

Motor Sounds

IF THE SOUL of a motorcycle is its engine, its heartbeat is its sound; throbbing, purring or even shrieking, depending on its cylinder layout and rpm.

Sounds reach our ears as ripples in the air; given off by the combustion events that occur between the pistons and cylinder heads. The loudest and most carefully managed sounds emanate from the mufflers. But, just as the wooden body of a guitar resonates with all the frequencies produced by its plucked strings, these combustion pulses also cause the engine's internal parts to vibrate and its external metal surfaces to act like convoluted loudspeakers. What we call tone is the overall effect of these intermingled frequencies. And the quality of any tone is determined by how well these frequencies harmonize, and why a Stradivarius is more valuable than an inexpensive student violin.

We all have favorite sounds that, just like the music of our youth, recall important times in our lives. I've always loved the sound of a built small-block V8 because it reminds me of the freedom of my college days and my roommate's fuel-injected, solid-lifter 327 Corvette, especially the way it sounded returning from high-rpm, crackling through the exhausts. But some sounds I remember fondly for their musical quality; the purity of their tones. Wooden-hulled Chris Craft boats powered by flathead engines plying the lakes of my childhood produced the purest tones, the motor equivalent of a Stradivarius, their higher frequencies muted by valve-in-head construction, leaving only the pulsating combustion to resonate through the hull, like the body of a huge cello. The vertical twin 650 Triumph made my favorite motorcycle sound, its long-stroke design providing a pleasing throaty growl that I could distinguish at a distance from the very similar but short-stroke 650 twins from BSA.

We measure sound frequency by how many ripples are created in one second in a given medium, for instance, air. At sea level in warm air, sound has a speed of approximately 780 mph, covering approximately one mile every five seconds (thus the rule of thumb for determining how far away lightning is striking). In metals, sound travels much faster, because the molecules are much closer and more tightly bonded—approximately 18 times faster in aluminum than air, for instance. Hertz (abbreviated Hz) is the unit of sound frequency, defined as cycles per second. If a twin-cylinder engine is running at 3000 rpm, combustion events are happening



3000 times per minute (one combustion cycle every other revolution times two cylinders) or 50 times per second, or 50 Hz. Compared with sounds in nature, thunder also has a frequency of 50 Hz. So, in fact, it's not just a slogan that a big twin can generate the "sound of thunder."

The precise nature of a motorcycle's sound is now a very important aspect of its engineering. In order not to exceed the DOT's legally allowable limit of 88 dB while preserving as much of the precious exhaust "thunder" as possible, extraneous engine sounds that would otherwise tip the dB scales must be quieted. Many engine covers now have sound absorbing materials on their insides. Transmissions are a major area of concern, as gearing down an engine multiplies the force on the gear teeth and resultant noise potential. Because engines are government tested over certain speeds and rpm, many manufacturers have found it prudent to use helically-cut gears on transmission ratios that will be subject to such testing, because angled teeth resist clatter at a slight penalty in side-thrust and friction. And we were intrigued to learn that when Victory recently redesigned its transmissions, it made sure to alter any gear pairs that had tooth counts that could divide equally into one another, such as 12 to 24, because these created resonant frequencies that were louder than necessary. For instance, 13 to 25 would give nearly the same ratio, but be quieter.

To remove unwanted high frequency sounds from the exhaust, many manufacturers employ some form of absorption silencer, in which a perforated core is

backed up by fiberglass packing so that sound waves will enter the holes and lose energy in the wooly fibers—preserving the desirable low-frequency thunder.

Of course, Harley-Davidson not so long ago made an attempt to patent the sound of its engines. Several factors besides the narrow 45° cylinder angle made it unique. One was that both cylinders were fed through a single intake pipe which made equal distribution difficult and combustion irregular. The other is that the ignition system was a dual-fire, meaning it would fire the sparkplugs in both cylinders with every ignition event. The "waste" spark would often create partial ignition, giving a coughing counterpoint to the already staggered exhaust pulses and an unmistakable Harley-Davidson sound. When it gave up its lawsuit, H-D tried building a motor like the competition's, with a split intake system and single-fire ignition. It ran smoothly, but didn't sound like a Harley should. That didn't last long.

Because engine sounds have a rhythmic pattern, they are very similar to music and are certainly music to our ears as motorcyclists. And just as music has the ability to soothe the savage beast or an anxious human being, our motors seem to have the same ability. This happens because the brain, which also generates certain frequencies depending on its function at any given time (sleeping, dreaming, doing logical work, etc.), tends to synchronize with repetitive frequencies. This is also the premise behind biofeedback machines, which seek to encourage particular brain frequencies for the purpose of stress relief or enhanced creativity.

Humans can only hear a limited range of frequencies (from 20 Hz–20,000 Hz as children) and lose sensitivity to higher frequencies as they age (just 13,000 Hz to 14,000 Hz as teenagers). And prolonged exposure to noises above 80 dB can further damage your hearing, so you should always wear earplugs when riding.

And if the sound of a baby laughing is supposed to be the most addicting sound in life, what sound does a baby hear first? The syncopated *ba-boom, ba-boom* of his or her mother's heart, which is incidentally nearly identical to the sound of a 45° V-twin Harley-Davidson—a sound we were born to love.

Cheers!
DAVE SEARLE

—Dave Searle
Editor