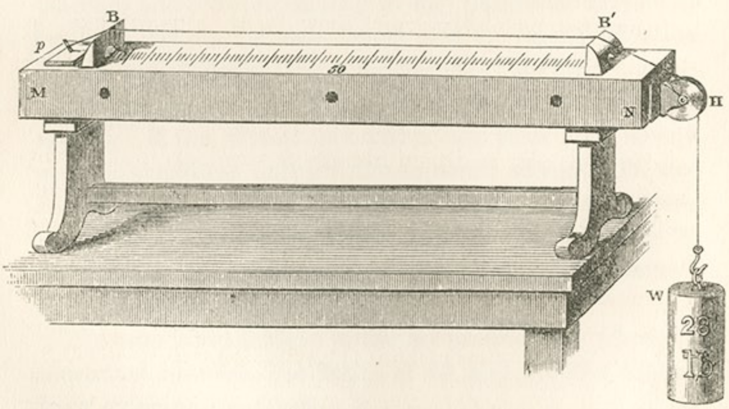
LECTURE III.

VIBRATION OF STRINGS—HOW EMPLOYED IN MUSIC—INFLUENCE OF SOUND-BOARDS—LAWS OF VIBRATING STRINGS—COMBINATION OF DIRECT AND REFLECTED PULSES—STATIONARY AND PROGRESSIVE WAVES—NODES AND VENTRAL SEGMENTS—APPLICATION OF RESULTS TO THE VIBRATIONS OF MUSICAL STRINGS—EXPERIMENTS OF MELDE—STRINGS SET IN VIBRATION BY TUNING-FORKS—LAWS OF VIBRATION THUS DEMONSTRATED—HARMONIC TONES OF STRINGS—DEFINITIONS OF TIMBRE OR QUALITY, OF OVERTONES AND CLANG—ABOLITION OF SPECIAL HARMONICS—CONDITIONS WHICH AFFECT THE INTENSITY OF THE HARMONIC TONES—OPTICAL EXAMINATION OF THE VIBRATIONS OF A PIANO-WIRE.

WE have to begin our studies to-day with the vibrations of strings, or wires; to learn how bodies of this form are rendered available as sources of musical sounds, and to investigate the laws of their vibrations.

FIG. 29.

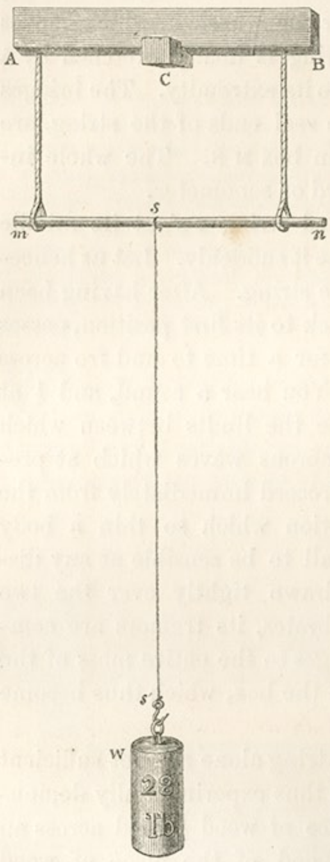


To enable a musical string to vibrate *transversely*, or at right angles to its length, it must be stretched between two rigid points. Before you, fig. 29, is an instrument employed to stretch strings, and to render their vibrations audible. From the pin *p*, to which one end of it is firmly attached, a string passes across the two bridges B and B′, being afterwards carried over the wheel H, which moves with great freedom. The string is finally stretched by a weight W of 28 lbs. attached to its extremity. The bridges B and B′, which constitute the real ends of the string, are fastened on to the long wooden box M N. The whole instrument is called a monochord or sonometer.

I take hold of the stretched string B B′ at its middle point, pull it aside, and liberate it suddenly. Let us henceforth call this act *plucking* the string. After having been plucked, the string springs back to its first position, passes it, returns, and thus vibrates for a time to and fro across its position of equilibrium. You hear a sound, and I at the same time can plainly see the limits between which the string vibrates. The sonorous waves which at present strike your ears do not proceed immediately from the string. The amount of motion which so thin a body imparts to the air is too small to be sensible at any distance. But the string is drawn tightly over the two bridges B B′; and when it vibrates, its tremors are communicated through these bridges to the entire mass of the box M N, and to the air within the box, which thus become the real sounding bodies.

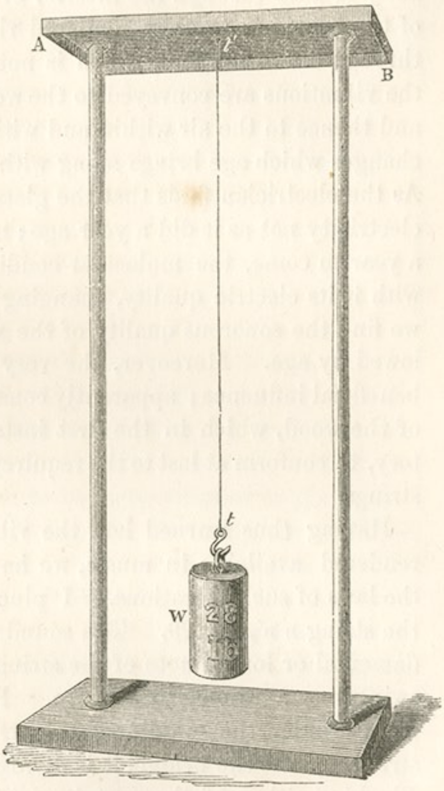
That the vibrations of the string alone are not sufficient to produce the sound, may be thus experimentally demonstrated:—A B, fig. 30, is a piece of wood placed across an iron bracket C. From each end of the piece of wood depends a rope ending in a loop, while stretching across from loop to loop is an iron bar *m n*. From the middle of the iron bar hangs a steel wire *s s*′, stretched by a weight W of 28 lbs. By this arrangement, the wire is detached from all large surfaces to which it could impart its vibrations. A second wire tt', fig. 31, of the same length, thickness, and material as ss', has one of its ends attached to the wooden tray A B. This wire also carries a weight W of 28 lbs. Finally, passing over the bridges B B′ of the sonometer, fig. 29, is our third wire, in every respect like the two former, and like them stretched by a weight W of 28 lbs. I now pluck the wire $s\ s'$, fig. 30. It vibrates vigorously, but even those upon the nearest benches do not hear any sound. The agitation imparted to the air is too inconsiderable to affect the auditory nerve at any distance. When the wire tt', fig. 31, is caused to vibrate, you hear its sound distinctly. Though one end only of the wire is connected with the tray, A B, the vibrations transmitted to it are sufficient to convert the tray into a sounding body. Finally, when the wire of the sonometer M N, fig. 29, is plucked, the sound is loud and full, because the instrument is specially constructed to take up the vibrations of the wire.

Fig. 30.



The importance of employing proper sounding apparatus in stringed instruments is rendered manifest by these experiments. It is not the strings of a harp, or a lute, or a piano, or a violin, that throw the air into sonorous vibrations. It is the large surfaces with which the strings are associated, and the air enclosed by these surfaces. The goodness of such instruments depends almost wholly upon the quality and disposition of their sound-boards.*

Fig. 31.



Take the violin as an example. It is, or ought to be, formed of wood of the most perfect elasticity. Imperfectly elastic wood expends the motion imparted to it in the friction of its own molecules; the motion is converted into heat, instead of sound. The strings of the violin pass from the 'tail-piece' of the instrument over the 'bridge,' being thence carried to the 'pegs,' the turning of which regulates the tension of the strings. The bow is drawn at a point about one-tenth of the length of the string from the bridge.

* To show the influence of a large vibrating surface in communicating sonorous motion to the air, Mr. Kilburn encloses a musical box within cases of thick felt. Through the cases a wooden rod, which rests upon the box, issues. When the box plays a tune, it is unheard as long as the rod only emerges; but when a thin disc of wood is fixed on the rod, the music becomes immediately audible.