

# LETTERS

## Comments on "The Piano"

SIR:

It is good to see in *Æ* such interesting and instructive articles as the two of Mr. Preisman's on "The Piano." Unfortunately the music trades magazines seldom carry articles of technical scope and merit on the science of musical tone production, and you are to be commended on these because we—your readers—are all interested in musical tone production as well as reproduction.

Especially since 1930, when my own research activities were transferred from reproduction to production of musical tones, especially through electronics, I have been much concerned with piano-tone production. Except for some sixty patents in this field, I have published very little on the results of these researches, but Mr. Preisman's articles leave a few interesting gaps which can be filled in.

For example, it does not appear to be generally known that the bridge and the soundboard respond to modulations of string tension, and since these are bicyclic, except at very high vibration amplitude, there is a strong frequency-doubling action. This occurs for all of the orbital rotational planes of the string vibration, and can be easily demonstrated with a small desk-type postal scale and a yard length of cord. Stretch the cord between fixed supports over the scale pan with the scale near one end and with an angle or "bearing" of, say, 30 deg. between this "string" and the "hitch pin" close by. If now the string's long section be displaced up, down, and to either side, the scale will in each case indicate a larger pressure and deflection. Since the scale pan, representing a piano bridge and soundboard, moves downward for a downward deflection of the string, and again downward for an upward or sideward deflection, there are two complete cycles of bridge motion for one cycle of string motion.

Force-displacement measurements of the bridge and soundboard show considerable non-linearity and this accounts for the appearance of a fundamental vibration component of the string in the soundboard motion.

The frequency characteristic of the soundboard varies from bass to treble along the bridge from about 90 cps to about 500 cps and these values change in different pianos. Poor fundamental response of a 30- to 60-cps string through a 90- to 100-cps soundboard is therefore to be expected. Likewise, in the treble end, a 3000- to 4000-cps string fundamental is beset by a 400- to 500-cps soundboard.

The high and low registers therefore suffer from poorly matched impedances and only the middle register—particularly the low middle range—has proper impedance matching, and it is here where the output tone is at its best.

The orientation of a grand piano soundboard is, of course, extremely bad. Acting as its own baffle, both top and bottom sides are about in the plane of a listener's ears, so there is strong cancellation of the low-frequency components of the lower tone registers. Upright pianos are much better in this respect, but the low-frequency performance of both types can be much improved by absorption of the radiation of one side or, as in some commercial loudspeaker enclosures, by reversing the phase of the radiation of one side through a folded horn, for example.

The better tone resulting from multiple unison strings is due not to the increased sound output so much as to the chorus effects among slightly detuned overtones. If these unisons are tuned to one beat in three seconds, for example—a value which is about as good on the average as a tuner can do—the higher numbered partials will have higher beating rates so that the 10th, say, will be ten times as fast or three per second. The vibration planes and orbits of the three unisons will also have random and changing phases so that the soundboard motion and output tones undergo a continuous change in quality as the tone decays.

Another element of piano-tone quality, as Baldwin's Knobloch has pointed out, is due to longitudinal vibration of the string. This varies according to the piano string scale design. In my six-foot Steinway "A" it is generally about four octaves above the fundamental frequency and only by rare chance is it harmonically related. We hear this as the ringing tone of the lower register strings. It has a full Fourier series of partials, all but the fundamental being well up into the high-frequency end of the audio spectrum.

The piano-tone production system is really very complex and much still remains to be learned. My few remarks cover only a small part of this generally unknown area. Piano designing and building is hardly an exact science, insofar as tone production is concerned, and this is a challenging field of research.

B. F. MIESSNER,  
Van Beuren Road, RFD 2,  
Morristown, N. J.

SIR:

Mr. Preisman's discussion of the practice of mistuning the octaves at the extreme ends of a piano in accordance with the "inharmonicities" of its overtones was read with great interest. In my opinion, this practice is ill-advised. Its theoretical usage seems to be dictated by the Pythagorean comma, a disparity existing between the pitch of octave unisons produced by a circle of perfect fifths, and those resulting from harmonics. However, the beats between the octaves of a piano "stretched" in this fashion are much more annoying to me than the "dead and lifeless" sound of a piano in which the octaves are precisely in tune. I am sure that a piano with octaves tuned to the interval of a diminished ninth would sound quite brilliant, but not necessarily pleasant. After all, equal temperament is in itself a radical distortion of natural harmonic relationships, so why compound the felony by further tampering? There is a possible parallel here between people who prefer "Stretched" pianos and people who like their reproducing equipment to sound spectacular rather than natural.

Aside from these small matters, I have found Mr. Preisman's articles valuable and informative especially with their emphasis of the musical element which all too often tends to lose itself in this business. Incidentally, the Conn tuning device is called a *Strobocon*, and someone seems to have recatalogued Chopin's Etude Op. 25 as Op. 75 in the footnote on page 68.

DAVID HANCOCK,  
4 West 93rd St.,  
New York 25, N. Y.