Tunnel Workers and DECOMPRESSION ILLNESS

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The men who dig America's tunnels perform a difficult, but highly important job.

A good many tunneling operations, such as in building sewers, aqueducts, bridges and traffic tunnels, require men to work in compressed air environments beneath the earth. This means that the work areas must be supplied with air which is placed under enough pressure to keep out water and to help support the tunnel structure. This is vital in tunnels being driven under rivers and streams and through water-soaked earth.

Breathing Compressed Air

The air we breathe is made of a number of different gases—chiefly oxygen (21%) and nitrogen (78%). Air which has been compressed, of course, contains more oxygen and nitrogen for the same volume of air than that for air which we breathe normally. Therefore, a tunnel worker in compressed air inhales more oxygen and nitrogen with each breath, causing greater quantities of each to be taken up by his body fluids.

While oxygen is used in the body for heat and energy, nitrogen cannot be used by the body and accumulates in abnormal quantities in the blood and body tissues while the man remains under pressure. This causes him no harm and does not make him feel any different. However, when decompressing, the dissolved nitrogen can cause a problem.

The Bends

Decompression sickness (also called the "bends," "air pains" and "caisson disease") occurs when a tunnel worker undergoes decompression too quickly—such as would occur if he were to suddenly leave the enclosed compressed air work area in the tunnel and go above ground where the air pressure is normal.

With such a rapid decrease in pressure, the excess nitrogen gas which has been dissolved in the blood and body tissues is suddenly released. Because the body is unable to get rid of this excess nitrogen fast enough through the lungs, the gas collects in the form of

bubbles throughout the worker's body—and the faster a man is decompressed, the larger and more numerous these nitrogen bubbles are. This is similar to what occurs when one removes the cap from a bottle containing a carbonated beverage. In a bottle of soda, it is carbon dioxide which is dissolved in the solution under high pressure. When the cap is removed, the pressure is suddenly reduced and the carbon dioxide can no longer remain dissolved—so it bubbles.

Decompression sickness is caused by the presence of nitrogen bubbles in the bloodstream. The bubbles cause severe pains in the joints and muscles by blocking the normal supply of blood. When they appear in the spinal fluid, paralysis can occur. Other symptoms of compressed air illness are: dizziness, weakness, collapse, blindness, numbness, convulsions, changes in behavior, and problems with hearing. When nitrogen bubbles block the blood supply to the muscular walls of the heart or to vital areas of the brain, death can result.

Nitrogen bubbles may also cause the form of decompression sickness known as *avascular necrosis* (also called aseptic necrosis). This occurs when nitrogen bubbles form in arteries and block the supply of blood to the bones. If the bubbles remain long enough, a portion of the bone may die from lack of oxygen and nourishment. When this type of painless bone destruction occurs along the shafts of long bones, new arterioles will eventually form and find their way to the bone, and new bone cells will be produced.

If, however, the blood supply is interrupted to bone areas around the joints, such as the hips, shoulders and knees, the problem is much more severe. The daily pressures applied to major joints of the body, as one walks or lifts heavy objects, can cause the diseased portions of the joints to chip and fragment before the healing process is complete. Avascular necrosis, when it involves a joint, can cause severe crippling and permanent disability.

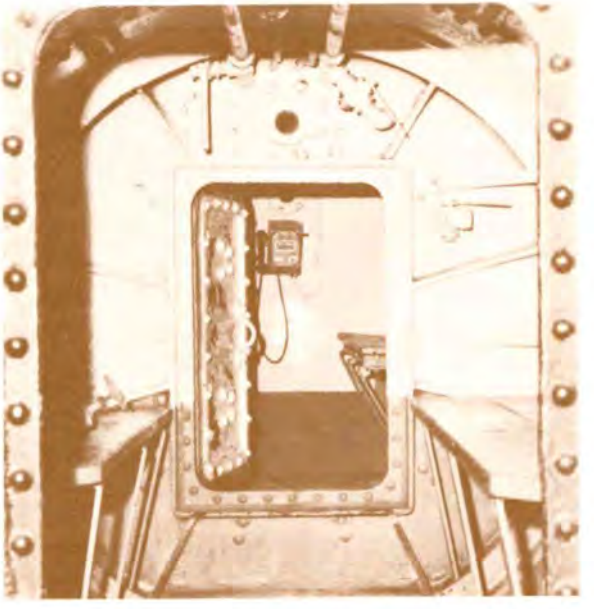
Prevention

The decompression of workers must be done in stages according to a decompression schedule in order for them to avoid the "bends." For that reason, tunnel operations using compressed air must include special decompression chambers (manlocks) for workers at the end of their shifts. The length of time workers must remain in these chambers and undergo decompression depends primarily on how great the pressures were in the tunnel and how long the workers were exposed to them—the air pressures within the decompression chambers are adjusted accordingly.

By undergoing decompression gradually, the worker allows the nitrogen in his blood and tissues to be released more slowly and to be eliminated through the lungs—without the rapid formation of large numbers of bubbles in the bloodstream. The Federal Government now has a standard which requires tunnel construction companies to assure proper decompression facilities for their workers and to provide decompression according to prescribed tables.

Treatment

Treatment of the "bends" is done by placing the victim in a special chamber (a medical lock), recompressing him, redissolving the nitrogen in the blood, and then gradually and properly decompressing him. More severe cases may require continued treatment by a physician.



Guidelines for Workers

Even with proper decompression, the threat of decompression sickness cannot be completely eliminated—at least some nitrogen bubbles occur with every decompression procedure. Severe "air pains" and permanent disability from avascular necrosis can be avoided, however, by compliance with prescribed standards. Each employee should follow these guidelines and others issued by his employer to protect him on the job.

1. Workers should never "short" themselves on the decompression times prescribed by their employers and by Federal regulation. The time saved is not worth the risk of this potentially fatal or crippling disease.

2. Workers should not sit in cramped positions during decompression. To do so allows nitrogen bubbles to gather and concentrate in the joints, thereby contributing to the risk of "bends." Because a worker is still eliminating nitrogen from his body after he goes home, he should refrain from sleeping or resting in a cramped position after work, as well.

3. Warm water should be used for showers and baths up to 6 hours after decompressing; hot water can actually bring on or aggravate a case of decompression illness.

4. Severe fatigue, lack of sleep and heavy drinking the night before can also help bring on decompression sickness.

5. Fever and illness, such as bad colds increase the risk of decompression sickness. Strains and sprains in muscles and joints are also "favorite" places for a case of the "bends" to begin.

6. When stricken by decompression sickness away from the job site, a worker should immediately contact a physician—preferably the company's physician or one knowledgable in treating this disease. Drinking alcoholic beverages should never be used as a "treatment" for the pains of decompression illness.

In case of off-the-job emergencies, the Federal Government now requires tunnel construction companies to provide their compressed air workers with durable bracelets or badges which identify them as subject to attacks of the "bends." These forms of identification also give instructions concerning proper action to take in an emergency, including the name and telephone number of the worker's physician. Wear your bracelet or badge at all times.

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