MILITARY SCIENCE

Smoke Protects Fighters

White phosphorus-filled shells shot from 4.2-inch mortars, and chemical fogs and fumes discharged from planes or motor cars, create concealing smoke.

By A. C. MONAHAN

➤ MODERN smokes, chemically created when and where wanted, screen advancing troops instead of giving away their positions. White phosphorus-filled shells shot from 4.2-inch mortars, or chemical fogs and fumes discharged from aircraft or rapidly moving motor cars, create the modern concealing smoke.

Observers in Civil War days used high hills or anchored balloons to spot the positions of fighting troops as revealed by their smoke-belching guns. Enemy observers today, stationed on mountain tops or high up in airplanes, are prevented by smoke screens from clearly seeing or photographing troop movements, cities, harbors, ships, camps and vital installations. Smoke also screens advancing troops from enemy gunners.

"Goon Gun Hill" in Sicily acquired this American designation from the effectiveness of the goon guns, or 4.2-inch mortars, which kept a misty tidal wave of white phosphorus smoke rolling up the hill in front of the rapidly advancing American infantry, permitting the attack to progress without exposure to the eyes of the defending Nazis.

Military smoke screens are clouds of extremely minute liquid or solid particles suspended in the air, dancing like jitterbugs. These tiny particles, in their aimlessly weaving movements, scatter the light by reflection, and probably absorb some of it.

Density of Particles

The scattering of the light rays by the smoke particles depends upon the number of particles in a given air space. This was the theory on which Dr. Irving Langmuir of the General Electric Research Laboratory worked in the early days of 1942 when he directed studies and tests that resulted in one of the most effective war smoke screens.

The particles must be of a specific size, he reasoned, to have their greatest effectiveness. Mathematically and scientifically he figured out the theoretically ideal particle. His conclusions were tested and a generator built to produce smoke to fit these specifications.

In less than six months from the time Dr. Langmuir began his intensive study on smoke for smoke screens, the completed field generating apparatus was ready for practical field tests.

The Army's biggest smoke producer, used for this particular type of smoke screen, is called the M1 mechanical smoke generator. It creates more smoke at less cost than any other method.

Permanently mounted on a four-wheel trailer, it can be quickly pulled by jeep, truck or tractor to where needed, and be used either standing still or travelling at considerable speed. It actually produces a dense white fog rather than smoke, by the steam distillation of a special petroleum product. Its haze does not soil clothing and in it men may continue to work.

Like Fire Engine

The apparatus in appearance resembles the fire engines seen in cities a half century ago. It consists of three fuel tanks, a gasoline motor, and a cylindrical boiler with vents for smoke discharges. It is operated by a two-man crew. With suitable wind, one of these generators can screen a square mile in ten minutes. Men can see in it but can not be seen from above or from a distance.

The Army is using smoke for screening over cities, harbors and vital installations to prevent accurate bombing, and to set up wall-like screens across battle fronts to blind enemy observation. Sometimes a smoke screen is laid to fool enemy planes into wasting their bombs on vacant areas.

Smoke is made in four different ways. Burning type munitions such as smoke pots use heat to vaporize their chemical mixtures. Exploding bombs, shells, and grenades scatter burning white phosphorus, which forms a dense white smoke. Liquid smoke chemicals are sprayed from tanks mounted under the wings of airplanes. Steam mixed with oil spray is produced by fog machines such as the M1 mechanical smoke generator.

Canned smoke is used in several forms. One smoke pot, filled with hexachloroethane, which weighs about 11 pounds and burns six minutes, gives off dense clouds of white smoke instantly when its match-head striker is pulled. A larger version is dropped from vessels or planes and floats with only its top third above water. It has a five-gallon steel pail filled with hexachloroethane, weighs about 27 pounds and burns from 10 to 15 minutes. One of its uses is to screen beachhead landings.

The HC smoke grenade also uses hexachloroethane. It is a two-pound bomb which burns for about two minutes. White phosphorus is used also in hand grenades. Both are used in street fighting, close-up attacks on pillboxes and for other similar purposes.

Is an Incendiary

The 100-pound M47 white phosphorus bomb not only makes a smoke screen, but its phosphorus is an incendiary and harasses the enemy with flaming fragments which cling to all persons within an area of about 120 feet in diameter and cause terrible, slow-healing burns. The Japs at Rabaul can testify to its effectiveness.

White phosphorus is made from phosphate rocks. Ground phosphate rock, silica, and carbon are mixed and heated by means of a large carbon electric arc, the phosphorus passing off as a gas. The process is carried out in the absence of air as phosphorus is extremely combustible. The gas is condensed by cooling into a soft wax-like solid which is kept under water to exclude air. Otherwise even at room temperature it combines with the oxygen in the air and forms white fumes of phosphorus pentoxide.

Hexachloroethane is a white crystalline solid chemical compound containing carbon and chlorine that smells like camphor and is used as a substitute for it. It is used in cleaning fluids and in the manufacture of explosives.

Sulfurtrioxide is also used in making smoke screens and, when used from airplanes, creates a particularly spectacular sight. The chemical is compressed in tanks fastened to the airplane wings and is discharged by gravity.

In action, a vent in the front opens simultaneously with the outlet in the rear, sucking in air to help force out the

SMOKE-SCREEN—With a portable fog generator the Army can carry large-area smoke screens to beachheads, mountain passes and jungle trails. With favorable conditions, this one generator can blot out an area five or six miles long and 200 yards wide.

contents. The liquid is broken up into tiny droplets and then atomized into smoke. Big bombers fitted for smoke layers carry their tanks of sulfurtrioxide in their bomb bay, from which a small pipe leads to the belly of the plane and through which the chemical escapes into the air.

Both the United States Army and the Navy have carried out extensive studies on smoke screening continuously since World War I. One method developed to protect battleships against submarines and other war vessels consisted of the use of fast destroyers scooting around and among the slower heavier boats, belching out heavy black smoke from their stacks. Another consisted of the use of low-flying light airplanes which dropped smoke pots to float in the water at intervals encircling the surface boats. Some are arranged to sink when empty.

In the Army the chief of the Chemical Warfare Service calls the skillful extensive use of smoke in this war a "startling development." The orders "make smoke" and "cease smoke" are becoming about as familiar to combat troops as "fire" and "cease firing."

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PHYSICS

Metal Torn By Friction

➤ WHEN two surfaces slide over each other and there is friction, little bits of material are exchanged between them.

This has been demonstrated at the Massachusetts Institute of Technology in experiments that used artificially radioactive metals as detectives to find out just what did happen.

Long-standing discussion as to nature of friction has received an experimental answer. Some have thought it is due to lifting over small roughnesses, others credited adhesion between the atoms, while still a third group assumed that contact electricity plays a major role.

Dr. B. W. Sakmann, who with the aid of Dr. J. T. Burwell, Jr., now a lieutenant in the Navy, and Prof. J. W. Irvine, Jr., working at M.I.T. in experiments detailed in the *Journal of Applied Physics* (June), found that no matter what material was rubbed on metal, the sliding material took up bulk metals from the base. Base material was taken up by metals as soft as lead and by substances as dissimilar to the base material as glass. The amount of deposited material increased with the surface roughness of the sliding specimen if it was harder than the base material. Lubrication with pure mineral oil reduced the amount of the deposited material.

Even paper can tear particles out of a metal when it is rubbed over it.

Artificial radioactivity provided a means of detection that is 10,000 times as great in sensitivity as the older microchemical and spectroscopic methods used for detection of small quantities of materials. As little as 1/10,000 of a microgram of metal can be detected. A copper-beryllium alloy was bombarded in the M.I.T. cyclotron with deuterons. This made the copper radioactive and tagged it so that the radiation it gave off could be used to distinguish it from ordinary copper and measure the amount present. When other substances were slid over the base plate of this bombarded metal, this radioactivity allowed a very precise determination of the amount of the base plate picked up.

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MEDICINE

Inexpensive Blood Banks By Use of Plastic

➤ A METHOD by which small hospitals can easily build their own blood plasma banks without expensive and elaborate equipment was reported to the American Medical Association by Dr. Charles Stanley White and Dr. Jacob Weinstein, of Washington, D. C.

Separation of the blood from the plasma, they find, can be accomplished by mixing the blood, as it is drawn from the donor with methyl cellulose. This plastic causes the red blood cells to pile up in rouleaux—like stacks of coins—and therefore settle out of the plasma faster. In 24 hours plasma equivalent to almost half the total blood volume can be siphoned off and used at once safely. The plasma may be stored for a year at room temperature and still be safe to use.

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