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Review Article

Smoke and Incendiary Weapons

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Abstract

The incendiary weapons were among the first that were used beside the considered personal weapons: clubs, stones, stone knives. When the human being began to dominate the fire, he managed to develop ways to use it for his benefit, both in peaceful actions (such as changing food by roasting or cooking the clay to produce pots, figurines and adobe for construction) and in other types of aggressive applications, developing methods to burn the possessions of the enemies. Of course, fire management also allowed the knowledge of the smoke, which was then used for at least two purposes: taking advantage of its toxic properties to dislodge strategic positions (or force the animals sheltered in caves to go out and be at the mercy of the hunters) or to raise screens that hid some aggressive movements to indiscreet eyes. It has been said that the first incendiary agent used for war purposes was the so-called "Greek fire", which was applied from the seventh century until the end of the Middle Ages. Its importance was supreme for the Byzantine Empire, helping to repel the attacks directed against Constantinople by the Arabs and the Russians between the years 671 to 678 of our era, but it was also of vital importance to repel attacks of the crusaders in the XII century. Although it is considered the direct predecessor of NAPALM, it may not be real that it was the first weapon of this class.

Introduction

The interpretation of some Assyrian reliefs shows that in the ninth century BC. incendiaries were used, especially during settlement sieges; torches, lighted resins and lighted oil pots were thrown at the aggressor troops. Herodotus mentions that the Persians used arrows whose tip was smeared with pitch lit during the capture of Athens, around 480 BC. The Peloponnesian War records the use of incendiary weapons against wooden walls in 429 a. C. The catapult made it possible to throw burning materials against specific targets at the sieges of Syracuse (413 BC) and Rhodes (304 BC). By that time (Alexander the Great already dead) they began to develop the incendiary missiles and the mixtures difficult to control. For example, Aeneas mentions (360 BC) that pine needles, sulfur, pitch and resin or incense were used, which produced a fire that was not quenched with water but with vinegar. History is full of events and battles fought in the midst of fire. The incendiary mixtures were improving as the scientific knowledge was increasing on time. The discovery of oil generated new possibilities in these aspects, because it allowed to defend stone walls by setting them on fire with materials that adhered to any solid. It is said that Alexander the Great once found a lake of naphtha that flared up as soon as a flame approached it. The material of the lake was distributed along a whole street and when a flame approached one end, immediately the fire spread to the opposite side. To extinguish such fires, it was necessary to use enormous quantities of water or soil, mud, vinegar or alum, among other materials. It should be noted that the current vinegar is not much more effective than plain water, but it is believed that in the classification of vinegar made by ancient authors such as Plutarco, mixtures and sauces made with vinegar and salt were included; in fact, Pliny mentions that the Gauls and the Germans extinguished the ignited wood using salt water from the sea. During the colonization of North America, American Indians used lighted arrows to set fire to the facilities of white pioneers. In Europe, the men of King Charles of Sweden, in 1701, burned straw to produce a smoke screen covering the activities of the aforementioned army, mainly when crossing the Dvina River. An incendiary agent is a chemical or a mixture of chemicals that produces a combustion reaction and releases a large amount of heat continuously. The oxygen necessary to maintain combustion can be obtained from the atmosphere or it can be part of the incendiary agent, which gives characteristics of autonomy to the corresponding weapon. The heat of combustion of an incendiary agent must be high enough to ignite or damage the selected target, with a speed that does not allow rapid dissipation and, at the same time, facilitates the transfer of heat between the agent and the target.

The primary purpose of incendiary weapons is to cause damage to the enemy in their persons and property, mainly by means of heat or direct flame. It may be the case that weapons of high explosive power cause heat waves and even fires, but because the predominant effects and the intention of their use are focused on the explosive and fragmentation effects, we will not address their use and characteristics. Some incendiary agents are poisons "per se", while some others produce toxic or asphyxiating effects when burning. The incendiary agents can be of an intensive or dispersive type; the intensive ones are destined to materials and constructions that are not very combustible, for which it is required that their combustion temperature is very high and that their flames form a compact mass. Within this type of agents we have the metallic ones (based on reactive metals) and the pyrotechnic ones (they contain their own source of oxygen). On the other hand, the dispersive agents are destined for easily combustible objectives or for living beings; these objectives do not require great intensity of fire and heat as the dispersion in large areas of small quantities of the incendiary in combustion is sufficient to cause damage. Here pyrophoric (substances that ignite spontaneously on contact with air) and those made with oils (such as Napalm) are highlighted, increasing their destructive power according to their adhesiveness, that is, their ability to stick to surfaces during the combustion, for which additives have been devised that improve their adhesive properties. Molotov street bombs (gasoline and oil in a fragile bottle with a rag on the mouth) are dispersive arsonists, which increase their adhesiveness if they are added sugar, for example. The sugar with the temperature begins to caramelize, sticking to the surfaces and takes some time to burn completely.

The incendiary weapons systems are composed of three main parts: the incendiary agent itself; ammunition to discharge and ignite the incendiary agent in the desired area, and a propulsion system that allows the ammunition to reach the established target. Current technology systems allow incendiary weapons to be launched by aircraft, artillery pieces, combat vehicles and even infantrymen.

For a Better Understanding of This Type of Weapons, We Can Classify Them As Follows:

Metal Incendiaries

This type of agent is made up of metals that react easily with atmospheric oxygen. The best known and most used is magnesium, not so much for its price as for its accessibility and its high reactivity. Very generally, to increase its performance as an incendiary, it is used in alloys, the best known being the so-called Elektron, which contains aluminum and small amounts of copper. It is also possible to heat it and react it with water, which generates hydrogen, which burns or explodes, making it difficult to control the fire. One way to further complicate the control of this kind of fires, is adding 20% of cadmium to an incendiary alloy, generating, as a combustion product, a gas that is twice as poisonous as hydrogen cyanide. In small bombs, whose weight ranges between 50 and 250 kg, it is very used against buildings of brick, stone, cement or metal, because the bombs have the capacity to penetrate across the roofs and explode inside the buildings, causing the inflammation of the goods contained in the targets. Looking for greater effectiveness, they are usually thrown in bunches of at least 100 units. Another metal used as an incendiary agent is zirconium, which has an additional property to those of magnesium: it produces sparks when hitting hard surfaces. Uranium is also a pyrophoric agent, which can be obtained for these purposes from the preparation of enriched uranium to be used as a nuclear fuel; Non-radioactive uranium is then used as an incendiary, for example, in aerial darts.

Pyrotechnique Incendiaries

This class of agents has the characteristic of containing its own source of oxygen, in such a way that an impoverished atmosphere does not hinder its combustion. The main agent of this classification, the termite, mixes aluminum powder and iron oxides. It is lit by a wick and burns with greater violence than magnesium and at a higher temperature; during combustion molten metallic iron is released, which contributes to the propagation of heat. It is worth mentioning that the termite was the most used incendiary agent during the First World War, and it still remains in use to this day.

The termite is usually modified to improve its characteristics, by adding some materials. Such is the case of thermate, which consists of thermite added with metallic aluminum, sulfur and barium nitrate. Other kinds of termatos include, in addition, carbonaceous materials that increase the total generation of heat. The thermats are widely used in hand grenades and aviation bombs whose use corresponds to that described for magnesium bombs.

Pyrophoric Incendiaries

These are materials that ignite spontaneously when they come in contact with the air. In dry air the beginning of the reaction it is difficult or delayed a little; for these specific cases a special wick is used. White phosphorus belongs to this classification, which is very common for burning very combustible materials. When it contacts the air, it explodes into flames and, due to the humidity, produces dense clouds of smoke. This last property causes it to be used, in addition to being an arsonist, to make signals or to spread smoke screens. Coupled with the above, it turns out that, once in flames, white phosphorus adheres strongly to surfaces and is extremely difficult to extinguish with water (and if it goes out, it self-ignites again once dry). All these properties make it difficult to control the fires started by this agent. To increase its efficiency, it is common to use plasticizers and flammable substances of high combustion temperature. A typical mixture of the latter class is composed of finely divided white phosphorus, suspended in a rubber and xylene gel. It is commonly used in aviation rockets, supporting ground operations. A single launcher can fire six rockets with a minimum caliber of 70 mm, and several of these rocket launchers can be attached to an aircraft. Another important pyrophoric is triethylaluminum, a liquid that burns on contact with air or water, sometimes with explosive violence. Polyisobutylene can be used as a thickening agent, which produces a plastic that is capable of causing severe epithelial burns and which is very difficult to extinguish. This is used in rockets that are fired from portable launchers. The most common rockets of this type, are projectiles of 66 mm of caliber that are fired with a launcher of four tubes resting on the shoulder; they have a weight of 1.5 kg, a range that varies from 200 m (with

millimeter accuracy) to 750 m (with less accuracy) and a payload of 0.6 kg of thickened triethylaluminum. Upon impact, this load is spread over a radius of approximately 20 m.

Oil Based Incendiaries

Petroleum-derived hydrocarbons are an excellent raw material for incendiary agents: they are abundant, have a high heat of combustion and generate appreciable amounts of carbon monoxide, among other properties. However, those whose volatility allows them to light easily, such as gasoline, burn too quickly, so when thrown away they are consumed in a large flamboyant but ineffective flash. For this reason, gasoline is mixed with thickeners that help to significantly increase its destructive power: they make it more suitable for warlike uses depending on the modifications to its flow properties; their cohesiveness and adhesion properties are also altered in such a way that they adhere to the surfaces, the burning time is prolonged and the combustion temperature is increased. The most common additive was rubber, towards the beginning of the Second World War; however, rubber became a strategic raw material for the manufacture of tires, so it was imperative to find a substitute. The isobutyl polymethacrylate and the polymethyl methacrylate began to be used; shortly after it was seen that certain soaps were more advantageous than polymers (soaps are metal salts of fatty acids).

In 1942 it was discovered that an aluminum soap obtained from coconut acid, naphthenic acid and oleic acid, is a thickener of special qualities. This soap was given the name of Napalm (contraction of the words NAphtenate and PALMitate), a term that has been generalized to designate, in addition to the soap that gives rise to, all the types of thickened hydrocarbons that are used as incendiary agents. This soap easily absorbs moisture from the air and can be mixed with gasoline to obtain a gelatin that varies in its consistency, depending on the amount of soap used, from a very fluid liquid to an almost solid jelly. For portable flamethrowers, for example, a mixture of 30 liters of gasoline thickened with 1 kg of soap is used. For use in incendiary bombs, larger quantities of napalm soap are required to ensure that the fragments that emerge from the explosion that disperses them are not less than 100 g in weight. They are employed profusely in the so-called tactical incendiary bombs, for the support of terrestrial activities, either against military installations and vehicles or against population centers. These bombs consist of a thin walled container loaded with napalm (one of the most used versions is 400 liters capacity). When impacting the ground, the bomb disperses its content on an elliptical surface of approximately 120 m in length by 25 m in width; in this model the napalm is lit by a load of less than 1 kg of white phosphorus, which produces a huge fireball that slows down by just 5 seconds, but leaves the napalm burning for at least 5 minutes more. Since the described container takes the form of an auxiliary fuel tank, a single airplane can carry several of these bombs under the wings.

You can also use napalm in flamethrowers (which from the invention of napalm acquired a special tactical importance), of which there are two main types: the portable and the mechanical. The first, to be transported by a soldier in the back, consists of a napalm tank, another one of compressed air (or any other propellant) and a nozzle with a lighter. The most used model weighs about 25 kg, has capacity for 15 liters of napalm, a range of 50 m and a minimum duration of 8 seconds when it is fired in a single burst; of course, you can also shoot in shorter bursts. The mechanical flamethrower can be used as a main or auxiliary weapon mounted on a combat vehicle. Its capacity is usually 1,300 liters, its range is 200 m and its minimum duration is one minute.

The most recent investigations about this type of agents indicate that the possibility of adding napalm pyrophoric substances that assure re-ignition once it has been turned off is studied, as well as adding special compounds called metallic carbonyls to its formulation that increase its toxic action in closed spaces, simultaneously generating carbon monoxide and poisonous metallic aerosols.

Employment of Fire Agents

Basically, the use of incendiary weapons is directed towards military targets to immobilize transports; for the destruction of strategically important facilities; for the destruction of centers of food supply or of fields of culture, cattle raising, etc .; obviously to kill and, finally, even when these are not the only uses, to bring down the morale of a people at war. The instinctive fear of fire dates from its discovery by the man of the caverns. Therefore, the psychological effect of the use of incendiary weapons can be more devastating than the weapons themselves, because of the consequences generated by a wave of generalized panic that hinders and even makes impossible the survival and control procedures that could be applied. The fact that incendiary weapons are artifacts whose effects go beyond any humanitarian consideration in acts of war, led to the signature in 1980 of the Protocol on prohibitions or restrictions on the use of incendiary weapons, within the framework of the holding of the United Nations Conference on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or of Indiscriminate Effects, which took place from September 15 to October 10, 1980. It should be noted that publication by The UN report on napalm and other incendiary weapons was followed very large efforts to regulate such weapons. It is argued that certain incendiary weapons can have a very high specific military value, but it is also true that the wounds caused by them are appalling and extremely painful, difficult to deal with and often lead to death or permanent deformations and incapacities, without counting the serious psychological traumas that leave as a sequel in the victims. The aforementioned report concludes that the use of these weapons must be considered to cause unnecessary suffering. Therefore, there is a tendency towards a complete and absolute prohibition rather than a limited prohibition, which lends itself more to violation than to compliance with the norm. This has happened in different parts of the world: Iraq, Bosnia and Herzegovina, Chechnya, Afghanistan, Syria, etc. It has come to the cynical extreme to say that bombs with white phosphorus are used not as incendiary weapons but as a method of night lighting! If this type of weapon is totally and absolutely banned, the road for its control and destruction is facilitated, that is, the road to disarmament is cleared and paving stones are laid to pave the avenue of peace. Hopefully we can see it soon, for the good of all humanity.

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