A Great Invention with Built-in Hazards

In 1830, a British engineer, Sir Thomas Cochrane, invented and patented an airlock which permitted workmen to enter and leave a sealed compressed-air caisson. Some years before, in 1802, William Henry, English chemist and physician, discovered the law bearing his name: "The mass of a slightly soluble gas that dissolves in a definite mass of liquid at a given temperature, is very nearly directly proportional to the partial pressure of that gas. This holds for gases which do not unite chemically with the solvent." (Weast, R. ed: Handbook of Chemistry and Physics, Cleveland, CRC Press, 1973) The fateful connection between these two seemingly unrelated events was brought to the fore by subsequent, literally painful experience. Compressed-air caisson was used first in bridge building by Triger of France in 1839. Colladon, Professor of Engineering, Genoa, Italy, recommended its use in underwater tunneling. James B. Eads, builder of the bridge across the Mississippi at St. Louis, Missouri, first used the pneumatic caisson in the United States in the fall of 1869. In connection with the building of the Brooklyn Bridge the first caisson was launched in 1870. In 1839, Triger noted that some of the laborers working under high air pressure developed various types of discomfort after leaving the caisson, such as sudden sharp cramping pains in the arms and legs, painful joints, tottering gait, paralysis of the legs, stooped posture. Other engineers engaged in similar projects recorded similar observations. Collated data reveal the following salient manifestations of caisson disease, also known as decompression sickness, and compressed-air illness. Musculo-skeletal system: gradually increasing, often severe, stabbing pain in the joints, muscles and bones, which may shift from one site to another, particularly in the legs, shoulders and arms. There may be concomitant loss of muscular function, stooping posture, inability to walk. Remenchik, AP pointed out (in Talso et al. (ed.): Internal Medicine, St. Louis, Mosby, 1968) that exposure to compressed air during working hours for eight months or longer may result in aseptic bone necrosis in the contiguous diaphyses of the femur and tibia, in the head and neck of the femur and of the humerus symmetrically bilaterally. Respiratory system: the so-called "chokes" comprise sudden dyspnea, fulness in the chest, choking sensation, chest pain which may be substernal, pallor, cyanosis, with possible shock. Central and peripheral nervous systems: vertigo, diplopia, sensory and motor disturbances, unilateral numbness and loss of muscle function, spastic paralysis, convulsions, syncope. Cardiovascular disturbances may result from gas emboli causing occlusion of or interference with blood flow in the coronary arteries, right side of the heart or pulmonary vessels. Other possible symptoms include earache, nosebleed, pain in the teeth, dysphagia, stammering, excruciating epigastric pain. During the construction of Eads Bridge, out of 600 men 119 had serious caisson disease and 14 died because of it. Engineers in charge of bridge construction and medical men in attendance observed that the incidence of caisson disease could be reduced by slowing the speed of decompression. Paul Bert, French physiologist (1833-1886) recognized that during sudden decompression nitrogen is freed from its solute state in the tissues and blood and it reaches in the form of bubbles the blood stream. In 1863, Antoine Foley, a French physician, advocated returning these patients to compressed air for slow decompression. As a corollary the pertinent comments of Lane, C E may be of interest (in Idyll, C P (ed.): Exploring the Ocean World, New York, Crowell, 1969). "Whales are known to descend more than a thousand feet and remain submerged for more than an hour. The ability of the great whales to dive very deep without incurring nitrogen narcosis on descent or the bends on ascent is probably due to the construction of their respiratory system. Their diaphragm is oblique instead of transverse as in most mammals, and their rib cage is relatively flexible. As a great whale dives, its rib cage squeezes the contained respiratory system, collapsing the lungs and driving the air up into the spacious head sinuses. This mechanism effectively turns off gas absorption and spares the animal the consequences of enhanced absorption of nitrogen."


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