observed at a distance of 50 ft. The charts are numbered 1 to 4 and are made of black lines cross-ruled on white as given in Table 1.

TABLE 1. RINGELMANN SMOKE CHART SPACINGS

NUMBER OF CARD	THICKNESS OF LINES, MM	DISTANCE IN CLEAR BETWEEN LINES, MM
1	1.0	9.0
2	2.3	7.7
3	3.7	6.3
4	5.5	4.5

Photo-electric Cell

The photo-electric cell is used in some apparatus developed for smoke density recording in large plants. The same device is included in the testing equipment for domestic oil burners described in *National Bureau of Standards*, Commercial Standard CS75-42 [56]. Under *Laboratory Tests* this publication contains the following section: "Smoke Determination. —After combustion has reached equilibrium, the amount of smoke in the flue gases, when viewed lengthwise through 4 feet of the smoke pipe in accordance with the *Underwriters' Laboratories, Inc.*, Standard for Domestic Oil Burners (Subject 296), March 1934 and subsequent revisions, shall not reduce the output of a standard photoelectric cell from 9 microamperes, with a clear smoke pipe, to less than 8 microamperes." The commercial standard also requires that during a test after installation, the burner shall operate without visible smoke at the chimney top.

A method of evaluating smoke produced by pot type oil burners was developed for the *Institute of Cooking and Heating Appliance Manufacturers* by R. N. St. John. A glass rod is interposed between a light source and a photo-sensitive cell both before and after being exposed to the flue gases from a heating device. The diminution of the light transmitted by the rod due to the deposit of soot on its surface causes a reduction in the cell emf which is taken as an index of the concentration of smoke in the flue gases. A description of the method is contained in National Bureau of Standards Commercial Standard CS104-46 [57].

Sound and Vibration Measurements

Approximate measurements of sound intensity can be made by aural methods. The ear is used to compare the measured noise with sounds of known strength.

Electrical devices in which the ear plays no part furnish the most satisfactory means of measuring noise intensities. The sound meter consists essentially of a microphone coupled to an amplifier designed with an ear-like response. The output of the microphone is read on a sensitive direct current milliammeter graduated to read directly in decibels. Instruments of this type if connected with suitable band pass filters can be used to study the intensity of the sound over its entire range of frequencies.

Electrical instruments are available for measuring the frequency, amplitude and acceleration of a vibrating mass. They are usually more convenient and accurate than the vibrating reed tachometer and the seismic type displacement meters and accelerometers which can also be used for this purpose. Sound level meters are discussed in several text books [58, 59] and standards [60].

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