

carbon monoxide to carbon dioxide, would appear as one outstanding American contribution, along with potassium superoxide and refinements in chemical oxygen sources). A number of impregnated actuated carbons have been developed for certain vapors and gases.

A recent advance of the British seems very significant. "Schliere" is the German word for "streak" or "shadow". When one has the proper light source, lenses, and mirrors, it is possible to see as well as photograph shadows representing different densities of air or vapors. In one case, a man was introduced into the Schlieren system and very clear pictures were made of the air movements during inhalation and exhalation, as well as the normal upward air flow of the air closest to the body. This technique could be useful in studying respiration and respiratory devices. Already, it has suggested why we can expect dust and bacteria from clothing, such as coveralls or nurse's uniforms, to be transferred to the breathing zone due to the upward movement of air close to the body. There is much need for more creative initiative in the field of respiratory protection.

If we want a supply of oxygen in a self-contained device of some type, an interesting question arises as to the most effective and light-weight source. Here is an interesting comparison between the three possible oxygen sources—gaseous, liquid or solid:

Oxygen Sources

	Volume of Free/ Stored O ₂	Weight Unit + Cont.	Space cu. in.
Gas	126	44.5	2,160
Solid	630	28	460
Liquid	860	19	1,355

Ref: Muller

All three have application; it should be obvious which offers the greatest potential for the future development of light-weight, long-life, self-contained breathing apparatus or hoods of some type if certain technical problems can be resolved.

As one practical illustration, a photo taken in Toronto a few years ago shows 72 forty-cubic-foot air or oxygen cylinders, part of the supply emptied by firemen in their attempts to control a fire. Large numbers of cylinders are needed, and few fire departments or plants have instant refill capability. This is certainly a serious limitation of the cylinder-supplied air or oxygen mask; chemical-oxygen self-generating masks have a similar limitation which is all too often overlooked. There are many instances of fires where many dozens of cylinders or canisters were expended. To illustrate the importance of this problem of masks as it affects the real world, here are some figures recently received from a state fire coordinator relating to the volunteer firemen in that state.

Active Firefighters 2,966

	No. of Devices	Mask/ Man	Time Mask	Man Hrs.	Add. Hrs.	Tot. Hrs.
Type N Masks	233	1-15	1 hr?	233	50?	283
Self-Gen. O ₂ B. A.	123	1-30	1 hr?	123	246?	369
Demand-Air-O ₂	351	1-12	½ hr	175	241	416
Spares	483					1068

50 men — 20 hrs. — alarm

Two-thirds time at actual exposure = 14 hrs. real "working time", for 2,966 men.

From this, the very real limits of operations of the firemen imposed by breathing apparatus and spare cylinders and canisters, become apparent.

There are certain fundamental limitations of any breathing equipment. These have not been widely appreciated.

1. Some substances highly toxic by skin absorption require skin, as well as breathing protection. Examples are: liquid HCN, aniline, other nitro and amino aromatic compounds, phenol, ethylenimine, and certain organo-phosphates. There are others.

2. Maintenance. There is no excuse for poor or inadequate maintenance of breathing apparatus, masks, or respirators, but in fact,