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# CHECK SPOKE TENSION BY EAR



Correct spoke tension is essential in order for a wheel to be strong and durable. An instrument for measuring spoke tension, the tensiometer, is available to wheelbuilders. However, unless you are musically tone-deaf, there is another instrument which does the job faster and easier: a musical pitch pipe - or a piano or church organ, or whatever other well-tuned musical instrument you happen to have in your workshop.

Like the strings of a guitar or harp, bicycle spokes ring when plucked. The resulting musical pitch is higher if a spoke is tighter, and the optimum pitch does not depend on the thickness of the spoke. To know what the musical pitch should be, all you need to know is the approximate spoke length and whether you will be using plain-gauge spokes or butted spokes, which are effectively shorter since their ends are thicker. At the end of this article is a table of optimum musical pitches. You may go there now in case you only need to look up a pitch and spoke length. Please read the rest of the article first if you haven't done that already. You may also read a scientific explanation of how spoke tension relates to musical pitch.

Check spoke tension on a wheel which is reasonably true. On a radially-spoked wheel or one whose spokes are not laced, you can pluck one spoke at a time. If spokes are laced, pluck them where they cross. You will be listening to the sound of two spokes at once.

If the tension of two laced spokes is very different, you will hear a dull thud. Pull the spokes across each other with your fingers to see which one is looser. Lift the looser spoke away to pluck the tighter one alone and check its pitch. Check for rim damage or a crooked rim joint near the unequally-tensioned spokes. Rebend the rim if necessary so the wheel will true up with the spokes at a more nearly equal tension. (Rebending rims is a subject for another article. . .) If you can't achieve a true wheel with even spoke tension, it's time for a new rim.

If the tension of the two laced spokes is approximately the same, as it should be, you will hear a single, clear musical note. In a typical 700C three-cross wheel, this should be an G with plain-gauge spokes and an A with butted spokes.

This pitch corresponds to approximately 1/3 of the yield strength of good-quality spokes - about as high as you can take the tension and still leave an adequate margin of safety. A common error in wheelbuilding is to leave the spoke tension too low. Low tension makes for a weak wheel, since spokes go slack under smaller loads, and fail to hold the rim steady. When spokes are tight enough, the nipples can be a bit difficult to turn; this makes many wheelbuilders leave wheels too loose. On the other hand, wheels are sometimes overtensioned, and then spokes are likely to pull up the rim around the spoke holes.

> It's time to pause for bad pun! Did you hear about the American-made recumbent bicycle with undertensioned wheels? It was a too loose low Trek!

Before assembling a wheel, dip the spoke threads in grease or a commercial spoke thread compound to reduce friction. Also place a dab of grease on the surface where each spoke nipple seats into the rim. A spoke is a good tool to grease the spoke holes. If you do not lubricate the threads and nipples, you may not be able to bring the spokes up to optimum tension.

Check musical pitch all around a wheel. In a new wheel with a good, lightweight rim, it should not vary from the optimum pitch by more than a musical semitone or two (one or two steps of the pitch pipe) up or down. A heavy and/or steel rim is stiffer - as is a deep-section aero rim. If you must compromise spoke tension to true such a rim, use your judgment. No spokes should be so tight as to risk pulling out or so loose as to risk a flabby wheel. Even with a fine rim, do not try to true the wheel by equalizing musical pitch. No spokes are perfectly uniform, and no rim approaches perfect roundness without some coaxing from the spokes, so there will always be some slight variation in pitch between spokes.

If a rim pulls up around the spoke holes when you stress it after raising it to the musical pitch recommended in this article, you must use lighter spokes or a stronger rim. Failure to heed this warning can lead to rapid wheel failure.

Due to the dishing of a rear wheel, the left spokes are under lower tension and have a lower musical pitch, if the same gauge and number of spokes are used on both sides of the wheel. The pitch should be about the same for all left-side spokes.

An elegant trick to build a stronger rear wheel is to use thicker spokes on the right side than on the left side. Spokes with a 2mm shaft on the right and with a 1.6 mm shaft on the left balance nicely; with this combination, spokes on both sides ring at approximately the same pitch, indicating that they are both carrying optimum tension.

You may ask why this approach makes a better wheel than using thicker spokes on both sides. After all, thick left-side spokes would be stronger. They would also be at the same tension as the lighter spokes would, though at a lower musical pitch. But because they elongate less, thick spokes on the left actually go slack and give up control of the rim under a lighter weight load; and even when the load is not so great that they go

slack, the rim warps to one side at the bottom of the wheel where it bears weight, due to the unequal lateral component of stiffness of the right-side and left-side spokes. The reason that thinner spokes on the left work better and last longer is that they are stretched by the same amount and have the same stiffness against lateral (side-to-side) motion of the rim as the thicker spokes on the right.

If you need instruction in wheelbuilding, read Sheldon Brown's article, on his Web site, which is as good as anything I've ever read on the subject.

Use the following table in connection with that article. The table shows musical pitches corresponding to optimum spoke tension. .

| **Spoke length (mm), plain** | **Spoke length (mm), butted** | **Musical pitch** (lowest pitch is F# above middle C; A=440 Hz.) |
|---|---|---|
| **308** | | **F#** |
| **292** | | **G** |
| **276** | **308** | **G#** |
| **262** | **292** | **A, 440 Hz.** |
| **248** | **276** | **A#** |
| **236** | **262** | **B** |
| **224** | **248** | **C** |
| **212** | **236** | **C#** |
| **201** | **224** | **D** |
| **191** | **212** | **D#** |
| **181** | **201** | **E** |
| **172** | **191** | **F** |
| **163** | **181** | **F#** |
| **156** | **172** | **G** |
| **147** | **163** | **G#** |
| | **156** | **A** |
| | **147** | **A#** |

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