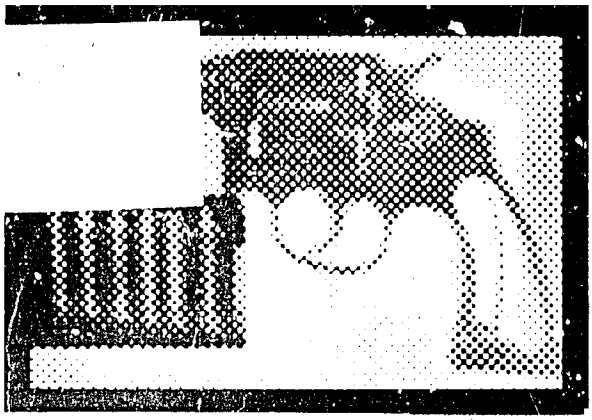

elements of criminalistics

ELEMENTS OF CRIMINALISTICS

by

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Foreword

About the book

In the unavoidable fight of law enforcers against the forces of criminality, there is a gap that is left unbridged after all these years and that is, the up-to-date training of policemen along scientific and modern methods of crime detection and investigation. This shortcoming has always besieged the rank and file of many police agencies in the country.

Economic progress is our urgent, immediate objective but without peace and order, this may be an unrealistic goal. Peace and order requires police forces to be fully equipped and well-trained scientifically in the modern methods of combatting crimes in all its forms. Classroom instruction is not all that is required in police training. Suitable, adequate, and authoritative books, references, and other materials are needed. While we have numerous books on criminal investigation, they are all of foreign origin authored by persons who are not familiar with local conditions and are, therefore, not entirely suited for local application.

This new book published by Messrs. Lorenzo Sunico and Elliot Hensel is indeed a pioneering effort towards the scientific approach to modern criminal investigation based on existing conditions and the idiosyncracies of our people, taking into consideration the laws of the country.

A perusal of this book would readily show that it is an invaluable material in the training of our policemen, a handy guide for all law enforcers, and a good reference for students of criminology.

I earnestly recommend, therefore, that all those engaged in the painstaking but noble profession of law enforcement to read this book.

JOLLY R. BUGARIN
Director
National Bureau of Investigation

About the authors

The Police Commission is pleased to present this first of a series of technical police manuals for the information and guidance of Philippine law enforcement officers.

Atty. Lorenzo A. Sunico needs no introduction to Philippine law enforcement. Besides giving expert testimony in hundreds of courts throughout the country, he has long been known as a teacher of criminalistics to thousands of policemen. Atty. Sunico began his career in law enforcement in 1939 as Assistant Chemist of the Medico-Legal Section, Division of Investigation under the Department of Justice. He later became Chief of the Forensic Chemistry Division when the Division of Investigation was expanded into a Bureau in 1947. In 1961 he was promoted to Assistant Director-Coordinator for Forensic Chemistry and in 1965 he was designated Chief of the Technical Services, National Bureau of Investigation (NBI), when all the technical divisions were consolidated into one office. He was designated acting Assistant Director for Criminalistics in 1968, and in 1969, Deputy Director for Technical Services in the NBI.

Mr. Elliott B. Hensel was educated as a clinical chemist but entered law enforcement in 1947 as Coroner's Toxicologist for the County of Ventura, California, U. S. A. He later became Director of the Ventura County Crime Laboratory. He joined the Office of Public Safety in 1961 and has served as an advisor in criminalistics to the governments of Libya, Ethiopia, Peru, and the Philippines.

Both authors draw on a combined total of fifty years of criminalistics experience in the preparation of this book.

Brig. Gen. CRISPIN M. de CASTRO
Chairman
Police Commission

Preface

Criminalistics has not yet become a fully independent scientific discipline, and no university yet awards a degree by this title. Men who practice criminalistics come from medicine, pharmacy, chemistry, engineering, and the ranks of the police. Questioned document examination and firearms identification are still learned entirely by the apprentice method, while a majority of fingerprint experts learned their work by home study through a well-known correspondence school.

Before World War II, much forensic science was done either by government chemists or private practitioners who were called upon by the police as needed. Lucas and Bamford were government chemists; Smith and Glaister were medical school professors; Burrud and Hatcher were army ordnance officers. The Los Angeles Police Department had a one-man laboratory in the '20s, Chicago formed its laboratory in 1929, but Great Britain did not create its Home Office laboratories until after World War II.

In the Philippines, forensic physicians were appointed in 1876 and a Medico-Legal Laboratory was created in 1894. After the revolution, the first Crime Detection Laboratory was established by the U. S. Army in 1899. By 1904, analyses of counterfeit coins, poison tests, and bloodstain analyses were being performed. In 1924, all medico-legal functions were consolidated under the Department of Justice. This later merged into the National Bureau of Investigation (NBI) in 1945 where it remains to this day. The NBI is not the only Criminalistics Laboratory in the Philippines. Both the Manila Police Department and the Philippine Constabulary also operate criminalistics facilities.

In Europe and other countries under the Inquisitory Legal System, there is still a sharp separation between Legal Medicine and what is called the Technical Police. All examinations of evidence from the human body, its organs, and excretions are done by physicians. Inanimate things are tested by policemen. This dichotomy prevents the development of a single concept of an **Evidence Evaluator** which is what a criminalist ought to be. Parker of California and Kind of Great Britain have argued strongly that a criminalist needs to be educated and trained as such from the ground up. In the meantime, a group of specialists will be necessary to staff criminalistics laboratories until a generation of generalists can be developed.

In England and the United States, the criminalist can get to the scene of the crime in person to supervise the collection of physical evidence. In the emerging nations this is not possible. The police must rely on a trained group of technical investigators who can recognize, collect, and preserve evidence for transmittal to the laboratory. The Republic of the Philippines, for example, consists of 7,000 separate islands. Many are not serviced by regular transportation and a criminalist could not get to the crime scene for several days. The technical investigator is therefore an important member of the Criminalistics Service. It is for him that this book is written.

Few authors of technical books consider that their reader may be starting out from absolute zero. There are policemen in many parts of the world who know little of scientific and technical police methods. English is not the first language of these policemen, so this book has been written as much as possible in simplified phraseology.

Manila, Philippines
November 1968

LORENZO A. SUNICO

ELLIOTT B. HENSEL

Acknowledgements

Criminalistics is a lonely profession. There may be no more than one practitioner in a single police department and sometimes only one man serves an entire country. Criminalists therefore know most other criminalists throughout the world. We have used so much reference material from men we are proud to call our friends that we tender a blanket acknowledgement to our fellow members of the:

AMERICAN ACADEMY OF FORENSIC SCIENCES
FORENSIC SCIENCE SOCIETY
CALIFORNIA ASSOCIATION OF CRIMINALISTS
INTERNATIONAL ASSOCIATION OF FORENSIC TOXICOLOGISTS

for use of their writings and experience. A list of works consulted will be found in Appendix A. We have to thank in particular: Mr. R. J. Abernethy and Dr. A. S. Curry for running down references that were not available to us; Mr. J. S. Baker of the Traffic Institute, Northwestern University for permission to use charts and photographs for Chapter VIII; to the Chief Constable, Durham Constabulary, Aykley Heads, England for kindly furnishing photographs of safes opened by explosives, and to Detective Superintendent Arthur Chapman for reviewing and contributing to the section on Robbery of Safes; Mr. Alfredo Z. Santiago of the **Evening News** (Manila) for a photograph.

We must express our sincere appreciation to the Communications Media Division of the USAID Mission to the Philippines for the publication of this book and to Miss Jeanette Ho of the Public Safety Division who typed and retyped and mothered this book to publication.

1

Criminalistics And Its Disciplines

Criminalistics is often mixed up in people's minds with criminology. Criminology is the study of criminal people. Criminalistics is the study of criminal things. A criminal does a wrong act by means of things. He spills blood, breaks glass, falsifies papers, lets off firearms, gets stains on his clothing, or leaves the marks of his feet or fingers at the place of his crime. These criminal things are called physical evidence.

Many of these criminal things are very small and have to be looked for with a microscope. Some must be tested with chemicals to find out what they are. Some criminal things are hidden and have to be dusted with powders or looked for with special lights to see them. The making of these tests is the work of a criminalist. A criminalist is a person trained in science who uses the ways of the laboratory to help the police. In some countries, he may be called a forensic scientist.

There are six main divisions of criminalistics. Three are scientific and three are technological. The scientific subjects are **Chemistry**, **Physics**, and **Biology**. The technologies are **Questioned Document Examination**, **Firearms Identification**, and **Latent Fingerprint Identification**. The scientific subjects require the study of science and mathematics before practical training in the laboratory. Technological subjects are usually learned directly by practical training in the laboratory under the supervision of an experienced examiner.

Chemistry. The original name for criminalistics was forensic chemistry, which shows the importance of the chemist in this field. The chemist is an important member of the laboratory staff because his tests are the most difficult. His work includes alcohol analysis, toxicology, narcotic testing, firearms discharge residues, identification of paint chips, chemical development of latent fingerprints, and all types of analysis that use electronic instruments.

Physics in a police laboratory is often done by the chemist because most of the physical problems in criminalistics are fairly simple. Firearms identification, toolmark comparison, scientific photography, the study of traffic accidents to find out the speed and direction of vehicles, and the use of X-rays are some of the duties of a physicist in a crime laboratory.

Biology is the study of living things. The biologist in a police laboratory examines all kinds of things that come from living things —blood, semen, urine, hairs, and skin. He identifies seeds and leaves of plants. He is particularly skilled in the use of the microscope. He may help the pathologist to make very thin slices of animal tissues to study disease and injury. His most important criminalistics duty is to examine bloodstains to find out if they are human or animal. If the blood is human, the biologist will try to find out which blood group it is.

Firearms Identification has to do with the comparison and identification of weapons used in the commission of crimes. It is sometimes wrongly called ballistics, but this is not a correct word for the work done

by a criminalistics examiner. **Ballistics** is a branch of engineering that studies the art of throwing missiles by means of a machine. It is also a study of the motion of such projectiles in flight. Ballistics engineers are concerned with the design of weapons and projectiles. Firearms examiners are concerned with finding out whether a bullet or cartridge was fired from a certain weapon. They also try to find out how far away the criminal was when he fired at the victim. They help the pathologist to decide from a study of wounds how the weapon was held. They tell the investigator what make and model of weapon was used to fire the bullet found at the crime scene. Firearms examiners must of course know something about ballistics, but they are not qualified ordnance engineers.

Questioned Document Examination is concerned with the examination of forged, altered, or suspect papers to see if they are genuine, or if they have been changed in any way. Document examiners develop hidden writing and reveal erasures and changes. They compare ink, pencil, typewriting, and printed material of all kinds. They try to restore burned papers so they can be identified. They use ultra-violet, infra-red, transparent, and sloping light as well as photography with special filters.

This branch of criminalistics should not be mixed up with graphology or "handwriting analysis." This is a method that claims to find out all about a person's character and personality by the way he makes his letters and shapes his words. The graphologists claim that they can examine a person's writing and tell whether he is honest or has a bad temper or is careful with his money. Most American and British document examiners do not concern themselves with these matters, but some European examiners use graphology.

Photography is not regarded as a separate criminalistics discipline because every criminalist should know how to photograph physical evidence. All student examiners in the United States Post Office Laboratory spend their first year of training learning to do the special photography required in criminalistics. This includes microphotography, macrophotography, infra-red, ultra-violet, and special light procedures. In a large laboratory employing many examiners, it is helpful to have a photographic technician to assist the criminalists with their work, but the responsibility of taking evidence pictures always belongs to the examiner.

Polygraph or **Lie Detection** is a scientific police method but it is not a part of criminalistics. The polygraph is sometimes placed in the laboratory because it is a scientific instrument, but it belongs in the Criminal Investigation Department. The polygraph examiner ought to have some schooling in physiology and psychology, but most of all he should be an experienced C. I. D. officer with training in criminal investigation and interrogation.

THE TECHNICAL INVESTIGATOR

Many thousands of crimes have been solved by investigators without any help from a laboratory, but no criminalist has ever solved a crime without the help of an investigator. It would be a fine thing if every policeman were carefully trained to locate physical evidence, collect it properly, and send it to the laboratory in the correct way. But some kinds of physical evidence have to be gathered in a special manner and put in certain types of containers, and for this reason it is better to have specially trained men. These men are called Technical Investigators or Scientific Aids Officers. They are provided with a field kit containing measuring tapes, sketching equipment, cameras, fingerprint material, forceps, plaster, and various types of paper bags and pillboxes for preserving evidence. They have been taught the correct manner of collecting and preserving bloodstains, hairs, paint, toolmarks, as well as the taking of plaster casts, moulage, and latent fingerprints.

Before a technical investigator can do his work properly, he should spend some time in the Criminalistics Laboratory to learn how the examiners make their tests after they receive the physical evidence. The technical investigator does not have to know how to make the tests himself, but by watching the examiners he learns why they have

to have physical evidence collected in certain peculiar ways.

THE CRIMINALIST

There are many different kinds of scientists, but there is only one kind of science. Science is an ordered body of knowledge based on the observation and the testing of facts. All scientists work by certain general laws and guiding rules called principles. These principles are the same for all branches of science. It does not make any difference whether it is soil science or space science or police science—there is no special Baptist biology or Communist chemistry or Republican physics.

Any scientist of course obeys the laws of his country and the administrative rules of the organization to which he belongs. But he also has to obey the Law of Gravity and Laws of Heredity, and he cannot make 2 and 2 add up to 5 even if his superior gives him a direct order to do so. This means that if he comes to certain conclusions from the results of his tests, he is going to remain firm in his opinions even if it will displease his superiors.

The policeman is much like a soldier. He is trained to respect authority—and that authority's opinions, no matter how stupid they may appear to be. The scientist, on the other hand, cultivates complete freedom of thought and expression. Anybody can argue with anybody else. What matters is not who you are, but what you have to say. The scientist has no respect for "authority" as such. He wants to examine the facts, check the calculations, verify the data.

The criminalist is therefore often not very popular with his fellow policemen. He has to have a particularly courageous form of intellectual honesty. He has to stand firm in the face of criticism by angry superior, hostile lawyers, and disgruntled detectives when his laboratory reports do not back up some detective's brilliant solution to a crime. The heroin capsules turn out to be milk sugar? Too bad! The firearms report will hang the Mayor's brother-in-law? The police scientist could care less. His findings may be hard to swallow and they may be ignored—or even suppressed. But the report goes in exactly the way he wrote it no matter what any superior officer says. It is for this seemingly obstinate attitude and stubborn loyalty to the ethics of science that many criminalists are ranked as civilians.

The criminalist is not allowed to use any secret methods. He is bound to tell exactly how he does every test. If he finds a new and better way of doing a test, he must put it before the public and share his knowledge with all other criminalists in the world.

The criminalist has a duty to teach others. Besides giving lectures and demonstrations to police cadets and field officers, he must instruct new laboratory technicians and examiners. He must give talks to professional societies and write papers to be published in scientific periodicals.

The criminalist has to be this way because unless he is, he cannot call himself a scientist. He will not be recognized and respected by other scientists in his own country or in other parts of the world. This approval by other scientists is very important to a criminalist because his work must be acceptable to the courts of law. The courts will make inquiries about the reputation of any criminalist who appears before them, and if he is not approved by his fellow criminalists, he probably will not be allowed to give testimony or submit official reports to the court.

THE EXPERT WITNESS

In the law courts a witness is not allowed to give his opinion about certain matters unless the court has decided that he has the necessary fitness to qualify as an expert. It is wrong to think that some persons are experts and others are not experts because every person is an expert to some degree. It is also wrong to think that an expert must be a person with high academic degrees, or that he must be a person who works in the field about which he is testifying. In English and American law, there are no permanent kinds of experts. The right to give an opinion is always dependent on the matter before the court, and whether the witness has the right to testify depends upon the subject he

is talking about, and not on him. The only necessary thing is that the witness must be fit to acquire knowledge about the matter he will testify to.

A person is able to give expert opinion only after special experience. The possession of this special experience cannot be assumed but must be shown beforehand. This experience may have been gotten in any way at all. All that the law requires is that it has been obtained. There are two main kinds of experience:

1. **Occupational experience** that a person gets by working at his job for a long period of time.

2. **Systematic training** that a person gets by study in school.

It is not possible to draw a sharp line between these two classes of experience. In some cases the witness might have to have both. Neither one is favored above the other by the law courts. The question in each case is whether the witness is qualified. The courts make no difference between the two kinds of experience.

In deciding fitness, the court must find out whether the matter to be testified to needs only general and ordinary experience, or if special experience is needed. The prosecutor must show that his expert has the necessary special experience. It is left to the judge at the trial to decide whether the expert does. The qualifications of a witness are usually established by his own testimony regarding the facts of his work and his special training.

The law courts usually require a person who testifies about chemical, physical, and biological matters to have a great deal of laboratory experience analyzing evidence. A police investigator often knows enough about a subject to qualify as an expert, but in matters where chemical and biological tests are made, the courts usually require that the expert must have worked in the laboratory for some time before they will let him testify. It is for this reason that even if a police investigator knows how to make test for blood or for narcotics, he must still send the evidence to the laboratory for corroboration by the experts.

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2

Principles Of Evidence Analysis

I keep six honest serving men
They taught me all I knew;
Their names are What and Why and When
And How and Where and Who.

—Rudyard Kipling

IDENTITY AND IDENTIFICATION

All police work is concerned with identification, or finding out WHO the criminal is, WHAT something is, WHERE the criminal has been, or HOW he broke into the building. Why he committed a crime interests the criminologist, not the criminalist. The investigator may know these things, but he needs proof to convict the criminal in court. He does a lot of this with physical evidence, and his main task is always to establish identity.

"Who Is He?" The first work in identification was concerned with people. In early times, criminals were branded to identify them. Sometimes the hand of a thief was cut off, or the tongue of a slanderer was cut out. Branding was still used in Russia until 1860. During World War II, prisoners in German concentration camps were marked with tattooed numbers. A system of identification by means of body measurements was invented by a Frenchman named Bertillion, and finally the fingerprint system was introduced by Galton and Henry. This is now the most common method of personal identification.

The art of personal identification by the inked impressions of ten fingers has become so specialized that it is now a separate branch of police service. It is usually not done by criminalists. The criminalistics laboratory is concerned with the identification of people by the things they leave behind, or the things they carry away with them. This includes latent or hidden fingerprints left at the scene of a crime.

"What Is It?" Usually the investigator knows what something is but needs a scientific analysis to prove it. An example of this would be bloodstains or marihuana plants. Or, the investigator has a white powder that requires a complete analysis to find out what it is. An example of this would be poisons or narcotics.

"Are These Two Things the Same?" A more important problem of identity is **comparison.** This kind of identification is often not understood by either laymen or scientists. Here, the criminalist is not at all concerned with the exact composition of physical evidence. He only wants to know whether two separate pieces of evidence are alike. An example of this would be two bullets. The criminalist only wants to find out if both bullets were fired from the same gun. He does not care at all whether the bullet is made of lead or antimony or even limburger cheese! The criminalist only wants to know if the lipstick stains on the shirt of a suspect are exactly the same as the lipstick on the mouth of the murdered woman. He is not at all interested in knowing the brand of lipstick, its chemical composition or the color, hue, or shade. His only concern is—are the two stains identical?

"Did These Two Things Come from the Same Place?" Identical means that two things are **alike in every detail.** Sometimes all that a criminalist can say is that two things are only **similar,** or of the **same sort** or **kind.** This kind of report sometimes causes disappointment to investigators and lawyers who fail to understand that this information can be just as valuable—if there is enough of it.

Leland Jones illustrates this with the following actual criminal case:

THE CRIME SCENE	THE SUSPECT
A robber climbed up some pipes at the rear of a building. The pipes were painted red.	Red paint of the same color and composition was found on the suspect's shoes.
He crawled across a roof and climbed over a wall, leaving fabric impression marks with ten to the inch weave and twelve to the inch weave.	The suspect was wearing a jacket with ten to the inch weave. He was wearing trousers with twelve to the inch weave.
He left footprints made by a size 6 shoe with rubber heels showing the name GOODYEAR, and a metal tap on the toe.	The suspect's shoes were size 6, had rubber GOODYEAR heels, and a metal cap on the toe.
The robber broke a window and crawled through a hole in a wall coated with yellow plaster.	Broken glass and yellow plaster were found in the turn-up cuffs of his trousers.
The sum of $1,250 was taken from the cash box in the building.	The suspect had $553 in his pocket when arrested. He had bought an automobile for $700 on the morning of his arrest, indicating that he had had $1,253 in his possession earlier that day.

All of this evidence consists only of similarities, and no single piece is conclusive by itself. Yet taken collectively, they all point

to the same conclusion. Their value is based on the Law of Probability, or the relation between chances that a thing is true. Jones sums it up as:

> *A number of individual similarities that are each of low evidentiary value, yet which all point to the same conclusion, can be just as important evidence as a fingerprint.*

"**Was He There?**" In the foregoing example, let us say that not more than one person in one hundred has red paint on his shoes, that only one in one hundred has yellow plaster in his trouser cuff, that only one person in one hundred has the exact amount of money that was stolen less what he spent, etc. These probabilities are conservative, yet the chances of finding one man having all these pieces of physical evidence would be 100 x 100 x 100 x 100 x 100 x 100, or one chance in a trillion!

SIMILARITY AND CLASS CHARACTERISTICS

Since so much of criminalistics has to do with comparison, it is important that the investigator always bring to the laboratory **standards of comparison**. Bloodstain evidence requires samples of blood from both the suspect and the victim. Suspected documents need genuine papers done at the same period of time. Bullets and cartridges should be accompanied by the weapon suspected of being used in the crime. Mud on the suspect's shoes should be accompanied by samples of soil from the crime scene.

The first thing the investigator should do before sending evidence and standards to the laboratory is to make sure the two pieces are **similar**. The criminalist cannot compare apples with oranges. He cannot match a .38 revolver bullet with a .45 automatic bullet. The similarities of physical evidence are called **class characteristics**. The most common example of this are bullets which have quite a number of class characteristics that can be distinguished by an investigator.

Type	Rifle or pistol?
Kind	Lead or jacketed?
Shape	Pointed, rounded, wadcutter?
*Caliber	.22, .32, .38, .45?
Grooves	3 to 16?
Twist	Left or right?

COMPARISON

Having come to a decision that two pieces of physical evidence are similar, the criminalist then proceeds to make a comparison. He puts the two pieces side by side and examines them for differences. If he cannot find any differences, then he reports that they are probably of common origin, or came from the same place. In order to say that the pieces are identical, he must try to find some point of individuality, or what makes one thing different from all other things like it.

Sometimes it is not possible to establish identity with certain kinds of physical evidence. Bloodstains are an example of this—at the time of this writing. There are fewer combinations of blood group factors than there are people in the world, so it is always possible that more than one person will have the same blood group. Scientists are continuing to study blood, and it may be possible someday to find some point of individuality between different persons.

Firearms, on the other hand, can be identified with a high degree of probability because the machines that make them leave uncommon and unusual markings on the barrel that produce individuality.

Automobile headlight glass is an interesting example of a material that used to have enough individuality for the criminalist to tell what make and model of car it came from. But with the introduction of the sealed beam headlight, all automobile manufacturers now buy their headlamps from only one or two manufacturers. While it is not now possible for the criminalist to tell what make

*If the investigator tries to measure a gun or bullet to find the caliber, he should remember that the numbers .22, .25, .32, .38, and .45 are only convenient factory numbers and are not the true measurements. These common numbers refer to the size of the bullet, not to the gun bore. The gun bore is always smaller than the bullet in order that the bullet will "bite" and be given a twisting motion. The popular size "38" takes a .36 inch bullet and its bore is .35 inch! Consult the table in the chapter on Firearms Identification for the true bore and bullet measurements.

of car it came from, he can usually tell exactly which particular car it was by fitting together the glass fragments from the accident scene with the broken glass found on the suspected car.

A comparison is made by finding a sufficient number of similarities and the absence of any dissimilarities that cannot be explained. There are both fundamental and explainable differences in a comparison. Fundamental differences would be such things as:

Bullets of different calibers
Shoes of different sizes
Typewriters with different type sizes.

Explainable differences would be such things as:

Parts missing
Rocks in a plaster cast of a footprint
Typewriter has been cleaned since document prepared.

The best kind of comparison is where the criminalist can fit two things together—two pieces of broken glass, the torn halves of a piece of paper. This is a very good kind of comparison to show in court if the two pieces are large enough. Usually, however, the fragments are so small that the criminalist must make the comparison with the help of a microscope. He will then make large photographs and bring these to court to show identity.

INDIVIDUALITY

After the criminalist has shown two things are similar, he then looks for individuality, or what makes one thing different from all others like it. He looks for something uncommon or unusual, some imperfection or peculiarity. If he can now show that this unusual thing is present on both the evidence and the standard, he has established a practical identity.

Kirk points out that no two things will ever be absolutely identical. Two marks made by the same tool one right after the other will always show some small differences no matter how carefully they are made. But the experienced criminalist can say with assurance that both marks were made by the same tool, or that two bullets were fired from the same gun. It must always be understood by the investigator that identity is practical and not absolutely free from imperfections.

RARITY

Rare means hard to find or seldom met with. In criminalistics, it is applied to physical evidence that is unusual or uncommon. Location has much to do with rarity. A hat on a suspect's head is of no value as evidence. Found at the scene of a crime, it becomes important. The value of physical evidence increases as it is found closer to the center of the crime scene. A footprint on the outside of a building is not as strong physical evidence as it would be if it is found next to the dead body or near the robbed cash box. Leland Jones describes three kinds of rarity associated with physical evidence:

1. **A common thing is found in an unusual place.** An example of this would be a robbery of a warehouse full of sugar. A suspect is arrested. He is a carpenter by trade. Sugar is found in his automobile, on his clothing, adhering to his shoes. We would expect to find sawdust all about him, but not sugar.

2. **An unusual thing is found in a common place.** An example of this would be a robbery of a mining company where gold bars were stolen. A suspect is arrested. He is a plumber by trade. Fine gold dust is found in his automobile, on his clothing, sticking to his shoes. We would expect to find lead, but not gold.

3. **A common thing is found which has some unusual quality.** An example of this would be a murder where the victim was struck with a beer bottle. The victim has Group B blood. A suspect is arrested. The suspect has Group A blood. Fragments of a broken beer bottle are found in his car. Blood of Group B is found sticking to the broken glass bottle. An ordinary beer bottle is not valuable as evidence because it is common, but with Group B blood on it, it now has individuality.

EXCHANGE

The famous French criminalist, Locard of Lyons, formed a principle on which much of criminalistics is based. This says that whenever two things touch each other, there is always a transfer of material from one to the other. Any contact between the criminal and his victim or the crime scene will leave trace evidence on both. These traces may be so small that both the criminal and the investigator may not notice them. A criminal may brush against a wall, getting dust and plaster on his clothing. At the same time, some fibers from the criminal may be left behind on the wall. This is **exchange**, and the physical evidence of it is called **contact traces**.

Locard was more interested in discovering the occupation or trade of the suspect. Modern interest in contact traces is concerned with **putting the criminal at the scene of his crime** by the traces he leaves behind or the traces he carries away. An example of the first is a fingerprint. An example of the second is the victim's blood on the suspect's clothing.

Finding a fingerprint at a crime scene is the best type of contact trace evidence because if the print is there, the suspect had to be there also. Without amputation, the finger goes with its owner. With other types of contact traces, the investigator has an additional problem of connecting the traces to the suspect. As Jones says:

> *I can put the shoes in the footprint, and the footprint at the scene of the crime, if the suspect will get into the shoes.*

ERRORS IN SEEING

Every investigator knows that witnesses often do not see what they think they do. They may see things incorrectly. They make mistakes in estimating the height, weight, or color of suspects. They do not make accurate estimates of time or the speed of moving vehicles. One of the main services of criminalistics to the investigator is to help him measure things exactly. This includes weight and distance and color as well as the brightness of light. The investigator himself must not make these same errors of perception. **Perception** means the ability of the human mind to make sense out of the signals it gets through the eyes, ears, nose, or fingers.

People get 87 per cent of all perception through sight, 9 per cent through hearing, and only 4 per cent by smell, taste, and touch. Correct seeing is therefore very important in law enforcement. Knowledge of the identity of objects and features of the surrounding is necessary to establish identity. The picture of the world that comes to the brain is not like a camera. One of the commonest kinds of wrong seeing is called form blindness.

Form Blindness

Criminalistics owes a debt to Mr. Albert S Osborne, noted examiner of Questioned Documents, for first pointing out the existence of **form blindness**. Just as there are some persons who are "hard of hearing," there are other persons who are "hard of seeing." By this is meant that some people do not see some things that most other persons do. No person sees everything. The eye cannot see light in the ultra-violet or infra-red regions. In every normal eye, there is a small section called the **blind spot** in which nothing at all can be seen. The normal eye cannot see well at night until it has become accustomed to the darkness.

But besides these normal defects which affect everyone, there are other forms of vision defects like color blindness in which a person is unable to tell the difference between red and green. A person must also have the use of both eyes in order to see in three dimensions. Some persons are nearsighted and others are farsighted and need corrective glasses in order to see properly under these conditions.

These ordinary forms of vision defects are very well known but Mr. Osborne pointed out there is still another form of vision defect that is not too well understood. This he calls "form blindness." By this he means that there are persons who cannot see small differences of form, size, or shape. One common kind of seeing ability is the power

to measure with the eye or to see small differences in size. If two fine lines are placed a short distance apart and one is slightly longer than the other, some people cannot say which is the longer or whether or not there is any difference in them at all. This ability to tell the difference can be helped by training. A proofreader in a printing shop detects a wrong letter that an ordinary person does not see. A sailor on a ship can recognize an object on the distant horizon that other people need a telescope to see. Many people go through life and never know that other people see things better than they do.

Form blindness is important in criminalistics because the criminalist depends on visual demonstration of his findings to support his opinions. He prepares photographic enlargements and charts so that he can point out to the judge or jury the small differences that make up **individuality**. There will always be some persons who suffer from form blindness and who will be unable to see the small differences that the criminalist points out. It has been a general rule among criminalists for many years that a microscope should never be taken to court. To see properly through a microscope requires training. The criminalist makes photographs and takes these to court. People who look through the microscope for the first time are unable to adjust their eyes to see properly. If these are intelligent people such as lawyers and judges, they will not want to admit that they cannot see through the microscope. Gross has said that once we have been trained to use a magnifying glass and see small details, we can later recognize small details without the help of magnification.

Optical Illusions

There is another kind of wrong seeing that the investigator has to watch out for. This is called optical illusion, and is a trick played on the eyes by certain arrangements of light or form. Such optical illusions can easily cause the investigator to make false estimates of length, area, angle, or curvature. This sort of optical trick may affect even very highly skilled observers such as artists and draftsmen as well as scientists.

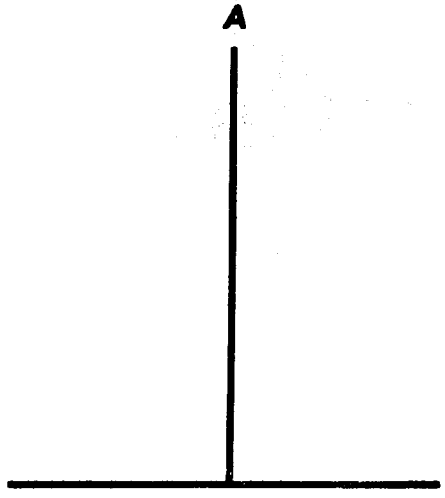


Figure 1

First look at Figure 1. Here are two lines of equal length, one vertical, the other horizontal. Most every person believes that the vertical line is longer than the horizontal one. A ruler will show that this is not true but without a ruler the illusion is very real.

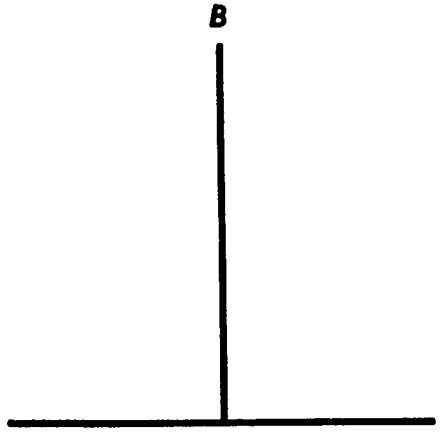


Figure 2

Now look at Figure 2. In this case the vertical line has been drawn to look equal to the horizontal line. Use of a ruler will show that the vertical line is a good deal shorter than the horizontal line although it looks the same. Professor S. Polansky of London University says that he always makes a mistake of 27 per cent for the measurement height of Figure 2 and that other persons do the same.

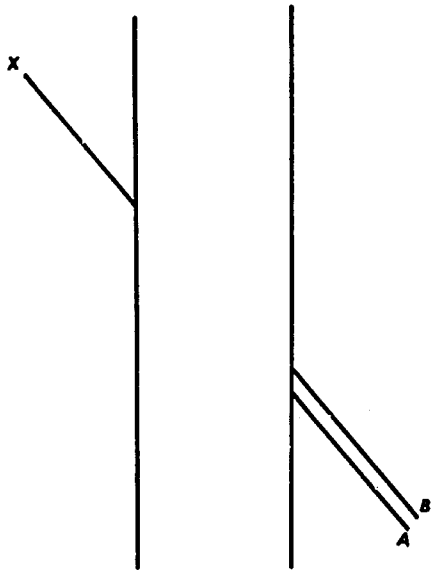


Figure 3

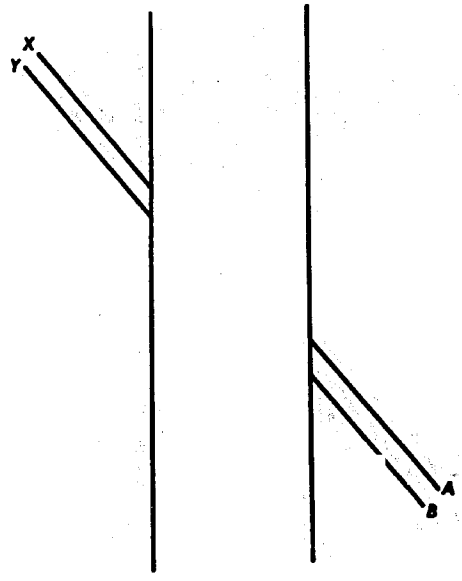


Figure 4

Now look at Figure 3. Which of the lines A or B are the continuation of line X? Check your opinion by using a ruler. The illusion is even more deceiving with Figure 4. Lines AX and BY seem to be parallel. A ruler will again show the truth. Hold the paper sideway and look at it from an angle.

These two examples show that it is always best to measure everything even if the dimensions seem obvious. We say, "about five minutes," "a stone's throw," "a snail's pace." These estimates or guesstimates will not do in a law court. Measure it! How fast is a snail's pace? Well, it has been measured by a scientist and found to be 58 cm per hour.

3

Examination Of The Crime Scene

Protect the Crime Scene

If the investigator is the first person at the scene of the crime, he must protect the crime scene from further contamination. Get everyone away from the crime scene who does not belong there. This includes other officers who have no responsibility for the investigation. Guard against touching or moving anything. Do not form any opinions. Write down the time you arrive at the scene and note weather conditions. Note whether doors and windows were open or closed and whether doors were locked. Note the license plate numbers of all cars at the scene of the crime. The criminal may run away then send a friend back to find out what happened. The criminal could be traced through the friend.

Do not touch anything until you have carefully inspected the crime scene and observed as much as possible. It is a good idea to put your hands in your pockets so that you will not accidentally touch anything.

Take Photographs

Make a Sketch of the Scene of the Crime

Collect Small Evidence First

Wear cotton gloves or use forceps to pick up small evidence. Look for things that are out of place or things that may have been carried away. Remember that the location of physical evidence is sometimes more important than its rarity. The closer it is to the center of a crime, the more valuable the evidence will be. A hat on the head of a suspect is not very valuable evidence, but if found at the scene of the crime it becomes more important.

Collect Fingerprints

Collect Standard Samples for Comparison

If bloodstains are collected as evidence, it is necessary to have a sample of both the suspect's blood and the victim's. For foot impressions, the suspect's shoes must be obtained and submitted with the evidence. It is most important that samples of the blood and the hair of a dead person be collected before the body is buried.

EQUIPMENT NEEDED BY THE INVESTIGATOR

Certain tools are needed to collect and preserve physical evidence. An evidence collecting kit should contain the following items:

Clipboard	Fine and medium emery paper
Carbon paper	Scissors
Measuring tape, 50 ft.	Pliers
Pocket magnifier	Plastic envelopes
Fish line, 100 ft.	Druggist's pillboxes
Thermometer	Twine
Clean comb	Vials with blood preservative
Medicine droppers	Ruler
Forceps	Chalk or crayon
Pocket knife	Level
Pry bar	Flashlight
Glass jars	Large spikes
Wrapping paper	Plasticine
Sealing wax	Hypodermic syringe
Squared paper	Screw driver
Thumbtacks	Small wrench
Steel tape, 12 ft.	Glass bottles
Compass	Test tubes
Plumb bob	Gummed labels
Piece of wire screen	
Hypodermic needle	

The investigator should make a habit of checking the supplies in his kit each time he finishes a case. He may not have time to do this when he is called out in a hurry. He might arrive at a crime scene and have to send someone back to headquarters to get materials he needs. Certain materials need explaining:

Carbon paper is useful for taking tracings or "rubbings" of irregular objects. It is also needed to collect typewriter comparison samples. The carbon impression of typewriters is explained in the Questioned Document chapter.

Thumbtacks are used to hold the end of a measuring tape in position against the corner of a wall. They are also useful to mark reference points for sketching. **Large nails** serve the same purpose out of doors. They are driven in the soil.

Fish line is used to mark off the path of flight of bullets. It is threaded through holes and stretched tight. Very often the position of the stretched fish line will indicate the position of the body when a bullet struck it.

Plumb bob is a pointed weight used by surveyors to mark the position on the ground of their transit. The investigator uses it to position his camera tripod and mark its location on his sketch.

Thermometer is used to take and record the temperature of a dead body to assist the medico-legal examiner in estimating the time of death by the cooling rate. The investigator should consult the doctor in his area for guidance in selecting the proper thermometer and instructions in its use.

Piece of wire screen is used to examine soil for bullets and other small objects. The operation is called sieving. It can be useful for recovering bone fragments that have been scattered over a large area. It should be mounted on a wooden frame.

Measuring tape. The best tape is made of metal and is 2 to 4 meters long. It rolls up to fit the pocket. For outdoor crimes and traffic accidents, a cloth tape at least 15 meters is needed.

Magnifying glass. A simple glass that enlarges three or five times is best because more powerful magnifiers do not cover as large an area.

Forceps. This is an instrument for gripping small things. It is also called "tweezers" or "pincers." It is used to pick up very small things without getting fingermarks on them. The best ones are the type used by doctors, but the ones used by women to remove extra hairs from their eyebrows are good enough and do not cost as much.

Envelopes. The best kind of envelope is one of plastic or wax paper. These can be gotten from shops that sell postage stamps to collectors. Photographic shops use them to keep film negatives. Small envelopes made of plain paper can be gotten from doctors, pharmacies, or hospitals who use them to give pills of medicine to their patients.

Flashlight. The investigator ought to have a small electric torch with him even in the daylight because he may have to look for small things in dark corners. The small torches called "penlights" are easy to carry in the pocket, but they are not very well put together and are easily broken.

Chalk and wax crayon. This is used to outline the position of a body or the location of an automobile. It should be kept in a plastic tube so that it will not break or rub all over one's clothing. A colored crayon like those used by carpenters for marking lumber is better than chalk on a paved highway where constant traffic or rain may wash the chalk away.

Emery paper is an abrasive paper used to polish metal. Its principal use by the investigator is to bring up serial numbers on vehicles when they are hidden by rust or grease. If there is any suspicion that the number has been altered, the criminalist should be called. He has chemical acids and electric devices to reveal hidden or altered numbers.

Clean comb is needed to collect hair samples.

Tools are required to take apart evidence for transport to the laboratory. The investigator might want to remove a window from its frame to take to the laboratory for glass and fingerprint examination.

Casting kit is discussed in the Molding and Casting section.

Camera kit is discussed in the Police Photography section.

NOTE TAKING

Notes are taken to assist the investigator in testifying before the courts. The law requires that the investigator use only his original notes—not reports in testifying. It makes a good impression on the judge when the investigator uses notes. He gives the impression that he is trying to be accurate. Notes are also used to refresh the recollection of a witness. The lapse of time between the crime and the trial in court makes it necessary to take notes. Use a convenient notebook that can be easily carried in the pocket. Always write in ink. Do not use a typewriter. Each case should have: time and date; type of crime; location; name of the officer making the notes and his assistant; person who gives you the information.

Always get the full name, age, address, and business of a person. If you have another person working with you, be sure he puts his initials on the notes. If he does this, he is allowed to use your notes to testify in court. Be very accurate in your notes because someone else may have to take the notes and continue the investigation if you become sick.

The investigator should include in his notes:

All measurements that he made.

A description of all the physical evidence that he collected.

The kind of container he put the evidence in and how he sealed it and marked it.

The number of photographs that were taken and who took them.

The kind of camera and the kind of film used.

The person who developed the film and made the prints.

The person to whom the physical evidence was given.

It is a good idea when giving physical evidence to another person to take to the laboratory, to write out a receipt in your notebook and have the messenger sign for it.

After the officer has made his report, he should keep a copy of his notes permanently in some safe place. Although the criminal may be convicted by the courts and sent to prison, there is always a chance that civil action or an appeal will be taken. The officer may have to refresh his recollection many years later.

CRIME SCENE SKETCHING

A good description of the scene of crime is necessary in every important case. Investigators used to write long and detailed descriptions but this is not necessary with modern photography. But photographs never take the place of a good sketch. A photograph contains too much detail, much of which is not essential. The photographs will also not show the necessary exact measurements. Both a sketch and photographs are needed in cases of homicide, assault, serious traffic accident, burglary, or robbery.

All measurements should be done with a ruler. Do not combine distances done by

pacing with those done by measurements. Do not draw the outlines of a room with accurate measurements and then mark the location of furniture on the sketch by estimation. Always show the compass direction. Take the measurements yourself. Do not put anything in the sketch that is not important.

Scale

The correct scale to use for diagram should depend upon the size of paper and the size of the area to be sketched. Good scales for police work are:

1:25 small room
1:50 large room
1:100 outdoors
1:200 city traffic accidents
1:250 highway traffic accidents

The easiest way to make field sketches is by means of cross-section or graph paper. It is helpful to have a clipboard to hold the paper with a piece of stiff cellophane to protect the sketching pad from the rain.

Materials Needed

A steel tape of 2 to 4 meters is easiest to handle if the investigator must work alone. It is not as good for outside work with long distances. A cloth tape is better than a steel tape for outside work because very often the investigator must make measurements on the highway, and a passing truck may run over and snap his steel tape. The investigator should carry a few large nails with him which he can push into the ground to hold the end of his tape. These are always helpful for making triangular measurements.

Reference Point

In both inside and outside measurements, there should always be a starting or **reference** point. On the sketch all measurements should begin at this starting point. It is usually simple to find a starting point in a building but it is more difficult outside on a highway or in a country. Do not use anything that can be moved, such as a rock or a tree that may be cut down. Kilometer markers made of stone are very useful but metal highway signs may be damaged or the location changed. In farm areas, the corner of a building may be used.

Pacing

Sometimes an officer will have to make measurements on a crime scene when he does not have his tape measure with him. The investigator should determine in advance what the length of his stride is and the length of his shoe. Approximate measurement can be made in this way. The investigator should never report such measurements on his diagram in exact meters and centimeters. He should clearly state on his notes the measurement was made in this way.

Station Method

This is a good way to measure along distances on a highway. It is similar to the coordinate method. This method needs both a cloth tape and a steel small pocket tape.

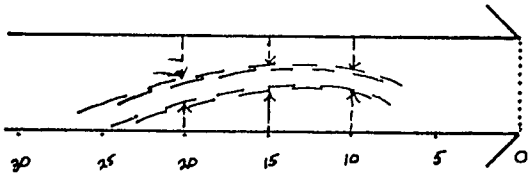


Figure 5. Station Method

Triangulation Method

This is a good way to measure irregular areas on unpaved roads that do not have clean-cut edges or curves or on very sharp curves where things cannot be easily located from the edges. Two reference points are selected and marked with a crayon or with pins. All items are then located by measuring from the item to two reference points. Do not use long, slender triangles. Keep the base line short.

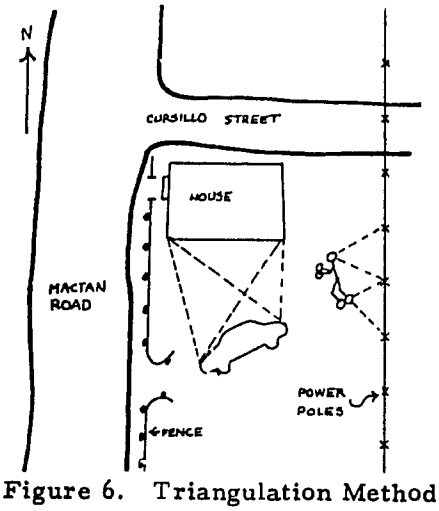
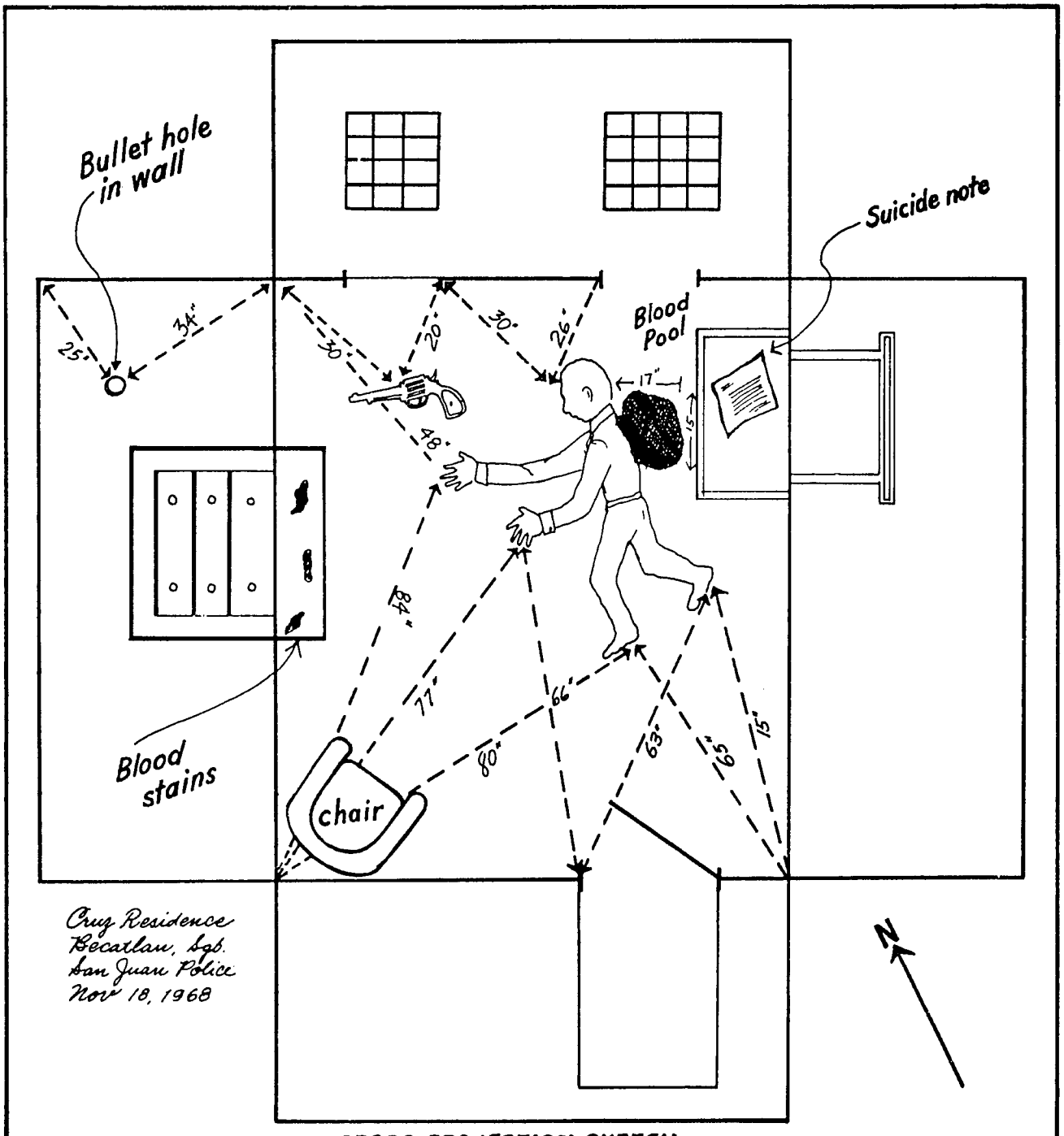


Figure 6. Triangulation Method

Cross-projection Sketch

This is a method for making a sketch of the inside of a room. It is done by drawing the walls as if they were folded down flat on the floor. (See diagram.) This method is very good where there are bullet holes or bloodstains on the wall or ceiling. Professor Soderman recommends making such a cross-projection sketch on cardboard so that the sides can be folded up to make a three-dimension model.



CROSS PROJECTION SKETCH

Locating Photographs

The investigator should fairly mark on his sketch the position of the camera in every photograph taken.

COLLECTION AND PRESERVATION OF PHYSICAL EVIDENCE

Get All of the Physical Evidence

Collect everything of possible value even though it does not seem important at the time. Start at the center of the crime and work outwards. The closer it is to the center of the crime, the more valuable the evidence is.

Mark the Evidence Correctly

First take photographs, then mark down on your sketch the exact place where you found the evidence. Record in your notebook the exact details. Remember that **location** is important. Mark the evidence with a small mark. Do not use the letter **X**. It is too common. It is not necessary to mark evidence that has a serial number such as a gun or a watch. Be careful not to cause damage to expensive jewelry and cigarette cases. It is not necessary to mark evidence that has damage in the form of scratches and dents—just describe the peculiar damage in your notebook. Make a tracing of broken pieces of glass or fragments of metal in your notebook. To mark clothing:

Coat—Mark on inside of an inside pocket.

Trousers—Mark on the back of the inside of the waist band; do not mark the pockets.

Shirt—Mark on the back part of the tail.

Bullets—Mark on the base; do not mark on the side or on the nose.

Cartridges—Mark on the inside of the open end.

Prevent Contamination

Do not do anything to physical evidence that changes it in anyway that you cannot explain. Do not let the evidence come in contact with anything that will leave traces on it. Keep separate things in separate containers. Do not put physical evidence from different parts of the scene of a crime in the same package. Use small bottles or envelopes or folded paper packet to put small evidence in. It is not a good idea to use envelopes for very small particles because it is difficult for the criminalist to remove them. Put them in a paper packet and put this in an envelope. Do not put two objects that are to be compared in the same container.

Maintain the Chain of Possession

The investigator who collects physical evidence should take it to the laboratory himself whenever this is possible. If he cannot do this, he should wrap the physical evidence and put a seal on it. Use a thumbprint or write initials on the back of the envelope at the place where the two parts come together. The envelope cannot then be opened and resealed without this being detected by a criminalist. A package can pass through many hands if it is sealed, but it is better not to have any more people handle it than necessary. The investigator should obtain a receipt from each person to whom he gives or receives evidence.

SPECIAL KINDS OF PHYSICAL EVIDENCE

Blood Samples

In all murders or other crimes where blood is spilled, a sample of blood should always be taken from both the injured person and the accused. The samples should be taken as soon as possible after the crime because it is frequently necessary to find out whether the person is under the influence of alcohol or drugs. In motor vehicle accidents, a blood sample should be taken from the driver for the purpose of a blood alcohol determination.

Blood samples must be taken by a doctor, a nurse, or a medical technician. Be sure these people do not use any alcohol to sterilize the skin because this will interfere with the blood alcohol test. Have the person taking the blood use the special bottles provided by the Crime Laboratory. If these are not available, ask the medical people to add some sodium fluoride—about the amount that can be put on the end of a toothpick. Seal the

bottle with an adhesive tape that goes around both bottle and stopper. The investigator should put his initials at the place where the two pieces of tape join. Unless the blood sample can be taken to the laboratory within a few hours, it should be kept in a refrigerator. Be careful not to let the blood freeze solid.

Bloodstains

The investigator should always make careful notes describing the exact location and condition of any bloodstains he finds. Photographs should always be taken. Note down the general color and condition of the bloodstain. If the stain has a bright red color, it is fresh. As the bloodstain becomes older, the red color is changed to a dark brown. Bloodstains may be liquid, wet, or dry. If the blood is liquid it should be picked up with a clean medicine dropper and placed in a bottle. If the special bottles containing a preservative from the crime laboratory are not available, it is best to put the bloodstain on a piece of glass such as a microscope slide, and allow the blood to dry carefully without any heat. Another way of taking blood samples for the laboratory is to soak them with pieces of blotting paper or filter paper and let them dry.

Dried bloodstains must be handled with great care because they may turn to powder and become lost. Put a clean sheet of paper below the surface bearing the stain and use a razor blade or clear knife to loosen and scrape the dried material onto the paper. The powdered blood is then shaken to the center of the paper and folded, put in an envelope and sealed with scotch tape. It is not necessary to add any preservative to dried bloodstains.

Hair Samples

In any crime where personal contact has happened, hairs are frequently found as a result of having been broken, fallen out, or pulled out. Hairs from the criminal may be found on the clothing of the victim and the victim's hair might be on the clothing of the criminal. Sometimes the hairs of the victim may be stuck in blood. Pubic hairs are important in cases of rape or sexual assault both from the victim and from the criminal. Hairs are best collected by using a clean comb. It is not a good idea to cut the hair. About 50 hairs should be obtained. Put the hairs in a small envelope.

Trace Evidence

This kind of evidence may consist of paint, glass, soil, wood fragments, debris, etc. It may be found adhering to the surface of clothing, inside the pockets, in trouser cuffs and on larger items like automobile cushions, seat covers, floor mats, inside the trunk of a car, or on robes or in other objects which have been in contact with either the victim or the criminal. Trace evidence may come from anyone of the following means of transfer: person-to-person, person-to-object, object-to-person, object-to-object.

Be sure to keep the clothing from the suspect and the clothing of the victim separate.

Clothing

Clothing to be examined should be taken away from the suspect as soon as possible. Do not cut or damage the garment. If it is necessary to cut the clothing to take from a dead person, be sure not to cut at any place where a bullet or a knife has gone through. If the clothing is wet or stained with blood, urine, or water, it should be hung up in a dry place and allowed to dry before packing. Each item of clothing should be marked and packed separately in a clean bag or paper. Do not handle the clothing any more than necessary. Look carefully to see if there are any large items, such as paint chips, threads or material that might fall off the evidence. Put these in separate paper and label, telling where he found them.

Firearms

Never unload a weapon or turn the cylinder of a revolver unless it is necessary because the position of the cartridges in the gun are very important to the firearms examiner. If it is necessary to ship a weapon, note the position of each cartridge in the weapon and include it in your notes. Be careful not to destroy any fingerprints on the cartridges. Very often it is easier to find fingerprints on the cartridges than on the weapon itself.

How to Collect Special Kinds of Physical Evidence

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
ARSON					
Ashes and debris to be taken at the place where the fire started and the place of most intense burning: mechanical or electrical devices which may have to be used to start the fire.	Place the label on the outside of the container indicating the place where the specimen is taken, date, time, and name of agent collecting the specimen.	Reasonable amount sufficient to fill a 2-gallon widemouth container with tight screw cover like containers for candies.	Take the specimen immediately after the fire and place in a clean and dry glass container with tight screw cover. If simple devices suspected to have been used as starting mechanism are found such as an alarm clock, candle, or simple electrical system, submit same intact.	None	Submit to the laboratory as soon as possible. Air express or railroad may be utilized if coming from distant place. Consult the nearest airline for information and/or suggestion
BLOOD					
Liquid blood for:					
(1) Grouping tests	Use medical tape on outside of the test tube or bottle and label indicating name of subject, age, address, and date.	Take 3 cc. of blood by venepuncture and place in a sterilized test tube or prepare a 2% saline solution of the red cells. Samples taken by venepuncture must be done by a physician or competent technician.	Place liquid blood in a clean and dry test tube or bottle without anticoagulant or preservative. Wrap tube with cotton or soft tissue paper and place in a strong mailing carton box. Keep cool, if possible and mark "Fragile."	None	Send by air express with the specimen kept in ice box or refrigerator, if available.
(2) Alcohol level for sobriety.	-ditto-	Take at least 5 cc. of blood by venepuncture if subject is a living person or 50 cc. of blood during autopsy if the subject is a dead person.	-ditto-	None	-ditto-
(3) Drowning	Use medical tape and label as above indicating further whether taken from the left or right chamber of the heart.	Take all blood from each chamber of the heart and place in separate container.	Place the blood from each chamber of the heart in separate container without any preservative. Pack with cotton or soft tissue paper to prevent breakage and mark "Fragile."	One quart of water from the place where the body was found.	-ditto-
Dried Bloodstain:					
(1) Bloodstains on heavy and immovable objects.	On the outside of the container which may either be a pill box, powder box, test tube or druggist paper packet, place a label indicating nature of specimen source, date, and name, if possible.	As much as can be scraped without disturbing the surface of the object.	Remove stain by careful scraping and place in a pill box, powder box, or test tube.	Submit sample of the blood of subject for comparison	If above methods are not available, send by registered mail.

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
(2) Stained clothing, rugs, weapons, or light movable objects.	Use string tags or gummed paper as label and indicate all preceding data.	All the movable objects.	Pack only when dry. If found wet, dry by hanging inside a room on a clothes line. Never use heat or electric fan for drying. Pack each object separately with corresponding label.	-ditto-	-ditto-
CLOTHING for: seminal stains, gynecological or obstetrical stains, gunshot range determination, etc.	Use string tag and label as above. Each specimen must be individually labelled. Identification may be placed outside of the wrapper.	All clothing to be examined.	Pack only when dry. Protect stained area with soft paper. Avoid unnecessary handling. Do not cut stained area unless absolutely necessary and after taking the photograph of the specimen showing the area to be cut.	None	-ditto-
CHEMICALS					
(1) Solids such as powder, tablets, etc.	Affix the label on the outside of the container indicating nature of specimen, source, date and name of person submitting the specimen.	All or a minimum of one ounce.	Seal to prevent any loss of specimen by use of adhesive tape. Pack in a carton box using soft paper.	If specimen is to be used in cases of adulteration or unfair competition, submit certified genuine sample for control.	-ditto-
(2) Liquids such as oils, gasoline, water, etc.	Affix label on the outside of the container as above. Medicines must be in original container where it was found. Label should indicate same information as above.	All or a maximum of one quart.	If the bottle has no stopper, transfer to a glass stoppered bottle except those which must be in the original container when found.	-ditto-	
DOCUMENTS for: (1) Age of ink (2) Age of paper (3) Erasures (4) Invisible ink (5) Other criminalistic examination	Do not label the document. Place label on outside of envelope containing specimen indicating same information as in solid chemicals.	All the documents to be examined.	Document should be handled, folded, and marked as little as possible. If folding cannot be avoided, the fold should be along old lines. Place in a glassine or transparent envelope.	For determination of age, of ink, submit samples of ink writings by the same person of approximately the same age suspected.	Registered mail is recommended unless it can be delivered personally.

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
EXPLOSIVES such as: (1) TNT, picric acid, nitroglycerine (2) Blasting caps (3) Fuses (4) Other explosives	Attach string tag or use gummed paper label. Label indicating same information as in chemicals.	For explosives, submit reasonable amount. For blasting caps, submit all. For fuses, submit about one foot.	Different samples of explosives must be wrapped separately. Blasting caps may be placed in a rigid container like carton box. Fuse can be wrapped with soft paper. Place all specimens, separately wrapped, in a carton box for mailing.	None	Explosives cannot be sent by air. Personal delivery or send by railroad or registered mail but label "EXPLOSIVES".
(5) Bombs	*Use every precaution to safeguard the lives and properties in the area where found. Call Bomb Disposal Squad of the Army.*				
FIBERS AND HAIRS (1) Rope (2) Strings (3) Twine	Place label on outside of the container which may be envelope, pill box, powder box, test tube, bottle or druggist's paper packets. For rope, strings, twine, use string tag and label indicating type of specimen, source, date, and name of agent submitting specimen.	For fiber and hairs—all. For rope, string, or twine, submit about one yard.	Transfer by means of forceps into a folded envelope, druggist's paper packet or test tube and seal.	Samples of any suspected fabrics, rope, string, or twine. For hair, submit several strands taken from different parts of the head of the victim, suspect, or defendant.	Personal delivery or registered mail
(4) Woven fabrics	String tag or gummed paper label may be used indicating same information as above.	The whole piece recovered.	Individual packing for the recovered piece of fabric and the suspected material.	None	-ditto-
FIREARMS (To determine if fired or for firearms identification) (1) Pistol (2) Revolver (3) Shotgun etc.	Attach string tag and label indicating type of weapon, caliber, serial number, source, date, and name of agent submitting specimen.	All.	Place in cotton or soft paper and pack in rigid container. Firearm should be rigidly fixed inside a wooden container without further wrapping. All firearms should be unloaded and ammunitions removed before packing.	None	Consult postal regulations before mailing otherwise deliver personally to the laboratory.
(4) Bullets, cartridges (5) Shells	Initial at the base. No mark should be placed at the rifling impression.	All.	Bullets, cartridges, and projectiles must be protected by packing in cotton and then pack rigidly in a carton box.	None	-ditto-

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
GLASS FRAGMENTS	Place label on outside of container indicating source, date, and name of agent submitting specimen.	All recovered fragments.	Wrap all pieces in cotton or soft paper and pack rigidly in a box.	For purposes of comparison, submit any glass suspected to be identical. In taking samples of window pane select from several parts of the pane.	Air express, railroad or registered mail.
METALS	-ditto-	For filings or turnings, submit at least one pound.	Wrap in paper if solid. Use paper boxes or pill boxes if filings or turnings. Seal all sides and pack in strong boxes.	None unless the purpose is for comparison; then, submit any suspected identical sample.	-ditto-
NUMBERS–tampering of serial (1) Jeep or cars (2) Firearms (3) Machines	For firearms, use string tag and label as above.	All.	For jeeps, dismantle the engine.	None	Railroad or personal delivery.
PAINT OR PAINT STAINS (1) Liquid (2) Solid	Place label on outside of container and indicate all information as in above specimen.	All or a minimum of one pound.	Container must be either a screw cap widemouth bottle or friction top paint can. To prevent breakage, pack in a carton box with cotton or soft tissue paper. No preservative is necessary.	One ounce of original paint if liquid or half pound if solid.	Registered mail or railroad if personal delivery is not possible.
(3) Stains	-ditto-	If paint is on movable object, submit the whole object. If on immovable object, submit scrapings as can be removed without disturbing object.	Wrap object with soft tissue paper to protect stain. Pack in hard carton box with soft paper to prevent friction. For paint scrapings, use pill boxes or druggist's paper packet.	Enough scrapings of original paint for comparison.	-ditto-
PROHIBITED DRUGS (1) Opium (2) Morphine (3) Heroin (4) Marihuana (5) etc.	-ditto-	One tael tin of opium and for opium derivatives and other prohibited drugs, a minimum of one ounce.	The tael tin of opium can be submitted as is but powders must be packed in pill or powder boxes, test tube, or druggist's paper packet. Seal all sides to prevent loss of the specimen.	None	-ditto-

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
PRINT IMPRESSIONS (Moulage) (1) Footprints (2) Tireprints (3) Small impressions	Positive identification is very important so that impressions must be identified by competent witness.	The impression must be three-dimensional and clear. The whole impression is necessary for casting.	On finding a footprint or tireprint impression on soft soil, the first precautionary measure is to protect the impression from destruction or alteration by covering with an upturned gasoline can with the edges buried in the ground to prevent seepage of water in case of rain.	Footprint impression may be compared with that of suspect. For tireprint, take the tire of suspected car.	Call expert for casting by long distance or send a telegram.
SOIL (1) Soil or soil smears	Place label on outside of container or if clothing, use string tag for label indicating nature of specimen, source, date, and name of agent submitting.	All.	Soil particles may be packed in pill boxes or powder boxes, paper packets or test tube. Clothing with soil smears must be packed with the stain or smear protected by soft tissue paper. Pack rigidly in a carton box to prevent unnecessary motion of the specimen.	Take "elimination samples", i.e., several samples within a radius of one meter at the scene of the crime at one foot apart.	Registered mail or railroad.
(2) Dust, dirt, debris, or safe insulators	Place label on the outside of container which may be pill or powder boxes, test tube, bottle or paper packet. Indicate all information as above.	All.	Collect dust with vacuum cleaner or by beating the clothing or rug over a clean paper. Pack samples as in soil specimen.	Dust collected from the scene of the crime or safe insulator taken from suspected safe.	-ditto-
TOOLS OR TOOLMARKS	Use string tag and label as above.	If toolmark is on movable object, submit the object otherwise conduct casting at the scene of the crime if the portion bearing toolmark cannot be cut. Suspected tool must be submitted.	Cover the portion bearing the toolmark with soft tissue paper and wrap with strong paper to prevent friction or contact with the container. Tools may be fastened on a carton or wood and packed in a strong box.	For toolmark, submit suspected tool.	-ditto-
TOXICOLOGY (Poisons) For details, see Chapter 6 Only specific poisons will be taken here.					

SPECIMEN	IDENTIFICATION	QUANTITY	PRESERVATION AND PACKING	STANDARD NEEDED	TRANSMITTAL
(1) Alcohol	Place label on outside of container indicating name of deceased, age, sex, date, nature of specimen and name of doctor taking the specimen.	About half of whole brain or 50 cc. of blood or all the urine collected from bladder. *Do not submit other organs from the deceased.*	Place in a dry, clean glass container with screw cover or tight-fitting cover secured by tape. For preservation: Urine and blood: use sodium fluoride, salt, or benzoic acid. Brain: use mercuric chloride, sodium fluoride or salt.	None	Air express or personal delivery. Refrigerate if possible.
(2) Other volatile poisons like cyanide, phenol, ether, chloroform, etc.	-ditto-	Portion of the liver weighing not less than 300 grams; one kidney; 100 cc. of blood; and 300 grams of brain.	The same method for packing. For preservation, use sodium fluoride or salt. Tissues can be preserved in mercuric chloride.	None	-ditto-
(3) Alkaloidal poisons	-ditto-	-ditto- Submit separately the whole stomach and contents.	If possible, each organ must be separately packed. Use glass container with screw cap cover to avoid metallic contamination. Use only pure alcohol as preservative if available otherwise you can use ordinary table salt to cover the specimen. In all cases stomach and contents must be separately packed.	Submit with the specimen a copy of the autopsy findings, the clinical history of the case and any remainder of the drug, food or drinks taken prior to onset of the symptoms for possible reference.	-ditto- Label "FRAGILE"
(4) Barbiturates	-ditto-	-ditto- Include all urine collected from bladder.	-ditto-	-ditto-	-ditto-
(5) Metallic poisons	-ditto-	-ditto-	-ditto-	-ditto-	-ditto-
(6) Carbon monoxide and other poisonous gases	-ditto-	100 cc. of blood	Blood must be placed in a widemouth bottle with cover. Seal cover with adhesives. No preservative must be added but refrigerate if cannot be submitted at once.	Sample of air, if deceased died in a mine shaft or tunnel.	Send specimen at once.

LATENT FINGERPRINTS

Latent means "something hidden." Some fingerprints can be seen with the aid of special lights but most fingerprint evidences require some method of development in order to make them visible. The classification of criminals by means of the ink impressions of ten fingers is a part of identification. The detection, development, and collection of latent fingerprints fall naturally into the field of criminalistics. A latent fingerprint is either an **imprint** or an **impression** depending on the material on which it is found. There are several types of latent fingerprints:

Imprints: Transfer of oils from the skin, transfer of blood, transfer of dirt.

Impressions in putty, in tar, in wet paint, in greasy surfaces or silt.

If a fingerprint exists as an imprint, it is processed by photographing with sloping light or by the application of powders. Powders stick to the sticky substances left by the skin and make the print visible for photographing or lifting. If the fingerprint is in the form of an impression, it can be photographed by sloping light or subject to casting techniques. If the fingerprint is on paper or other porous surfaces, it is treated in the same manner as an erasure or obliteration on document examination and are treated with chemicals, fumes or powders to reveal it.

Some large departments have special fingerprint technicians who work in connection with scenes-of-crimes officers to collect fingerprint evidence. In a small department, the scientific investigator will usually have to collect fingerprint evidence along with other types of physical evidence. The investigator later calls upon an Identification Specialist to assist him in the eventual comparison of his latent prints with records on file in the Identification Bureau. The investigator does not limit his search for the prints of fingers but also considers footprints of bare feet, thumbprints, and even impressions made by gloves.

Collection of Fingerprint Evidence

The investigator should first make a general survey of the premises to determine the most likely places where fingerprints could be found. These places include broken windows, doors, door handles, light switches, weapons, drinking glasses or articles of furniture that may have been moved. The investigator should make use of sloping light from a strong flashlight since many fingerprints are partially visible with this method.

Visible imprints are the most obvious and noticeable and should be collected first. Imprints made with blood should be photographed with a good high-contrast film if they have been made on a permanent surface which cannot be taken to the laboratory. In all cases where the item is movable, the material should be carefully packed and transported to the laboratory.

Hidden imprints are revealed by dusting. If the imprints are on immovable objects, they should be dusted with an appropriate powder, photographed and lifted to cards. Movable objects should be packed carefully and sent to the laboratory for further processing. Since the investigator frequently lacks equipment to photograph the latent before lifting it, the latent fingerprint card should always include the following information. Along with the case name and numbers:

Exact place lifted from _____
Lift witnessed by 1. _____
Lift witnessed by 2. _____

Invisible impressions should be photographed carefully with sloping light to reveal detail. If a location is on an immovable object, casting techniques using silicone or Wood's metal can be attempted.

In all cases when possible the investigator should take movable objects to the laboratory for processing. No attempt should ever be made to develop fingerprints on any wet surface or to use dusting techniques during rain.

Preservation of Fingerprint Evidence

Extreme care must be used with fresh fingerprints since they are easy to smear. The best way to pack fingerprint evidence is to put the articles in some kind of a box where the fingerprints are not touched by anything else. It is possible to package a small movable object in such a way that the sides do not touch the container.

Development of Latent Fingerprints

A fresh fingerprint is sticky. If a finely powdered material is put in contact with it, the pattern outlines of the friction ridges will be made more visible. A powder should be used which is a different color from the background on which the fingerprint is found —black on white or white on black. If the investigator is not sure what type of powder to use, he should make an experimental fingerprint on a similar type surface and try the effects of different kinds of powders. Many good fingerprints have been destroyed by the use of the wrong powder.

Ninety-five per cent of all fingerprints can be developed with only three powders—black, gray, and white. There are some chemical substances that can be used directly to produce these colors, but most have some disadvantages if used by themselves and are best mixed with other substances.

Fingerprint Powder Formulas

Scott's Black Powder #2
10 parts Lampblack
4 parts Rosin
3 parts Fuller's earth
Cost = $1.09 lb.

Scott's Gray Powder #2
7 parts Basic Lead Carbonate
1 part Gum Arabic (Acacia)
Cost = $1.28 lb.

Scott's White Powder #3
5 parts Titanium Oxide
5 parts Basic Lead Carbonate
5 parts Gum Arabic (Acacia)
Cost = $1.22 lb.

Combine the ingredients and grind together in a mortar. Pass through a 100-mesh sieve. If a sieve is not available, use a woman's stocking stretched tight on an embroidery frame.

Single Substances Suitable for Fingerprint Powders

Graphite is sold in plastic tubes for lubricating purposes and can usually be obtained from garages, plumbers, or locksmiths. In this form it is too coarse for fingerprint use and must be ground up and passed through a sieve.

Manganese dioxide is a dark metal powder which can be obtained from high school science laboratories or a pharmacist. It must be screened to get out large particles. It is one of the best natural-colored dark fingerprint powders. It will develop fingerprints on paper without staining the paper and it gives very strong details.

Lead carbonate is a white heavy powder that sticks well. It is usually fine enough that it does not have to be sieved.

Silver powder. Aluminum powder is a lightweight metal. The usual form of aluminum paint is not suitable for fingerprint powder. The powder can be obtained from painters. It sticks well to fingerprints. It must be used carefully because it often fills up the clear spaces in between the ridges. Experience and practice are necessary to get good results with it. It sticks well and may be brushed rather strongly without damaging the print. A test print should always be made on an important part of the evidence before applying aluminum powder to a print.

Mixed Fingerprint Powders

Many patented fingerprint powders are sold by police supply companies. They are very expensive. There is no reason why the investigator cannot mix his own powders or have it done by a local pharmacist. All that is needed is a mortar and pestle to ground the powder finely and some sort of sieve to screen it free from large lumps.

Application of Fingerprint Powders

Some experts recommend the use of an atomizer to blow powder on the fingerprint. This procedure is not very satisfactory. It wastes powder and may contaminate other types of physical evidence at the crime scene. The oldest and best method is careful dusting with a soft brush. The investigator should never apply fingerprint powder to prints on paper or cardboard. There are better methods using fumes and chemicals for detecting prints on paper. The use of powder will spoil attempts to use these methods later. Powder will work all right on a fresh print but as the oily material

soaks into the paper, the powder is no longer satisfactory and chemical development must be used.

Preserving Developed Fingerprints

The most satisfactory way of preserving dusted fingerprints is by "lifting." This method uses a sticky transparent tape to pick up the powder material which is then transferred to a suitable background. Older methods of lifting used rubber tire patches. This has a disadvantage of producing a reversed fingerprint which had to be later photographed and turned around for comparison. Lifting by the use of transparent tape gets around this difficulty.

Black powder prints can be easily transferred to a white card. White prints must be transferred to some kind of background. The simplest type of black background is made by taking sheets of photographic paper, exposing them to light, and then developing them. It is a good idea to cover up a small portion of the paper which will remain a white after development. The papers are dried in the usual manners and ferrotyped. This portion can be used for writing down the data about the fingerprint.

Ordinary scotch tape sold in stores is not very suitable for lifting fingerprints because it will pick up paint, paper, and fibers that are not wanted and may interfere with the examination of the fingerprint. A special grade of fingerprint lifting tape has been designed and can be obtained from police suppliers. The method of using lifting tape is easy but requires care. After the powder has been applied to the fingerprint, several centimeters of tape are slowly and carefully pulled from the roll. The free end of the tape is fastened down just to one side of the fingerprint. The roll of tape is held in the other hand. The tape is kept firm by pulling with the hand holding the roll of tape, while the other hand slowly smooths down the print. Care must be taken to push out any small air bubbles which may become trapped under the tape. The tape is then slowly removed from the surface by pulling back in the same direction it was put down. The tape will peel away and bring the powder with it. As soon as the fingerprint itself is free from the surface, a card of suitable color is put underneath it. The tape is then pushed back a second time on to the card. The used part of the tape is cut off and the roll put aside. The lifted fingerprint should always be put on the card in the correct position with the tip of the finger toward the top. This will make it easier to compare with the rolled impressions in files.

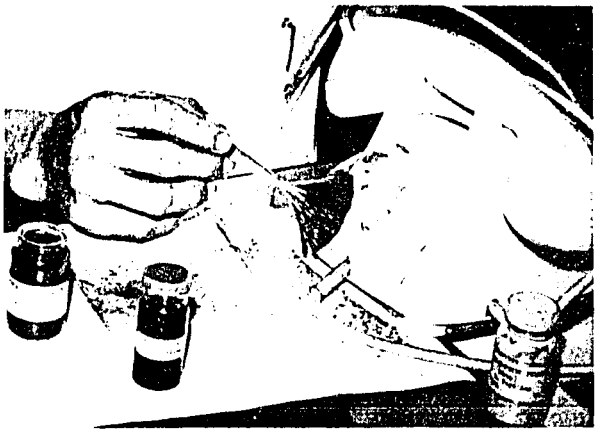
Development of Fingerprints by Fuming

Development of fingerprints by fuming with iodine vapor has been recommended by many experts. Iodine is a chemical but the use of iodine vapors is largely physical. It reacts to disturbances in the fibers of paper in some manner which is not quite understood. For this reason iodine has been recommended for developing fingerprints on paper and for the detection of erasures, obliterations, and secret inks on documents. The success of iodine fuming is uncertain. If the fingerprints are not developed by iodine vapor, it is unlikely that powder will be helpful. The method does not work well on old fingerprints. Iodine vapor does not appear to have any effect on a fingerprint that will make it unsuitable for powdering. Developments of fingerprints on paper by means of iodine have been recently replaced by newer chemical processes.

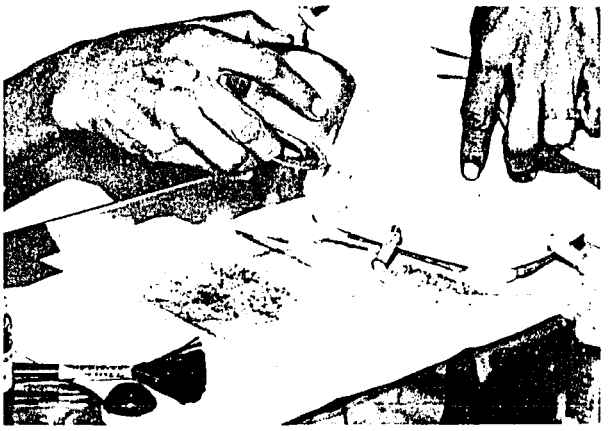
Development of Fingerprints on Paper by Ninhydrin

Powder development of fingerprints is based on the oils left behind by finger impressions. Another process often used on paper is the silver nitrate process which is based on the salt which is present in body sweat. The newest process for developing fingerprints on paper is the **ninhydrin process** which is based on the presence of certain substance in the body called amino acids. These acids form a part of the flesh of the body and can be detected in very small quantities by the use of a chemical called **ninhydrin** or 1, 2, 3-triketohydrindene, an organic chemical which turns to a purple color when in contact with amino acids and then heated. This procedure is best done at the laboratory. A particular advantage of this method is that it works even better on old fingerprints than it does on fresh ones.

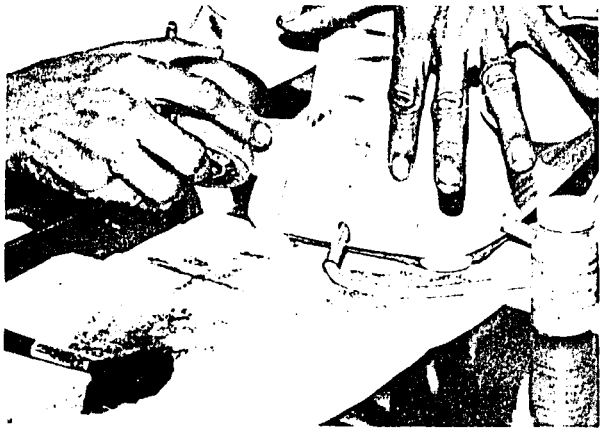
LIFTING LATENT FINGERPRINTS



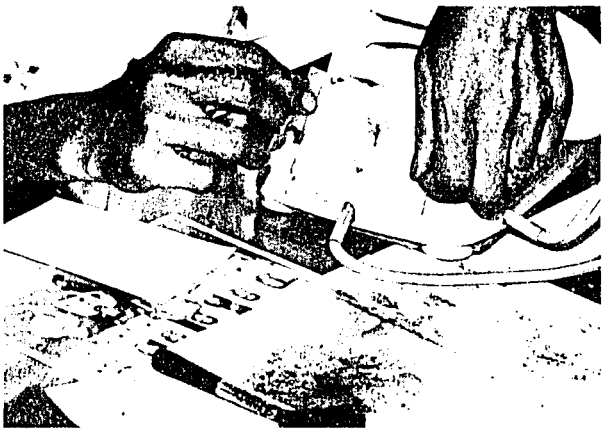
Dusting latent print with fingerprint powder



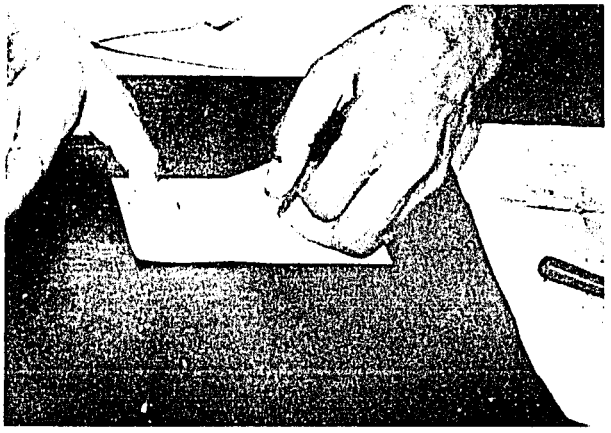
Placing transparent tape on developed print



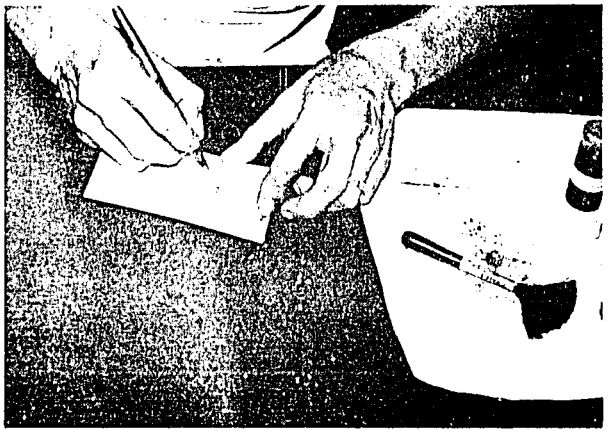
Pressing tape to remove air bubbles



Pulling back the tape from the surface



Transferring lifted print in white card



Labelling

MOLDING AND CASTING

Casts of Tool Marks

Plaster is not so good for tool marks as it is for footprints because the detail of tools is much finer. The best material for making test of tool marks is the compound used by dentists to make a cast of teeth. If this is not obtainable, the plasticine used by children or the putty used by workmen to put glass windows in frames can be used. Do not try to make comparison cast of the tool but send it to the laboratory which has special ways of doing this. Do not try to fit the tool to the scratches at the crime scene. You may damage both the tool and the impression.

Taking Plaster Casts

You will never find a complete, perfect print. You will be lucky if you get 25-50 per cent of the shoe clear.

Prepare the print by picking out and removing any leaves, sticks, or papers that can be removed without disturbing the print. If a stone or stick is stuck to the print, leave it there. The best footprints are in soft ground. Sand and silt are not as good. Light dust will make an excellent print but it is more difficult to prepare. Put a cardboard box with the top and bottom cut out of it around the print to protect it from winds. Spray with a fly spray containing shellac. Spray across the top of the box and let the mist settle on the print. Never spray directly on the print—you may get a stream which will destroy it. Let the shellac dry and repeat three or four times.

Footprints and Tire Prints in Water

Dry and remove as much water as possible by draining off, but leave a little moisture in the print. Sift the plaster directly into the print.

Preparing the Plaster

Always add the plaster to the water. Sprinkle the plaster over the surface of the water and let it sink down. When the plaster no longer sinks, stir the mixture and pour quickly. The plaster should be about as thick as motor oil. Pour the plaster down a stick and not directly into the cast. Try to cover the whole surface with the first pour no matter how thinly. You can always reinforce it later. Put some green sticks in the plaster for reinforcement. Never use dry sticks; they will absorb water, swell, and split the cast.

Removing the Prints

Test the cast by feel—it gets warm as it hardens. When it is cool, it can be removed. It is best to wait several hours. Cut away around the edges with a knife until the cast stands up. Leave the dirt on the cast. When the cast is dry, wash off the extra dirt carefully. Use only the soft part of your hands; do not use a brush.

Marking the Cast

Before the cast is completely dry, scratch identifying marks on the back. Be sure to include: the date, the location, your mark, which print this is of the crime scene.

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4

Crime Scene and Evidence Photography

The first thing to be done at any crime scene or traffic accident is to make photographs. The camera is an important tool for making records for future use when the original situation does not exist anymore. All expert examination for fingerprints and other physical evidence is going to change or destroy things to some degree. Photography is necessary to make a record that will be useful later on. The investigator must provide: (1) a record of the crime scene as it was left by the criminal; (2) a record of all physical evidence as it is discovered; (3) a record of the work done by fingerprint technicians, criminalists, pathologists, and technical experts to show things that cannot be preserved.

The Photographic "Expert"

A great many crime scenes never get photographed because investigators think that only an "expert" photographer can take pictures that will be accepted by the courts. This is not true. The law is quite clear on this point. All that is necessary to introduce a photograph in evidence is for the investigator to testify that "...this photograph is an accurate representation of what I observed at the place it records...." Of course a **skilled** (not "expert") photographer may take a better picture, but if he cannot be found at a critical moment, there is no reason at all why the investigator should not take the necessary pictures.

Actually, only the investigator knows exactly what he wants to record on film. While he could act only as a director to the cameraman, it is time-consuming to explain in detail just what is wanted. The investigator had better do it himself.

Routine police photography is concerned with things as they are. The photographs must show what a witness could see when he first viewed the crime scene. The investigator must use normal film, standard lenses, correct lighting, and standard developing and printing. He must avoid any distortion, keep his camera level, and not add or subtract anything from the object photographed.

The criminalist, on the other hand, uses photography for quite a different purpose. The criminalist wants to **extend the eyes of the viewer.** He wants to show things that are not normally visible. He wants to emphasize, enlarge, subtract, or isolate certain particular features. He does this with special lights, colored filters, and various de-

grees of magnification. He may cut two photographs apart and paste one alongside the other to demonstrate the comparison of tool marks. He may use a green filter to hold back a green back stamp so that a signature will show up better. He uses sloping or grazing light to show hidden pressure marks on paper. The criminalist therefore violates every rule that the investigator must observe.

Prosecutors and courts must understand the difference between these two classes of law enforcement photography. It is also important that the investigator make the correct kind of photograph in the proper situation.

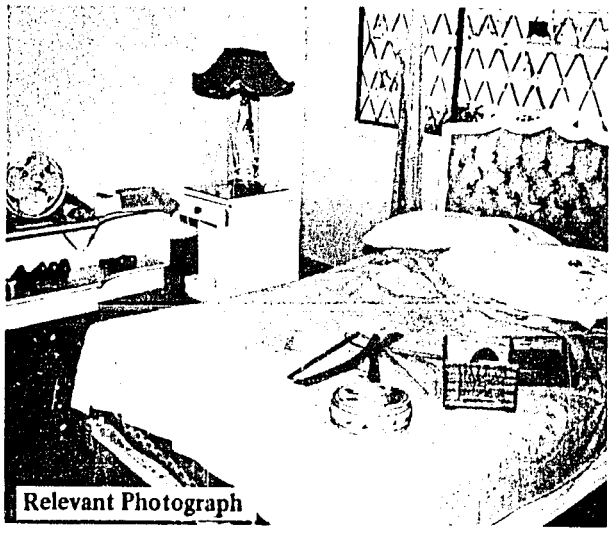
The "Best Evidence" Rule

All physical evidence should be photographed, but the investigator must remember that a photograph is not a legal substitute for the object itself as evidence. A photograph of a revolver will not be accepted in evidence. The weapon itself must be brought to court. It is the "best evidence."

The courts recognize that certain evidence cannot be brought to court. Buildings or a street intersection are an example. Other evidences change quickly. Skidmarks on the highway will be quickly destroyed by the continuing passage of other vehicles. The wounds and bruises of a man who has been beaten will heal and disappear before the case comes to trial. Such evidence can be preserved by photography and introduced in court as evidence.

Relevant and Inflammatory Photographs

All police photographs must relate to the matter at hand. They must be appropriate and must not show anything that has nothing to do with the case. One of the most frequent faults in crime scene photographs is the presence of a lot of policemen in the picture. These men are not relevant. The crime scene should be photographed empty of everything that was not there when the police arrived. The photographer must not leave his camera case in a place where it will get in the way. Sometimes it may be necessary to put a ruler in a photograph to show size, or leave stakes along the highway in photographing a traffic accident. Some courts will object even to this, so the investigator should make two photographs—one with and one without the measuring device.



Relevant Photograph

Another thing to avoid in police photography is the inclusion of emotional things that might be classed by the court as **inflammatory**, or tending to affect the emotions of the viewer. An example of this would be a photograph of a murder scene with hysterical female relatives of the victim crying in the background. Or, a photograph of the wounds on a corpse includes the exposed sexual organ of the victim. If these private parts are not relevant, they should be decently covered.

Inflammatory Photograph

TECHNIQUES OF PHOTOGRAPHY

Nobody can learn to take photographs by reading a book. Having selected a camera and related equipment, the investigator should seek out an experienced photographer to show him how to focus, arrange his lights, develop the film, and make the prints. The important thing for the investigator to know is **what** photographs he needs. If he knows this, he can direct the taking of the pictures by another person even if he does not operate the camera himself. The investigator must always select the photographs he wants. He must keep control of the procedure so he will get legally acceptable photographs that can be introduced into evidence.

Ordinary commercial photographers have ways of making photographs that are wrong for law enforcement purposes. The commercial photographer has to please his customer, and he tries to make the objects he photographs look good. He softens the focus when he photographs a middle-aged woman so her facial wrinkles will not show. He makes an automobile look long and low and shiny. He makes pictures of a small store from a low camera position to make it appear larger than it is. There is nothing wrong in doing this for commercial purposes, but it must not be done in law enforcement work. The investigator must carefully supervise the work of any commercial photographer he might employ to make crime scene photographs.

Very often at serious traffic accidents, a newspaper photographer or amateur will have taken photographs before the investigator arrives at the scene. The investigator should get the name of any such person in case investigation later discloses that changes occurred in the condition of the crime scene after the accident but before the police arrived.

SPECIAL PROBLEMS OF POLICE PHOTOGRAPHY

There are a number of unusual photographic problems in law enforcement photography that are different from the ordinary amateur or commercial practice. Some of these are:

Camera Height. How far the camera is above the ground when the picture is taken is not too important in ordinary photography, but it may be critical in police work. An example would be in traffic accident investigation where a picture is taken to show just what and how far a driver could see from a certain location. The driver of a big truck would see a different view than the driver of a Volkswagen. The investigator should find out at what level the eyes of a driver would be, then set his camera accordingly. This distance is usually about 44 inches or 112 centimeters.

In all cases, the investigator should make a note of his camera height. This can be quite important if a twin-lens reflex camera is used. These cameras are usually operated from waist level, but are sometimes used at eye level. This distance is usually 65 inches or 165 centimeters.

Camera Level. The camera should always be perfectly level no matter how much slope there is on the ground. An inexpensive pocket bubble-type level will make sure this is carried out.

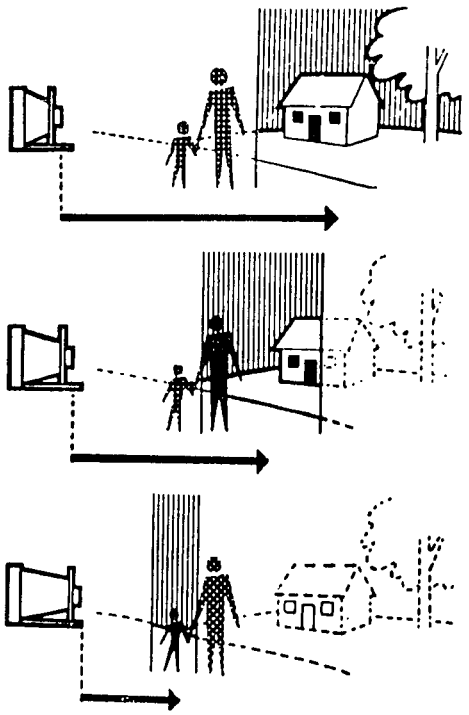
Camera Location. The investigator should find out by asking questions of witnesses exactly where they were standing or sitting when they observed certain things. The camera should be placed accordingly. Very often the photographs will demonstrate that the witness could not have seen what he thought he saw from the position he was in.

Camera Depth of Field

Police photographs must be sharp and clear. They must show everything in proper focus. Sharpness is obtained by keeping the camera steady. Clearness is obtained by correct focusing. A most troublesome problem in police photography is to determine on what point to focus the camera so that everything in the picture will show correctly.

When a camera is focused on a certain point, only that point will be in perfect focus. Points beyond or behind will be less clear. Finally, a distance is reached where places in the picture look blurred or fuzzy. The near and far limits of clear focus are called the **depth of field.**

Depth of field does not matter much when pictures are made out-of-doors in strong sunlight. The size of the lens opening influences the depth. The smaller the opening, the greater the depth. The lens opening can be very small outdoors and this gives a large depth of field. Depth of field also does not matter much in portraits of people. Here, the range of depth from the tip of the nose to the tip of the ears is only 6 inches. The difficult kind of focusing problem is the crime scene. The investigator wants to get as much as possible in the picture, and he wants it all to be clear if possible. The light is poor and the distances are fixed. The investigator wants to know: At what distance must he focus in order to get the greatest depth of field?



Focusing Point. It might seem logical to focus the camera on a point midway between the near distance and the far distance. This is not correct. The correct place to focus is on a point that is one-third of the distance between the near point and the far point. An example will make this clear.

We want to take a photograph where the dead body is 18 feet from the camera and a revolver 9 feet away. At what distance do we focus?

18 - 9 = 9 ft.
9 + 3 = 3 ft.
9 + 3 = 12 ft., the focusing point

This rough calculation will be satisfactory for large distances but for close work, the distance settings have to be worked out by arithmetic. The exact methods of calculation are given in Appendix B.

Photo Data. The investigator must keep an accurate record of every photograph he takes. J. Stannard Baker of the Northwestern Traffic Institute recommends the use of a Photo Data Sheet that provides for both identifying and recording photographs. Put on a clipboard, it can be included in the photograph to identify it. For the first photograph, the entire sheet appears in the picture. For the second picture, the sheet is folded back and under an inch from the bottom so that 2 is the lowest number appearing. This procedure is repeated for each succeeding exposure.

Spoiled Negatives. Mr. Baker reminds us never to throw away any spoiled film. Somebody may remember that you took four pictures at the crime scene. If you can produce only two, you may be accused of suppressing evidence.

PHOTOGRAPHING THE CRIME SCENE

Like a motion picture, the still photographs of a crime scene must **tell a story.** The purpose is to help the prosecutor and the court learn what happened, where it happened, and how it happened. The pictures should therefore be taken in a logical, orderly manner to show as much information as possible. The following pictures will always be needed:

Establish Shot. This is an over-all view from one extreme to the other. It shows where we are: a busy intersection, a farm, a residential area, an airport, a factory, or even the middle of a jungle. The investigator should pay attention next time he goes to a cinema and note that everytime the location of the story changes, a large view of the general area is always flashed on the screen first to show the audience where they are now.

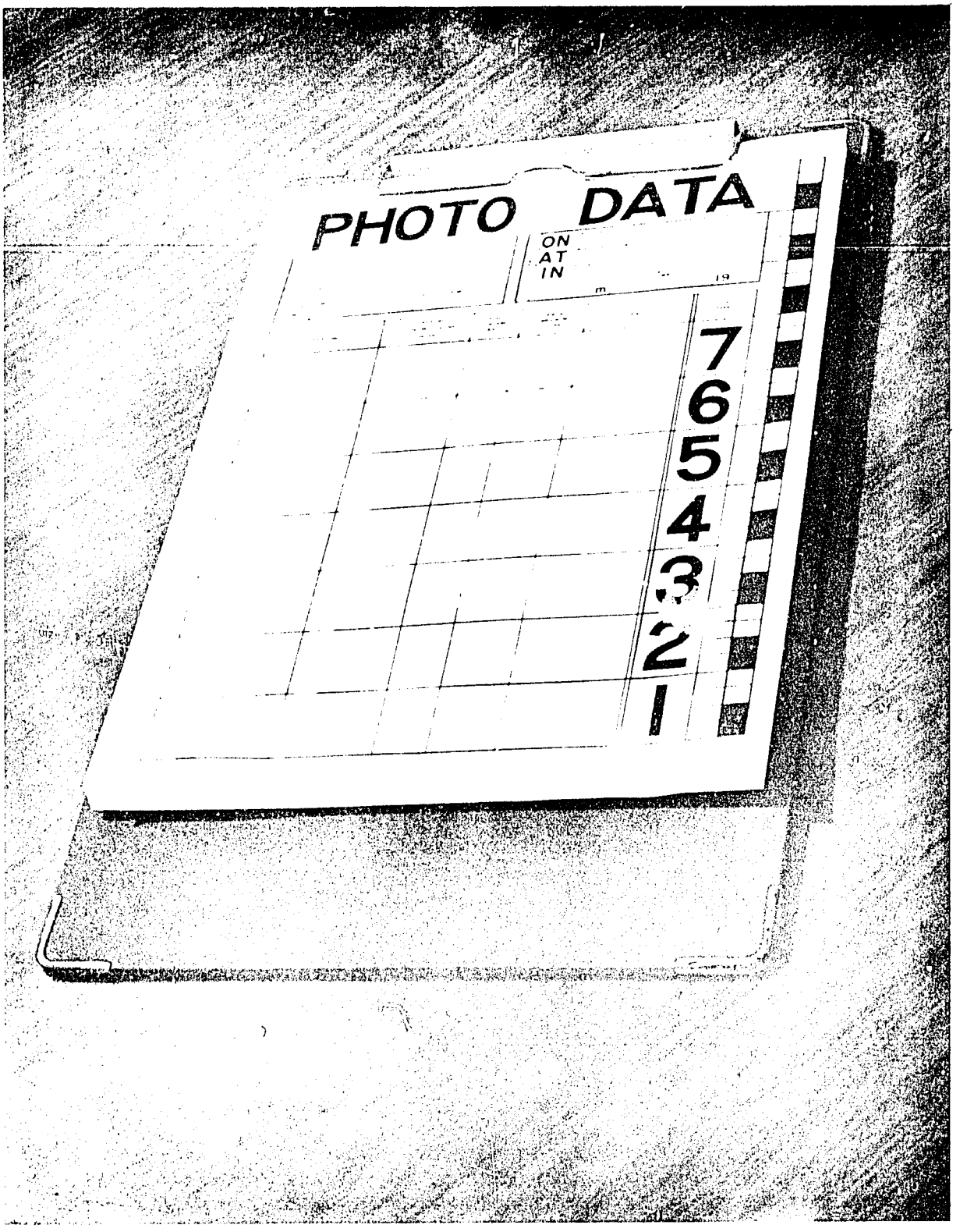


PHOTO DATA
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If the over-all shot is a large outdoor area like a flat field, it is a good idea to include some identifiable distinguishing feature in it. Traffic accidents are particularly troublesome in this respect. Try to find a bridge, a river, a telegraph pole, or a highway marker to include in the photograph for reference purposes. The investigator can then describe in his notes: "Camera located 168 meters north of kilometer marker 68 on Highway 69."

The Building. The next photograph should show the building in which the crime was committed. This shows whether it is a private home, a factory, a small shop, a hotel, or a garage. Usually, two photographs will be needed of the front and the back of the building. A photograph taken from two opposite corners can show all four sides of one building. (See photograph above.)

The Entrance. This is usually the door, but it may be a window in a housebreaking robbery. If there is both a gate and a door, take two photographs, one of each entrance.

The Hallway. The camera now shows us what we would observe immediately after we enter the door. It should show the location of other doors or rooms through which we must pass to get to the room in which the crime was committed.

The Room. This may be a bedroom, an office, or a bathroom. The most difficult problem is to include the entire area. Sometimes, like in the building shots, two photographs from opposite corners will be enough. A wide-angle lens is useful in photographing very small rooms. If such a lens is used, however, the investigator's notes should clearly show that this was done, and each photo print should also be carefully marked with the information.

Close-ups. The number and type of close-up pictures will of course depend upon the kind of crime. In general, close-ups should be made of:

Object attacked. This may be a person, a safe, a cash box, or a display counter. The purpose of these pictures is to show the amount and kind of damage and the method of attack.

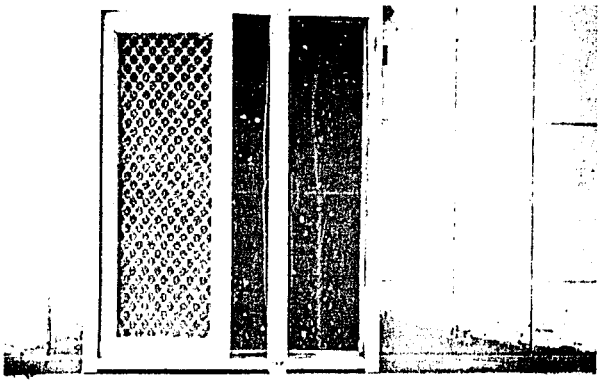
The weapon or tools used. The photographer must be careful here to show a reference point in every picture. Some stationary object must be included to orient the picture and show which are right, left, up, down, north, south, etc. It is here that a ruler ought to be inserted in each picture. It should always be put in the same place, say, the lower left-hand corner, so there will be no problem of orienting all the pictures in the same direction.

Significant clues. These may be fingerprints, bloodstains, footprints, imprints, skidmarks, gauge marks, broken glass, or any other physical evidence. Fingerprints in particular should be photographed after dusting but before lifting. This creates a problem in certain jurisdictions because the best fingerprint powder for lifting may not be the best one for photography. In England, for example, investigators are not permitted to lift a latent fingerprint at all. They must record all fingerprints only by means of photography. In this case, the correct fingerprint powder would be the one best suited for photography—white on a black background, black on a white background, etc.

There are special cameras made for photographing latent fingerprints. They contain their own electric lights and are made so they can be pressed against the area containing the prints. They are then in correct focus. Acceptable photographs can be made with ordinary cameras if they are fitted with certain close-up attachments. The Speed Graphic or Century Graphic view cameras with bellows do not need any such attachments; they can be adjusted to photograph a fingerprint in its natural size.

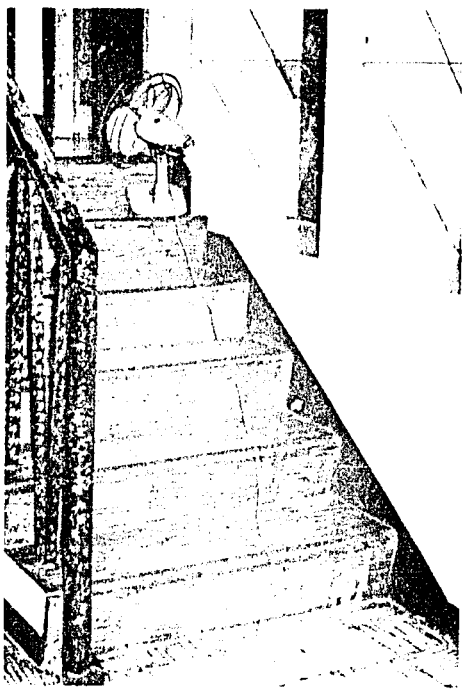
Wounds and bruises. These are important photographs that must never be overlooked in crimes against living persons. Injuries are of a temporary nature and will heal and disappear long before the case comes to trial. An accurate photograph will be the only evidence of these temporary conditions. Color film should

The Building

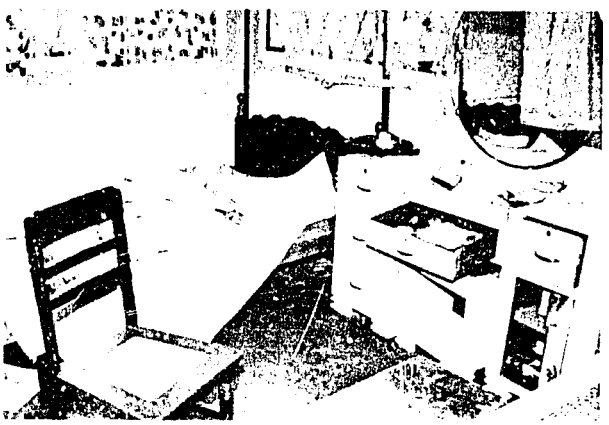


Entrance

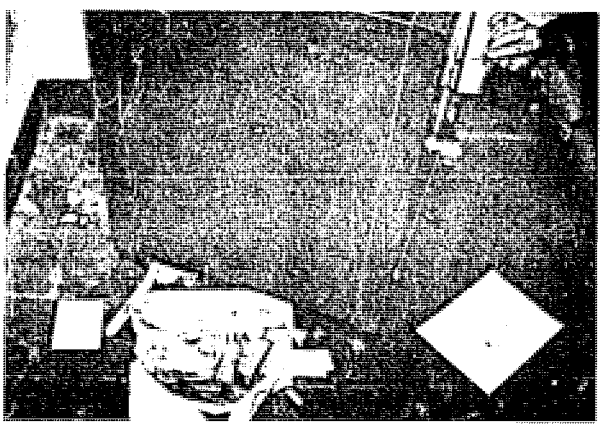
CRIME SCENES



Hallway



Room



Close-up

be used here if available. The cooperation of hospitals and doctors is of course necessary. If possible, a second photographer should be immediately dispatched to the hospital to make these photographs before the wounds are stitched or the broken leg put in a plaster cast. The crime scene photographer might get there too late.

Do not overlook wounds, bruises, and particularly scratches on the criminal himself. The victim of a rape or assault may have put up a fight and made marks on the attacker. Women victims of rape often use their fingernails to scratch the face of their attacker. Photographic evidence of these scratches would be important proof that force was used. It can destroy a criminal's claim that the woman submitted willingly to his advances.

Other temporary conditions. The most common example of a temporary condition is skidmarks on the highway from a traffic accident. The continual passage of other vehicles will obliterate these clues in a short time. Fires are another type of temporary condition. While a photograph of the flames may not seem useful evidence, an experienced arson investigator can tell a great deal about the nature and origin of a fire from study of photographs. Use color film here also if available.

PHOTOGRAPHS OF PHYSICAL EVIDENCE

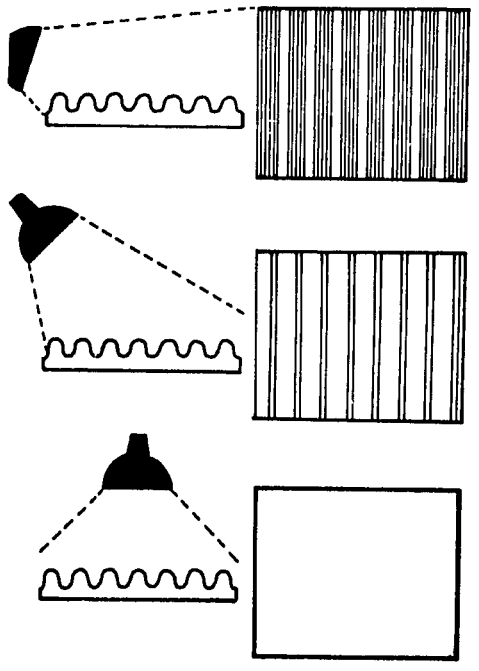
After all the required photographs of the crime scene are taken, the investigator can then carry articles of physical evidence back to Headquarters to make the special photographs he needs. Some of these photographs would be:

Making records of marks, imprints, damage or alteration to evidence. This includes bloodstains on weapons, toolmarks, imprints on paper, and fingerprints on bottles and glasses.

Copying documents that may have to be returned to the owner for use until the case comes to trial. Business records need not be impounded for evidence since this may inconvenience an innocent victim of a crime. A photograph will guard against loss and make sure that the evidence is recorded as it was at the time of the crime.

Close-up or magnified photographs to show details.

Special light photographs to show indentations by means of lights grazing sideways. This has to be done in a darkened room.



Technical Methods of Photography

Most police departments have a staff photographer who knows the technical details of taking and processing photographs. For those departments where the investigator must do his own work, the methods of equipment selection, camera operation, and processing have been put in an Appendix at the end of this book.

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5

Physical Materials

TRACKS, TRACES AND IMPRESSIONS

Anything a criminal uses may betray him to the laboratory. The knife he cuts with, the tires of his automobile, any of these things can be identified under the microscope in much the same way as a weapon. The edge of every tool is slightly different from every other one. The scratches caused by each tool are individual. The marks of tools are much finer than marks caused by blows or impressions. They can be seen very easily under a microscope. A comparison can be made of the scratches left at the scene of a crime with sample scratches made in the laboratory of a tool taken from the accused person. Any tool which is put against another object with force will leave a mark on the surface. These marks are called "impressions." A sample mark can be made from the suspected tool and compared against the mark made at the scene of a crime.

Trace means a mark or sign left behind by something that has passed by.

Track means a series of traces that show the direction that something went.

Impression means a strong mark made by pressure that goes below the surface.

Imprint means a weak mark made by pressure that stays on the surface.

An impression causes damage to the object. An imprint either disturbs some material—like dust—that is on the surface, or transfers a pattern of itself by means of some substance—grease, blood, or paint—that is on the object making the imprint.

A footprint in soil is an example of an impression. A fingerprint is an example of an imprint.

Footprints and Tire Tracks

These two kinds of impressions are discussed together because they are the same sort of physical evidence. It is important for the investigator to understand how to collect these samples because they must be collected by the investigator himself. The investigator cannot dig up the footprint and send to the laboratory; he must make a cast of the impression. The investigator should get: (1) the best print at or near the scene of the crime and (2) the nearest print to the center of the crime.

The investigator must never expect to get a perfect cast of all the footprint or of the entire mark. He will have to be satisfied with getting several casts, each one of which will show an important part of the print.

Footprints and Imprints

A footprint is a **positive**; a cast must be made of the print and compared with the actual shoe. An imprint is a **negative**; a similar imprint must be made with the shoe and compared with the other negatives. Footprints and imprints may be similar or identical depending upon how many points of comparison can be made. It may be only possible to say that the print and the shoe are of the same size and shape and therefore are similar. This is not a strong evidence as where certain individual marks are present in both samples sufficient to make an identity.

Imprints are best found on hard surfaces where the highest point of the shoe are transferred to the surface. The best imprints are on a hard smooth surface. Footprints are best on soft ground where the dirt is finer than the shoe.

It is always best to send the shoe itself to the laboratory, but if this cannot be done, the investigator should make comparison samples himself. For impressions in soft ground, the investigator should put the shoe on himself since shoes often spread when they go into the ground. To make a sample of an imprint, the investigator should put fingerprint ink with a roller on the bottom of the shoes and have the suspect walk on a large sheet of paper until the ink will no longer make a print.

Proving the Suspect in the Shoes

The investigator should remember that it is always necessary to prove that the suspected person was wearing the shoes at the time of the crime. He may later claim that a "friend" was wearing his shoes.

Comparison of Footprints and Imprints

A comparison is made by enough similarities and the absence of any dissimilarity which cannot be explained. There are both **explainable** and **fundamental** differences:

Explainable differences. Parts of the cast are missing, rocks are in cast, a slight increase of size is caused by pressure, or a slight decrease is caused by suction.

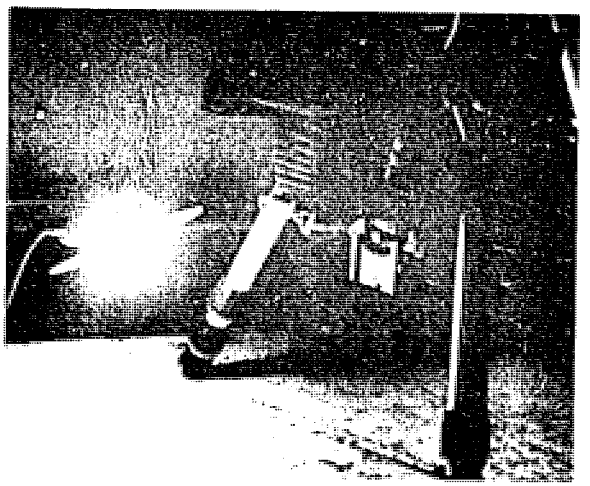
Fundamental differences. The shoes are of different sizes or of different makes.

Tire Marks

All of the rules for making footprints and imprints are the same for tires. In making comparison samples of tire prints, the investigator should remember that the circumference of the tire is very long and he must be able to get the same area in his comparison samples as the portion he finds at the crime scene. Tire print comparisons can also be made by running the tire over a piece of paper after it has been inked.

Impressions in Dust

The best way to secure evidence in dust is by photography. This photograph should be taken at night with the light coming from a sloping manner.



Impressions of Fingers

This subject is discussed in Chapter 3 under Fingerprints.

Impressions of Clothing and Fabric

Clothing can leave both imprints and impressions. This is often the case with gloves. Some criminals put their stockings on their hands to take the place of gloves. The comparison of fabric is not as good as a fingerprint, but if there is a tear or a mend

in the clothing, this may cause individuality. Cloth imprints should be photographed. Cloth impressions should be cast with dental compound. The details of comparing cloth and fabric impressions will be discussed under the appropriate subject.

Impressions of Tools

The marks of tools are very much finer than those of fabric, shoes, or tires. It is always best to send the impressions to the laboratory instead of trying to make casts. If the impression of the tool is in wood, it is possible to saw out the part and send it in. Tool marks in paint are very difficult to make a cast of. The investigator could inspect the tool mark to be sure it shows enough individuality before going to the trouble of cutting it out. Photographs should always be taken to show the tool mark in relation to the surroundings. Sloping light should be used.

FIBERS AND FABRIC

Most crimes cause contact between one person and another and there may be transfer of fibers from the victim to the criminal and vice versa. The accused may rub against things in a crime and deposit fibers from his clothing. Fiber evidence will sometimes be found when no other physical evidence exists. Not all fiber evidence is valuable because of the use of white cotton in so many kinds of garments. It is for this reason that criminalists wear white cotton smocks in the laboratory. If fibers come from this source, they will not contaminate other evidence. Many people wear the same kind of clothes such as the khaki uniform of policemen and soldiers. Many fibers made into thread and clothing are mixtures of natural and artificial fibers and therefore offer good possibility for a comparison. The Principle of Rarity exists in this case as unusual fibers have more value than common ones.

Fibers are important as physical evidence because there are many kinds, and many things are made from them. Fibers can be twisted together to form thread and the threads can be twisted together to form cord, rope, or yarn. Fibers can be woven to form fabrics, cloth, and clothing; or pressed to form felt, pillows, pads, and carpets. All these physical things made from fibers may become valuable physical evidence. There are four main kinds of fibers:

Animal fibers—hairs, wool, and silk

Vegetable fibers—cotton, flax, jute, and hemp.

Mineral fibers—asbestos and glass

Man-made fibers—made by taking natural things or chemicals and forming them into threads.

Animal hairs will be considered separately, as well as woven fibers made into fabric and spun fibers made into rope and cord.

Collection of Fiber Evidence

Fiber evidence will usually have to be collected by the criminalist in the laboratory from the clothing of the accused and the victim. The investigator may find small bits of fiber evidence and this should be carefully picked up with a forceps and placed in a paper. If the investigator has some idea as to the source of the fiber, he should not forget to collect control samples. Usually the investigator must wait for a report from the criminalist in order to know what sort of fiber comparison samples he must look for.

THREAD, CORD AND ROPE

All these forms of physical evidence come from fibers. A number of fibers can be twisted together to form a **thread.** A number of these threads can be twisted to form a **cord.** A number of cords can be twisted together to form a **rope.** The difference is usually that of size and strength. If the fibers are very loosely twisted together, the thread is called a yarn which is used to make sweaters. If the threads are woven together crosswise, this is called a **fabric.** Fabric will be dealt with separately.

Thread

Thread is usually made from cotton. Use of thread in criminalistics is important where the criminal has a button break from his clothing. The laboratory can show that

one part of the thread on the clothing matches another part attached to the broken button left at the scene of the crime. The investigator should always search for buttons and should carefully examine the clothing of the suspect to see if he has lost any. Buttons may be lost during a struggle and are often found at the scene of the crime.

Cord

Cord is called by many names depending on the purpose for which it is used. It is sometimes called twine or string. The criminal may use cord or string to tie up packages of tools or stolen goods. It is possible to determine that a fragment of string found at the scene of a crime matches a similar type of string found in the house of the suspect.

Rope

Rope is very often valuable physical evidence in a crime. A victim may be tied with rope or strangled with it. The criminal may wrap stolen goods with rope found at the scene of the crime. It is possible to determine and match the cut ends of two sections of rope.

Examination of Thread, Rope, and Cord

The investigator can often make a preliminary examination of these materials to determine family or class characteristics. He should look for: (1) the type of material whether cotton, linen, silk, hemp, etc.; (2) the number of fibers in each thread; (3) whether the threads are twisted to the right or to the left; (4) the color of the cord; (5) the diameter of the cord; (6) presence of any foreign material such as stains, dirt, dust, or debris; (7) presence of any knots or splices in the cord.

Criminals sometimes use special kinds of knots which may help to identify them. Doctors use a special type of knot in their work. Sailors are taught many different types of special knots. Men who tie bundles on animals have special kinds of hitches.

CLOTHING AND SHOES

Clothes and shoes are very personal. They go with a person everywhere he goes. A criminal often gets marks or stains on his clothes when committing a crime. This kind of physical evidence is sometimes very small and the criminal does not know he is carrying it. The criminal does not understand how valuable this kind of evidence is so he does not try to remove it.

The investigator should take the suspected person's clothes away from him as soon as possible after the arrest. Do not turn the pockets when making a search. Do not shake the clothes or try to remove any particles sticking to the clothes. Wrap the clothes in a large sheet of paper. Keep the clothes of each suspected person separate from every other suspected person. If the clothes are wet, they must be dried carefully with as little handling as possible before they are taken to the laboratory.

Never take a suspect back to the scene of the crime in the clothes and shoes he was wearing when he was arrested. The criminal may later say that the investigators caused him to walk in the blood and that is how the stains got on his shoes.

Things To Look for on Clothing:

Dust from the scene of the crime or near to it.

Vegetable fragments from the scene of the crime.

Glass, wood, paint, lipstick, grease.

Blood, semen, flesh, and **vomit.**

Metal particles and rust.

Burned places.

Feathers, hairs, fibers.

Ink, fruit stains, dyes.

Examination of Clothing in Shooting Cases

The gun, the bullets, and the cartridge cases are important evidence in a shooting case, but traces of powder grains, discharge residues, smoke, and metal fouling on the clothing are also valuable physical evidence.

The laboratory may be able to examine these traces and determine: (1) the direction of fire, (2) the caliber of the weapon, (3) the distance from the muzzle to the point of entrance, (4) the type of ammunition, (5) the sequence of the shots.

The laboratory will carefully examine the diameter of the various traces around the entrance hole then by making tests with the weapon, it can give a fairly accurate estimation of the distance between the muzzle and the entrance hole.

Shoes

Besides footprints and imprints, materials adhering to shoes may be valuable evidence to put a person at a particular place. Shoes should be sent to the laboratory without being disturbed by the investigator if possible. Each shoe should be wrapped separately. Samples of soil from the crime scene should be submitted along with the shoes. If the shoes cannot be sent to the laboratory, soil, dust, and dirt should be scraped and collected on clean paper. Do not forget that a suspect sometimes gets material in his shoe which adheres to his socks. If the suspect is wearing socks, they should be removed and placed inside each shoe before it is wrapped.

Often the accused person steps in unusual material at the crime scene which sticks to his shoe. This might be blood, oil, or paint. The investigator should inspect suspicious stains with his hand lens and try to get comparison samples of the material which he thinks are on the shoes. Most of the material on the shoes will be contaminated with soil, dust, and debris. The laboratory has special methods for separating the stain from dirt. The investigator should be sure to give the criminalist exact details of what he thinks the material is, as this will affect the method that the criminalist uses to remove it.

DIRT, DUST AND DEBRIS

Debris means the small remains of anything broken down or destroyed. **Rubbish** is an example of debris. These small particles are the most common type of contact evidence found on the clothing and shoes of the suspect, or left behind by him at the scene of the crime. Some examples of debris are:

Powdered paint rubbed off the wall, dust from bricks and cement, fertilizer, sawdust, and special kinds of material from certain shops. If a criminal steals sugar, we will expect to find it in his clothing. Debris is sometimes called **dirt**. Dirt means any small material that is in the wrong place.

Dust means small particles which are fine enough to float in air and usually can be identified only by a microscope. Dust may be peculiar to a certain place and is very valuable as evidence.

Collection of Debris

The most common place to find debris is on the clothing of the suspect. For this reason, it is best to take the clothing of the suspect from him as soon as possible after his arrest. Never take the suspect back to the scene of his crime after an arrest in the same clothing or shoes he was wearing when arrested. The suspect may later tell the court that the debris the criminalist found did not get on his clothing until the officers took him back to the scene of the crime.

Clothing should be wrapped very carefully in strong paper and sent to the laboratory. If it is not possible to send the clothing to the laboratory, it should be spread out on a large clean piece of paper and examined with a magnifying glass. Large pieces of debris are removed with forceps. The cuffs of trousers and the various pockets should be emptied out carefully and separately and the debris from each place put in a separate paper packet and sent to the laboratory. The investigator should make a sketch in his notebook showing the place on the clothing where he found the debris. It is always best to send the clothing used and other things containing debris directly to the laboratory. The laboratory uses a special vacuum sweeper to collect all the dust and debris sticking to the clothing and inside the pocket. It is most important for the investigator to collect standard samples for comparison.

SOIL

Soil means different things to different people. A farmer plants crops in it, an engineer builds with it, a miner takes minerals from it. The criminalist regards soil as the top layer of the earth. This includes any substance on the earth that may stick to a person's clothing or shoes. There are a number of different forms of soil:

Dust consists of soil so fine that it floats in air.

Grime is dust mixed with body oils and fluids.

Mud is soil mixed with water.

Stones or **gravel** are pieces of soil larger than 2 millimeters.

Sand is soil measuring from 0.2 to 2 millimeters.

Fine sand is soil measuring from 0.02 to 0.2 millimeters.

Silt is soil measuring from 0.002 to 0.02 millimeters.

In addition to the mineral part of soil, there are also vegetable and animal materials. Man also contributes a lot of his manufactured wastes.

There are two main problems about soil that the investigator wants to know. First, where did a particular kind of soil come from? Next, did the soil on a suspect's clothing come from a certain place?

Origin of Soil

Finding out exactly where a soil sample came from is difficult. The criminalist will need to consult a geologist or other specialists to help him. An example of this is a case reported by Nickolls where earth was substituted for diamonds in an air parcel shipped from South Africa to England. Before the investigator could know where to start, he had to know where the substitution took place. A geologist identified the soil as coming from Tripoli in North Africa.

Comparison of Soil

This is the more common request by the investigator. Here, the problem is to put the criminal at the scene of a crime by things carried away. Careful analysis may show particular kinds of seeds, leaves, fertilizer, or brick on the shoes of the suspect that are similar to the crime scene. If a footprint can also be found, this is excellent use of physical evidence.

Methods of Soil Comparison

The criminalist will use a number of methods to identify and compare soil. Some of these are: (1) microscopic examination, (2) passing through sieves of different sizes, (3) ashing, (4) determination of density gradient, (5) chemical testing for various minerals in the soil, (6) examination by ultra-violet light, (7) chromatography.

Of these, the density gradient method of Gain and Kirk is the best and most frequently used. Glass tubes are put upright in a rack and filled with a mixture of liquids in such a way that the liquid is thick at the bottom and thin at the top. When a soil sample is put in the tube, the different particles float or sink or stay in the middle. Two tubes containing the same kinds of soil particles will show a similar distribution when put side by side.

Collection of Soil Samples from the Scene

The absolutely correct collection of questioned and standard soil samples is more important with this kind of physical evidence than any other. Quantity is not important, but **exact location** surely is. The samples should be taken from the footprint, the tire track, under the broken window, or place where the body was found. A spoonful is enough and a spoon is a good tool to collect the samples. The investigator should not dig into the soil. Only the surface layer that is no deeper than any impression should be collected.

Standards should be taken from the crime scene and also from any different place the suspect says he was at the time of the crime. Several standards should be taken from about 10 to 20 feet from the crime scene. The criminalist can then show in his gradient tubes that nearby soil is different from the exact place. This will prevent the defense

counsel from arguing that all soil in a large area would be the same. The exact points should, of course, be noted exactly by measurement in the crime scene sketch.

Collection of Soil Samples from the Suspect

Clothing and shoes should be taken from the suspect as soon as possible. If wet, it should be put out to dry. Great care must be taken not to shake or disturb the clothing for fear that particles, when dry, will fall off. Each separate piece of clothing is carefully wrapped in paper and sent to the laboratory. The investigator should never try to scrape off soil himself. Let the laboratory do it. Again, it is necessary to repeat: **Do not take the suspect back to the crime scene in the clothes he was wearing at the time.**

PAINT

Paint is a common form of physical evidence often found in hit-and-run accidents or burglary. Paint evidence may occur in the form of chips, flakes, smears, or dust. The criminal may get the dust of old paint on his clothing or he may rub against a liquid type of fresh paint. Paint chips or flakes are the most valuable kind of paint evidence because they can be compared microscopically to show individuality.

Nature of Paint

Paint is used to protect wood or metal surfaces from the action of the weather. It is made up of a liquid material which dries to form a hard surface. It contains a binding material to hold it together and some form of color pigment. Older paint used to be made from oils but the more modern kinds may be made of plastic, animal, or vegetable material which can be mixed with water. A popular new kind of paint is made from the casein of milk. Automobile paints are usually called lacquer and are made of plastic.

Examination of Paint Chips

Paint chips are most often found in automobile cases where there has been contact between two cars, or between a car and a person. There will often be a transfer of material from one car to the other so that the paint of one car is found on the other and vice versa. Paint chips of a hit-and-run vehicle may be found at the scene of an accident. Comparison of paint chips can be done by several methods: (1) Fitting together various pieces of paint like a puzzle; (2) matching the various layers of paint by cross-section; (3) chemical or spectographic analysis of the materials in the paint.

The first two methods are always tried before destructive chemical analysis. Physical fitting together or microscopic comparison of materials is better evidence than a chemical analysis, which may only prove similarity. The investigator should remember that many automobiles may be painted from the same large batch of paint and a chemical analysis may not be able to show any difference between them. Such things as telephone equipment or furniture are often made in large factories in great numbers and are all painted with the same identical type of paint. Spectograph analysis used to be very popular in the laboratory when most paints were made with metallic materials. This type of examination with modern plastics and synthetic materials is not now too helpful.

GLASS

Glass is important as physical evidence because it breaks and pieces are scattered at the crime scene and on the suspect. It is a common type of thing-carried-away evidence in burglary and vehicle hit-and-run cases. Glass can be compared by simple matching of larger pieces, or by special laboratory procedures for small fragments. A criminal can get glass on his clothing and not know it. Even the criminalist in the laboratory will need to use a vacuum sweeping machine to find small particles of glass.

Broken Panes of Glass

The investigator is often called upon to determine whether a window was broken from inside or outside, or whether a hole in

a window was caused by a stone, a bullet, or some other force. Another problem may be to determine which of two holes in a window was made first.

Some criminalistics textbooks have very detailed descriptions and illustrations about determining glass damage. These include such things as conchoidal lines, radial fractures, concentric fractures, etc. Our own experience indicates that interpretation of glass damage should be left to an experienced criminalist. A great deal of experience is needed to interpret all the physics of glass. The criminalist also needs his microscope and special types of lighting. The investigator should therefore: (1) Call the criminalist to the crime scene or (2) remove the entire window from its mountings and take it and all broken fragments to the laboratory.

Glass Fragments in Burglaries

Unlawful entry into buildings is most often made by breaking a window. The burglar then reaches through the break in the glass to release the lock. Skillful burglars use pieces of adhesive tape to keep the pieces of glass from falling down and making noise. What they overlook is that when glass is broken by bending it until it breaks, very small pieces of glass go backwards from the direction of force. These pieces will be driven into the clothing.

Glass Fragments in Hit-and-Run Traffic Cases

Glass is the best physical evidence where a driver leaves the scene after an accident. This is discussed in the section on Traffic.

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6

Chemical Materials

POISONS

Any substance which gets inside a human body and causes serious injury or death can be a poison. Even water can be poisonous if too much is taken in a hot climate without enough salt. It is usual to exclude from poisons certain mechanical substances which may cause death if taken such as chicken bones or hard objects in the throat which may cause death by choking. Most poisons are chemicals, medicines, or natural products which can cause illness or death if taken in very small quantities. Alcohol in beverages, nicotine in tobacco, and even the common aspirin tablet can cause poisoning if enough is taken. Alcohol and narcotic drug poisonings are so common that they are treated separately.

The detection and identification of poisons in the body is the most difficult criminalistic procedure. A great deal of experience and a large amount of laboratory equipment is needed to make an analysis for poisoning. The detection and identification of poisons is called **toxicology.**

Classification of Poisons

There are several different ways to classify poisons. The doctor classifies poisons by the effects caused. The toxicologist classifies poisons by the method used to extract them from the body. Another way of classifying poisons is by their nature — gases, metals, acid—or by the means that they get inside of the body—eating, breathing, soaking through the skin, puncture of the skin or by insertion through the natural holes in the body.

The classification system used by the toxicologist is not important to the investigator but the information used by other persons to classify poisons is very important to the toxicologist. The investigator must supply the laboratory with a very detailed history of all the circumstances of the case. There are thousands of poisons and the toxicologist cannot test for each and every one. He has to be selective and test for either the most common and probable poisons, or for unusual poisons that are suggested by the history furnished to him by the investigator.

Collection of Information and History

Both successful and attempted poisoning may come under the usual classifications of deaths: natural, accidental, suicidal, or murder. For this reason, the investigator should regard any suspected poisoning case as a homicide until he can prove it to be otherwise. The investigator should follow the same procedure he would use in the investigation of any other homicide. Only about 1 in 200 cases of poisoning is caused by murder. There are probably many more that go undetected for lack of clues or a proper investigation. Sometimes when a murder by poison is discovered, further investigation uncovers other victims by the same killer which have gone undetected.

Poisoning should be suspected in any case where a person in good health becomes suddenly sick and dies quickly after eating or drinking something, or where a number of persons who have all taken the same food or drink become sick at the same time. Besides chemical poisoning, the investigator should remember that some poisonings are caused by micro-organisms in food called bacteria. The investigator should always ask for the assistance of the local Public Health Officer in investigating any case of suspected poisoning.

The Health Officer may be able to tell if the signs and symptoms are due to bacterial poisoning. The Health Officer or another medical officer will assist the investigator in determing the following items of information:

How long a time was it that the person was in good health before he got sick and died?

The exact time and date of death if known.

If a person died suddenly, give details and the time of the last meal.

Did the person take any medicine within 3 days of his death? What medicines were given to the dead person by the doctor or hospital in treating him?

Did the dead person show any of the following signs and symptoms: (1) vomiting; (2) diarrhea; (3) blue color of the skin; (4) yellow color of the skin and eyes; (5) shivering; (6) convulsions; (7) were pupils dilated or contracted; (8) sweating (9) delirium; (10) If a person was unconscious before death, what was the nature —fast breathing, slow breathing, condition of eyes, etc. ?

The investigator should search and take possession of all bottles, glasses, dishes, and remains of food and drink taken at the last meal. He should examine and take possession of any containers of powder, liquid, or solids. He should not overlook common things like flour and sugar because mistakes are made in packaging and labeling. The flour or sugar is sometimes used to hide a poisonous substance. If the poisoned person took the same food or drink as other persons, their names and addresses should be gotten and they should be questioned as to whether they observed any bad effects from the food they ate. In accidental poisonings from food or drink there are usually other persons who are also affected unless the poisoned person is accustomed to using only one particular seasoning or beverage that other persons in the household do not use. In suicidal poisonings, there is usually a bottle or container near the poisoned person. Very often the circumstances suggest a reason why the person should kill himself, or he may have left a note or told someone what he was going to do.

The investigator should get full details of the kind of work that the poisoned person does. Many occupations use poisonous substances and the poisoned person may have been made sick by this. Farmers very often use poisonous substances to protect their crops and are careless about leaving containers of agricultural sprays and dust around where they can be gotten into by children or innocent people who do not know what they are. Metal workers use acid and cyanide baths to clean things. Photographers use many poisonous substances to develop pictures. A pharmacy or hospital has many poisonous substances on the shelves. Many chemicals are used by painters and builders.

Collection of Physical Evidence in Poisoning Cases

Besides collecting bottles, containers, and dishes, the investigator should be present at the autopsy to gather specimens taken by the doctor. If the person has been in a hospital before death, all specimens of vomit, urine or stomach washings should be collected in bottles and preserved for testing. During the autopsy the pathologist should be asked to gather the following specimens: (1) All of the stomach contents; (2) At least 1 kilo of liver; (3) All or one kidney; (4) At least 4 ounces of blood taken from the heart; (5) Urine taken by tube from the bladder if present; (6) At least 2 meters of the intestines taken just below the stomach; (7) The doctor should tie a knot in each end before putting it in the bottle so the contents will not leak out.

Do not add any preservative to any samples submitted for analysis. All specimens should be kept cold and should be delivered to the laboratory as soon as possible. If it is necessary to preserve specimens for shipment, they should be sent by air and delivered to the aircraft from the refrigerator just before take-off.

In remote places without refrigeration or speedy transportation, specimens are best preserved by adding salt. The preserving of meat by means of salt is known as "pickling" and is a very ancient method. It is most successful with samples of liver and kidney and brain. The specimen should be cut into small pieces and then sliced. First a layer of salt 5mm. deep should be put into the bottom of the container, then the sliced pieces of flesh should be put on top of this. Another layer of salt is added, then more tissue and this is continued until the jar is filled with alternating layers of salt and tissue. The jar should then be filled completely to the top with salt and the lid fastened securely. A small sample of the salt should be put in a separate container and sent to the laboratory in order that the toxicologist can be sure that the salt itself did not contain any poisonous material. In the case of liquid stomach contents, the stomach should be opened and the contents should be placed in a jar large enough that the material will not take up more than one half the space of the jar. Solid salt should then be added with continuous shaking until it has absorbed all of the liquid and the specimen will not take anymore. This produces a situation known as "brine" or a saturated salt solution which has the effect of preserving the material from bacterial spoiling.

ALCOHOL AND SOBRIETY EXAMINATIONS

Alcohol is only one of many poisons but it is so common that it is considered separately. It is most important to find out if a suspect has drunk too much to drive a car safely. This is commonly called "drunk driving", but the most dangerous drivers are those who are not drunk, but "under the influence". The best way to find this out is by a chemical test of the blood or urine. The examination of such a person by a doctor is not very helpful. The doctor has no trouble if the person is drunk but it is more difficult for him to determine whether a person is merely under the influence of alcohol. A blood test should be taken of all dead persons involved in traffic accidents and all murder victims. It may be useful evidence to show that the victim was intoxicated.

Alcoholic Beverages

There are many kinds of alcohol but the most common one is ethyl or ethanol (C_2H_5OH). It is also called **grain** alcohol because it is usually made from grain products. There are two other common kinds of alcohol. One is methyl alcohol which is used in lamps. The other is iso-propyl alcohol which is used in hair tonics and cosmetics. These other two kinds of alcohol are very poisonous and do not produce a good feeling to persons who drink them. They are not commonly found in intoxication cases.

Alcohol in beverages comes from the chemical change of sugar. If grain is used to start, it must first be changed to sugar. The process is called **malting**. All intoxicating beverages are mostly water, alcohol and flavoring materials. These are added or may come from the burned barrels in which the beverages are stored. The burned

wood of barrels gives whisky and scotch its brown color. Beer is made by fermentation and contains about 6% alcohol. Wine is made from grapes and contains up to 8% alcohol. It is not possible to get more than 12% alcohol by natural fermentation. It is necessary to distill beer or wine to make it stronger. Whisky is distilled beer. Brandy is distilled wine. Gin and vodka are made from pure alcohol with other substances added for flavor. Whisky, gin, brandy and vodka contain 40% to 50% alcohol.

What Happens to Alcohol in the Body

Alcohol does not have to be changed in the body. It goes into the stomach and directly to the blood. About one half of the alcohol taken gets into the blood in about fifteen minutes and all of it within thirty minutes to one hour. It goes into those parts of the body which contain water. It does not go into places like the bones and the fat. For this reason the per cent of alcohol in the whole body is always less than the per cent in the blood. When a criminalist calculates the amount of alcohol in the body, he uses a figure of 67% for men and 5[illegible] for women.

The best way to find out how alcohol is affecting a person would be to measure the alcohol in the brain. Since this is not possible, tests are made on blood, urine or breath. Machines have been made to measure alcohol in breath but they are expensive and the policemen who use them have to take a special training course in how to do it properly. If there is a laboratory that can make chemical analysis, it is much better to get blood or urine tests and let a qualified chemist do the tests. The chemist can also test for drugs and medicines if necessary.

Meaning of Blood Alcohol Levels

0 to 0.05%. Hardly anyone is affected by this amount of alcohol and in the law it is customary to say that this person is not under the influence of alcohol.

0.05% to 0.10%. People with this amount of alcohol begin to show the effects of liquor but they are not usually thought to be unsafe to drive a vehicle.

0.10% to 0.20%. Persons with this amount of alcohol may not be drunk but they are not safe to drive a vehicle. If the alcohol concentration is more than 0.10%, these persons are charged with driving a vehicle while under the influence of alcohol.

0.20% and higher. Persons with this amount of alcohol are definitely drunk.

0.35% to 0.45%. Persons with this amount of alcohol are usually unconscious.

0.50%. Persons usually die from alcohol poisoning at this level.

Sobriety Examination by the Investigator

Even though the investigator has a blood or urine sample, he should also make certain tests of the person in order that he can testify in court, as: (1) balance, (2) coordination, (3) reaction time, (4) eye condition and reaction to light, (5) speech, (6) breath odor, (7) walking and turning ability. The investigator should interrogate the suspect to find out:

What has he been drinking?
How long has he been drinking?
How many drinks did he have?
What kind of beverage was he drinking?
Where was he drinking and with what persons?
Is he sick?
Is he taking any medicine?
Has he been to a doctor or a hospital recently?
Is he injured?
Is there anything physically wrong with him; injured leg, injured arm; blindness, deafness, etc.?

Effects of Alcohol

The effects of alcohol are so well known that the law will allow any person to give an expert opinion about drunkenness. The investigator should know some of the physical symptoms of intoxication. The most important effects of alcohol are to the nervous system. As the amount of alcohol in the blood gets higher, functions of brain like reason and judgment are affected first. The use of muscles are affected next. It is the

first effects on the brain that make the person drinking alcohol a dangerous driver.

Effect on Vision and Hearing

When a person drinks alcohol, his ability to see out of the side of his eyes is greatly affected. He may get to a point where he sees double. He may find it hard to focus his eyes. If a bright light such as an automobile headlight shines in his eyes, he may not recover his ability to see in the dark very soon.

Effect on Muscles

The slurred speech and staggering walk of a drunk person are well known. Before these signs show alcohol causes an effect on the ability to perform muscular movements. A person becomes clumsy and cannot stand without swaying or make quick turns while walking.

An important effect of alcohol on the muscles is to lengthen the reaction time. With a blood alcohol level of 0.10 or 0.20% the reaction time may be increased as much as 30%. This affects a driver's ability to stop a car quickly and may cause an accident.

Effect on Judgment and Self-control

The main thing that makes man different from animals is his ability to control himself and to think. Alcohol affects these parts of the brain. He cannot control himself but he thinks he can. He may try to do things he would not usually do. He loses his sense of caution and will take chances he would not take when sober. Besides being a dangerous driver, a person may commit crimes of violence.

Collecting Body Fluids Samples for Chemical Analysis

The best body fluid for alcohol analysis is blood. There are times when it is difficult to get blood because there is no qualified medical person to collect blood. The next best sample is urine. This is easy for any investigator to collect. Blood and urine samples have to have a preserving chemical put in them to keep the sample in the same condition when it is out to the laboratory as it was when collected. Sodium benzoate is the best preservative for urine and sodium flouride is the best preservative for blood. These chemicals can be obtained from a pharmacy or hospital. When the investigator collects a urine sample himself, he should pay attention to the following rules:

Use clean bottles or jars. They should have a tight stopper or the alcohol will evaporate. Fill and empty the bottle several times with clean water and then turn it upside down and let all the water drain out. Dry the bottles by heating in an oven if possible.

Stay and watch the accused while he provided the sample. The investigator must be able to say that the sample in the bottle comes from a certain person. Only if he watches the person give the sample can he do this. Some accused persons may try to get a friend who has not been drinking to put his urine in the bottle. If the accused says he cannot urinate, the investigator should keep him in the station until he does. A bottle can be given to a constable who stays with the accused and does not let him uriate unless he does it in the bottle.

Seal and label the specimen correctly. A tag is better than a label because it is difficult to write on a label that is already attached to the jar. After putting all the information on the tag, the officer should fasten it to the bottle with a piece of tape that goes around the tag, the bottle and the stopper.

Be present when a sample is taken by a doctor or a hospital. Doctors, nurses and hospital technicians do not always understand the legal needs of the police. The investigator should stay at the hospital and watch all the steps of the collection procedure to be sure they are done correctly. The investigator should be sure that the hospital people do not use alcohol to clean the skin of a person from whom a blood sample is taken. The investigator should watch every step of the procedure and then

take possession of the sample at once. The investigator must ask questions of the medical people to be sure that all bottles and medical equipment are free from substances that would affect the tests. The investigator must write down the names of any medicines that the hospital gives the person for treatment.

Give the laboratory all information. The investigator should always send in a detailed report with the sample to help the laboratory. A copy of the standard sobriety form should be submitted. The investigator should also send any medicine that the accused is taking. If this is not available, he should ask questions of the accused person to find out what this medicine is. Is it liquid, a capsule, a tablet? what color is it? how often does he take it? who gave it to him? where did he get it, etc. ?

DRUGS OF ADDICTION AND HABITUATION

Sir William Osler once said that the thing that makes humans different from animals is that humans take various kinds of drugs to make them feel differently than they usually do. Drugs quiet them when they feel nervous, make them feel strong when they are weak, or make the poor conditions under which they live seem better for the moment. There are thousands of drugs taken for this reason and various ones are used in different countries by different kinds of people. Some drugs are weak and fairly harmless like coffee, tea, and tobacco. Others are stronger and more dangerous and are forbidden by law. The taking of some drugs like alcohol is not forbidden by law but the effects it produces may cause the person to commit crimes or become a concern for the police. The investigator must have some knowledge about the different kinds of drugs.

There are many drugs that are not exactly addicting or habituating but are misused by emotionally unstable persons. These drugs will be considered here. The use and abuse of alcohol is such a large problem that it is considered separately.

Drugs of Addiction

True drugs of addiction must have the following qualities:

The drug produces a feeling of well-being in a person.

The person must take more and more of the drug to get the same feeling. If the drug is stopped suddenly, serious effects are produced on the body. The person reaches a point where he is only interested in taking the drug and nothing much else.

The most important points are that the person takes greater quantities of the drug to get the same effect and that serious disturbances will occur in his body if he stops taking the drug. There are other drugs which produce a feeling of well-being to which a person becomes dependent. These other drugs are called:

Habit-Forming Drugs

Coffee and tobacco are common examples. The person is satisfied to take the same amount of the drug each day. He could stop taking the drug but he does not want to because he likes the feeling it produces. Like the addicting drugs, many of the habit-forming drugs are prohibited by law. This is because the use of these drugs may cause the person to be a dangerous automobile driver or to commit a crime while under the influence of these drugs.

Narcotic Drugs

The narcotic drugs are those which: (1) relieve pain, (2) produce sleep.

All narcotic drugs without exception produce addiction. Because they relieve pain, they are used by physicians. A normal person gets no pleasure from taking narcotics and if he is not in pain, he gets a bad feeling when he takes them. A normal person may get physically addicted to narcotics if they are given to him by a doctor over a long period of time. If he is given medical treatment to cure him of this addiction, he will not use narcotics again. There is a certain

class of unstable people who get great pleasure from taking narcotics. These people will continue to use narcotics even if they do not have pain. Such persons are described as addicts.

The addict needs larger and larger quantities of his drug. Because he cannot get it lawfully through a pharmacy, he must buy his drug from criminals. He has to pay very high prices and he cannot earn the quantity of money he needs by honest work. Since his use of the drug makes him unfit to do honest work, the addict has to turn to crime to get money to satisfy his need for the drugs. The addict is not exactly a criminal, he is a sick person. Because he does commit crime to satisfy his need, he does become a problem to the police.

Control of Narcotic Drugs

The manufacture and use of narcotic drugs is strictly controlled both by national and international law. Only doctors may lawfully use the drugs to relieve pain. The regulation of the use of narcotic drugs was started many years ago and international control was given to the League of Nations. A number of international treaties and conventions between nations were formed in which many countries agreed to assist each other in stopping the unlawful use of drugs. The growing of narcotic drugs was restricted to only a few countries and was prohibited to all others. Each nation made its own laws to control the use of narcotic drugs inside its own borders.

After World War II, the international control of narcotic drugs was given to the United Nations. Most—but not all—members of the United Nations adopted a set of laws to control the international movement of narcotics. Each nation agreed to help other nations stop the international trading of narcotic drugs. Police agents throughout the world work through INTERPOL. A small nation may have no problem in its own with narcotics, but it may be used as a place where drugs are manufactured or stored before they are shipped to another country.

Opium

The most serious drug addiction throughout the world is opium which comes from the poppy plant and from which many different narcotic drugs can be extracted.

Opium is a juice from the poppy (Papaver Somniferum). It contains about 20 drugs. In Asia, opium is smoked in pipes mostly by Chinese people. Most legal opium for medical purposes is grown in Turkey and Bulgaria.

Morphine is the most common drug in opium. It is used by doctors all over the world to relieve pain. Another natural drug in opium is called **codeine** which is used in many liquid cough medicines. It is a weak drug of addiction and may be safely used under supervision. The medical need for codeine is greater than the need for morphine so some of the morphine is changed in the laboratory to codeine. Many persons become accidentally addicted to morphine through use in hospitals by doctors. Morphine can be changed by chemical means to form a drug called **diacetylmorphine** or **heroin.** German chemists invented heroin many years ago and it was found to be a very good drug to stop coughing in persons with tuberculosis. It was later found to be much more addicting than morphine and for this reason doctors stopped using it. The manufacture of heroin is prohibited in many countries of the world, except England and France. It is the favorite drug of addiction among addicts. Illegal trading in heroin is a big problem to the police in all countries.

Artificial Narcotics

Because morphine causes addiction, drug companies have tried to create in their laboratories new and better drugs which would stop pain like morphine but would not produce addiction. None of these attempts have been successful; any drug that stops pain as well as morphine will also produce addiction. Some of these drugs do not produce as great an addiction as morphine and are therefore preferred by doctors. Some of these drugs are: pethidine, demerol, amidone, dolophine and meperidine. Addiction

to these drugs is usually found only among persons who work in hospitals or doctors' offices—nurses, doctors, hospital technicians.

Cocaine

Cocaine comes from a plant that grows in the high mountains in South America, mostly in Peru. Natives of Peru who live in high places chew the leaves to get the effects of cocaine. It was discovered that cocaine was a useful drug to produce local anesthesia. This is a method of making a part of the body numb and free from pain so a doctor can do small operations without hurting the patient or putting him to sleep. It was found that cocaine also causes addiction. A search was made to find other drugs and the drug companies were successful in doing this. They created a drug called **novocaine** which is now widely used by doctors and dentists. Cocaine is now only used by eye doctors. Recently, the government of Peru has stopped the growing of the cocaine plant in its country because there is no longer much medical demand for the drug. It is not usually found in other countries.

How Narcotic Drugs are Taken:

Opium can be smoked and also taken by mouth into the stomach. The more common way of taking narcotics is by injection with a hypodermic needle because the action is more rapid. Users of narcotic drugs usually make a special kind of injecting syringe out of a medicine dropper and a needle. The narcotic is put in a bottle cap or spoon, heated with a match, and then injected into one of the large veins in the arms. Since this equipment is not very clean, the addict soon has many small scars all over his arms. The police investigator should look for these scars on the arms of persons whom he suspects of being addicted with the narcotic drugs. Addicts usually always keep their injecting equipment in their pocket or in their home. If the police investigator finds such injecting equipment, he should send it to the laboratory to be tested for the presence of narcotic drugs.

Signs and Symptoms of Addiction

Besides the puncture marks on the arms, the addict shows certain signs and symptoms. There are 2 different kinds of symptoms in narcotic addiction:

When the addict is fully under the influence of the drug.

When the addict does not have the drug and needs it.

In the first condition when the addict has enough of the drug he will feel good and will not care about anything. The most common sign is the condition of his eyes. The dark part of his eyes or **pupil** will be closed down very tightly so that the opening in it is no larger than the pin--"pinpoint pupils". Since strong sunlight can produce these signs, the police investigator should take the person to a dim or dark room to see if the eyes open up. If the person is under the influence of drugs, the eyes will not do so.

If the person needs the drug and does not have it, he will show symptoms of **withdrawal.** He will be very nervous. His eyes will be watery. He may have a running nose like a cold. The pupils of his eyes will be large or **dilated.** If he does not receive an injection of narcotic pretty quickly, he will soon develop other signs and symptoms. He will get pains in his stomach and throw up. He will continue to throw up even after there is nothing left in his stomach to do so.

Duties of the Investigator in Narcotic Cases

If an investigator suspects that a person is under the influence of narcotic drugs, he should have him examined by a physician as soon as possible. If a physician is not available, the investigator should take the following steps:

Examine the skin of the arms for hypodermic needle marks.

Examine the eyes in a dark room with a flashlight to observe whether the pupils are large or small and whether they react to light.

Search the person and his room for the presence of injecting equipment and suspicious powders.

Put the person in custody and wait to see if symptoms of withdrawal occur.

Collect a sample of the suspect's urine for laboratory examination for drugs.

Habit-Forming Drugs

The drugs in this group are sometimes classified as narcotics. Cannabis or hemp is usually forbidden under the International Codes in the same section as narcotics although it is not a narcotic drug. Other drugs, like tchat, are not prohibited for use but they may become a police problem if they affect a person to such a degree that he commits a crime. Taking of habit-forming drugs may cause a person to rob or drive an automobile in a dangerous manner. A great many of these drugs are natural plants and are different in each country. Other drugs are useful medicines which are taken without the prescription of a physician. They are "abused". Most drugs are sleeping tablets or stimulating drugs.

Cannabis Sativa

The hemp plant grows in many wrong parts of the world and its principal use is manufacture of rope. The best hemp comes from the Philippine Islands and good rope is called Manila. The leaves and flowers of the hemp plant are called by many names. In Arabia, it is called **hashish**, in Persia **beng**, in Morocco and Libya **kif**, in South America **dagga**, in India **charas**, **bhang**, or **gangha**, in Mexico and the United States, **marijuana**.

Hemp is taken in many ways. In mexico the leaves of the plant are rolled in cigarettes and smoked. In Tibet, a product called **momaa** is a mixture of **cannabis** and human fat. In Bombay it is made into a sweet called **maajun** which is popular with women. In Egypt and the Middle East **hashish** is smoked in special pipes called **josies** along with charcoal. In Algeria, the hemp is ground up with sugar, spice, cinnamon cloves and nutmeg.

Cannabis sativa is the correct botannical name for this weed which may grow to a height of 3 meters.

Effects of Cannabis on the Body

The first effect of cannabis is a feeling of excitement. Next, the user begins to get visions and nervousness, followed by a time of extreme happiness and peacefulness. Finally a deep sleep occurs. Persons who take cannabis for the first time may be sick as with tobacco but they soon become used to it. There are no certain signs of cannabis use. The user may have disturbances of time and space. He may try to take a large step over a very small item. Users have been known to step out of second storeywindows thinking they can easily reach the ground. At the present time, there are no satisfactory chemical tests for cannabis in body fluids.

Barbiturates

Many persons use barbiturates to calm themselves. There are many of these drugs usually sold in colored capsules and called jargon names by users. Nembutal is a yellow capsule and is called "yellow jackets". Seconal comes in red capsules and is called "red devils". Persons who use these drugs may also mix them with alcohol and show surprising symptoms.

Amphetamines

The most common form of amphetamine is benzedrine which is a drug used to help persons who feel low and also to stop the appetite and make fat persons lose weight. It is stimulating and is used bypeople somewhat the same as **tchat**. It is usually sold in the form of a white tablet.

Laboratory Analysis of Narcotic Evidence

A laboratory can detect very small quantities of drugs or narcotics so small that they cannot be seen even with a magnifying glass. The laboratory can detect an amount as small as 10/1000 of a milligram. It can detect very small amounts of drugs or narcotics in the urine of a person who has been taking them. All suspicious evidence that may contain drugs or narcotics should be sent to the laboratory even if the investigator cannot see any traces on the materials.

Mind Manifesting Drugs

Hallucinogenic or **psychedelic** is a new term used to describe certain drugs that cause visions. Such drugs have been known for centuries. Many are used for religious purposes. Any of the narcotics, sedatives, or stimulants may cause hallucinations, but these effects are not certain. Nutmeg and belladona are sometimes taken for this purpose.

The ancient Persians had a drug called **soma pulari.** Homer mentions one called **nepenthe** in the Odyssey. We do not know exactly what plants these were.

Fly agaric is a mushroom called **Amanita muscarina** that is used by Siberian nomads. Another form of mushroom is found in Mexico where it was known to the ancient Aztecs as **Teonanacti.** It has become popular as a psychedelic recently. It contains psylocybin. The ordinary Morning Glory flowers, **ipomoea violacea**, can produce hallucinations if the seeds are chewed. They are called "Heavenly Blue" or "Pearly Gates" by users. Another common drug from Mexico and the southwestern United States is **peyote cactus** (lophophora Williamsii) that is used by certain religious groups.

Long before the arrival of Columbus to the New World, the cohoba snuff (pitadenia peregrina) was inhaled by Indians during tribal dances. A similar compound is found in the skins of toads and is called **bufatenine.** Amazon indians use a vine called yagé, ayahuasca, or caapi that contains an alkaloid named Harmine. In the Congo, the Bantu chew the root or bark of the **tabernante iboga** during their tribal initiation rites.

The modern psychedelics come from the chemical laboratories. LSD or d-lysergic acid diethylamide tartrate was discovered accidentally by a Swiss chemist named Hoffman in 1938 while he was experimenting with ergot. Most all hallucinogens contain a similar chemical structure called an indole ring. Many are now made artificially in the laboratory instead of being extracted from native plants. All of these drugs are dangerous because such a very small dose is needed. LSD is commonly supplied soaked on sugar cubes. The doses are so small that the chances of finding the drugs in body fluids and organs are not very good. The laboratory can test the sugar cubes, however.

PHYSICAL EVIDENCE FROM FIRES

A person who sets fire to a building is very dangerous. In many countries a person who sets fire at night to a building that has people in it can be punished by death. The crime of causing a fire is called **arson.** There are several motives for arson:

Pyromaniacs. These are people with a mental condition who get pleasure in watching the fire burn or in watching the firemen put out the fire.

Frauds. Many persons who are not usually criminals may set fire to their own shop in order to collect the insurance.

Concealment of another crime. Buildings are often set afire because a criminal wishes to conceal a murder or he may wish to destroy papers that may get him into trouble.

Revenge is sometimes the cause of a fire where the person wishes to destroy the goods of another person against whom he has a bad feeling.

Examination of the Scene of a Fire

When arson is suspected, the criminalist investigator should go to the scene of the fire as soon as possible because most of the substances used to cause a fire will evaporate quickly and will disappear. The investigator should work very closely with the Fire Department so that they know he can be called upon to assist them if they have a suspicion that the fire is a criminal one.

Fires Caused by Flames

Flame is a cause of fire when it spreads from some other fire such as a person burning rubbish. An electric heater might be placed too close to clothing. Wood may fall out of the fireplace onto the carpets or other furniture. Wind may blow curtain or towels into the fire. A very frequent cause of fires

are persons who are careless with cigarettes and matches and who may go to sleep while smoking and set fire to the bed. In some countries it is against the law for a person to smoke a cigarette when he is in bed.

Fires Caused by Electricity or Gas

When fires are caused by gas, there is usually an explosion of storage bottles. This kind of fire is caused by leakage of the gas which ignites when it comes in contact with some flame. Fires from electricity are much more common, particularly if the circuits are overloaded. People attach more electrical appliances to a circuit than it can handle. Usually the heat from the short circuit causes the insulation of the wire to burn away. This ignites wood or paper. The investigator should examine the location and type of all electric appliances.

Fires Caused by Heat of the Sun

The heat of the sun can cause dry material to catch on fire, particularly if the sun's rays pass through glass. Broken parts of bottles or glasses containing water can do this.

Fires Caused by Chemical Action

There are a number of chemicals which when mixed together burst into flame. The most common form of this kind of fire is called **spontaneous combustion.** It is due to the slow oxidation of vegetable substances or oils. Clothes soaked in linseed oil will heat up when stored in a big pile.

Fires Caused by Bacterial Action

It is quite possible for a manure pile to catch on fire if it is dry. A large amount of grass cuttings or hay can become preheated. It takes a long time for hay to reach a sufficient temperature for combustion and usually no haystack will catch on fire until about one or two weeks have passed.

Fires Caused by Sparks

There are two kinds of sparks which may produce a fire:

Impact sparks. These are caused by moving machinery which come in contact with stationary hard objects. This kind of spark does not heat anything but can cause an explosion. It is most common in petrol stations or in places where paint is stored. Fires of this kind are very common in textile mills where there is a great deal of cotton dust.

Static or Friction Sparks. This kind of fire is most common on large lorries which carry petrol. Most countries have regulations that make petrol carriers have a chain hanging down below the lorry to carry off the static charge of electricity to the ground.

Collecting Physical Evidence from Fires

All of the usual physical evidence used to put the accused at the scene of the crime should be collected. These include broken glass, hair, fibers, soil, debris, etc. If the criminal used a liquid to set the fire, there is a possibility that this material may be on his clothing or shoes.

Special debris from fires include such things as matches, burned papers, and suspicious materials used to start the fire. Some liquids used to start a fire may survive the heat of the flames because they are soaked up in non-burning things such as plaster walls. These liquids will disappear very quickly by evaporation and the investigator should collect them as quickly as possible and put them in sealed jars or tins.

Locating the Place Where the Fire Started

The investigator will need the help of an experienced fireman with special knowledge to do this. Electrical wiring should be inspected and a search should be made for small piles of burnable material or candles that might have been used to start the fire.

Burned Automobiles

Setting fire to an automobile to conceal a murder is a very frequent crime. The investigator should look very carefully at any case where a person has been burned to death in an automobile fire. He should al-

ways consider such a case to be a murder until he has satisfied himself that it is an accident. The fuel pipes of an automobile should be inspected very carefully to find out if any of them have been loosened to allow petrol to run out and cause fire. Fires do not usually occur in a vehicle unless the fuel tank is broken or one of the pipes has a leak. It is always suspicious when a person is burned to death in a car and there is no damage to the car from an accident. The personal identity of any person found dead in a fire should be checked very carefully since many criminals have tried to substitute another person for themselves in order to collect large amounts of insurance.

EXPLOSIVES, BOMBS, AND GAS

The investigation of explosions and bomb reports is no longer limited to large city police departments. Homemade bombs and Molotov cocktails may show up in even the smallest town. When a bomb report is received, it is too late to begin planning how to handle the situation. There is no time to send for an explosives expert. Live explosives are very dangerous and should not be touched except by an experienced demolition expert. Such an expert may be found among highway construction engineers, mining engineers, or in the Military Ordnance Department. The most common form of explosives that will concern the investigator are homemade bombs.

Types of Explosives

Not every explosion is caused by chemicals. Many substances can explode under the correct conditions. A steam boiler may explode if the safety valve is out of order. The fuel tanks of an automobile or an aircraft can explode during a fire. Gas tanks used for cooking may leak and fill a house with vapor. If someone lights a match, the whole building will blow up. In general anything that will burn will explode if it is confined in a closed space. A prisoner in a California jail committed suicide by blowing himself up with a bomb that he made from match heads and playing cards. Dust from vegetable products like cotton and wheat may explode in a warehouse. The only thing needed is a material which can change from solid or liquid form to a gas form quickly. Most of these unusual forms of explosions will be accidents and the cause will be easily discovered.

Low intensity explosives include such things as black powder, smokeless powders and bottles of gases. Ordinary black powder is not much used anymore but is occasionally found in a homemade bomb. Materials to make black powder can be obtained at any pharmacy. It is no longer used in firearms because it produces smoke and poisonous gases, and causes much corrosion of the barrel of firearms. Smokeless powder is used in most ordinary modern pistol and rifle cartridges.

High explosives that burn rapidly are of several kinds. One of the first commercial explosives was:

Nitro-glycerine is a mixture of nitric acid, sulfuric acid and glycerine. It is an oily liquid that is very dangerous because the slightest shake will cause it to explode. The only place nitro-glycerine is now seen is in the opening of safes by explosives. Liquid nitro-glycerine is used by criminals because it will run down into the cracks of a safe. Since nitro-glycerine was so dangerous, Alfred Nobel found a way of making it safe by changing it to:

Dynamite which is made by mixing nitro-glycerine with powdered clay or sawdust. Nitro-glycerine is safe to handle in this form. The mixture is pressed into sticks containing different percentages of nitro-glycerine. It is very commonly used in construction work and mining. Modern dynamite is now made by mixing nitro-glycerine with gelatine. It is not affected by water and is usable underwater.

Trinitrotoluene (T. N. T.) was first made in Germany and is used mostly for military explosives. If T. N. T. is found in an investigation, the Military should be notified at once because the material was probably stolen from an Army depot. T. N. T. is a safe explosive. It will burn but not explode if set on fire.

Plastic explosive is a military explosive that looks like ordinary putty or molding clay. Stolen plastic explosive was used in the Algerian War against the French. The men who used it were called "Plasticutiers".

Ways of Starting an Explosion

Black powder can be exploded by a simple fuse but other kinds of explosives need a **detonator.** This is a cap like the primer of a cartridge. It is exploded by a fuse, electricity, or by impact. Dynamite is exploded by what is called a **blasting cap.** This is a metal device that looks like an empty cartridge. It is put around the end of the fuse and pinched into place. These caps are found near construction projects by children and sometimes cause serious accidents and injury to them.

Safety or time fuse is a slow-burning fuse used to set off a black powder charge. It burns slowly and the person who uses it can walk away to a safe place before it explodes. It is made from black powder wrapped with fabric. The color may be orange, black, white, or green and it comes in 15-meter lengths.

Electric blasting caps are used to set off dynamite and other high explosives that cannot be exploded by a flame. These are copper-filled tubes containing a very sensitive explosive. Two wires come out of this to connect to the electricity. The wires are usually shorted together to prevent stray electricity from setting off the cap before it is needed.

Firing Trains

Explosives like gunpowder can be set off with a simple match or fuse, but high explosives like dynamite and T. N.T. are desensitized for safety in handling and require a shock to explode them. The firing train consists of: (1) a fuse, (2) a primer or detonator, (3) the main charge.

Collection and Preservation of Explosive Evidence

It is unsafe and dangerous for any police officer to collect, preserve and transport bombs to the laboratory or to introduce them in court as evidence. An explosive expert should be called to make the bomb harmless. If this cannot be done, a number of good photographs should be taken. The judges and law courts understand the reason for this and will usually make an exception to the "best evidence" rule.

Evidence found **after** an explosion should of course be collected and preserved. In spite of the terrible effects of an explosion, there is always some physical evidence to show the kind of bomb, trigger device, and nature of explosive. The investigator should look for fragments of torn metal from the bomb itself or bits of wood and cardboard and parts of clocks used to set off the explosion. While it is not possible to gather every single piece of a bomb, the soil should be sifted through a screen to gather all possible fragments. The investigator should be particularly alert for any odor of an explosive or strange chemical, or carbon blackening resulting from black powder. If the residue of any powders or liquids is found, they should be placed in a glass bottle and sent to the laboratory for analysis.

Old Military Ammunition

In any country that has been the scene of a war or revolution, there are very often left behind mines and unexploded artillery ammunition. If the investigator has a report of any type of this ammunition, he should inspect it cautiously and then call for military experts to come and remove it. No untrained person should ever tamper with military ammunition. All persons should be removed to a distance of at least 50 meters from the site of any such explosion.

Tear Gas

So-called tear gas is actually a very fine powder that is dispersed in the form of a dust. It is usually diluted with an inert compound like magnesium oxide or Fuller's

earth. The gas can either be fired from a cartridge similar to a bullet or exploded by a grenade. A common form uses a small gun like a fountain pen and is carried for personal protection. There are three principal kinds of tear gas:

Chloroacetophenone. Commonly called "CN" is also known as 2-chloroacetophenone, alph-chloroacetophenone, or phenacyl chloride. The chemical formula is $C_6H_5COCH_2Cl$, molecular weight 154.51, melting point 54-57°C, and it is supplied as a white to tan crystalline solid of about 30 mesh.

Orthochlorobenzalmalonitrile, commonly called "CS".

Phenylchloromethyketone, commonly called "helpless gas" or "chemical mace", is a liquid that produces intense burning and also penetrates the skin to attack nerve endings. This incapacitates the victim. It is supplied in a metal can that operates like a hair sprayer and is fired by spraying the liquid at the victim.

Toxicity

Under normal conditions, tear gases are relatively harmless and the effects pass off quickly if the victim is removed from exposure. But the toxicity can be more serious and even fatal in certain circumstances: (1) direct injection into the eyes, (2) excessive concentration in a closed room, (3) injury from the propellant charge or primer.

Two fatal cases have been reported from the effects of tear gas. In both of these cases, autopsy showed damage to the lungs although this was not the direct cause of death. Death was attributed to secondary nerve poisoning by the chemical agent itself. The fatal cases both occurred in situations where a grenade type canister of the size designed for riot control was hurled through the window into a small room in an attempt to drive the occupant outside.

Direct injection of the gas powders into the human eye can cause serious injury unless treated promptly by a physician who can remove particles embedded by explosive force in the cornea. There may also be eye or skin injury if a gas gun is used at too close a range. In this case, primer discharge residues and paper or foil wadding can produce the same sort of injury as would be produced by firing a blank pistol cartridge at too close a range.

7

Biological Materials

BLOOD AND BLOODSTAINS

Blood is usually spilled in most crimes of violence and it may be shed by the criminal while committing other crimes. It is the best specimen for testing for alcohol in sobriety examinations. It is also used to investigate disputed paternity cases.

Blood is a heavy liquid that makes up 1/13 of the weight of the body. The body of a child contains about 275 cc or 1/2 pint of blood at birth. This increases until an adult male has about 5000 cc or 10 pints and a female 3800 cc or 8 pints. A liter of blood contains about 780 gms of water and 220 gms of solid material. The red color of blood comes from billions of tiny red discs called red blood cells, or **erythrocytes** that float in the liquid part of the blood. The purpose of these cells is to carry oxygen from the lungs to all parts of the body. If blood is removed from the body and put into a bottle, the red cells will gather together in a large clump called a **clot**. The clear liquid left behind is called **serum**. If certain chemicals are added to the blood as it is taken from the body, the blood will not clot. The red cells will simply settle to the bottom of the bottle and the clear liquid at the top is then called **plasma**. Both serum and plasma are a light yellow or straw color.

If a thin layer of blood is placed under a microscope, the red cells will be seen to be small red discs about 7/1000 of a millimeter in diameter. All animal red cells are round except in the camel family (camel, alpaca, llama, vicuña, and dromedary). The red blood cells of fish, birds, and reptiles have red blood cells with another small cell in the center called a **nucleus**. The only exception is the eel or lamprey.

The red cells contain an iron compound called **hemoglobin**, with which oxygen combines to travel through the body. This hemoglobin is the same for all animals, fish, birds, and reptiles. For this reason, chemical tests to detect blood are based on finding this hemoglobin. They will not distinguish the blood of one animal from another.

Special Properties of the Blood

Besides the different kinds of blood cells, the blood contains other substances called blood groups. There are many different blood groups which are named by the letters of the alphabet—A, B, C, D, E, M, N, P, S, etc. These groups can be detected by

testing the red blood cells of one person against the serum of another. Only groups A and B remain in the blood after it dries and these are used to determine the blood group of bloodstains. All other groups must be looked for in blood while it is still wet.

All persons can be divided into 4 main groups by means of the two blood factors A and B. A person either has A, B, both, or neither. If he has neither, his blood group is called "O". With the blood groups M and N there are 3 possibilities: M, N, or MN. There is no negative group in this system. The blood groups C, D, and E are called the Rh system. A person may have all three of the letters C, D, and E, only 2, only 1, or none, making a possibility of 7 blood groups.

If only dry bloodstains are sent to the laboratory, the laboratory can determine the presence of groups A and B, and possibly M and N if the blood is in good condition. If the investigator wishes tests for other blood groups, he should submit preserved liquid blood. The blood must also contain chemicals to keep it from becoming spoiled by the action of bacteria.

Individuality of Blood

It is not possible at this time to determine that a certain sample of blood came from a certain person since there are only a limited number of blood groups divided among all the different people in the world. All that the laboratory can say is that a blood sample is **similar** to that of a certain person. The laboratory can say that a certain blood was **not** the blood of a person if it is different from the samples submitted. This information is often very helpful in eliminating suspects.

Percentages of Blood Groups Among the People

The number of persons belonging to each blood group is not equal throughout the world. It is different in each race of people and the scientists who study races use blood groups to help them trace the origin of different peoples. Japanese and Eskimo people are all positive for the Rh factor C, D, and E. If a scientist finds Rh negative blood in such a person, he knows there is a mixture of some other race with the pure Japanese or Eskimo. Usually blood groups A and O are the most common. About 80% to 85% of all persons belong to these 2 groups. Group B is less common and Group AB is the most rare. For this reason it can be seen that unless a suspect or a victim belongs to one of these rare groups, the determination of a blood group of a bloodstain may not be very helpful. This is an example of the Principle of Rarity.

Precipitating Substances

If the blood of one animal is injected into the body of another animal, a reaction will occur. The animal that receives the strange blood will begin to produce substances to resist the strange blood. The resisting substances are called **anti-bodies**. They are used in Criminalistics to determine the exact animal from which a bloodstain comes. The blood of a different animal is injected into a rabbit. After waiting a certain time, the rabbit's blood is removed and is found to contain anti-bodies against the strange blood. The serum of a rabbit which has been injected with strange blood is put in a tube and some of the unknown bloodstain is put in contact with it. If the bloodstain is from the same kind of animal whose blood has been used to inject the rabbit, a white substance will be formed which is like the white part of an egg that has been boiled and turned to a solid. This reaction is called a **precipitate** reaction or a **precipitin test**.

The precipitin reaction tells to which **animal family** the blood belongs, and usually this is all that is necessary in police work. If a rabbit is injected with blood from a cat, the test will also be positive with blood from any other species of the cat family, like a lion or a tiger. Dog precipitin serum will also react with the blood of wolves and foxes. It is possible to make a precipitin serum which is exactly true for only one species of animal family, but this is difficult and very expensive. It is usually done only in special laboratories. The Criminalistics Laboratory will report that a bloodstain is positive for a certain family. As with other animal families, the test for human blood will also give a positive result with the blood of monkeys

and apes. In America and Europe where monkeys and apes are usually only found in zoos, this is not a very great problem. In Africa and Asia where these animals run wild, the possibility that a positive test for human blood might be that of an ape should be considered. The investigator should always tell the laboratory if he has any reason to believe that a bloodstain might be that of a monkey or an ape. The laboratory will take special precautions when making the test for human blood.

Poisons in Blood

It is possible to detect some poisons in blood if there is enough of the poison present in the body. Since it is not possible to take much blood from a living person, there are some medicines and poisons which cannot be detected very well only in a blood sample. In this case, other body fluids such as urine have to be collected. Alcohol is easy to detect and measure in a blood sample. For this reason, blood is the best specimen to use for this purpose.

BLOODSTAINS AS PHYSICAL EVIDENCE

There are several questions that the investigator asks of the laboratory. These are:

Is the stain blood?
If it is blood, is it human or animal?
If human, to what group does it belong?
If animal, to what species does it belong?
From what part of the body does the blood come?

Is the Stain Blood?

There are a number of chemicals that will change color if mixed with hydrogen peroxide. The change of color is usually very slow. It will happen very quickly in less than a minute if a small amount of blood is added. This helping action is called **catalytic** and is the basis for the color tests. It is the hemoglobin part of the blood that causes the reaction. The catalytic color tests therefore only indicate the presence of hemoglobin.

If Blood, is it Human or Animal?

The laboratory will determine this question by using the precipitin test. Because the testing serum is very expensive, the laboratory will usually not proceed to test for the blood of other animals unless the investigator gives the laboratory a good reason why this information is necessary. The investigator must be sure to tell the laboratory when he sends in a sample exactly what he suspects the stain to be. Sometimes bloodstained clothing may be submitted from a case where a person is suspected of killing animals belonging to another person. The suspect may deny that the stains on his clothing are those of an animal. He may claim that they came from himself as a result of a nosebleed. In this case, the laboratory will test both for human blood and for the animal blood suspected.

If Human, to What Group does it Belong?

The laboratory can test dried bloodstains for the ABO factors. It can sometimes determine the M and N factors. At this time, it is not possible to determine other blood group factors.

If Animal Blood, to What Species Does It Belong?

The laboratory usually has precipitin sera to test for the following animal families:

Bovine	Cattle in general--cows, oxen
Canine	Dogs, foxes, wolves
Caprine	Goats
Cervine	Deer
Equine	Horses, mules, donkeys
Feline	Domestic cats, lions, tigers
Gallinacine	Chickens, pheasants
Leporine	Rabbits, hares
Murine	Rats, mice
Ovine	Sheep
Porcine	Pigs, swine, hogs
Primate	Man, monkeys, apes

From What Part of the Body Does the Blood Come?

It is not possible for the laboratory to tell with certainty that a bloodstain comes from a certain part of the body The only way this could be done is by other physical evidence

mixed with the blood. If it is suspected that blood comes from the private parts of a woman, the laboratory will search for distinctive cells from the vaginal epithelium. If there are hairs mixed with the blood, the laboratory may be able to identify them as head, pubic, beard, or axillary. For this reason, the investigator must be careful not to remove any foreign materials found sticking to a bloodstain.

Collection of Blood Samples

The proper way of collecting blood samples has already been discussed. It should be repeated here that in any case where bloodstains are sent to the laboratory for examination for blood groups, it is necessary that the laboratory know the blood groups of all persons involved in the case. The best way is to have a doctor or hospital technician take blood samples from the victim and all suspects and send them in with the stain evidence. If this cannot be done, a sample of the blood of both the victim and suspect should be taken and dried on pieces of paper or glass slides. The laboratory will find out the blood group by the same method that it uses for the bloodstains. This is not a very satisfactory procedure. It should only be done if absolutely necessary.

Uses of Blood as Evidence

Length of Time the Victim Lived. When a person dies, his heart stops pumping, and the body no longer bleeds. The amount of blood around a dead body may indicate how long it lived after being wounded. Of course, much blood could simply leak out by drainage. A large pool of blood around a body with many small wounds indicates that the victim lived quite a while. Where death comes quickly from a gunshot wound, there may be little or no blood at all on the outside. If a large blood vessel is punctured, all the bleeding may take place inside the body. An autopsy will show this.

Escape Route of a Wounded Suspect. If blood strikes the ground from straight down, it of course leaves a round drop. If the bleeding person is moving, the blood strikes the ground at an angle. This makes a stain like a bowling pin with usually a couple of smaller drops ahead of the stain in the direction of travel.

Origin of Blood Flow. A suspect will try to explain blood on his clothing by saying he had a nosebleed. The form and location of bloodstains will be important to prove or disprove his story. It would be difficult to believe that stains on the back of a coat came from the nose. In any case where a nosebleed is claimed, the investigator should ask to see the suspect's handkerchief. Any person who gets a nosebleed is bound to try and stop it by using his handkerchief. A fairly clean handkerchief would tend to disprove his story.

Time the Crime Was Committed. Blood from arteries is scarlet red while vein blood is a little darker. Blood will start to clot in three minutes and will be firm in 15 minutes. As blood dries, it loses its red color and slowly turns to brown. This takes from 12 to 36 hours. Blood will be completely dry and completely brown in 10 to 12 days. Of course, these times are only approximate and the investigator should use great caution in drawing conclusions.

Where To Look for Blood

Weapons. When a knife is withdrawn from a wound, it is wiped fairly clean by the edges of the wound and by the clothing. Only a thin film may remain and sometimes no visible blood at all. Sometimes the suspect wipes or washes the blood from the knife. The criminalist will search for blood in the cracks of the handle. Wooden handles may have cracks or splits and no amount of cleaning or sandpapering will get it out. The suspect usually forgets to clean the inside of the scabbard or leather sheath of a knife, bolo, or dagger.

Blood from cracks and crevices is not quite as good evidence as blood on the blade. The suspect may claim that such blood got on the knife a long time ago. There is also the possibility that such blood may be from an animal that was butchered with the knife, The investigator should always ask if the knife had been used for this purpose.

Hidden Places. The investigator often overlooks places to find blood that are not obvious. Fingernails may retain blood even if the hands are washed. The suspect may have wiped his hands under a table or on pieces of tissue or toilet paper that were thrown into a trash can. Blood can soak through cracks in the floor and be found underneath the house. A very good source of blood is the waste trap of a sink. The criminal thinks the blood has gone away when he washes his hands, but quite a bit may remain in the waste trap.

SEMINAL STAINS

Semen is the male fluid given off during sexual intercourse. It is a milky white fluid containing millions of small cells with tails called **spermatozoa**. Each giving off or **ejaculation** by the male produces about 3.5 cc or a teaspoonful of semen. Semen is important physical evidence in cases of seduction, rape, unnatural acts of perversion, and bestiality with animals.

The investigator should get the clothing of both victim and suspect as soon as possible after the offense is committed. Special care must be taken in handling seminal stain evidence. The clothing must not be rolled or crumpled because this might separate the heads from the tails of the spermatozoa. This makes the work of the criminalist difficult because he depends upon finding intact cells to make a microscopic identification.

The victim should be examined by a physician as soon as possible after the offense. The doctor should be asked to look for signs of injury. If there are no signs of injury or struggle, the investigator should be very careful before he makes an arrest. He should question the woman very carefully about the circumstances of the attack. Many women sometimes make false charges of rape against the man when they have in fact freely consented. It is important to find out if the woman knew the man who attacked her. Check the victim's statement very carefully. Have her tell everything she has done for several hours before the offense. The investigator should remember that a woman is sometimes frightened by the strength of a man and submits to him rather than suffer injury. She may not show any signs of struggle even though she has been raped. The examining doctor should be asked to take a **vaginal swab** from the private parts of the female. This is a wood stick with cotton wrapped around one end. The swab is put in a test tube just as it is and sent to the laboratory.

The finding of seminal stains on the clothing of a man does not necessarily prove that he committed rape. If the man is married he may have gotten seminal stains on his clothing during sexual relations with his wife. The investigator should examine the man for scratches on his face. This is one of the most common signs in rape cases. Since these fine scratches may disappear in a few days, it is important to have them photographed as soon as possible. Other valuable physical evidence from the suspect would be soil stains on his clothing, blood, pubic hair from the female, and fiber evidence from contact with the victim's clothing.

The crime scene should be searched for stains, buttons torn from clothing during the struggle, weeds, seeds, dirt, dust, and debris. The nature of this type of crime causes considerable contact between the participants and their environment. Material is transferred between persons and objects. Physical evidence can confirm that a struggle took place and support the victim's claims that force was used. The investigator should bear in mind that young girls are often more concerned about damage to their pretty clothes than damage to their honor. They may remove their clothing voluntarily when rape seems unavoidable, rather than allow it to be torn.

Careful interrogation of both the victim and the suspect is necessary in rape cases. If the victim is over 21 years of age, the investigator must prove enough force was used to overcome objection. Where did she meet him? Did she know him previously? Remember that young girls are easily led. Do not say: "Did he do this or that?" Get her to tell you in her own words exactly what happened. It is helpful to suggest a polygraph examination of the victim if the investigator has any doubt in his mind of the truth of her story.

Laboratory Examination

The laboratory will first examine the clothing by ultra-violet light to locate suspicious stains. It will then soak the stains and make a microscopic search for spermatozoa. If it finds intact spermatozoa, this is enough evidence for an identification. If it does not, it will make tests for a substance called **acid phosphatase**, an enzyme found in semen. It can also make a biological precipitin test specially for semen. It may be able to perform grouping tests if the suspect is one of a certain class of persons called **secretors**.

HAIR

Hair examination is one of the oldest forms of physical evidence. Its use is older than fingerprints. It was first used in a court case in the year 1847. It is valuable because the hair of each kind of animal is different and distinct from all others. Like fibers it is most likely to be involved in contact between the victim and the suspect.

Types of Hair

Hair grows out from the body like paste coming from a toothpaste tube. The width of the hair is not always the same along its length. It starts out pointed and narrow and then strays more or less the same. Hair is different from other types of tissue in the body. It is made from the same kind of substance that the fingernails and the horns of animals are made of. It does not spoil after death. Hairs may be found on a skeleton which has been buried for a long time. Animals have both **fur** hair and **guard** hair. Humans do not have much hair, which is why they must wear clothes to keep them warm. The hair from various parts of the human body is different.

Structure of Hair

Hair consists of a root, tip, and a shaft. All hairs have roots. If hair falls out naturally, the root is found to be dried up and small. If hair is pulled out, it is shaped like a bulb. Examination of the root will tell whether a hair has fallen or has been pulled out by force. The tip of the hair may show whether a hair has been cut. The tips of body hairs become rounded from rubbing against the clothes. The hair of women usually shows a fine tip while men's hair is apt to be cut off square. When hair is examined under the microscope, it will be seen to have several parts:

Cuticle, or the outer scale cover of the hair.
Cortex, or the center part of the hair. This is filled with small pieces of material called fibrils which may be either straight or crosswise.
Medulla, or the center of the hair that runs through the cortex.

Identification of the hair is made by comparing the width of the medulla with the width of the whole hair. The percentage of space occupied by the medulla is called the **medullary index**. It is calculated by dividing the width of the medulla by the width of the whole hair. This has to be done by special instruments under the microscope. The index of most animals is greater than 0.5. Horses and cows have an index of about 0.5. Humans have an index of less than 0.5.

The cortex does not help much to identify hair but newer methods using atomic energy may be helpful in the future. The cortex is examined for the presence of pigment or coloring matter in the form of tiny granules. These are either evenly spread throughout the cortex or gathered around the outside or thicker near the center.

The outer covering or cuticle is covered with scales like a fish. Examination of these scales is helpful to tell what species of animal the hair comes from. The scale pattern may be of several types.

Color of Hair

The color of the hair is mostly due to a chemical called **melanin.** The difference between black and brown hair is due only to the amount of this pigment and not to a difference in it. Red hair is thought to be due to iron.

Shape of Hair

A hair is not completely round but may be oval or flattened. The amount of flattening determines whether the hair is straight or curly. The natural shape of a hair can be found out by making a cross-section of the hair by very delicate laboratory methods. The criminalist uses these methods to help determine the part of the body where the hair came from.

Laboratory Information From Hairs

It is not possible to know everything about hairs because this would take a lifetime of study. The laboratory will be able to tell whether:

The hairs are human or animal.

If animal hair, what family it comes from. The examination here is similar to the problem in determining bloodstains.

The hair is similar to that of a certain person. Absolute identity cannot be proved with ordinary laboratory techniques.

What part of the body the hair came from.

The hair has been deformed by cutting. If the hairs contain dirt, dust, or debris, it will help to tell from what part of the body the hair comes from. It may help to tell the occupation of the person.

The hair has been dyed or bleached.

Collection of Hair Samples

Hair evidence should be looked for on clothing, combs, weapons, in pockets, on the fingers of the victim and inside the hat. The investigator should always get samples of hair from both the victim and the suspect. The investigator should be sure to get head and pubic hair samples from a dead body before it is buried, even if there is no idea at the time that hair may be evidence. The best way to collect hair samples is by combing. This gives a better sample than cuttings made by a barber. The barber cuts only certain parts of the hair. Investigator should try to get at least 100 hair samples and put these in a packet.

Examination by the Investigator

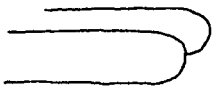
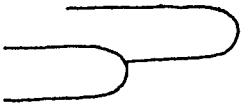
The investigator should be very careful in examining hairs because it is easy to get them mixed or contaminated. Never take a sample of one hair at the same time as another.

The investigator may examine the hair and note the following things:

Color	Condition of root
Length	Kind of cuticle
Character (wiry, wavy, kinky)	Cortex
	Medulla
Thickness	Presence of dyes and bleaches
Kind of tip	
How did it drop off?	Cross section
	Medullary index

Is the Hair Human or Animal?

It is necessary to make a microscopic examination in the laboratory to tell the difference between human and animal. Besides microscopic examination of the cross section of the hair, the laboratory must make an examination of the scale pattern. The individual characteristics that help the laboratory to tell the difference between human and animal hair are:

HUMAN	ANIMAL
Medullary index is **less** than 0.5	Medullary index **more** than 0.5
Medulla may not be present	Medulla **always** present
Scale pattern is fine and each one overlaps the other more than 4/5. 	Scale is coarse and overlaps less than 1/2. 
Pigment granules are **fine**.	Pigment gr · ules are **coarse**.

Measuring the length of a hair is the most helpful thing in telling hair from different parts of the body. Head hair usually shows cutting at the tip. Pubic hair is coarse and curly and has many broken ends because the clothing rubs off against it. Armpit hair looks like pubic hair but the ends are sharper and the hair is not so curly. Eyebrow and eyelash hair is usually very short and has a sharp tip. The hair of the beard or mustache is usually triangular in shape and very stiff. A cross-section is necessary to show this.

BONES AND SKELETON REMAINS

The investigator frequently finds bones under several kinds of circumstances. He may have to make an identification or determine if the bones are human or animal, whether a crime has been committed, or whether the person died by natural means. These cases may be:

Natural causes where death has happened so long ago that only the skeleton or some of the bones are left. There may be flesh but the usual means of identification such as fingerprints have disappeared.

Criminal cases where someone has tried to get rid of a human body by cutting it up and scattering the parts, or has tried to destroy the body by the use of chemicals or fire.

Accidental cases such as mass disaster where fire or very great injury has destroyed the body so badly that identification is difficult.

Certain scientific specialists called **physical anthropologists** can find out by examination and measurement of the bones whether they are human or animal, male or female, the age, and sometimes the race or nationality. This type of specialist is usually found at a university. The crime laboratory will be able to assist the investigator in locating the specialist. The expert will usually not be able to tell the cause of death, but he can assist the investigator in establishing the identity.

Collection of Bone and Skeleton Evidence

The investigator is usually called when the first bones are discovered. It is important that the finder be told not to try to take any more bones out. Photographs should of course be taken and a series should be continued as the digging progresses. A sample of the soil should be collected. Do not attempt to remove hair or other objects from the bones and do not attempt to wash or clean them in any way.

If a biology teacher or doctor is available, he can be of assistance in supervising the digging and the fitting together of parts as they are found. A careful search for all teeth should be made. A piece of wire screen should be used to sift all soil in the area to look for missing teeth and very small bones. Sometimes the smallest piece of bone or teeth may be important in establishing identity.

Preliminary Examination by the Investigator

If the skull and the pelvic bone are available, the investigator may be able to draw certain conclusions. The capacity of the female skull averages about 200 cc less than the male and for this reason a large skull usually indicates a man, a small one a woman. The female skull is usually more spherical than the male. The investigator should examine the portion of the skull between the eyes. In the man there are usually two noticeable prominences called the **glabella** on the forehead which is not present in the female. The jaw is usually larger and thicker, the eye sockets are larger, the cheekbones are heavier. If all of these things are considered together it will usually be possible to get a fair idea as to whether the skull is that of a man or a woman.

The pelvic bone of men and women is different because of the child bearing functions of the woman. This difference is noticeable even in small children. It is not easy to describe these differences, but if the investigator makes a comparison with pictures and drawings in an anatomy book he should be able to notice the differences.

If neither of these two important bones are available, the investigator will need to get help from an expert in determining the sex of the bones. The expert uses a great many measurements of various parts of the bone and then compares the relation between one measurement and another. To do this, he needs to consult many mathematical tables. The more bones he has, the better estimate he can make.

Examination of Bones and Skeletal Remains in the Laboratory

Besides the help of a physical anthropologist, the crime laboratory can make a number of tests. If the bones still have some flesh on them, the laboratory can make a biological precipitin test in the same manner as it determines blood. The laboratory will also examine hair adhering to the bones of the skull and any other physical evidence found with the body, such as jewelry, watches, bits of paper, letters or other associated evidence. If any skin is present, it can examine it for friction ridge patterns. If the inspection shows that there have been breaks in the bone at sometime in the past, the laboratory will arrange to have X-ray pictures made which can be compared with hospital records. If the investigator has any suspicion as to who the bones belong to, he should make a careful inquiry of all doctors and hospitals to find out if the suspected person has ever had treatment. Sometimes scars of operations can be identified from hospital records. In the famous English murder case of Crippen, the scar caused by an appendix operation was the only identifying feature used to prove the identity of the murdered woman.

Additional Information Obtained by Specialist

The physical anthropologist can often determine the **age**, the **height**, and possibly the **race** or **nationality**. Certain experienced dentists can also give valuable information from a study of the teeth. By his knowledge of the average amount of flesh over certain bony parts of the body, the physical anthropologist can often reconstruct the face of a person using clay over the skull. This has been done in several famous murder cases. If a good photograph of the suspected victim is available, the expert may be able to take a photograph of the skull and compare it with the photograph of the person.

Bone evidence should always be sent to the laboratory for examination.

8

Special Materials

QUESTIONED DOCUMENTS

From the very earliest times, man has put down marks on different materials to make a record or to send messages to other people. The first forms of writing were simple pictures on the walls of caves. Man soon found he could not express all of his thoughts by means of pictures so systems of writing were developed. Early writings were on stones and metal. Later skins of animals were used. Paper was first invented by the Chinese more than 2,000 years ago but it was not common in other countries for a long time. With the making of paper, writing became more common to many people. Criminals were quick to learn that it was profitable to make false documents. A knowledge of the methods of making false documents is therefore necessary to the police investigator. The examination of questioned documents falls into two broad classes:

Criminalistics examination for the detection of forgery, erasures, alterations, and obliterations.

Handwriting identification to find out who is the author of a writing.

The criminalistics examination of documents is similar to other kinds of laboratory work. Dr. Wilson Harrison, the noted British Examiner of Questioned Documents, says that an intelligent police investigator can detect almost 75% of all forgeries by careful inspection of a document with simple magnifiers and measuring tools. The examination of documents in the Criminalistics Laboratory is also a strictly scientific procedure which can be learned in a very short time.

It uses ultra-violet lights, special photography, and chemical and microscopic tests to determine the age and kind of ink or the composition of the paper. Because the typewriter is a mechanical tool, the identification of typewriter specimens is also strictly a criminalistics operation.

Handwriting analysis, on the other hand, is a more difficult procedure and requires long study and experience. Because we recognize the handwriting of other persons fairly easily we think that it is a simple matter to detect forgery in handwriting. This is not true. The problem is that no person ever writes his letters exactly the same way every time. The handwriting expert has to learn differences of form and structure by a sort of intuition which is not easy to reduce to a science. For this reason, the police investigator or the laboratory criminalist should confine his work to the detection of forgeries and erasures and leave the identification of handwriting to a more qualified document expert.

Collection and Preservation of Standard Samples

Usually by the time the investigator has received a questioned document as evidence, it has been handled and mishandled by many persons. The investigator should not add any additional contamination of his own. He should place the document under a protective cover as soon as possible. The investigator should always insist that he be given the original of any document submitted for examination. It is difficult if not impossible to make an accurate examination of a copy of a document. The investigator should photograph or arrange to have photographed any document submitted. He should do as much as possible in the way of examination with the duplicate, consulting the original only when necessary. A good photograph will also protect the investigator and the laboratory from later charges that the document has been altered while in their possession. The investigator should not place any additional marks on the original document or use staples or pins to fasten it to other documents!

Samples of copying machines are sometimes submitted for examination to determine if a certain document was copied on a certain machine. In this case, the investigator will need samples from the suspected machine and should find out if there are any other machines like it in the same community. He should get samples from these machines.

In cases involving seals or rubber stamps, the investigator should get the original stamp in order that the laboratory can make its own standard samples. He should also secure samples of the same type of paper used for the suspected document.

Collection and Preservation of Document Evidence

The best type of standard samples are those made by the suspected person for some other reason than the case in question. A good source of standard material are school records, driver license papers, statements made to the police, letters written to government agencies, application forms to employers, applications for passports, receipts signed for money, or letters written to friends. The list is endless, and the good investigator will think of many places he can find standard samples written by the suspected person.

Sometimes it is necessary to collect dictated suspected samples where it is not possible to obtain good standard samples written for other purposes. In this case, the investigator should always dictate the sample and not let the person copy from written or printed material in front of him. If the person thinks that he is suspected of forgery, he may try to disguise his handwriting. The investigator should have the suspected person write the material 3 or 4 times. After each sample he should take away the paper and provide a clean sheet for the next sample. In this way the suspected person will forget how he made the letters in earlier examples and will go back to his own personal habits of writing. The examiner will want to compare characteristics from the standard sample with the questioned document. Sometimes it is not advisable to let the suspect know the nature of the document he is suspected of forging. In this case, the investigator should prepare an artificial standard writing which contains the important characteristics. Among these should be any misspelled words which have been noted in the questioned document. The same misspelled words in both the standard and the questioned document are very good evidence.

The standard sample of writing should be collected with the same type of instrument and the same kind of paper used for the forgery. If ruled paper is used on the questioned document, ruled paper should be used to collect the sample. If a ballpoint pen is used in the questioned document, a similar type of instrument should be used to collect the standard. No instruction should be given the suspected person as to how to put the material on the paper. He should be allowed to do it by himself. In this way the examiner will be able to observe how he makes his margins and how much space he leaves between lines.

Typewriting standards can be collected by the investigator himself without the knowl-

edge of the suspected person. The best sample to get is an exact copy of the suspected document which will contain the same letters and punctuation marks that were used in the questioned document. If the investigator is not a good typist, he should get an experienced typist to make the sample. A typewriting sample should be collected in several forms:

A copy of the original document on the suspected machine using the same ribbon and without cleaning the keys.

A standard sample of all of the letters on the typewriter, both lower and upper case, including all punctuation marks and all numbers.

A carbon impression of the standard paragraph containing all letters, numbers, and punctuation marks. The carbon impression is made by first carefully cleaning all the keys with cleaning fluid and a brush. Next, a piece of good bond paper and a clean sheet of carbon paper are put in the typewriter and the ribbon control set to the stencil position. At least one paragraph of the suspected material is then typed directly on the carbon paper, followed by a group of all the letters both upper and lower case, the punctuation marks, and the numerals.

A notation is made at the bottom of the page giving the make, model, and the serial number of the typewriter from which the sample was taken, the date, time, and place collected, the name of the person making the sample, and the names of the persons who usually use this machine should be included.

Rubber stamps or seals should always be submitted to the laboratory in order that the examiner may make his own standard samples of the imprints and impressions. If this is not possible, the investigator should collect standard samples in the following manner:

Make a series of standard imprints by inking the rubber stamp heavily, then make a series of imprints on after the other until the ink will no longer print. In this way the examiner will be able to note the effects of different amounts of ink and pressure.

Clean the rubber stamp carefully with a solvent, dry thoroughly, ink lightly, and make another series of samples collected using different amount of pressure—heavy, medium, and light. Examine both these impressions and the original stamp to be sure that any imperfections in the original stamp are reproduced accurately on the standards. Advise the laboratory the location of any damages or imperfections.

To make a preliminary examination of a document, the investigator will need a magnifying glass, a good ruler and the type of square used by draftsmen. He will also need a good lamp or strong flashlight in order to examine the effects of direct, sloping, and transmitted light.

Class characteristics should be looked for first. These include: the kind of paper, whether it is ruled or plain, bond or sulphite, or whether it contains any printing. The kind of writing instrument should be noted and the dimensions of the paper carefully made with the ruler. The document should next be examined for the presence of a water-mark by transmitted light.

The document should next be examined by the magnifying glass for the presence of blots, stains, erasures, or obliterations. The nature and position of any perforations caused by staples or pins should be noticed.

If the examiner has an ultra-violet light, the document should next be inspected under this light. Many types of chemical erasures will show up under this type of illumination. Differences in paper caused by the presence or absence of optical bleaches will be noted. Optical bleaches are chemical compounds used to whiten paper. They flouresce strongly under ultra-violet light. They were not used until after World War II.

After all forms of examination by magnification, measurement and inspection under different kinds of light have been used, the examiner should next turn his attention to the actual writing itself.

In the case of forgery, the investigator and the laboratory have certain limitations. They may be able to say that a document is a forgery but not who actually wrote it. In general, there are four types of forgery:

Writing something in the name of another person without trying to disguise the handwriting. This is a common type of forgery with checks. The forger relies on the fact that the bank in which he cashes the check may not know the genuine signature.

Disguised writing where the only effort by the forger is to prevent his own writing from being detected. He does not try to imitate the genuine handwriting of the person in whose name he makes the document.

Drawn forgery where the forger tries to imitate the handwriting of a genuine person by copying it freehand. If done properly by a skilled forger, this is a very difficult form of forgery to detect. Many government agencies employ this method to sign the name of important officials to large numbers of documents. In this case these are not criminal forgeries.

Traced forgeries where the criminal puts the document he wishes to copy behind a new sheet of paper and traces the writing. This type of forgery can usually be detected easily because the writing shows signs under magnification. The lines are not sure and smooth and there is evidence of patching. The investigator may be able to say that the signature is a forgery but he will not be able to tell who did it.

Anachronisms

An anachronism is something in the wrong time or place. This means that the forger has trouble matching the paper, ink, or writing material to the exact date it was supposed to have been written. He may use the wrong stamps or the wrong letterheads. He may use the paper that was not manufactured at the time the document was supposed to have been written. He may use a modern style of writing for a document that was written many years before this kind of writing was taught. Some examples of anachronisms are:

Printed headings. The printed headings of government forms and letterheads change frequently as new orders are placed. The names of the officers of companies, and the telephone numbers are very frequently different. The type from which the letters are printed may wear out and be replaced with a slightly different type. The amount of space between the lines on a letterhead may change. Careful measurement with a ruler will show this. A good way for the investigator to detect changes is to put the suspected document and a sample of the letterhead known to have been used at the date the document was prepared, one on top of the other and look at them by transmitted light. Any changes in the two letterheads will be immediately apparent.

Stamps. While the picture of the ruling monarch may not be changed, many people do not know that the design colors of stamps may be changed from time to time. The forger may have trouble getting a stamp of the same kind used at the date the document was supposed to have been prepared. He may use a more modern stamp which will betray him. Sometimes the forger will remove a stamp from a genuine document of the correct date and try to affix to the forged document. Evidence of the glue and the writing on the stamp will be apparent under careful examination.

Paper. The earliest form of material on which writing was placed were the skins of animals called parchment or vellum. The first artificial material was used in Egypt and called papyrus. The inside of a grass-like plant was sliced into layers that were beaten and pressed together into sheets. The word **paper** comes from this **papyrus.** The first paper was made from rags. At first linen rags were used and afterwards a mixture of linen and cotton or cotton only. Letters dated A.D. 874 have been found in Egypt and the oldest manuscript in England on cotton paper is the year A.D. 1049. Straw was used to make paper in 1800. Paper made from wood was not attempted until 1869 and modern type of paper called sulphite was first used between 1880 and 1890. A form of grass called **esparto,** grown in Libya, was first introduced in England in 1861.

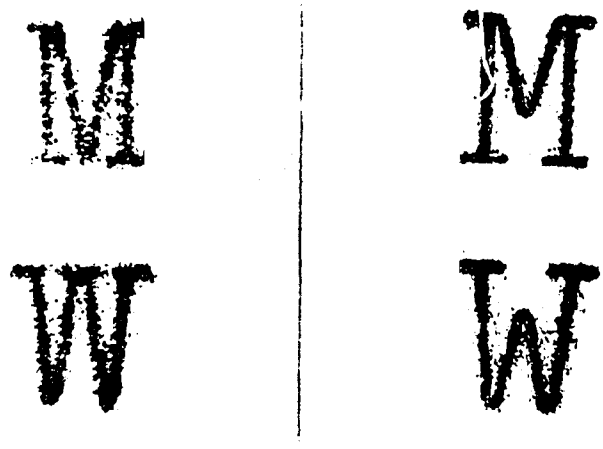
The easiest way of identifying the date of manufacture of the paper is by the watermark. This is a brand put on the paper by the manufacturers. It is impressed into the

paper by wires on the rollers that make the paper. These designs are changed from time to time. All paper manufacturers keep careful records of changes in their water-marks. If the water-mark of the suspected document and of other papers genuinely prepared at the same time are not the same, an inquiry should be made to the paper manufacturer. Wrong water-marks are one of the most common mistakes of a forger. Another valuable kind of evidence obtained from paper is the presence of official water-marks belonging to government agencies. All paper manufactured for the United States Government bears a water-mark of the Seal of the United States of America on it. Any document supposed to have come from a U.S. Government agency should bear this Seal as a water-mark. Other governments have similar special marks for paper made exclusively for government use.

Writing Instruments. The earliest kind of ink was India ink. It was made from soot or carbon mixed with water. This ink does not penetrate the paper and can be scraped off with a knife. It was not until the middle of the last century that any considerable changes were made in the preparation of ink. At this time, blue dyes were added to iron ink to make it show. Another kind of ink called logwood was used many years ago but is not now common. The investigator should not attempt to make analysis of ink by himself but should refer the matter to the laboratory.

The ballpoint pen is the newest and most popular type of ink writing instrument. A very few were made in Europe before 1935. A document could have been written with a ballpoint at this time, but it is not very proable. A practical ballpoint pen was first used in Argentina in 1943. By 1945 similar pens were being sold by the millions. It is fairly safe to assume that any writing with a ballpoint pen is almost certain to have been made after the year 1943. The age of a ballpoint writing can sometimes be determined closer by examination of the type of ink. Before 1951, most ballpoint inks were made with an oil base. After 1951 there were improved inks using a different chemical compound which did not smear as the oil did. The laboratory can make a simple test for these types of ink and determine whether the ballpoint writing was done before or after 1951.

Typewriting. The first typewriter was marketed in 1874. It is unlikely that any typewritten document was done before that time. Most machines were not introduced until 1890 to 1910. A document examiner with a good collection of typewriting samples can often date a typewritten document by the differences in type. Significant changes were made in 1940 in the design of the letters "m" and "w". Until 1936 practically all machines had the high type "m" and "w". Since 1940 almost none have them, except the Royal typewriter which was not changed till June of 1950.



Typewriter Design Changes

All of the above examples of anachronisms should be looked for since these are very common forms of forgery and usually give a very good clue as to the genuineness of a document.

Alterations

Alterations can be generally seen with the aid of a good magnifying glass and the help of special lighting. The forger usually tries to change a 1 to a 7, or to add a 0 behind a number to increase value by 10. A check or receipt for $7 could be raised to $70 if sufficient space is left in the original document. The forger will also have to change the written "seven" to "seventy" by adding the additional letters "ty". The investigator should be careful to be sure that any alterations on

a document were not done by the writer himself. People often correct mistakes in writing at the time they make it. The forger will usually not have the same pen or ink and the alteration will be noticeable.

Erasures

The changing of documents by removing certain parts is very common. It is not easy to do with chemical inks. Some form of solution must be used to remove it. Examination by transmitted or ultra-violet light will usually show signs of such erasure. In the case of mechanical erasure by rubbing, the paper is usually thinner in this place and transmitted light will show it. If the investigator suspects chemical erasure, he should submit the document to the laboratory. The laboratory has special chemicals and apparatus for detecting it

Obliterations

Sometimes a forger spills ink on a document to hide parts he does not want to be seen. He tries to make this look accidental but examination by the investigator with a magnifying glass will usually show that the obliteration happens in only a very important part of a document. Obliterations by ink can usually be uncovered by the laboratory with infra-red photography or ultra-violet light. If the obliteration is done with colored inks, the laboratory can sometimes show this with colored filters. If the investigator can find colored filters in his Photographic Department, he should look at the document with different filters to see if he can read the writing.

Fingerprint Signatures

The use of fingerprints as signatures is common in many parts of the world. The discovery of fingerprints as a way of identification came from this practice in Ancient India. The detection of forgeries of this kind is a fingerprint identification problem and should be referred to this type of specialist.

Opening and Resealing of Envelopes

A common form of theft is stealing checks and money from envelopes sent to banks and business companies. The thief substitutes cut-up pieces of paper to take the place of genuine checks and banknotes in order that the loss will not be quickly discovered. The thief uses hot steam or the careful application of a knife or scissors to do this. In repairing the damage, he cannot conceal the signs which are detectable by magnification. The investigator should look for signs of excess glue that the thief has used to paste back the portion of the envelope where he opened it.

IDENTIFICATION OF HANDWRITING

It would seem to be easy to tell if a certain person wrote a document. It is a common experience for bankers to be asked whether one signature is the same as another. Most people recognize the handwriting of their relatives and friends on an envelope before they open and read the letter. This is done by a quick look at the general form of the writing and not by any attention to details. A study of handwriting must be done by scientific methods and by persons having great experience in this work.

The investigator can make a preliminary examination which will show whether two samples of handwriting have similar **class characteristics**. He will then know whether he has enough evidence to refer the matter to a specialist. The comparison of handwriting is based on the sample principles of individuality as other forms of physical evidence except that every person makes his letters a little different each time. The handwriting expert cannot make a direct visual comparison of one sample of handwriting with another. He must look for the most **frequent form** of a letter. This requires a study of all the different ways in which one person makes each letter.

Method of Examination

The first step in examination for handwriting is to examine genuine writing and note carefully all of the important features. The

suspected document is looked at in a similar way and the results are compared. The difference between an ordinary opinion by an investigator and that of a specialist is that a specialist knows which features of a sample of handwriting are important and which are non-essential. The principal features by which a writing is identified are: (1) form of the writing, (2) method used to make the writing, (3) punctuation, spelling, and composition, (4) method of using numerals and dates, (5) type of margin and spacing, (6) distances between lines and distances between words, (7) peculiarities of spelling.

If the standard sample and the suspected document agree in most of these characteristics, there is a strong probability that the two documents were written by the same person. A mere opinion, however, is not sufficient to constitute evidence. The investigator should send the document to a specialist who will prepare the case properly with all of the various reasons to support the opinion.

National and Racial Evidences in Handwriting

The investigator may often get valuable information from the content of a document by certain peculiarities of writing and punctuation used by different races and nationalities. Some of these clues are:

Shapes of letters and numbers. There is a difference between American and British and other nations in the way figure "1" and figure "7" are made. European practice is to make the 7 with an extra cross stroke and to add an upper stroke to the figure "1" which American and British do not do.

Method of dating. Americans make a date with numbers by putting down the month, day and year. February 21, 1966 would be written 2/21/66. A European would reverse the order of the first 2 numbers and write the date 21/2/66.

Spelling differences. There are different ways of spelling used between English and Americans. Care should be used in interpreting this evidence. It would depend upon what kind of teacher a person had.

Punctuation Marks. The usual quotation marks used in the English language are not used in the Spanish and French languages who make a dash.

Words and Phrases. Americans say: "Do you have a pencil?". The British say: "Have you got a pencil?". Experience is necessary to interpret these fine distinctions but they may give a valuable clue as to the national origin of the writer.

COUNTERFEITING

A counterfeit is something made to imitate the real thing and used for gain. The word is usually applied to a form of forgery involving money. The right to make coins and print paper money is limited by law to governments and most nations prohibit not only the making of coins of their own but also the making of coins or paper money of any other government.

Counterfeit Metal Money or Coins

Coins made of gold used to be widely used but are not now often seen. Governments keep their gold in the form of heavy bars called bullions and then issue paper notes for the value of the gold. Metal coins issued nowadays are mostly in amounts for less than one dollar. In most countries the possession of gold coins is now forbidden except for coin collectors.

Casting is a common method of making gold coins. Plaster molds bearing an image of a good coin are filled within a low temperature alloy made with lead or tin. Sand molds are used for high temperature metals such as copper or silver alloys.

Striking or stamping consists of making an impression of a coin on a metal blank by pressure. Stamping is done by way of steel dies.

Examination of Counterfeit Coins

A suspected counterfeit coin should be examined by a magnifying glass and comparing it with a known, genuine coin. Defects in cast coins are usually caused by the formation of air bubbles or by the removal of small parts of the mold along with the coin. The best place to examine a counterfeit coin

is on the **edge** since there are usually special milling marks or designs which are added to a genuine coin by machinery. A cast coin will have a faint joining mark caused by the parts of the mold. It will be necessary for the counterfeiter to file the edges to destroy this rim. Evidences of this filing can be detected with magnification. The counterfeiter will also try to remove various defects and blemishes by handwork and this can usually be detected in the form of fine scratches or toolmarks. If a number of coins are suspected of being counterfeit, the investigator should look for the appearance of the same kind of defect on the same place on all the coins examined. Unless the counterfeiter can get an absolutely perfect brand new coin from which to make his casts, any imperfections in the coin he uses will also show in the counterfeits.

Some very crude and simple counterfeits have been seen which are done by coating brass coins with mercury or silver paint to make them look like silver coins of a higher denomination. These counterfeits are usually easily detected by the investigator.

Making of Paper Money

There are 3 principal ways of printing paper:

Engraving is a process by which the lines to be printed are cut into pieces of metal by hand or with a machine. Ink is rubbed over the plate to fill the cuts in the metal and the extra ink wiped off the top. Pressure of the paper on the plate causes the ink in the holes to be left on the surface of the paper. This type of printing can be detected by running the finger over the surface of the paper. The ink lines will be felt to be raised above the surface. The engraving process is used for the production of all genuine bank notes.

Letterpress Printing is the most common form of printing for books, magazines, letterheads and the usual printed forms in common use. In this process, the letters are made on raised pieces of metal which are covered with ink and then impressed upon the paper in the same form as a rubber stamp or cliche. The serial numbers of bank notes are usually added by this letterpress process after the note has been produced by engraving.

Offset Printing. In this method, a photograph is taken of the desired material and a print is made on a specially prepared aluminum plate. The plate is kept wet with water. When ink is applied, it sticks only to those parts of the plate where printing is desired. The aluminum plate is then put in contact with a rubber ruler which transfers the ink to the paper. The offset process is quite often used in small printing plants. Because it uses a photographic process, it is the most common modern method used by counterfeiters to make false paper money.

Banknote Paper

Paper banknotes get a lot of handling. If a good grade of paper is not used, they would soon wear out and have to be replaced. Even with the best paper, one dollar bills usually wear out and have to be replaced at the end of thirty days. Governments buy the very best grade of paper they can get in order that the paper money will last as long as possible. Special paper also makes it difficult for the counterfeiter to duplicate it. The most difficult problem for a counterfeiter is to get the "right" kind of paper. It is usually the use of the wrong paper that causes the counterfeit banknotes to be detected. A useful test for the investigator is to examine a suspected counterfeit banknote by ultra-violet light. As mentioned in the chapter on Questioned Documents, most modern printing papers have chemicals added to them to make them look whiter. These chemicals cause a brilliant flourescence under ultra-violet light. Banknote paper does **not** have this filler and does **not** show a flourescence under ultra-violet light.

Examination of Suspected Counterfeit Banknotes

As well as inspection under ultra-violet light, the investigator should look at the banknote with a hand lens. He should pay particular attention to the quality of the portrait on the banknote. This is the one place where it is difficult for the offset process to duplicate the extremely fine detail of a good

engraved plate. The color of the ink should be compared with the color of a genuine banknote. It is very difficult for a counterfeiter to match exactly the same shades of ink used by a genuine manufacturer.

If a foreign banknote is suspected of being a forgery, the investigator should communicate at once with the INTERPOL office at Police Headquarters. INTERPOL supplies all police agencies with current news of possible counterfeit bills. By international agreement, all governments are required to immediately report the presence of counterfeit money to INTERPOL. If local national currency is involved, the National Bank or Treasury Department should be also notified immediately.

Counterfeit Traveler's Checks

The use of traveler's checks has become so common that counterfeiters now turn their attention to the forging of these documents. Traveler's checks are issued by private companies but most governments have laws which make it an offense to reproduce these documents. Traveler's checks are manufactured by the same companies that manufacture banknotes and the same safeguards are used in the printing of traveler's checks.

Counterfeit Stocks and Bonds

The counterfeiting of stocks and bonds has been used by some fraudulent swindlers for the purpose of putting up security at a bank for the loan of money. A bank rarely makes a detailed inspection of such bonds but puts them in the vault as security for the loan. If the note is due and not paid, only then would the bank remove the documents from the vault and the fraud is noted. It will be necessary to get a genuine bond and to make a comparison. Most stocks and bonds have very elaborate scroll work which is done by machines in a banknote company. It is very difficult to reproduce these fine details by anything but the machine engraving process. Inspection of the details of the scroll under a hand magnifying glass will, in comparison with the genuine stock certificate make this quite apparent.

Counterfeit Passports

Passports are rarely counterfeited because they are quite complicated in design and manufacture. The most usual method of forgery is to steal a genuine passport and make changes in it. Many safety features are incorporated in passports and are easily detected by close inspection. Ultra-violet light is very useful in this type of examination. The investigator should look particularly at the photograph in any passport or identification card. It is always necessary for the forger to remove and substitute another picture. The position of perforations caused by staples and other fastening devices should be looked at very carefully. The place where a seal joins the photographs with the paper should be inspected for evidence of misplacement.

BURGLARY, SAFES, AND NUMBER RESTORATION

ROBBERY OF BUILDINGS

Entering a building to steal things of value is called by different names in different countries. **Burglary, housebreaking** or **robbery of enclosed premises** are some of them. **Burglary** will be used here. This crime produces more physical evidence than any other criminal act. There are so many burglaries that investigators often complain they cannot collect physical evidence because they are allowed so little time to work on each case. The burglar leaves behind so many traces of his entering and leaving that there is always some physical evidence worth collecting. The investigator who fails to develop this type of clue is just not doing his job properly.

Investigators often spend too much time in a fruitless search for fingerprints. Experienced burglars are careful about fingerprints but overlook other physical evidence that can trap them—broken glass, paint, footprints, toolmarks, fibers, fabric impressions, and even teethmarks on food they pause to eat.

It is true that the large number of burglaries makes it difficult for an investigator to

make as good a crime scene search as he would like to. Many police departments therefore have special crews of policemen detailed just to crime-scene search. These officers carry all their technical equipment in their assigned vehicle and can respond to a burglary call on a moment's notice.

Looking for Things That Were Left Behind

Tools are often deliberately left behind by the burglar. He does not want them found in his possession by the police as he leaves the crime scene. The type of tool may show that the burglar belongs to some particular occupational class: automotive mechanic, carpenter, plumber, etc. This will give leads to searching the records for suspects. The tools themselves may carry marks of identity from the place they were taken.

While the burglar may carry his tools away, he will always leave the marks of these tools behind. The tool may break when force is applied to a door or lock, and fragments of the tool will be left behind. Matching these fragments with a tool in the suspect's possession is excellent physical evidence.

Fingerprints are of course the best physical evidence, but nearly every criminal knows enough to avoid leaving them behind. He may forget about palm prints, however. The **location** of a fingerprint is most important in burglary cases. The criminal may claim he was in a building for an honest reason at an earlier period of time. Fingerprints on the outside surface of a glass display counter can be explained away. Fingerprints on the **inside** of the counter or on the smashed window that was used for entry are more difficult for the criminal to explain.

Blood is not often considered by the investigator in a burglary case, but the criminal always risks cutting himself on broken glass, or scratching himself with a cut wire, or causing an abrasion of his skin when squeezing his body through a narrow opening. If blood is found at the scene of a burglary, the investigator should be alert to carefully examine the body for scratches of any suspect arrested.

Fibers and fabrics can be scraped off the clothing of a suspect as he crawls through an opening. Any broken glass or scraped metal should be inspected with a pocket magnifier for fibers and bits of torn fabric. Here again, the investigator should immediately seize the clothing of the suspect and take it to the laboratory for comparison.

Footprints are found more often in burglaries than in any other type of crime. The burglar enters the building by an unusual place. This place may be above soft earth where he leaves a shoe impression. More commonly, the burglar carried dirt and dust from the soil outside the point of entry and leaves a shoe **imprint** inside the building. The burglar may walk across a roof or other place not frequently walked upon. His passage leaves very good shoe imprints in the dust.

Looking For Things That May Have Been Carried Away

Paint is the most frequent kind of trace evidence carried away by a burglar. It rubs off on his clothing and is scraped on his shoes as he squeezes his way through small holes and windows to get into a building. Paint chips from doors and cash drawers may get on his clothing when force is applied to get into a building.

Wood fragments may stick to clothing in the form of splinters from forced doors and cashboxes. Wood is usually a very good kind of physical evidence for a comparative match by fitting together.

Glass from broken windows can usually always be found on clothing if the criminal breaks glass to effect entry. The pieces are usually so small that the criminal will overlook them even if he takes care to inspect his clothing. The criminalist uses a vacuum sweeping machine to collect glass fragments from clothing. The investigator should not try to collect this evidence himself.

ROBBERY OF SAFES

Large boxes for storing valuables are commonly called safes. Most of old safes

are only safe against fire. Modern business firms do most of their business on credit and are paid by checks. They do not keep cash on the premises. The records that show who owes them and who they owe are very important to them. They buy a safe that will protect these records against being accidentally destroyed by burning. But since modern safes are large and strong, they may also use it to store money. In fact many modern safes are designed to resist attempts to open them by drilling, chisel cutting, thermo cutting or even with explosives. Fireproof boxes give little protection against robbers. They are actually two metal boxes one inside the other. The space between the inner and outer boxes is filled with clay, powdered brick, sawdust and alum or asbestos. This protects against heat but not against robbery. A burglar can open one pretty quickly. Robbery of safes produces two kinds of physical evidence:

Toolmarks. All of the tools used by a safe robber can leave impressions or sliding marks that can be matched by comparison with tools found in the possession of the suspect. A professional safe robber usually abandons his tools at the scene of his crime because he knows about these comparison methods. Casts with plasticine or dental impression compound should be made of all toolmarks even if the tools are not soon discovered. It may be possible for the criminalist to later prove that a certain suspect committed a number of separate crimes all with the same tools. Before casts are made, it always helps to take a photograph. This may be useful to the scientist who will have to examine the casts and instruments.

Many professional safe burglars have the legitimate occupation of automotive body and fender repairman. The tools used to straighten out smashed-up vehicles are also well suited to opening safes. The safe burglar may carry all his safe-breaking tools in his car or keep them in his home without inviting suspicion from the police. There have been instances where explosives have been hidden inside empty auto grease guns. The investigator should make a visit to an automotive body repair shop and familiarize himself with the particular tools used in this work.

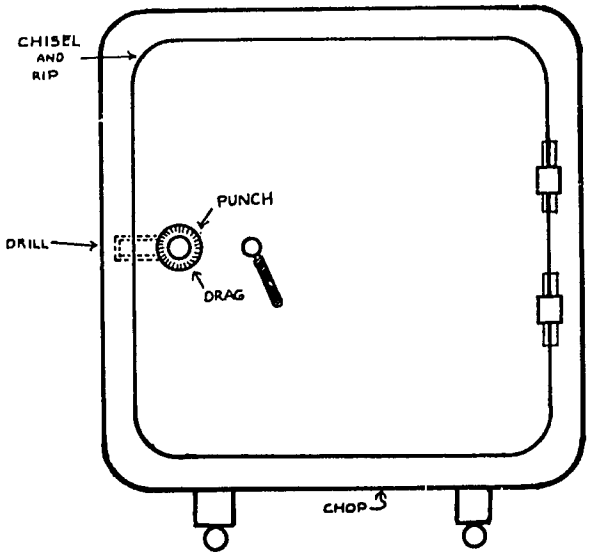
Trace Evidence. While smashing open a safe, the criminal will get all kinds of trace evidence on his clothing and shoes. This can be paint, glass, metal filings, or drillings and particularly the insulation material used in fire boxes. This insulation material may show very good individuality because different manufacturers use different materials to pack the safe and the composition of the material is not uniform between one safe to the next. Some of this material can often be found in the robber's getaway vehicle.

Safe Attacks With Tools

Safes are opened by pounding or ripping a weak point such as the bottom or back of a fire box. All safes are weak at the cracks of the door, particularly the upper left corner. Chisels, screwdrivers, or pry bars are pounded into a crack until the door frame gives way. If the safe robber is not bothered by the noise, he may use a large sledgehammer to force open the door.

Points of Attack on a Safe

The combination dial is also attacked. The knob is smashed away with a hammer and a device like an automobile wheel puller or a machinist's gear puller is used to pull out the combination mechanism and get at the bolts. This is called a "drag job". The mechanism can be knocked out into the inside of the safe. This is called a "punch job". The rivets around the lock mechanism are



sometimes drilled out. Holes can be drilled in the side of the safe opposite to the bolt holes. The bolt can then be punched back with a pin put through the hole. One of the newest tools used to attack safes is a large circular cutter. The hole is made in the rear of the safe and the locking mechanism is not bothered at all. The robber merely puts his hand and arm through the hole and takes out the valuables by feel. This type of tool will leave fine metal filings on the criminal's clothing, etc.

Safe Attacks With Welding Torches

The high temperature welding and cutting torches used in industry are frequently also used to attack a safe. Some skill is needed with this method because the robber may set the papers inside the safe on fire and burn up all the money he is after. The principal disadvantage of torches is transporting the large heavy tanks of oxygen and acetylene gases that produce the cutting flame. Many "torch" robbers will only attack safes in industrial premises where the torches or gas tanks are already there somewhere in the shop. Torches are usually left behind at the scene of the crime because the robber does not want to risk being stopped by the police in the middle of the night and asked to explain why he is carrying welding equipment in his vehicle. Care should be taken in going into buildings where welding torches have been used as the robbers often leave the cylinder taps open which causes the room to be filled with dangerous gases—oxygen enrichment or oxyacetelene explosive mixtures.

Physical evidence in a "torch job" would include melted pieces of metal that may stick to the clothing of the suspect. This metal can be chemically or spectrographically compared with the metal from the safe. There are often minute burns on the suspect's clothing from flying sparks.

Safe Attacks With Explosives

Nearly all criminals who open safes with explosives are the most highly skilled and highest paid carftsmen of crime. This is because the risk is high and the danger is great that a mistake will kill the criminal.* There is also the risk of extra penalty if he is caught. Many governments add ten years or even double the jail sentence for robbery with explosives. If the investigator discovers a safe tha has been skillfully opened with explosives, he can be confident that an out-of-town specialist was called in to do the job. These "consultants", however, do not linger at the crime scene. In these days of rapid transportation, they may fly out of the country before the crime is even discovered.

A few old time safe "blowers" used liquid nitroglycerine to open a safe. Glazier's putty or children's plasticine was put around the crack in the upper part of the door to make a sort of trough. The safe blower carried the dangerous unstable liquid nitroglycerine or "soup" in a small bottle suspended from a cord around his neck. The soup was carefully transferred to the trough with an eyedropper. It slowly soaked into the crack of the door. A detonator exploded the charge and blew open the door. Another method used is to put explosive into the door keyhole and push it in with a pencil or piece of wood and then push in the end of a detonator.

An experienced American detective who reviewed this portion of the book points out, however, that he once investigated a "soup" burglary done fairly skillfully by a 15-year old boy who had obtained the nitro-glycerine by boiling dynamite in a pan of water and skimming off the oily nitroglycerine that floated to the surface of the water!

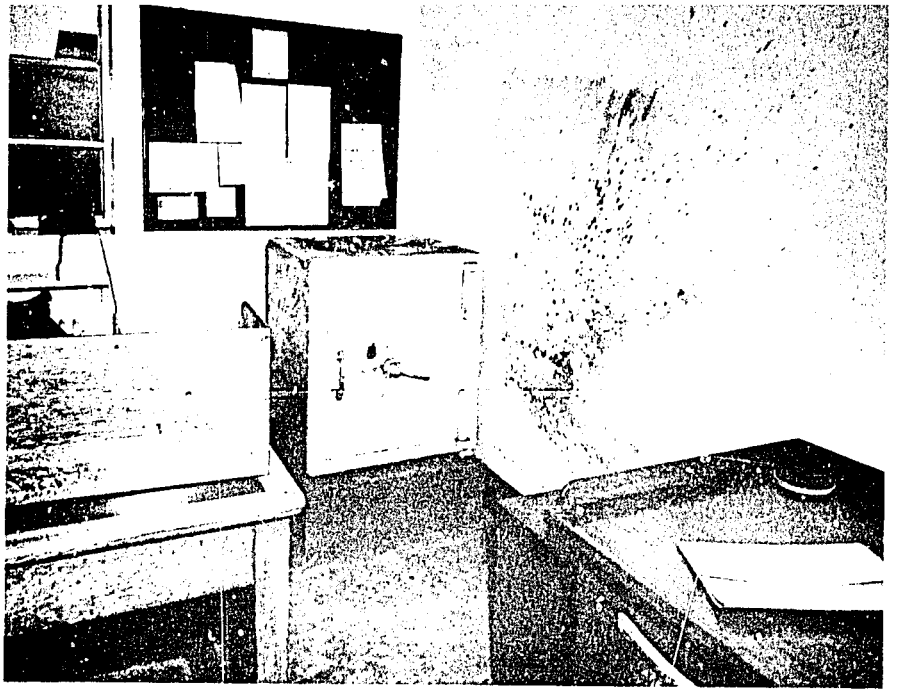
Modern safe blowers drill a hole in the dial spindle hole after knocking off the dial with a hammer. They use plastic explosive, primacord, or powdered dynamite. With this method more than one charge may be necessary.

Physical evidence in explosives cases may include plastic impression fingerprints in the putty or detonators, fuses, and other material that may trace the criminal by showing the source of the materials. There will of course be a great deal of trace evi-

*But a few use explosive because in their work such as a quarry-blaster, mines or civil engineer, they use explosives and it is easy for them to steal it.

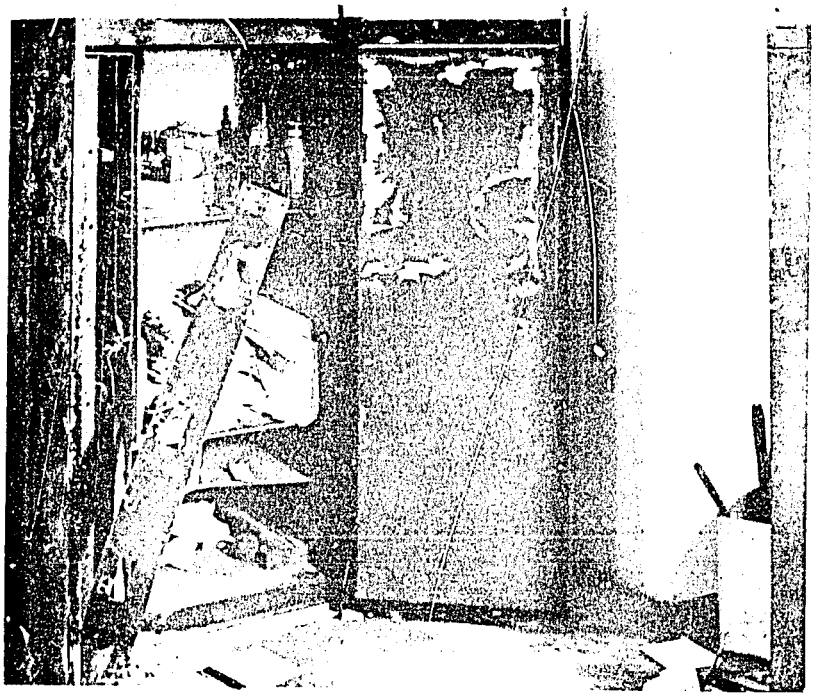
dence from the crime scene on the suspect's clothing. The explosion itself will surely scatter dirt, dust, and debris on every person present in the place where it happened. The person who handled the explosive may have traces on his hands. If he is caught quickly swabs of cotton wool moistened in distilled water can be rubbed over his fingers. The scientist will then be able to prove that certain materials in the explosive has been passed onto the swabs from his hands.

Many detailed closeup photographs should be taken of any safe robbery. Safe robbers are specialists. Once they have perfected a certain technique, they use it every time and rarely change. There are police officers who specialize in investigating safe robberies. These specialist investigators may be able to quickly identify the safe robber because they recognize his method or **modus operandi.** INTERPOL may be able to assist in identifying an international safe specialist criminal by his technique.



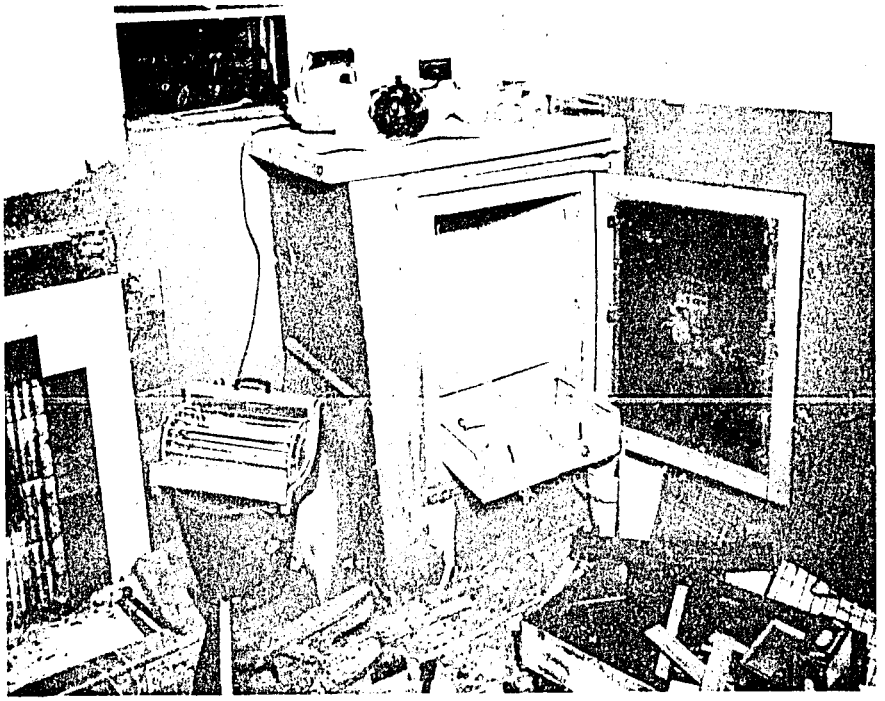
Modern but cheap safe successfully opened with explosives. No apparent external damage. No muffle was used. Note pieces of explosive droppings on floor in front of safe.

Courtesy, Durham Constabulary



Old-fashioned safe opened with mining or quarry explosive.

Courtesy, Durham Constabulary



Safe opened with mining or quarry explosive (gelignite).
Inner drawers were forced open with tools.

Courtesy, Durham Constabulary

Unsuccessful attempts to open three safes with explosives. (Left) Explosive packed around the dial, (center) dial forced off and attempts made to open mechanism, (right) dial blown off.

Courtesy, Durham Constabulary

MOTOR VEHICLES AND TRAFFIC ACCIDENTS

The most volume of work done in a criminalistics laboratory has to do with automobiles and related motor vehicle problems. These include traffic accidents, vehicular homicides, hit and run, auto theft, driving while under the influence of alcohol or drugs, illegal transport of narcotics and contraband, and practically any type of crime that could be committed by or with a motor vehicle. In the United States, over 100 persons die every day in traffic accidents. Thousands of cars are stolen. While many places have special police traffic forces to deal with these cases, in thousands of places in the world the investigator is the only qualified man available to deal with motor vehicle problems.

Traffic Accidents

An accident is something that happened that was not expected. Criminal charges arising out of traffic accidents are mostly due to negligence on the part of the driver. Negligence means "failure to take proper care." There are two main kinds:

1. **Errors of Commission** where a person does a thing that he should not have done. He (a) drives too fast for road conditions, (b) goes on wrong side of road, (c) drives at night with head lamps turned on, (d) makes a turn from wrong lane.

2. **Errors of Omission** where a person does not do something he should have done. He (a) goes through intersection without making required stop, (b) turns without making signal, (c) does not have faulty brakes fixed, (d) does not replace broken lamps.

Alcohol intoxication does not by itself prove negligence. A person might be charged for the offense of intoxicated driving, but the investigator must still prove that the intoxicated man did some other wrong act that caused the accident.

It is a mistake to think that all vehicle accidents are caused by negligence. A research study group at Harvard University discovered that many automobile deaths are caused by wrong design of the highways, failure of the mechanical parts of the automobiles, emotional problems of drivers, illnesses and poisoning of drivers, and even suicide and murder. The investigator and the criminalist should both consider an automobile death just as serious a matter as any other homicide.

The investigator is usually not the person who makes the first examination of the scene of a traffic accident. He is called in after another officer or policeman has made the original accident report. From the information gathered by this first officer at the scene, the investigator is asked to help find out what happened. He may be asked to do such a simple procedure as measuring the grade or slope of the road so that speed can be correctly calculated from skidmarks. He may be asked to determine whether the driver of the vehicle was intoxicated, under the influence of drugs or alcohol, or to reconstruct the way in which an accident happened in cases where there were no witnesses. If the driver in an accident has run away, the investigator will be asked to find out what kind of car was used in the crime. If the vehicle is located, the investigator and the criminalist will work together to prove that it was his vehicle that was used or that a certain person was driving the car at the time of the accident.

Proving Driving

In all cases of traffic offenses, intoxicated driving, or hit and run, the first and most important thing that must be proved is that the accused person was driving the car at the time of the offense. This can be done either by eye witnesses or by physical evidence. But it must be proved. The investigator must not assume that the owner of the vehicle was the person actually driving it.

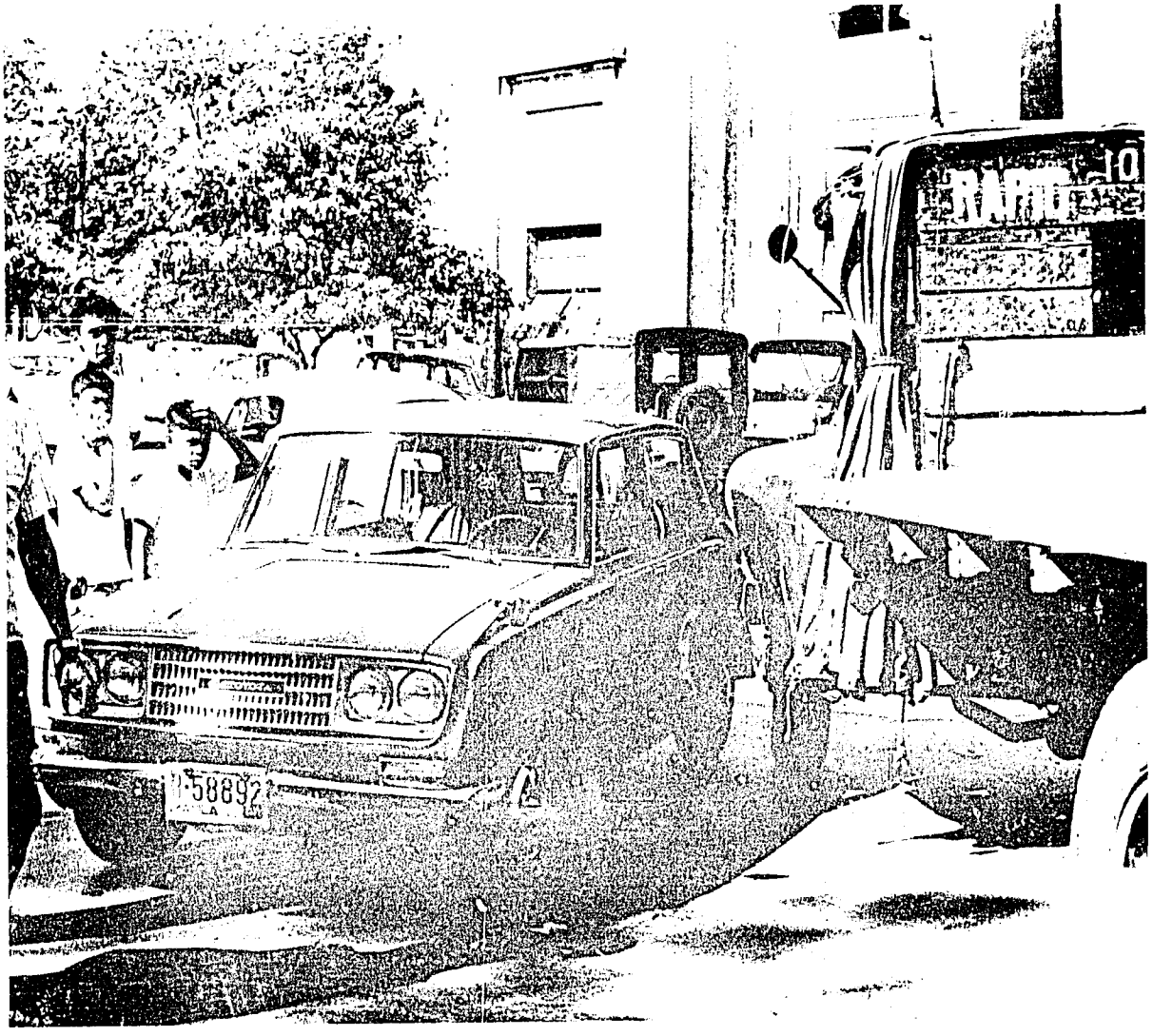
Intoxicated Driving

This procedure will be considered under a separate heading because tests for alcohol are important in many other kinds of crime. Alcohol is only one of several thousand poisons but it is so important that it is considered separately.

Technical Aspects of Accident Investigation

In large cities there are usually special teams of police trained to investigate accidents, but in the smaller cities and rural areas the local investigator will have to investigate these cases along with his other duties. The investigator should do just as good a job on this type of investigation as he would on a case of murder or other serious crime.

The investigator should know how to make proper sketch of an accident with correct measurements of all the important data. He should know how to photograph the scene of the accident properly to show the important facts. He should know how to measure skidmarks correctly. He must know what kind of physical evidence to look for in hit-and-run cases. He must know how to get the facts, record the facts correctly, and then figure out what happened in order to help the prosecutor present the case in court.



A TRAFFIC ACCIDENT. Note the important facts of the picture—position of the cars and damages to each vehicle.

SUPPLEMENTARY FIELD NOTES

This form is for FACTS; omit guesses, assumptions, conclusions and opinions. Estimates may be recorded but circle them to show they are estimates. Use separate form for additional vehicle, etc.

ADDITIONAL ☐ PHOTOS ☐ MEASUREMENTS	MADE BY	
ADDRESS – Number and Street	City	State

EVENT ☐ ACCIDENT ☐ VIOLATION	NUMBER	CASE OR FILE NUMBER
ON	Street or road	
AT	Intersection with or distance from	
IN	City,	County

HOUR of event	DATE	MONTH	19
m			

HOUR BEGAN	HOUR FINISHED	DATE	MONTH	19
m	m			

NOTES BY	ASSISTED BY

TRAFFIC CONTROL AND VISIBILITY

ON WHAT ROAD	GOING WHICH WAY

SIGNAL FACE		SPEED LIMIT	
Location		Sign distance	
Visibility		WARNING SIGN	
STOP – YIELD		Distance	
Size of sign		BARRIER LINE	
Location		Kind	
Visibility		Visibility	
PROHIBITED move.		LANE LINE	
Size of sign		Visibility	
Location		OTHER	
Visibility			
VIEW OBSTRUCTION		GLARE FROM	

ROAD CONDITIONS

	Height	Width	Length		Shoulder	Roadside
Curb	in.			Hard		
Lip	in.		ft.	Soft		
Hole	in.	in.	in.	Rutted		
Bump	in.	ft.	ft.	Loose		
Washboard	in.	ft.	ft.	Guard rail ☐ None ☐ Struck ☐ Broke		

TRIP PLAN	Time		Place	Purpose
Trip began	AT m.			
Stop	FROM m	TO m.		
Next to Last stop	FROM m	TO m.		
Last stop	FROM m	TO m.		
Trip end	ESTIMATE m			

DASH BOARD	Dented	Deformed by occupant	Pushed back toward seat	Buckled by car damage	No damage apparent
Left					
Center					
Right					

STEERING WHEEL	Severely deformed	Bent	Broken	No damage apparent
Rim				
Ring				
Spokes				

WINDSHIELD

☐ Flat	☐ Outside force	☐ Cracked
☐ Curved	☐ Occupant contact	☐ Hole
☐ Two-piece	☐ Buckled by distortion	☐ Partly out
☐ Unbroken	☐ Unknown breakage	☐ Completely out

PEDESTRIAN

Where struck	Left	Center	Right
Front			
Side			
Rear			

UNDERBODY GROUND CONTACT

Body or Frame between wheels	Left	
	Right	
	Front	
	Rear	
Engine		
Transmission		
Drive shaft		
Differential		
Muffler		
Other		

OCCUPANTS' FINAL POSITIONS

Position in vehicle		Inside	Partial	Entirely outside
Front	Left			
	Cent.			
	Right			
Rear	Left			
	Cent.			
	Right			

DAMAGE SEVERITY

- ☐ 0 None
- ☐ 1 Inconspicuous
- ☐ 2 Superficial
- ☐ 3 Unsafe
- ☐ 4 Briefly drivable
- ☐ 5 Reparable
- ☐ 6 Not Reparable
- ☐ 7 Demolished
- ☐ 8 Fire

SURFACE MARKS LEFT BY VEHICLES

Which vehicle		
Front left		
Front right		
Rear left		
Rear right		
Other left		
Other right		
Pavement kind		
Condition		
Grade		

Describe gouges or scratches left in road.

Describe ruts or furrows left in the roadside.

TEST SKIDS

MADE BY – Name	WHEN
WHERE	

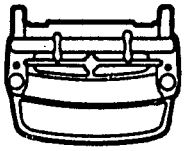
At what speed		
What vehicle		
Front left		
Front right		
Rear left		
Rear right		
Pavement kind		
Condition		
Grade		

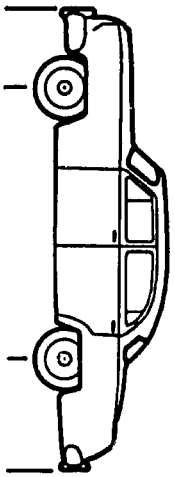
Form 1062, Traffic Institute 1962

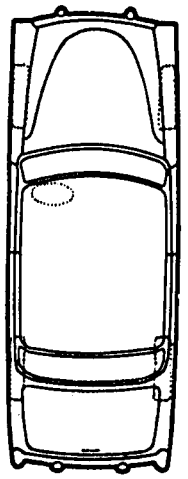
Copyright Northwestern University

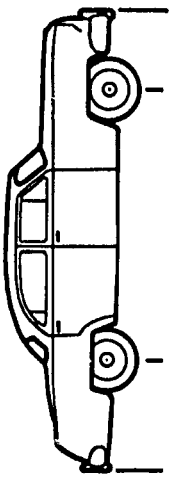
EXAMINED AT			
ADDRESS			
CITY			
HOUR m	DAY	MONTH	19

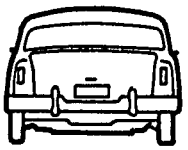
VEHICLE TYPE		
REGISTRATION	STATE	YEAR
SERIAL NO.		
COLOR	ODOMETER	











RUNNING GEAR			Broken, punctured	Not working	Worn, bent	Good condition
Front Axle	Left	Wheel				
		Tire				
	Right	Wheel				
		Tire				
Rear Axle	Left	Wheel				
		Tire				
	Right	Wheel				
		Tire				
Other Axle	Left	Wheel				
		Tire				
	Right	Wheel				
		Tire				
Brakes						
Hand Brake						

Dents, scratches, cracked glass, trim damage, bumper dents, hub caps off.

Torn metal, wheel dented or bent, tire flat, broken part or glass broken out.

Pushed in or collapsed areas, tire or wheel off and frame distortions.

Apparent direction and center of application of external forces.

Areas of contact with ground other than by tires or underside.

Limits of area of contact damage other than with ground.

SEAT BELTS occupied seats only		Front		Rear	
		Left	Right	Left	Right
None					
Fastened	No				
	Snug				
	Loose				
Failed	No				
	Webbing				
	Buckle				
	Anchor				

Light switch position:
Gear shift position:
Speedometer reading m/h

DOORS	Front		Rear	
	Left	Right	Left	Right
Forced open				
Locked inside				
Jammed shut				
Operate normally				

LIGHTS			Broken	Not working	Dirty, obscured	Good condition
Head lamps	Left	Drive				
		Meet				
	Right	Drive				
		Meet				
Tail Light		Left				
		Right				
Stop Light		Left				
		Right				
Turn Signals	Left	Front				
		Rear				
	Right	Front				
		Rear				
Other						

Form 1062 page 2 Traffic Institute

Hit-and-Run Investigation

The search for physical evidence at the scene of a hit-and-run accident must be done properly and quickly because it is not possible to close off and guard the scene of this kind of crime. The street or highway must be cleared to permit the ordinary flow of traffic as soon as possible. Another problem is that passing vehicles will crush or blow away important pieces of small physical evidence. Good ways of searching the scene of a hit-and-run accident are:

Look over the ground at what seems to be the point of collision.

Follow the path that the vehicle took in leaving the scene to find out if it left tire prints in soft dirt, or whether parts of the vehicle or broken glass fell off as it drove away.

Study the objects the vehicle has struck to see if there is transfer of physical evidence like paint.

Look for things that may have spilled from the vehicle.

The investigator should collect all materials found at the scene of the crime which cannot be satisfactorily explained. Broken parts of an automobile are the most important physical evidence in hit-and-run accidents. When the broken parts match parts still on the car, this is good positive identification. Broken parts are more important than damaged parts. Part of a broken bumper or door handle is better than a damaged hubcap.

Glass is very important physical evidence in hit-and-run cases. Get as much glass as possible, but if you cannot get it all, get the largest pieces. You have a better chance of fitting these to pieces left on the car. Comparison by matching and fitting together of broken pieces is better here than density methods used in other glass comparison cases. Most all vehicle headlamps are now made by only a few manufacturers and are not likely to be individual from one make of vehicle to another. Colored parking lamps and tail lamps are more likely to be individual for each make of vehicle. This kind of glass is more valuable as evidence.

Ornaments are also very individual for each make of vehicle. Broken ornaments make very good identity of both the make and the individual vehicle.

Paint is very useful physical evidence to find out the color of a vehicle in a hit-and-run accident. Paint rubs off from one vehicle to another. Paint from the automobile may rub off on signs, posts, and even on the clothing of a victim. Paint is also rubbed off from solid objects such as road signs and markers onto the vehicle. Remember Locard's Exchange Principle—collect samples of such paint transfer at the scene of the accident as well as controls for the expert to make his comparison.

Oil spilled or dripped from a vehicle can sometimes be identified as coming from a particular car. The sample from the suspected car should be taken as soon as possible because engine oil is changing all the time because of wear.

Clothing may be valuable as evidence in a pedestrian accident. Collect the clothing of the victim as evidence. Look for matching cloth fibers on the vehicle. Look for clothing in the inside of vehicle. Sometimes the driver of a car runs away and it may later be necessary to show that he was inside the car.

Lamp filaments from broken lights should be collected for examination. It is often important to know if the lamp was lit at the time it was broken. The criminalist can examine the wires with the microscope to find out.

Traces and impressions can come from the body and clothing of pedestrians who are struck by a vehicle. When a person is struck, the pattern of his clothing may leave an impression on the vehicle. The parts of the vehicle may leave impressions on the skin of the person. Look under the vehicle for signs of scraping. If the wheel passes over a person, it will leave tire prints on his clothing and skin. Oily dirt from the underside may be transferred to the victim.

Radiator grill should be examined. The victim may have been carrying some material that might stick to the grill. Leland Jones reports a case where bakery goods carried by the victim were found imbedded in the grill of the hit-and-run vehicle.

Bloodstains are not very often found at scene of an accident unless the victim was dragged by the vehicle for some distance. Usually the victim was struck quickly and thrown away from the vehicle before he began to bleed.

Fingerprints are not as helpful in traffic accidents as in other criminal cases. Their main uses are to help show who was driving. Fingerprints should be looked for on the steering wheel and on the rear view mirror.

If there is a possibility that the dead person may be untruthfully accused of driving the car, be sure to take fingerprints of the dead body before it is buried.

Tire prints and footprints are often helpful to prove that a certain vehicle was the one involved in an accident. Take plaster casts of any tire impressions in soft earth and take photographs of tire prints on the pavement.

Determining Speed From Skidmarks

One of the most common problems in accident investigation is: "How fast was he going?" It is a difficult question to answer, but speeds in excess of the legal limits are important to the police, because they must decide if the driver did his best to avoid the accident. The criminalist cannot determine exactly how fast a vehicle was traveling, but he can make a very good estimate by mathematical calculations based on the skidmarks left by a vehicle before the collision. It is important that the field investigator take correct and accurate measurements to help the criminalist make correct calculations.

Skidmarks

Skidmarks are marks left on the road by tires that are not moving because the brakes are applied strongly enough to lock the wheels. There are two kinds of skidmarks: (1) made by a car going straight ahead and (2) made by a car going sideways.

The second type is commonly called "scuffs." It is important not to confuse skidmarks with tire prints. Tire prints indicate that the wheel was still turning. Tire prints should **not** be used in calculating speed. To make an accurate estimate of speed, it is important that the marks of all four tires are obtained.

A car is always going faster than the speed calculated from skidmarks because in addition to losing speed in sliding as shown by the skidmarks, the car also loses its speed in one or more of the following ways: (1) Skidmarks do not happen until the tire slides far enough to get hot enough to smear the rubber on the paving; (2) the total distance of the skidmarks cannot be seen because the car hits something before stopping; (3) some braking action occurs before the skidmarks appear; (4) the brakes are not put on hard enough to lock the wheels.

In accidents with pedestrians, the skidmarks are more reliable because there is nothing to stop the forward movement of the car. In a collision accident, the amount of damage to the cars must be considered in determining the reliability of speed from skidmarks.

Drag Factor

This is a measurement of the amount of resistance that the road puts on the tires compared to the weight of the car. It is expressed by a number, usually a decimal fraction. On a level road the drag factor is determined by the slipperiness of the road surface. There are usually two tables of drag factors; one for wet and one for dry pavement. The drag factor is influenced by the kind of road surface, the length of slide, the material of the tire, the kind of tread, and the temperature. The best way to determine the drag factor is to make actual measurements with the same automobile at the same place on the highway. If the car is wrecked, the investigator will have to consider a range of possible values for drag factor. Use the "less than 48 km/hr" drag factor for the first calculation and if the final answer comes out more than 48 km/hr, repeat the work using the factors for higher speed.

Length of Vehicle

The investigator sometimes makes the mistake of determining the speed from the **total** length of the skidmarks he finds. Re-

DRAG FACTORS

KIND OF ROAD SURFACE	WET				DRY			
	Less than 48 Km/hr		More than 48 Km/hr		Less than 48 Km/hr		More than 48 Km/hr	
	From	To	From	To	From	To	From	To
Concrete								
New	.80	1.00	.70	.85	.50	.80	.40	.75
Travelled	.60	.80	.60	.75	.45	.70	.45	.65
Traffic Polished	.55	.75	.50	.65	.45	.65	.45	.60
Asphalt or Tar								
New	.80	1.00	.65	.70	.50	.80	.45	.75
Travelled	.60	.80	.55	.70	.45	.70	.40	.65
Traffic Polished	.55	.75	.45	.65	.45	.65	.40	.60
Excess Tar	.50	.60	.35	.60	.30	.60	.25	.55
Brick								
New	.75	.95	.60	.85	.50	.75	.45	.70
Traffic Polished	.60	.80	.55	.75	.40	.70	.40	.60
Stone								
New	.75	1.00	.70	.90	.65	.90	.60	.85
Traffic Polished	.50	.70	.45	.65	.30	.50	.25	.50
Gravel								
New	.40	.70	.50	.80	.40	.80	.40	.60
Packed and Oiled	.55	.85	.50	.80	.40	.80	.40	.60
Loose	.40	.70	.40	.70	.45	.75	.45	.75
Rock								
Crushed	.55	.75	.55	.75	.55	.75	.55	.75
Ice								
Smooth	.10	.25	.07	.20	.05	.10	.05	.10

member that the beginning and end of the skidmarks may include both front and rear wheels of the car and unless it is possible to measure each wheel exactly, the length of the car or wheel base (distance between the middle of the hubcap of the front wheel to the middle of the hubcap of the back wheel) should be subtracted from the total length of the skidmark.

Grade or Slope

Grade or slope means the steepness of a hill and is important in calculating speed from skidmarks because a car going downhill will take longer to stop than a car going uphill. Grade or slope is the number of meters the road rises for each meter of level distance along the road. The resulting number is less than 0.1 except for very steep hills. It can be measured by using a traffic template or with an ordinary carpenter's level. Put the carpenter's level on the road with one end uphill and the other down. Raise the downhill end until the bubble centers. Hold the level in that position while you measure the distance from the bottom of the level down to the road. Divide this distance by the length of the level. For example, if the level is one meter long and the lower end is one centimeter off the ground, the grade would be 0.01.

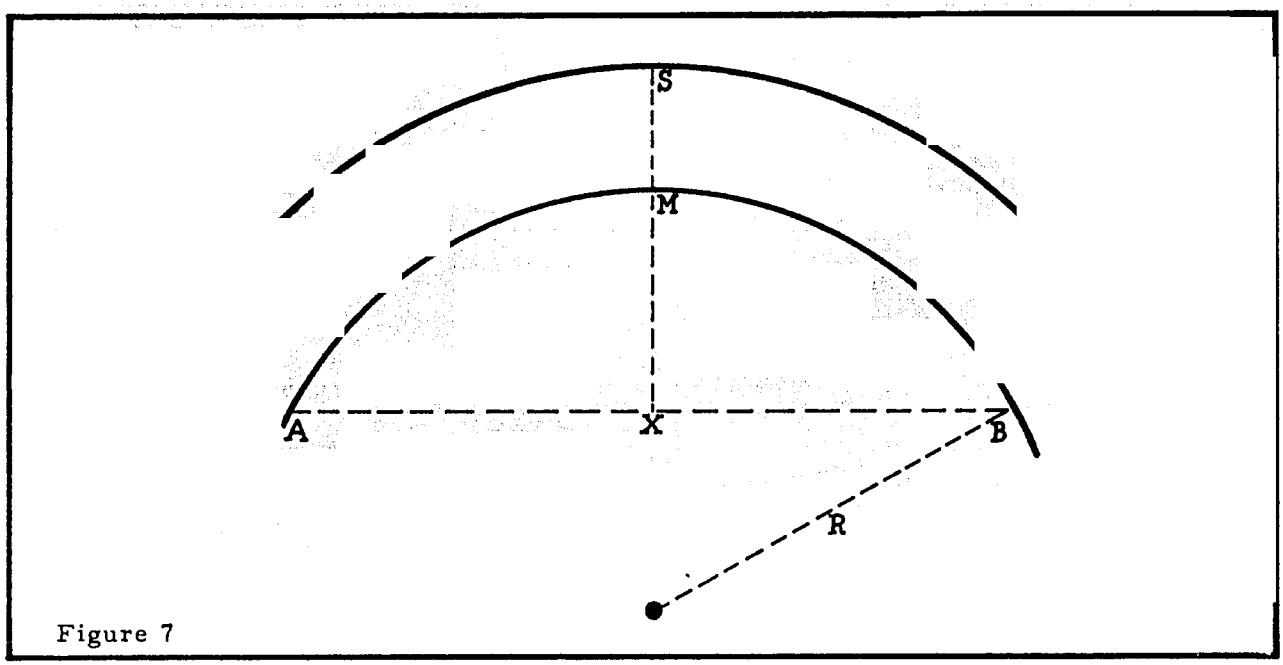


Figure 7

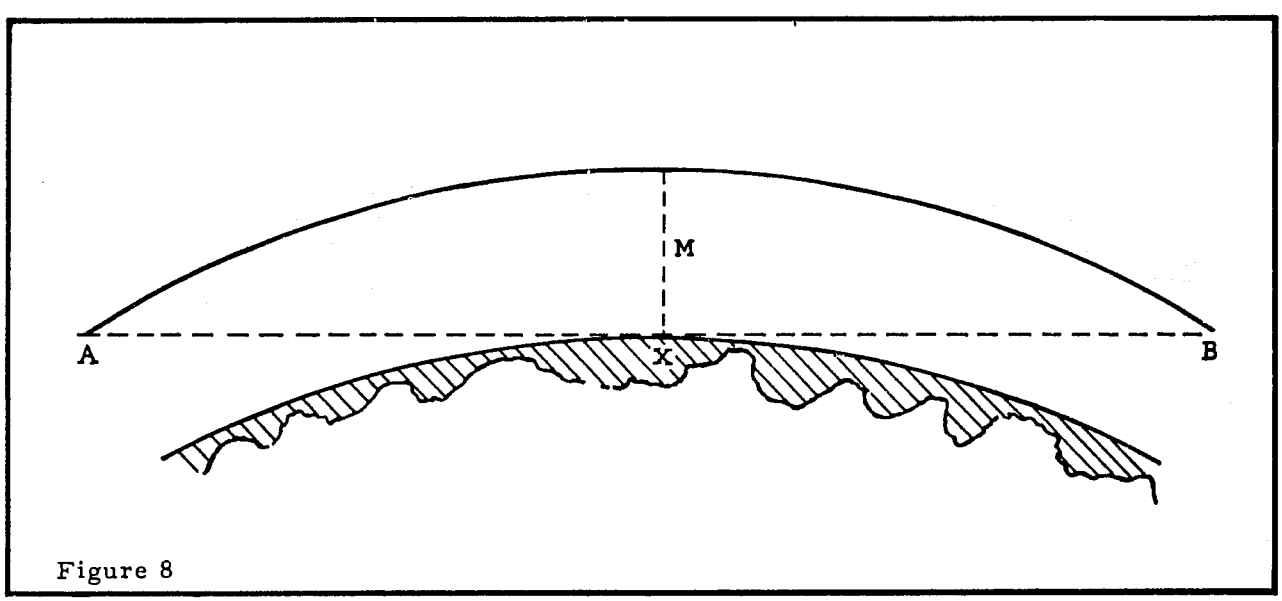


Figure 8

Sometimes the inside of a curve is blocked by a hill or an embankment and the chord cannot be measured at this point. If this happens, make the measurements on the outside of the curve as shown in Figure 7.

Finding the Radius of a Large Curve

It is not easy to measure the middle ordinate accurately on a long or shallow curve. On a curve with a 600-meter radius, the middle ordinate measured with a 30-meter tape is only about 20 cm. A better procedure is to take the width of the road as the middle ordinate and determine the length of the chord. See Figure 8. Middle ordinate is fixed, chord is the variable in this case.

Find an important point on the curve. The place of the accident is good. Put a marker at this point (X on the diagram). Measure the width of the road at this point. This measurement is the middle ordinate. Now stretch your tape across the arc to form a

straight line AXB with X as the middle point of the tape. Distance AB is the chord.

Determine the superelevation at the point of the middle ordinate using a level. Calculate the radius as follows:

$$\text{Radius} = \frac{C^2}{8M} + \frac{M}{2}$$

C = length of the chord
M = length of the middle ordinate

Finding the Critical Speed

The critical speed can now be calculated in the same way and using the same formula as for skidmarks. In place of the skidmark distance, one-half of the radius is used. The formula then becomes:

$$S = 15.9 \times \sqrt{1/2\ R \times (F + g)}$$ where

F = drag factor
g = superelevation or sideways slope
R = radius of the curve

Reaction Time and Total Stopping Distance

In addition to the distance needed to stop a vehicle after the brakes are applied, it takes time for the driver to see the danger and take corrective action. This is called the reaction time and is from 0.5 to 1.25 seconds. The average is 0.75 seconds. It must be added to the skidding distance to find out at what point the driver could have first seen the danger.

MINIMUM STOPPING DISTANCES AT DIFFERENT SPEEDS
(To nearest 10 cm–reaction time = 0.75 seconds)

Metric Measure

Speed in Km	Reaction Time Distance	Breaking Distance	Total Stopping Distance
8	1.6 m	1.3 m	2.9 m
16	3.4 m	2.8 m	6.2 m
24	5.0 m	4.6 m	9.6 m
32	6.7 m	7.0 m	13.7 m
40	8.4 m	10.1 m	18.5 m
48	10.1 m	13.7 m	23.8 m
56	11.8 m	18.6 m	30.4 m
64	13.3 m	24.8 m	38.1 m
72	15.1 m	32.0 m	47.1 m
80	16.8 m	40.5 m	57.3 m
88	18.4 m	51.0 m	68.5 m
96	20.1 m	63.0 m	83.0 m
104	21.5 m	77.0 m	98.5 m
112	23.5 m	94.0 m	116.5 m

The total stopping distance is important to determine if the driver of a vehicle could **have stopped in time** to avoid an accident. The problem arises most frequently in situations where a pedestrian—usually a child, an elderly person, or a drunk—suddenly steps out into the street directly into the path of an oncoming vehicle. Bystanders and the relatives of the injured pedestrian become emotional and are inclined to blame the driver. Most uninformed people do not understand the mechanics of momentum and the physiology of perception and reaction.

English Measure

Speed in M.P.H.	(3/4 Sec.) Driver Reaction Dist. in Feet	Vehicle Braking Dist. in Feet	Total Stopping Dist. in Feet
10	11	6	17
15	17	14	31
20	22	25	47
25	28	39	67
30	33	55	88
35	39	78	117
40	44	105	149
45	50	136	186
50	55	188	243
55	61	230	291
60	66	300	366
65	72	380	452
70	77	455	532

The investigator should first determine the speed of the vehicle from the skidmarks. The estimate is always a little more accurate where a vehicle strikes a soft body because the mass of the body is not great enough to offer much resistance to the heavy metal machine. The vehicle lays down its full range of skidmarks before coming to an uninterrupted stop. This is the **braking distance.**

The investigator next adds the reaction time distance. This can be obtained from the table or by multiplying the calculated speed by 0.210. This gives the reaction time distance in meters. This is added to braking distance. From these two measurements, the investigator is able to find the nearest distance that the driver could have seen the danger.

A word of caution is needed here. Just because the calculations show that it would have been impossible for a driver to have

stopped in time, it does not mean that the driver is free from negligence. The investigator must also find out if the driver might have taken some other evasive action like turning to the right or left.

WEAPONS

Anything used to cause injury or death to another person may be a weapon. Weapons are usually classified by the type of wound or injury they produce, which can be:

Blunt instruments—clubs, sticks, and hammers.
Cutting instruments—knives, razors, hatchets, axes, swords, and spears.
Stabbing instruments—knives, nails, sticks.
Projectile weapons—guns and arrows.
Explosive weapons—bombs and grenades.

Type of Weapons Used

The type of weapon used is usually plain in cases involving firearms, explosives, arrows, and axes. It may be more difficult to decide what type of weapon was used to cause a blunt instrument wound. Impressions made on the flesh of the victim may give a clue to the type of weapon used. A blow from a metal object will usually leave a definite impression. Cutting wounds are examined to determine whether a knife or a razor was used. If both a cutting and a stabbing wound are present on the same person, a knife should be suspected.

Weapons that have come in contact with the victim will usually show some form of physical evidence from the victim. A single stroke from a weapon may not produce blood but hairs, fibers, or fragments of cloth may be present. The weapon should be examined for fingerprints without using powder. The weapon should be examined with sloping light. Finger marks may be in the form of imprints in blood or grease.

Blunt Instruments

Any heavy object may be used as a blunt instrument. The criminal often picks up the nearest thing he can find. A stone, a heavy board, or a piece of metal are common. An automobile can be used as a blunt instrument. If the body is carried away from the highway and put in some other place, the investigator may be puzzled as to what caused the wounds.

Cutting Weapons

The nature of the wound will give a clue as to what type of cutting instrument was used. A razor should be suspected if the cut is clean and sharp. A common form of cutting weapons is a broken bottle or other pieces of broken glass. Wounds by glass may happen if the person is thrown or tries to go through a broken window or is thrown through the window of a car.

Stabbing Weapons

The nature of a stabbing wound can usually be determined by measuring and determining the shape of the wound. Many stabbing wounds are caused by common kitchen implements or the tools used by workmen.

Projectile Weapons

These are commonly firearms and will be considered separately.

Explosive Weapons

There is usually no doubt as to what caused death, but since the explosion destroys the weapon, it may be more difficult to determine what it was. Careful inspection of the body and its surroundings for fragments will help the criminalist to identify the type of weapon used.

Collection of Weapons at the Crime Scene

A weapon should always be photographed before it is touched or moved and careful measurements of its location should be made on the crime scene sketch. A weapon should not be handled more than necessary. The investigator should be careful not to turn the cylinder of a revolver or unload it without noting the positions of the shells in the chamber. He should not remove the maga-

zine clip from a self-loading weapon. The bullets and magazines of firearms are usually very good places to find fingerprints. The criminal may wipe off the outside of the weapon but forget that his prints are on these inner parts.

The best way to prepare a weapon to send it to the laboratory is to attach it to a piece of cardboard with pieces of string which go through holes punched in the cardboard, and are tied on the other side. A weapon should be wrapped in a way that keeps the sides of the box from touching it. If it moves around in a protective cover or paper, valuable microscopic evidence might be rubbed off.

FIREARMS IDENTIFICATION

The identification of firearms is based on the fact that it is never possible to make two things exactly alike. It is therefore similar to the comparison of toolmarks. The hammer that strikes the primer and the baseplate that strikes the cartridge produce tool impressions. The inside of the gun barrel leaves impressions on the bullet as it passes through. A comparative analysis of any of these points of contact will show individuality sufficient for identification. Automatic weapons will show an additional point of comparison by the marks of ejectors and extractors used to load and throw out the bullets.

Class Characteristics

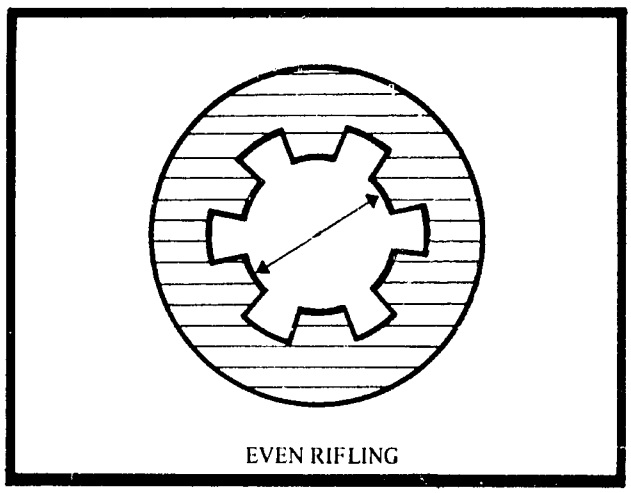
Firearms have many points of similarity. This fact is often not appreciated by the investigator. It is foolish to submit guns for laboratory examination unless it has been shown that the guns, cartridges, and bullets all have the same class characteristics. These are:

Type of weapon. Firearms designed to be fired from the shoulder are called **rifles** or **shotguns**. Firearms designed to be fired in one hand are called **handguns**. Handguns that must be reloaded each time they are fired are called **single-shot** or **target pistols**. Handguns that can be fired several times by means of a rotating cylinder are called **revolvers**. Handguns that can be fired several times by means of cartridges stored in the handle are called **self-loading pistols**. These pistols are sometimes incorrectly called "automatics." Only a machine gun is a true automatic weapon.

Type of jacket. Bullets are mostly made of soft lead because the hard metal of the weapon must grip the bullet firmly as it passes through and cause the desired twisting. The softness of the lead is not important in a revolver but it may cause difficulties with the loading operations in other kinds of weapons. For this reason, cartridges designed for semi-automatic weapons have a jacket of copper alloy around the bullet. A bullet of plain lead is probably fired from a revolver and a jacketed bullet is probably fired from a semi-automatic or self-loading pistol.

All of these many different factors add up to class or family characteristics. The similarities should be determined by the investigator before he submits the evidence to the laboratory.

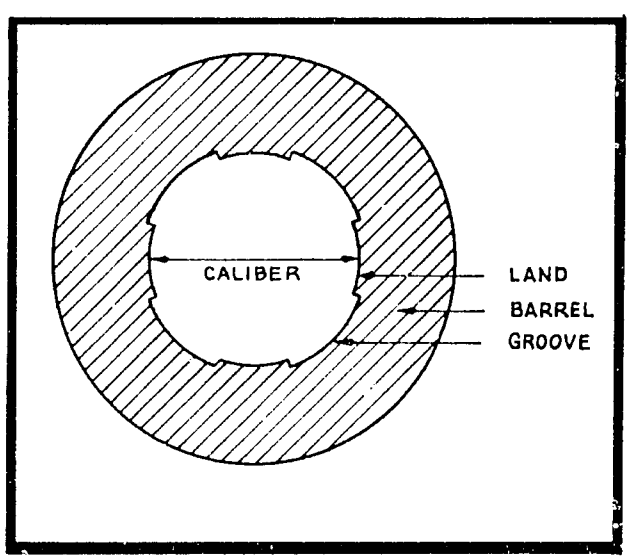
Type of rifling. The number of grooves in a rifled gun can be any number from 3 to 16, but 5 to 7 are most common. The direction of rotation or twist can be either to the right or to the left according to the preference of the gun manufacturer. The combination of number of grooves and twist is valuable in rapid elimination of the wrong bullet and in getting some idea of the make and model of gun used to fire the bullet. Obviously, there is no need to compare a bullet with 5 grooves right with a test shot that shows 6 grooves left. In the United States, only the Colt has a left twist while all others are right twist. An experienced firearms examiner may be able to consult his reference file and tell the investigator that a fatal bullet was fired from a Colt revolver, or perhaps a Smith and Wesson. This information may be helpful as an investigative aid. A further example would be the finding of .45 caliber jacketed bullets. If there were six grooves with a left twist, this would point to having been fired from a self-loading pistol. If there were six grooves with a right twist, this would indicate a sub-machinegun.



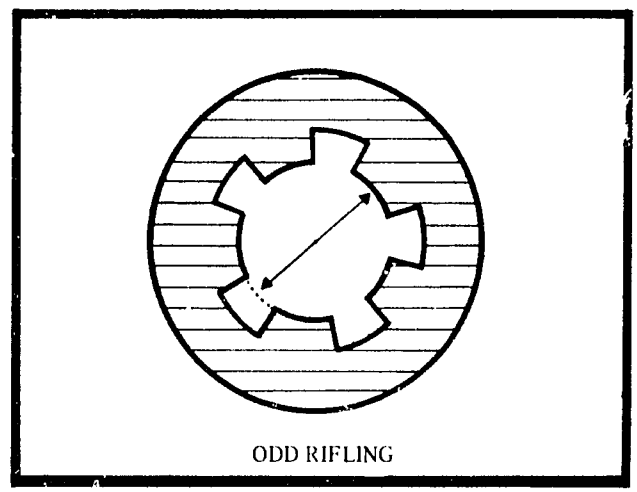
EVEN RIFLING

Size of Caliber

The hollow tube inside a gun barrel is called the **bore** and is measured by **caliber**. This is the diameter measured across the smallest opening between two **lands**. The lands are the raised part of the spirals that bite into a bullet and make it spin. The exact caliber is different with every make of gun, but for convenience certain average numbers are used for groups of calibers. Common English groups are: .22, .25, .32, .38, and .45 inches. Common Metric groups are: 6.35, 6.5, 7.62, 7.65, 9.0, and 11.0 millimeters.



A bullet is also measured by caliber and put in the same groups as the gun bores. The bullet diameter must be slightly larger than the bore diameter of the gun to make a tight fit. The investigator can measure the bore and bullet diameters by means of a machinist's calipers and comparing with the measurements in the Table. An accurate set of calipers must be used because the difference between the largest .32 and the smallest .38, for example, is no more than 1/100th of an inch.



ODD RIFLING

Do not confuse the measuring device (calipers) with the measurement (caliber). The investigator must also be careful when measuring a gun bore with an **odd** or **uneven** number of lands.

ACTUAL MEASUREMENTS OF FIREARMS CALIBERS AND BULLETS

(Adapted from Crime Detection by Svensson & Wendel)

CALIBER	GUN BORE	BULLET DIAMETER
Revolvers (Inches)		
.22	.212 to .217 in.	.2235 in.
.32	.303 to .307 in.	.312 to.314 in.
.357	.347 in.	.359 in.
.38	.346 to .352 in.	.359 in.
.44	.417 to .420 in.	.427 to .434 in.
.45	.435 to .445 in.	.451 to .455 in.
Revolvers (Metric)		
7.5	7.48 to 7.50 mm	5.68 mm
7.62	7.64 mm	7.83 mm
11.0	10.7 mm	11.42 mm

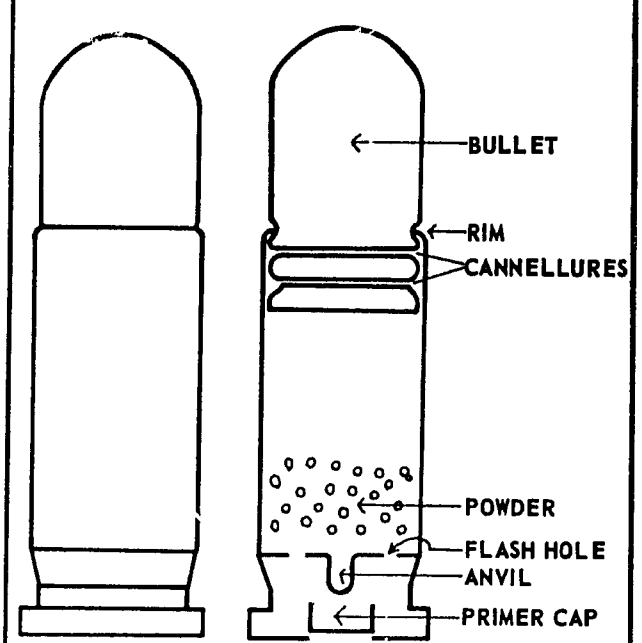
ACTUAL MEASUREMENTS OF FIREARMS CALIBERS AND BULLETS (Continued)

CALIBER	GUN BORE	BULLET DIAMETER
Pistols (Inches)		
.22	.212 to .219 in.	.2235 in.
.25	.243 to .244 in.	.25 in.
.32	.303 to .305 in.	.312 to .315 in.
.38	.348 to .349 in.	.359 in.
.380	.348 to .354 in.	.356 in.
.45	.443 to .444 in.	.451 to .455 in.
Pistols (Metric)		
6.35	6.17 to 6.22 mm	6.37 to 6.40 mm
6.5	6.50 mm	6.70 mm
7.62	7.69 mm	7.80 mm
7.65	7.64 to 7.67 mm	7.92 mm
9.0	8.77 to 9.02 mm	9.04 mm
11.25	11.25 to 11.28 mm	11.45 to 11.56 mm
Rifles (Inches)		
.22	.2165 to .221 in.	.224 to .228 in.
.270	.270 to .2716 in.	.278 in.
.30	.299 to .301 in.	.3086 to .310 in.
.300	.300 in.	.309 in.
.303	.300 to .303 in.	.309 to .3125 in.
.30-06	.300 to .3015 in.	.3086 in.
.32	.301 to .315 in.	.3125 to .3385 in.
.33	.330 in.	.3385 in.
.348	.340 in.	.350 in.
.351	.345 in.	.352 in.
.35	.345 to .350 in.	.351 to .359 in.
.375	.366 in.	.3755 in.
.38	.394	.401 in.
.401	.399 in.	.407 in.
.405	.405 in.	.4115 in.
.44	.422 in.	.427 in.
.45	.448 to .450 in.	.458. in.
Rifles (Metric)		
6.5	6.30 to 6.53 mm	6.30 to 6.65 mm
7.0	6.96 to 7.01 mm	7.16 to 7.21 mm
7.5	7.49 mm	7.74 to 7.79 mm
7.62	7.62 mm	7.87 to 7.93 mm
7.65	7.64 to 7.67 mm	7.87 to 7.89 mm
7.7	7.70 mm	7.87 mm
7.9	7.87 to 7.92 mm	8.15 mm
8.0	7.80 to 7.94 mm	8.05 to 8.25 mm
9.0	8.78 mm	8.98 to 9.05 mm
9.3	8.97 to 9.02 mm	9.23 to 9.26 mm
9.5	9.50 mm	9.70 mm
12.7	12.12 to 12.17 mm	12.60 to 12.68 mm

What Kind of Firearm Was Used?

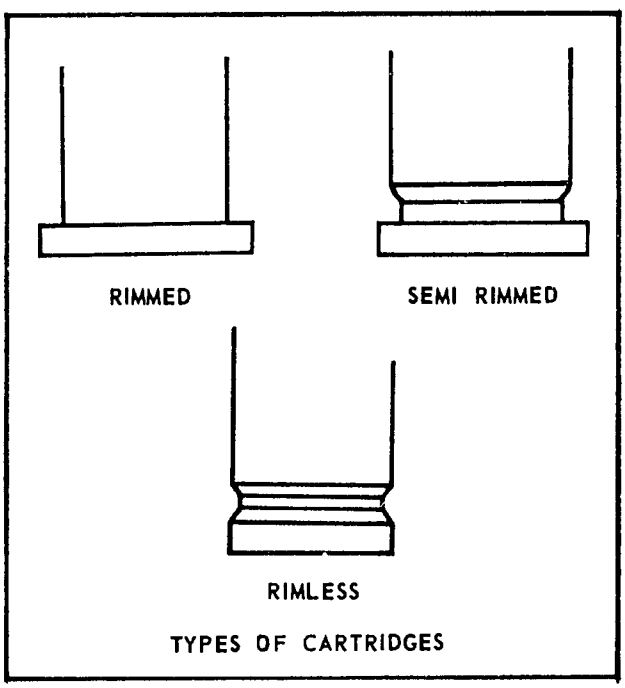
If no cartridges are found at the scene of a shooting, it may be suspected that a revolver or single-shot pistol or shotgun was used. While the criminal might possibly pick up and take away the empty cartridge cases, he is usually too nervous to think about this.

Cartridge cases fired from a rifle can generally be separated from pistol or revolver cases except for .22 caliber (5.6 mm) cartridges which can be fired from either pistols or rifles. The investigator should not forget that some self-loading pistol cartridges will also fit revolvers. Many military revolvers made during the war had special clips to take the standard .45 caliber self-loading cartridge used in the Colt Model 1911 pistol which is a widely used side arm in the army.



HANDGUN CARTRIDGE

If bullets are recovered from the body of the victim or from the crime scene, it is usually easy to tell if they have been fired from a revolver or a self-loading pistol. Revolver bullets are made of lead while self-loading pistol cartridges are usually jacketed with a copper coating. Careful measurement of the diameter of the bullet will help the investigator to determine the possible make and model of weapon used to fire it.



TYPES OF CARTRIDGES

From What Distance Was the Weapon Fired?

The firing distance of shotguns can be fairly well measured up to about seven meters because the group of bullets will keep together about this far. The shotgun is fired at a paper target from measured distances and a comparison is made of the degree of spacing or scatter between the targets and the person or thing shot at.

Rifled bullets leave the muzzle and travel to the target without spreading. The only way to estimate the firing distance is by comparing the products of combustion, or smoke, dirt, powder and primer residues that come out of the weapon behind the bullet.

This type of estimation is reliable only to a range of about one meter.

Collection of Firearms Evidence

Watch for fingerprints! Pick up the gun by the checkered part of the grip. Be careful about fingerprints on the magazine and on the cartridges. These are better places to find prints than on the outside.

Do not unload unless you must. Ship the gun in a package that is marked "DANGER—LOADED" on the outside. If you must unload, mark position of each cartridge in a revolver. Leave cartridges in the magazine in a self-loading pistol. Put the cartridge from the chamber in a separate package.

Do not clean the gun or put anything in the barrel. Do not work the action or spin the cylinder.

Put a tag on the gun and write down in your notebook the make and model, the caliber, and the serial number. Many rifles that are not military weapons do not have serial numbers. Most shotguns do not have serial numbers.

Make a sketch of the location of any ejected cartridges.

Mark the bullets on the bottom. Mark the cartridge cases on the **inside.** Put each of these items in a small box with cotton.

Making Test Shots for Comparison

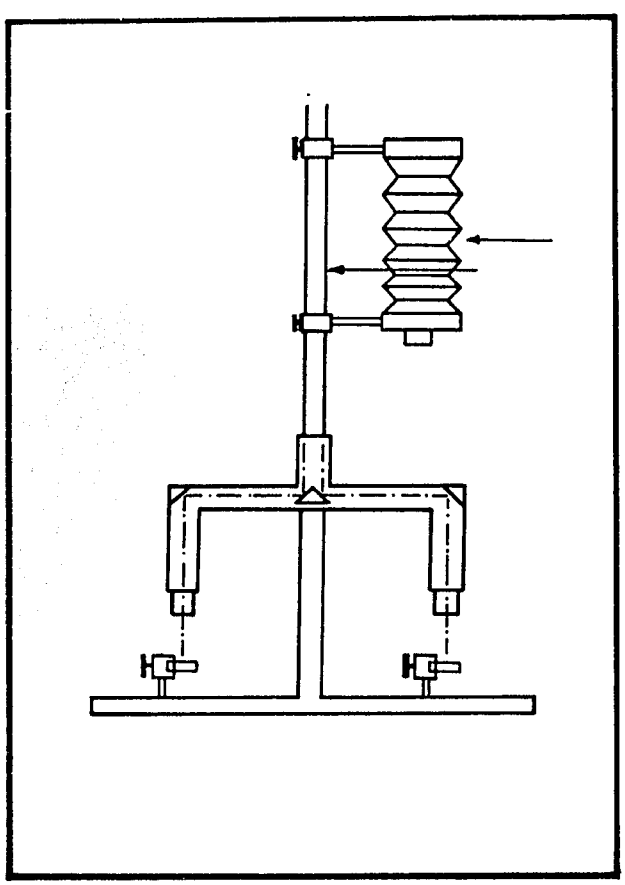
Always make the test shots with the suspected gun and with the same kind of ammunition as used in the crime. While sometimes it will be necessary to use a similar type of gun when the suspected gun cannot be found, only estimates can be made.

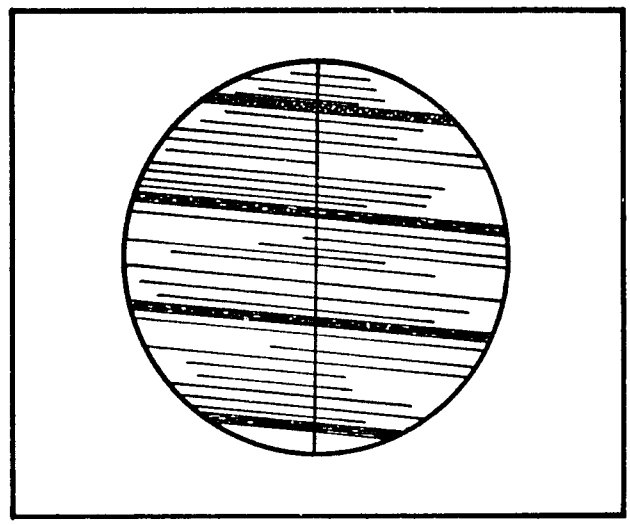
Collection of Test Bullets

It is always better to send the actual gun to the laboratory, but sometimes this is not allowed by the courts. In this case, the officer can collect the test bullets best by shooting into a large tank of water. The bullets are then picked out by means of a piece of soft clay fastened to the end of a stick. At least these bullets should be collected from each case.

Value of Cartridge Case as Physical Evidence

It is possible to find out if a certain weapon fired a certain bullet by examination of the markings on a bullet. It is also possible to identify a certain cartridge with a certain weapon. The markings made by the firing pin and the extracting mechanism are used by the criminalist to identify a certain cartridge with a certain weapon. It is usually easier to identify the markings of the firing pin on the soft metal of the cartridge primer than it is to identify the scratches on the side of the bullet. The investigator should always look for ejected cartridge cases from rifles. It becomes a habit with persons who use rifles to pull the bolt and reload the chamber immediately after firing. Self-loading military rifles will of course do this automatically. Often at the scene of a shooting, a firearm will eject a cartridge which has misfired. This type of cartridge will usually show the impression of the firing pin which may be useful as evidence.





Removal of Bullets From a Body

The investigator should always supervise the removal of bullets from a body. The surgeon should be asked not to use sharp forceps in removing a bullet because this may destroy the identifying scratches on the side of the bullet. The sharp teeth of the forceps should be covered with small pieces of rubber tubing. A doctor always has such tubing when he operates, and if he understands the reason why he must do this, he will usually cooperate.

The investigator should himself take the same precautions if he is trying to remove a bullet which has been stuck in a tree or a wall. He should not use a knife or metal instrument to take the bullet out. He should try to remove it by cutting around it, then prying it out with a piece of soft wood.

Firearms Discharge Residues

Policemen have looked for a test that would tell them whether or not a suspect fired a gun in a shooting case. Since firing a cartridge is caused by a chemical reaction, it seems reasonable to develop some laboratory tests that would detect one or more of the reaction products that would come from the explosion that pushes a bullet out of the barrel of a gun.

Residues from the discharge of a firearm may come from the bullet, the gunpowder, or the primer percussion cap.

The bullet contains mostly soft lead that has been hardened by the addition of from 0.5% to 5% of antimony, arsenic, or tin. This simple mixture is used only for revolver bullets. Bullets for rifles and automatic weapons are further coated with a jacket of copper-nickle, copper-zinc, or steel, since soft lead would foul the barrel grooves of a high-velocity weapon. Some rifle bullets may also have a steel or aluminum tip.

Black powder is now little used but may be encountered in homeloaded ammunition for collector's weapons or in some primitive parts of the world where muzzle-loading weapons are still in use. Black powder consists of potassium nitrate, sulfur, and charcoal. When exploded the residue may include potassium, carbonates, sulfides, sulfates, thiocyanate, nitrates, thiosulfate, and ammonium carbonate as well as unburned sulfur and a great deal of carbon from the charcoal.

Modern smokeless gunpowder is composed of nitrocellulose with or without the addition of nitroglycerine. This simple mixture would be likely to detonate and blow up the gun before the bullet could be pushed out of the barrel. Other chemicals are therefore added to slow down the explosion and prevent corrosive effects on the weapon. These additives may include barium nitrate, potassium nitrate, potassium dichromate, potassium oxalate, potassium bicarbonate, diphenylamine, nitrobenzene, dinitrotoluene, camphor, and even sawdust. After ignition, unburned amounts of all these substances may be present along with substituted ureas, nitrates, nitrites, and as many as 18 nitro products.

Older primers contained mercury fulminate, antimony sulfide, and potassium chlorate. Mercury is now usually replaced with lead azide or styphnate while barium nitrate is used instead of potassium chlorate. Powdered aluminum, zirconium, or manganese may be used along with 1, 2, 4, 5-tetrazine, trinitrotoluene, or pentaerythritol tetranitrate. Walker analyzed the primer residues of ninety-six makes and types of cartridges and found the following elements:

Element	Percentage of Primer Residue
Barium	90%
Antimony	87%
Lead	75%
Mercury	67%
Potassium	31%
Tin	9%
Manganese	4%
Zirconium	1%

Tin is not incorporated in the primer mixtures but comes from the small disc used to seal the primer compound in its cap. Copper, tungsten, zinc, chromium, lanthanium, cerium, and uranium have been detected in primer residues by neutron activation analysis.

The first attempt to solve this problem was made in 1933 when Mr. Teodoro Gonzales of the Criminal Identification Laboratory of Mexico demonstrated the use of a paraffin cast in the detection of gunpowder residues on the hand of a person suspected to have fired a gun. This test originated in Cuba. Iturrioz first used paraffin to collect firearms discharge residues. Soon after the test was introduced in the United States, the Federal Bureau of Investigation (FBI) called the attention of the investigators to the fact that this test cannot distinguish between nitrates and nitrites of gunpowder origin and those coming from other sources. In spite of this admonition, many law enforcement agencies continued the use of the test in the investigation of crimes of violence using firearms.

It is admitted that the paraffin test has some limitations. Wrong interpretations may be given to the test if the expert is not well acquainted with the test. In the first place, the term "Paraffin Test" is not correct since paraffin is used only to extract the gunpowder residues from the skin for later tests with Lunge's diphenylamine reagent. Some authorities refer to the test as "Gonzales Test" in honor of Mr. Teodoro Gonzales, who introduced the test at the Police Department in Milwaukee in 1933. Others call it "Dermal Nitrate Test", indicating the substance to be detected. The expression "Test for Gunpowder Residues" is also misleading since the test cannot distinguish

nitrates or nitrites of gunpowder origin from those coming from other sources. In the Philippines, the test is often called "Diphenylamine Test" because of the reagent employed in the test. The "Diphenylamine Test" is, in reality, a test for nitrates or nitrites, and therefore the source cannot be differentiated. Since the role of the nitrates or nitrites is simply that of an oxidizing agent, it is apparent that the test is not specific. Some false positive reactions will then result if the hands of the suspect are contaminated with certain substances with oxidizing property that are met in the ordinary course of life. Thus, nitrates from soil fertilizers, explosives, tobacco, firecrackers, urine, cosmetics, and so many other goods will give the test. Laundry workers may have sodium hypochlorite, a bleaching agent on their hands, chemists or pharmacists working with oxidizing chemicals will likewise give positive results to the diphenylamine test. It is, however, probably true, as many proponents of this test claim, that in general, persons do not have nitrates or nitrites or other oxidants for that matter on their hands as a matter of common occurrence.

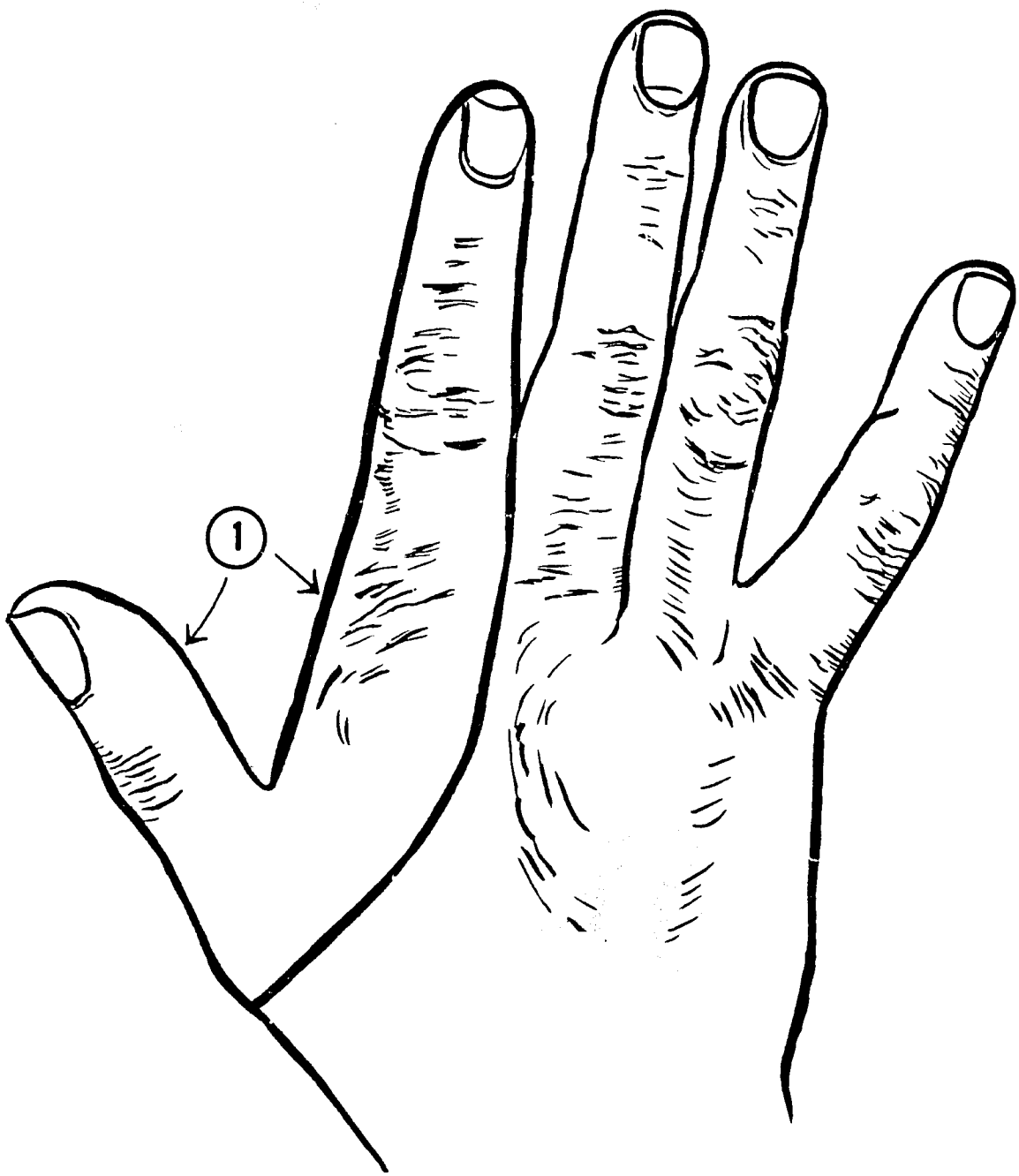
Another important argument which may be given in support of the test is the fact that in the interpretation of the test, the location, distribution, and character of the specks (streaming fleck type reaction) are considered. If the person tested has his hands contaminated with nitrates from other sources or any other oxidants, one will expect to find either a smear of blue color or a conglomeration of blue specks located at different places of the hand, both dorsal and palmar. Contamination of this nature can easily be removed by having the hands carefully washed with soap and water. This modification to the original procedure of paraffin test was adopted by the NBI several years ago to offset allegation of contamination to destroy the validity of the test.

Firearm discharge residues include the residues of the primer, gunpowder, lubricants, and metals resulting from the discharge of a firearm. It is a general term covering all products of the explosion of a round of ammunition. Primer residues are those resulting from the explosion of the primer when hit by the firing pin of the firearm. Leakage residues are those escaping from a fired weapon from openings other than the muzzle of a gun. In the firing of a gun, the first explosion will be that of the primer. Since the amount of explosive in the primer is only small, the force of explosion will cause primer residues to be deposited superficially on the region of the thumb and index fingers as indicated in the diagram. With the explosion of the primer, the gunpowder in the shell will explode producing the gunpowder residues which, unlike the primer residues, are embedded in the skin because of the force of explosion. Thus, the hand of a person firing a gun will have the primer residues on the surface of the firing hand and gunpowder residues embedded in the skin of the same hand. Both the primer and gunpowder residues are found in the leakage residues which will serve as basis to establish whether a person has fired a gun with bare hands within a reasonable time.

Collection of the Discharge Residues

Modern criminalistics practice encourages the collection and preservation of physical evidence by police investigators but leaves the analysis and evaluation to the laboratory expert. A suitable test for firearms residues should therefore be simple and straightforward from a collection standpoint. One major drawback of the paraffin test is the need for a pan to melt the wax, some source of heat, and a reasonable amount of skill on the part of the evidence collector to avoid scalding the suspect. As a consequence, most testing is either done at the laboratory or a technician goes out in the field carrying his cooking equipment.

The swabbing technique of Harrison gets around these difficulties. Any investigator anywhere can collect a sample with easily available materials. The swab can be mailed to the laboratory in an ordinary letter. The use of cotton cloth squares seems questionable, however, since the purity of the fabric is always unknown. Curry recommends torn strips of pocket handkerchief,



AREA OF FIRING HAND MOST LIKELY TO REVEAL FIREARM DISCHARGE RESIDUES

but here again there is no knowledge of the ionic blank of the cloth, and it seems unreasonable to ask an investigator to sacrifice his personal linen even in the furtherance of justice.

Scott and Guinn use ordinary laboratory filter paper, but this is not always readily available in the field. Damp filter paper has little wet strength and tends to disintegrate with manipulation. Filter paper also contains quite a number of contaminating ions. Whatman #1 shows potassium, sodium, calcium, chloride, magnesium, nitrate, iron, sulfate, and a trace of manganese.

We have found the most practical collection device to be the simple 2" x 2" gauze square or "sponge" found in every pharmacy, hospital, doctor's office, or even the first aid kits carried in police vehicles. The gauze sponges are clean, unused, sterile, and sealed against contamination in a wax paper envelope. Blank tests of American commercial products show only sodium, magnesium, and potassium to be present. After collection of residues, the swab can be put back in its individual envelope for transportation to a laboratory. There is a special radiopaque sponge that must be avoided; it contains lead to make it show up under X-rays. It is usually only supplied in unwrapped bulk packages of 100 for use in surgical operating theaters.

The routine procedure now adopted in the National Bureau of Investigation of the Philippines for the detection of firearm discharge residues on the hand of a person suspected to have fired a gun is as follows:

1. The entire upper portion of the hand including the web and upper surface of the thumb and index finger, are rubbed moderately with a gauze sponge moistened with 1% hydrochloric acid solution prepared by diluting C.P. hydrochloric with double distilled water. This precaution is necessary to avoid the presence of even traces of metallic elements which might interfere in the sensitive test to follow.

2. The swab is laid carefully on the outside of an envelope and allowed to dry. Protect from dust and other contamination by covering with a watch glass.

3. Wash the hand carefully with running water to remove the hydrochloric acid and other contaminations which may be on the surface of the hand.

4. Take the paraffin cast of the hand in the usual manner employed in the "Paraffin Test".

5. By this time (after taking off paraffin cast) the swab would be dry enough to be placed in the envelope. Make the subject initial the envelope.

6. Remove the cast, label, and mark which is left or right. Indicate whether the subject is left- or right-handed.

The swab is examined for primer residues while the usual diphenylamine test is applied on the paraffin cast. If both the gunpowder and primer residues are found present, the subject must have fired a gun. It will be quite a coincidence that several substances characteristic of primer and gunpowder residues will be on the hand of a person by mere contamination only.

The investigator should remember that firearms discharge residue tests are excellent investigative aids but cannot stand alone as probative evidence in court.

PHYSICAL EVIDENCE IN MASS DISASTERS

A mass disaster is a situation where a large number of people die at the same place at the same time from the same cause. Some examples are:

Natural forces—flood, earthquake, hurricane, extreme cold.
Disease—epidemics, bacterial food poisoning.
Machines--industrial, transportation, air craft.
Fires and explosions
Mass poisoning
War and insurrection

Machine disasters are of most concern to the police because there may be a crime involved—sabotage or murder. Every investigator may be faced with the identification of a large number of persons in a mass disaster. An aircraft may suddenly crash in front of the police station. An explosion may occur in a nearby factory. Fire may kill a

large number of people in a cinema. In Lima, Peru, several hundred people were trampled to death during a riot at a football stadium. Every police station, no matter how small, should have a disaster plan arranged for in advance so that proper action to properly identify the dead can be taken at once.

There are many important reasons why proper identification of all dead persons in a mass disaster should be made. Questions of responsibility, insurance, inheritance, and survivorship depend upon proof of death. The law courts will not be satisfied with a mere opinion but will insist on correct physical evidence. In many cases, it will not be possible to prove conclusively that a person is dead but there can be a reasonable degree of probability if a good job of investigation has been done.

First Steps To Be Taken at the Scene

The first and most important thing the investigator needs to investigate a mass disaster is a great deal of assistance. The scene of the mass disaster must be closed off and guarded properly as quickly as possible. All police reserves should be summoned at once and any nearby military units should be called upon for assistance. Sentinels should be posted entirely around the scene of the accident with instructions to allow no one, to remove anything from the scene until it has been properly collected in the correct method. Personal articles such as watches, jewelry, wallets, documents, clothing and luggage are important because these things are physical evidence to assist in identification. If they are removed without detailed records being made as to where they come from, it may prove impossible to identify a dead body.

The police investigator will need assistance from other experts. A doctor will be needed to identify parts of bodies. He should be a pathologist if such a specialist is available. A dentist will be needed to assist in identification by means of teeth. In the case of an aircraft crash, the airline should be notified immediately for they will send teams of specialists who will help to identify various parts of the aircraft. By means of their special knowledge, they can determine the cause of the accident.

Investigating Procedure

A preliminary field sketch should be made as quickly as possible, and this sketch should be divided off into squares by the coordinate method. The area should now be searched square-by-square or room-by-room. A stake with a tag as a marker should be placed at every place where parts of a human body are found. When this has been completed, the searching team should then go back and begin to collect together all articles of clothing and jewelry that are found in the same place as these parts of bodies. All of these materials should be placed in one container and removed to some place set aside as a temporary morgue. The investigator may find it very difficult to deal with the relatives of dead persons where local religious and burial customs exist. The investigator will need help from powerful and important government officials to prevent relatives from taking away bodies until identification has been completed.

After all visible physical evidence found above the ground has been collected and taken away in numbered parcels, it may be necessary to go back again and make a search below the surface of the ground for articles which may be buried by impact. The searching should again proceed systematically square-by-square and if necessary, the soft dirt of the surface of the ground should be screened with a sieve to find small articles of bone, teeth, or jewelry, that may be helpful in identification.

The investigation team should now proceed to the temporary morgue and proceed to identifying each group of material.

Value of Physical Evidence in a Mass Disaster

Experience in investigation of aircraft disasters has shown that physical evidence is valuable in the following order:

Documents are most valuable in cases where fire has not caused so much damage as to destroy them.

Jewelry and identification tags have been the next most valuable clue. Many persons have their initials engraved on wedding rings. Members of the military always wear identification discs.

Clothing is valuable for identification. Uniforms are particularly helpful because most have distinctive buttons.

Visual identification by friends and relatives is not very helpful. In British experience, less than 12% of cases were identified in this way. It should not be regarded as conclusive unless there is physical evidence to support it.

Medical evidence will help in 10% to 40% of cases. This includes evidence of sex, height, dental, X-ray, and other special examinations. Medical evidence is not very helpful with young people and children since they have not usually had very much happen to them to cause individuality. Older people may be identified by operation scars, broken bones, and fillings and restorations of their teeth. Medical examination of a very mutilated body may be very limited. It may be impossible to determine no more than sex. Dental evidence is only of value if there exists somewhere a record of work done to the person's teeth, or if relatives are able to give detailed description of peculiarities; X-rays of bones, if there are records to show that the person has had any breaks or deformities of his bones.

Fingerprints are not very helpful for all cases. Many countries do not permit the fingerprinting of persons unless they have been convicted of a crime. In the United States, a large percentage of the population have been fingerprinted, and it will be a useful procedure in cases involving Americans. Fingerprints are not usually helpful with children and infants. An effort should be made to take fingerprints whenever possible since comparisons can later be made with articles in the suspected person's home known to have been touched by him.

Identification by Exclusion. After all bodies have been identified as much as possible, there will always remain some bodies that are not easily identified. If a list of all persons known to have been in the accident is available, it is then possible to match the poorly identified bodies with the names of the persons that have not yet been identified. Such identification is not the best kind and should only be labeled as "presumptive".

A mass disaster that happens to people who live in one place is the most simple to investigate. Aircraft accidents are more difficult, but here, a detailed list of all passengers is available. Railroad and bus accidents are most difficult since usually no record is made of the names of passengers. The only way to be sure of doing a good job in a mass disaster investigation is to:

Plan in advance
Call for outside help

SUSPICIOUS DEATH INVESTIGATION

About one of twenty people die in a manner that calls for official investigation. Usually there is a public official responsible for this inquiry, but he will need help from the police and the criminalistics laboratory. If an accidental death is wrongly called a natural death, the family of the deceased may lose extra insurance benefits. If a natural death is wrongly called a murder, an innocent man may be kept in jail and put to great expense to defend himself. If a death is wrongly called a suicide, the deceased may be denied the sacraments of the church and refused burial in sacred ground. This would be needlessly embarrassing to his family.

The investigator should work carefully and slowly, and he must always remember that as soon as the dead body has been moved or embalmed or buried, there is little hope of finding the truth. In countries where cremation is the usual method of disposing of a dead body, there will be no chance at all of making a successful investigation once this has been done.

Deaths that happen in a hospital or to a person who has been under the care of a doctor do not usually need to be investigated. The doctor knows the cause of death and signs the certificate. But sometimes he is not sure. He will ask for an **autopsy** which is an operation performed after death by a specialist called a **pathologist.** A pathologist is a physician who has had special training in finding the cause of disease and

death. If the pathologist cannot find the cause of death, he may ask the help of a **toxicologist.** This is a chemist specially trained in the analysis of poisons.

An autopsy does not have to be done in every suspicious death to determine the cause. The cause of death is obvious in shootings, stabbings, and most accidents. The investigator may need an autopsy, however, to remove bullets or collect organs and fluids for poison analysis. The investigator must always be present to assist the doctor in collecting these samples. He should take immediate possession of all things removed from the body and handle them as he would any other kind of physical evidence.

Identification

An important duty of the investigator in a suspicious death case is the correct identification of the body. It can be difficult when the body has not been discovered for a long time and has begun to spoil. Another difficult identification problem comes in what are called **mass disasters.** This will be discussed separately.

Fingerprints are helpful if the dead person has been fingerprinted. Often there are no prints on file with the police. The investigator should search the home of the person and look for things that the persons may have touched, such as his personal papers, his shaving things. The investigator should be careful to check and verify identification made by persons who think they know the person who is dead. If the body is greatly spoiled, they may be mistaken in their identification. The investigator should study personal items like watches, rings, jewelry, or papers which may be helpful in the identification. Clothing should be removed and carefully saved. The dead person should of course be carefully photographed.

X-rays may be useful in cases where the dead person is known to have suffered broken bones or other deformities of his body.

Dental examination may be helpful if the person has ever been treated by a dentist. Dentists keep a record of the work they do, and they may be able to identify their own dental work. The investigator should make inquiries to find out if the dead person has ever had dental work done.

Systematic Investigation of a Death Case

Suspicious deaths that come to the attention of the police are of four kinds: (1) natural, (2) accidental, (3) suicide, (4) murder.

Experienced homicide detectives always follow the rule that every suspicious death case must be considered a murder until investigation has shown it to be natural, accidental, or suicide. By taking this attitude, they make sure that their investigation will be thorough and that no important steps will be neglected. Such an investigation must be systematic which means that certain procedures must be carried out in a step-by-step order so that nothing will be overlooked.

Examination of the Surroundings

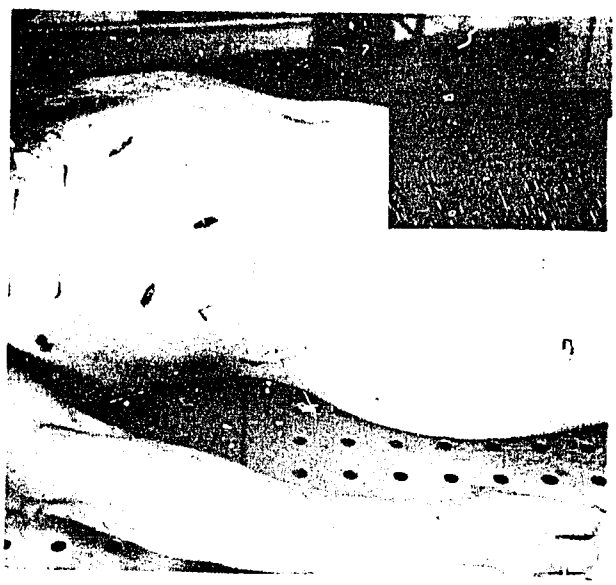
Pause at the doorway, and put your hands in your pockets as a precaution against the normal human instinct to touch things. Stand still and sweep the room with your eyes like a radar. Look particularly for footprints. As soon as anyone steps closer to the body, he is going to spoil those footprints. Decide what photographs will be needed and where the photographer must place his camera. **The photographer is the first person allowed to enter the crime scene.** No one else goes in until he has taken his first over-all or "establishing" shots.

Take photographs. The detailed procedures for taking crime scene photographs are discussed in Chapter IV.

Determine the Condition of the Scene. Interview the person who first discovered the body and find out if there has been any change before you arrived. Someone may have pulled down a window shade, closed a door, shut a drawer, or done some little thing that may disturb physical evidence.

Search for Latent Fingerprints. The detailed procedures for taking latent fingerprints are discussed in Chapter III under **Latent Fingerprints.**

Examine the Body. Assist the doctor in making this examination. Search for marks and scars that may help to identify it. Note carefully the type and location of wounds and their measurements in all directions. Note blood and seminal stains as well as abrasions, bruises, and tearing of clothing. Examine fingernails, hands, hair, and arms. Get fingernail scrapings and samples of head hair. Ask the doctor for his opinion as to the time of death and the probable cause.



Make Close-Up Photographs of the significant things discovered during examination of the body.

Examine Clothing. Before the body is removed, make a thorough inspection. Search carefully for hair, fibers, dirt, dust, debris, glass, paint, and soil.

Examine Under the Body. Carefully outline the body with chalk, then turn the body over and examine the back. Look for wounds and search for physical evidence. Then search the ground underneath for blood, vomit, and especially for fired bullets. This is particularly important. In the assassination of President John F. Kennedy, a fired bullet was completely overlooked and later discovered on a hospital stretcher by a maintenance employee.

Search for Weapons. Examine for traces of hair, tissue, fibers, fingerprints, dirt, rust, and blood. **Do not remove or separate any of this physical evidence from the weapon.** Wrap carefully and describe in your notebook. Do not unload any firearm or spin the cylinder of a revolver. Send it to the laboratory exactly as you found it.

Search the Surroundings. Start from the body and work outward in gradually widening circles. Examine the floor or ground, walls, ceiling, furniture, doorways, and all exposed surfaces. Remember that the value of physical evidence decreases as it gets farther away from the center of the crime. Examine the point of entry for the usual signs of toolmarks.

Finally, search the unexposed places. Look inside books, behind pictures on the walls, in trash containers, under rugs, inside flower vases and dishes. An old proverb says that the darkest corner of the room is the one the coin rolled into.

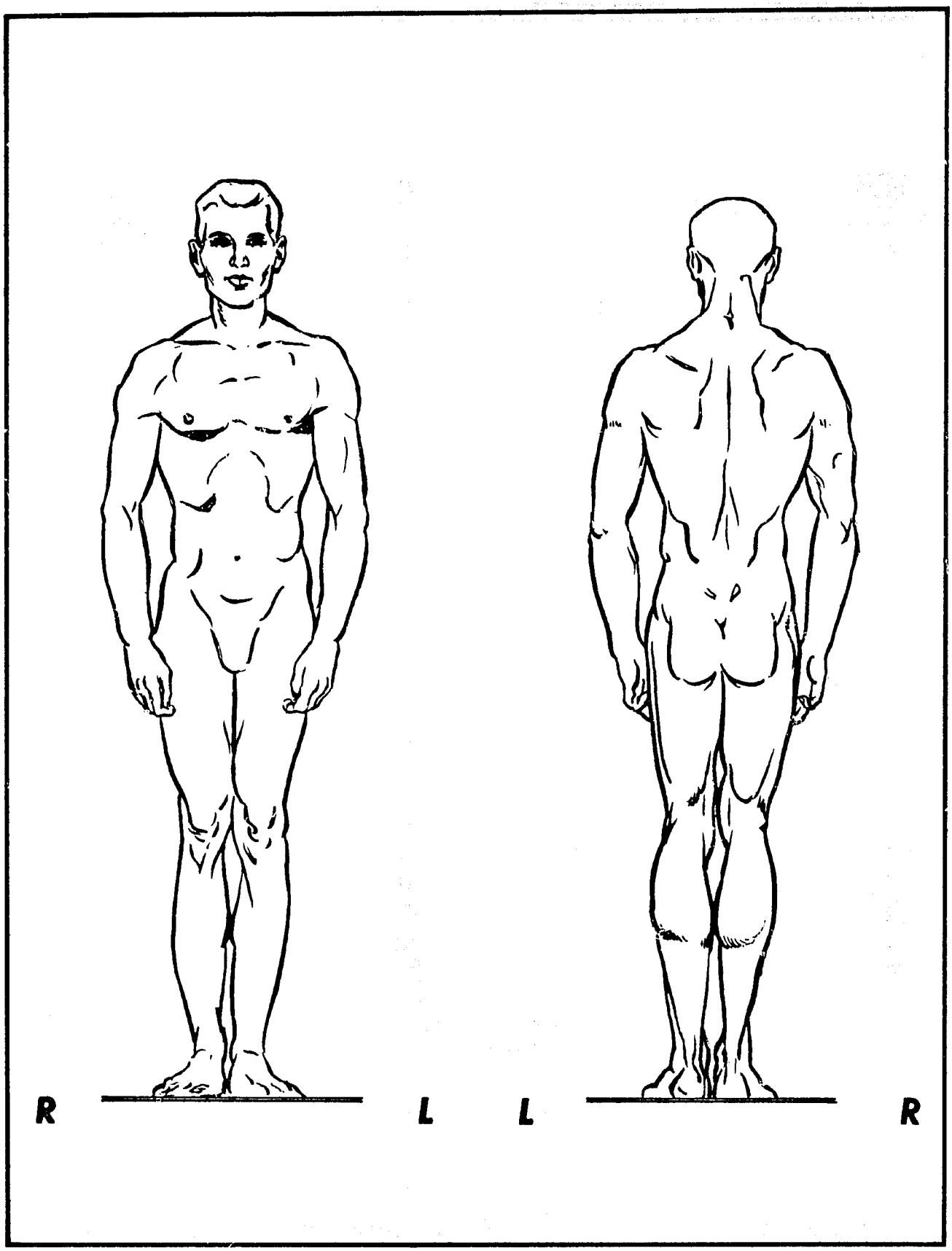
Signs of Death

Death can be said to happen whenever breathing stops for more than three minutes. A healthy human being can survive ten days without water in a cool climate, or several weeks without food in a warm climate. He can stand an air temperature of 212°F for about an hour and water temperature of 41°F for a half hour, but if his breathing stops or his heart stops, he will die quickly. The heart may continue to beat for several minutes after breathing stops.

The only reliable signs of death are therefore absence of breathing and absence of heart beat. Skin color, condition of pupils, or surface temperature of the body are not reliable guides for recognizing death.

Estimating the Time of Death

The most important fact to the investigator is to fix the time of death as close as possible. In spite of frequent claims in detective stories and mystery movies, it is never possible to fix the exact time of death to within a few minutes. Only a rough estimate is ever possible.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There are two ways of estimating the time of death. One is by observing the changes that have taken place in the physical condition of the dead body. The other is by relating the finding of the body to certain other events that took place at the same time. The first way is called the **rate method** and the second way is called the **association method.**

The **Rate Method** is based on the degree of change in the body after death. Some of these changes are:

Cooling. When life ceases, the fires are turned off, so to speak, and the temperature of the body then slowly drops to the temperature of the surroundings. This fact was noted a long time ago, and at first, it was thought that a dead body cooled in the same way as other inert masses according to Newton's Law of Cooling which says that:

"The rate of loss of heat from a hot object cooling in air is directly proportional to the excess of temperature of the object over that of its surroundings."

But many experiments with actual dead bodies has shown that the temperature drop is not regular during the first 12 hours after death. In fact certain Irish doctors have found that the temperature may **rise** in 50 out of 2,000 cases they studied. After 12 hours the rate becomes proportional as expected.

The body temperature is most easily determined by putting a thermometer into the rectum and taking readings at regular intervals for several hours. A laboratory thermometer reading from 0° to 50° and accurate to $0.1^{\circ}C$ is used. It is inserted 4 inches into the rectum and left undisturbed. The height and weight must also be recorded. The temperature of the surroundings must be recorded.

During 18 hours after death, the body of an average male will cool from $99^{\circ}F$ to $82.7^{\circ}F$ where the temperature of the surroundings is $75^{\circ}F$. This means that an average male will take 18 hours to reach room temperature, while a fat man might go as long as 41 hours. The complete cooling time is determined by the size of the body and not by the temperature of the surroundings. The cooling rate can never be more than a rough approximation.

A rough formula for estimating the time of death is:

$$\frac{\text{Normal temperature } (98.6^{\circ}F) - \text{Rectal temperature}}{\text{Rate of temperature fall per hour}} = \text{No. of hours since death}$$

The rate is usually $2.5^{\circ}F$ for the first few hours and $1.5^{\circ}F$ per hour afterwards.

Muscle Stiffening. After death, the muscles of the body begin to become stiff. This is known as **rigor mortis.** It usually begins in the jaws in from 3 to 5 hours and is very strong in the arms and legs within 8 to 12 hours. It usally goes away in 48 hours.

Chemical changes. Many experiments have been made on changes of various chemical substances in the body such as calcium, sodium, and potassium. None have proved reliable.

Attack by Insects. Flies may lay eggs under the eyelids or within the lips within a few minutes after death. Maggots will hatch in 24 hours. Different kinds of insects are attracted to meat in varying degrees of freshness. An entomologist may be able to estimate the time of death by study of the insects present.

The **Association Method** tries to relate the time of death with other events. These may be acts performed by the victim indicating he was alive at a certain time. If the lights in the house were turned on and darkness occurred at 7:00 p.m., he was probably alive up to this time. If the exact time of a meal is known, the pathologist may be able to estimate the death period by studying the stomach content at autopsy.

Gunshot Wounds

The usual cause of death in gunshot wounds is shock and bleeding or both. If a person does not die right away, he may die later from infection of the wounds from organisms that get inside. The investigator should look for signs of burning marks. In a suicide by firearms, the investigator should determine if it is possible for the wound to have been made by the person himself. A person cannot shoot himself in the back very easily.

Often when a person shoots himself, the recoil of the weapon makes a scratch or bruise on the part of the hand that held the trigger. If there are no powder marks or burning, the investigator should collect the clothing for examination for powder residues. The investigator should look very carefully for the exit wound or place where the bullet came out of the body. If he cannot find an exit wound, the bullet is still inside the body. If there is an exit wound, the investigator should search for the bullet. Usually a bullet that passes through a body does not travel very far. It may be difficult to find a bullet in an outdoor shooting but the ground all around the area should be very carefully searched to find it.

All firearms deaths should be considered murder until proven to be otherwise. Even if the case looks like accident or suicide the investigator should proceed to do his work exactly as if the case were a murder.

Stabbing and Cutting Wounds

Deaths by stabbing and cutting should be considered a murder until proven otherwise. An autopsy is usually more necessary in this type of case because it is not always possible to tell how deep the knife went in by looking at the outside. Stabbing and cutting wounds produce a great deal of blood and the investigator should be sure to get a blood sample from the victim because it is very possible that there will be blood stains on the murderer. Careful photographs and sketches should be made of the position and location of all bloodstains as they may help to show in what manner the blows were done.

Hangings

Hangings are very often used to hide other kinds of death. The investigator should make a careful investigation of claims that a person hanged himself to be sure it is not murder. The investigator should look carefully at deaths by drowning as this is sometimes used to conceal another form of death.

Careful close-up photographs should be taken of any injuries. If the tongue is sticking out between the teeth, the investigator should suspect strangulation and should examine the neck for signs of a rope or the marks of fingers. Persons who die of choking very often turn blue and there may be red bruises beneath the skin.

Drownings

In a case of drowning, a person may stop breathing but may still be alive. This is also true in poison cases. The investigator should hold a small piece of cloth or a fiber in front of the nose and lips to detect breathing. The eyes should be examined to see if they are still moist. The eyes of a dead person begin to get dry and cloudy very soon after death.

Death by drowning should be carefully investigated. Dead persons are thrown into the water in an attempt to conceal the body or to cover up other causes of death. The first question that the investigator asks is: Was the victim dead or alive before he hit the water? A useful laboratory test to determine this is the **Gettler Chloride Test.**

Blood from the lungs goes to the left side of the heart and then through the body and back to the right side of the heart. From here it goes back to the lungs. If water enters the lungs, it goes quickly to the left heart and dilutes the blood in it. No water can get into the left heart if the body is thrown into the water after death. Blood contains 1% salt, or sodium chloride. Fresh water has little salt, it will lower the chloride in the left heart. Sea water contains from 3% to 6% salt and will raise the chloride in the left heart.

The pathologist should be asked to collect two separate samples from both the left and the right sides of the heart. He can do this with a hypodermic syringe and a big long needle. The investigator sends these to the laboratory for chloride analysis. Be sure to tell the laboratory whether the victim was found in **fresh** water or in **sea** water.

Murder Happening After a Sexual Attack

A search should be made for seminal stains on and inside the body of any woman who is murdered because the cause of murder of woman is often the result of a sexual

attack. Cotton swabs should be taken of the sexual parts of any dead woman for laboratory test. A search for fibers, hairs and other physical evidence should be made. The under-clothing of women should be sent for laboratory examination. The fingernails of a dead woman should be looked at very carefully to see if she had scratched someone, and if there appears to be blood, samples should be taken for laboratory examination.

Criminal Abortion

In all cases of criminal abortion, the investigator should look for physical evidence in the form of medicine or instruments that might have been used. A medical examination of the suspected woman always has to be made. Blood stain evidence would be quite important in these cases and a search of the premises should disclose bloody towels and rags.

Poisons

Death by poisoning is usually accidental or suicide. Less than 1% of poison cases are murder. The investigator should proceed to investigate these cases as if they were murder. The most important thing in a poisoning case is a careful investigation of all the circumstances. The toxicologist needs this information to decide what poisons to look for. He will need samples of the blood and urine and the stomach contents and other organs such as the brain and the liver. No preserving chemicals should be added to these organs unless it is not possible to get them to the laboratory in a short space of time. In this case, the organ should be packed in a clean jar with salt. Your instructor will explain the proper ways of collecting poison samples.

Appendix A

BOOKS AND PERIODICALS

A basic scientific library is essential in any police department. Besides the standard reference books, all of the special magazines, called "journals" or "periodicals" must be available. Books can never be up-to-date. The average book is over a year old from the time the author turns in his manuscript and the book is printed and distributed. Therefore, the scientific journals are important to keep the investigator aware of the latest developments in his craft.

GENERAL CRIMINALISTICS

Crime Investigation: Physical Evidence and the Police Laboratory, Paul K. Kirk, Interscience Publishers, New York (1960) $10.00.

The standard American work in the field. The book consists of two parts—one for the investigator and the other for the laboratory worker.

Forensic Chemistry and Scientific Criminal Investigation, A. Lucas, Edward Arnold & Co., London (1948) $7.50.

Although an old book, it contains much valuable material relating to the peculiar problems of Africa and the Middle East. It has many useful tests that do not require complicated instruments.

An Introduction to Criminalistics, O'Hara & Osterburg, MacMillan Co., New York (1949).

Covers much of the mathematical theory of probability relating to evidence evaluation. A more advanced work than the title suggests.

Scientific Investigation & Physical Evidence, Leland V. Jones, Charles C. Thomas —Publishers, Springfield, Illinois (1959) $8.50.

Written for the investigator and based on the author's many years of practical experience with the Los Angeles Police Department Laboratory.

The Crime Laboratory, James E. Osterburg, Indiana University Press, Bloomington (1968) $6.00.

This excellent book is designed for teaching evidence evaluation. The author has assembled many photographs from police departments all over the United States that illustrate the uses of association evidence.

Forensic Science, Hamish J. Walls, Sweet and Maxwell, London (1968) $10.00.

This book is written by a retired Director of the Metropolitan Police Laboratory, New Scotland Yard. (Compare: Nickolls, Scientific Investigation of Crime).

Gradwohl's Legal Medicine, Francis E. Camps, John Wright & Sons, Bristol, England (1968).

This is the first revision of Gradwohl's pioneer work, re-written by British authors. It includes identification of the living and the dead; death, injury and disease; mental illness; alcohol and sobriety; and toxicology.

Scientific Investigation of Crime, L. C. Nickolls, Butterworth & Co., Publishers, Ltd., London (1956) $7.00.

The standard British work in the field, written by a retired Director of the Metropolitan Police Laboratory, Scotland Yard. Particularly good on Arson and Toxicology.

Techniques of Crime Scene Investigation. Svensson & Wendell, Elsevier Press (Van Nostrand), New York (1965) $15.00, 2nd Edition (American).

The newest edition of this Scandinavian work has been translated and edited by two American criminalists, Joseph Nichols and Jan Beck.

Methods of Forensic Science, Vol. I, F. Lundquist, Edition (1963) $19.95; **Vol. II**, F. Lundquist, Edition (1963) $10.00; **Vol. III**, A. S. Curry, Editor (1964) $10.00; Interscience (John A. Wiley Publishers), New York & London: **Vol. IV**, A. S. Curry, Editor (1965) $14.00 Interscience (John A. Wiley, Publishers) New York & London.

These four volumes represent a collection of specialist articles on many fields of criminalistics, each chapter written by an expert and representing a worldwide collection of authors.

QUESTIONED DOCUMENTS

Suspect Documents: Their Scientific Examination, Wilson D. Harrison, Frederick A. Praeger, Publishers, New York & London (1958) $15.00.

The standard modern work in the field written by the recently-retired leading British expert. Contains much detailed technical methodology. This book has supplanted Osborne's book which has been out of print for many years.

Questioned Documents, Albert S. Osborne. This book is no longer in print and copies are difficult to obtain. Occasionally one can be secured from a dealer in rare books, but the price will be very expensive.

Evidential Documents, James V. Conway, Charles C. Thomas Publishers, Springfield, Illinois (1959) $7.50.

An excellent and well-written book principally aimed at the lawyer or investigator. Contains little technical method material.

Scientific Examination of Questioned Documents, Ordway Hilton, Callaghan U Co., Chicago (1956) $15.00.

Hilton writes mainly to the lawyer who must present questioned document cases in court. Little technical data.

Forgery Detection: A Practical Guide, Wilson R. Harrison, Sweet & Maxwell, London (1964) $5.00.

A small and inexpensive supplement to Harrison's larger work, it is aimed at the investigator whom the author maintains can detect 75% of all forgeries by means of the simple step-by-step procedures outlined.

FIREARMS IDENTIFICATION

Firearms Investigation, Identification and Evidence, Hatcher, Jury and Weller, Stackpole Co., Harrisburg, Pennsylvania (1957) $10.00.

A well-written and exhaustive work in the field. Almost encyclopaedic in scope.

Firearms Identification, J. Howard Mathews, University of Wisconsin Press, Madison, Wisconsin (1962) 2 volumes, $40.00.

Most of these two volumes consist of photographs, charts, and tables of all

types of handguns. An essential reference work in any firearms laboratory.

Identification of Firearms and Forensic Ballistics, Major Sir Gerald Burrard, A. S. Barnes & Co., New York (1962), (Out of print).

The leading British work in the field.

Toolmarks, Firearms, and the Striagraph, John A. Davis, Charles C. Thomas (Publishers) Springfield, Illinois (1958) $8.50.

About one half of this book deals with a special apparatus designed by the author. The portion on general technique is clear and explicit.

Hatcher's Notebook, Julian S. Hatcher Stackpole, Co., Harrisburg, Pennsylvania (1962) $8.50.

Although not primarily a forensic work, the material is useful for the inclusion of much miscellaneous data on firearms. The late General Hatcher was America's first and foremost firearms examiner.

Explosives and Homemade Bombs, J. F. Stuffel, Charles C. Thomas—Publishers, Springfield, Illinois (1962) $8.50.

Not a laboratory book but essential to an understanding of the construction and use of the type of bomb that the criminalist will encounter.

Explosives and Bomb Disposal Guide, Robert R. Lenz, Charles C. Thomas—Publishers, Springfield, Illinois (1964).

Similar in content to the preceding book.

Center Fire Metric Pistol & Revolver Cartridges, Henry P. White and Burton D. Munhall, Infantry Journal Press, Washington 1948, $10.00.

TOXICOLOGY

Poison Detection in Human Organs, A. S. Curry, Charles C. Thomas Publishers, Springfield, Illinois (1963) $8.50.

The standard work in the field. Well written and exhaustive. Aimed specifically at the bench worker.

Toxicology Mechanisms and Techniques, two volumes, Stewart and Stolman, Academic Press, New York (1958) $40.00.

Progress in Chemical Toxicology, Vol. I, A. Stolman, Academic Press, New York (1963), $21.00; **Vol. II** (1965), $15.00; **Vol. III** (1967) $16.00.

The basic two volumes and their supplements have been prepared by leading toxicologists from all parts of the world.

Legal Medicine, Pathology and Toxicology, Gonzales, Helpern and Vance, Appleton-Century-Crofts, New York (1954) $20.00.

A comprehensive work on all fields of forensic science. The toxicology portion is particularly good.

Spectrophotometric Analysis of Drugs Including Atlas of Spectra, Irving Sunshine and S. R. Gerber, Charles C. Thomas—Publisher, Springfield, Illinois (1963) $10.50.

Valuable reference source for laboratories that have ultra-violet or infra-red instrumentation.

Pesticides in Clinical Practice, Royal L. Brown, Charles C. Thomas—Publishers, Springfield, Illinois (1966).

Agricultural chemicals are so widely used that the criminalist must have a working knowledge of these poisons.

HAIRS AND FIBERS

Guide to the Identification of Animal Fibers, H. M. Appleyard, Wool Industries Research Association, Leeds (1960).

Fiber Microscopy, A. N. J. Heyn, Interscience, New York (1954).

Manual of Man-Made Fibres, C. Z. Carroll-Porczynski, Astex, Guilford, England (1960).

Man-Made Fibres, R. W. Moncrief, Heywood & Co., London (1963).

These books are written for industrial workers but are valuable reference sources for the criminalist.

BLOOD AND BLOODSTAINS

An Introduction to Blood Group Serology, K. E. Boorman & B.E. Dodd, Churchill, London, (1960).

Blood Groups In Man, R.R. Race & R. Sanger, C.C. Thomas, Springfield, (1950).

Blood Grouping Techniques, F. Schiff & W.C. Boyd, Interscience, New York, (1942).

Medico-Legal Blood Group Determination, D. Harley, Grune & Stratton, New York (1945).

The Human Blood Groups, P.H. Andresen, C.C. Thomas--Publisher, Springfield, Illinois (1952).

Blood Groups and Transfusion, A.S. Wiener, Charles C. Thomas--Publishers, Springfield, Illinois (1945).

With the exception of Harley's small volume, there are no books on forensic blood testing. All of the listed volumes contain some information on the subject.

Techniques in Blood Grouping, Dunsford, I, and C.C. Bowley--2nd Ed. Charles C. Thomas--Publishers, Springfield (1967).

FINGERPRINTS

Fingerprint Mechanics, W.R. Scott, Charles C. Thomas, Springfield (1951).

This is the only fingerprint book dealing exclusively with technical methods of interest to the criminalist.

MISCELLANEOUS

Footwear Evidence, John Reginald Abbott, Charles C. Thomas—Publishers, Springfield Illinois (1964) $4.75.

Special treatise on footprints and shoe impressions.

Law, Medicine, Science and Justice, Larry Alan Bear and Brian Parker, Charles C. Thomas—Publishers, Springfield, Illinois (1964) $14.50.

Transcript of a symposium on Forensic medicine and criminalistics held in Puerto Rico and containing contributions by 20 experts.

The Scientific Investigator, Richard O. Arthur, Charles C. Thomas--Publishers, Springfield, Illinois (1965) $8.75.

General outline of criminalistic procedures written for the investigator. Most emphasis on lie detection.

Density and Refractive Index, Paul L. Kirk, Charles C. Thomas--Publishers (1951) $2.50.

An earlier work of Kirk describing the use of this analytical procedure. Most of the material is included in Kirk's Crime Investigation.

The Crime Laboratory: Organization and Operation. Paul L. Kirk and Lowell W. Bradford. Charles C. Thomas--Publisher, Springfield, Illinois (1965) $5.50.

Covers the business side of criminalistics. Mainly oriented towards the United States viewpoint.

Traffic Accident Investigator's Manual for Police, J. Stannard Baker Northwestern University Traffic Institute, Evanston (1963)

Written for the traffic investigator, the book contains much information of interest to the criminalist.

Highway Collision Analysis, J.C. Collins and J. L. Morris, Charles C. Thomas, Springfield (1967) $11.50.

Gives methods for determining the causes of traffic accidents.

Accidental or Incendiary? R.D. Fitch and E. A. Porter; Charles C. Thomas, Springfield (1968) $15.00.

Special methods of arson and fire investigation.

HOW AND WHERE TO BUY BOOKS AND JOURNALS

Many countries have restrictions on the exportation of their currency. Scientific and technical books can be purchased abroad by means of special coupons issued by the United Nations Educational Scientific, and Cultural Organization (UNESCO). Each country appoints a national body to distribute the coupons. They are sold in the local currency in amounts equal to $1, $3, $10, $30, $100, and $1000 and blanks which can be made out for odd amounts of from $0.01 to $0.99.

The buyer should write to the book agent in the foreign country and find out the exact cost of the books and postage. He then goes

to the official UNESCO distributing agency and purchases the necessary number of coupons with his own local currency.

Coupons can also be used to pay membership dues in scientific and technical societies if the cost of the membership also includes a subscription to the magazine published by the society.

Coupons can also be used to purchase photocopies, microfilms, charts, film strips, and magazine subscriptions.

Book agents who will accept UNESCO coupons are:

UNITED STATES

Acme Code Company
102 First Street
Hackensack, New Jersey
07601

UNITED KINGDOM

Dillons University Bookshop
1, Malet Street
London, W. C. 1, England

Microfilm copies of articles in scientific and technical journals can be purchased with UNESCO coupons from:

Photoduplication Service
The John Crerar Library
33 West 33rd Street
Chicago, Illinois 60616

By international agreement, books and other educational materials are not charged customs duty. Some countries do have small "handling" charges, however.

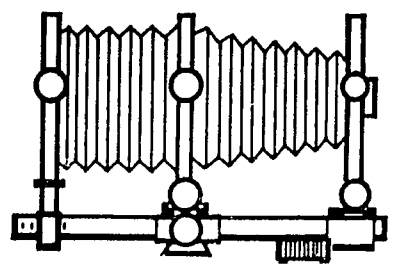
Appendix B

PHOTOGRAPHIC EQUIPMENT, TECHNIQUES AND PROCESSING

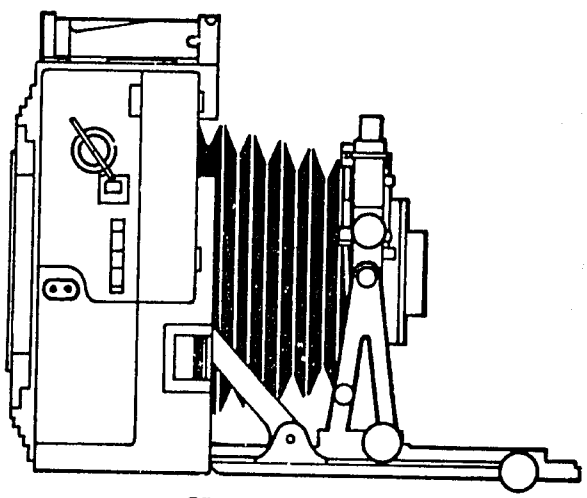
Beginners usually ask: "What is the best camera for police photography?" This is like asking what is the best automobile, or the best radio. There are different kinds of cameras and each kind has certain features that make it better for certain work. Good police photographs can be made with any kind of camera. There are five main kinds of cameras:

View Camera. This is a rather large camera that is mostly used in studios for portrait pictures. It is also used a great deal for advertising, architecture, and other commercial work. While it makes excellent large pictures that are very sharp, it is large and clumsy and hard to transport to the scene of a crime. The film is expensive and often hard to get.

Graphic Camera. The Graphic is a view camera, but it is smaller and is designed to be folded up when not in use. For many years, the 4 inch by 5 inch Speed Graphic Camera was the favorite camera of police and newspaper photographers. There are several principal advantages to the Graphic camera: (1) the image can be observed on a



VIEW CAMERA

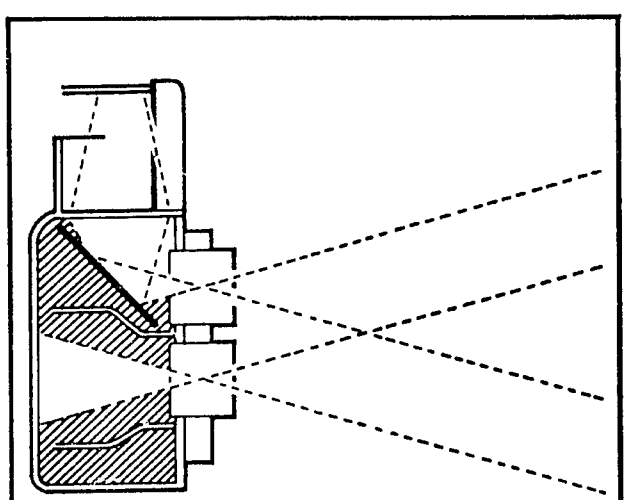


GRAPHIC CAMERA

ground glass before it is taken; (2) the negatives can be printed by the contact method; and (3) by means of special holders, only a single film has to be taken if that is all that is needed. There is no need to use up a whole role of film to take only one or two pictures. With this method, the photographer can take pictures with black and white, then with color, then with infra-red film one

The 4" x 5" film is expensive, so a smaller Graphic camera called a "Century Graphic" has been designed. This model uses 2-1/4" x 3-1/4" film. It also has a roll film attachment for common size 120 film. Ten pictures can be made on one of these rolls.

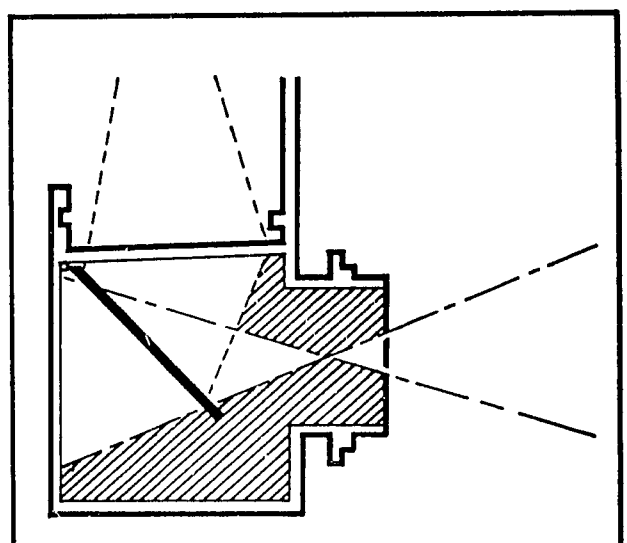
Twin Lens Reflex Camera. This camera is a roll-film camera that uses two lenses: a taking lens and a viewing lens. The photographer holds the camera at the level of his waist and looks down into a ground glass with a mirror in it. The most well-known twin lens reflex camera is the Rolleiflex. There is a less expensive model called a Rolleicard. A Japanese company makes a similar camera called a Yashikamat.



TWIN LENS REFLEX CAMERA

The twin lens reflex camera is very useful in police work, particularly in traffic accident photography. Both color and black and white film can be used. The only disadvantage is that the pictures are square and do not enlarge to a conventional size.

Single-Lens Reflex Camera. In this kind of camera, the photographer looks through the lens that actually takes the picture by means of a mirror. When he takes the picture, the mirror moves up out of the way just a fraction of a second before the shutter opens. Most single-lens reflex cameras are in the 35mm. size, but there are two larger ones, the Swedish Hasselblad and the Japanese Bronica. Both are 2-1/4 x 2-1/4. They are very expensive and their advantages do not justify their high cost for police work.



SINGLE LENS REFLEX CAMERA

Miniature 35mm. Cameras. The first 35mm. camera was the German Leica. It was designed to use motion picture film which was manufactured in great quantity for the cinema and was consequently very cheap. There are now hundreds of different brands of 35mm. cameras, and probably millions in use by all kinds of users all over the world. Every tourist has one. There are two principal kinds: the rangefinder (Leica and Contax) and the single-lens reflex. Most all miniature cameras use a moving curtain instead of a shutter to control the amount of light reaching the film. Because there is no need for a shutter in the lens, the user of a miniature camera can accumulate a large variety of lens and attachments. There are so many "gadgets" for 35mm. cameras that the manufacturers refer to their products as a system.

An important advantage of 35mm. cameras is their inexpensive operating cost. Each separate exposure costs only a penny or two. But it should be remembered that **all 35mm. pictures have to be enlarged.** The tourist usually shoots only color slides. His film comes back to him from the processor as small transparent pictures only one inch by one and a half inches in size. He projects these on a screen. In police work, we must have paper prints for the files, for the prosecutor, and for the Courts. Since the 1" x 1-1/2" negatives are too small for contact prints, the user has to have an enlarger that may cost as much as the camera itself.

While the 35mm. camera is capable of producing photographs as good as those taken with a larger camera, this does not mean that it always will produce them. The miniature takes more care and more painstaking in processing. This is the greatest disadvantage in its use in law enforcement photography.

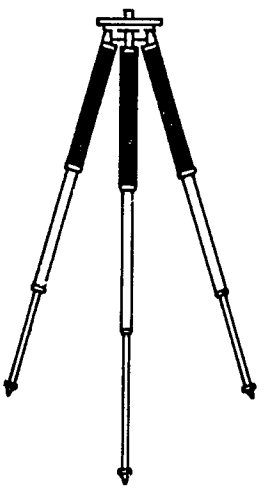
Ultra-miniature cameras. These are mentioned only to condemn them. The Minox was the first and became popular during World War II as a spy camera. It was designed to copy documents. It is as expensive as a good press camera and not nearly as useful.

ACCESSORY EQUIPMENT

The greatest advantage of crime scene photography is that the objects photographed **do not move.** The investigator can take his time, set his camera solidly, and use a long exposure if he has to. He can make three or four exposures of the same object at different lens settings. There is no excuse for not getting sharp and clear crime scene pictures. The most important accessories for the investigator-photographer are:

Tripod. This three-legged device is familiar to everyone who ever had his portrait taken in a studio. Modern tripods fold up and the legs collapse so they take up little space for transport. Only a solid, sturdy tripod should be purchased. The flimsy little ones are worse than no tripod at all.

Flashgun. Some extra light is always needed because many crime scenes are indoors in poorly-lighted rooms. Modern electronic flashguns are now so cheap that it is foolish to spend money for flashbulbs.



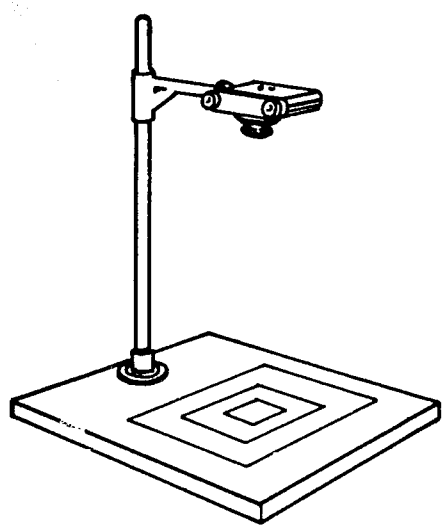
TRIPOD

Tape measure. Even with focusing devices, it is always best to measure the distances in photographs. The investigator will of course have such a tape in his investigative kit.

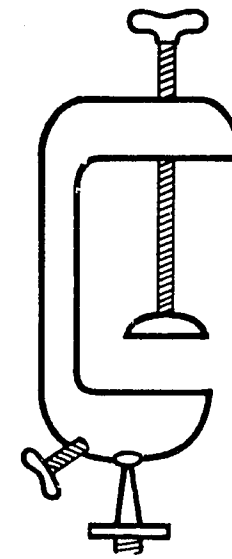
Level. The camera must be absolutely level when accurate photographs are made. A small and inexpensive level should be in the camera kit.

Notebook. The investigator must record all details used in taking every photograph—lens opening, shutter speed, type of film, etc.

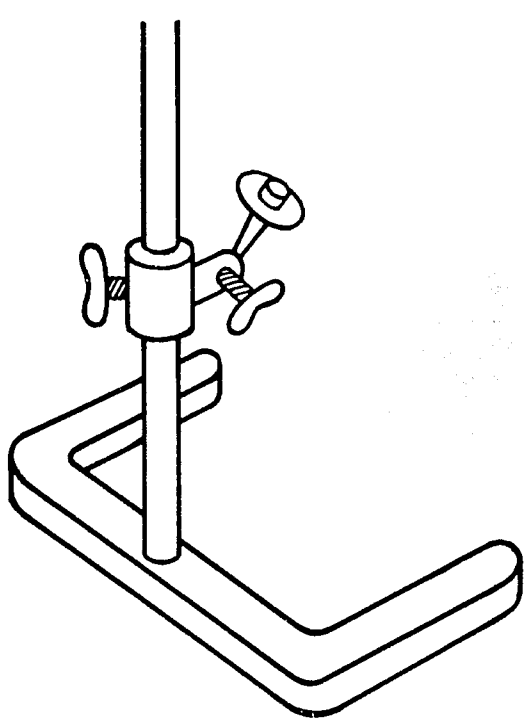
Supports. All evidence photography must be done while the camera is held firmly in place. This not only makes the camera steady but makes it possible to measure distances exactly. The commonest form of camera support is a three-legged tripod with a provision to screw the camera to the top. A tripod is not good for vertical pictures, however, and most objects photographed in the laboratory cannot be easily fastened to a wall.



SUPPORT



CLAMI SUPPORT



PORTABLE SUPPORT

The most convenient support is a **column stand.** This is a metal tube or rod fastened upright to a large wooden board. This arrangement is used to support photographic enlargers. Some makes of enlargers provide an adapter to exchange a camera for the enlarger. The support stands can also be purchased separately with correct screws and adjustments to accommodate the camera. It is sometimes necessary to put heavy sandbags around the edge of the baseboard to make it more steady.

A good camera support can be made locally by a plumber out of pieces of pipe. The base is in the form of a "U" which can go around the object to be photographed. There are some commercial stands of the "U" type that can be folded up for easy transportation or taken apart to store in a cupboard.

BLACK AND WHITE FILM

There are many different brands of film. There is little difference in quality between them. The investigator should find out which film is ordinarily stocked by dealers in his area, select one brand, and then stay with it. Since the investigator is going to use a tripod most of the time, he is better

off to use one of the slow speed films. Some of these are:

Manufacturer	Brand	ASA Speed	BSI Speed
Agfa	Isopan IFF	25	25°
Adox	KB-14	20	24°
Adox	KB-17	40	27°
Ferrania	P-3	40	27°
Ilford	Pan F	50	28°
Kodak	Panatomic X	40	27°
Perutz	Pergrano 19	20	24°

Sometimes these slow speed films are not always available everywhere. A good second choice are the medium speed films. These are sold for general amateur use. Some of these are:

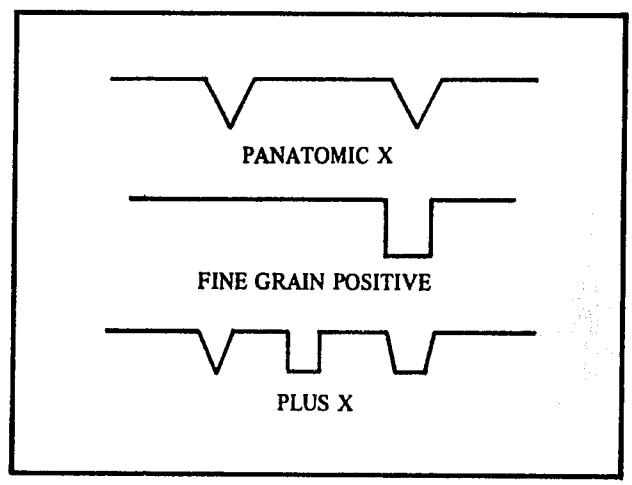
Manufacturer	Brand	ASA Speed	BSI Speed
Adox	KB-21	100	31°
Agfa	Isopan IF	100	31°
Ansco	Versapan	125	32°
Ferrania	Panchromatic S-2 or 32	100	31°
Gevaert	Gevapan 30	125	32°
Ilford	FP-3	125	32°
Kodak	Plus X	125	32°
Perutz	Peronmia 21	100	31°

In hot countries, the investigator should be careful about buying film that might have been kept too long on the shelf in the photo store. Heat spoils film. A good idea is to buy a bulk stock of film directly from the manufacturer, then store it under refrigeration. If this is done, however, the investigator must remember to take the film out of the refrigerator several hours before it is needed and let it warm up to room temperature. Otherwise, moisture will form on the film.

Film should always be developed in the developer recommended by the manufacturer. When he recommends that you develop Plus-X in Microdol for example, the manufacturer knows you cannot get better results or finer grain with anything else. Of course he wants you to buy his product, so he spends a lot of money working out the very best developer for his particular brand of film. Use it.

Special Films for Special Purposes

The slow or medium-speed films will handle 90% of the pictures needed in police photography. There are a few situations that need special films. This is why a Graphic camera is a useful police camera because it can take individual holders of sheet or "cut" film. This sheet film is purchased in packages of 25 sheets. Each sheet is measured carefully and has a special code marking on the upper right corner made w notches of a distinctive type. The purpose of these notches are to help the photographer load his holders right side up (emulsion side) in total darkness. The distinctive notches also tell the photographer which film he has. Some examples of common notches are:



Sheet film is sometimes hard to get in the small 2-1/4 x 3-1/4 sizes, but it is usually available in larger sizes for commercial work with large view cameras. Five inches by seven inches sheet film can be cut in quarters to form four 2-1/4 x 3-1/4 small sheets. The cutting is best done with a paper cutter mounted on a board because it has to be done in total darkness. It would be difficult to make an absolutely straight cut with scissors in the dark. The most useful special films are:

Contrast Process Panchromatic Film. This is a fine-grain film that gives a sharp difference between black and white. It is used in police work for copying documents and photographing fingerprints.

Contrast Process Ortho. This film is similar to the panchromatic film, but it is much slower and more sensitive to blue than to red light.

Infra-Red Film. This is a special film that is sensitized with colored dyes to make it record only invisible infra-red or heat waves. It is sensitive also to blue light, so special filters have to be put over the lens. Criminalists use it for special purposes in the laboratory. It is used by investigators to take secret pictures in the dark. A filter is put over the flashgun to conceal the visible light of the flash. The light is not completely invisible, however, but the only thing a subject could notice would be a dull, weak, red glow if he happened to be looking directly at the place where the flashgun was located.

Hidden cameras and infra-red flashguns can be set up to take a photograph of a thief. The camera and flashgun are hidden in a box with holes in it for the lens and flashgun. Some sort of trigger or trip wire is put in place. If the thief upsets the trigger, he takes a photograph of himself!

Very High Speed Film. Eastman Kodak has recently manufactured a superspeed film that is particularly valuable for law enforcement purposes. It is labelled only with the number #2475. It could be useful for taking secret pictures at night. It has an ASA speed of from 800 to 2,000.

EXPOSURE

There are usually three adjustments on a camera that have to be made by the photographer before he takes his picture. These are **distance, lens opening,** and **shutter speed.** Some small cameras do not have any adjustments or else only one or two. Many modern 35mm. cameras now have automatic electric eyes to set the lens opening. The adjustments for distance have been explained. Now we want to know how to set the shutter speed and lens opening to get a correct exposure.

Lens Opening. This is controlled by a diaphragm that opens and closes like the pupil of the eye. The investigator can see how this works by looking into the lens and moving the lens opening back and forth. The size of the opening is measured by a unit called "f". The letter "f" is an abbreviation for the word **factor.** It expresses a relation between size of the opening and the length of the lens. It is not necessary to understand all the optics of this except to know that f. numbers mean the same thing on all lenses.

The lens opening controls **how much** light enters the camera. The different f. numbers are set so that each one lets in **twice as much** or **half as much** light as the setting next to it. The actual numbers are square roots, and the sequence may be slightly different on different cameras. The following table shows the relationship if f/8 is taken as a reference:

f. number	f/4.5	f/6.3	f/8	f/11	f/16	f/22
Relation	¼	½	1	2	4	8

The settings for f. numbers are often called "f. stops". Instructions may say: "Open two stops" or "close one stop". This means to change the setting up or down the scale to the next **lower** number (open up) or change to a **higher** number (close down).

Shutter Speed controls **how long** the light falls on the film. The shutter is also regulated so that each speed is double or half of the next one. The relation is easier to understand with speeds. Different cameras may use a different series, but the relation is always the same. Some examples would be:

Leica	1 second, 1/2, 1/4, 1/8, 1/15 1/30, 1/60, 1/125, 1/250, 1/500
Graphic	1/10th, 1/25th, 1/50th, 1/100th, 1/200th.

The numbers are of course rounded off to the nearest even number.

The machinery in the shutter can only operate down to about one second in the Leica or 1/10 in the Graphic. Longer exposures need to be measured by the photographer. There are two adjustments on the camera to allow for this. "B" or **bulb** setting means that the shutter will open when the button is pressed and will stay open until the pressure on the button is released. This

is useful for short times such as one second to 10 seconds. "T" or **time** setting means that the shutter will open and stay open when the button is pressed and released. A second pressing of the button is needed to close the shutter. This is useful for very long times because the photographer does not have to keep a steady pressure on the button.

The "T" setting will be used most often for outdoor pictures at night. The investigator can open the lens and then go around setting off flashes to illuminate different parts of the crime or accident scene. The "T" setting is also used with the Graphic camera to hold the shutter open while the photographer looks through the ground glass.

Relation Between Lens Opening and Shutter Speed

Both the lens opening and the shutter speed are set so that each setting is twice or half the next. The exposure is equal to **amount X time.** Either the opening or the speed can be changed in one direction if the other is changed in the other direction. For example:

From the table for Verichrome Pan, we find that the film manufacturer suggests a combination of 1/50 second at f/11 for a street scene. Some other combinations that could be used to get the same exposure would be:

1/15 at f/22
1/25 at f/16
1/100 at f/8
1/200 at f/6.3

and all would let the same amount of light strike the film. But other things would change that would affect the picture. First, the **depth of field** if affected by the f. number as has been pointed out. The investigator prefers to use as small an f. number as possible to get the best depth of field. Next, the shutter speed is important if there is anything that might move in the picture. Identification pictures of people are an example of this. Another thing affecting the choice of speed is whether the camera is mounted on a tripod or held in the hand. Tripod shutter speeds can be most anything. Hand held shots have to be kept to at least 1/25th—if the photographer is a steady man—and are usually done at 1/100th to be sure the camera does not move very slightly while the shutter is open and make the picture blurred and not sharp.

The investigator will mainly use a tripod. He will usually select a lens opening that gives the greatest depth of field and adjust the time accordingly.

Determining the Correct Exposure

There are three ways of determining correct exposure: recorded data, trial and error, and by using an exposure meter. The investigator makes the most use of the first two ways because 90% of his pictures are taken with flash or floodlights. Exposures are calculated from recorded data.

Recorded data is nothing more than trial and error the first time with the results written down for future reference. The investigator does not start out completely ignorant. He has guides to exposure given him in the form of suggestions by the film manufacturers. Every film manufacturer puts an instruction leaflet in or on each package of film. Users often throw these little slips of paper away, but they should be saved and studied. The instruction sheets give recommended exposures for film under different lighting conditions. A table for Verichrome Pan or All-Weather Pan, for example, might look like this:

Conditions	Shutter Speed	Lens Opening
Water, beach or sea	1/50th	f/22
Landscapes, with some sky	1/50th	f/16
Close views, streets	1/50th	f/11
Cloudy day or scenes in the shade	1/50th	f/8

These tables are very good guides to exposure under average conditions. The investigator will learn by experience to judge exposure pretty accurately. Kodak has a simple cardboard calculator with a dial that is very helpful in making changes of expo-

sure under different conditions. These instructions are only **guides**, of course.

Correct exposure has to take into consideration the condition of the camera, the film, the developer used, the enlarger, and even the personal working habits of the man who makes the prints and enlargements. The investigator will start out with his guides and after he has studied the final prints, he will modify his exposures to suit his particular working conditions.

Trial and Error will still need to be done in special situations that do not fit existing data. Outdoor traffic pictures at night, or close ups are examples. Professional photographers, who know they will not get a second chance to take an important picture, use a trick called **bracketing.** After making a picture at the calculated exposure, the photographer takes another picture at **one stop larger,** and a third at **one stop smaller.** The investigator should use the bracketing method in any case where he is not sure about his exposure.

Exposure Meters are useful exposure aids. They come at all prices from US$10 to US$100. The simple ones made for amateur snapshooters are good enough for black and white use. A better meter would be needed for color because color photography needs much more exact exposure.

Photographers are apt to put too much trust in meters. The meter only measures the average of all the light reflected from the object photographed to the film in the camera. If there is a lot of very bright sky in a scene, the meter may cause the objects on the ground to photograph too dark. The investigator who uses a meter must be careful to point the meter at the most important object in his picture and take his reading from that. This may cause the sky to "wash out" completely, but this would not be important for police purposes. The investigator must be prepared to explain the **reason for this in court.** A clever defense lawyer might make quite an issue about this unimportant detail. He would hope to get the photograph rejected as evidence because the "exposure was not correct". The investigator will of course have kept careful records and will be prepared.

The best way to use a meter in police photography is with the help of a simple device called a Neutral Gray Test Card. This is sold by Kodak in an envelope containing two such cards. It costs about US$1. One side of the card is white and the other side is a dull gray color that reflects exactly 18% of the light that falls on it. The card is put against the most important object to be photographed and a careful reading taken of the Gray Card. This gives a good average exposure without the meter being affected by strong skies, deep shadows, or unimportant areas in the scene. If the light is very dim and the meter does not give any reading at all on the Gray Card, the card is turned over and a meter reading taken of the white card. The exposure from the White Card is multiplied by 5 to find the correct exposure.

Exact Way to Find the Correct Focusing Point

A rough way to find the focusing point was given in Chapter IV. This was to aim the camera at a place 1/3 of the way ahead of the near point. This way is good enough for distances over 10 feet (3 meters) but not accurate for close-range photographs. It is better to measure and calculate exactly.

First, the investigator measures the **nearest** distance he wants to be sharp, then the farthest distance. This can be done with the camera rangefinder, but it is more accurate to do it with a measuring tape. The end of the tape should be fastened to the tripod socket on the camera. Then calculate the focusing point:

$$\text{Focusing point} = \frac{\text{Near distance} \times \text{Far distance} \times 2}{\text{Near distance} + \text{Far distance}}$$

Finding the Correct Lens Opening to Use

Knowing the right focusing point does not tell what lens opening to use to get the most depth of field. Depth of field is not of much importance when pictures are taken outdoors in sunlight at a distance. This is because the lens opening is closed down to a very small size. It is the size of the lens opening that controls the depth of field.

Depth of field can be a problem when pictures are taken indoors in small rooms with poor light. The photographer must take special care to get as much depth of field as he can.

The investigator must know two additional things to calculate the right lens opening: the hyperfocal distance and the circle of confusion.

Hyperfocal Distance. For every different lens and lens opening, there is a point called the hyperfocal distance. This is a place where everything from half that distance to as far as the eye can see will be in clear focus. It is not too important for the investigator to understand the reason for this. He only needs to know how to calculate it.

$$\text{Hyperfocal Distance} = \frac{\text{Far distance} \times \text{Near distance} \times 2}{\text{Far Distance} - \text{Near Distance}}$$

Notice that this is almost the same formula as the one for finding the focusing point. The difference is, the near and far distances are subtracted instead of added.

Circle of Confusion. This is only a fancy name for **sharpness**. What it stands for is the amount of blurring or lack of sharpness that the human eye will notice in a photograph held at 10 inches (25 cm). This is the usual viewing distance. A dot in a picture really has some width. If this width is not any larger than 1/100 inch (0.25mm), the picture will look sharp. The lens can bring dots to a sharp point on the film only if it is focused at one certain distance. At any other distance, the dots will become small circles and look blurred or "confused". How well the lens can keep the dots from looking like circles is therefore called the circle of confusion. This is measured by dividing the length of the lens by 1,000.

$$\text{Circle of Confusion} = \frac{\text{Length of lens, in in. or mm.}}{1,000}$$

Now we have all the information needed to find the correct lens opening. The formula is:

$$\text{Correct lens opening} = \frac{\text{Focal length of lens, squared}}{\text{Circle of confusion} \times \text{hyperfocal distance}}$$

Remember, of course, that all measurements must be the same, either **inches** or **millimeters**. Remember also to change distances from feet to inches or from meters and centimeters to millimeters before calculating.

Example

We want to take a picture of an automobile skidmark. The near distance is 6 feet and the far distance is 22 feet. First, we find the right focusing point:

$$\frac{6 \times 22 \times 2}{6 + 22} = \frac{264}{28} = 9.4 \text{ or } 9 \text{ ft. } 6 \text{ in.}$$

Next, the hyperfocal distance is calculated:

$$\frac{22 \times 6 \times 2}{22 - 6} = \frac{264}{16} = 16.5 \text{ or } 16 \text{ ft. } 6 \text{ in.}$$

Now, the circle of confusion. We are using a Graphic camera with a 4 inch lens, so:

$$\frac{4}{1,000} = \frac{1}{250}$$

We can now find the correct lens opening to use:

$$\frac{4^2}{1/250 \times 199\ (16.6 \text{ feet} \times 12)} = \frac{16 \times 250}{199} =$$

$$\frac{4000}{199} = 20. \text{ or f22, the nearest setting}$$

Here is another example, worked out in the metric system:

We want to take a picture of the top of a table that has two bloodstains on it. One is 50 cm away and the other 78 cm.

$$\frac{50 \times 78 \times 2}{50 + 78} = \frac{7800}{128} = 61 \text{ cm, the focusing point}$$

$$\frac{78 \times 50 \times 2}{78 - 50} = \frac{7800}{28} = 278 \text{ cm,}$$ the hyperfocal distance

$$\frac{100 \text{ mm (4 in. lens)}}{1,000} = \frac{1}{10} = 0.1 \text{ mm,}$$ the circle of confusion

$$\frac{100^2}{0.1 \times 2780} = \frac{10,000}{278} = 36$$

The largest opening on our camera is f32, so we are not going to get both bloodstains sharp and clear even though we close the lens down to its smallest opening. The only solution in this case is to **move the camera farther away** in order to increase the depth of field. An example will make this clear:

The camera is moved back an extra 25 cm. Circle of confusion remains the same.

$$\frac{75 \times 103 \times 2}{75 + 102} = \frac{15450}{178} = 86 \text{ cm,}$$ the focusing point.

$$\frac{103 \times 75 \times 2}{103 - 75} = \frac{15450}{28} = 551 \text{ cm,}$$ the hyperfocal distance

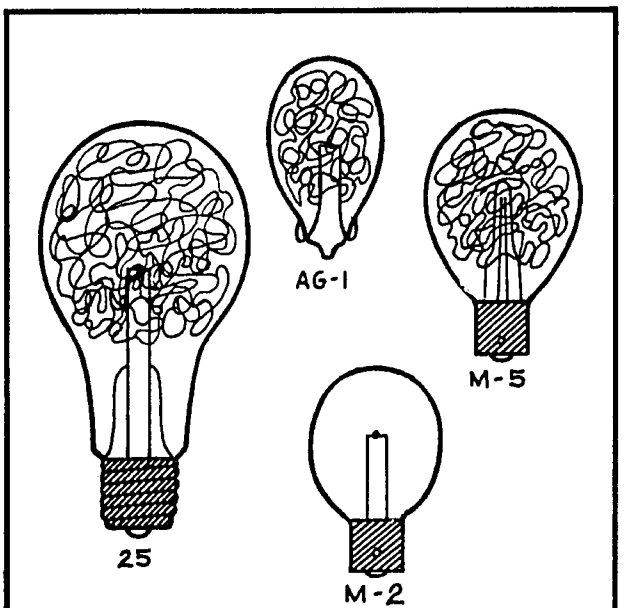
$$\frac{100^2}{0.1 \times 5500 \text{ mm}} = \frac{10,000}{550} = 18,$$ or halfway between f16 and f22

It can be seen that taking a little time and trouble to do some simple arithmetic may make the difference between a good, sharp picture and an unsatisfactory blurred one.

PHOTOGRAPHIC LIGHTING

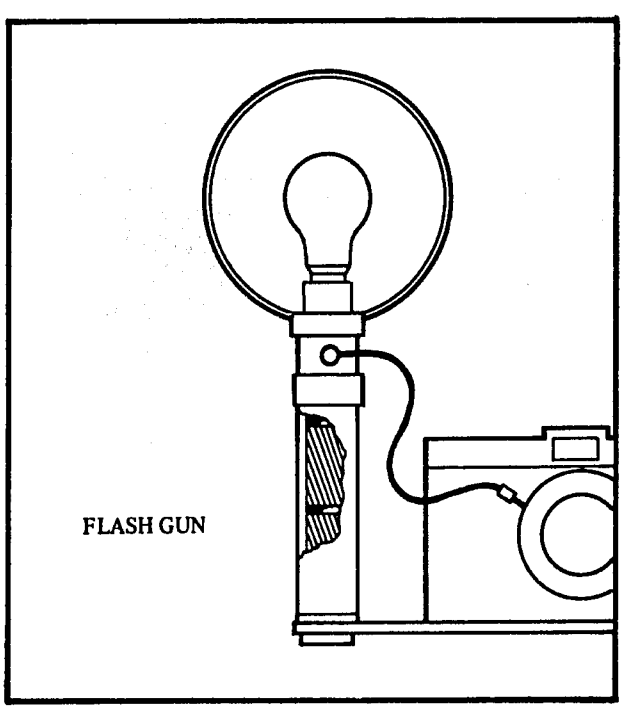
The investigator cannot choose the time, place, or level of light in which to take his picture, so he has to carry enough light along with him for any situation. Floodlights can be used at Headquarters, but many crime scenes have no electricity. The best source of portable light is flash illumination. There are two kinds of flash:

Flash Bulbs are artificial light sources that make light by burning certain metals in an atmosphere of oxygen. The burning takes place in a glass bulb that looks like a light bulb. The flash bulb is ignited electrically and can be used only once. There are many sizes or **classes** of flash bulbs depending on the amount of light given off and the length of time or duration of the light.



TYPES OF FLASH BULBS

Flash bulbs require some sort of holder commonly called a **flashgun.** These are sometimes a permanent part of certain small cameras, but are usually separate devices that are fastened to the camera



when needed. The **flashgun** consists of a case for the flashlight batteries, a socket for the flash bulb, a reflector to direct the light in a certain direction, and an electrical cord to connect the flashgun to the camera.

The output of a flash bulb is measured in **lumen seconds.** This measurement is not important to understand, but the number values are useful for comparing one flash bulb with another. The common sizes are:

Clear Flash Bulbs

Size	Output	Size	Output
AG-1	7,000	5	20,000
M2	7,200	11	33,000
M3	16,000	22	70,000
M5	16,000	50	5,000,000

Blue Flash Bulbs

Size	Output	Size	Output
AG-1-B	5,500	5B	9,400
M2B	4,200	22B	32,000
M3B	8,500	50B	2,300,000
M5B			

The bulbs that have the letter B at the end are colored blue. They are designed for color film and have a built-in filter. The blue color reduces the amount of light given off as compared with the clear-numbered bulbs. Blue bulbs can be used for black and white photography as well as color. If the investigator plans to take both color and black and white, the #5-B bulbs are the best choice.

The AG and M bulbs are used in popular amateur cameras. They have special pin-type bases that require the correct socket for each. No. 5 is the most popular police flashbulb. It has a bayonet base similar to the bulbs in automobiles. Quite a number of these #5 bulbs can be carried conveniently in a camera case.

Bulbs #11, #22, and #50 are large bulbs about as big as ordinary household lamps. They need a special socket similar to a household lamp. These large bulbs are useful for outdoor pictures of traffic accidents at night. Since they need a separate flashgun, it is best to buy an inexpensive unsynchronized flashgun consisting of only a battery holder and a reflector. They can be operated by the open flash method.

Electronic Flash is a method of making light by passing an electrical current through a glass bulb containing a gas. Electronic flashguns produce a light of much shorter duration than flashbulbs. The electricity can come either from the electric wiring or from batteries.

The amount of electric voltage required to light or **discharge** an electronic flashgun is too high to come directly from either house current or batteries. The electronic flashgun therefore has a device for storing up a large amount of electricity. This is called a **capacitor.** Electric current from the line or the battery runs in to this storage device until it is full. When the camera shutter is operated, the entire electric content of the capacitor flows through the gas tube all at once. The situation would be similar to slowly filling a large bucket with water, then dumping out the water suddenly all at one time. Each time the electronic flashgun is fired, the photographer has to wait about 20 seconds for the capacitor to fill up again before he can take another flash picture.

Flash Synchronization

It is important that the flash happen at exactly the same moment in time that the camera lens is open. This is called **synchronization.** Most cameras have adjustments on them to change the synchronization for either flash bulbs or electronic flash. This adjustment is necessary because flash bulbs operate at from 1/20 to 1/200 seconds while electronic flash operates at from 1/300 to 1/3,000 seconds. There are two main types of synchronization:

X Synchronization fires the flash at the instant the shutter is fully open. This is the correct setting for electronic flash and for F, M, and S flashbulbs if the shutter speed is no more than 1/25 or 1/30 second.

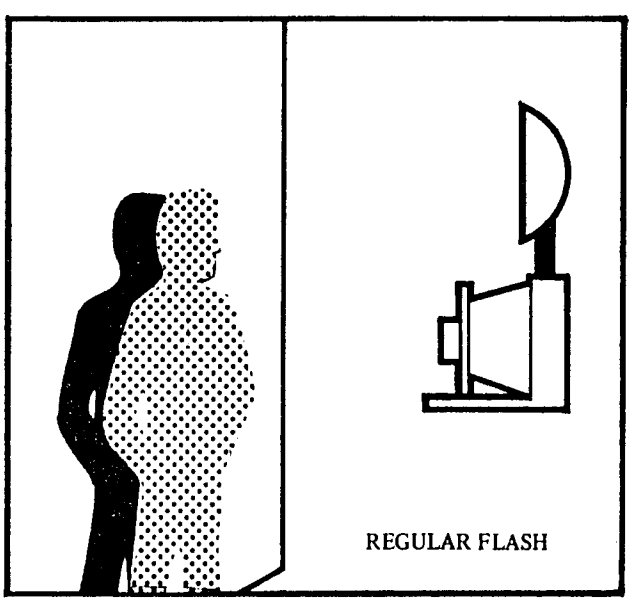
M Synchronization fires the flashbulb about 1/10th second before the camera shutter is fully open. It is used for Class M, #5, #11, and #50 flashbulbs.

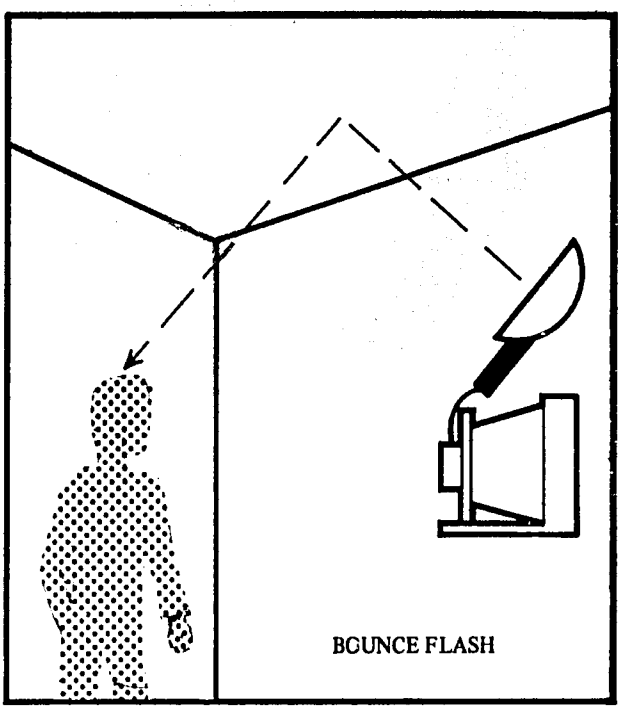
Open Flash

Flash illumination can be used without synchronization if the camera is mounted firmly on a tripod. All flashguns have a separate release button on them that will fire the gun without connection to a camera.

The camera lens opening is set to "Bulb" or "B" on the dial. With this setting, the shutter will stay open as long as the button is present. It will close when the button is released. The shutter is opened with one hand, the flashgun fired with the other hand, and the shutter is closed by releasing the button.

The open flash method is very useful in police photography because it is often necessary to take pictures of large areas or outdoor areas at night. In these situations, one flash per picture is not enough. A series of multiple exposures with multiple flash can cover a large area. This is best done with a helper. The photographer stands by his camera and opens and closes the lens while his assistants walk around the crime scene firing the flashgun from different locations. The method is particularly useful in photographing skid marks on a highway at night.





Illumination with Flash

The output of a flash is always the same. The amount of light needed is controlled by either changing the distance between the flashgun and the object photographed, or by opening and closing the lens. The manufacturers of flash bulbs and electronic flash always provide for adjusting the light. This is called a **guide number.** It is a product of **distance x lens opening.** If one of these is known, the other can be worked out by simple division. For example: the camera-to-subject distance is 10 feet. The Guide Number is 64. What lens opening should be used?

$$\frac{64}{10} = 6.4, \text{ or f6.3, the closest number}$$

Sometimes the lens has to be set at a certain opening to get the best Depth of Field. Suppose this opening is f.6.3. At what distance from the object should the flashgun be placed?

$$\frac{64}{63} = 10 \text{ feet, the closest number}$$

Using Flash in Close-Up Photography

Using Flash in Close-up Photography

Flash guide numbers work all right up to a certain limit. This is determined by the **smallest lens** opening divided into the guide number. If the guide number is 66 and the smallest lens opening is f. 22, the closest flash distance is 3 feet. There are two ways of using the flash at a closer distance:

1. **Take the flashgun off the camera.** The guide number is always determined by the distance from the flashgun to the point of focus, not by the camera distance.

2. **Reduce the intensity of the flash.** This can be done with an ordinary pocket handkerchief. One layer of white cotton handkerchief will reduce the intensity of the flash by 1/2. A second layer will reduce this new intensity by 1/2 again. The photographer must remember, however, that reducing the flash intensity by 1/2 only cuts the distance by 1/3. For example, if the closest distance for the flashgun is 3 feet, one layer of handkerchief will reduce the distance to 2 feet, and a second layer will reduce the distance to 16 inches.

IDENTIFICATION PHOTOGRAPHS OF PERSONS

The most frequent use of photography in law enforcement is the making of personal photographs or what are commonly called "mug" shots. This type of picture is similar to but not identical with the portrait photography practiced in commercial studios. The investigator should always keep in mind that a commercial photographer wants to please his customers and make his photographs look good. The investigator, on the other hand, wants an exact likeness with every mark, scar, blemish, or imperfection showing. If these differences are understood, the methods of personal identification photography are the same as portrait photography.

An important point in black and white identification photography are the **correct** skin tones. Careless printing of the negative can make a person darker or lighter and confuse identification by witnesses. Photographs of known robbers, bag snatchers, or hired killers are customarily assembled in books so victims of such crimes can inspect them for the purpose of making an identification. It is a common experience for a victim to point to a picture and say: "This looks like the man, but the one who robbed me was lighter (or darker) skinned."

For this reason, many police departments are now using color pictures for identification photographs. Color films has to be correctly processed or the colors will be noticeably incorrect.

Studio

All mug shots should be taken in the same place with the same lighting and the same film. This produces uniformity of all police photographs and makes comparison easier. A section of the Records and Identification Division should be set aside for the express purpose of taking identification photos. This should **not** be in a jail since many innocent people have to be photographed for passports and employment clearances.

It is of course possible to set up the studio near a window and use outdoor daylight for lighting, but this defeats the objective of uniformity in identification photography. Flood lamps are the best lighting method for this purpose. The lamps on their stands can be permanently put in place in a correct, standardized arrangement. At least two flood lamps are required, plus a standard lamp to put a little light on the background.

The background or area behind the person photographed is important. There must be nothing in it to distract the eye of the viewer or call attention to it. It should, therefore, be neutral in color and medium in shade and hue. Gray is a good choice for a number of reasons, mainly on account of color photography.

A lot of the light that falls on objects photographed is reflected light from the walls, floor, and ceiling. If the walls are painted green, for example, green light will be reflected to the face of the person photographed. The human eye is like a camera, but with the difference that the brain takes the images and rearranges them in terms of what its experience tells it the images ought

to be. If green light falls on a person's face, the brain of the viewer rejects this and filters it out. But color film cannot make a choice. It records what is there, and if green light is reflected from green painted walls, the person photographed will have a green tinted face in a color photograph. Therefore, all walls and ceilings and the background in a portrait studio should be some shade of gray in case color photography needs to be done.

The subject should be positioned on a stool at least three feet or one meter in front of the background. If he is any closer, his head may cause distracting shadows from the flood lamps on the background. Some will form, however, and this is the reason for putting a weak light on the background itself—to remove shadows.

Positioning the Subject

Traditionally, police mug shots are taken as a pair—one straight on front and one of the side. Such a pair of photographs is not always the best kind for good identification because we seldom look at a person squarely in the eyes.

A police department must make a decision when an Identification Photography Division is set up as to whether it is going to take one or two mug shots. If the decision is to make a pair, then the following position is used:

Front and Side. The subject is seated on a stool and his shoulders are adjusted so that they are at right angles to the camera. Looking through the camera finder or ground glass, the photographer moves the camera up or down by means of the elevator on his tripod until the center of the lens is at the same level as the subject's eyes. Still looking through the finder, the subject is asked to move his head left or right as needed to make both ears clearly visible.

After this view is taken, the subject now turns on the stool until either his left or right profile is at right angles to the camera. The shoulders are checked again to be sure they are parallel to the camera this time. No adjustment of the camera height should be necessary. The second view is now taken.

Older techniques took both front and side views on a single 4" x 5" Graphic camera negative. This was done with a special kind of cut film holder called a "split back". The film holder slide was replaced with a divided slide that covered one half the slide at a time. It was inserted first one way for the front view, then withdrawn and reversed for the second side view.

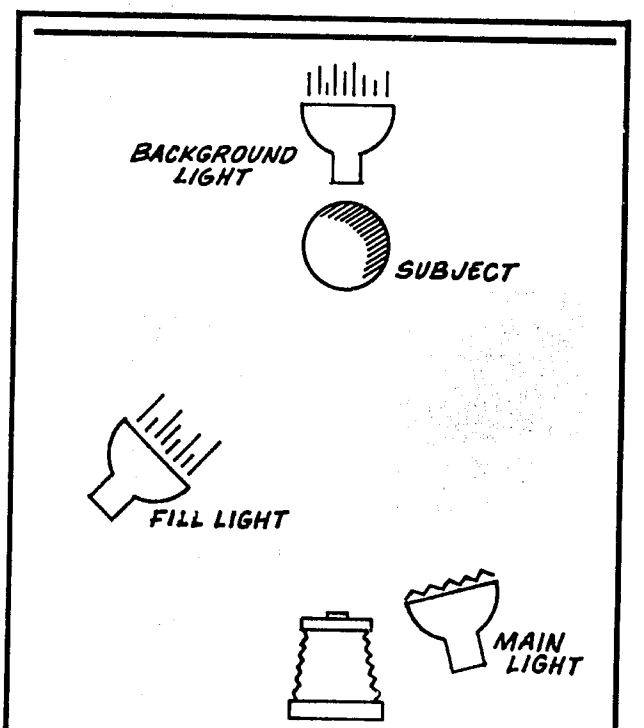
With modern roll film cameras, two separate negatives must be taken. The RH/10 roll film holder for Graphic cameras makes 10 exposures each 2-1/4" x 2-3/4" (5.7 x 7.0 cm) which provides five sets of mug shots that can be contact printed in pairs to make a mug shot 2-1/4" x 5".

Single View. This picture is best for passport, employment clearance, identity card and other non-criminal purposes. It can also be quite satisfactory for criminal record purposes. It has the additional advantage of cutting costs in half. Only the straight front view is taken.

Lighting Arrangement for Portraits

Two lights are fundamental for personal identification photographs: the main light and the fill light. The main light is placed to the right of the camera at a 45° angle between the camera and the subject, and raised so that it points down on the subject at a 45° angle.

The main light of course produces shadows around the nose and the eye sockets, so a second fill light is positioned to produce just enough light to "kill" these shadows. It should not compete with the main lamp but only supplement it. Since both lamps are usually photofloods of equal size, the intensity of the fill light is reduced by positioning it farther away from the subject. It can also be made smoother by using it as a bounce light. In this method, the light is pointed against the wall, and all illumination comes by reflection. In general, the fill light is on the opposite side from the main light, and either on the camera tripod itself, or at a 90° angle.



PLACING LIGHTS FOR MUG SHOTS

The background light does not have to be a photoflood lamp, but it should be in a photoflood reflector. A 150 or 200 watt household light is satisfactory. It can be put at floor level behind the subject, but in such a position that it cannot shine into the camera lens.

CLOSE-UP PHOTOGRAPHS

Ordinary cameras are built to take pictures from as far as the eye can see down to a distance of 2-1/2 feet (about 1 meter). Special equipment is needed to work closer than this.

Close-Ups. These pictures range from 2-1/2 feet down to a point where the image on the negative is the same size as the object photographed.

Macrophotography. These are pictures from same size down to the limits of the camera and its special equipment. This limit is usually about 10 times the size of the object photographed.

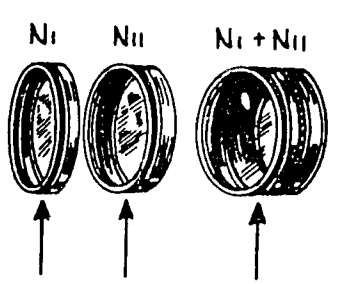
Photomicography. This is taking pictures through a microscope. It is only of concern to the criminalist in the laboratory.

The investigator can make acceptable close-ups at the crime scene of fingerprints and toolmarks. Any pictures larger than same size should be done by specialists in the laboratory.

Special Equipment for Close-Up Photography

The Graphic camera needs no special equipment to make 1:1 (same size) pictures. It is only necessary to pull out the folding bellows to its maximum range. Other cameras will need:

Supplementary Lens. This is the simplest and least expensive way to make close-ups. These lenses are commonly called Close-Up, Proxar or Portra Lenses. They are measured by an optician's unit called a **dioptar** and are labelled +1, +2, +3, etc.

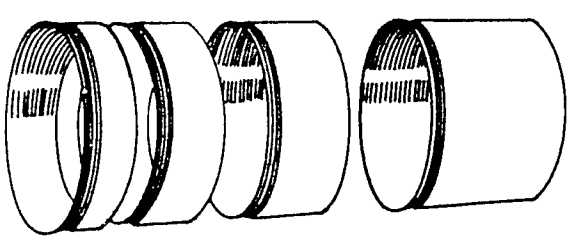


SUPPLEMENTARY LENSES

A +1 will reduce the working distance from three feet down to 20-40 inches. A 2-1/4" x 2-1/4" twin lens reflex camera with a +3 closeup attachment can focus down to around 10 inches. The lenses are clamped on or screwed in on top of the regular camera lens.

Extension Tubes. Thirty-five millimeter miniature cameras can use plastic tubes that are inserted between the camera body and the lens. These tubes work best on single lens reflex camera where the focus can be checked through the actual lens.

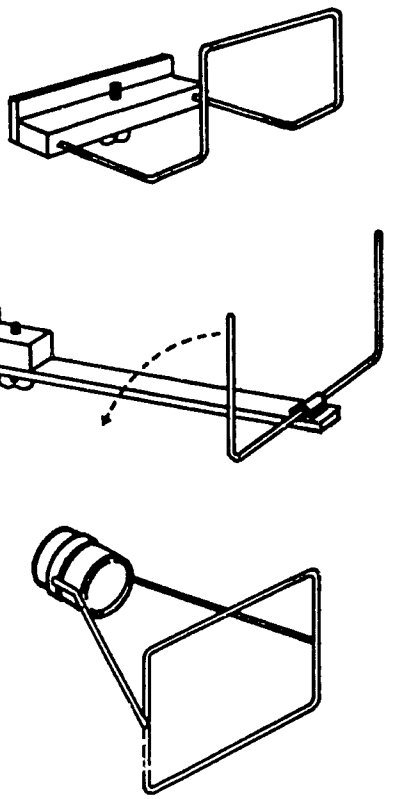
Bellows. Supplementary bellows are available for all kinds of reflex and miniature cameras. These are better than tubes because they can be adjusted to different measurements.



EXTENSION TUBES

Focusing for Close-Ups

Focusing must be very exact as the camera gets closer to the object photographed because the depth of field becomes very shallow. It may be only a few millimeters (1/8" x 1/4"). The camera is easily focused through the ground glass of a Graphic camera or through the lens of a single-lens reflex. Other cameras present difficulties. The exact distance must be measured very carefully. A good way to avoid having to make these critical measurements is to use a framing device. This is nothing more than a board or wire frame. It is attached to the camera and bent or shaped until when it is pressed firmly against the object, the camera is at the right distance. The frame shows exactly how much space will be included in the picture.



TYPES OF FIELD FRAMES FOR CLOSE-UP PHOTOGRAPHY

Parallax

Many cameras have a viewing device that does not work through the lens. This viewer may be positioned as much as three inches away from the lens. The viewer is adjusted to show the correct area at normal picture taking distances. It will show the wrong view when close-up pictures are made. A framing device will take care of parallax, but otherwise, the investigator will have to learn by experiment just how much to tilt the camera up or down to correct for parallax. Exact correction by tilting is practically impossible at very close distances. As a general rule with Portra lens:

Tilt up 1/8" in the view finder for a +1 attachment.

Tilt up 1/6 of the whole picture for a +2 attachment.

Tilt up 1/4 of the whole picture for a +3 attachment.

Exposure Increase for Close-Up Photography

The amount of light entering the camera through the lens opening depends on the distance between the lens opening and the film. If supplementary (Portra) lenses are used, there is no change in this distance and no changes are needed in the exposure. If the bellows of the Graphic camera is pulled out, or extension tubes are used on a 35mm. camera, the exposure must be increased. No change is needed if the relation between the size of the object and its size on the film is larger than 14 to 1, or a scale of reproduction of 1:14. Below this, the amount of exposure must be increased.

The easiest way to calculate the exposure increase is to measure the size of the image on the ground glass or in the view finder of the camera. If the object photographed measures 3-1/4 inches in a camera that uses 2-1/4 x 3-1/4 inch film, then the image is the same size and will need a 4 x 5 increase in exposure. An image 35mm. wide would be same size on a 35mm. camera. The only term that is helpful to know is called the **scale of reproduction.** This means the relation between the actual size of the object photographed compared to its size on the film. Same size would be 1:1, 1:2 would be one-half size, etc.

Put a small ruler, preferably one divided in millimeters, in the photograph after it is focused. Arrange it so that the "O" mark is lined up with the left hand edge on the ground glass screen or in the reflex view finder. Read off the widest distance on the right hand edge. If we know the actual width of the viewer, it is only necessary to divide this by the field of view.

Invisible Light Photography

Photography by ultra-violet or infra-red light is very useful in the police laboratory. Any good camera can be used with certain special filters over the lenses to keep out unwanted light rays. Ordinary film with special lights is used for ultra-violet. Special film with ordinary lights is used for infra-red.

If the Width on the ground glass is	The Scale of Reproduction is	The Exposure Must be Increased by
112 cm	1:14	1.1X
104 cm	1:13	1.2X
96 cm	1:12	1.2X
88 cm	1:11	1.2X
80 cm	1:10	1.2X
72 cm	1:9	1.2X
64 cm	1:8	1.3X
56 cm	1:7	1.3X
48 cm	1:6	1.4X
40 cm	1:5	1.4X
32 cm	1:4	1.6X
24 cm	1:3	1.8X
16 cm	1:2	2.3X
12 cm	1:15	2.8X
10 cm	1:1.33	3.1X
8 cm	1:1	4X

EXPOSURE INCREASE FOR 35MM CAMERAS

If the Width in the Viewfinder is	The Scale of Reproduction is	The Exposure Must Be Increased by
50 cm	1:14	1.1X
47 cm	1:13	1.2X
43 cm	1:12	1.2X
40 cm	1:11	1.2X
36 cm	1:10	1.2X
32 cm	1:9	1.2X
29 cm	1:8	1.3X
25 cm	1:7	1.3X
22 cm	1:6	1.4X
18 cm	1:5	1.4X
14 cm	1:4	1.6X
11 cm	1:3	1.8X
7.2 cm	1:2	2.3X
5.4 cm	1:1.5	2.8X
4.8 cm	1:1.33	3.1X
3.6 cm	1:1	4X

Uses

Infra-red photography is useful for examining documents that are suspected of having been altered; reading charred papers; detecting differences-between different inks and papers; detecting stains in cloth, particularly gunpowder residues that are hidden by bloodstains; studying fingerprints; and taking photographs in the dark.

Ultra-violet photography is also useful for detecting forgeries and erasures on documents as well as examining fingerprints against colored backgrounds; detecting invisible inks; and for locating seminal and urine stains on clothing.

Special Filters

Certain filters are necessary for both types of invisible light photography to remove unwanted light rays. At least three are essential: Wratten 2A for ultra-violet, and Wratten 25(A) and 87 for infra-red. The filters can be purchased as gelatin squares which are not too costly, but it is better to buy them cemented in glass to fit standard lens attachments.

For ultra-violet photography outside of the darkroom, a Wratten 18A Pure Glass filter can be used. It comes only as a solid glass square, 5 cm x 5 cm and needs a special holder to fit it to the camera lens. It is expensive but is helpful because no special filters are needed over the lights.

Special Lights

Two kinds of ultra-violet lamps can be used for photography. Short-wave lamps produce light at 253.7 mu. This light will not pass through the camera lens because ordinary glass stops rays shorter than 350 mu. However, the visible flourescent effect produced by short-wave lamps can be photographed.

Long-wave lamps produce light at 366.6 mu and can be used for both flourescent and reflected ultra-violet photography.

Ordinary photoflood lamps are the most convenient source of infra-red light. For infra-red luminescence, a microscope lamp or 35mm. slide projector having a projection lamp can be used with a glass bottle filled with chemicals as a lamp filter.

Special Film

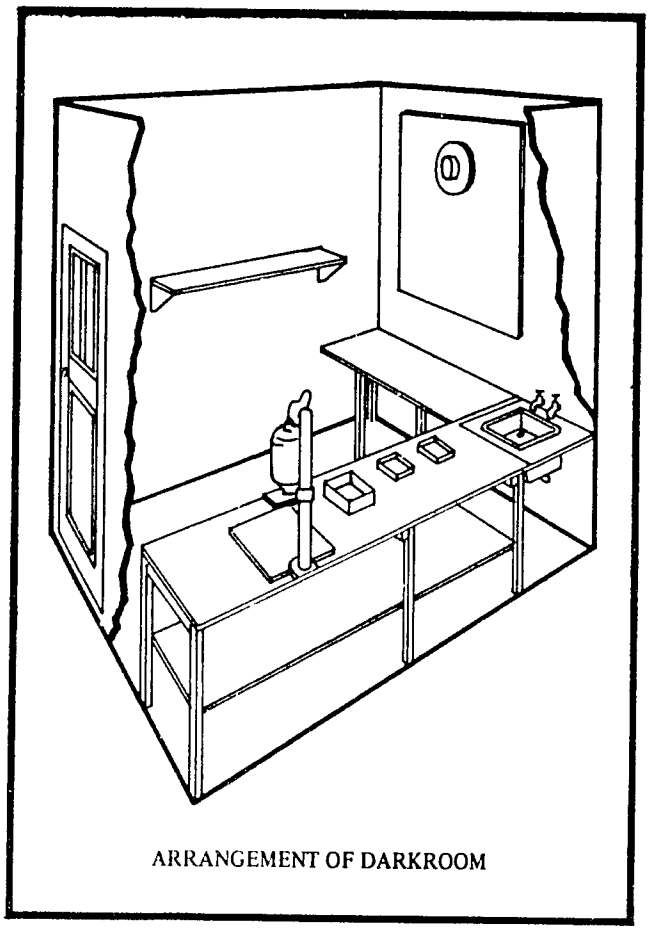
The most convenient film for infra-red work in the police laboratory is 35mm. film in 20 exposure cassettes. Both regular and high-speed infra-red film can be purchased as 50 foot and 100 foot rolls in bulk for repackaging in the darkroom. It is better to use the 20 exposure rolls because these come in a special cassette which will give protection against unwanted infra-red rays. Infra-red rays are heat waves and can penetrate through ordinary materials. All film should be stored in a cold place except while being used.

DEVELOPING AND PRINTING THE PHOTOGRAPHS

The investigator should process his own pictures if possible. This makes it easier to introduce them into evidence. This may not be possible in a busy police department. In this case, a photo lab technician may do the work. The investigator should be sure to initial and identify his negatives after they are dry. It can be embarrassing on the witness stand if nobody can remember who actually took the photographs.

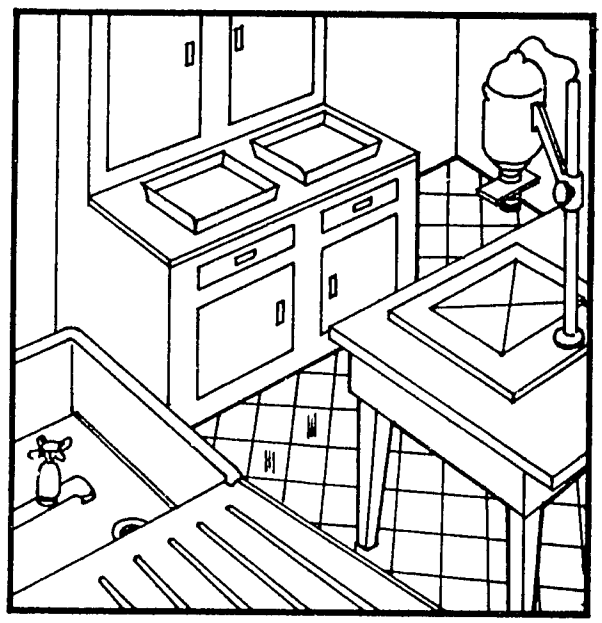
The Darkroom

The most important thing needed to process pictures is a darkroom. This means what it says—the room must be dark. It is very difficult to get a room completely light tight. Many people solve this problem by working only at night. Enlarging and printing can be done in dim light, but developing of negatives requires complete blackness. One solution to darkness problem is to use a **changing bag** to load film into a "daylight" tank. The changing bag is a rubberized cloth bag with elastic sleeve holes in it. The photographer puts his equipment inside, zips the bag closed, then works inside through the elastic sleeves to load his film holders or his developing tank.



ARRANGEMENT OF DARKROOM

Pictures can be developed in a bathroom, a kitchen, or even a small closet. The problem with any darkroom is ventilation. When the room is closed to make it dark, it can become unbearable for the photo technician. A suitable exhaust fan or air conditioner must be provided.



DARKROOM IN BATHROOM

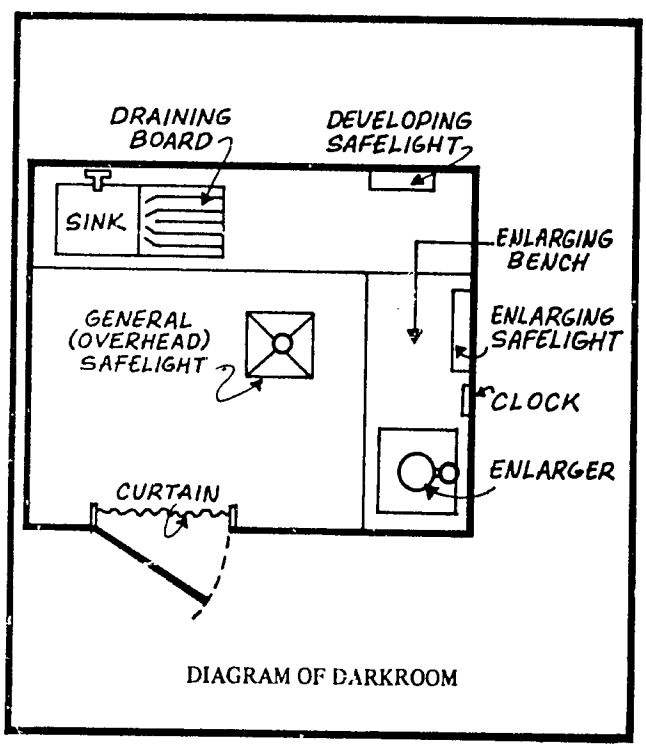
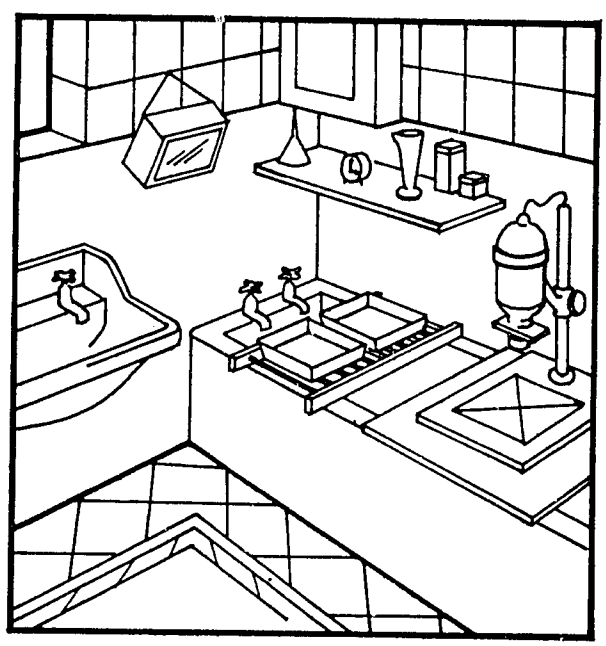
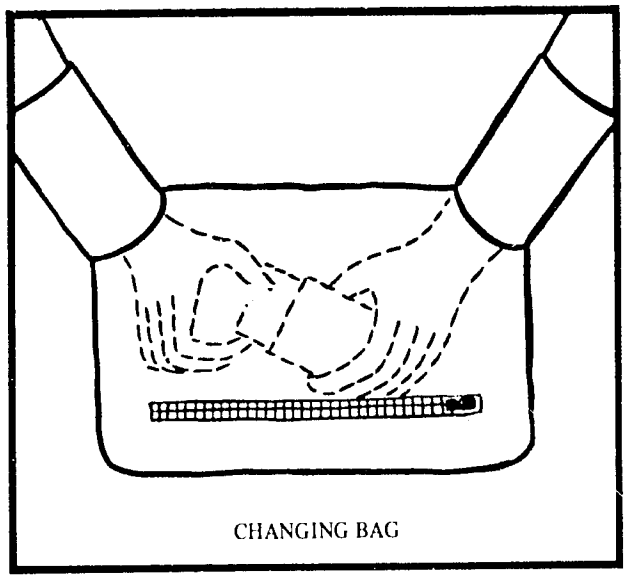


DIAGRAM OF DARKROOM

DARKROOM IN KITCHEN





CHANGING BAG

Things Needed for the Darkroom

1. **A table or bench** large enough for an enlarger and four trays.
2. **Plastic bucket** for mixing chemicals.
3. **Photographic thermometer**
4. **Developing tank** There are a number of models. Some are of stainless steel and use a wire reel for holding the film (Nikkor or Kindermann). The one pint (500 cc) size will hold:

   a. Two 35mm. rolls, or
   b. One 120 roll, or
   c. Adapter for 2-1/4 x 3-1/4 cut film.

The other kinds are of plastic and use a strip of clear plastic. The film is rolled up with the plastic strip which has a small nipple on it to keep the film from touching the plastic. A number of different-sized aprons can be obtained. This tank is not suitable for cut film.

5. **Plastic bottles.** These can be purchased in any store. The kind used for storing fruit juices are satisfactory. They must have tight fitting screw caps to keep out air. At least six are needed. The size depends on the package size of the photo chemicals. Developers are usually supplied in quart (1,000 cc) or gallon (4,000 cc) size. Fixing solution (hypo) is most economical in the gallon size since it keeps well. The package size of developer depends upon the number of films or prints processed each month. Developer does not keep more than a month or two. The gallon package can be wasteful if little processing is done.

6. Large plastic funnel.

7. **Safelight for printing and enlarging.** Films must be developed in total darkness, but paper is processed in a dim red, orange, or green light. The color of the safelight depends on the type of paper used. The lights are sold without filters. The colors of the filters for black and white are:

Filter	Color	Use For
Kodak OA	Greenish yellow	Contact papers
Kodak OC	Light amber	Contact and enlarging papers
Kodak 10	Dark amber	Kodak Panalure panchromatic paper
Ilford 910	Orange	Contact and enlarging papers
Ilford 902	Light brown	Ilford Multigrade panchromatic paper
Dupont 5-55-X	Orange brown	Varigam variable contrast paper

8. **Clock or interval timer.** This must have a large dial with a sweep second hand that can be seen in dim light, because the enlarging times run from 10 to 40 seconds.

9. **Developing trays.** At least four are needed. These should be larger than the largest print that will be made. Eleven inches by 14 inches will handle 8 inch by 10 inch prints. These large trays need a large amount of liquid to fill them. It is a good idea to have a set of smaller 5 inch by 7 inch trays to handle contact prints.

10. **Contact printer.** This can be a simple device like a picture frame, or else a more elaborate box containing a safelight and a switch that turns on the printing light when the cover is pressed down.

11. **Measuring graduates.** The glass pyrex kind are more accurate than the plastic

ones. One 2 quart and one 8 ounce size are needed.

12. **Film clips or plastic clothespins** These are used to hang up film and paper to dry. About a dozen should be strung on a wire and the wire then stretched and mounted high in a dust-free place in the darkroom.

13. **Photographic enlarger.** This should be the best that the police department can afford. It should have negative carriers for all size films used and it should be a **condenser** type.

14. **Miscellaneous supplies** will include towels, print tongs, envelopes for filing negatives, a plastic dishpan for washing prints, etc.

15. **Water for washing.** Water is needed during all stages of the photographic process. Running water is advisable, but in many parts of the world, it is hard to be sure of a steady supply all year round. It is a good idea to have a large plastic container holding about 20 liters of water always in the darkroom in case of emergency. Most instructions call for washing films and prints for from 20 minutes to one hour in running water. This is impractical in many countries. It is just as efficient to rinse films and prints in a number of changes of water. With a simple solution called "Hypo Eliminator", this method will do as good or better a job of washing as running water.

Prints and film can be washed well with ocean water. The only thing then that has to be done is to soak them for five minutes two times with fresh water to get the salt out afterwards.

16. **Water for making developing solutions.** Photographic chemicals have to be made up in pure water. It does not have to be distilled, but it must be clean and free of too many minerals. There are four kinds of impurities present in water:

1. **Suspended mineral material** such as dirt and rust from the pipes. These impurities can be removed by filtering.
2. **Animal and vegetable material** like bacteria, slime, or pond organisms that are so small that they will pass through a filter. These can be removed by boiling first and then filtering.
3. **Chemicals from the earth** that get in the water as it collects on the ground and runs into the well or reservoir. These chemicals are difficult to remove.
4. **Dissolved gases.** Besides ordinary air, there may be chlorine added to sterilize the water, hydrogen sulfide (rotten eggs) from decomposing organic matter, or sulfur from certain hot springs. These gases can be removed by boiling.

Usually water can be made pure enough for photographic purposes by boiling and then filtering. A plug of cotton is pushed into the stem of a big funnel and the boiled-and-cooled-water allowed to trickle through. If there is too much organic matter, the filter may clog frequently. In this case, it may be necessary to add some alum (aluminum potassium sulfate) to the water before boiling it. About 1 gram in four liters is correct. The local pharmacist will weigh it out. This treatment coagulates slime and colloidal matter, carries down suspended particles, and clears the water quickly. The little bit of alum remaining does no harm in the solutions. A commercial product called CALGON (sodium hexametaphosphate) will soften the water and neutralize the excess of earth minerals in hard water.

PROCESSING FILM NEGATIVES

The negative is more important than the prints or enlargements. It is the only record the investigator has. He cannot go back and make negatives over if they are spoiled during development. Prints and enlargements can be done over and over until they are correct. There is only one chance to develop the negative. It should be done as carefully as possible.

The authors recommend that each investigator develop his own negatives. Printing and enlargement can then be entrusted to a photo lab technician. Negative development needs very little equipment, and it does not even require a darkroom. A daylight loading tank or a changing bag will provide dark-

ness for loading the film, and the work can be done in a bathroom or a kitchen. The investigator will find that he learns a great deal about correct exposure and lighting by studying his negatives after he has developed them.

No instructions on enlarging and printing will be given in this book. The interested reader is referred to the many excellent photography manuals that are available.

Developing is best done under standard conditions of **time** and **temperature**. Both are carefully controlled by measuring. It is easier to change time than it is to change temperature. For some unknown reason, film manufacturers recommend that films be developed at a "standard" temperature of 68°F or 20°C. There are very few places in the world where the average temperature is this low most of the time. Around the equator, the average temperature is more likely to be at least 78°F or 26°C. The photographer must therefore shorten the **time** of development to take the place of lowering the temperature. There are limits as to how much this can be done. It cannot be done at all with color film. The reason for keeping the developing solutions cool is because of a substance called **gelatine** on both film and paper. Gelatine is an animal product obtained from the hides and horns of slaughtered cattle. It melts at a fairly low temperature. Gelatine is mixed with sensitive chemicals to form an emulsion and spread on a plastic base where it hardens. It will get soft and melt if kept too long in warm liquids.

Cooling the Developing Solutions. Putting an air conditioning machine in the darkroom might seem to be an obvious way to cool down the solutions. An air-conditioner makes a room seem cooler by taking water out of the air. It may not lower the actual temperature more than 8°F or 10°F. The water in the air, or humidity, makes the heat more difficult to hear. A thermometer will usually show that the temperature of the liquids in the bottles is still a great deal warmer than 68°F or 20°C.

Photographic equipment manufacturers make special cooling machines that keep a large bath of water at a constant temperature. These machines are quite expensive and cost at least US$450 or more. This expense is not practical for a small police laboratory.

Ice can be used if available in large enough amounts. The ice cannot be put directly into the solutions, of course, because it would melt and weaken them by dilution. The ice is put in a large pan of water and the bottles of solutions are put in this ice bath until they are cooled to the proper processing temperature. The thermometer must be put into one of the solution bottles, not into the ice bath. During development, the developing tank must also be kept in the ice bath. A large bottle of plain water for rinsing must also be cooled because if there is too much difference in temperature between the developing solutions and the rinsing water, the film may get cracked or **reticulated**. These cracks are very fine and look like a very old oil painting.

Special High Temperature Processing Methods. The easiest and most economical way of developing films in hot climates is to change the developing methods or use special formulas. Regular solutions can be changed for hot weather use by making them thicker. A chemical called Glauber Salt (sodium sulfate) is added in amounts of 5% to 10%. Sodium sulfate is sold in pharmacies for use as a laxative. The chemical is added after all other developing chemicals are dissolved but before the solution is diluted to final volume. Eastman Kodak recommends the following changes in their developers for hot-weather use:

Developer	Temperature F°	Temperature C°	Add Sodium Sulfate
D-11, D-19, D-61a	75 - 80	24 - 27	50 gm
D-76	80 - 85	27 - 29	75 gm
	85 - 90	29 - 32	100 gm
DK-50 DK-60a	75 - 80	24 - 27	100 gm
D-72 (1:1)	80 - 85	27 - 29	125 gm
	85 - 90	29 - 32	150 gm

Special Tropical Developers. Some photographic manufacturers make special formulas for tropical use. Some of these are

Ansco #64, Gevaert #223, or Agfa #16, They are not usually sold made up, but have to be mixed by weighing out the chemicals each separately. The small police department is better off to use prepared developers and add sodium sulfate if needed.

Developing Solutions

Two solutions are needed, the developer and the fixer. A third solution, called a **short stop**, is used by many photographers. The purpose of the short stop is to stop the action of the developer quickly. The solution is usually diluted acetic acid about the strength of vinegar. We do not recommend such an acetic acid short stop. We prefer to use two quick rinses of pure water. For high temperature development, however, a hardening bath should be used instead of a water rinse. The hardener is potassium chrome alum and the solution has to be made up fresh each time it is used.

Developers are sold in quart (1,000 cc), half gallon (2,000 cc) and gallon (4,000 cc) sizes. Developers do not keep well, however, and the investigator will have to decide how much processing he is going to do before deciding what size to buy. Another point to think about is whether the investigator is going to use the solutions only one time, or whether he is going to re-use them.

One Time Development. The solution is thrown away after each use. Since the 35 mm. tank holds 500 cc of solution, the developer is best purchased in the gallon (4,000 cc) size. Some developers like Kodak Microdol-X, are usually diluted 1:1 with an equal amount of water if they are going to be used only one time. This means that a gallon of developer can process 16 to 32 rolls of 36-exposure 35mm. film, or 8 to 16 rolls of 120 film per gallon. This method is the most costly, but produces the best negatives. The solution is always clean and full strength.

Re-Use of Developer. Developer can be use more than once, but of course it will get weaker and dirtier with every roll of film processed. The weakening can be allowed for by either:

Increasing the Developing Time. This is usually 10% for each time, but the manufacturer will always give correct instructions on the container. This would mean that if the time were 10 minutes, the next load would be 11, then 12, etc. There is a limit as to how many times this can be done, so a better way is to use:

Replenisher Solution. This is sold clearly marked as such with instructions on the container as to how much to add for each roll of film. The replenisher is measured and put in the developer bottle. The used developer is poured in on top of it. There is also a limit as to how many times and how much replenisher can be used. The manufacturer's instructions should be followed exactly.

Developer should always be filtered before it is put back in the bottle. Reduced silver, dirt, and bits of emulsion get into it and should be removed. This is best done with some cotton pushed into the stem of a funnel. The funnel is put into the stock bottle and the used developer allowed to trickle through.

Fixing Solutions

Sodium thiosulfate or "hypo" is commonly used for fixing both films and paper prints. It is made up as a strong solution (20%). It is cheap and keeps well, so the gallon size is the most economical. It can be re-used until it is exhausted, but if this is done, two different bottles of hypo should be used for either films or paper prints. Some photographers like to use a double bath of hypo. They put used hypo in first for half the necessary time, then pour it out and throw it away. Fresh hypo is now added for the rest of the necessary time. This second hypo is saved to become the first hypo for the next batch of films or paper prints.

Hypo is rarely used all by itself. Alum and acetic acid are added to cause a hardening action. Hypo sold for photographic use usually has the special chemicals for hardening already in it.

Preparing the Solutions

Prepared photographic solutions always have instructions for mixing included, and these instructions should of course be followed exactly. It is important that the chemicals be added in the exact **order** called for. Each one is put in the water and stirred until it has all dissolved before the next one is added. After all are dissolved, more water is added to fill up the container to the correct volume—1,000, 2,000, or 4,000 cc as the case may be.

Developers do not keep long because of air. The air causes changes called **oxidation** which weaken and spoil it. Certain chemicals called **preservatives** are included in every developer, but even these chemicals cannot preserve the solution if too much air gets to it. Air on top of the solution in a partly filled bottle causes most trouble. For this reason, it is best to divide a large amount of developer into several small bottles that are filled right up to the top. A gallon of developer is poured into eight pint (500 cc) plastic bottles, for example.

All photographic solutions should be stored in a cool but not a cold place. Do not put them in a refrigerator. Some of the chemicals will come out of solution and will not dissolve again at room temperature. We like to keep our solutions near an air conditioner machine.

Film Development

Loading the tank. The stainless steel Nikkor or Kinderman tank has a spiral reel. The roll of film is fixed to the center of the reel and the film and wound carefully outward. The edges of the film go between the wires and the film is kept from touching itself. Winding the film on this kind of reel takes some practice. The investigator should try it out with a spoiled film in the light. The actual loading must of course be done in total darkness.

Sheet film is loaded into slats in a special rack that fits the 500 cc tank. A curved guiding frame is provided to make sure the individual films do not touch each other.

Development. The temperature of the developing solution is now tested with the thermometer. The time of development is looked up on a chart and the timer clock is set **but not started.** When all is ready, the clock is started and the developer poured in as quickly as possible. The cap is put on the pouring hole and the tank is then turned upside down to wet the film. The tank is now brought back and slammed down sharply on the table. This shakes loose any tiny bubbles that may be on the film.

Agitation. The chemicals in the developer that are close to the film get used up quickly. It is necessary to mix the solution from time to time to bring fresh solution in contact. This is called agitation, but it is not done all the time as the word might suggest. It is done at even, regular intervals, usually every 30 seconds. The tank is simply picked up and turned upside down, then put back on the table. Too much or too little agitation will change the development. The investigator must learn a regular procedure and stay with it every time.

Rinsing. About 15 seconds before the end of the correct time, the developer is poured off into a plastic jar. Do not pour directly back to the bottle because the used solution needs to be filtered and there is no time to do it now. The tank is filled and emptied quickly two times with pure water and then the fixing solution poured in.

If a hardening solution is used, the hardener is poured in directly instead of the water. The hardener is allowed to act for the required time and then poured off and thrown away. The tank is rinsed once with pure water and the fixing solution poured in.

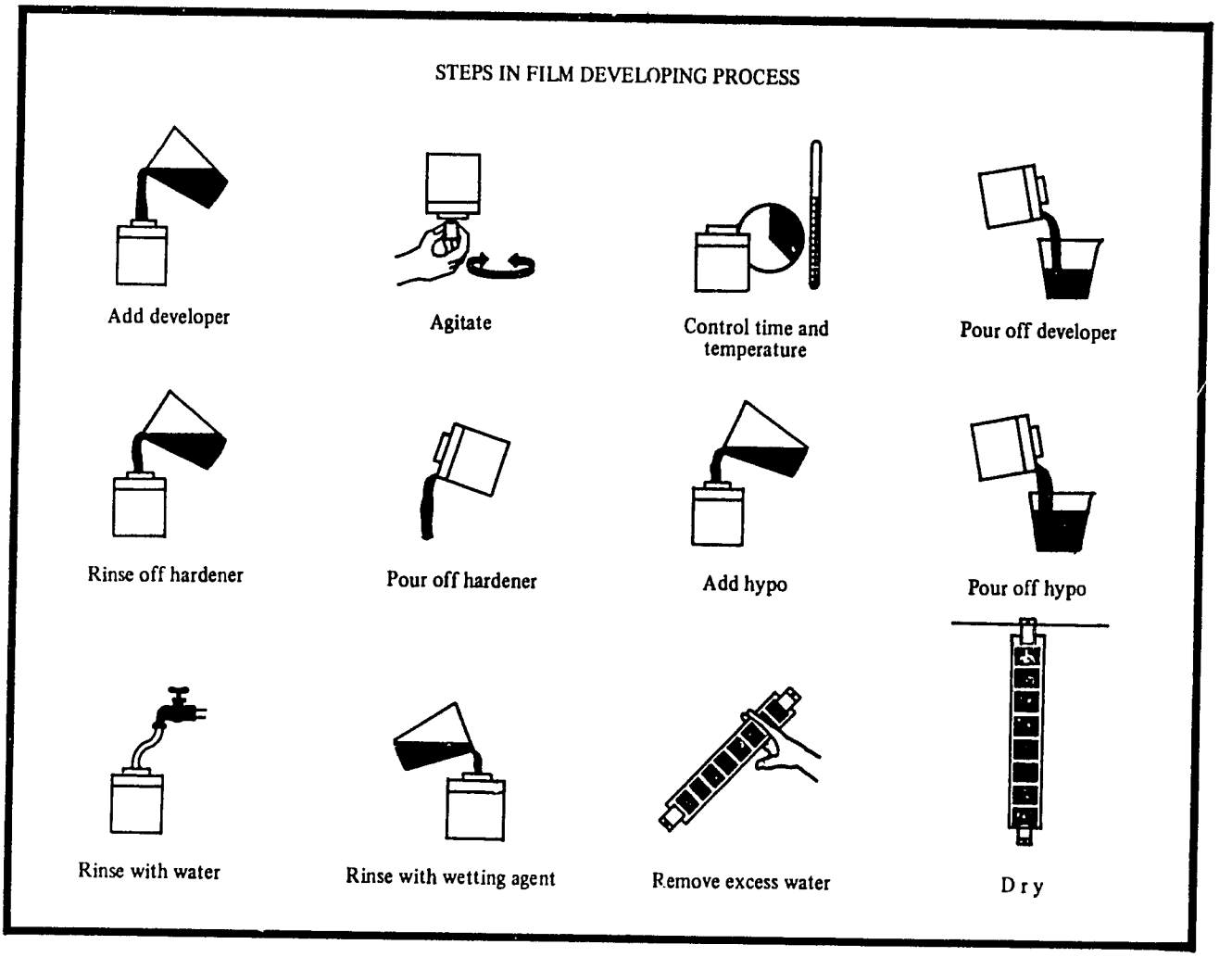
Fixing and Washing. The hypo is allowed to act for not more than five minutes. It is poured off and the tank can now be opened. The tank is put under a faucet of running water and rinsed for five minutes. Hypo Eliminator is now added and allowed to act for five minutes. This is poured off and the film rinsed for another 10 minutes.

Where water is scarce, a different washing procedure is used. The tank is filled and emptied five times with pure water. The water is allowed to stand two minutes

DEVELOPING TIME AT DIFFERENT TEMPERATURES														
°C	17.8	18.3	18.9	19.4	20	20.5	21.1	21.7	22.2	22.7	23.3	23.9	24.4	25
°F	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Time	1.32	1.16	1.10	1.05	1.00	.95	.90	.85	.81	.78	75	.72	.69	.66

Multiply the recommended time by the factor in the table.

STEPS IN FILM DEVELOPING PROCESS



each time. Hypo Eliminator is added for five minutes, then five more washes are given. Only a little more than a gallon (5,000 cc) of water is needed.

Before hanging up to dry, the film should be bathed in a wetting agent. This is a chemical that causes liquid to run off quickly. The purpose is to prevent water spots and streaks. Eastman Kodak PHOTOFLO is specially made for the purpose, but any common liquid detergent—NOT SOAP—can be used. A few drops in a tank of water is all that is necessary. The film is shaken vigorously in this wetting agent, then taken out and hung up to dry by one end.

Drying. The film should be allowed to dry thoroughly in a place free from dust. We know a man who hung films to dry in a bathroom. His wife came in, used talcum powder on herself, and of course it got on the damp films! We do not recommend any heat for drying negatives.

Marking and Filing. Keeping track of a lot of negatives can be a problem unless some system is used. Different police departments have different policies about where to store films and how to mark them. Our experience indicates that films are better kept in order in a separate file by themselves. They are apt to get lost if put in with the general case or identification records. **Prints** are put in the case file, but not negatives.

The best way to record negatives is **chronological**, or in order by time. Each roll is numbered and then each picture on the roll. A new series of numbers is started on the first of every year. The number will therefore be, for example, 68-26-5, This means the 26th roll of film taken in 1968 and the 5th picture on the roll. The numbers are written in China ink on the clear space at the edge of each roll **before the films** are cut apart.

Single sheets of cut film are numbered with the same system. Since there is no roll, each group of films taken at the same time on the same case get a "roll" number. All the negatives from one group or roll go into one filing envelope. Some photographers like to make a **proof sheet** of each roll. This is done by putting all the negatives at the same time on a single sheet of 8" x 10" enlarging paper. The films and paper is covered with a large piece of glass and exposed briefly to a lamp. After developing, the 8" x 10" sheet is punched and put in a ring binder.

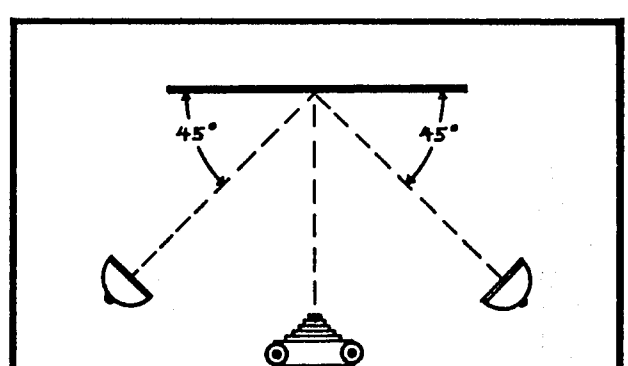
The 35mm. miniature film has to be handled a little differently. The numbering and proofing are the same, but the negatives are stored in **strips of six negatives.** The very small 1" x 1-1/2" (24 x 36mm) negatives are too tiny to be easily handled in the enlarger if cut apart to separate negatives.

Copying Photographs and Documents

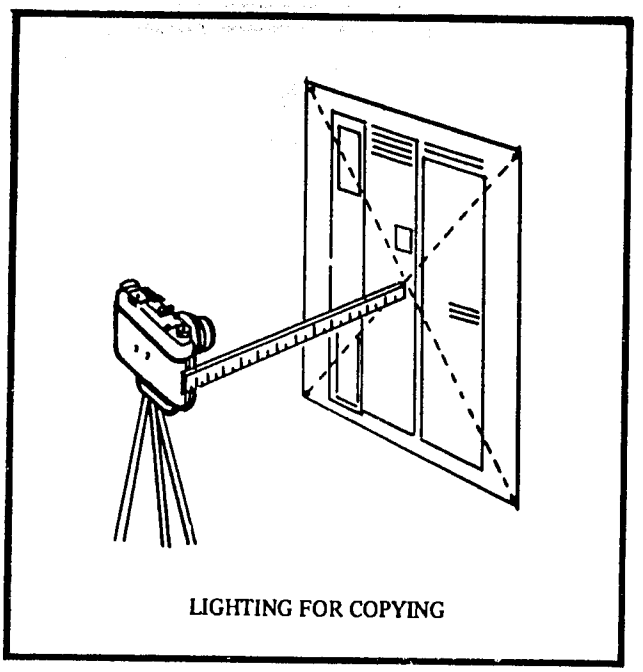
Once in a while, every investigator needs to copy another photograph. The main problem here is reflections from the camera and lights on the shiny surface of the photograph. A lot of playing around with the lights may be needed to get rid of these reflections. Next, the camera must be adjusted so that the film is parallel with the photograph. The easiest way to do this is to put a tape first on one side and then the other of the photograph and measure from these points to the center of the lens. If the two distances are equal, the camera is lined up correctly. Here again, a lot of adjustment may be needed.

Use two lights at equal distances on each side of the picture and at an angle of 45°. Now calculate the exposure. If many copies are made with the same lights at the same distance, the exposures can be worked out by trial and error and a chart prepared. The best way is to use a meter, but a certain care is needed to use a meter correctly for copying. Eastman Kodak sells what is called an "18% Gray Card". This is a piece of cardboard that is white on one side and gray on the other. The gray side reflects 18% of the light falling on it. When read with a meter, it gives a standard average exposure.

In copying a photograph, depth of field is not a problem, so it is not necessary to close the lens too much. Sharpness is what is wanted in copying and most lenses are most sharp **two or three f. stops below wide open.** This means with a f. 4. 5 lens, the best opening would be f. 6. 3 or f. 8. Of course focusing is done with the lens wide open, but the investigator will notice that the image will get sharper and clearer when he closes down the lens to make his exposure.



COPYING AGAINST WALL



LIGHTING FOR COPYING

Documents of all kinds need to be copied for the record. They are photographed differently than photographs. Photographs have a **range of tones**, which means that there are black through gray to white values in them. Panchromatic film must be used to correctly record all these different shades of gray. Documents, on the other hand, are only pure black against pure white, so a special contrast film is best to make the difference between these two tones sharp and clear. Ordinary film can of course be used, but better results will be obtained with a film like Process Pan or Process Ortho. The illumination of documents is the same as for photographs.

Formulas for Photographic Developer Solutions

The investigator is advised to always use the developer recommended by the film manufacturer for his particular product. It will always give the best results. Sometimes the film is available but the packaged developer is not. The investigator ought to know a few formulas and how to go about making them.

Stockler Two-Bath Developer. This simple formula is not available in packaged form. It is mentioned in many photographic books. It produces the greatest possible sharpness without loss of speed and it does not block highlights. This makes it good for police work where the wide range of light can cause photo problems. It is used in two separate solutions.

Stockler Solution A:

Water (warmed to 125°F or 52°C)	750.0 cc
Metol*	7.5 gm
Sodium sulfite	75.0 gm
Water to make	1000.0 cc (1 liter)

Stockler Solution B:

Water (warmed to 125°F or 52°C)	100.0 cc
Borax (sodium borate) granular	20.0 gm
Water to make	1000.0 cc (1 liter)

Develop 4-1/2 minutes in Solution A at any temperature up to 80°F or 27°C. Pour out the solution, and WITHOUT RINSING, pour in Solution B for another 4-1/2 minutes. If the processing temperature has to be more than 25°C, a chrome alum hardening bath should follow the developer.

Old time photographers will recognize Solution A as Kodak Developer D-23—with the sulfite reduced. The solution can be used over and over for at least 20 rolls if care is taken not to contaminate it with Solution B. Solution B should be limited to 10 rolls. It is so cheap that it is foolish to risk spoiling a valuable negative with poor solutions.

A white scum of calcium sulfite sometimes forms on film processed in this formula. It is soluble in fresh acid fixer solutions.

Kodak D-76. This is the old reliable standard developer against which all other developers are compared. It was worked out for motion picture films and billions of photographs have been developed with it.

Water (warmed to 125°F or 52°C)	750.0 cc
Metol	2.0 gm
Sodium sulfite	100.0 gm

*p-Methylaminophenol sulfate. Also known as ELON, MONOL, PHOTOL, PICTOL, SCALOL, Methylparaminophenol sulfate.

Hydroquinine	5.0 gm
Borax	2.0 gm
Add water to make	1000.0 cc (1 liter)

Sodium sulfate can be added for tropical use. See Table on page 139.

High-Contrast Developer D-19. Copies of documents and photographs of latent fingerprints come out better if they are processed in a developer that makes black very sharp from white. D-19 produces very "clear" negatives.

Water (warmed to 125°F or 52°C)	500.0 cc
Metol	2.0 gm
Sodium sulfite	90.0 gm
Sodium carbonate	52.5 gm
Potassium bromide	5.0 gm
Add cold water to make	1000.0 cc (1 liter)

Dissolve the chemicals in the order listed. Sodium sulfate can be added for tropical use. See Table on page 139.

Chrome Alum Hardening Bath

Potassium chrome alum	15.0 gm
Water to make	500.0 cc

Prepare fresh each time. It does not keep. Use 5 minutes.

Hypo Neutralizer

Sodium sulfite	18.0 gm
Water to make	1000.0 cc

This will keep well and will take care of 100 rolls.

Appendix C

HOW TO PLAN AND BUILD A CRIME LABORATORY

Every police force would like to have its own criminalistics laboratory, but few police administrators know the special problems that such a laboratory presents. The laboratory is too often regarded as just a pretty toy to show visitors. The complicated apparatus and the busy scientists in their white coats are very impressive.

The modern police criminalistics laboratory is an important—but expensive—service function that is costly to build and to keep running. No police force should even consider building a laboratory unless it is prepared to support it with enough money to run it properly.

The first—and most important—material needed to build a police laboratory is a skilled criminalist. Money spent on instruments and apparatus will be completely wasted unless there is a trained examiner to operate them. A police administrator who is thinking about starting a new laboratory had better find his scientist first. Only after he has done this should he consider buying chemicals and apparatus.

Types of Service

There are several types of criminalistics laboratories. Which is the best kind will depend upon the nature and number of services, the legal system of the country, the geography and availability of transportation, and the number of policemen to be served. Some of the different types of laboratories are:

General. A general laboratory provides service in all the major fields of chemical analysis, biological analysis, physical testing, examination of questioned documents and the comparison of firearms.

Special. Some police agencies can limit their laboratory service to only certain kinds of examinations such as counterfeit money, postal cases, narcotics, customs, or food and drug tests.

Limited. Other police agencies may only need a small laboratory that collects and transports physical evidence to a larger laboratory for detailed testing. Such a limited laboratory does only the most simple kinds of tests with magnifiers, photography, and various kinds of lights. It is usually

staffed with trained police technical investigators.

Mobile. This type of laboratory is mentioned only to condemn it. Over 500 separate items are needed to provide the minimum requirements of a laboratory. It is impossible to carry even a small part of the necessary things in a vehicle or in boxes. A laboratory does not use every item every day, but like a pharmacy it has to have all the necessary chemicals and equipment in case they are needed. A doctor could perform a surgical operation in the field with only a pocket knife if he were forced to do so, but any surgeon will always take his patient to a properly equipped hospital if he can.

Police agencies that have tried to use mobile laboratories have usually given them up. A mobile laboratory has to be a fairly large vehicle if it is to carry all the equipment needed to make tests. It also has to have gas, water, electricity, and a photographic darkroom. Such a vehicle would be limited to operating only on good paved roads. But it is in isolated areas far from good roads that such a vehicle would be most useful. It is better to use Technical Investigation Units that can carry their equipment for the collection of physical evidence in boxes. These boxes can be transported in small vehicles, on railroad trains, in airplanes, or even on the backs of animals. The collected evidence can then be sent back to a proper laboratory for testing.

Portable laboratories have all the disadvantages of mobile laboratories. Field investigation should be limited to only the collection and preservation of physical evidence. The only chemical test that ought to be done at the scene of a crime is a simple, preliminary test for blood. The objection to commercial kits is that the chemical solutions are secret formulas marked "Narcotic Reagent Number 3" or "Document Solution 007". There is no way of knowing if the solution is fresh or spoiled. If the bottle were to leak or break, a replacement would have to be ordered from the factory. Many criminalistics reagents contain acids and cannot be sent by post. Another disadvantage of the commercial kits is that unless the investigator understands the exact principles of the procedure, he cannot ever be sure that he has done the test correctly. He would not be allowed to sign a report or testify in court about a test made with mysterious and secret solutions.

The greatest danger of all in using mobile and portable laboratories is that evidence may be spoiled by unskilled persons or by lack of correct tools and equipment. The investigator cannot return to the crime scene and get another sample if he spoils the first one.

The portable fingerprint field kits that are sold by police supply companies should be examined very carefully before any decision is made to purchase them. Many are too large and contain too many unnecessary items such as purple and green fingerprint powders that are hardly ever used in field work. The small pocket portable fingerprint kits for latent work, which contains three different powders and two kinds of lifting tape are perfectly satisfactory. Complicated fluorescent light work and procedures that call for selective color filters should only be done at the laboratory.

Systems of Service

Physical evidence must be brought to the laboratory or the laboratory examiners must travel to the crime scene to collect it. The examiners may also have to travel to distant places to testify in court. The geographic size of the area to be served and the availability of good transportation have to be considered in planning a criminalistics service. Several different arrangements that can be used are:

One central laboratory makes all the examination. This system is used by the U.S. Federal Bureau of Investigation. The advantage of this system is economy of equipment and people. The laboratory procedures become more efficient because the examiners gain a great deal of experience in doing only certain kinds of tests. The most serious objection is that examiners have little personal contact with the field investigators. They may not receive important information they need to do their work properly. Another disadvantage is that a big central laboratory serves too many people,

may become too independent, and is often very slow in getting reports back to the submitting agency.

Several regional laboratories make all the examinations for their own separate geographic areas. This system is used in Great Britain which has eight such regional laboratories. The most serious objection to this arrangement is duplication. Each laboratory must be completely supplied with the same equipment and staff. This is not only costly, but it is often very difficult to find enough trained experts. Even the British have found it expedient to concentrate questioned document examinations in one laboratory at Cardiff, Wales.

One central and several branch laboratories. In this system, the main laboratory makes the complex examinations and the branch laboratories do only the simpler routine tests. All difficult tests and procedures that require such expensive instruments as infra-red recording spectrophotometers, emission-arc spectrographs, or X-ray apparatus are done at the main laboratory. This system has its own peculiar problems. First of all, the branch laboratories should have the same essential minimum equipment and a minimal staff. Unless generalists are available, they must be staffed with many specialists. In this case, they become regional laboratories and all the advantages of this system are lost. There is also a danger that local eagerness or the pressure for an immediate answer may cause a branch laboratory to attempt to make examinations that it is neither staffed or equipped to do.

The best way to decide which kind of laboratory is most suited to a particular police force is to have a survey made by an experienced criminalist who can consider all the planning factors and make correct recommendations.

Outside Resources

Police administrators are often reluctant to ask for assistance from persons outside of the police. They usually make the excuse that "reasons of security" compel them to use only their own people to make laboratory tests. The truth is usually a matter of false pride. The police do not want to admit that there are some special tests that they do not have the trained people or instruments to do.

There are many other scientific places in even the smallest cities that can help the police. Some of these are:

Hospital laboratories
Pharmacies
Geology laboratories
Medical schools
Agricultural experiment stations
Petroleum testing laboratories
University science departments
Engineering laboratories

These scientific places often have special and expensive instruments that can be made use of by the criminalist. A metallurgical laboratory is likely to have a spectrograph. The local hospital will have an X-ray machine. An oil company laboratory may have a gas chromatograph or infra-red apparatus. A professor of geology can help to identify soils, a professor of botany will help to identify seeds and plants. Sometimes a skilled automotive mechanic will be useful to examine a damaged automobile. The pharmacist can quickly identify common pills, capsules, and tablets. The list is endless, and the resourceful criminalist should make it a point to find all of the outside talent that is available in his community.

Of course the criminalist will have to be careful in using this outside talent because these consultants may not understand the special requirements of the law about the proper handling of physical evidence. The criminalist should work with the outside consultant and guide him in order that legally correct information will be obtained.

PERSONNEL

Status

There is a difference of opinion as to whether criminalists should be police officers or civilians. Some agencies have both kinds of criminalists in their laboratories. In either case, every civilian worker should be required to take basic criminal investigation training, and all police officer techni-

cians should have some training in science.

The main disadvantage of police-officer criminalists is the problem of promotion. It is not fair to make technical specialists compete for promotions with line officers. It is also not fair to expect an officer with special abilities to serve at the same rate of pay as a regular line officer. Rating criminalists as civilians solves both of these difficulties. Criminalists then compete only with other criminalists for promotions, and they can be paid on a separate salary scale suitable to their technical ability and academic qualifications. Police administrators should keep in mind that they have to compete with private industry and other governmental agencies for scarce scientific talent.

If police officers are assigned to laboratory duties, they should be kept permanently in this work and should not be subjected to transfer. Technical ability can only be developed by continuous service in order to gain the necessary experience and proficiency.

Background

There is a difference of opinion as to whether or not a criminalist should have a medical background. In Europe, Latin America, and other countries using Inquisitory Law, many police laboratories are staffed and directed by physicians. In the United States, Great Britain, and other countries under Adversary Law, physicians usually keep to the limits of autopsies and histopathology, while the police laboratories are staffed and directed by chemists, physicists, or biologists.

This problem cannot be resolved logically but will depend upon the attitude of the courts in each locality. Many judges have a very great respect for physicians and will give greater weight to any opinion expressed by a Doctor of Medicine. This is particularly true in Inquisitory Law countries. The police administrator will simply have to go along with the prevailing custom in his own community.

Specialization

Criminalistics borrows and adapts principles and methods from every scientific discipline to do its work. Some of these are chemistry, physics, biology, physiology, biochemistry, pharmacology, geology, and botany. It is obvious that a police laboratory cannot employ a separate specialist in every one of these fields. Some degree of generalization has to be required of a criminalist. At most, a chemist, a physicist, and a biologist are the three specialists needed in a criminalistics laboratory, plus firearms, document, and fingerprint examiners.

The danger of specialization is that specialists may become too narrow-minded and will look at physical evidence only in terms of their own restricted field. A biologist has been observed who tested a brown stain for blood and then returned the evidence with a negative report without thinking to ask the chemist to see if it might be iron rust. It has become a scientific joke that some specialists cannot even talk to different specialists, let alone to ordinary people. On the other hand, Kirk points out that a master of all techniques may remain merely a technician, and the best of all technicians is not necessarily a satisfactory criminalist.

Personal Qualities

A disciplined imagination is more important than technical ability in a criminalist. What is needed is a scientist who can recognize the uncommon and unusual qualities of physical evidence and who can then develop tests to demonstrate these peculiarities to the courts. There are many laboratory workers who are excellent technicians and who can perform examinations skillfully if the procedures are straightforward and require little modification. They can do acceptable work if they are not faced with an unusual situation that requires innovation or adaptation. Some will go on steadily for years and will acquire considerable occupational experience, but they may never achieve the necessary special aptitude that makes a satisfactory expert.

Versatility is also an important requirement because the criminalist may have to handle an important case in an emergency when a specialist is not available. This does not mean that a criminalist can be fully expert in every field because there are al-

ways certain areas in which every criminalist works better because he has a particular aptitude or interest. This should not prevent him from knowing the general principles and procedures of other areas of criminalistics. There is no reason whatsoever why every specialist should not retain some capacity to act as a generalist.

Courageous intellectual honesty is absolutely essential to a criminalist. While intellectual honesty is of course expected in the practice of any science, the criminalist has to have a high degree of firmness in defending a correct but sometimes very unpopular opinion in the face of criticism by hostile lawyers and dissatisfied investigators. There is a saying in medicine that if the laboratory findings do not give support to the physician's brilliant diagnosis—the laboratory must have made a mistake! This feeling is even more true in law enforcement where the scientist must work with laymen who do not understand or put a high value to the requirement of complete objectivity under which the scientist has to work.

Grades of Criminalists

The **laboratory director** should be a scientist with a broad knowledge of all branches of criminalistics and with previous experience in a criminalistics laboratory as an examiner. He should be made directly responsible to the Chief of Police through the Deputy Chief for Services. There is a difference of opinion as to whether this director ought to be a police officer, a chemist, or a doctor of medicine. The persons who argue in favor of a certain group are usually members of the same group they put forward. Each can argue convincingly for his own particular profession. The confusion arises from a lack of understanding of the difference between **administration** and **direction**. Certainly a police executive or medical doctor can administer a criminalistics laboratory if he is wise enough to delegate authority for its direction to a qualified technical specialist.

Examiners. Borkenstein has suggested the term **examiner** for those technical specialists with the necessary fitness to qualify as expert witnesses. Just when a criminalist arrives at that point in his career when he graduates from technician to examiner will have to be determined in each individual place. There are no hard and fast rules among the various specialties. Criminalists who have advanced academic degrees in chemistry, biology, physics, or medicine may expect to be accepted more quickly by the courts. It is in the technological fields of firearms, documents, and fingerprints that there is greater difficulty in determining fitness to be an expert. These specialties are learned by the apprentice system of on-the-job training. The quality and thoroughness of the training will depend entirely on the competence of the examiner giving it. A very excellent examiner might be a very poor teacher.

Technicians are skilled laboratory workers who make tests under the guidance and supervision of an examiner. These men have technical ability but usually do not have as much knowledge as an examiner. Some of them will become examiners after sufficient training in the laboratory. Medical doctors train their laboratory technicians to be only technicians and never anything more, but a police laboratory should not hire any persons as technicians who could not become qualified experts after training and experience. Every technician should be a student examiner. In this way there will always be new men who will be ready to take the place of older examiners who retire.

A technician will need at least three to five years of training and experience to become a qualified examiner. He should spend a part of his time in each different specialty in order to learn all kinds of criminalistics tests. A technician who is trained in this way will become a good generalist. He can then be sent to start a branch laboratory and be able to take care of many different types of tests.

It is not a good idea to train a technician in a small branch laboratory as the men do not see as many cases as they do in a large central laboratory.

Technical Investigators. Many thousands of crimes have been solved by investigators without any help from a laboratory, but no criminalist has ever solved a crime without

the help of an investigator. It would be a very fine thing if every policeman were carefully trained to locate physical evidence, collect it properly, and send it to the laboratory in the correct way. But some kinds of physical evidence have to be gathered in a special manner and put in certain types of containers, and for this reason it is better to have specially-trained policemen at each police station who know how to gather physical evidence. These men are called **technical investigators** or scientific aids officers. They are provided with a field kit containing measuring tapes, sketching equipment, cameras, fingerprint materials, forceps, plaster, and various types of paper bags and pill boxes for preserving evidence. They have been taught the correct manner of collecting and preserving bloodstains, hairs, paint, toolmarks, as well as the taking of plaster casts, moulage, and latent fingerprints.

Before a technical investigator can do his work properly, he has to spend some time in the criminalistics laboratory to learn how the examiners make their tests after they receive the physical evidence. The technical investigator does not have to know how to make the tests himself, but if he watches the examiners he will understand why they have to have the physical evidence collected in certain peculiar ways.

Laboratory assistants are needed to wash glassware, prepare chemical solutions, get rid of waste materials, take care of supplies, and keep the laboratory clean. The usual cleaning people who sweep the police buildings must not be allowed to clean the laboratory. They might accidentally throw away important physical evidence. College students who are studying science are often used as assistants since they can work after classes and during holidays. Sometimes older policemen who are not fit for ordinary police duties are more useful in these duties.

Clerks, Typists and Drivers. Clerks and typists assigned to the laboratory should be above average in intelligence because they will have to understand the scientific language used by criminalists. For security reasons, all clerks and typists should be assigned permanently to the laboratory and be responsible to the director. The laboratory will keep its own records and in this way there is less risk of confidential information getting outside the laboratory to persons who should not have it.

Drivers can be very helpful to a criminalist when he works on outside cases in the field. They can help with the cameras, hold measuring tapes, carry equipment, and protect the scene of the crime. All drivers, clerks, and typists should be given some simple lessons in criminalistics in order that they will see the value of the correct ways of handling physical evidence.

Training

Criminalistics training is mostly self-training under the supervision of an experienced examiner in handling actual cases. Training is more than just being shown how to do the testing. Continual practice is needed to put the training to use.

A police agency usually begins its criminalistics work with photography and fingerprints. Later it may expand its activity to include questioned documents and firearms identification. These technical branches of criminalistics are usually learned by apprenticeship training together with local and foreign participant courses.

Learning the scientific branches of criminalistics is more difficult because more educational background is necessary. Trainees must have a good knowledge of English because a great deal of study and reading has to be done. Most criminalistics literature is published in the English language.

A good way to select criminalistics trainees from within the police is by a double selection process. Local commanders are asked to select officers who show an interest in scientific police methods and who have had some experience in photography and identification. Such officers already have some familiarity with the principles of **identity** and comparison which are important to criminalistics. These officers must be at least secondary school graduates who have had science courses.

These officers are given a four-week course in **Fundamentals of Criminalistics.**

This course shows them the ways in which science can be used to help in criminal investigation. The students learn how to recognize, collect, preserve, and transport physical evidence correctly. They are taught how to search a crime scene, sketch and photograph it, develop and lift latent fingerprints, make casts, and supervise the correct collections of body fluids and organs for analysis.

There are several positive results from this program. First, a group of trained technical investigators is developed who can assist CID officers in the field to use scientific assistance correctly. At the same time, the instructor has a chance to observe these men and to select outstanding students for further training as technicians.

An additional benefit of this training is that the laboratory has a group of interested men in the field who will stimulate interest in using more scientific aids. This will cause physical evidence to be sent to the laboratory on which the trainee technicians can practice. Both groups benefit because unless the technical investigator can get his evidence processed by a laboratory, he will become discouraged and lose interest. Unless the laboratory technicians are supplied with actual cases to work on, they will also become discouraged and lose interest in the work.

Membership in professional organizations. Every criminalist should belong to at least one professional society or association. Most police agencies pay the membership dues because the criminalist also receives a professional journal that would have to be subscribed to anyway. The police agency should encourage—and in fact require—that staff members attend both national and international meetings, conferences, and seminars. The police agency should pay the costs of these meetings. Criminalistics is a lonely profession. It stands unique in the law enforcement field in that its members cannot look to their fellow officers and supervisors for guidance in technical matters. They can only get advice and assistance from other criminalists, and their nearest colleague may be thousands of miles away in another country. By attending professional meetings, the criminalist has an opportunity to establish friendly relations with other criminalists who may be able to help him if needed. The other obvious advantage of attending conferences and seminars is, of course, the opportunity to learn new techniques and developments.

Post-Graduate Education. Members of the laboratory staff should be encouraged to continue their education to obtain advanced degrees. The costs of this education should be paid for in part by the criminalist himself. He will be encouraged to keep up his studies if he has some of his own money invested in his education. The laboratory can help him by arranging his work schedule to permit him to continue with his studies.

If staff members are sent abroad for special training, they should be required to sign a contract that makes them continue working in the laboratory for a certain length of time after they return. Then if they resign, they can be made to pay back the costs of their training.

Research

Every scientist remains a student all of his working life. He never finishes studying and learning because there are always new ways of testing physical evidence being discovered each day. For this reason, every criminalist has to spend a part of every day in reading books and scientific magazines which are called journals or periodicals. Sometimes the criminalist has to invent a special new way of testing an unusual kind of evidence that he has never seen before. All of this study and creation is called research, which means a careful investigation or experiment having for its aim the finding out of new ways of testing facts and using scientific ways to examine physical evidence. The criminalist must have time and equipment set aside for this research work. He may need extra chemicals or a new instrument. The laboratory director and the police administrator must give support to this research work.

LABORATORY FACILITIES

Space. The laboratory should be located as far as possible from busy administrative

operations. The top floor of headquarters or even a separate building is advisable. Putting the laboratory in the police academy or training center is a good choice. The laboratory staff is then available to give instructions, and the student policemen can be given practical demonstrations of scientific methods. Selected officers can also be brought in from the field for intensive training as technical investigators.

Security. Physical evidence must be protected from loss and contamination. Only authorized persons should be allowed to enter the workrooms because careless persons might accidentally destroy small items of evidence. Glass doors and partitions are helpful to allow the display of the laboratory to visitors yet still maintain good security.

Storage. Adequate space must be provided to store physical evidence while it is being examined and until it is introduced in court at the trial. This storage section may be located away from the laboratory workrooms if proper locks and safeguards can be provided. Additional space is needed to keep reserve stocks of chemicals and glassware. It is better to have two separate storage rooms for evidence and supplies. Many chemicals are flammable, and there is always a danger of loss or destruction of valuable physical evidence by fire or from chemical fumes.

Darkroom. The laboratory must have its own separate darkroom not only for photographic purposes, but for special types of examinations by ultra-violet, infra-red, transmitted, and sloping illumination. The laboratory may share a darkroom with the photographic or identification section only if these operations are close by or adjacent to the laboratory.

Office and Library. A separate room is needed for clerical work, interviews with visitors, and the reception of evidence. Enough shelves should be provided for scientific books, catalogues, and scientific periodicals unless a separate library can be provided.

Examination of Vehicles. Since the laboratory often has to examine automobiles involved in traffic accidents, a suitable space should be provided at the police garage or motor pool for this purpose. This location must have good and powerful lighting and should be protected from rain, wind, sand, and dust. It must be capable of being locked or properly guarded. There should be a mechanical hoist or inspection pit available to make examinations of the underside of vehicles.

Explosives and Bombs. This type of physical evidence cannot be brought to the laboratory until it has been deactivated and made harmless. A suitable space must be provided at the police pistol range or other outdoor location for this work.

Furnishings and Fixtures

Construction. The tables, benches, drawers, and cupboards can be built by local carpenters according to plans prepared by the laboratory experts. Sinks can be obtained from and installed by a local plumber. This is the least costly method. Or all the necessary furniture and fixtures can be purchased from laboratory supply companies assembled in "units" which are bolted together in any arrangement desired. There are special sinks, fume hoods, and drawer-cupboard units available in many sizes. All of the units have special material on the tops that is resistant to attack by corrosive chemicals and stains.

Tables. At least one large table is needed in each laboratory workroom in order to sort out and examine clothing or large items of physical evidence under strong lighting.

Benches. Two levels should be provided —one for working at a standing position (36 inches or 90 cm) and a lower one for working while seated (30 inches = 76 cm). The firearms section will need still another very low bench for the comparison microscope.

Shelves and Drawers. Most laboratory equipment consists of many very small and delicate glass pieces that must be protected from breakage and kept free of dust and contamination. A great many drawers or closed cupboards must be provided to store these items.

Sinks. At least one sink is needed in each workroom and two should be provided whenever possible. The examiner may need to use one sink while his assistant is wash-

ing glassware in another. An extra cold water tap should be provided at each sink to provide running water for washing and cooling without interfering with ordinary use. Another important reason for having two sinks is safety. Examiners work with strong acids and powerful chemicals. In case of an accident, they may need running water in a hurry to wash their skin or clothing.

Fume Hood. The chemistry section has to have a place to make tests that produce unpleasant odors or that use chemicals that are dangerous to breathe. Some tests cause vapors that are harmful to the skin and clothing. A special, enclosed cupboard must be provided that has glass doors and is equipped with a powerful exhaust van.

Utilities

Water. A dependable and unlimited supply of both hot and cold pure water is necessary. Some laboratory operations require a continuous flow of water for cooling the apparatus and for washing photographic films. A separate storage tank on the roof of the building should be provided if the local water supply is irregular. Some tests will be damaged if the water stops flowing in the middle of a procedure. A fire or even an explosion might happen if the cooling water in a distilling apparatus should fail. Filtered and distilled water is also necessary, and unless it can be purchased locally, a small distillation apparatus with large glass or plastic storage bottles must be provided. Metal tanks are not suitable for distilled water.

Electricity. Excellent illumination is essential. Besides the usual overhead ceiling lamps, many small microscope lamps and other devices are needed. Enough power must be provided to operate electric motors, electric heaters, ovens, water baths, and incubators. Heavy wiring, good fuses, and a large number of electric outlets are needed.

Unless the line or main voltage is kept at the proper level at all times, the instruments will not operate correctly and may be damaged. Costly repairs and a shorter equipment life may result. The electricity in the laboratory should not change more than 10% or less than 5%. If tests show greater changes than this, some form of regulator should be provided. This regulation is also important in the photographic darkroom if any color printing is done.

Gas. Electric heaters will not substitute for flame-type bunsen burners. Either piped or bottled gas must be provided.

Room Temperature Regulation. Adequate heating and cooling must be provided. The chemistry and photographic sections in particular must be kept as closely as possible to a temperature of 20° centigrade (68°fahrenheit). Serious errors in measurement or analysis and costly damage to valuable films will occur if the air temperature in these sections becomes too hot or too cold or too moist. In tropical climates with very high humidity, the excess moisture in the air should be controlled with a dehumidifying (air drying) machine or else damage may occur to delicate instruments. Molds and fungi may get inside optical instruments and cause costly repairs. The microscopy section must be protected from dust and sand. It is not a luxury to install air conditioning in a criminalistics laboratory. The cost of repairing or replacing damaged equipment is far greater than the original amount of money necessary to install air conditioning or dehumidifying machines.

Vacuum and Pressure. A suitable combination pump and suction machine will provide both of these facilities.

Refrigeration. A refrigerator is needed to store specimens of blood, urine, and body organs as well as to preserve some testing serums, chemicals, and photographic supplies.

Waste Disposal. Some form of furnace or incinerator is needed to destroy bad smelling and infected waste materials. A heavy-duty garbage disposal unit as is used in home kitchens is very useful to dispose of clotted blood and body organs if the local health department regulations and the capacity of the sewerage system will permit. The religious customs of some countries do not allow parts of human bodies to be disposed of in this way. The police administrator should give thought to these matters in planning a disposal method.

Museum. A criminalistics museum is not the same thing as the usual collection of stuffed animals in glass cases put up for public display. What the laboratory needs is collection of all kinds of objects for comparison in order to make correct identifications. Probably the first thing a laboratory will need to collect are bullets and cartridges for the Firearms Section. Samples of all common calibers of cartridges are needed to make test firings for comparison. Another important collection of objects will be of drugs and medicines that are commonly used in the community in which the laboratory operates. With this collection, the chemist can more easily identify pills, capsules, and tablets sent in for analysis. The document examiner will need to have common kinds of paper and inks, as well as samples of printed forms—checks, receipts, certificates, customs documents, and shipping documents. The Biology Section should have samples of animal hairs and blood. The Physical Section needs a collection of cloth and fabrics, ropes and cord, paint and oils, and soil from different parts of the country.

Except for firearm cartridges, most of these things do not have to be bought. Drugs, medicines, and weapons can be collected from the cases that are sent in for testing. The laboratory should get permission from the law courts to keep a part of the evidence for its museum. The Wisconsin State Laboratory in the United States was able to get a law passed that made the police and the law courts send all firearms taken in evidence to the laboratory for its collection.

Merchants who sell paper, ink, paint, and rope will furnish free samples of their products for the laboratory collection. Medical doctors get many free samples of drugs which they will give to the laboratory. Printing companies will give samples of their forms since they always keep several copies of everything they print in case they are asked to print more.

All of these collections of things for comparison can be kept in one or two ordinary filing cabinets. These cabinets should be kept locked because it takes a lot of time and trouble to get the things together, and if any are lost, they cannot be ordered from a laboratory supply company.

Books and Periodicals. A scientific laboratory must have a good library of technical books. It must also have all the new books as soon as they are published. All criminalistics periodicals should be provided. The more important technical journals are:

The Journal of Forensic Sciences (U. S.)
The Forensic Science Journal (U. K.)
Medicine, Science, and the Law (U. K.)
Journal of Criminal Law and Criminology (U. S.)
Analytical Chemistry (U. S.)
Journal of Forensic Medicine (South Africa)

The criminalist has to be fully informed of all new developments in his field in case he is questioned about them by the courts. The usual public and university libraries do not have the books and periodicals in the criminalistics field. It is therefore important that the laboratory maintain its own professional library.

Transportation. Each laboratory must have one suitable vehicle for its exclusive use to transport the staff and their equipment to a crime scene. This vital requirement is ignored in virtually every country in the world. Observations of crime laboratories in six countries on four continents reveal that criminalists are forced to go about their duties in privately owned automobiles, buses, taxis, and even street cars. In one instance a crew of experts was observed walking to the scene of a major homicide because the only available vehicle had been appropriated by a high-ranking officer for his personal use.

Administrators usually argue that the laboratory should share the vehicles in the common motor pool. What they overlook is that the criminalist has to carry a great deal of equipment with him to do his work, This equipment is heavy and bulky and is better left permanently in one specific vehicle, ready to proceed to the crime scene without delay.

In adversary legal systems, additional vehicles will be needed to get the experts

to the courts to testify. Sometimes as many as three of the experts will be needed in three different courts in three different places, all at the same time. Judges will not excuse the absence or lateness of an expert simply because he has no transport. Some testy judges might even punish a witness for contempt of court by fine or imprisonment for failure to appear when commanded to do so.

The most practical laboratory vehicle is a station wagon or small panel truck. If much operation in rural areas is likely, four-wheel drive vehicles of the jeep or landrover type would be better. The vehicle could be equipped with a two-way radio, but it does not require other emergency equipment. Another advantage of this type of vehicle is that it is less likely to be appropriated by other police officers for personal transport.

LABORATORY EQUIPMENT

Essential minimums. Even the smallest criminalistics laboratory has to have a certain minimum amount of apparatus and chemicals regardless of the number and kind of examinations it will be asked to do. Most of the minimum equipment will consist of many small items—test tubes, microscope slides, forceps, and an adequate assortment of chemicals. In addition, certain basic instruments are needed such as three microscopes—a high-powered medical, a low-powered stereoscopic binocular and a bullet-comparison model. Other essential items are centrifuges, water baths, drying ovens, and an assortment of cameras and photographic equipment.

Desirable maximums. Many special procedures such as poison detection, narcotic analysis, and firearms examination may need more sophisticated instruments. It is here that the police administrator should be very careful and ask for very good reasons for the purchase of these expensive machines. Some of them are: ultra-violet and infra-red spectrophotometers, emission-arc spectrographs, and X-ray machines. Often these instruments can be found at a nearby hospital, university, or commercial laboratory, and arrangements can be made for the criminalists to use them when necessary. **In no case should any such instrument be purchased unless there is a qualified examiner in the laboratory who is capable of operating it.**

About 90% of all the apparatus needed in a criminalistics laboratory is the same as that used in a hospital, medical, or public health laboratory. Any community large enough to support a criminalistics laboratory will have such a hospital or public health laboratory. This laboratory will have microscopes, glassware, chemicals, and serums that can be shared with the Police Department. Many criminalistics laboratories in all parts of the world have started their work in a hospital or public health laboratory.

The Police Department furnishes the criminalist, pays his salary, and provides the specialized equipment peculiar to law enforcement needs. This would include such things as a stereoscopic binocular microscope, ultra-violet lights, fingerprint and casting materials, and all the materials for examining the crime scene and collecting physical evidence. There will also be a need for special reagent chemicals and unusual glassware. For budget purposes, the Police Department usually pays the hospital a monthly fee to cover the cost of extra electricity, gas, water, cleaning service, and replacement of broken glassware and used-up chemicals.

Besides the economy of materials, there are several other advantages to a sharing arrangement. The medical technologists in the hospital laboratory learn a great deal about criminalistics procedures just by watching the criminalist do his work. A number of unofficial assistants are thereby developed who can help the criminalist in an emergency when extra hands are needed. They also serve the criminalist by collecting blood samples from suspected persons, securing urine samples from drugged and poisoned persons, and preserving clothing of victims of crimes of violence when they are brought to the hospital to have their wounds treated. The hospital pharmacist helps the criminalist in the identification of drugs and

medicine. Physicians are available for consultation on medical problems.

Such a sharing arrangement has much to recommend it to a small police department just getting started in criminalistics.

Criminalistics Equipment

The amount and kind of equipment needed to stock a criminalistics laboratory will of course depend on how big it is and how much work it will be expected to do. No exact listing of items can be made that will fit every laboratory. The following list should be considered as a "check" on which to base needs:

MEASURING INSTRUMENTS

Rulers	Tapes
Protractors	Angles
Pipets	Cylinders
Calipers	Micrometers
Levels	Drawing Instruments
Flasks	Graduates

WEIGHING INSTRUMENTS

Balance Scales Weights

VIEWING INSTRUMENTS

Microscope, low power stereoscopic binoculars
Microscope, high power medical
Microscope, bullet comparison
Microscope, polarizing

COLOR INSTRUMENTS

Colorimeter
Spectrophotometer
Spectrograph

Temperature Instruments

Incubator	Oven
Hot Plate	Refrigerator
Melting point apparatus	Burners
	Furnace
Water bath	Thermometers
Autoclave	

Apparatus, Machinery and Glassware

Clamps	Racks
Basket	Tripods
Filter paper	Labels
Wrapping paper	Sieves
Supports	Timer clock
Animal cages	Envelopes
Lens paper	Cartons
Mailing containers	

Laboratory coats	Rubber gloves
Aprons	Rubber stoppers
Scissors	Needles
Towels	Rubber tubing
Corks	Forceps
Spatulas	Scalpels

Centrifuge	Water still
Magnetic stirrer	Rotating machine
Vacuum pump	Air conditioner
Dehumidifier	Waring blendor
Siphon	Voltage transformer
Shaking machine	Typewriter
Microscope lamp	Burets
Beakers	Condensers
Capillary tubes	Flasks
Connecting tube	Refractive index
Bottles	Liquids
Culture dishes	Crucibles
Centrifuge tubes	Dessicator
Surface illuminator	Funnels

Jars	Mortars & pestles
Dropper pipets	Micro pipets
Culture tubes	Test Tubes
Transfer pipets	Vials

Chemicals and Stains

About 200 chemical reagents are needed for minimum list.

Photographic Equipment

Filters	Close-up devices
Printer	Print tongs
Safelights	View box
Ventilator fan	Projector
Film	Enlarger
Extra lenses	Lamps
Drier	Developer tank
Trays	Photo chemicals
Print drier	Screen
Paper	Sinks

COSTS

Salaries

The police administrator should keep in mind that criminalists have to be paid on the basis of their ability, education, and training. Unless this is done, the administrator will wake up some morning to find that his scientists have quit their positions and have gone to work for an industrial laboratory at double their police pay. There was a time when service in the police had many advantages such as pensions, sick pay, and job security that took the place of a higher salary. In modern times most private industries offer the same benefits and also higher wages. The most expensive item in a criminalistics laboratory is the criminalist. Some specialists such as forensic pathologists often receive a higher salary than the commissioner of police.

It is not possible to set an exact amount for the annual salary of a criminalist, but by comparing it with the amount paid to police officers of a similar pay grade, the police administrator may have some idea as to what these experts will cost him.

A director should receive a salary equal to one of the three top grades of police officer. A director of a Regional Forensic Science Laboratory in England receives the same pay as a chief constable. In the United States, a director is usually paid the same salary as an inspector. This is the same rank as a chief superintendent in England or a colonel of police in countries that use military ranks.

Examiners should receive the salary of captain or lieutenant in the United States, superintendent or chief inspector in England, or lieutenant colonel or major of police in countries that use military ranks.

Technicians usually receive the salary of sergeant in the United States, inspector in England, or captain of police in countries that use military ranks.

Maintenance

The laboratory must be given enough money every month to replace the things it uses up in making tests such as chemicals, serums, photographic film, and developing solutions. It is not a good idea to make the laboratory use pro-forma system of bidding for these small items. The laboratory should be allowed a certain monthly sum of money for chemicals and photographic supplies.

Replacement

Much of the laboratory equipment is made of glass, and no matter how carefully it is used, some of it will get broken every day. Replacement of glass items—beakers, flasks, test tubes, and microscope slides—may go as high as 100% each year. Another material that must be replaced often is light globes for the many lamps. Most of these are special sizes and shapes and cost more than ordinary lamps.

While some things like microscopes will last for many years, most of the electrical instruments will wear out in from three to five years. Money should be set aside to buy new instruments when necessary.

Repair

A skilled criminalist is expected to be able to make minor repairs to his instruments, but the most complicated apparatus has to be serviced by a skilled mechanic just like a motor vehicle. Money must be available to pay for these repairs. Sometimes an instrument like a spectrophotometer will operate for several years without trouble, but will suddenly break down without warning and require several hundred dollars for repairs. The police administrator should expect this and have reserve funds in his budget to take care of it.

Travel and Transportation

Criminalists have to travel about more than most policemen because there are fewer of them, and they must cover a wider area. Besides having to go to the scenes of important and serious crimes, they will have to obey the orders of the courts and attend the trials. Money will be needed for this purpose.