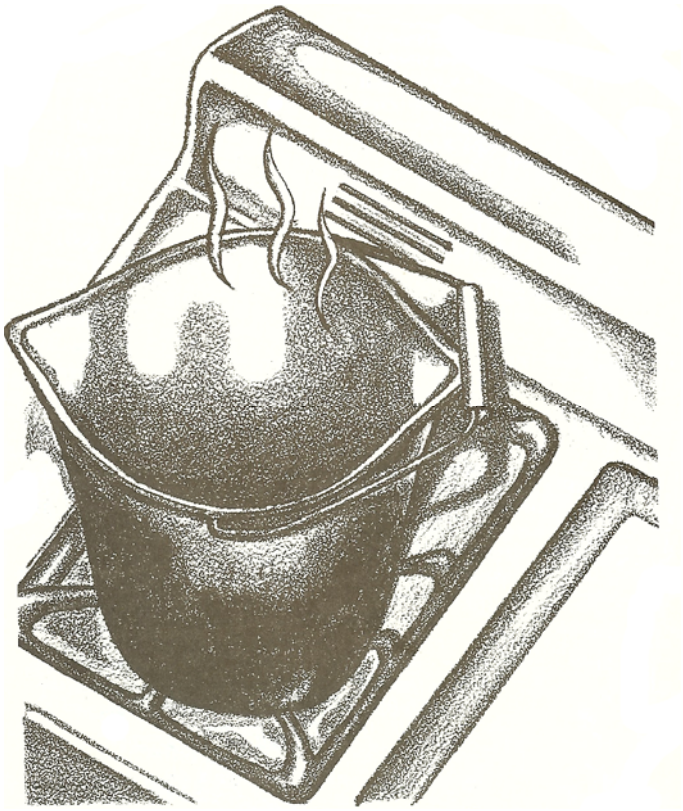
The Blackened Bucket by Henry C. Freimuth

Some years ago the police asked me to investigate an unusual incident that took place in an old apartment in a poor section of the city. At the time (the mid 1950s) I was chief toxicologist at the Medical Examiner's Office in Baltimore. The police had pieced together a sequence of events something like this:

Terry was an elderly man who lived alone in apartment 2-E. A quiet man, he spoke to the neighbors only occasionally, usually to complain about his aching feet. His job, he said, forced him to stand all day. Terry took a bus to work – somewhere in downtown Baltimore – and returned at the same time each afternoon. When he got home he often soaked his feet in hot water to ease the pain.



That Monday, the afternoon bus was crowded and Terry had to stand during the ride home. He passed a neighbor in front of his building, exchanged a few words, and limped up the stairs to his apartment. Inside, he filled a bucket with water, put it on the stove to heat, pulled a chair close to the stove, sat down, took off his shoes, and dozed off.

The neighbors didn't see him leave for work on Tuesday. When he didn't answer a knock at the door, they called the police. Terry was found seated in the chair, dead. The burner on the gas stove was still lighted, heating a now-empty bucket.

The medical examiner (sometimes mistakenly called the coroner) is required by law to investigate any death that occurs when a doctor is not present; the staff must determine whether the death was an accident, suicide, or homicide. At first, this appeared to be a simple case. The man had been dead about 12 hours before the discovery of the body and, because of the characteristic cherry-red color of the skin, it was apparent that his death was due to poisoning by carbon monoxide – a toxic gas. This was confirmed during autopsy by analyzing a sample of his blood, which showed a high percentage of carboxyhemoglobin (hemoglobin combined with carbon monoxide instead of oxygen). For several reasons, we suspected the gas range was the source of the carbon monoxide.

Prior to 1950, deaths from household gas were quite common in the metropolitan Baltimore area because the city used a manufactured gas that contained carbon monoxide. Carbon monoxide is highly toxic because its molecule, CO, is similar to the

oxygen molecule, O_2. The hemoglobin in red blood cells normally attaches to O_2, forming oxyhemoglobin, which carries the oxygen throughout the body. However, if CO is present, its molecules attach to hemoglobin in place of oxygen molecules. The resulting combination, carboxyhemoglobin, is more stable than the normal oxyhemoglobin. It is also deadly. Eventually, the red cells become laden with carboxyhemoglobin, thus depriving the body of oxygen necessary to sustain life.

In 1950, the gas and electric company changed to natural gas, which is nontoxic, and the number of deaths dropped dramatically. (Technically, natural gas is nontoxic. However, it can cause death by suffocation if a large quantity of it fills a room and forces out the air.) Terry's stove operated on natural gas – therefore, we knew he was not killed by simply breathing household gas. When natural gas, which is over 99% methane, CH_4, is burned normally, it is converted to carbon dioxide and water:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

However, if a natural gas appliance is not adjusted properly and is operating with inadequate air, it can produce carbon monoxide.

$$2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$$

Suspicious that the burner was not working properly, we asked the gas and electric company to check the operation of the gas range. Arriving at the scene the same day, they thoroughly examined the stove, the air-gas mixture, the color of the flame, and the amount of CO in the air. To our surprise, the gas and electric company issued a report stating that the range was functioning satisfactorily. The source of the carbon monoxide was still a mystery!

We returned to the apartment the next day looking for another source of CO. Since the case was unresolved, the police had left the objects in the apartment undisturbed. Monday's newspaper was spread out on the kitchen table; a chair was pulled close to the gas range' a pair of old shoes lay on the floor. Then, we found the explanation – in plain sight. Sitting on the stove was the bucket the man had used to heat water for soaking his feet. The exterior of the bucket was coated with a heavy deposit of soot. We placed the bucket on the gas burner and lighted the flame. Within 15 minutes, the air in the vicinity of the stove contained 0.5% carbon monoxide. This concentration of CO was enough to cause death after about 20 minutes exposure.

Where did the CO come from? As the gas burned, it produced carbon dioxide, just as it should. But the flame also heated the outside of the bucket until the soot (carbon) became incandescent. At high temperature, the carbon dioxide reacted with the carbon (a classic oxidation-reduction reaction.) Both the CO_2 and the C were changed to carbon monoxide:

$$CO_2 + C \rightarrow 2CO$$

The source of CO, therefore, was poor housekeeping.