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TECHNICAL SERVICE REPORT

SUBMITTED BY: RUSSELL W. PETERS

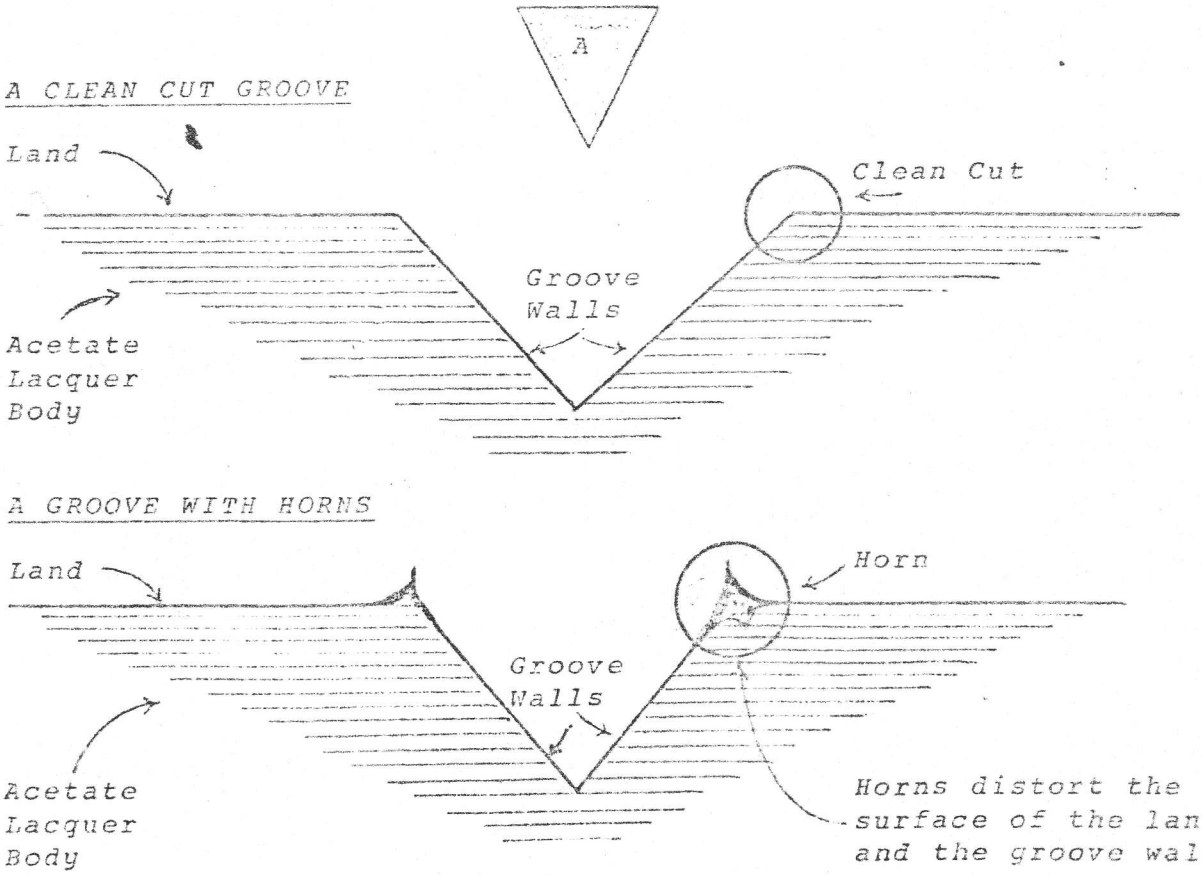
DATE: AUGUST 4, 1975

SUBJECT: HORNS

After many years of investigation into the quality problems associated with phonograph record manufacturing, information relating to "Horns" has been compiled, and is herein presented to the industry for the improvement of phonograph record sound.

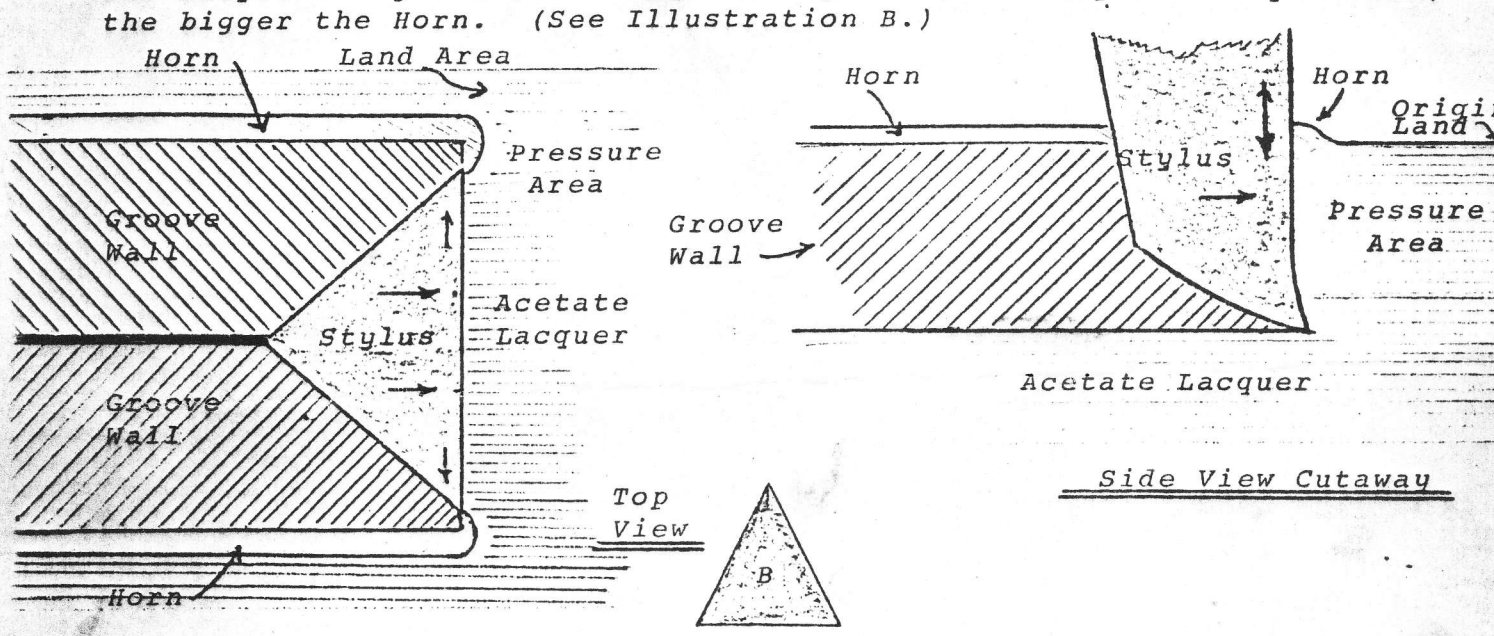
ORIGINATION

Horns originate during the cutting of an acetate lacquer. They are made from the pressure exerted by the cutting stylus against the acetate lacquer as it ploughs through the material cutting out the groove. The horns are a ridge or shoulder, formed on the top edges of the groove that vary in size from insignificant to paramount. (See Illustration A.*)



*Exaggerated Drawing

The deeper the groove, the wider the groove, the higher the pressure, the bigger the Horn. (See Illustration B.)



B

A horn is also the continuation and part of the groove wall. It is distorted in shape (relative to the wall) and its size is proportional to the pressure exerted against the acetate by the cutting stylus. This distorted part of the wall is caused by the acetate cold flow and/or memory. It starts happening immediately behind the cutting stylus as it cuts through. The horn that has just been formed is at a higher internal pressure area from the plough-pressure effect of the stylus. It is warmer than the other material from the pressure, friction, and stylus thermal heat, so it is softer. These factors help the horn to try and flow back to its original place (that it was pushed from) so, at the top of the groove wall the wall actually sags inwardly. (See Illustration C.)

C

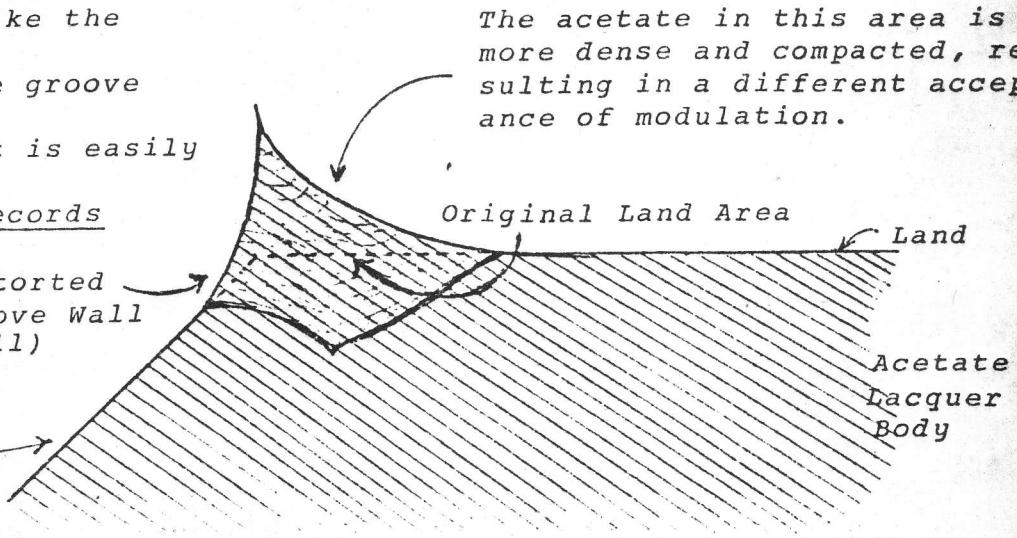
HORN

<u>Horn on Acetate</u>

1. Part of the groove wall.
2. Carries modulation like the groove wall.
3. Is distorted from the groove wall.
4. Has a thin point that is easily bent.

<u>Horn After Effects on Records</u>

1. Sound Loss
2. Distortion
3. Surface Noise
4. Silver Lines (Non Fill) on Groove Left Side.



Exaggerated Drawing

FURTHER GROWTH

After cutting, the acetate may be subjected to hot lights, warm rooms or other detrimental conditions right up to the time in the preparation room before silvering. Until the start of the plating process, the horn on the acetate is in motion, the speed dependent on its environmental condition and size.

HORN DEVELOPMENT

Horns are caused by, and can be a combination of the following reasons:

1. Modulation Level - When the amount of level increases, the stylus cuts a wider and deeper groove in order to capture the modulations - this causes an increase in pressure on the cutting face of the stylus since the stylus gets larger towards the top and is cutting out more acetate.

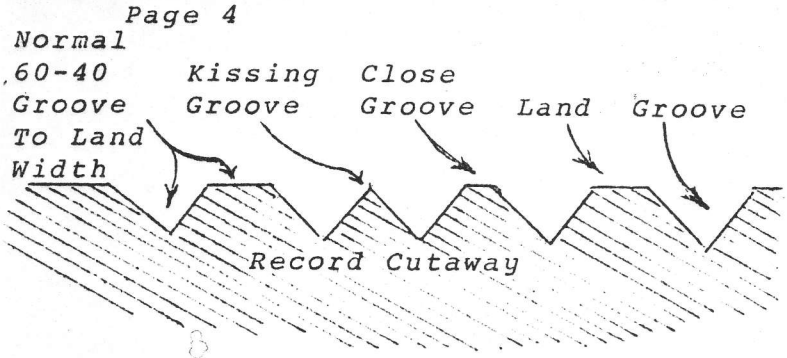
2. Green Lacquer - With all of the mechanical reasons in specification, a lacquer that still has an excess of volatiles in it (not dried properly), is softer and more elastic, and forms horns more easily as the stylus pushes and cuts through it.

3. A Dull Stylus - increases the pressure against the acetate it is trying to cut, forcing the material up into shoulders or horns.

4. A Hot Stylus - overheats the acetate, melting it and causing volatilization of the surface area, forming minute cracks. This hot-soft area makes the horns pooched out in front, resulting in fry and distortion on playback.

5. A Cold Stylus - increases the pressure against the acetate, forcing the top edges of the groove to Horns and also causes groove edge chipping.

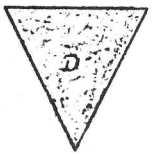
6. Kissing and Close Grooves - When grooves come too close together, they actually eliminate the original land area by overlapping the shoulders or horns of each groove. This buildup superimposes the land area, making the groove deeper than it actually is (in comparison to the original land) and accepting modulation to the top of it. The closer the grooves, the higher the horn until the grooves actually touch at the top where the original land was. This is a "kissing groove," and probably the worst offender of all because the modulation was imposed all the way up the horn side. When the stylus made the "kiss," it cut and pushed its way through the horn from the 1st groove, cutting a super high and pointed horn that is pushed over towards the 1st groove - (outside of record direction). Because of the extra heat from friction and the thinness of this horn, it tends to curl over the 1st groove. See Illustration "D."

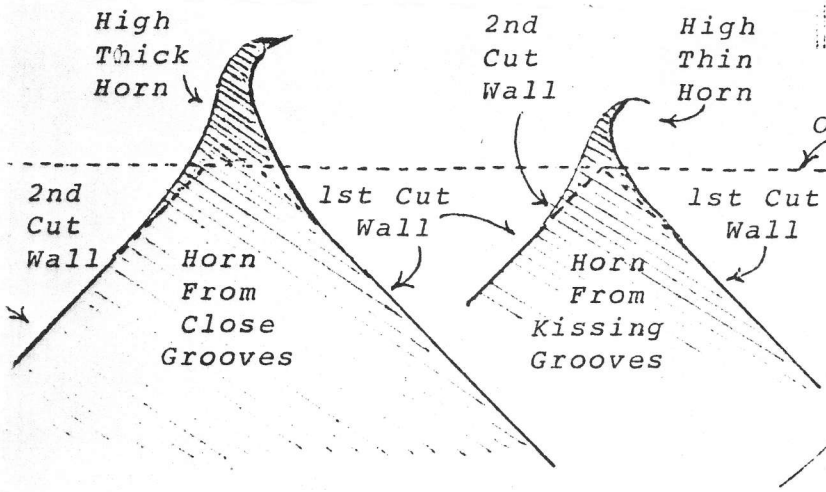


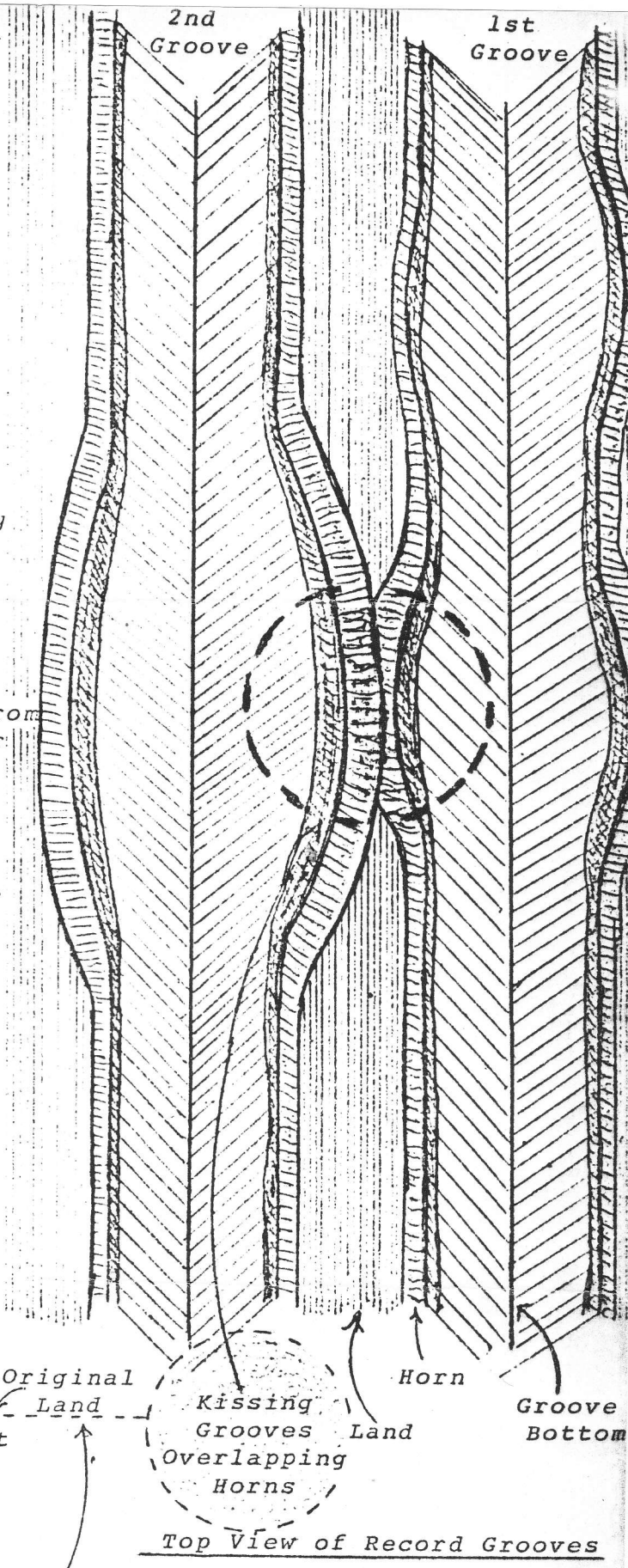
The top of the double horn actually curls like an ocean wave, making a hollow in the stamper that is extremely difficult to fill with compound when pressing the record. This type of horn results in a loud, unacceptable noise and can be seen when looking at a record from the outside edge towards the center on a horizontal plane as silver lines, stiching, or white lines - all meaning un-fill. (See Illustration E.)

Kissing and Close Grooves

When the land area between grooves is reduced to where the Horns touch, pressing problems increase in proportion to the horn overlap.







Top View of Record Grooves

otted lines show where the land would be with a proper cut.

Horns Effect on Stamper Staining

When stampers are formed from masters with small, or no land areas (Big Horns), the deep crevasses formed in the stamper are not only hard to fill with compound but, when they do fill, the compound in the horn is overheated. This is because of the large surface heating area in relationship to the amount of material, and the additional amount of external friction heat generated when the compound is forced into the horn. This excess heat breaks down the stabilizer properties in the compound and so the compound degradates, and the stabilizer separates from the compound and bleeds out. The bleed-out accumulates on the stamper and causes more un-fill in the record, which is part of the silver lines noise. See Illustration "E".

Horns Effect on Record Un-Fill

When records were being pressed six or seven years ago, the biggest single complaint was non-fill. Keysor-Century developed a fast-flow compound that virtually eliminated this problem when pressing parameters are within reason. When the problem of silver lines (or stitching, or white lines) occurs, this un-fill phenomena is never completely solved. The compound is usually blamed for the problem, and rightly so, because the compound is not properly filling the record. The flow of the compound is at fault and even though it can be changed by formulation, heat, pressure, cycle time or a combination of these things, a severe horn problem is seldom solved by adjusting the compound flow properties. See Illustration "E".

Horns Effect on Distortion

Horns distort the modulated groove walls. Sound distortion is created because the curve traced by the playback stylus is not an exact replica of the modulated groove.

De-Horning Effects on Horns (Good and Bad)

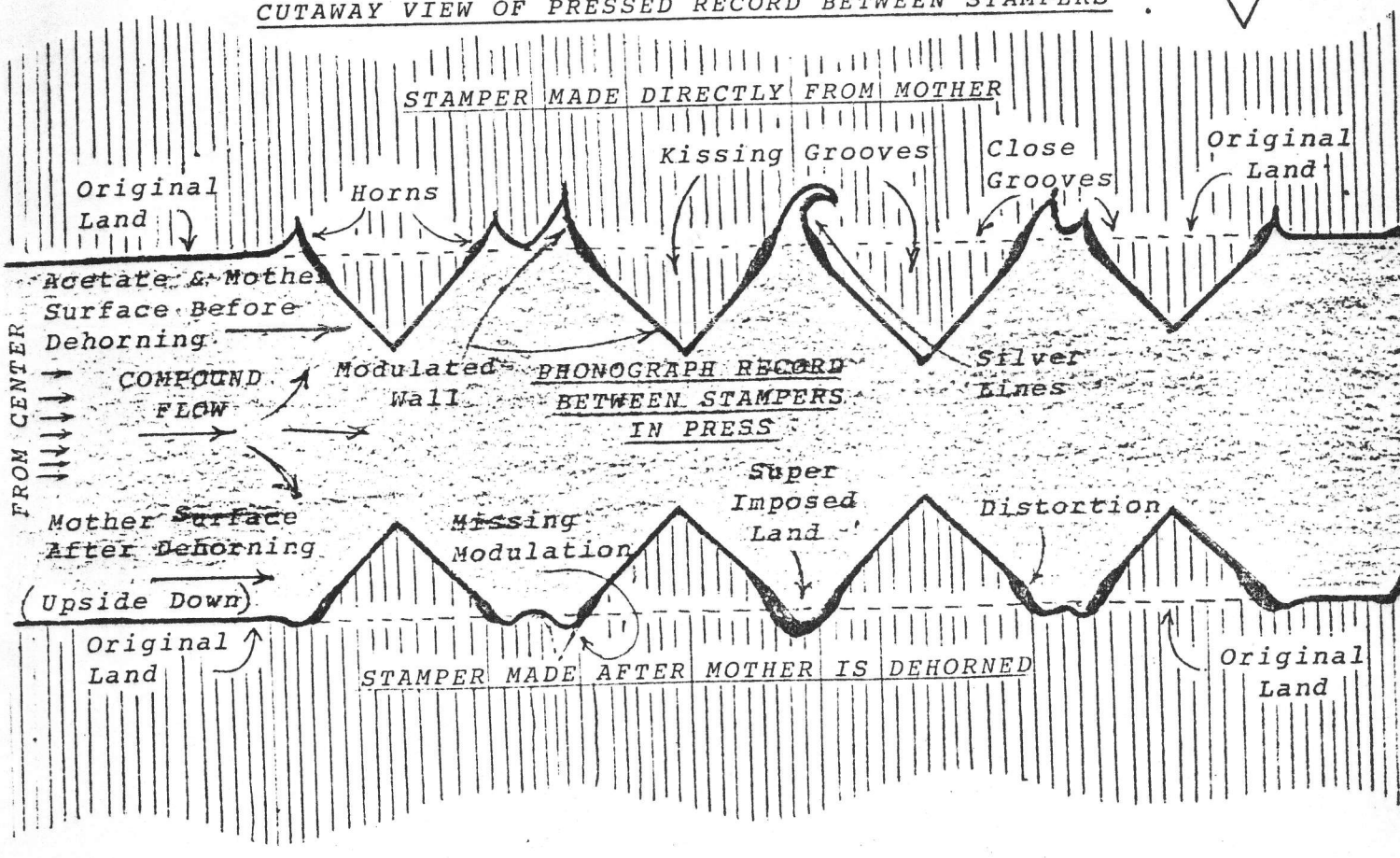
It has long been recognized that de-horning mothers is a process that is very questionable in reference to the pros and cons of the finished product, the phonograph record. De-horning a mother does reduce record surface scuffing and non-fill. It also makes pressing easier and gives the finished record a more cosmetic effect. In some cases it probably also reduces distortion. Now, the bad news...Removing the horns or part of them from the mother also eliminates the part of the modulation that has been recorded into them. As un-fill in the horn inside wall causes noise in the recorded sound, it shows that the horn is an integral part of the groove wall that is modulated and if it is removed, the modulation goes with it.

Nickel Plating Effect on Horns

After the acetate master has been cut, it is prepared, silvered, preplated, and/or plated to produce a nickel stamper or unconverted master. From this step, the stamper may be placed in the press, and using the normal phonograph record pressing plant system, records can be pressed. Otherwise, the unconverted master may be treated and replated to produce a "mother" the exact duplicate of the acetate master in nickel, instead of plastic. The Horns, unchanged and as impressive as before, are now made of nickel. Except, where the horns on the acetate were extremely large and curly, the chances of reproducing them perfectly is remote because the horn configuration is located in the bottom of the stamper grooves, so plating those minute crevasses in detail is remote. To make the odds of failure even better, when the stamper-mother is separated, if a long deep horn was formed properly it then breaks off and stays in the bottom of the stamper or falls out. So, weak areas are formed in the top of the groove walls, which later result in damaged grooves and noise on the stamper made from the mother. This particular problem usually is discovered after some records have been pressed where the test pressing and even the first part of the run is ok; then, the part fails and the following records are rejects. This problem is usually blamed on contaminated and hard compound, or press operator carelessness.

E

CUTAWAY VIEW OF PRESSED RECORD BETWEEN STAMPERS



Conclusion

Horns are a detriment to the finished record. The only solution to this insidious problem is in better mastering. Acetate lacquers must be cut with a minimum of horns. A sampling of records cut the same day by different lathes in the same location on a comparable sound level basis, shows the size of the horns formed on the records are different, indicating that the greatest portion of the horn's formation can be eliminated at the lathe using standard cutting techniques. Mastering engineers follow specific control instructions when cutting a disk. If all the controls are followed, the chances of cutting an acceptable disk are good. The chances of cutting a good disk are poor because the variables of acetate lacquer age and condition, cutting stylus heat, age, angle, and type are all measured for average performance acceptance of a finished record that has been doctored through every sore step of its pregnancy to meet acceptance. If it was cut properly in the first place, doctors would not need "No-fault insurance."

Recommendations

1. Use a scale to determine the hardness of each lacquer before cutting, so that cutting conditions like heat and stylus wear can be adjusted to acetate hardness.

2. Make test cuts of the modulation on the back of the acetate lacquer master to test for horn formation before cutting the side on that lacquer.

3. Develop a lacquer formulation that will offer less resistance to the stylus and stop cold flow.

4. Design a cutting stylus with a profile that will reduce surface pressure in the hot areas and reduce horn size.

5. Standardize a minimum groove-to-land ratio so that hot cuts will not overlap and produce a superimposed horn. The 60-40 ratio for regular cutting can be 90-10 when the cutting parameters are right and horn formation is nil.

Summation

From the many variables that govern the quality of phonograph records in this day and age of fast-flow compounds, super lathe cutting heads and superior electronic equipment for listening, it appears that the formation of horns when cutting a lacquer is the greatest single contributor to rejects of masters, mothers, stampers and records.

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