*Principien der Akustik* (1898), and the physiological and psychical aspects in his *Die Lehre von den Tonempfindungen* (1st ed., 1863; 5th ed., 1896), English translation by A. J. Ellis, *On the Sensations of Tone* (1885). Sedley Taylor, *Sound and Music* (1882), contains a simple and excellent account of Helmholtz’s theory of consonance and dissonance. R. Koenig, *Quelques expériences d’acoustique (1882)* describes apparatus and experiments, intended to show, in opposition to Helmholtz, that beats coalesce into tones, and also that the quality of a note is affected by alteration of phase of one of its component overtones relative to the phase of the fundamental. Lamb, *The Dynamical Theory of Sound* (1910), is intended as a stepping-stone to the study of the writings of Helmholtz and Rayleigh. Barton, *A Text-Book on Sound* (1908), aims to provide students with a text-book on sound, embracing both its experimental and theoretical aspects. J. H. Poynting and J. J. Thomson, *Sound* (5th ed., 1909), contains a descriptive account of the chief phenomena, and an elementary mathematical treatment. John Tyndall, *Sound* (5th ed., 1893), originally de!ivered as lectures, treats the subject descriptively, and is illustrated by a large number of excellent experiments. Good general accounts are given in J. L. G. Violle, *Cours de physique,* tome ii., “Acoustique”; A. Winkelmann, *Handbuch der Physik,* Band ii., “ Akustik Müller-Pouillet, *Lehrbuch der Physik* (1907), ii. 1; L. A. Zellner, *Vortrage über Akustik* (1892), pt. 1, physical; pt. *2,* physiological; R. Klimpert, *Lehrbuch der Akustik* (1904- 1907); A. Wüllner, *Lehrbuch der Experimentalphysik* (1907), 6th ed., vol. i.; and C. L. Barnes, *Practical Acoustics* (1898), treats the subject experimentally. (J. H. P.)

**SOUND, THE** (Danish *Oresund),* the easternmost of the straits giving entrance to the Baltic Sea from the Cattegat, between the Danish island of Zealand and Sweden. Its extreme length reckoned from the promontory of Kullen to that of Falsterbo, both on the Swedish shore, is 70 m. Its narrowest point is between Helsingör in Denmark and Helsingborg in Sweden, which are 3 m. apart. Its extreme width, 30 m.,is towards the south, where Kjöge Bay indents the coast of Zealand. Three islands lie in it—Hven, belonging to Sweden, and Saltholm and Amager (which is separated from Zealand by a narrow channel at Copenhagen), belonging to Denmark. The strait between Amager and Saltholm is called Drogden, and is followed by the larger vessels passing through the Sound. The extreme depth of the Sound is about 14 fathoms. Navigation is open in winter, though three instances are recorded of the Sound being frozen completely over: in 1306, 1830 and 1836. From the 15th century Denmark levied “ Sound dues ” on foreign vessels passing through the strait, the Hanse traders and certain others being exempt. In the 17th century quarrels arose on this matter between Denmark and the Netherlands and Sweden, while in modern times the powers found the dues irksome, and in 1843 and 1853 protests were made by the representatives of the United States of America, but Denmark based her right on immemorial cus­tom, and adhered to it. In 1856 the matter came up in connexion with the renewal of the treaty of 1826 between the two countries; considerable tension resulted, and the possibility of reprisals by the United States against the Danish possessions in the West Indies was discussed. But the treaty was provisionally extended to the following year, and a conference in Copenhagen, at which most of the affected powers were represented, resulted in the remission of the dues from the 1st of April 1857, Denmark receiving a united compensation of 30,476,325 rix-dollars (equalling about £4,000,000), out of which the amount paid by the British government was £1,125,000. The annual income accruing to Denmark from the dues during the ten previous years had been about 2,500,000 rix-dollars.

**SOUNDING** (for derivation see Sound above), the term used for measuring the depth of water (and so, figuratively, of anything). The process of ascertaining the depth of the sea has been practised from very early times for purposes of navigation, but it is only since the introduction of submarine telegraphy that extensive efforts have been made to obtain a complete knowledge of the contour of the ocean-bed (see Ocean).

The operation of sounding is readily performed in shallow water by letting down a weight or “ lead ” attached to a cord, which is marked off into fathoms by pieces of leather, rag and twine. The bottom of the weight usually presents· a hollow, which is filled with tallow, so that a portion of the material from the bottom may be brought up and give an indication of its nature as well as an assurance that it has really been touched.

For depths over 2o fathoms sounding machines are often employed, and for deep soundings they are practically indispen­sable. In them wire, the use of which for this purpose was introduced by Sir William Thomson (Lord Kelvin), has entirely superseded hemp gear. Its smooth surface and minute section, reducing friction to a minimum, give a rapidity of descent of about 100 fathoms per minute, and this velocity is not materially diminished even at great depths. Reeling in may be accom­plished at nearly the same rate. Soundings are thus obtained with a degree of accuracy not formerly possible. The apparatus is light, compact and automatic in its action. Soundings with wire can be carried out at night with the same facility as in daytime, and in almost any circumstances of wind and weather short of a strong gale, against which the ship could not steam or face the sea. A sounding of 1000 fathoms may be obtained in twenty-five minutes from the time the weight is lowered to the time the order is given to put the ship on her course, or in half that time if sounding from astern and going ahead on getting bottom; 20∞ fathoms will require forty-five minutes and 3000 fathoms seventy-five minutes. Beyond that depth, much greater caution being required, the time occupied is correspon­dingly increased, and reeling in must then be done very deliber­ately. A sounding of 5269 fathoms was obtained near the island of Guam by the U.S. cable-surveying ship “Nero.” Soundings at such depths may occupy as long as five or six hours.

Among the sounding machines in general use the Lucas carries nearly 6000 fathoms of 20-gauge wire, and is fitted with two brakes—one a screw brake for holding the reel when required, the other an automatic brake for stopping the reel when the weights strike the bottom.

A guider for the purpose of winding the wire uniformly on to the reel is also attached, and is worked by a small handle. After leaving the reel the wire passes over a registering wheel, the dial of which indicates the amount of wire run out. Similar machines of smaller size are supplied for use in boats. The large machine is represented in fig. 1.