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Acoustics · Shock · Vibration · Signal Processing

March 2003 Newsletter

Ni hao

Sound and vibration are significant effects in a surprising number of contexts.

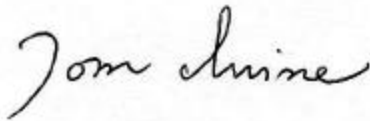
I recently came across a television program about a horse breed called Paso Fino, or "fine step." The merit of a Paso Fino is judged according to its staccato cadence as it tap dances its way across a sounding board, which amplifies the hoof beat sound.

On another topic, some years ago I was standing in the Disneyland parking lot, in Anaheim, California. The weather was damp and foggy as is often the case during the mornings in that area. A friend and I noticed the sharp, crackling sounds emitting from overhead power lines. The cause was corona discharge, although we only vaguely understood the principle at the time.

I have yet to hear the same effect in Arizona, which has a very dry climate.

I hope you enjoy the articles dealing with these sound and vibration topics.

Sincerely,



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Feature Articles



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Paso Fino Hoof Beat Sound

by Tom Irvine



Figure 1. Paso Fino (Photo courtesy of Jack Schatzberg)

The photograph shows Ms. K.K. DuBois riding her performance mare over the sounding board at the Carousel Horse Show in Scottsdale, Arizona. Note that the sounding board has nearly the same color as the surrounding soil.

Introduction

The Paso Fino is a horse breed that has a naturally smooth gait.

The Paso Fino breed originated in Spain. The Andalusian, the Barb, and the Spanish Jennet were crossed bred to produce the Paso Fino.

Columbus brought Paso Fino horses to Santo Domingo, in his second voyage to the Americas. These horses became the foundation stock for the Conquistadors.

Today, Paso Fino horses are used for trail riding, cattle herding, and in competitions.

Furthermore, Paso Fino may have any equine color.

Gait

Fino means fine, and paso means step. The Paso Fino's gait consists of rapid, small steps. This gait produces very little bounce. It is thus very comfortable for the rider.

The natural footfall of the Paso Fino is Right Hind, Right Front, Left Hind, Left Front in a perfect four beat gait.

Speeds

The Paso Fino has 3 speeds of square 4 beat gait:

FINO is a collected version of the gait, performed with slower forward motion than a regular walk. It is performed in competitions.

The horse needs to be very fiery, giving the impression he is about to explode, while moving his feet with incredible speed and accuracy with up to 10 beats per second, while barely moving forward. The horse is often ridden over a sounding board, so the judges can hear that the cadence is even. An image is shown in Figure 1. This is strictly a show gait. It is unique to the Paso Fino breed.

CORTO is the medium speed gait, like a leisure trot. The Paso Fino prefers corto walking or canter and will use it frequently in the pasture, but some prefer trotting unless carrying a rider. The horse can stay in corto for many, many miles.

LARGO is the most extended version of the gait, most horses perform it at the speed of a fast trot, some much faster.

Sounding Board

Again, the cadence of the Paso Fino gait is judged in competitions as the horse travels over a sounding board. The exceedingly rapid, staccato beat of the hooves is magnified by the sounding board. The amplified beat reverberates though the arena.

The evenness of the footfall is the criterion. This is determined by sound rather than by sight. A judge may look away or down to concentrate on the sound of the hoof beats' rhythm.

In addition, the staccato beat is very entertaining for the audience.

Sounding Board Construction

The sounding board is constructed of 4 ft x 8 ft sheets of plywood nailed to a base of 2 in x 4 in beams. The board is thus hollowed out underneath. The total board length is 48 to 64 feet. It is also called the "Fino Board."

Paso Fino Sound Data

An example of an acoustic pressure time history is shown in Figures 2 and 3.

This data originally came from a wav file that is posted at a number of Paso Fino websites. The author converted it to ASCII text format using the CoolEdit software program.

Furthermore, the author has posted the audio file at:

<http://www.vibrationdata.com/pasofino.wav>

This energy in Figures 2 and 3 is the result of the hoof impacts against the sounding board.

A power spectral density of the time history is given in Figure 4. The data shows that most of the spectral energy is in the 80 Hz to 300 Hz domain. This response is the product of the board's structural response, as well as the response of the air volume in the hollow cavities underneath the board.

The energy distribution in the frequency domain could perhaps be described as narrowband random.

ACOUSTIC PRESSURE TIME HISTORY
PASO FINO TRAVELING OVER A SOUNDING BOARD

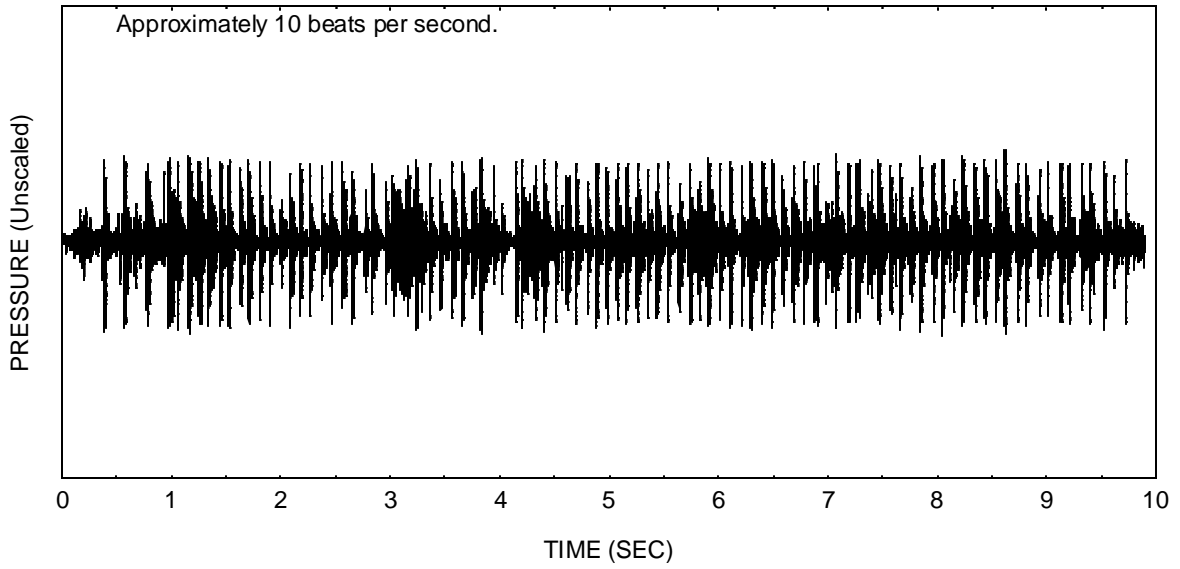


Figure 2.

ACOUSTIC PRESSURE TIME HISTORY
PASO FINO TRAVELING OVER A SOUNDING BOARD

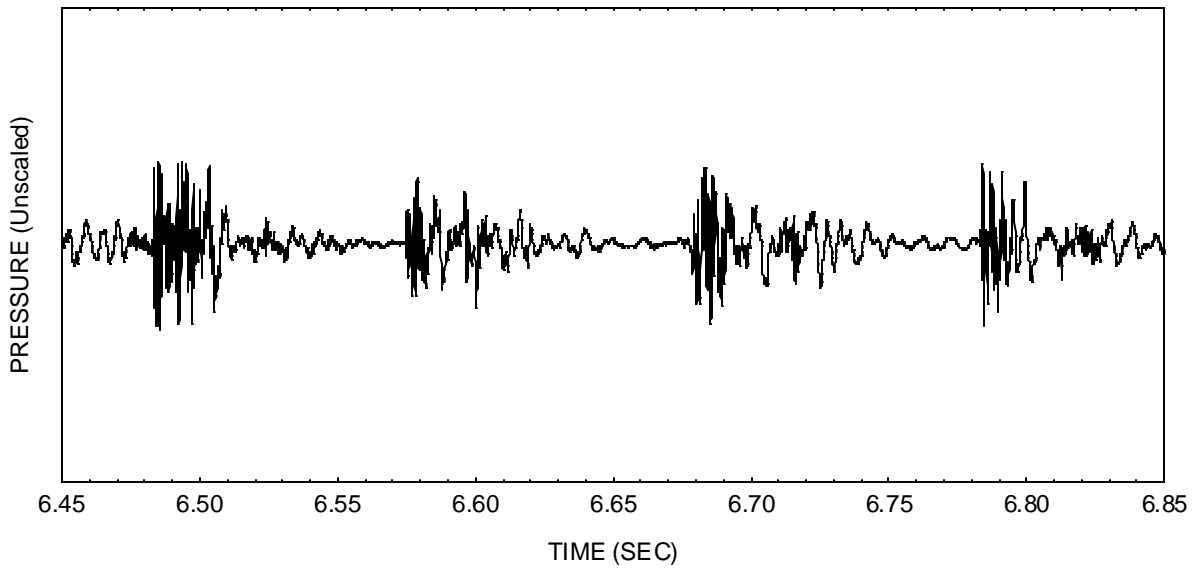


Figure 3.

ACOUSTIC POWER SPECTRAL DENSITY
PASO FINO TRAVELING OVER A SOUNDING BOARD

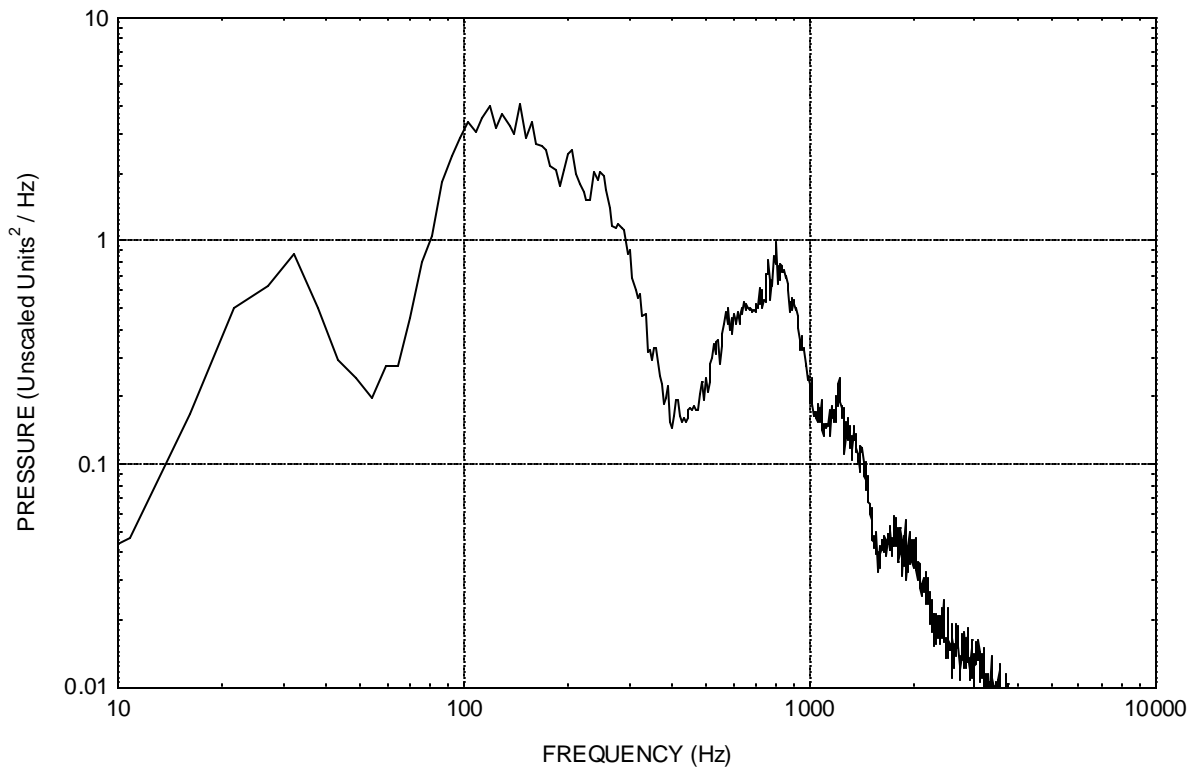


Figure 4.

Power Line Noise by Tom Irvine

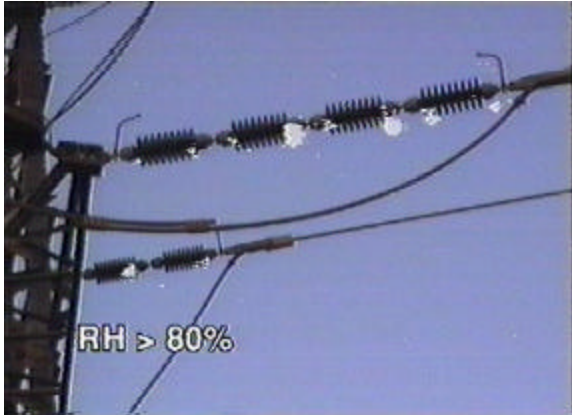


Figure 1. Corona Discharge

The light-blue spots are evidence of Corona Discharge. The relative humidity was greater than 80%.

Corona Discharge

High tension power lines may produce sizzling or crackling sounds during damp weather. The crackling sound may also be accompanied by a low frequency hum, with a frequency of about 100 Hz.

This noise is a particular concern in coastal communities where fog is common.

The crackling sound is an effect of "corona discharge" which forms around the conductive wires. The corona discharge is a type of electric spark. Sometimes, it is accompanied by a blue light. The high voltage breaks apart air molecules causing the air to glow. This breakdown is a form of ionization.

High-voltage power lines carry 230,000 volts or more. These transmission lines are designed to operate below the threshold voltage for discharge, but surface irregularities such as rain drops or solid debris can cause discharge to occur, with the accompanying crackling sound.

"The presence of moisture in the air or on the conductor promotes electrical conduction and reduces the voltage required for corona onset to occur," says Richard Johnson, an electrical engineer at the Public Service Company of New Mexico. There is always a small amount of corona discharge going on, he says. "The presence of moisture simply magnifies the effect."

Specifically, the electrical field around the drops of water becomes strong enough to tear electrons away from the surface or from the negative ions that are always present in the air.

The free electrons increase their speed in the electronic field and release new electrons from other gas molecules. An avalanche of electrons is thus created. Nevertheless, the electric field is quickly weakened outside of the power line, and the electrons lose speed and ability to ionize.

The free electrons are caught by gas molecules that need electrons, such as oxygen and halocarbons.

Effects

Corona discharge produces annoying sound and electromagnetic interference. This interference may disrupt TV, radio, and telephone reception.

The power company must deal with these complaints.

The Southwire Company of Georgia gives the following data for sound measured 30 meters from power lines:

Level	Number of Complaints
60 – 70 dB(A)	High
50 – 60 dB(A)	Moderate
40 - 50 dB(A)	Few

Additional Sources and Concerns

Corona activity may also occur along sharp edges on energized hardware, broken conductor strands, or defective insulators.

The discharge from a broken insulator can find a path to ground in certain cases, resulting in a highly destructive ground fault.

Detection of corona discharge is thus critical in the power industry.

Prevention

Even well-designed transmission lines may suffer corona discharge during wet weather. The threat can be reduced, however, through proper design and maintenance.

A design mitigation method is to transmit the power over a bundle of lines, with each line spaced 18 inches apart. This reduces the electrical power than each line must carry.

Furthermore, the lines must be properly maintained. Smooth conductor surfaces minimize electrical stress, thus reducing the potential for corona discharge.

On the other hand, older conductors can become pitted or scratched and thus more susceptible to water penetration. Corona discharge is thus more likely to occur.

St. Elmo's Fire

Corona discharge is called St. Elmo's Fire, when it occurs naturally.

St. Elmo's Fire may develop around pine trees, masts, and lightning rods during thunderstorms. It also occurs on the wings and surfaces of aircraft flying through heavily charged air masses.

A buzzing or hissing sound may accompany St. Elmo's Fire.