust and dirt that otherwise might find its way into the moving parts, to create a reasonably clean "work area" for the subsequent detailed restoration tasks, and as part of the general discovery/inspection process. After all, you can't inspect it if you can't see it!

Detailed Interior Cleaning. Once you are satisfied that the general interior cleaning is adequate, the next step is detail cleaning. Use Q-tips and paper towels, moistened with isopropyl alcohol, to clean all rubber idlers and belts, the metal surfaces those rubber parts contact, and any other metal or plastic areas too small to cover with the previous cleanup. The locations of some of those components within a typical vintage recorder is shown in Fig. 5. Note that, particularly on machines from the 1950s, you might encounter cloth belts. Those belts were tensioned via a spring-loaded intermediate pulley. Remarkably, many of those belts are still serviceable today! If your machine has one of them, do not attempt to clean it with isopropyl alcohol. In fact, don't get it wet at all.

Also, be very careful if you encounter any felt contact areas. Most likely that would be in the form of brake-band linings (if you have a three-motor machine), pressure pads in the tape-path area, or turntable "slip-clutch" pads. Do not get the felt wet; in fact, don't attempt to clean the felt or touch it at all. Rather, just inspect it—and make a note if it appears to have significantly disintegrated over time.

If the machine has brake bands, you'll most likely have to remove them in order to clean the mating contact surfaces. The bands may have one fixed end and one pivoting end, which is spring loaded. Often by very carefully removing the pivoting end (noting all points of attachment), the band can be gently folded back enough to allow you to clean thoroughly. Those mating surfaces must be absolutely spotless—no dirt, no adhesive residue, nothing! Be extremely careful not to crease the metal bands—it will not be possible to completely remove the crease, and that could cause rubbing.

Transport Lubrication. The next part of the detail cleaning gets into areas that require a greater degree of manual dexterity, concentration, and observation; it is vital to keep track of what you are doing, what parts you are removing, and in what sequence you are removing them. That's because the mechanical components we'll be discussing next must be removed in order to be properly cleaned, and certainly prior to lubrication.

If the recorder dates back only to the 1970s or 1980s, and was very clean on the inside when you first removed the cabinet, then you might be relieved of this chore. For all others, however, this next step involves the removal of all rubber idler wheels and the pinch roller in order to clean the shafts with isopropyl alcohol. It may be advisable to remove, clean, and re-assemble those one at a time to eliminate the possibility of putting them back in the wrong place. Also, keep your eye out for dried grease clumps adhering to the base of the shafts. All shafts should be shiny-metal colored when you are finished. Use a wet Q-tip to clean the bushing surface inside the wheels. As you reassemble these wheels, put a drop or two of light oil on the shafts.

While the oil is in your hand, go

ahead and oil the capstan shaft (sometimes a tiny oil hole is provided for that purpose, and at other times you may find both a front and rear bearing support for the capstan/flywheel assembly; in either case, be certain that all bearing surfaces are oiled). Also apply one drop of oil at each pivot point, where friction and wear can occur. One word of warning here: never over-oil. One or two drops are sufficient. If you use too much, the oil will seep onto surfaces that shouldn't have oil contamination (*e.g.*, rubber) or will simply make a mess that will later become a "dirt farm."

Oiling the motor(s) can be a simple chore, or it can be very difficult—even virtually impossible—as a function of design. If you're lucky, the motors will have either an oil hole through the front and rear bushings (around the motor shaft) or a tiny metal tube protruding through a side opening of the motor enclosure. In either case, use three or four drops of 20 weight motor oil at each hole.

In other cases, however, you will find motors that are said to be "permanently lubricated" by their manufacturer. Sometimes, what that meant was a greased, sealed, bearing race on the front and rear motor-shaft support points. There's not much you can do with motors of that design without resorting to complete disassembly and replacement of the bearings (or somehow re-packing them). Note that no matter the quality of the original components, the grease is now 25 to 50 years old and probably not lubricating very well anymore. Even so, I do not recommend that you disassemble the motors, and certainly not at this point. Just add a drop or two of oil at the point where the shaft enters the motor housing (front and rear). If the motors later prove to work okay (without excessive motor noise), then just leave it go at that, and consider yourself lucky. If that doesn't work out, then you might need to find a motor repair shop for assistance.

You will generally find at least remnants of the areas where grease has been applied to movable chassis components at the factory. These areas should first be thoroughly cleaned, and then have grease applied. It might be best to clean, and then grease, one area at a time; otherwise, you might forget to re-grease some areas. Use Vaseline in those delicate areas where it's apparent that a heavier grease might upset the movement of low-mass, low-spring-tension, components.

The basic premise here is that if contacting metal parts slide against each other, or the chassis, then grease should be applied. If, on the other hand, parts rotate against each other (*i.e.*, there's a confined space there), then oil should be applied. The logic is that grease applied to confined spaces will eventually cause the rotating parts to seize as contamination, separation, and hardening take place over the years. I'm sure there are a few exceptions to this rule, but not very many.

Initial Electronics Check. Now that we've gotten most of the cleaning accomplished and have performed the basic lubrication operations for the mechanics, it's time to turn our attention to the electronics. Prior to the initial power-up, we want to do a bit of electronics cleaning and inspection.

First, carefully inspect the electronics area for signs of overheating. That includes bulging or cracked resistors (take your time and look very carefully here; use a small flashlight to help identify any abnormalities), burned wires, or capacitors with "stuff" oozing out. Make a detailed note of all such occurrences, and replace any suspicious components. For example, a cracked-open resistor in a power-supply section should not only be replaced but also carefully noted. It's possible that the reason it overheated was a shorted electrolytic capacitor on the output side.

Next, grab your can of tuner cleaner and carefully spray clean all potentiometers. To do that, place the can's extension nozzle at the opening where the three electrical contacts emerge from the body and give it a brief spray. Then rotate the control a few times through its complete range.

In some cases, you might find that the potentiometer is sealed; that is, it has no opening. In such cases you might have the best of all worlds or the worst: The "best" since that usually means the manufacturer used a superior quality potentiometer that was moisture sealed at the factory to prevent contamination; the "worst" is that if and when such potentiometers do become contaminated, there is no simple way to restore proper operation. As a last resort, some have been successful with drilling a tiny hole through the back of the device to allow entry of the spray cleaner. At this point or the operation, if the potentiometers are sealed, just make a note of it and go on.

Finally, while you still have the tuner cleaner in hand, spray clean all switches with exposed contacts, including rotary switches. By the way, most of the available spray cleaners also contain a light lubricant, such as silicone; that helps extend component life.

Final Inspection. At this point, check all fuses. That includes rear-panel-accessed fuses—with screw-on caps—as well as internal fuses. Internal fuses are sometimes hidden, so make sure you look all around; some may be "inline" fuses, mounted inside wire-lead holders, while others may be chassis-mounted fuse blocks. In addition to ensuring continuity, make sure that all fuses are of the proper ampere rating and "speed." By speed I mean the length of time before an over-current situation blows the fuse. So-called "slow blow" fuses are often designated "SB." Do not intermix these with the more-common fast-blow types. Make notes in your log of any abnormalities as you go. If a wrong fuse is inserted, it has obviously been replaced; later you must ask yourself "why?" If it has a larger current rating than the manufacturer designated, then you should consider the possibility that the electronics may be drawing excessive current. If that is the case, go back and double check for any over-heated components or wires. If none are found, proceed with the next step.

Okay, we're just about ready for power-up. But before we do, let's take one more look through the

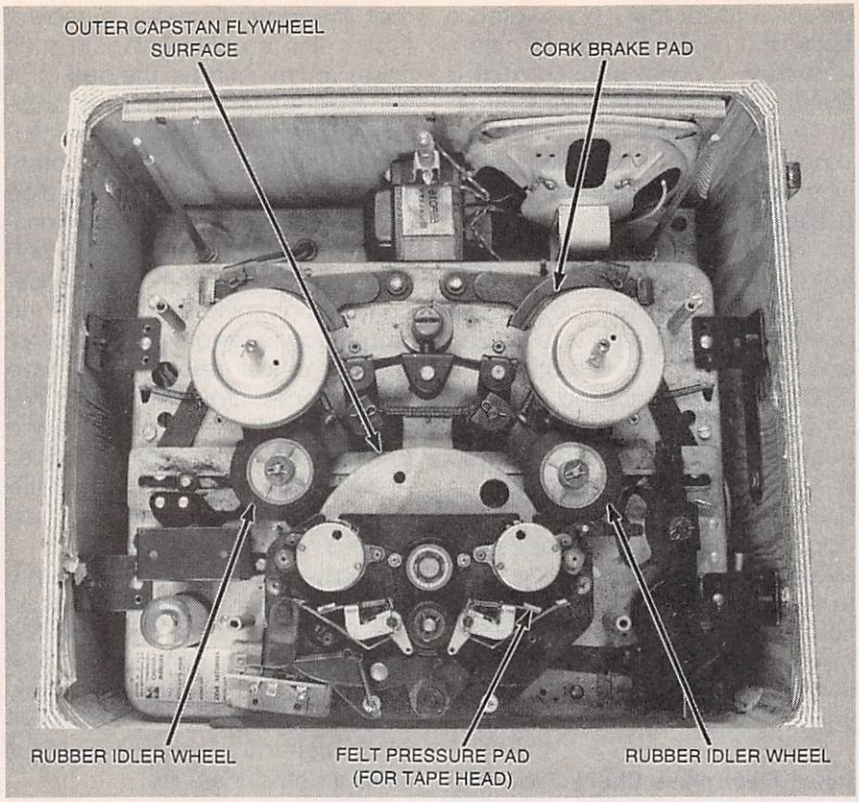

Fig. 5. Some of the internal mechanical components found within a typical recorder. Clean the contact surfaces of the rubber idler wheels and mating flywheel; inspect—but do not moisten—the felt and cork pads.

electronics. If the unit is transistorized, are all the transistors firmly seated in their sockets, with no twisted or "about-to-short-out" leads? Are all internal wires and cables dressed away from any mechanical components, and are they run so that they will not be pinched when the cabinet is re-assembled? Is the AC-line cord still supple and free from any cuts, abrasions, separation at the plug end, or wear at the chassis strain-relief end? Redress, repair, or replace any problems you find, and then re-assemble the cabinet.

Initial Power-Up. Finally, we are about ready to see what this recorder can do. I say "about ready" because first, there is a conditioning step that we must go through. What we are trying to accomplish with this next step is to re-condition the electrolytic capacitors in the hope that you will not need to replace them. Without going into detail, electrolytic capacitors deteriorate with time and lack of use, and that deterioration can be made worse by storage conditions, leading to a rather high probability of failure if the AC power is suddenly applied at full voltage. Instead, by gradually applying that voltage, the capacitors will sometimes re-condition themselves to a point of being quite serviceable again.

Now, connect your Variac to an AC supply. Making sure your recorder is off, with the Variac's voltage control at zero, plug the tape recorder into the Variac. With the recorder in stop mode, and with all volume controls at their minimum position, turn on the recorder. Now slowly increase the voltage up to about 40 volts and then stop. Leave the voltage at this level for about 10 minutes, and then increase the voltage by 10 volts and wait 5 more minutes. Keep repeating that process until you reach about 95 volts, carefully watching the recorder as you do this. Do not leave the room during this procedure! Look for any smoke, hum, noise, or other abnormalities that could be signs of problems. If any of these occur, shut off the Variac, disconnect the power, and correct the problem before proceeding.

Assuming you've been successful to this point, let's do a quick check on the motors before we load tape on the machine. With the AC voltage still at 95, switch into play mode and, if there is a motor shutoff switch in the tape path (usually that will be on either side of the capstan/pinch-roller area), defeat that switch momentarily by using your finger to move it into the position it would have if tape were threaded. observe what happens.

What should happen is that the pinch roller should be solidly contacting the capstan shaft (that actually would have occurred before tripping the switch in a non-solenoid operated machine), and the take-up reel turntable should be rotating in a counter-clockwise direction. Depending on the type of drive, the supply turntable will probably also be rotating, in a clockwise direction. Before releasing the switch, use your other hand, to check if a light touch on the turntable platforms is sufficient to stop the rotation. (When you do this, stay away from the outer edge of the turntables and the center post, as the turntable edge and the post flanges could be sharp.) While we're not doing a formal calibration here, I do want you to make sure that there isn't an excessive amount of force needed to stop the turntable's motion.

All the turntables are supposed to do in the play or record modes is keep the tape from slackening. Any excessive pulling can stretch the tape, and any significant "jitter" or "fluttering" can increase W/F significantly. If there is excessive pulling, do not proceed until the cause is removed (some tips on that will be offered in the next installment of this series). If there is a little bit of jitter, go ahead and proceed, but make sure you take note of the problem.

Tape Path Demagnetization. The next step is to demagnetize the tape path. This is important, and really should be done on a regular basis—let's say after every 10 hours of use. The problem we are trying to correct here is the gradual magnetization of the metal tape guides and heads, which is caused by the electronics, stray external fields, the use

(Continued on page 70)

of magnetized tools, or even improper previous use of the recorder. Whatever the cause, that condition could damage prerecorded tapes by erasing high-frequency passages.

With the demagnetizer at least three feet away from the recorder, and with the recorder turned off, plug in the demagnetizer and slowly bring it close to the recorder, sweeping close to—but not touching—the guides and heads. One or two passes are sufficient; then move the demagnetizer at least three feet away before unplugging it. The technique here is to always keep the demagnetizer moving slowly—never let it stop and never abruptly change direction. To do so could actually cause magnetization. Also, don't leave the demagnetizer plugged in for more than about 30 seconds as it typically draws lots of current and is not designed for continuous duty.

Time to Load the Tape! So, now—finally—we have gotten the machine into sufficient shape to where we can actually check it out with tape! We know it's clean (inside as well as outside); we've performed numerous safety checks (line cord, fuses, wiring, components); we know it has sufficient lubrication; we know the active electronic devices are all in place (tubes and transistors); and we are confident that any tape we thread on this machine will not become contaminated, stretched, or partially erased.

For this final step in our preliminary check-out procedure, thread a "work" tape (that is, a tape with some non-irreplaceable, but high-quality, pre-recorded stuff along with some room for new recordings) onto the machine. You may now directly power the recorder from the AC line; the Variac should no longer be needed.

You might begin by simply getting a feel for the transport controls. At first, don't allow the tape reels to move very fast. Instead, go into the fast-forward and rewind modes for just a second or two; then hit stop. Do this for progressively longer periods of time until you become confident that both the wind motors and the brakes are working well before moving on.

Take note of any abnormalities here, such as excessive initial force being applied to the tape when a fast-wind mode is begun or insufficient pulling force (slow wind). If the latter problem is present, check to see whether it is really due to low pulling force, or whether it's due to excessive back tension on the opposite reel. For example, in rewind mode, the take-up reel turntable should normally have only a very light amount of counter-clockwise rotational force. If that "back tension" is too great, the tape will not rewind quickly; in the worst case, the tape could be stretched in the process.

Remember that these are just initial gross-tension checks to ensure that we can safely move tape in all transport modes. We'll cover detailed tension measurements next time.

If all is well so far, turn up the volume a bit and note the quality of reproduced, pre-recorded sound. Assuming the original was good stuff, the playback should also be good. This is, of course, still a quick preliminary test—nothing scientific. Now proceed to make a recording; really anything will do here—familiar music is fine, or even a 1-kHz tone to get a quick feel for W/F. Again, note any problems encountered.

That concludes our preliminary conditioning and check. One final note though for those of you who were unable to complete these steps due to faulty electronic or mechanical parts. Any faulty components will have to be replaced before you can go on with the restoration. Broken belts; worn-out rollers or bearings; bad vacuum tubes, transistors, or other components; shorted motors; and even bad AC-line cords all must be replaced before you can proceed with the restoration.

That's all the room we have for now. Next time, we'll look deeper into what we must do to bring our old recorder back to its full, original glory. Ω