

Development and Improvement of Breathing Apparatus

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(Read before Western Branch, C. M. Inst., Nanaimo, June 4th and 5th, 1919.)*

Self-contained breathing-apparatus, more often called, "rescue-apparatus," is designed for the purpose of saving live and property when endangered by fire, smoke, fire damp or other poisonous gases, either above or below ground. The portable apparatus is one which enables the wearer to penetrate the irrespirable gases without being supplied with air from any outside source. It is therefore essential that such apparatus should provide the wearer in these circumstances, with good air, by continuously rendering the exhaled air fit for reinhalation, that is to say, it must be provided with means for renewing the consumed oxygen in a continuous manner and in sufficient amount, besides making harmless the carbon-dioxide produced in the lungs. At the same time the apparatus must not form a hindrance in the performance of work.

Breathing-apparatus of the self-contained type was first introduced into the United States in 1907, following which the Proto, Draeger and Westfalia apparatus were installed at various mines and plants throughout the United States and Canada. The Proto apparatus was manufactured in England, while the latter types came from Germany. Little change has been made in the Proto apparatus up to the present time, although several more or less important improvements have been made on the Draeger. The Westfalia did not meet with great success, and the sale of this type was soon abandoned.

Importation of these types of apparatus continued until 1914, when it became necessary for the American representatives to manufacture for themselves. Considerable difficulty was experienced in this work for some time. Investigations conducted by the United States Bureau of Mines demonstrated very forcibly that there was considerable room for improvement in the various types of European made apparatus, and the work was commenced by the various engineers, physiologists and chemists of the Bureau of Mines for the development of an improved type of oxygen breathing-apparatus which will be referred to later in this paper.

Before taking up the question of improvements on the various types of apparatus let us look for a few minutes at the principal defects in the three types previously mentioned. In January, 1917, the United States Bureau of Mines published Technical Paper No. 82, written by Yandell Henderson and James W. Paul. The purpose of this publication, or report, was to supply information regarding the relative merits and defects of the various types of apparatus then in use. With this in mind I trust that I may be pardoned if I quote from this report, for I feel that after the thorough investigation which these men made, no one is better qualified to present this matter to the public, and so in pointing out the limitations of the apparatus in use in 1917, I will use their report.

*Reprinted from the Canadian Mining Institute Bulletin for July, 1919.

In developing self-contained breathing-apparatus the real problem is not only to make an efficient and reliable device, but also to fit it to the peculiar and varying needs of the wearer. It is important if a man is to wear breathing-apparatus for even a few minutes, and essential if he is to depend on it to keep him alive for several hours, and do also considerable work, that the condition in his lungs should be essentially similar to those when breathing normal air. The apparatus must adjust itself to the respiratory needs of the wearer, and also to wide variations in these needs. Until recently, however, the wearer has been expected to adjust his breathing to the apparatus. To forget, or fail to do this even for a few minutes, might cause his death.

One of the principal defects of former types of rescue apparatus as usually arranged, was that the oxygen supply was set at a fixed amount per minute, and that this amount, although more than sufficient to cover the requirements of the wearer while resting, was quite insufficient to allow him to make vigorous physical exertion.

Oxygen is often spoken of as a food. In one sense this is correct, but the demand for oxygen differs from the demand for food in the fact that the supply of oxygen must be continuous. A man may go without eating for several days, and still be able to do considerable work. After being properly fed he may be none the worse for his experience. Conditions as regards the oxygen supply are far more peremptory. The amount that the body uses in any one minute it needs and must have within that minute, or at least during the next succeeding minute. Even a slight deficiency in oxygen impairs intelligence and judgment, and produces almost immediately a condition of intoxication or delirium, rendering the subject incapable of intelligent action and paralyzing the muscles so that he cannot stand or walk. If this deficiency is continued for even a few minutes serious and often permanent injury to the nervous system (or even death) results. These considerations have not heretofore been adequately taken into account.

This insidious effect of breathing air deficient in oxygen cannot be over-emphasized. The symptoms are in practically all respects identical to those of breathing carbon-monoxide, and in some respects resemble those of alcoholic intoxication. The peculiar danger in breathing such air lies in the fact that discretion and judgment are quickly impaired. Moreover, in many individuals, perhaps in most men, the breathing is at first so little affected that the man remains unwarned of his danger until his legs give way and he falls helpless.

Secondly in importance to a sufficient supply of oxygen is an efficient arrangement for absorbing from the air in the apparatus the carbon-dioxide that the wearer produces. One of the most important facts demonstrated by recent advances in physiology is that in normal men and animals, under ordinary conditions, the amount of breathing is principally regulated, not