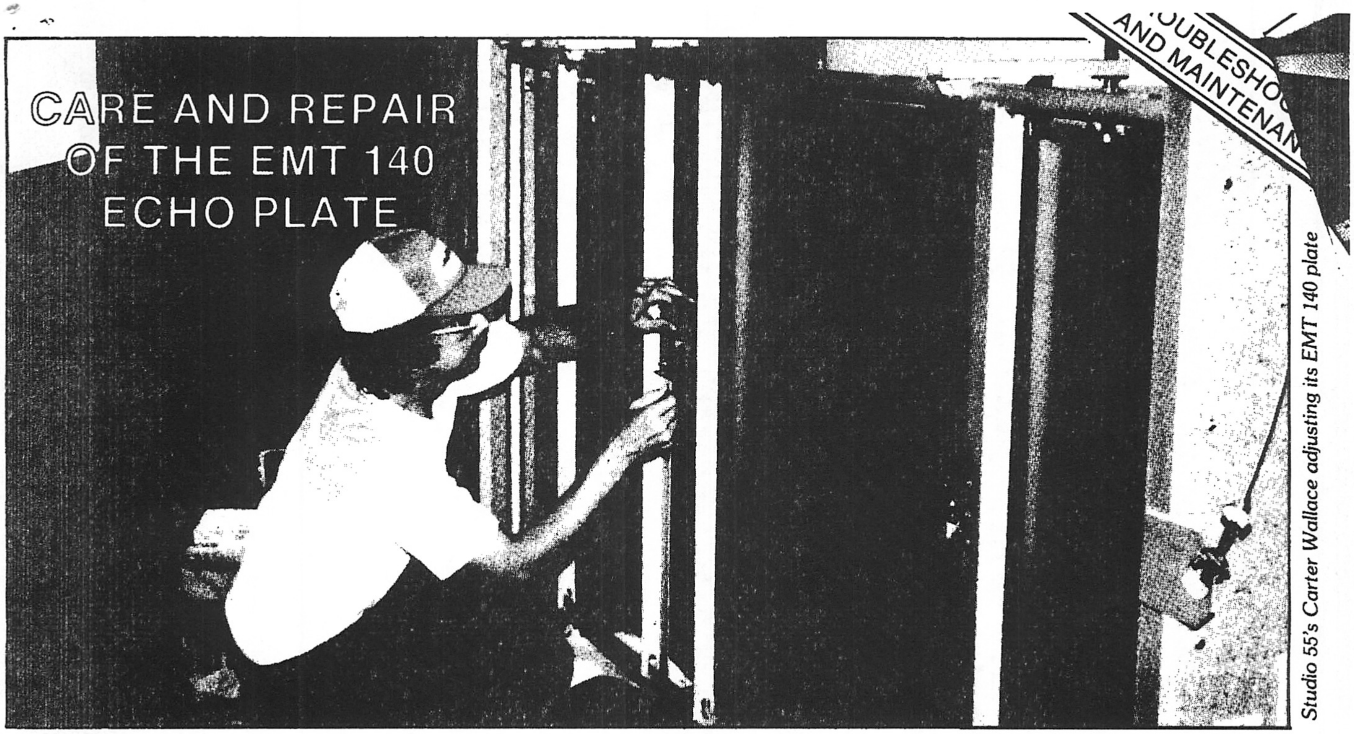
CARE AND REPAIR OF THE EMT 140 ECHO PLATE



Studio 55's Carter Wallace adjusting its EMT 140 plate

by Greg Hanks

Haven't you been there? The lead vocalist asks if you can give him a more "orange" echo in his cans. You kind of know what he means, and turn for another 2 dB at 1 kHz, only to discover that whatever you do, the echo is somehow off. The EMT 140 echo plate has appeared on more hits than you have years, but yours doesn't seem to sound like "them." Maybe it's time for a tune up.

The EMT 140 Reverberation Plate is found in studios the world over. Its popularity is evidenced in part by the introduction of the Studio Technologies Ecoplate, and the Audicon Plate, both of which work on the same basic principles. (These brands were introduced as soon as the various EMT patents expired.) There are a number of variations on the 140 – 140 Mono, Tube, 140ST Stereo Tube, 140 Stereo, Solid State, Q, Quad Return Solid State, all with or without servo remote, etc. – but, for the time being, the following considerations applies to them all.

Principle of Operation

Let's look at what the EMT manual has to say (sections below in quotes), and try to see what it means:

> "The EMT 140 reverberation unit utilizes the physical properties of metal to achieve its effect. It is a fact that a steel sheet which has been excited by an impulse, setting up within it bending oscillations, will deliver reflections which increase in density with time. Reflections in a three-dimensional room, on the other hand, become more dense as a function of the square of the time. The human ear is unable to recognize the difference between these two operating modes . .
>
> "The main component of the reverberation plate is a steel plate which is suspended in a tubular frame. Parallel to this plate, another panel made of porous material is suspended in such a way as to permit it to be swung towards or away from the steel plate with an extreme distance ratio of about 30:1. The choice of plate material requires great care, and takes into consideration its internal damping characteristics and the resulting reverberation time . . "
>
> "Through the use of appropriate steel and critically chosen dimensions, it is possible to produce a plate which possesses an adequate number of self resonances. The length and frequency response of the decay time produce the reverberation effect . . "

These quotes have been taken out of sequence and are incomplete, but they basically sum up the heart of the EMT.

In order to obtain optimum results from an EMT 140 echo plate it must be set up properly. To adjust one of these devices it is necessary to have an understanding of what mechanisms are at work, and how to optimize them individually. To this end this article will examine the basic operation of an echo plate, outline the various adjustments, and explain the subtleties of the mechanical adjustments and their interactions.

Borrowing from the owner's manual a moment:

> "The steel plate's losses are additively formed by the non-frequency dependent and frequency dependent parts, which are caused by the heat conductivity losses of the bending modes.. "

This roughly translates to: The losses of the plate can be attributed to friction (within the plate's molecular structure); such losses are termed "damping." For high frequencies, the non-frequency *dependent* terms are predominant, and for mid and low frequencies, the damping is frequency dependent.

> "Damping through heat conductivity is through practically the entire audible range, directly proportional to the frequency, and inversely proportional to the plate thickness. . "

These losses occur through bending friction; the higher the frequency the more damping, and the thicker the plate the less damping.

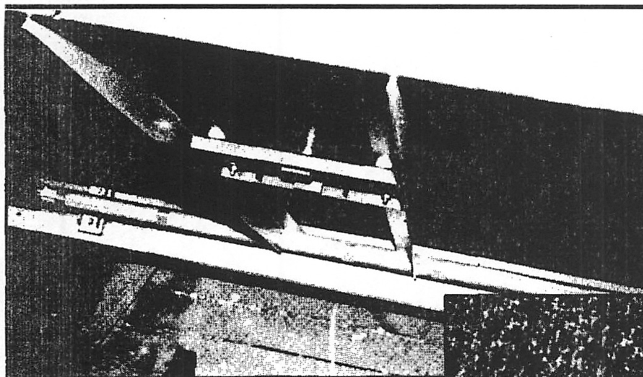
> "The plate used must not only be completely undamped, but must also be extremely flat. . "

The low-frequency response of the reverberation unit is a function of the decay time.

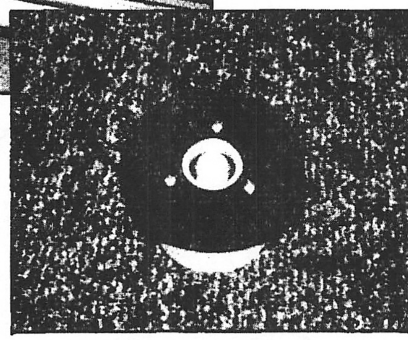
The term "Echo Plate" is really a misnomer, since echo is a distinct repetition of the original (direct) sound with given time delay(s). Reverberation, on the other hand, is a series of rapid repetitions of the original sound which, if of sufficient density of repetition, form a smoothly decaying sound devoid of distinct echo.

Reverberation density – how many reflections occur per unit time – is determined by a number of factors, the first of which is decay time. The greater the density of reflections, the less echo slap is perceived, and the better the reverb sounds. Where there are density discontinuities in time, these frequencies

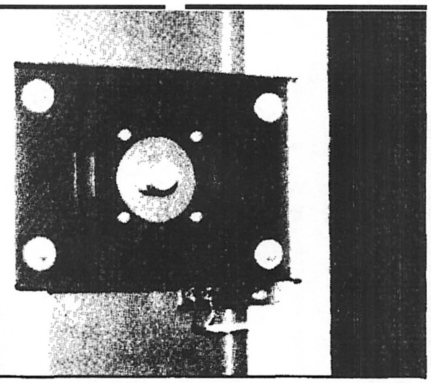
. . . *continued overleaf* –



Top View of drive coil assembly, showing mounting for drive magnet and packing washers.



Drive magnet removed from mounting plate.



Front view of drive coil assembly with the magnet removed.

exhibit decay time anomolies, which create what is known as echo flutter. To minimize this echo flutter effect, the signals obtained from the contact microphones are entirely incoherent in terms of the physical mounting relationships of the driver and pick-up assemblies. The mountings are not spaced an equal integer of the plate's horizontal or vertical dimensions as given by the manufacturer's mounting method. If the damping is equal across the surface of the plate for short decay times, and if the suspension is such that the tension of the plate is equalized from the four corners to the center of the plate, then with an impulse-type input the reflections perceived are statistically distributed. In other words, the reflections will be random in relation to one another, rather than being equidistant in time, resulting in "echo." Thus the reflections smoothly increase with time, and a good-sounding echo results.

There are a number of things that affect the smooth reflection packing density of the plate, and these are as follows:

A. The plate density/uniformity. If a plate has rust or oil on it, then in these affected areas the damping is greater, and this unequal damping can produce echo flutter.

B. Tension differences in the plate suspension cause area tension differentials, which in turn will cause low-frequency time intervals, resulting in "roll-around," or low-frequency echo flutter.

C. Centering of the plate in the mounting which, given the mounting method, can cause uneven tension distribution throughout the plate, with equal torque on each mounting bolt.

D. To a small extent, magnetization of the place around the driver, resulting in even-order harmonic distortion, and a lowering of overall driver efficiency.

E. The uniformity of damping across the plate, which on short delay settings can affect how much one area of the plate is damped, without equally affecting the other parts of the plate in the same manner. The result will be a minute degree of unevenness in damping across the plate, resulting in coloration of the reverb by small degrees of low-frequency echo flutter.

Plate Tensioning

The plate is non-reverberantly suspended in a rigid, tubular frame. Suspension and decoupling are provided by springs and clips mounted perpendicularly to the plate edge at all four corners. These clips and springs are under tension and, because of their location, provide tension to the plate as a vectorial product. In other words, the tension is equal to the algebraic sum of the individual tensions, and centered along a line that is tangential to their application (Figure 1). If these tensions are all equal, then the tension at all points on the plate will be uniform, falling to a minimum at the plate center. This implies circumferential dispersion of the wave emanating from the driven point, which in turn means that the major natural resonance is the product of the direct dimensions of the plate, and not an integer thereof, thereby reducing

. the equidistant, or time-repetitive reflections, or echo flutter.

The problem with this mounting technique is that the springs are tensioned beyond their elastic limit, and that the tension provided by the stretched spring is not necessarily stable. To my knowledge, all EMT plates (with the exception of s/n 100, located at Nola Recordings, New York City, and probably dating from the early Fifties) are equipped with two holes per spring position. Utilizing both of these holes, I double clip each corner so that each spring can operate in its stable elastic region. This maintains the same tensions as a stretched spring, but ensures long term stability.

The drive signal is electromagnetically coupled to the plate by means of a rigidly mounted voice coil. The voice coil is positioned in a magnetic gap, with the magnet attached to a mounting plate, which is supported by the rigid tubular frame by means of two vertical pieces of angle iron. In order to most efficiently couple the drive signal to the plate, this coil should be positioned:

A. Perpendicular to the plate, so as to impart maximum energy to the plate.
B. Radially centered in the gap.
C. Axially centered in the gap.

I have found the axial centering to be the most common misalignment with an EMT plate (Figure 2A and 2B). Axial miscentering of the coil in the gap is probably done at the factory to allow for more freedom of movement of the plate without bottoming (and damaging) the voice coil in transit.

The pick-up assembly is a piezoelectric accelerometer, whose output is nearly inversely proportional to frequency. The most important consideration when dealing with this apparatus is that they are positioned perpendicular to the plate, and that the leads have sufficient clearance to prevent any additional damping to the plate.

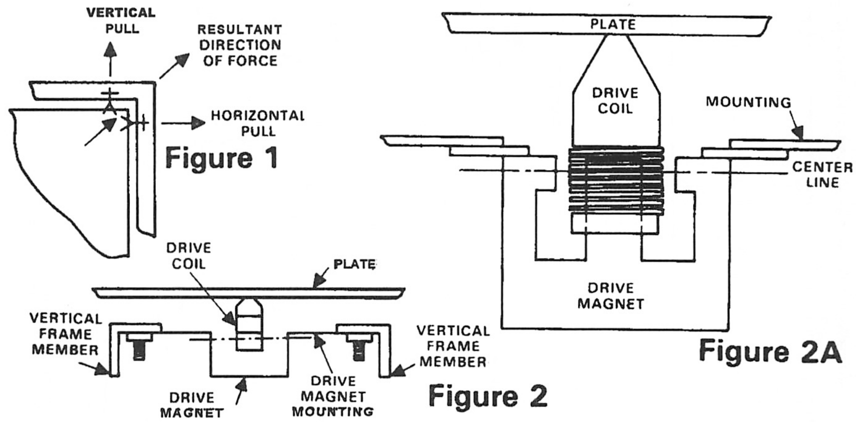


Figure 1

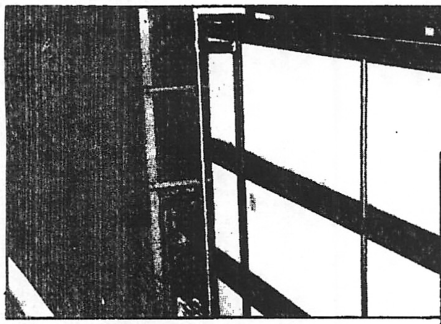
Figure 2

Figure 2A

Tuning and Mechanical Refurbishment

The following is dedicated to the hardy soul who wishes to exercise great care, is willing to dedicate 6 to 12 hours and wants to indulge in frustration. (I broke the drive coil during my first EMT plate tuning

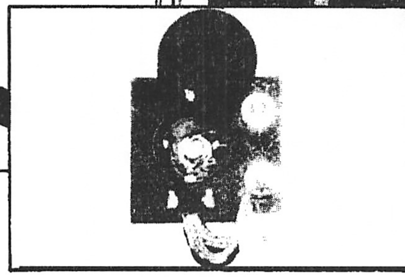
1. Dis-assemble the unit, removing all side bolts and end bolts on the end panel without electronics. Remove damper plate by removing the two top bars that retain the main vertical support bars, carefully lifting out by the same vertical bars.
2. Remove the driver magnet, inspecting for any metal chips stuck inside the gap, cleaning with double-sided tape. If necessary, cover with masking tape to prevent further contamination. Remove magnet mounting plate.
3. Inspect and repair damper plate. If repairing an older unit, check the integrity of the small tiles that make up the damper. On newer models, check thick damper for edge damage, trim frayed edges, and glue back any loose fibres. Check flatness of damper assembly.
4. Remove the pick-ups by unscrewing the retaining screws on the damper side of the plate, replacing the screw in the pick-up since these are impossible to replace, and leaving the pick-up in the shield can.
5. Remove the drive coil by unscrewing as above, and tape in place on the phenolic strip.
6. Slacken the eyelet bolts around the plate, and remove all but the top two and bottom end two. Inspect the plate for rust and dents, remove and repair as necessary, on a large flat surface (like a floor).
7. Slightly enlarge all of the eyelet holes so as to accommodate two springs in the hole. (Note: break the sharp edge of the hole on the non-countersunk side, as this operates as a clip shear under high tensions.)
8. Re-install the plate into the frame. I do this by re-clipping the top two, the top-end two, the bottom two, and then the bottom-ends. When initially hanging the plate in



Damper plate and operating mechanism.

place, it is not necessary to install the clips on the springs, but only to hold the plate in place with the springs alone. When installing the clips on the springs, I use a pair of long-nose pliers, and a pair of 4%inch Channel-lock ignition pliers, and I install the clips so that I am always applying pressure away from the edge of the plate. The procedure outlined in the EMT owner's manual works well when double clipping, but stresses the springs unduly when only one is used per position.

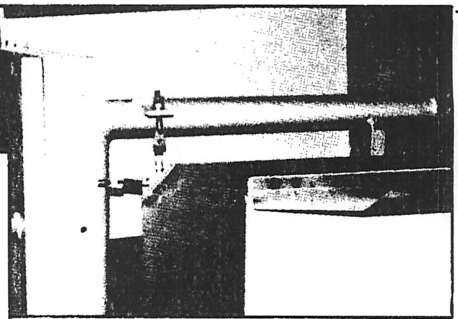
9. With all corners clipped, the next step is to center the plate within the frame, with a slight offset to allow for tensioning. This means positioning the plate slightly lower than center, and a shade



Pickup coils attached to front side of plate.

closer to the electronics end.

10. The next step is to tension the plate. I tension the top two and end two eyelets only, on the assumption that if the plate is centered within the frame assembly, the tension applied to the top bolts and end bolts will be, by nature of the symmetry of the plate mounting, the same on the bottom and the other end. To tension the plate, I use a torque wrench supplied by Snap-On Tools, which has a bidirectional range of 30 inch-pounds. When using this method, be sure to apply some light machine oil to



Suspension springs and clips at corner of plate.

the threads of the eyelets, to assure that the thread drag does not skew your readings from actual tension/torque relationships. After initially tensioning the plate to a given torque figure, check the centering of the plate within the frame, and make adjustments as necessary. More on this later.

11. Remount the pick-ups, taking care not to damage the connecting wires, eyeball the perpendicularity, and adjust the shield can to be centered around the pickup. Remount the drive coil, again taking care not to damage or distend the connecting wires. If any stretching of the coiled leads takes place, it can be rectified by rewinding the lead around a #0 Phillips screwdriver shaft. The voice coil should be made perpendicular to the plate using a machinist's square, measuring any two points that are displaced by 90 degrees.

12. Center the drive coil axially on the magnetic gap of the magnet. This step requires some measurements and calculations, because you must measure the distance from the plate to the center of the coil, then measure the distance from the plate to the center of the gap, and make up the difference with the spacer washers removed during disassembly of the driver plate. The spacer count necessary for centering is almost always less than were removed. (I have a bag of extras that you would not believe!)

13. Center the magnet assembly with the Lucite ring that is supplied with the unit for this purpose, as per the instruction manual, avoiding the step that says to make small adjustments by bending it non-perpendicular.

14. Re-assemble the damper plate assembly, making sure that the top and bottom of the damper are the same distance from the plate at all four corners throughout the adjustment range; re-adjust if necessary. Make sure that the damper does not touch the plate at the shortest decay setting.

15. Re-assemble the cabinet and res-

tore the plate to its proper home.. ***Carefully.***

16. Adjusting the electronics is best done by following the procedure outlined in the manual, then rolling off all the bottom end, and setting the drive level to maximum.

Studio Applications

Receive levels:

Adjust so that the stereo returns are the same level, and the chamber noise is approximately equal to the noise floor.

Drive level:

Adjust to desired subjective effect.

Equalization:

1. To attenuate the highs, EQ the returns.
2. To boost the highs, EQ the send.
3. To attenuate the lows, EQ the send if "rolling waves" of echo are the problem, or EQ the returns if chamber or outside noises are the difficulty.
4. To boost lows, EQ the sends whenever possible, clipping of the chamber being the limiting factor. Keep in mind that the longer the decay setting, the more apparent bottom-end will be in the echo.

Insert all echo delay devices in the send bus, so as to use the high-frequency attenuation of the chamber to mask the additional noise of the delay.

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The prime objective of this article is to impart some of my experiences in obtaining a reverberation device that has a smooth decay characteristic free of echo flutter, and how to use this device with a minimum addition of noise. These objectives may be reached through attention to mechanical detail in set-up, and judiciously avoiding the accentuation of reverb noise in application.

Addendum

In reference to the chosen torque figures for tightening the plate, it is best to make this choice for the particular plate and spring material in question. In order to arrive at a torque figure, tension a single spring/clip combination until you see the elastic limit has been reached. This is the point at which the torque does not go up as you continue tightening, but in fact may even decrease! Such a tension is a good place to put your torque with double clips – it usually works out to be somewhere between 13 and 19 inch-pounds. ∎ N=

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