

This conclusion that the applied voltage may be proportional to the frequency at high frequencies has been reached through experiment also.⁷ The second to last equation fits new experimental data using frequencies from 400 to 40,000. K and k change, however, although particular values apply to large frequency ranges.

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The Thoracic Window.

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Direct observations of activity in the lungs and heart have always been complicated by the fact that artificial respiration has been required to keep the animal alive. The results of the observations were often vitiated by the lung movements and consequent difficulty of maintaining a focus when microscopic observations were made.

Hall¹ described a method in which the isolated lung was studied by transillumination. The method was complicated and observations were limited to a rather short survival period. Later, Wearn² developed a much simpler method in which the animal was not exposed to excessive surgery. The tip of a lower lobe of the lung was used. Illumination was secured by a light directed through the diaphragm. Observations were made through the thinned thoracic wall. Intratracheal insufflation was used. The field for observation was definitely limited to a small area in the lowest portion of the lung.

The thoracic window is another method of making direct observations not only of the lungs and heart grossly, but also microscopically. Artificial respiration is not needed. The animal (cat or rabbit) is thoroughly anesthetized. An oval section of skin is removed from the anterior aspect of the chest. The skin remaining on the thorax is separated from the underlying muscles. Artificial respiration is begun when the chest is opened. Several ribs are resected on each side at a point about midway between the sternum and vertebral column. After removal of the ribs and sternum

⁷ Asher, Leon, *Skand. Arch.*, 1923, **43**, 6.

¹ Hall, Harry L., *Am. J. Physiol.*, 1925, **72**, 446.

² Wearn, J. T., Ernstene, A. C., and Bromer, A. W., *Am. J. Physiol.*, 1928, **85**, 410.

a hole is punched through the chest wall out through the skin. A catheter is then drawn through this opening, the end resting inside the chest cavity. A window of clear photographic film is cut to fit the opening in the chest. It is made larger than the skin incision. The window is now placed over the chest opening, on the thoracic muscles, but *under* the skin. The skin is pressed down carefully and firmly on the window. By suction applied to the exposed end of the catheter, negative pressure is re-established in the new intrathoracic cavity. The catheter is closed by means of a clamp. Artificial respiration is now discontinued. The animal is capable of carrying on its own respiration for many hours with the thoracic window in place. The lungs and heart are thoroughly exposed to view.

The method is available for numerous and various observations on vascular and bronchial reactions to intravascular or intrapulmonary administrations of drugs or other agents. The heart may likewise be readily observed. The animal shows no distress. No indication of imperfect oxygenation of the blood is apparent. The window becomes sealed in place by means of the exuded tissue juices and remains air-tight, just as a similar window when placed in the abdominal cavity.³

The advantages of this method are: 1. Artificial respiration is not required, thereby eliminating obvious difficulties. 2. A large area of lungs or heart is exposed so that suitable fields for microscopic observation may be selected. 3. It may be used to study the effect of intravenous injection of drugs on heart and lungs either macroscopically or microscopically, the effects of inhalations of various agents, of nervous stimulation, or of local applications on the heart or lungs. 4. It has the possibility of clinical application in the treatment of diseased conditions in the thorax. Placing a quartz window in the chest over a diseased area for the purpose of irradiation of the area has been considered.

³ Mendenhall, Walter L., *Science*, 1931, **74**, 245.