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Oleksii SHEVCHENKO
Deputy of Chief of Hetman Petro Sahaidachnyi National Army Academy, 32 Heroes of Maidan street, Lviv, Ukraine, postal code 79012 (shevchenko_om@asv.gov.ua)

ORCID: 0000-0003-0734-6533

Олексій ШЕВЧЕНКО
перший заступник начальника Національної академії сухопутних військ імені гетьмана Петра Сагайдачного, вул. Героїв Майдану, 32, м. Львів, Україна, індекс 79012 (shevchenko_om@asv.gov.ua)

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EVOLUTION AND EMPLOYMENT OF INCENDIARY WEAPONS DURING WORLD WAR I

Abstract. The purpose of the study *– generalization of world experience in the invention of incendiary weapons during World War I, the analysis of tactics for its employment in defensive and offensive operations.* ***The methodology*** *was based on the general scientific principles of historicism, objectivity, systemics, determinism and the dialectical unity of the historical and the logical methods. They are implemented through the application of general scientific methods of a scientific research: generalization, analysis and synthesis, logical, chronological, periodization, as well as specific methods of historical research, in particular: historical and genetic, historical and comparative ones. The combination of these methods of a scientific research in a comprehensive analysis of sources and literature has triggered achievement of the designated objective.* ***The Scientific Novelty.*** *On account of a significant source base and modern methodological approaches, the world experience due to the invention of the incendiary weapons during World War I has been generalized and systematized. The tendencies which emerged in the course of evolution of diverse incendiary weapons, in particular land, aviation and sea types have been revealed. The data related to the place of the incendiary weapons among other types of weapons, their tactical and technical specifications and methods of employment in defensive and offensive operations, including Ukraine, have been clarified and supplemented.* ***The Conclusions.*** *During World War I, under the influence of science and the conditions of war, new promising incendiaries (jet flamethrowers based on land and sea, incendiary air bombs, shells, hand grenades, subversive incendiary devices, etc.), as well as incendiary substances and mixtures were rapidly to be created. Under modern conditions their unique combat properties have not lost their significance. Under conditions of a maneuverable and "trench warfare" flamethrowers, as auxiliary weapons of close combat, proved efficiency against tanks and various defensive structures, which the infantry could not destroy or suppress with artillery, machine gun or rifle fire. They turned out to be efficient under specific circumstances, in particular during the offensive or defensive combat in the urban area, especially in producing powerful fires and smoke screens. In addition to the destruction and fires caused, the incendiary weapons crucially impacted on the morale of troops and civilians, causing panic and fear.The experience gained by mankind in development of the incendiary weapons and their use during World War I has not only scientific but also practical significance from the perspective of enhancing the combat capabilities of the Armed Forces of Ukraine. Its consideration will contribute to the further development of incendiary means, as well as tactics for employment in diverse combat environment.*

Key words: *World War I, incendiary weapons, flamethrower, incendiary substance, flame tank, incendiary bombs, incendiary means for subversive activities.*

РОЗВИТОК І ЗАСТОСУВАННЯ ЗАПАЛЮВАЛЬНОЇ ЗБРОЇ У ПЕРШІЙ СВІТОВІЙ ВІЙНІ

Анотація. Мета дослідження *– узагальнення світового досвіду створення запалювальної зброї під час Першої світової війни, розкриття тактики її застосування в оборонних і наступальних діях.* ***Методологія дослідження*** *вибудовувалася із застосуванням загальнонаукових принципів історизму, об'єктивності, системності, детермінізму та діалектичної єдності історичного і логічного. Вони реалізовані через використання загальнонаукових методів наукового пізнання: узагальнення, аналізу і синтезу, логічного, хронологічного, періодизації, а також спеціальних методів історичного дослідження, зокрема: історико-генетичного, історико-порівняльного. Поєднання названих методів наукового дослідження при всебічному аналізі джерел і літератури уможливило реалізацію визначеної мети.* ***Наукова новизна.*** *На основі значної джерельної бази та сучасних методологічних підходів узагальнено і систематизовано світовий досвід створення запалювальної зброї у період Першої світової війни. Виявлено тенденції, що проявилися у процесі еволюції різних видів запалювальних засобів, зокрема, сухопутних, авіаційних і морських. Уточнено та доповнено відомості щодо місця запалювальної зброї серед інших видів зброї, її тактико-технічних характеристик і способів застосування в оборонних і наступальних діях, у тому числі на теренах України.* ***Висновки.*** *У період Першої світової війни під впливом досягнень науки і умов війни почали швидко створюватися нові перспективні запалювальні засоби (струменеві вогнемети сухопутного і морського базування, запалювальні авіаційні бомби, снаряди, ручні гранати, диверсійні запалювальні засоби тощо), а також запалювальні речовини і суміші. Їх унікальні бойові властивості не втратили значення і в сучасних умовах. У час маневреної та "окопної війни" вогнемети, як допоміжна зброя ближнього бою, виявилися результативними проти танків і різноманітних оборонних споруд, які піхота не могла знищити або придушити артилерійським, кулеметним чи рушничним вогнем. Вони результативно застосовувалися і в особливих умовах, зокрема, під час наступального чи оборонного бою в місті. За їх допомогою створювалися потужні пожежі і димові завіси. Окрім руйнувань і пожеж, запалювальна зброя спричиняла значний вплив на моральний дух військ і цивільного населення, викликаючи паніку та страх. Набутий людством досвід створення запалювальної зброї та її застосування у Першій світовій війні має не лише наукове, а й практичне значення з точки зору підвищення бойових спроможностей Збройних Сил України. Його урахування сприятиме подальшому розвитку перспективних запалювальних засобів, а також тактичних прийомів їх застосування у різних бойових умовах.*

Ключові слова: *Перша світова війна, запалювальна зброя, вогнемет, вогнеметний танк, запалювальна бомба, запалювальні диверсійні засоби.*

The Problem Statement. The experience of military conflicts in the XXth – the beginning of the XXIst centuries, in particular the military actions in the East of Ukraine, shows that in military affairs there have been significant changes associated with the development of scientific and technological progress. There are fundamentally new models of weapons and equipment, a wide arsenal of which is used, for example, by the Russian Federation in Donetsk and Luhansk regions (Rudomskyi, 2017; Virtualna fotovystavka, 2014).

These conditions, as well as Ukraine's renunciation of nuclear weapons (Zakon Ukrainy, 1994; Memorandum, 1994; Savchuk, 2018), require scientific research into effective ways of countering the aggressor by conventional means of destruction, among which not the last place is occupied by *incendiary weapons* in the armed struggle nowadays – weapons or ammunition designed to destroy enemy manpower and objects based on the use of *incendiary substances* (special chemical mixtures that emit large amounts of heat and toxic substances during combustion) (Protokol, 1980; Voennyy Entsiklopedicheskiy Slovar, p. 347).

From the point of view of the development of military history science, World War I is of interest, during which the first models of incendiary weapons were created and tested under real combat conditions, more perfect examples of which are still in service in many

countries around the world, as well as there were developed principles and methods of incendiary weapons use. Therefore, the experience gained by mankind in the creation of incendiary weapons and its use during World War I is not only of a scientific but also practical significance in terms of increasing the combat capabilities of the Armed Forces of Ukraine.

The Analysis of Sources and Recent Researches. The analysis of historiography on the issue showed that the development of various types of incendiary weapon and its use during World War I, despite its topicality and scientific significance, has not been fully researched yet. Till nowadays, a small number of scientific researches have been published, but in them, with a few exceptions, only some aspects of incendiary weapon are analyzed. The researches are fragmentary or descriptive. The monographs of the Soviet and foreign researchers are worth of attention, in particular H. Teyne (Teyne, 1927), P. Traynin (Traynin, 1939), A. Ardashev (Ardashev, 2001), T. Wictor (Wictor, 2010), the article by L. Sergeev (Sergeev, 2013), K. McFadden (McFadden, 2017), O. Oleynikov (Oleynikov, 2018) and the others. The authors based on primary sources (diaries, memoirs of direct participants in the events, leadership, instructions, combat documents, etc.) analyze the weapons, equipment and tactics of the flamethrower troops of the opposing armies, provide tactical and technical characteristics of almost all known models of the flamethrowers of that period. At the same time, in their researches, the scientists prefer analyzing the experience of fighting on land, ignoring the development of aviation and naval incendiary weapons. There are no generalizing scientific works on this issue in Ukrainian historiography. This issue is also fragmentarily covered in popular literature and is the subject of lively amateur discussions on various specialized sites and forums, etc. The lack of military and historical research of the issue topic in Ukrainian and foreign historical science necessitates such study, which is based on the achievements of predecessors and new sources.

The Purpose of research – to do a research on the evolution and tactics of the use of various types of incendiary weapons which appeared during World War I.

The Main Material Statement. Significant development of incendiary weapons took place in the XXth century, on the eve and during World War I. The development is associated with the invention of jet flamethrowers (or flamethrowers, as they were called at that time), their iclusion into the army armament and the first use in armed combat. According to the analysis of literature and sources, the first work on the creation of flamethrowers, which were originally intended to disperse street demonstrations, began at the end of the XIXth century. But only in 1912, in Germany two samples of jet flamethrowers were taken by the engineering (pioneer) troops, designed at the beginning of the 1900s by an engineer Richard Fiedler as "a means of producing large masses of flame" (in German – "*Verfahren zur Erzeugung grosser Flammenmassen*"). At that time, flamethrowers were designed to storm and defend fortresses and were classified as small (a portable backpack) – "Kleif" (in German – *Kleif*, from *Kleinflammenwerfer* – a small flamethrower) and big (heavy, carried) – "Grof" (in German – *Grof*, from *Grossflammenwerfer* – a big flamethrower), also known as the "1912 Model" or M.1912. Flamethrowers consisted of a tank for fire mixture, a cylinder for compressed gas, a device for carrying (transportation), as well as a flexible hose (a hosepipe) with a fire hydrant, at the end of which was a torch-shaped igniter. Flamethrowers functioninig was as follows: from the tank with compressed gas, the fire mixture flew through a hose to the fire hydrant, where it was automatically ignited by the igniter and directed at the target. The combination of two "Kleif" devices allowed to create a "double Kleif", and the combination of two "Grof", three or more devices – to create a "double Grof", a "triple Grof" or a flamethrower battery. In 1917, the M.1917 Wechs knapsack flamethrower

was invented in Germany (from German *Wechselapparat* – a replaceable device), which proved to be lighter and more reliable compared to other German flamethrowers. During the war, these flamethrowers underwent a number of upgrades, which significantly improved their tactical and technical characteristics. In general, German small (knapsack/backpack) flamethrowers had the following combat characteristics: a range of a fire jet – 22–25 m, duration of a continuous fire jet – 20–25 s, the number of fire shots – 18–23. The heavy flamethrower "Grof" weighed 135 kg, a range of a fire jet was 30–40 m, the duration of the continuous fire jet was 40 s, the number of fire shots – 30. These characteristics allowed to solve combat goals. Depending on the season and temperature conditions, different versions of liquid (non-thickened) incendiary mixtures were used in stream flamethrowers, among which the most widespread was the mixture created on the basis of products of distillation of coal tar with light and heavy hydrocarbons, coal oil and sulfur carbon. A certain drawback of liquid incendiary mixtures was their short throw range. In addition, a significant part of them burned during flight, not reaching the object (target). The positive properties included the following items: easy preparation, availability and cheapness of raw materials, storage stability, easy flammability at low temperatures, the ability to give a wide stream of flame during firing, enveloping the object of defeat and demoralizing the enemy (Teyne, 1927, pp. 11, 15–17, 30–43, 46; Supotnitskiy, Petrov & Kovtun, 2017, v. 1, p. 56; Sergeev, 2013, p. 56; Balias, S., 2009, p. 40).

In 1915, the German troops carried out the first flamethrower attacks: on February, 26 – against the French troops near Verdun (France) (Teyne, 1927, p. 13), and also a massive attack on July, 29 – against the British troops near Ypres (Belgium) and on October, 27 (November 9) – against the Russian troops defending Skrobivska position north of Baranovychi (modern Belarus). Flamethrowers, which threw flames, accompanied by a loud roar and thick clouds of black smoke, caused panic in the ranks of enemy infantry and helped the German units capture the enemy's position with relatively small losses (De-Lazari, 1935, pp. 50, 108–110; Barsukov, 1948, pp. 350–352).

It has been clarified before these events, none of the warring states was engaged in the elaboration of flamethrowers. When the front demanded the supply of these weapons to infantry and sapper units, the weapons had to be invented during the war, in a hurry, by means of various improvisations, many times spending more money and resources than in the planned training during peacetime (Supotnitskiy, 2018, T. 2, p. 81). Later on, flamethrowers began to be elaborated in many states and were used by all warring armies. The most common among small (knapsack) flamethrowers were: "Lawrence" systems (Britain, 1916), system "T" (Tovarnitskogo, Russia, 1916) and № 3 bis ("Schilt", France, 1916). In general, they had the following combat characteristics: range of the fire stream – 15–35 m, duration of a continuous fire stream 25–30 s. As a combustible substance there were used the mixtures of phosphorus, hydrogen sulfide and turpentine, oil with gasoline and kerosene, coal tar with gasoline and the others. As compared with the German analogues, it can be concluded that they had almost similar tactical and technical characteristics. Heavy flamethrowers – system "Vincent" (battery with 4 interconnected tanks, Britain, 1916), system "T" (Russia, 1916), L2 (France, 1916), – weighed from 200 to 300 kg. and had a jet range of 33 to 80 m (Sergeev, 2013, p. 56).

The British Livens Large Gallery Flame Projector System was the largest among the flamethrowers during World War I. It was developed in 1915 – 1916 by the British military engineer William Howard Livens. The flamethrower was used from a shallow tunnel, consisting of several fuel tanks, a 360 mm diameter pipe and a nozzle which was brought to the surface. The flamethrower weighed 2.5 tons, it was 17 m long and could fire three

10-second shots (each emitted about 320 kg of fire mixture, at the pressure of 24 atmospheres). The maximum firing range was 90 m. The flamethrower was operated by a unit of 8 people. A brigade of 300 people was allocated for its transportation to the front line and assembly (Copping, 2010; McFadden, 2017).

In 1916, in the Russian Empire, the engineers Stranden, Povarnin and Stolytsya developed the world's first high-explosive piston flamethrower (SPS, according to the initial letters names of designers' names). The fire mixture was ejected from the flamethrower by the pressure of powder gases formed by the special metal charge detonation. This principle of operation is still used nowadays. Compared to jet flamethrowers, the operation of a high-explosive flamethrower is characterized by a higher pressure in the tank and, as a result, a higher initial velocity of the fire mixture and a much longer range. The flamethrower weighed about 16 kg (completely equipped – 32.5 kg), the range of the flamethrower – about 35–50 m, the duration – 1–2 s. SPS flamethrowers began to be produced (a serial production) in 1917, but they were not used during the war. For the first time and for the last time they were used in the hostilities only during the Civil War in Russia (1918 – 1921), in particular on October 14, 1920 at Kakhovka bridgehead (Kakhovka district, Ukraine), where the combats took place between the "Russian Army" under the command of P. Wrangel and the Red Army for crossing the Dnieper River. A flamethrower group of the Red Army soldiers from the Attack-Fire Brigade fired two shots at a light cavalry artillery battery of the "whites", who in the morning darkness approached the positions of the flamethrowers, forcing them to retreat (Sergeev, 1939, pp. 124–130; Belash, 2015).

Under the conditions of maneuvering and "trench warfare" flamethrowers were used mainly as auxiliary weapons during a close combat. They hit the targets effectively, which the infantry could not destroy or suppress by means of artillery, machine gun or rifle fire (tanks, flanking and strongholds, blockhouses, nests, gorges, cellars, deep dugouts and other similar defenses) (Teyne, 1927, pp. 27, 43–44).

During the offensive, mainly small (knapsack) flamethrowers were used, which facilitated, in some cases, the beginning of the battle, helped the infantry to make a rapid attack (raid), to consolidate and clear the occupied positions, further advance and to repel enemy counterattacks. During the war, offensive tactics were formed with the employment of flamethrowers. Germany is an illustrative example (in other countries, development of flamethrowers was not given much attention). 15 minutes before the attack, the sappers blew up enemy barriers in order to make holes in them. Flamethrowers brigade began to act exactly on the signal, usually sirens from trenches or airplanes. In the beginning, heavy (trench) flamethrowers were targeted at the enemy's fornt trenches from the distance of 40–60 m for a minute, literally flooding them with fire. Then the sappers went forward to break through the enemy's line and to make the passages in the barricades of enemy positions finally. The sappers were followed by flamethrowers group with light (backpack) flamethrowers and strike groups, which occupied and cleared the attacked area. At the same time, mortars and trench guns concentrated barricading fire on the rear of the enemy position, and longitudinally, on the enemy's adjacent areas, thus "fencing" the perimeter where the combat took place. Sometimes before a flamethrower attack, a long artillery shelling was carried out, which simultaneously performed the following functions: the destruction of field fortifications, wire fences and the loss of enemy manpower, with an emphasis on the suppression of the enemy's machine gun points. As war experience showed, the best time to attack was during a complete darkness or at dawn. An unexpected flank strike by means of

flamethrowers was especially effective, if the enemy's position was suitable for the attack. By means of flamethrowers and flammable materials (wood, straw, etc.), powerful fire flares could be made, as well as smoke curtains, by directing the burning jet to the ground. Fire and a thick black cloud of smoke, which quickly approached the enemy's position, masked the attacking infantry and made a moral influence on the enemy, forcing the enemy to run away from the battle field. At the same time, fire and smoke had the opposite effect on the infantry, raising its fighting spirit and encouraging them to attack the enemy. As experience showed, a properly formed group of small, medium and large flamethrowers quickly broke the enemy's resistance and ended the combat in invading the enemy's territory, position (Teyne, 1927, pp. 43–44, 61–62, 64–65, 80).

In defense, heavy (trench) flamethrowers were used to defeat the attacking enemy. The jet of fire mixture they emitted also had a great impact force (Supotnitskiy, Petrov & Kovtun, 2017, v. 1, p. 56; Sergeev, 2013, p. 56). For this purpose, the flathrowers were located primarily in places where there was a concentration of the enemy ready to attack, in narrow passages, gorges, tunnels, galleries, etc. (Teyne, 1927, p. 81). Small (backpack) flamethrowers were effective in defense against tanks. The flamethrower jet attack was directed mainly at tank's front part, where there were holes for observation, through which the fire could penetrate without hindrance. The most effective distance was 10–15 m from which the tank was attacked (Teyne, 1927, pp. 43–44, 83).

Flamethrowers were also used effectively under special conditions of offensive or defensive combat, in particular in residential areas where it was possible to approach the enemy at short distances without any obstacles. The enemy, who fired small arms from windows and roofs, and was smoked from basements, cellars, barricaded houses, dugouts and other shelters and was hit by a double jet of fire (Teyne, 1927, pp. 61–62). Thus, in our opinion, the army that had a flamethrower in its unit was in a more advantageous tactical position.

The war experience showed that weather conditions must be taken into account when flamethrowers were used. Otherwise, it would lead to tragic consequences. For example, on June 6, 1915, at the positions near Vokua (Vauquois), the French troops conducted the first flamethrower attack using 18 Schilt № 1 knapsack flamethrowers. The flamethrower attack was blown away by a strong headwind: the fire destroyed several flamethrowers, ammunition and equipment (which was on the front line), one flamethrower soldier was killed (18 – wounded) and 24 infantry (6 – missing and 109 – wounded) (Oleynikov, 2018).

It is believed that the greatest success in the development and use of flamethrowers was achieved by Germany. There are reports that during World War I, the German soldiers-flamethrowers took part in 653 combats, in which 523 attacks were carried out and knapsack flamethrowers were used. In 1916, the German soldiers-flamethrowers for successful operations at Verdun and Somme (the Somme Battle), who "made the enemy value the strength of the German weapons, and in a short time achieved success, and the French soldiers considered the German soldiers-flamethrowers the worst enemy in a close combat", received from the Crown Prince (an heir of the Emperor of Germany) personally, as the highest honor of valor – "Totenkopf" (Eng. Dead Head), the soldiers-flamethrowers' patch (Nashivka nemetkikh ognemetchikov, 2009) on the left sleeve, which "will serve a reminder in a further development of the spirit of disrespect for death in a combat" (Teyne, 1927, p. 13).

During World War I, in order to smoke deep galleries, cellars, gorges, enclosed spaces, tanks and other shelters where the jet of fire could not penetrate, there were used "fire layers" or "fire bombs" of various designs filled with combustible oil. They were usually made of sheet

iron and filled with 2 liters of combustible oil. Tubes of ball or egg-shaped grenades were used to ignite "fire bombs". The sound, fragments, smoke and flames from the explosion of these bombs (range 5–7 m) indoors had a great moral impact on the enemy (Teyne, 1927, p. 60).

During the war, in Germany and the United States, there began the first experiments on the installation of flamethrowers in tanks. But the first prototype tank with flamethrowers appeared in the United States only in 1918 and it was called "America". Its exterior part looked like the British "rhombus" tank of 1916 – 1917. It was a "Steam Tank Tracked" driven by two 2-cylinder steam engines with a total capacity of 500 h.p. A flamethrower was the main weapon of the tank located in the front cabin. Unlike other systems, a separate gasoline engine with a capacity of 35 h.p. was used to eject the fire mixture but not a compressed air cylinder. The range of the flamethrower was 27 m, which was a very good characteristics for that time. The tank's additional armament was located in onboard sponsons and consisted of four machine guns "Browning" M 1917 caliber 7.62-mm. Under combat conditions the firethrower tank was not tested because of an insecure design of the power equipment (Steam Tank Tracked, 2018).

In Britain, the attempts were made to install flamethrowers on warships. Thus, two flamethrowers were installed as special weapons on the armored cruiser HMS "Vindictive", which on April 23, 1918 took part in the raid on Seebrugge (*Zeebrugge operation*, the attempt by the Royal Navy to block the port of Zeebrugge (Flanders, Belgium) – important for Germany and a well-fortified naval base, where submarines and destroyers were stationed. The flamethrowers were to help clear the way to the pier for airborne forces. But both flamethrowers were damaged by the enemy artillery during the combat: one had a broken tube supplying fire mixture from the tank, and the liquid spilled on the deck, what could cause fire; another one – had a flammable device knocked down and it turned into an "oil jet" instead of emitting flames (Traynin, 1939, pp. 5–6, 50, 53, 57–58).

During the war, Germany was the first country in history to use aviation incendiary bombs. They were perforated metal funnel-shaped containers filled with a mixture of kerosene and oil or termite. The shells of such bombs were made of a thick rope which was absorbed in an incendiary mixture and filled with rubber, or simply wound on a core. The bomb was ignited by an igniter which was activated during the launch (Bombardirovka angliyskikh pribrezhnykh gorodov, 2017). On the night of September 8–9, 1915, the L-13 zeppelin (LZ-45) of the Air Force Division of the German Navy made one of the successful air strikes on the capital of Great Britain, London, dropping from the height of up to 2.5 km about 2 tons of high-explosive and incendiary bombs: 55 incendiary 5-kilogram bombs, 14 high-explosive 100-kilogram bombs and one 300-kilogram high-explosive bomb (which was a technical novelty and used for the first time during the combat). Due to the weakness of the British air defense, the airship (dirigible) was able to penetrate unnoticed into the British airspace, to reach its capital, drop bombs on the city and return unhindered. In addition to a massive destruction and fires caused, the air strike affected the morale of the civilian population of London significantly, causing panic and fear.

During World War I, there began to be actively developed and widely used phosphorus and termite amunition, including incendiary hand grenades, artillery shells, bullets for aircraft and anti-aircraft machine guns, etc. Incendiary hand grenades and phosphorus artillery shells were used as incendiary smoke for ousting the enemy from trenches, destroying armament and military equipment, damaging gas masks, and etc. Termite grenades proved to be quite effective in setting fire to wooden shelters, warehouses, vegetation, military equipment engines, and etc. Incendiary artillery shells firing was carried out to set in fire the enemy locations primarily;

especially effective was firing at warehouses with fuel and ammunition. Incendiary artillery shells were used rarely for other purposes (Artilleriya, 1968, pp. 131–132).

With the invention of aviation, the development of incendiary bullets intensified which was based on white phosphorus. Incendiary bullets were used mainly for the destruction of air targets by igniting balloons, airships refueled with combustible hydrogen, as well as airplanes that had a wooden and fabric construction at that time. White phosphorus left a trail of blue smoke after the shot, that is why, the first ignition bullets were called "smoke tracers". A rapid burning of phosphorus caused effective firing at the distance of up to 320 m (Romanov, 1995). Nowadays, artillery and aircraft ammunition with termite and phosphorus are still used by many armies around the world.

During World War I, incendiary devices were developed for sabotage activities. For example, in Germany, an incendiary device was made in the form of a blue pencil of 175 mm long, 11.1 mm in diameter and weighing 12–13 grams. Inside the device there was a glass ampoule of sulfuric acid and a celluloid tube with potassium chlorate. When the ampoule was broken, the acid reacted with potassium chlorate and caused an explosion. Both substances were separated by a layer of clay, which delayed the weapon activation for up to 30 minutes. The "incendiary cigar" was another similar invention, constructed in 1915. It was a lead tube at the size of an ordinary cigar, divided by a membrane into two halves: one contained sulfuric acid, and the other one – a mixture of substances (for example, potassium chlorate mixed with powdered sugar), which after activating the "cigar" by the detonator interacted with the acid, released a large amount of heat energy, led to an explosion and a flame. The device was placed in the holds of ships with a military cargo heading from the United States to Europe. By this kind of devices, there were burnt and exploded more than 40 military enterprises and 47 ships loaded with a military cargo in the United States. Experience showed that the use of incendiary means during subversive activity usually gives a much better result compared to the use of even big explosive devices. Fire can spread and cause much more damage than an explosion. In addition, they are small in size, a variety of designs and appearance, they are easy to be disguised under the surrounding objects. Therefore, subversive incendiary devices, both regular (incendiary means, etc.) and special means disguised as ordinary household items, are still widely used in subversive activities (Ardashev, 2001, pp. 146–147).

The Concusions. Thus, during World War I, under the influence of science achievements and war conditions, new promising incendiary devices (jet flamethrowers of land and sea bases, incendiary bombs, shells, hand grenades, subversive incendiary devices, etc.), as well as incendiary substances and mixtures. Their unique combat properties of incendiary devices have not lost their significance under modern conditions.

Germany was the leader in invention of flamethrowers and incendiary aerial bombs. Russia was the leader in invention of high-explosive flamethrowers, Britain – ship flamethrowers, and the United States – a flamethrower tank.

Under the conditions of maneuvering and "trench warfare" flamethrowers, as auxiliary weapons during a close combat, provedto be effective against tanks, flanking and strongholds of positions, machine-gun nests, gorges, cellars, deep dugouts and other similar defensive buildings which infantry could not destroy or suppress with artillery, machine gun or rifle fire. By means of flamethrowers, powerful fires and smoke screens were made.

Flamethrowers were used under special conditions of offensive or defensive combat effectively, in particular in residential areas where the enemy was attacked by a jet of fire. The enemy, who defended in houses, was ousted from basements, cellars, dugouts and other shelters.

In addition to the destruction and fires, incendiary weapons had a significant impact on the morale of troops and civilians, causing panic and fear.

Mankind's experience in creating incendiary weapons and its use during World War I has not only a scientific but also a practical significance in terms of increasing the combat capabilities of the Armed Forces of Ukraine. Taking into consideration this experience will contribute to the further development of perspective incendiary devices, as well as tactics for its use under various combat conditions.

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