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Special Topic: ***Forensic Examinations – Terms and Techniques***

Forensic Studies of Trace Evidence Altered by Fire

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Abstract

When investigating crimes involving fire, it is necessary to assess the event of a crime and the circumstances and to find the causes and spread of the fire, and the possible evidence supporting that the fire was used as a means of concealing a previously committed crime, i.e. murder, burglary, etc. Forensic studies of the objects damaged by the fire require the knowledge of theoretical aspects and the ability to detect and evaluate changed patterns in handprints, shoe prints, traces of break-in tools and documents, rifling impressions on bullets and shells that have been subjected to high temperatures. The paper outlines a list of objects of forensic examination that are relevant to disclosing and investigating crimes involving fire. During the course of the study the authors have reviewed the information available in forensic science literature and conducted their own experiment. The authors propose additional guidelines on techniques and methods for differentiating signs of thermal effects on traces and objects, evaluating the damage caused by heat and assessing the results for their effective use in identification and diagnostic procedures. The combination of the technologies used makes it possible to decipher the damaged language of traces.

Keywords: Trace Evidence; Forensic Studies; Fire; Thermal Effects

Abstract

Для раскрытия и расследования преступлений, связанных с пожарами, необходима оценка самого события пожара и его последствий, цель и предмет доказывания (причины и механизм пожара, способствующие его возникновению условия, использование пожара, как средства сокрытия ранее совершенного преступления – убийства, кражи со взломом и др.). Для криминалистических исследований объектов, подвергшихся изменениям в условиях пожара, необходима проработки теоретических аспектов, выявления закономерностей изменения следов рук, обуви, орудий взлома, следов оружия на пулях и гильзах, документов и его реквизитов под действием высоких температур. С учетом потребностей практики раскрытия и расследования преступлений, связанных с пожарами, выделена актуальная группа объектов криминалистических экспертиз. В решении задачи по выявлению закономерностей изменения материальных объектов и следов на них под действием высоких температур авторами обобщены имеющиеся в криминалистической литературе сведения, проведены собственные экспериментальные исследования. Внесено предложение дополнить методики экспертного исследования рекомендациями о приемах и методах дифференциации признаков термического действия в следах на объектах, производства измерений вносимых теплом изменений, оценки таких изменений в контексте возможности использования следов в решении идентификационных и диагностических экспертных задач.

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Oftentimes, items found at the scenes of the fire bear trace evidence, such as traces of weapons, tools and other objects used in the process of committing the crime as well as traces of the culprit himself. Traces of crimes are signs that make up a special language, which requires special knowledge to read. According to Peirce's classification, traces are signs-indices (Peirce, 1932, pp. 391-426). (Gaspard, 2021) sees the possibility of applying the concepts of “terms”, “propositions”, and “arguments”, which allows to consider the tasks of forensic investigation as a linguistic logical task. For example, a forensic procedure such as physical match or end match (the realignment of two or more objects to prove that they at one time formed a single object) (Brooks et al., 2020) can be considered a disjunction In the event of a fire, meanings must be derived from signs that are damaged. Nowadays, one of the main objectives of forensic science and forensic examination is to develop technical tools and methods that can be used for detection, recording, extraction and research of trace evidence affected by fire. However, there is no comprehensive solution to this problem.

The current state of forensic research of objects altered by thermal effects of the fire reveals that the main issues are determined by the currently established methodological approach of ensuring the disclosure and investigation of crimes involving fire. The main goal of this approach is to assess the event of the fire and its consequences, which also means finding evidence.

In the context of an investigation or search operation, the fire is described as the result of deliberate or careless actions that leads to the destruction and damage of property as well as death. It is often used to hide trace evidence of a previously committed crime, for example, murder, burglary, etc. A fire can also be the result of natural phenomena (a lightning strike, etc.). Lastly, fires can be caused by law enforcement operations that localize and disband armed gangs and terrorists (pyrotechnics, specialized models of small arms and ammunition, etc.).

This approach to the fire assessment was taken into account when determining different fields of studies and scientific bases of forensic studies of objects extracted from the fire scenes.

First of all, it is necessary to mention the specifics of forensic analysis in fire investigation. It includes establishing the cause of the fire, the area of its origin, the direction of flames spread, the time and temperature of thermal exposure, finding flammable and combustible liquids in the fire origin, calculating the weight and volume of burned and charred substances and materials.

Biological objects that have traces of thermal and chemical effects of the fire such as a person’s body or an animal carcass are subjected to forensic medical examinations. The purpose of these examinations is to determine the cause and time of death; the nature of found traces, how they were formed and if they were formed before or after death; the M.O. of the committed crime; to analyze the victim's blood type and match it to the blood found at the crime scene, during searches of suspects or on furnishing and clothing; to investigate the possibility of committing murder and then destroying the body in a certain place and at a certain time; to establish the sequence of when the death and fire occurred; to examine the chemical composition of the victim’s bone remnants and then match it to the chemical composition of the bones typical for a person of that sex, age, physique and

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other individual characteristics which is then used as a basis for identifying the person; to match hairs found at the crime scene to a specific person.

Forensic investigations of the objects collected from the fire sites are conducted in order to detect conventional trace evidence such as human traces (handprints, footprints), shoe prints, traces of break-in tools, firearm traces, etc. However, the current state of expert forensic investigation of the objects altered by the fire appears to be significantly less developed in comparison with forensic science in fire investigation and forensic medicine. Its application is mostly limited to solving certain issues with detecting handprints (Dashko, 2018, pp. 92-95); experiments with weapons damaged by the fire and their firing capabilities (Astapov, 2013, pp. 93-94); studying the nature of thermal damage done to clothing, as well as the thermal source and its temperature (Mailis, 2014, p. 103); studying burnt and charred banknotes (Sosenushkina, 1996, pp. 49-55), chemometric applications related to the analysis of ignitable liquids and fire debris (Sigman & Williams, 2020; Vergeer et al., 2020).

This negatively affects the quality of forensic investigation of the objects that have been altered by the fire, and limits the effective use of its results when establishing truth in court. Therefore, there is a need for a comprehensive solution for various areas of such research.

1. First of all, in theoretical terms, it is necessary to determine the nature and subject of forensic studies of trace evidence that has been altered by the fire.

The authors suggest that, in order of priority, this type of studies relies on theoretical knowledge in forensic science, the theory of forensic examination (forensic expertology), forensic examination and its various aspects (traceology, fingerprint analysis, forensic ballistics, technical examination of documents), forensic analysis in fire investigation and other engineering and physical sciences.

Knowledge and deep understanding in the mentioned areas will ensure higher success rate in detection, analysis and use of forensically significant information about objects and traces subjected to thermal effects in the fire in order to establish the circumstances of a crime. This knowledge covers the objective needs for investigating and disclosing crimes in practice.

In terms of forensics, this scientific knowledge allows us:

– to study the change patterns in traces and objects that have been exposed to the fire under various conditions, as well as the process of damage formation on objects and traces during the fire;

– to give an expert assessment of changes in the appearance, structure of objects and traces;

– to determine the possibility of expert identification of the criminal by handprints, shoe prints, identifying the firearms, tools and other items used in the crime;

– to resolve issues of a diagnostic nature, including complex forensic examinations, aimed at establishing the process and circumstances of the crime.

It is noteworthy that each type of forensic examination has its own objects, traces and methodological approaches to solving expert problems. At the same time, the thermal effect on the objects and traces on them makes it possible to separate the forensic study of the objects damaged by the fire into a separate group. Taking into account the current state of conducting forensic examinations, it would be reasonable to add the following

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items to the number of thermally affected objects and traces constituting those signs that can be read :

– small arms and their marks on bullets, gun shells and obstacles;
– traces of break-in tools and shoes, mechanical damages to items of clothing, etc.;
– traces of hands and bare feet;
– documents with traces of thermal effects on them.

Evidently, forensic ballistics studies damaged objects, i.e. small arms, cartridges, bullets, shells, shot marks. Traceological examinations study changes and damages inflicted by the fire to break-in tools and the traces they leave, mechanical damage to clothing, track traces left at the crime scene and so on. Forensic fingerprint analysis study damaged handprints on various surfaces, including Molotov cocktails, as well as handprints hidden under a layer of soot. In the forensic document examination, important results can be obtained by examining documents damaged by the fire, restoring their contents and studying damaged records, seals, etc.

Overall, forensic research of trace evidence altered by the fire studies and assesses the patterns and traces under various conditions of exposure to the fire, and studies their effectiveness in identifying objects, establishing the circumstances of the event of a crime.

The main subject of research of trace evidence altered by the fire are the facts and circumstances established by means of this examination that are used to identify objects, to determine the circumstances of a crime, while taking into account the impact of the fire on the objects under study.

2. In terms of application, the development of forensic studies of trace evidence altered by the fire requires solving problems of identifying change patterns in objects and traces on them, determining the effectiveness of using these traces in identification and diagnostic processes.

Identifying and explaining the change patterns in traces (i.e. handprints, shoe prints, traces of bullets, shells, etc.) relies on fire being described as a physicochemical process. This fact creates a need to analyze the damaging aspects of the fire, their influence on a specific object and trace. Understanding these aspects is crucial for identifying these patterns and interpreting them in order to solve any given task.

With regard to individual objects in the forensic literature, there is data on the nature of the change in an object under the influence of high temperatures, the dynamics of changes in traces and the preservation of their morphology in the context of the subsequent use of traces for solving identification and diagnostic problems.

According to the observations made by V.D. Katorov and L.V. Dashko's handprints of the criminal can often be found on the shards of glass that made up a Molotov cocktail used to commit arson. However, such traces usually are undetectable visually. An exception is the situation where handprints are left on the outer surface of a glass bottle with a thin layer of gasoline. When the gasoline burns, handprints can be seen with a magnifying glass. Barely visible handprints on the glass surface of a bottle after its breaking can be detected with cyanoacrylate vapors (Katorov, 2017, pp. 58-64). After such procedures, it is possible to conduct forensic identification.

Scientific literature describes many studies on forensic identification and study of handprints at the scene of fire (Ivashkova, 2019, pp. 117-120) (Fig. 1)

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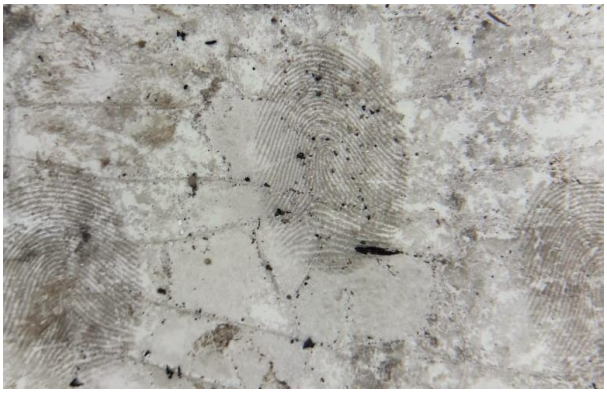

Figure 1. Detected handprints that were left on glazed ceramic tiles under a layer of soot (temperature – 4500 ºC, time of exposure to heat – 15 min; a fire hose was used to extinguish the fire)

The forensic assessment of small arms seized from fire sites, as well as the assessment of rifling impressions is discussed in a number of scientific works by I.V. Latyshov (Latyshov, 2012, pp. 61-64; Latyshov, 2015, pp. 50-59).

The results of the study have shown patterns and correlations between changes in bullets, shells, rifling impressions and various temperature regimes, the duration of exposure to fire. The changes that were tracked included the appearance of oxide films or mill scales of different color and structure, the destruction of rifling impressions, the influence of these changes on the possibility of identifying the weapons (Fig. 2).

According to S.E. Kazakova, in the study of the physicochemical properties of documents, there are 4 transition stages depending on the temperature (Kazakova, 2013, pp. 74-81): drying – up to 150 °C; charring – 150-200 °C; incineration –200-500 °C; ashing – 500-800 °C.

However, the results of the study do not cover the whole variety of cases of changes in the trace evidence altered by thermal effects of fire. A considerable part of the objects and traces generally remain without due attention, which requires conduction of experiments and observations of their changes under high temperatures.

In this aspect, there are experiments planned that will study a group of objects mentioned higher: small arms, rifling impressions on bullets, shells and obstacles; traces of break-in weapons, shoes and mechanical damage to items of clothing; handprints and footprints; documents and their attributes.

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Figure 2. Changes recorded in bullets fired from a 9 mm Makarov pistol that were subjected to high temperatures (temperature – 250, 500, 750 and 10000 °C, exposure time to heat – 10, 20 and 30 min.)

During the simulation of fire in experiments, the varied parameters should include the object material, the time and temperature of exposure to fire. The results obtained during the study make it possible to explain the change in objects and traces, to assess the nature of traces and the effectiveness of using such evidence in identification and diagnostic procedures.

3. As for the methodological side of the problem, there is a need to design guidelines for conducting expert studies of trace evidence altered by fire and to integrate these studies into other expert procedures. It is also necessary to provide appropriate technical solutions for this research.

The authors propose developing a set of guidelines on techniques and methods to add to the current structure of expert research used in forensic examination. These methods include differentiating signs of thermal effect in traces and objects, making measurements of the changes caused by heat and assessing these changes in the context of using the results in identification and diagnostic procedures.

The development of expert methods for forensic research of objects altered by the fire is directly linked to the technology used for such examinations. For example, there is currently a need to determine the full scope of necessary technical means, equipment and software that make the identification and analysis procedures of the nature of trace evidence possible.

In the authors' opinion, certain stages of forensic studies of trace evidence altered by fire can be carried out by prior agreement in specialized laboratories for forensic analysis in fire investigation. This allows using such equipment and tools as a muffle

furnace, specialized metal cases for conducting fire tests, etc. It is also necessary to use specialized outdoor test sites for fire tests.

An example of using specialized knowledge in investigating crimes involving fires is the compound forensic expert studies or a complex of forensic examinations.

In the course of developing technical and forensic tools and methods that can be used for detection, recording, extraction and research of trace evidence altered by fire, the authors obtained a patent for a utility model. The patent is given for a portable device which can detect and record traces left on unpainted metal surfaces coated with industrial oil (Pakhomov, 2014). In practice it opens up new opportunities for identifying footprints in industrial facilities that have been exposed to the fire.

The forensic research of trace evidence altered by the fire can be upgraded by determining the nature and subject of such research, finding change patterns in objects and traces on them inflicted by high temperatures, adding guidelines on techniques and methods for differentiating signs of thermal effects in traces on objects, making measurements of changes caused by heat, assessing the results and evaluating the effectiveness of identification and diagnostic procedures. The combination of the technologies used makes it possible to decipher the damaged language of traces.

The guidelines and suggestions proposed by the authors for the development of forensic research of objects altered by fire include an integrated approach which increases the efficiency of disclosing and investigating crimes involving fires.

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