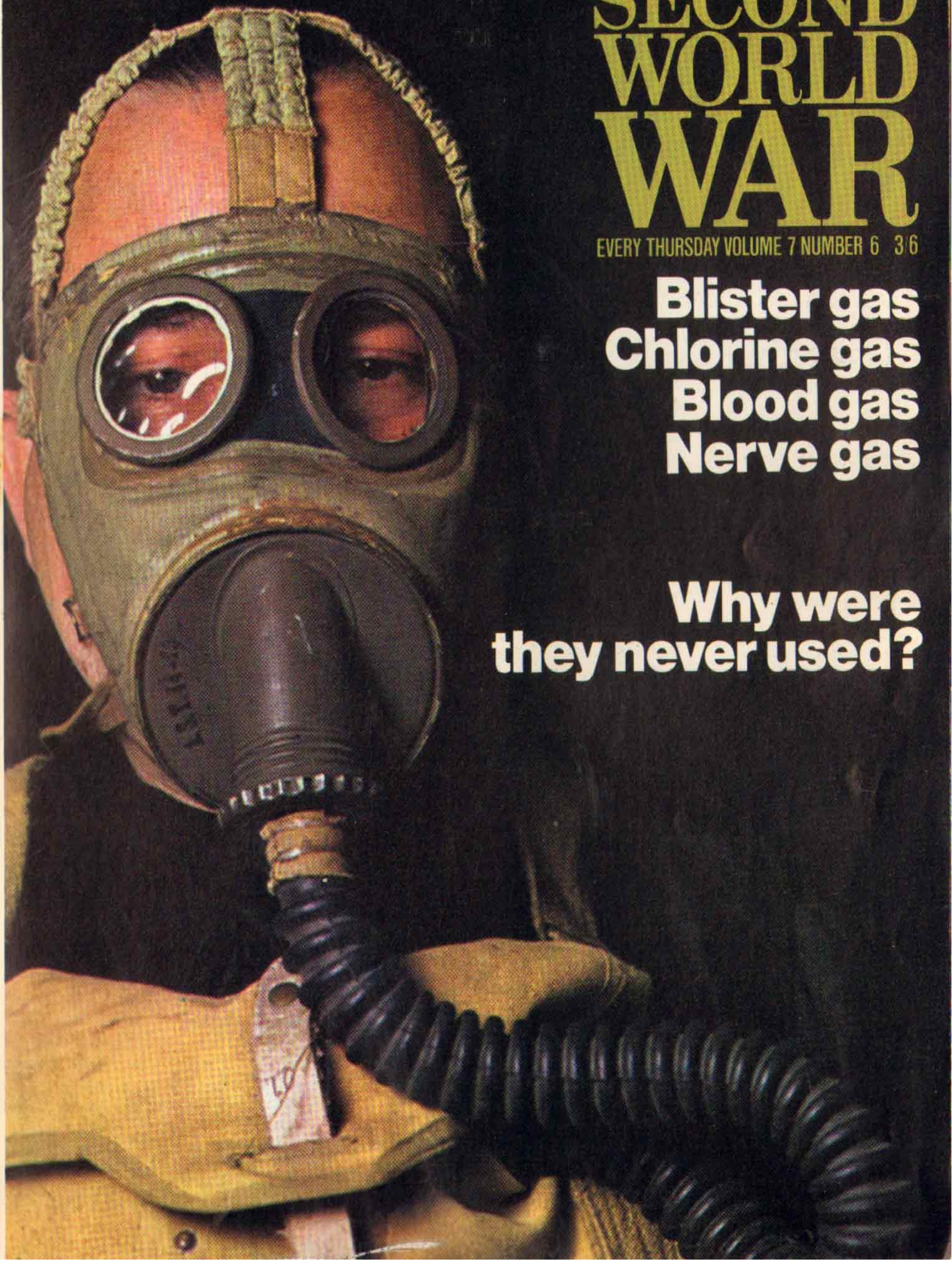
HISTORY OF THE SECOND WORLD WAR

EVERY THURSDAY VOLUME 7 NUMBER 6 3/6



Blister gas
Chlorine gas
Blood gas
Nerve gas

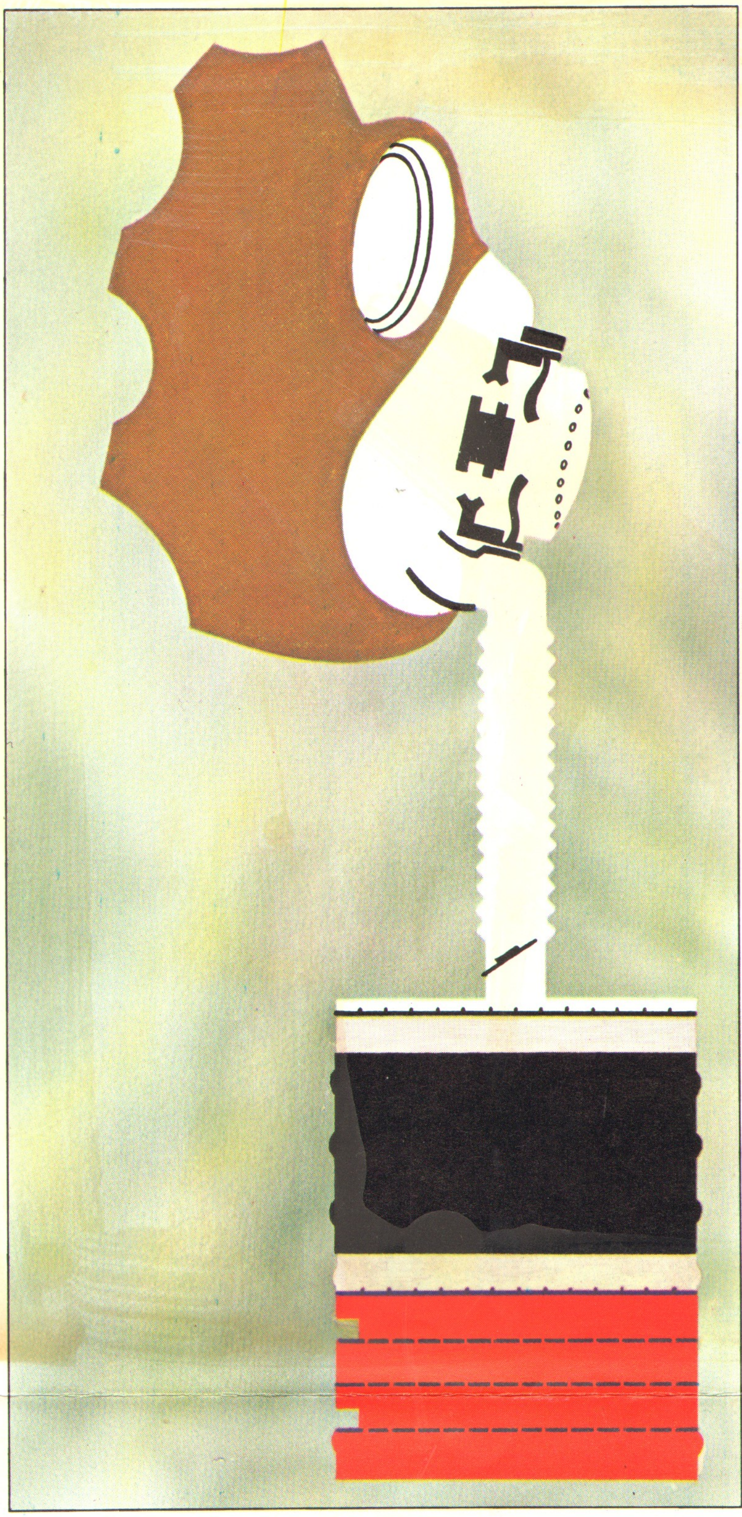
Why were they never used?

Chemical Warfare

Technology, 1940/1945

The wartime use of gas and other chemical weapons has never been considered 'civilised', and successive conventions have tried—unsuccessfully—to ban even so much as their manufacture. The use of mustard gas during the First World War (*below*) gave rise to widespread fears of this weapon during the inter-war period; but although both sides stockpiled large numbers of chemical weapons, they were never used, probably through fear of retaliation. **Brian Ford** describes the development of chemical weapons, from the early 'choking' gases to, most terrible of all, the 'nerve' gases

Imperial War Museum



Peter Warrington

The basic pattern of the gas-masks of the Second World War was that of a close-fitting face-mask unit, containing the outlet valve, connected by a flexible hose to a respirator. The latter unit contained the air inlet holes, the anti-gas filters, and the inlet valve. The cycle as indicated on the diagram at top left is as follows:
1. Air is drawn through the inlet holes and passes through four filters separated by grids;
2. The indrawn air then passes upwards through the main anti-toxic filter of carbon granules sandwiched between two cotton pads, and passes on up the flexible tube through the inlet valve (which closes when the wearer breathes out);
3. The indrawn air is then channelled straight to the wearer's nostrils and mouth where it is breathed in;
4. When the wearer breathes out, the foul air passes straight through the outlet valve (which closes when the wearer breathes in) through the ring of holes in the gas-mask's 'snout'.
The British mask (*top right*) and the French (*below right*) both used this system—but both were rendered obsolete on the introduction of nerve gases which work through contact with the skin—and which do not have to be inhaled to be deadly

A First World War legacy which would not be needed . . .

By 1939, Britain was looking nervously to her anti-gas defences . . .

The history of poison gases is an interesting and almost prophetic one, in that this method of warfare has never been considered morally acceptable. One of the earliest decisions to use sulphur dioxide, produced by burning flowers of sulphur up-wind, was taken by Lord Dundonald in the 1855 Crimean campaign. The suggestion, however, was vetoed by the British government as being inhumane. A similar decision was reached when, in 1862, it was proposed that 'noxious gases' be used in the American Civil War; it had been requested that chlorine shells be used in battle, but the government declined to permit the step.

In 1899, at The Hague International Peace Conference, a resolution was put forward to ban such gases in warfare. But America, not yet convinced that the use of gas was demonstrably inhumane, did not support the proposition – nor did Britain, at least in the vote: she felt that the proposition was right, but her vote depended on unanimity within the other countries represented and America, of course, precluded that possibility.

It was Germany that first used the gas chlorine in the First World War, on the Russian front in Poland in 1915. Mustard gas was introduced by the Germans in 1917, and by the end of the war 50% of the German shells were filled with such materials; the British by then were prepared to load 25% of their shells with gas chemicals. Mustard gas was first used at Ypres: the French called it 'Ypérite' for a time.

It is important, before we examine the gases available for use in the Second World War, to emphasise one fact: not all of them were gases in the true sense. Many were in fact minute solid particles, suspended as an aerosol in the atmosphere. None the less, they did exert their effects as a gas – although, because of their nature, they were not removed from the air by the normal adsorbent elements in gas-masks.

There are several major types of gas used in wartime, of which 'choking gases' are the most common. They affect the respiratory system and are irritants. As a result, since their point of attack is the soft, unprotected lining of the lungs, they may produce extensive damage and cause death. They produce an initial response of coughing, as the lung involuntarily tries to expel the irritant, and then as fluid accumulates in the lung tissue to attempt to wash away the gas, oedema, or watery swelling, occurs, and death, virtually from suffocation, results.

Chlorine (which was, as we have seen, first used in the First World War) is now an obsolete combat gas. It is a dense, yellowish-green vapour which when propelled by a light breeze rolls along the ground in dense, choking clouds, filling crevices and trenches where men may be hiding. It damages the tiny bloodvessels in the lungs and causes oedema; the lung tissue swells into a spongy, wet mass and air exchange becomes virtually impossible. Diphosgene is a similar choking gas obtained in the form of a clear, volatile liquid. Its effects are often delayed for some hours, but it is moderately persistent in its action. Carbonyl chloride, a closely related phosgene, is more immediate in its effect, and it passes off quicker; but both phosgene and diphosgene produce the same characteristic odour of freshly cut grass or hay.

Tear-gas compounds produce a similar irritation, though in most cases it is confined to the eyes and the upper respiratory tract. The tear gases are not persistent, and the effects are generally gone a short while after the victim leaves the contaminated area. Much of the use of tear-gas in the war was, naturally enough, in civil disturbances. Another compound, Adamsite, acts initially as a tear-gas but produces more severe effects. This yellowish-green solid acts within a minute or so to produce irritation of the eyes and respiratory passages, coughing, blinding headache, violent spasms and pains across the chest with difficulty in breathing, nausea, and vomiting. The gas persists for less than 10 minutes in the air, and is therefore classed as 'non-persistent'.

Blister gases are capable of producing agonising surface effects. Technically known as *vesicants,* they attack any part of the skin which they contact, producing burns, destruction of the tissues, and painful, raw ulcers. More general systemic effects may also become apparent. 'Distilled mustard' is a straw-coloured liquid (colourless when pure) with an odour rather like garlic. It is highly persistent when liberated as vapour and may produce delayed effects for over a day after release. Methyl *bis*-amine hydrochloride – nitrogen mustard, as it became known – is a dark-coloured liquid which produces burning and blistering of the skin. The gas is persistent, often for over 12 hours. A more quick-acting gas is Lewisite, an oily fluid which in addition to the effects of nitrogen mustard also produces pulmonary oedema (rather like the choking gases) and pneumonia. It has a musty odour which may vary somewhat from specimen to specimen, but is said to be quite characteristic.

Painless, but deadly

Most severe of all in their lethal effects are carbon monoxide, cyanide, and cyanogen chloride. Apart from a slight 'gassy' or metallic odour, they are – when pure – odourless in practice. All interfere with the uptake of oxygen by the haemoglobin in the blood – thus a form of 'physiological suffocation' takes place. The poison forms a kind of loosely bonded compound with the haemoglobin, by becoming attached in the blood molecule at the site normally occupied by the oxygen. As a result, oxygen can no longer be carried. The effects are, in the main, irreversible and, unless the victim can be removed to fresh, uncontaminated air and allowed to conserve what oxygen capacity he may have remaining, death is certain. These gases are non-persistent, however, since they are low in density and tend rapidly to leave the place of release. Hydrogen cyanide, of course, is the same gas which the state authorities in the United States have used for legal execution in peacetime. Death is rapid, sure, and relatively painless.

Nerve gases (one of the first to be developed was the German discovery, Tabun) are among the most unpleasant of these agents. They act by destroying the enzyme cholinesterase. Normally acetyl choline is produced at the nerve endings during their normal message-carrying functions, and cholinesterase is the material which leads to the breakdown of the compound; otherwise the acetyl choline would tend to accumulate in harmful amounts.

These gases, by damaging the enzyme, cause large amounts of the acetyl choline to accumulate in the nerves; they are no longer able to transmit messages effectively and therefore bodily functions become uncoordinated and spasmodic, and the nerves themselves are damaged by the toxic accumulations that result. Tabun, a pale brownish liquid, is fairly persistent, and is generally quite odourless when pure. On inhalation, nausea, vomiting, and diarrhoea occur, muscular twitching and convulsions ensue rapidly, and there are systemic effects on the blood system. Even the smallest traces have an effect on the eyes, making the pupil contract which hinders clear sight and makes the victim uncertain and, in war, unable to fight effectively. Large doses in any degree produce potentially fatal results.

Sarin is a similar material, but it tends to be less persistent. Soman, however, is the most lethal of all the nerve gases. It has a fruity smell (Sabun tends to have this characteristic when impure) and in most respects its behaviour is the same – but it is far more severe in its effects, and they are swifter. Often within seconds of inhalation the victim is in a state of convulsive collapse which may prove fatal.

The effects of these poison gases have been codified, since the war, by American strategic experts, since many of these materials are still held for possible use today. The US Army Technical Manual TM 3-215 lists the following sequential effects of the nerve gases:

- running nose
- a tightness of the chest which interferes with breathing
- pinpointing (severe contraction) of the pupil of the eye resulting in distorted vision
- severe difficulty in breathing
- salivation and heavy perspiration
- nausea and vomiting
- painful cramps, accompanied by involuntary urination and defecation
- twitching of the muscles, jerky and uncoordinated movements of the limbs, a staggering gait
- coma
- convulsion, cessation of breathing altogether, and death.

When a nerve gas is absorbed through the skin the effects come on rapidly and death may occur within one or two minutes. With smaller doses coma and death may be delayed for over an hour, as the effects listed occur in that order; should the gas contact the naked membrane of the eye or be inhaled, death comes within about 10 to 15 minutes.

Before the Second World War, phosgene was always considered to be the most lethal

For the people of Britain:
a weird new way of life

Prime Minister to War Cabinet, 14/VII/40:
It seems to me very important that everybody should be made to look to their gas-masks now. I expect a great many of them require over-hauling, and it may well be Hitler has some gas designs upon us. . .

of all war gases. However, the danger of death from Sarin is more than 30 times as great. One-tenth of a milligram of this gas (equivalent to a particle about the size of a large grain of sand) is enough to kill a child, and three-quarters of a milligram will kill a healthy adult. Even so, it has been calculated that over 250 tons of the material would have to be distributed to reach a lethal concentration, to an average depth of some 50 feet, covering a city the size of Paris.

Another of the 'blood gases' – so-called since the effect is primarily exerted through dispersion through the bloodstream, rather like the cyanide compounds discussed earlier – is Arsine, a colourless gas with a smell somewhat like garlic. Arsine is an inflammable gas, though it would take a high concentration to provoke any risk of an explosion; and it is very poisonous indeed. Its action in the body is to interfere with the normal metabolic transport system of the red blood cells. Arsine tends to accumulate in the liver, where it also causes severe and often irreversible damage, and is excreted to some extent by the kidneys, although they too soon become damaged, and death may occur. Arsine is one of the most long-term of the war gases, in the sense that the onset of symptoms may be greatly delayed. There have been instances where an accidental exposure to the gas has produced severe handicap and death well over a week after the incident. In the field, however, the gas is classed as 'non-persistent' since it rapidly diffuses into the air in concentrations too low to cause damage.

Experiments on prisoners

The Second World War gave rise to these nerve gases and, together with the materials which had been developed from earlier knowledge, both sides in the war effort stockpiled a considerable amount of gases. The Germans (who discovered the gases of the Tabun/Sarin series) produced a number of nerve-gas weapons, and by the end of the war they had stockpiled over 7,000 tons of Sarin alone – enough, as we have calculated earlier, to kill the population of some 30 cities the size of Paris. The Americans, too, had considerable reserves of sophisticated war-gas materials, and devoted much effort, both during and after the war, to improving their knowledge of the subject. In many ways, then, the period was an important one for the development of poisons that could be used in war, and many of these agents have since been used for other purposes – for experimental work in the laboratory, for example, and also in medicine. Mustard gas has given rise to the techniques by which human chromosomes have been studied in the laboratory, and newer hallucinogenic materials developed from war gases are used in psychiatry. It will be remembered (see 'The New Dark Age', Vol 3, page 1114) that the Germans used poisons of this sort in a series of fatal experiments on prisoners.

Yet, although these agents were so intensively studied and produced in sizeable quantities, they were never released for widespread use in the war, and never became part of the conventional armoury. Why should this be?

Almost certainly the reason lay in the mutual deterrent balance that both sides were led to observe because of occasional Intelligence reports about the secret developments that were going on in the enemy's chemical laboratories. Indeed so well have the secrets of this research been kept that even today there is only scant information about the research that went on. What *is* certain is that war gases (whose effects, as we have seen, are terrifyingly widespread and severe) were ready for use – but neither side was in a position to risk reprisal by an opponent using similar, or perhaps even more severe, gases in retaliation. The possible consequences of the use of poisonous gases are incalculable; but had they been sanctioned for use the effect on 'civilisation' and the policy of chemical warfare might have been very different indeed.

In one respect, however, the chemical industry did provide an important tactical innovation: the production of chemical (as opposed to gas) grenades. One of the most widespread of these was the phosphorus bomb, which contained an explosive charge and a quantity of white elemental phosphorus. These bombs were used as incendiaries by both sides in air attacks on large cities, and with devastating results. As the charge burst, fragments of the white phosphorus would be scattered over a wide range at speed, and the particles spontaneously ignited on contact with the air. They had a marked tendency to adhere to naked skin, where they would continue to burn and cause painful flesh wounds which took a great deal of time to heal effectively. Thus the direct incendiary effect was supplemented by an anti-personnel one as well. Large tonnages of phosphorus were produced by the leading chemical manufacturers in Germany, America, and Britain, and were used as the normal incendiary bomb throughout the war.

The advent of Napalm

An even more effective incendiary arrived on the scene as the war progressed. The 'Molotov cocktail', of course, has been a traditional weapon for some time, but petrol (the inflammable ingredient of this hand-made 'bottle' grenade) is not usually an effective incendiary material, as it disperses and evaporates too rapidly. However, research was directed to overcoming this problem, and it was determined to find a means of forming the petrol into a 'gel', a jelly-like substance. Eventually a formula, made from palmitic and naphthalenic acids, was perfected. It has the effect of converting the petrol into a viscous jelly, the basis of a high-efficiency incendiary material which burns fiercely for longer than ordinary petrol. On contact with organic materials it continues to burn with a violent, intense flame and its detonation near personnel results in their becoming human torches.

This gelled petrol was called Napalm and it is still used by American forces today. In the war it was used widely by all the Allies against soldiers entrenched on the battlefields, and also against civilian populations in large towns and cities.

The chemical industry thus played an important part in developing weapons of unprecedented lethality. Much of the effort was devoted to the production of explosives for high-blast bombs, but the crucial development work was, without doubt, centred on the poisonous war gases which, as it happened, were never used. Their discovery, however, was one of the most far-reaching and significant chemical developments of the entire war.

[For Brian J. Ford's biography, see Vol 3, page 1117.]

US Air Force

Sophisticated incineration: the 'splash' of napalm

More chemical horrors: napalm and phosphorus

US Army

Fragments shoot skywards from a phosphorus grenade