Sound Talk®

A Technical Service to the Industry from the makers of Scotch Magnetic Tape

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ALIGNMENT

Since the design of the first tape recorder and the use of magnetic recording tape, the equipment and tape have continuously undergone improvements. Some of the improvements have allowed greater fidelity, better signal-to-noise ratio, excellent reliability and service life. These improvements have also reduced distortion, crosstalk between channels and high frequency (short wavelength) losses.

All of the aforementioned benefits are the result of better machine electronics and also better mechanical drive and guiding systems. Ironically, the advanced electronics, which record and play back the program material, are at the mercy of the mechanical drive and guide systems which move the tape across the head to assure proper head-to-tape contact. Therefore, correct guiding, intimate head-to-tape contact and head alignment are prerequisites for maximum recorder performance, especially when using multi-track or professional type wide-width (½″ to 2″) tape equipment.

This issue of SOUND TALK will discuss the various elements which are involved in guiding a tape across the deck. Because of the variety of recorders available, guiding and alignment will be discussed in terms of basic principles only; and those adjustments which are deemed necessary should be performed by a qualified technician familiar with the individual machine manufacturer's specifications.

Oftentimes problems with recorder operation or performance degradation are blamed on what appears to be faulty heads or poor tape when, in reality, the problem is actually caused by a misaligned head or improper tape guiding. These problems can occur in any machine, regardless of quality or age. The situation of guiding and alignment is so critical that major recording and duplicating studios make it a practice to systematically check their decks for these parameters to assure proper operation.

To assure that the tape moves across the deck in the proper manner and ultimately crosses the head correctly, it is necessary to establish the correct tape path from the supply reel through the guide system to the heads and back to the take-up reel. Once the correct path is established it is usually quite simple to maintain this condition.

TAPE PATH CENTERLINE

The centerline of each component which is in direct contact with the tape should maintain an unvarying reference plane (Figure 1). The edge clearance limits of these guiding components are within a few thousandths of the prescribed maximum tape widths; therefore, any slight variation from the true centerline reference can cause bending of the tape edges. Additional effects could be tape skewing on a tangent from its path, azimuth misalignment and excessive friction. True centerline tracking is particularly important when using wide tape widths (½″ to 2″) because wider tapes exhibit greater resistance to longitudinal changes or "steering." Wide recording tape exhibits a tendency to curl or roll along its edges when subjected to the steering action of inaccurate centerline tracking.

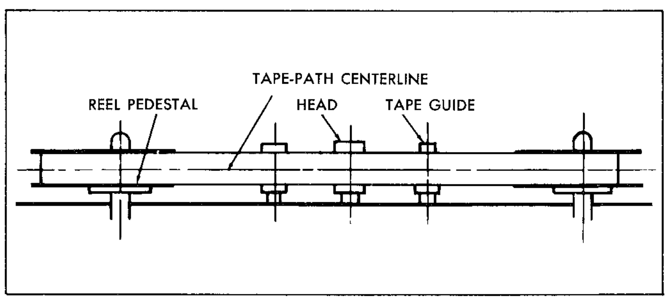


FIGURE 1. SIMPLIFIED TAPE PATH CENTERLINE

PEDESTAL HEIGHT AND ANGLE

Tram error and tape edge damage may occur from improperly positioned tape reel pedestals. A slight variation of the pedestal axis from a true right angle to the tape path creates an exaggerated error at the reel flange circumference (Figure 2).

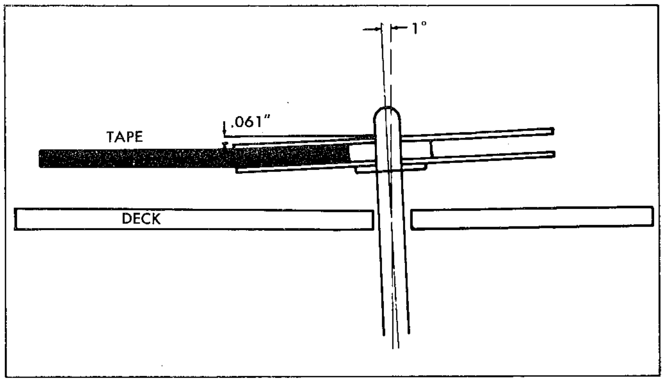


FIGURE 2. IMPROPER PEDESTAL POSITION

A pedestal with an angular error of just one degree will displace the edge of a 7 inch reel flange by 61 mils from the proper horizontal position. If the pedestal height adjustment is incorrect and compounded with an erroneous angle, the total error is cumulative; for example, with an angular displacement of 0.061" and improper height of 0.030" the total error reflected to the tape path is 0.091" – nearly 1/10th of an inch. This type of irregularity will create guiding problems throughout the tape path and can cause the tape to rub along the edge of the reel, creating edge damage (Figure 3).

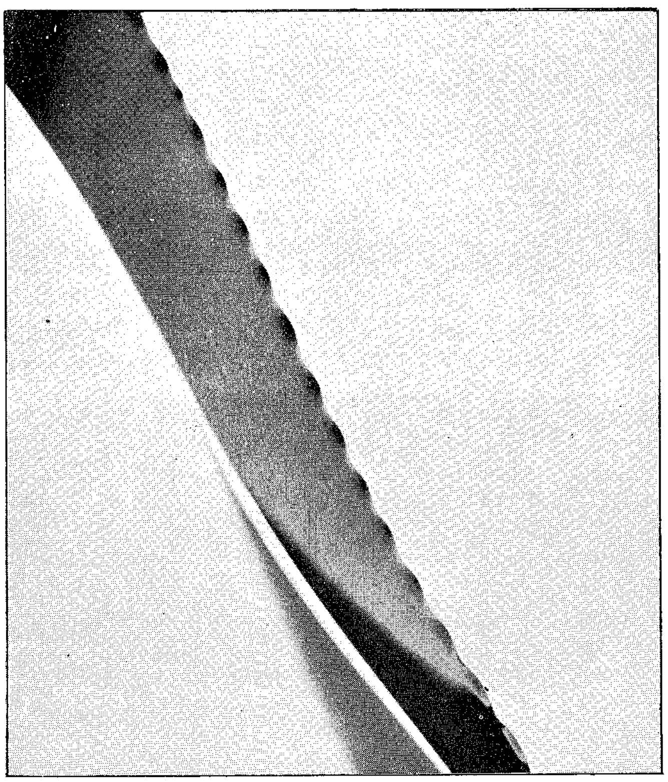


FIGURE 3. SINGLE STRAND OF TAPE SHOWING SEVERE EDGE DAMAGE

The type of edge damage shown in figure 3 may also be caused by a damaged reel. If the reel flanges are bent or warped so that the normal clearance between the tape and the flange is reduced, the tape can scrape against the flanges.

When determining proper pedestal height, differences between the flange thickness of plastic and metal reels must be taken into account. Plastic reels have thicker flanges than metal reels to provide the needed strength. If both metal and plastic reels are used, the centerline reference should be established using a plastic reel. Although this will cause the tape to wind slightly above the center on the metal reel (the thinner flanges will cause it to rest slightly lower on the pedestal), the thinner flanges also provide greater clearance which compensates for the difference in tape wind. When adjusting pedestal height in reference to the tape centerline, it is important to determine the dimensions of the reels normally being used. The Electronic Industries Association (EIA) has suggested basic reel sizes and dimensions in its Standard RS 254A, which specifies a nominal reel width of 0.462" for ¼" reels (nominal tape width plus 0.212"). Other reel widths follow the same standard (½" reel width is 0.500" plus 0.212" = 0.712"). The specified dimensions are standard for the precision reel, which is carefully manufactured to assure concentricity of the hub and flanges, accurate flange run-out and consistent separation distance between flanges. If a precision reel is unavailable or impractical to use (normally available in only 10½" or larger sizes), the dimensions established may be applied to the reel being used to check the transport (see calculations in figure 4).

For ¼-inch Precision Reels:

$$W_F = \frac{W_R}{2} - \left(\frac{W_T}{2} + W_C\right)$$

$$W_F = \frac{.462}{2} - \left(\frac{.246}{2} + .005\right)$$

$$W_F = .103\text{-inch}^*$$

where . . .

W_F = distance between pedestal and nearest flange inner face

W_R = .462-inch average or nominal overall reel width within the lateral mounting area

W_T = average tape width

W_C = desired clearance between each tape edge and adjacent flange

To Then Determine Pedestal Height:

$$H_P = X - (W_C + W_F)$$

$$H_P = X - (.005 + .103)$$

$$H_P = X - .108\text{-inch}$$

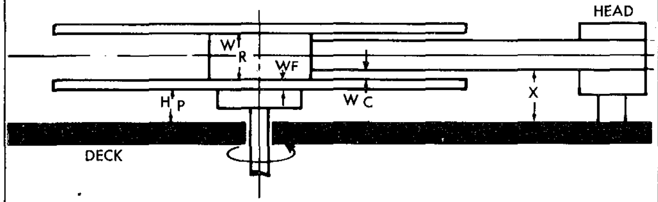
where . . .

H_P = height of pedestal from reference plane

X = distance from reference plane (deck) to nearest tape edge correctly positioned with respect to guides and heads

FIGURE 4. PEDESTAL HEIGHT AND TAPE PATH DIMENSIONS

*For other (½, ¾, 1, 1¼, 1½, 1¾, and 2") precision reels it can be easily shown that W_F = .102-inch. This is because average tape widths for these reels are .002 rather than .004 inch less than the appropriate multiple of ¼-inch. (e.g., average width for ½-inch tape is .498, for 1-inch tape, .998, etc.).



Dimensions important to tape-path centerline and pedestal adjustments.

FIGURE 4. PEDESTAL HEIGHT & TAPE PATH DIMENSIONS (CONT.)

Because tape reels are symmetrical, a perfect wind on a correctly adjusted transport would center the tape equally between the flanges. When establishing the centerline, some type of reference must be used. Generally the mounting plate or deck is adequate for measuring the tape position through the entire tape path. By establishing a reference measuring method, such as "X" in figure 4, any deviations in the tape path created by the pedestals, capstan and idlers, or guides can be easily discovered. The intricate calculations shown in figure 4 provide the basic dimensions for establishing pedestal height and tape centerline.

GUIDING

As the tape moves across the deck, its path is determined by a series of guides. The guides may be fixed, roller type, or mounted on tape tensioning devices. Fixed guides, because of the direct mounting, generally will not become misaligned. Fixed guides can create edge damage problems, such as shown in figure 3, if they become worn or damaged.

Movable guides, especially those mounted on tension compensating arms, are vulnerable to misalignment because of bent arms. During tape centerline measurements, be sure to check the perpendicular attitude of the guide with reference to the deck surface throughout its entire operational arc. Precise measurement of the tape path entrance into the guide and the tape exit path will determine proper alignment. Careful visual inspection (with a magnifying glass) of the tape passage through the guide will determine if the tape is being subjected to any excessive edge pressure which may cause curling or bending along the edge of the tape.

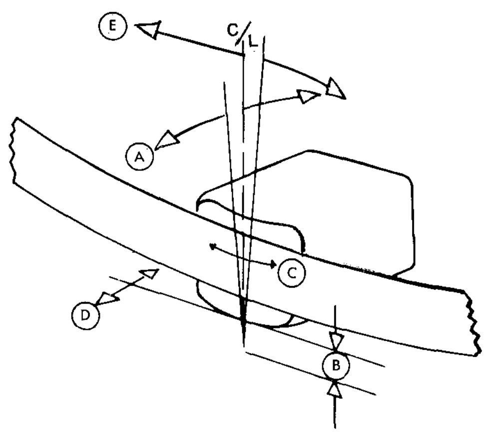
Roller guides, drive capstans and idler wheels can also create guiding problems. Any misalignment or uneven wear on these components may cause the tape to deviate from the ideal centerline. A capstan or idler wheel which not truly perpendicular to the established centerline or is worn into a tapered shape will cause the tape to travel in an improper path, following the component's angular deviation from perpendicularity.

All of the preceding considerations are intended to assure an even and smooth tape passage throughout the entire path. Proper tape movement across the deck is essential for correct head-to-tape interface. The intimate relationship between the recording tape and the recorder head or heads is the final parameter which must be explored to assure proper operation.

HEAD ALIGNMENT

In magnetic recorders, the high frequency response and inter-channel crosstalk are extremely dependent on head alignment. In most tape transports the heads are adjustable and can be aligned as required to establish the correct head-to-tape interface. The adjustment is very precise and is best accomplished by a factory qualified technician referring to the manufacturer's service manuals. There are five basic adjustments involved in correctly positioning a recorder head, as shown in figure 5. Two of these positioning adjustments (A and B, Figure 5) are concerned with the tape centerline.

HEAD ALIGNMENT — Includes all mechanical adjustments necessary to assure proper coincidence of head gap with tape, or more specifically, a properly recorded tape track.



A) Tilt, in which the face of the head must be simultaneously tangent to the same degree with both edges of the tape and without distortion of either of the latter.
B) Height, in which the gap width dimension is centered on the standard track location.
C) Tangency assures that the tape contacts the portion of the head face containing the head gap.
D) Contact, head position into or away from the tape to assure proper contact pressure between head and tape ("wrap"). Not as critical with machines employing pressure pads at the heads.
E) Azimuth or skew, in which width dimension (corresponds to track width) of gap is exactly 90° with tape edge.

FIGURE 5. HEAD ADJUSTMENT PLANES

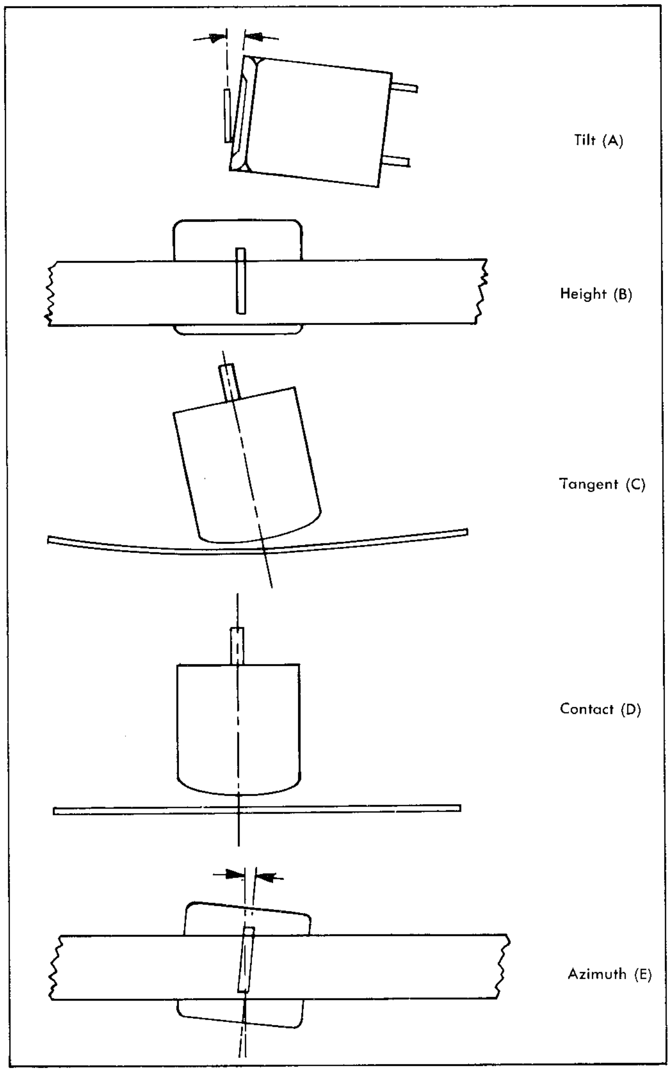


FIGURE 5. HEAD ADJUSTMENT PLANES (CONT.)

TILT

The first basic head adjustment is to establish a true vertical position for the face of the head (Arc A – Fig. 5) with reference to its contact with the tape. The correct attitude is one in which the head neither tilts into nor away from the tape surface. Establishing the correct vertical attitude is important to maintain uniform tension across the entire width of the tape in contact with the head. If the tape is under more tension at one edge than at the other, total intimate contact between the tape and head will be disturbed. The difference in tension can also cause the tape to skew away from the centerline.

HEIGHT

The next basic head adjustment, within the centerline reference, is head height (B – Fig. 5). Improper head height is manifested as mistracking or crosstalk. On multiple track recordings this particular adjustment is very critical in that loss of output, noise and inter-channel crosstalk can result if the playback head gap is not perfectly tracking the recorded path on the tape. If recording with a head maladjusted in height, it may be virtually impossible to play the tape back on another machine.

While checking head height, inspect the face of the head for wear. As the head wears, an indentation is formed along the tape path which actually becomes a tape guide (Figure 6). If the head position or tape path is changed, the worn area will no longer coincide with the tape edge. This will cause tape damage. If a severely worn head is discovered, replacement is recommended.

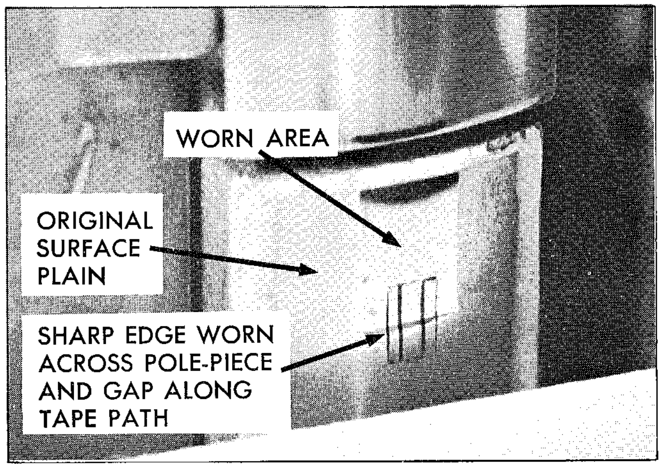


FIGURE 6. EXAMPLE OF IMPROPERLY POSITIONED HEAD EXHIBITING WEAR PATTERN

TANGENCY

Once the tape centerline path across the head is established, the head-to-tape interface must be checked. Tangency (Arc C – Fig. 5) is simply the squaring of the record and playback gaps to the tape's surface. Correct tangency is important to assure proper head-to-tape contact at the head gaps. If the tape contact is not correct, high frequency response will suffer and, more important, the system may become oversensitive to dropouts. Dropouts are usually caused by debris or contamination which separate the tape's oxide surface from the head gaps. Needless to say, any interruption of head-to-tape contact will result in a degraded signal output; and if the separation is severe, a complete signal loss may result.

CONTACT

Contact (D – Fig. 5) is the head position in respect to the tape wrap. Correct head-to-tape contact is assured by the slight bending or "wrap" in the tape path as it passes over the head. Insufficient contact can result in poor high frequency response and oversensitivity to dropouts, as previously mentioned.

Many recorders are equipped with pressure pads which force the tape against the head by applying pressure to the tape's backing adjacent to the head. When inspecting the head position, the pressure pads must be checked for signs of wear or damage. The pad can become worn, developing a channel which corresponds to the tape path. If the pad is deeply worn, head-to-tape contact can be reduced, which will affect high frequency response. Because of the intimate contact between the pad and the tape's backing, surface contamination will tend to stick to the pad. Contamination deposits and build-up on the pressure pad may create hard spots and form an uneven contact surface which can produce "squeal," loss of head-to-tape contact and cause excessive tape wear. If the pressure pad is worn or contaminated, it should be replaced. During pad replacement, care must be taken to assure proper pad size, installation and correct positioning.

A most important head adjustment is that of azimuth (Arc E – Fig. 5). If the reproducing gap (playback head) is not parallel to the recorded poles on the tape, serious loss of high frequency (short wavelength) response will result, as shown in figure 7.

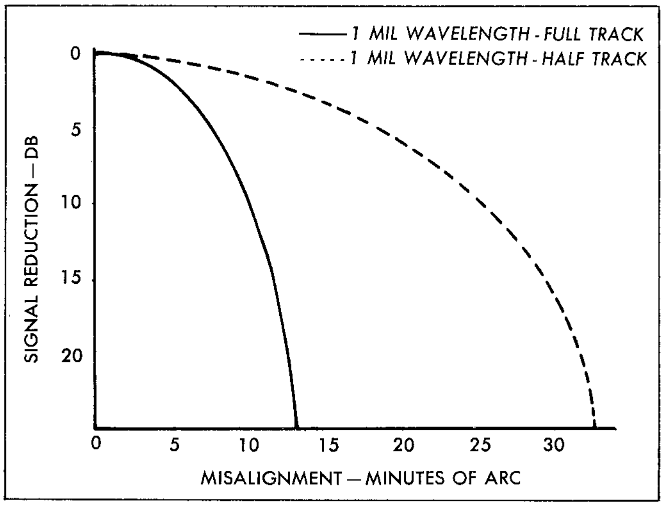


FIGURE 7. HIGH FREQUENCY LOSSES DUE TO HEAD MISALIGNMENT

AZIMUTH

To assure compatibility and interchangeability, it is quite important that record and playback heads are adjusted so the gaps are exactly perpendicular to the tape path centerline. Since it is very difficult to establish true vertical reference with a head because of the extremely small gaps in the pole piece, the azimuth adjustment is best determined by using a special pre-recorded alignment test tape. The alignment test tape has a carefully recorded high frequency signal which, when played back, is used to determine output level. Because of the high frequency dependency on head alignment, any misalignment is readily apparent in the loss of output, as shown in figure 7.

When using an alignment tape to check azimuth, a variety of methods can be employed, the simplest being to deliberately skew the tape across the head while checking output. If the output, as indicated by the signal level meter (or the playback volume), is highest with normal tape alignment across the head, it can be assumed that azimuth is correct. If the output signal level increases while deliberately skewing the tape, it can be assumed that the head azimuth is incorrect and should be re-adjusted. The head should then be realigned to yield maximum or peak output. In the case of separate record-playback heads, the playback head should be peaked per the output signal level determined while using the pre-recorded alignment tape. The record head azimuth should then be peaked while recording on a blank tape and playing back through the correctly positioned playback head. Only a studio prepared pre-recorded tape should be used for an azimuth test.

While checking head azimuth it is also good practice to inspect the pressure pad (if used) for wear. If a pad which has become worn does not properly position itself against the tape, it will have a tendency to skew the tape out of alignment with the head gap, giving the same effect as incorrect head azimuth. If the pressure pad shows signs of a wear-created channel, it should be replaced.

SUMMARY

The improvements in recorder design, electronics and magnetic recording tape have contributed to a media which provides excellent frequency response, low distortion and virtually perfect reproduction of recorded material. The benefits of these improvements are limited to the component condition and the adjustments of each individual machine. By periodically cleaning and inspecting your recorder to verify that the tape path is properly established by the reels and guiding system and that the interface between head and tape is correct, maximum recorder performance can be assured.

If at any time you have specific questions about this topic, simply write to:

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