à M. Salomon Reinach
bien sincère et respectueux hommage
Harry Söderman

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# Science and Criminal Investigation

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DURING the last decades there has gradually developed a new science which in Europe is ordinarily called *police scientifique* or *technique policière*. It is rather difficult to say which of these terms is preferable. The former refers to a given, definite science, the latter, to the practical application of that science. The term *technique policière* is no doubt best, since it refers to the eminently practical application of a large number of different sciences to the investigation of crime.

## Modern Police Technicians

The founder of modern police technique is no doubt the Austrian Hans Gross (1847–1915), author of the famous *Handbuch für Untersuchungsrichter*. At the beginning of his career Gross was an examining magistrate (*Untersuchungsrichter*) and as such he had ample opportunity to witness the unreliability of human testimony. He therefore tried to supplant or strengthen such testimony by scientific means. Gross was a lawyer and made no great discoveries in police technique, but with inexhaustible energy he gathered, from all the different branches of science, everything that could be useful in his work. Thus he had a productive and animating effect upon the new art to which he gave rise.

Alphonse Bertillon (1853–1914), the famous chief of the *Service d'Identité judiciaire* in Paris, is of equally great importance although more within the field of identification technique. Bertillon created the anthropometric method of identification, the criminal photograph, the *portrait parlé* and the metric photograph of the scene of the crime. In the public mind he is erroneously credited with the discovery of fingerprints. On the contrary, Bertillon was for a long time opposed to the fingerprint method which displaced his own anthropometric system. The honor of having made fingerprints of use to the police falls to the Englishmen Sir Francis Galton and Sir Edward Henry and to the Argentine Juan Vucetich.

Following Gross and Bertillon, natural scientists became interested in police technique, and during the first decades of this century a number of new methods were perfected. Among the foremost representatives of modern police technique mention should be made of Edmond Locard at Lyons (poroscopy; questioned documents; dust and blood analysis), R. A. Reiss, formerly at Lausanne and now at Belgrade (criminal photographic methods), De Rechter at Brussels (identification of bullets, cartridges and traces of burglars' tools), Edmond Bayle in Paris (use of optical and photographic methods in police technique), Robert Heindl (metric photography and fingerprints) and Hans Schneickert (questioned documents; a number of classification methods), both in Berlin, Siegfried Türkel in Vienna (the examination of objects of art and antiques), and Van Ledden-Hulsebosch in Amsterdam (numerous chemical and optical methods of criminal investigation). The technique of identification alone presents a long list of prominent names, such as the late Jørgensen in Copenhagen (distant identification by means of a dactyloscopic code; single fingerprint classification), Wentworth at Dover, Maine (classification of palmprints and footprints; dactyloscopic code), Collins in London (distant identification by means of a dactyloscopic code), and others.

As mentioned, police technique has borrowed its methods from many sciences, but principally from three, i. e., biology, chemistry and physics. Under biology falls the fingerprints, certain examinations of blood and of hair, and strictly speaking the identification of disguised or imitated handwriting, in the sense that handwriting may be regarded as the self-registered expression of a biological process of mind and body. Under chemistry fall the examinations of stains and dust, poisons, counterfeit coins, and so forth; and under physics, all sorts of measurements and methods of comparison, as well as the more and more frequently used aids of a physical nature, such as spectrography, photometry, luminescence analysis, and so forth. In reality it is very difficult to draw any definite border line between the chemical and the physical methods used in police technique. On a reduced scale we see here the same phenomenon as in the relationship between the domains of physics and chemistry; the boundaries fade and disappear more and more. Besides this general tendency, there is something else in police technique that speaks in favor of physics, and that is the frequent necessity for working with very small quantities of material for investigation. Here spectrography and other physical methods offer the possibility of determining infinitely small quantities. Many modern criminalists maintain that the police laboratories of the future will almost entirely base their investigations on physics. Another advantage offered by the physical methods lies in their objectivity and in the relatively few sources of errors existing, in comparison with those in chemistry. This is to a certain extent true, particularly with reference to the sources of errors, but microchemical analysis still is in many cases decidedly superior to spectrography because it permits quantitative measurements. It is true that a quantitative spectro-analysis has been worked out through the researches of De Grammond, and others, but it does not give sufficiently exact results and, furthermore, is not always applicable.

In the following pages, besides a short description of some of the most important instruments used in a modern police laboratory, a brief survey will be made of the different fields of police technique in which the natural sciences or their applications play an important part. For the benefit of the reader I have made this survey from a critical point of view, at the same time emphasizing the most recent conquests of science, wherever made.

## THE EQUIPMENT OF A POLICE LABORATORY

Some time ago I was asked to propose a plan for the equipment of the Copenhagen Police Laboratory. Copenhagen has a population of about one million. With its heavy traffic, its teeming business life and its large groups of foreigners, this city offers a wide variety of crimes, although their frequency is relatively low, as is the case in the other Scandinavian countries. The plan proposed included the following apparatus:

*A microphotographic apparatus* with complete optical equipment and a special arrangement for the illumination of objects by means of oblique light, as in the examination of intersecting ink lines or in the photography of bullets.

*A microscope*, equipped with dry objectives, magnifying from eight hundred to nine hundred times.

*A comparison microscope*, an apparatus consisting of two objectives from which the light is cast through a series of prisms to a common eye piece. It is used in the identification of bullets and cartridges and gives exceedingly rapid and accurate results.

*A thick, welded steel pipe* for use in the firing of trial bullets.

*A spectrophotometer* or else a Zeiss *Stufenphotometer*, for the determination of the absolute shade of color in the examination of ink, stamps, and so forth. This apparatus is indispensable in many investigations, primarily because it permits the construction of accurate filters in the photographic process when it is necessary to distinguish between or to remove colors.

*An ultraviolet ray lamp* for so-called luminescence analyses in filtered ultraviolet light. This apparatus consists of an ordinary quartz lamp, from the light of which all visible rays are removed by means of a special filter, through which only ultraviolet rays pass. Different articles show a fluorescence in different colors under exposure to ultraviolet rays. This lamp is therefore an excellent and speedily operating aid in the examination of counterfeit bills, the bringing forth of otherwise invisible spots on woven material, and so forth. The ultraviolet ray lamp is furthermore indispensable in certain photographic processes.

*A spectrograph* for the photography of both the visible and the ultraviolet spectrum. This apparatus, which is quite expensive, is not absolutely indispensable but of very great value in the analysis of dust and powder stains, as well as in certain examinations of objects of art.

*A polarizer* to be inserted, when needed, in the microscope. This small apparatus is of great help in the examination of hair, fibres, textile material, and so forth.

*A reproduction camera* for plates.

*A magnifying apparatus* with a condenser, magnifying negatives up to thirteen by eighteen.

*A complete set of filters*, for instance, Wratten's.

*A chemical balance.*

*Chemical glass*, such as test tubes, retorts, microfiltration apparatus, and so forth.

*Various chemicals*, such as reagents for ink testing, filters, and so forth.

Some of these apparatus presuppose for their correct usage considerable scientific training. We shall discuss them further in connection with the description of problems of police technique which require their use.

## PHOTOGRAPHING THE SCENE OF THE CRIME

Although photographs of this kind are usually taken by a special police photographer, it is in many countries included in the work of the police laboratories. As mentioned above, Bertillon was the first to photograph systematically the scene of the crime, and he also devised the so-called metric photograph, which made it possible to compute all the measurements directly from the photograph. The camera for metric photography is equipped with a series of wide-angled objectives, the focal distances of which are exact multiples of ten. Each objective is fitted with a thread, which at each turn produces a change corresponding to one tenth of the focus. This arrangement makes a sharp focus possible for all levels of reduction from one tenth on.

The camera is a simple, square box without either bellows or pinions, and the plates are thirty by thirty centimeters. The depth of the box is thirty centimeters, and inside, it has five ridges for the insertion of the plate-holders. The distance between the ridges is five centimeters. The objectives are all in the same place, five millimeters in front of the first ridge. Thus nothing is movable in the apparatus, but, owing to the decimal focal distances and the regularly increasing distance between the ridges, one can obtain all sorts of combinations to meet the infinitely varying needs that the photographing of the scene of a crime may bring.

When a photograph is to be made, the apparatus is placed absolutely horizontally and at a "decimal" height, in practice usually fifty centimeters, one meter or one and a half meter. Bertillon also constructed a special base for this purpose.

With the aid of a simple geometrical process one can compute all measurements from the finished photograph. In order to simplify this, Bertillon had special cardboard mountings printed with scales varying according to the height of the apparatus and the focal width of the objective. Thus without any mathematical operations one could make all the measurements on the mounted photograph.

The metric photograph was a very important device but it has never been appreciated to its full value, due perhaps to the fact that it is more complicated to take than an ordinary photograph. In spite of the fact that several German, Austrian and Dutch students have tried to simplify it, it has fallen into disuse, and even in Bertillon's old laboratory in Paris it is probably used only in rare cases. This is deplorable, because it is often very important to be able to measure accurately the distances between different objects in a room as it appeared when the crime was committed.

In place of the metric photograph one nowadays uses two parallel methods: partly ordinary photographs of all interesting features, taking great care to retain the natural perspective, and partly sketched plans. As regards the latter it is noticeable that the so-called method of cross-projection in sketching interiors is used more and more. In such sketches the room is seen from above with walls and ceiling folded out so that they appear level with the floor.

### FINGERPRINT RESEARCHES

We shall not deal here with the classification of fingerprints although this is often made by the police laboratories. The methods for taking fingerprints at the scene of the crime have not undergone any great changes during the last decades. Latent fingerprints are still being stained with the aid of a hair brush and a staining powder, white lead for prints on a dark background, for instance, and lampblack for those on a light background. Many bureaus of identification have their own special staining powder and since almost every pulverized, heavy metallic salt can be used, there are many opportunities for variation. Photographs of fingerprints are made with an ordinary camera or possibly with a so-called fingerprint camera (Kodak or Bermpohl). Other special apparatus constructed for the photographing of fingerprints have proved unsatisfactory. In many European cities, especially in Berlin and in Vienna, so-called fingerprint foils are now used instead of photographs. These are thin celluloid plates covered on one side with a sticky substance which is protected by a very thin leaf of celluloid. The leaf is removed when the foil is to be used. The fingerprint is stained in the usual way, in this case preferably with aluminum powder, whereupon a foil is carefully pressed against it. The pigment adheres to the foil and the whole fingerprint with its minutest details is transferred to it and can be brought to the laboratory for leisured study.

The researches so zealously carried on some decades ago by Stockis, Lecca-Marzo, and others, in order to discover a perfect staining powder for fingerprints, preferably one that would chemically affect the fat deposits of the print, have not brought remarkable results and have been discontinued. It may furthermore be mentioned that the above staining powders serve the purpose very well, so long as very old fingerprints or those on paper are not concerned.

Old fingerprints may sometimes be stained with ordinary methods—the author has, for instance, with normal results stained two-year-old fingerprints on glass with lead white—but in many cases one must use other means. Reiss and Stockis, and others, have developed staining fluids containing alcohol, for the staining of old fingerprints. These methods are, however, complicated, often bring no results, and can only be used in important cases when other methods fail. Paper with fingerprints becomes considerably soiled by the usual staining powders. Therefore one frequently makes use of pulverized metallic antimony, but this also soils the paper although to a less extent than the others. Hence in place of powders iodine fumes have long been used. The paper is held above a heated receptacle with iodine, whereupon the rising fumes from the iodine are sublimated on the cold paper so that the fingerprint appears in a dark brown color. This method has the advantage that the iodine evaporates very quickly, leaving the paper white again. Although lately several apparatus have been constructed to spread the iodine fumes evenly over the surface of the paper, it is nevertheless very difficult to get a uniform stain. Hence the problem of staining fingerprints in this way has not as yet been definitely solved.

As a novelty in the field of dactyloscopy one may designate Professor Kögel's method of taking fingerprints by making use of the reaction of p-phenylenediamine upon wood fibre. When this method is used, the fingers are moistened with a hydrochloric acid solution of p-phenylenediamine and then pressed against a wood-fibrous paper. Due no doubt to the formation of azo-pigments, the fingerprints then appear in a blood-red color. The disadvantage of this method is of course the use of wood-fibrous paper which is not durable.

### EXAMINATION OF STAINS

In the common term of stains we include bloodstains, those from semen, urine, feces, meconium, paint, fat, and so forth. The differential diagnosis of stains and their determination and individualization are among the most important tasks of police technique.

The discovery of stains, which presents very great difficulties in case they are on a background of the same color, as for instance bloodstains on rust-colored plush or those of semen on dark woollen material, has become an easy matter through the aid of ultraviolet rays. Van Ledden-Hulsebosch relates for example a case in which he had to examine a large couch cover to ascertain the presence of spermatozoa. The couch cover had been removed from the office of a doctor accused of sex assault upon a woman patient. Formerly the search for a few spermatozoa by means of a microscope would, if carefully done, have taken several days. Now, however, with the aid of the quartz lamp all the stains were localized in a few minutes.

### BLOOD ANALYSIS

The problems arising in connection with blood analysis have been carefully studied during the last few years by several experts and although as yet one cannot say that all the questions have been answered, it can safely be asserted that within a relatively short time this will be the case. It has long been possible to determine whether a stain is blood or not. In doing this one makes use of Teichmann's or Stryzowsky's microchemical methods, by which, in case blood is present, one gets crystals of hematine-chlorhydrate and hematine-iodohydrate, respectively. Stryzowsky's method is particularly delicate but nowadays many laboratories make use of microspectroscopic methods by which the presence of blood is noted through the characteristic bands produced in the spectrum by the hemo-chromogene.

In determining whether blood is human or animal, the old methods of measuring and determining the form of the blood corpuscles have been generally displaced by serological methods, such as anaphylaxis, Uhlenhut's precipitation test, erytro-agglutination, and so forth. Uhlenhut's precipitation test is no doubt most commonly used nowadays, although anaphylaxis is, in spite of its complication and length, no doubt still used in some places. In the case of the precipitation test, the suspected bloodstain is dissolved in a small quantity of physiological salt solution, whereupon one tests if this solution is precipitated by animal anti-serum. If this reaction is controlled by a sufficient number of tests, one can consider it very reliable.

With the modern methods of blood determination it is also, owing to the discovery of the four blood groups, possible to individualize blood, although unfortunately in a negative way. The four blood groups are based upon two different characteristics in the red blood corpuscles—A and B—and two characteristics in the blood-serum—$\alpha$ and $\beta$. Serum $\alpha$ precipitates blood corpuscle A, and serum $\beta$ precipitates blood corpuscle B, if mixed. This phenomenon, in which elements contained in certain sera precipitate or agglutinate certain blood corpuscles, is called iso-agglutination. In blood group One, the blood corpuscles are agglutinated by sera from all the other three groups, while serum from this group has no effect upon the blood corpuscles of the other groups. In blood group Two, the blood corpuscles are agglutinated by sera from groups Three and Four, and serum from this group agglutinates the blood corpuscles in groups Three and One. In group Three the blood corpuscles are agglutinated by sera from groups Two and Four and the serum from this group agglutinates the blood corpuscles from groups Two and One. The blood corpuscles from group Four remain unchanged in all sera and its serum agglutinates the blood corpuscles from all the other blood groups. By following the method of Moss one can, with a very simple reaction, in a few minutes determine the category of a blood group. Using only a drop of serum each from groups Two and Three one mixes each drop with a drop of the blood to be analyzed. The group can be determined at once by watching the reaction in the two drops of blood:

If agglutination occurs in test sera Two and Three, the blood belongs to group One;

If no agglutination occurs in test serum Two, but in Three, the blood belongs to group Two;

If agglutination occurs in test serum

Two, but not in Three, the blood is from group Three;

If no agglutination occurs in any test serum, the blood belongs to group Four.

As mentioned above, one cannot make a positive identification by using the blood groups, as each group includes a very large number of people. In the case of a murder, however, a blood analysis may offer grave evidence.

In determining the presence of *semen*, Florence's reaction is still chiefly used. The reagents consist of potassium iodide, iodine, and distilled water, and if spermatic fluid is present, brown crystals are formed, which are visible under slight magnification. Since, however, the reaction can also occur in connection with several other fluids of organic origin, it is regarded as conclusive evidence of the presence of semen only when spermatozoa have actually been found.

The development of the technique for the differential diagnosis of other stains has kept pace with that of microchemical analysis, and due to the great progress of the latter there nowadays scarcely exists any problem connected with stains that cannot be solved.

### MISCELLANEOUS TRACES LEFT BY CRIMINALS

Under the heading of traces left by criminals we usually include footprints, marks of burglars' tools, hair, dust, and so forth.

*Footprints.*—The technique used in making a cast of footprints has undergone no great changes in late years. Plaster of Paris is still used, while the suggestions of older authors as to the use of wax, for instance, are not followed nowadays. It is moreover rather odd how very few policemen actually know the best way of making a cast, although theoretically almost all are acquainted with it. During the last decades it has become more and more common simply to photograph footprints, which of course was necessary previously in cases where the footprint was made in such soft material that it would be ruined if a cast were taken.

In the last mentioned case, a method invented by an Austrian gendarme, Johan Müller, is used which will save the minutest details of the print even if it is made in light dust. His method is to shake fine plaster of Paris in a very thin layer over the footprint, which is then moistened with a fine spray of alcohol from a suitable syringe. This is repeated three or four times, whereupon one reinforces the plaster with sticks and proceeds to make an ordinary cast.

Another novelty in the technique of making casts is the method devised by Poller of Vienna, who uses a special kind of paste, called *Negocoll*, in making casts of all sorts of objects. Poller's method gives surprisingly fine results with facial masks, and therefore it has been suggested that, for identification purposes, negocoll casts should be made of the faces of all unidentified corpses. When bodies that are in a more or less advanced state of decomposition are photographed, the face is discolored to such an extent that it can hardly be recognized from a photograph. The casts which are white may be painted flesh color, and according to Poller several corpses in Vienna have been identified by relatives with the aid of his method, when recognition from a photograph would have been difficult or impossible.

*Traces of Tools.*—Regarding casts of traces made by burglars' tools we shall notice only that the old principle has been followed: the simpler the better. Hence, all complicated methods suggested earlier, such as galvanic casts, Bertillon's effractometer, and others, have been replaced by the simple way of taking an impression with plasteline and from it make a plaster cast.

*Hair.*—The technique in examining hair, which in the case of so many crimes proves important, has not changed during the last decades unless one regards the studies in polarized light as having a place here. When hair is to be identified, its color, length, curliness, and so forth, are established macroscopically. The microscopic examination includes the examination of impurities attached to the hair, damages, which may have been inflicted upon it, the distribution of the pigment grains inside the hair, the position of the air cells in the canal, and the relation between the diameter of the canal and that of the hair itself.

During the last few years it is a noticeable fact that experts have become more careful in reaching conclusions in the identification of hair. There are very few cases nowadays in which an expert would grant to the identification of hair absolute and decisive value as evidence, although such identification may be of great subsidiary assistance.

*Dust.*—The examination of dust from the clothes of a suspected person may be of great significance in proving that he has been at a certain place where characteristic dust is found, or in ascertaining his occupation. The analysis of dust, which was first introduced by Sir Arthur Conan Doyle and used by him as a valuable ingredient in his Sherlock Holmes novels, has during the last few years been systematized and organized by Dr. Edmond Locard at Lyons. The technique is briefly as follows. With the aid of a specially constructed vacuum cleaner or else by beating the clothes of a suspect in a large paper bag, the dust is collected and examined under the microscope. Here all the most modern methods of microanalysis are used, and in many cases special experts must be employed to ascertain the origin of the extremely small vegetable particles, textile fibres, and so forth, that might be found. Numerous cases in which dust analysis has given good results could be related. A counterfeiter shows traces of antimony and other metals in his clothes; a man who has broken into a mill has flour dust, and so on. One might also include here cases in which the soil that may adhere to the shoes of the suspect is analyzed.

## THE EXAMINATIONS OF FIREARMS

One branch of police technique that has made considerable progress in the last few years is the examination of firearms. Nowadays it is regarded as an axiom that every firearm gives each bullet and each cartridge discharged from it absolutely individual characteristics that cause them to differ from all other bullets and cartridges. This holds true not only with regard to weapons from different factories but also for those of the same make, and of the same series. A Browning barrel number 46647 is absolutely different from barrel number 46648. If these characteristics are sufficiently pronounced, one is able to distinguish between the bullets discharged from these barrels.

This is easy to explain. The final work upon the barrel is done by a groove-making tool, which is subjected to a microscopically measurable wear during each operation. The material in the barrel also varies a little as to hardness, and these factors so operate together that the grooves or rather their bottom never has the same appearance twice. When a bullet passes through the barrel and the grooves are stamped on it, it becomes the carrier of all the scratches and the irregularities that it meets. When the bullet leaves the barrel it bears evidence of all the obstructions it has met on its way.

Let us suppose that a murder has been committed and a bullet found in the body of the victim. A man is arrested for the murder and a pistol is found in his possession. It is now necessary to discover if the fatal bullet was discharged from this particular weapon. This is done in the following manner. A series of trial bullets are discharged from the suspected weapon. For this purpose one shoots into a heavy steel pipe which is three fourths filled with water. The resistance of the water is quite sufficient to check even a Mauser bullet within a distance of somewhat more than one meter; it drops quietly and undamaged to the bottom of the steel pipe where it can be collected with the aid of a sieve. This device was prepared by the author for the Lyons Police Laboratory and has proved decidedly superior to the older methods which employed cotton, wax cakes, earth, sawdust, and so forth, instead of water.

In order to compare the suspected bullet with the trial bullets, each groove is photographed according to De Rechter's method, under medium magnification in oblique light. To simplify the search for the corresponding grooves, the Americans Waite, Goddard and Graville have constructed a special comparison microscope in which one can examine two bullets at once and compare their characteristics. Each bullet is put into a holder, strongly illuminated, and then placed under the objective of a microscope. The light from each objective is cast towards a prism, deflected in a horizontal direction and, again, vertically by means of another prism, in the middle of the apparatus, which deflects it upwards through a common eye-piece. In the eye-piece one now sees the two bullets side by side and can easily compare the microscopic scratches in the grooves. These comparison microscopes are now made in France in a form modified by the author and have spread to quite a few police departments in the Old World.

Regarding the value of these identifications as evidence, it must be pointed out that they do not always give full certainty as some experts declare, for the characteristic marks may be more or less pronounced. Contrary to earlier principles of the examinations of firearms, the idea is now held that a new weapon leaves more characteristic marks on its missiles than does an old one.

### IDENTIFICATION OF GUNPOWDER

Closely connected with the examination of firearms there are many other problems, such as the identification of the gun powder used and the fixing of the distance from which the shot was fired. The identity of the gunpowder is determined through the deposits on the inside of the barrel or the powder stains on the clothes or on the skin of the victim. It is naturally very easy to ascertain if it is black gunpowder or smokeless gunpowder, but when it comes to determining the individual powder, its make, for instance, the difficulties are greater. If it is black powder the problem cannot be solved, for almost all gunpowder factories use the classical recipe. If it is smokeless powder, on the other hand, the whole matter looks more favorable, especially if one has been able to find unconsumed grains in the powder stains. A simple microscopical examination coupled with microchemical analysis often enables one in such a case to determine definitely the origin of the gunpowder. If, as is usually the case, the smokeless powder only occurs in the form of very small deposits inside the barrel, a spectrographic examination may give good results. In such a case one tries to determine the inorganic elements which might be found in the gunpowder in the form of stabilizers or oxygen-carriers. All smokeless gunpowder by no means contains such elements, and on the whole one may consider the close differential diagnosis of the powder deposits as rather difficult.

Through the researches of Chavigny, in particular, it has been established that one can approximately ascertain the distance from which a close shot has been fired. This determination is made through observing the distribution of the powder stains and necessitates a large number of verified trial shots.

### Counterfeit Coins and Bank Notes

During the years immediately after the War counterfeit coins disappeared from Europe, coins of precious metals being no longer in circulation on the continent. Recently they have appeared again and before long this industry will thrive as vigorously as it did before the War. All falsifications of this kind, however, are easily revealed through chemical analysis, no matter how skillfully they have been made. Besides, this industry would not be very lucrative if it were not based on the carelessness with which people generally accept money.

Another kind of counterfeit coins which probably soon will have become as common as they were before the War is the factory-made genuine coins, manufactured in Spain and in several other countries. The manufacturers stamp real coins of full weight from different countries and make their profit by the rather great difference existing between the value of the coin and that of the metal. It is, of course, quite impossible to discover these counterfeiters if they have carefully observed the composition of the real coins.

Bank notes and all sorts of easily-disposed-of bonds or paper securities are forged in great numbers and since the forgers keep up to date regarding the latest progress of the technique of forgery one may come across some very well-made counterfeits. The luminescence analysis mentioned earlier, as well as microchemical analysis and photography with the aid of filters, infallibly reveal all such forgeries. The luminescence analysis, in particular, has great practical value, for with its aid one can rapidly examine large quantities of bank notes with comparatively safe results. The examination is so easy that it can be made by any bank clerk.

### Postal Thefts—Counterfeit Stamps

Under the heading of postal crimes we usually find all sorts of tampering with letters, forgeries of seals, and so forth. Such a crime never fails to be discovered if it is handled by an expert. A microscopic examination and luminescence analysis reveal the addition of sealing wax in damaged seals, gummed edges that have been disturbed, forged seals, and so forth.

Postage stamps are forged both in order to profit from philatelists and to circulate them through the mails. There are two classes of forgeries to be distinguished here: copies of postage stamps, seals, and so forth, which must of course be made by real printers; and old stamps that have been washed with some bleaching fluid in order that the stamped date, and so forth, should disappear, or that have had a second print put over the first in imitation of an official second print. Here again luminescence analysis comes to the aid of the investigator. During late years it has become widely used among stamp dealers. When stamps that have been treated with a bleaching fluid or that have very faint traces of a second print are to be examined, the ordinary luminescence analysis cannot be used, but in its place we may employ some of the ingenious methods elaborated by Professor Kögel, such as kathode-fluorescence, direct ultraviolet photographs, spectrostatic methods, and so on. In order to understand these, however, one must have a rather thorough training in the natural sciences.

### QUESTIONED DOCUMENTS

The examination of questioned documents may be divided into two groups, one of which may be suitably called the examination of *mechanical* forgeries and the other the identification of *imitated or disguised handwriting*. In the case of the former group one makes use of chemical and physical methods that allow a rather high degree of objectivity; in the latter, on the other hand, in spite of creditable attempts to introduce scientific and objective methods during the last years, one cannot to a certain extent avoid subjectivity.

The mechanical forgeries include erasures, uses of bleaching fluids, tracings, and so forth. To these belong also the problems connected with the determination of kind and age of ink, writing in pencil, intersections of lines and folds, investigations of paper, and so forth.

To distinguish between different kinds of ink there are several methods of which we might mention Miehte's photographic method, fluorescence photography, spectography and "touch" analysis. Due no doubt to its simplicity, the last mentioned is most frequently used. The principle of this analysis is as follows. With the fine point of a glass rod or a gold pen one places tiny drops of different reagents on the writing to be examined. The changes that occur make it possible to determine the nature of the ink. Naturally it is not possible fully to individualize ink in this way, for within each main group of ink there are a number of makes of similar composition. For closer individualization one makes use of photography with filters, examination with a so-called color-microscope using Lovibond's tintometer glass, or optic color analysis with the help of a photometer.

The determination of the age of ink is still a delicate chapter. Thanks to the researches of Osborn, Van Ledden-Hulsebosch, and others, there now exist methods that determine whether an ink is old or not, but when an iron-nutgall ink has become more than six months old there is scarcely any possibility of determining its age up to the time that it begins to turn yellow, which, depending on the way it is stored, does not begin until it is from six to ten years old.

As regards writing with lead pencil and indelible pencil there have been valuable researches made during the last few years by Michael Ainsworth, Locard, Türkel, Beroud, and others.

As is well-known, the identification of imitated or disguised handwriting is an old art; its ancestry goes back several hundred years. One might say that it is to the graphology of olden times what chemistry is to alchemy. Extensive researches by Locard, Schneickert, Osborn, and others, have led to systematization and to attempts to create an objective evaluation of the importance of the specific peculiarities of handwriting. As evidence of great progress we might note Locard's graphometry and Schneickert's division of the peculiarities in handwriting into primary and secondary groups. Briefly told, Locard's graphometry proposes to calculate and evaluate statistically a number of quantitative peculiarities in handwriting. It can only be applied, however, to long texts and the value of the investigation is in direct proportion to the number of measurements made.

The value of identifications of handwriting is still a much debated matter and is usually an apple of contention in the courts. A certain degree of subjectivity is unavoidable when the graphologist tries to find and build up a composite whole of those peculiarities of handwriting which characterize the writer. The handwriting expert must have a highly developed power of observation and a sense of form. The latter is not the least important, for many people are blind to form and cannot notice small differences in details. Furthermore, he must be able to evaluate the specific peculiarities in handwriting, an ability that calls for great experience and knowledge of modern methods of graphology. If all handwriting experts would realize their own limitations and, when formulating their conclusions, would try their very best to help the court by stressing the degree of probability that they consider as characteristic of the results of their investigations, and if they all had special training and were conscientious, the results of the identifications of imitated or disguised handwriting would be of the very greatest aid in the repression of crime.

## OBJECTS OF ART AND ANTIQUES

Thanks to microchemical analyses, X-ray examinations, different applications of fluorescence photography, spectrography, and so forth, most forgeries can probably be revealed. However, since one can never tell how skillful a forger may be, the principle holds true that although the expert may be able to establish the fact that an object of art is forged, he may nevertheless be unable definitely to prove that it is genuine.

The above review of scientific methods in criminal investigations is naturally superficial and incomplete. I hope, however, that it will give the reader an idea of the importance of scientific methods in all kinds of criminal investigations. It is an old truth that criminals always take advantage of the latest progress within technique and science. Therefore, the police, fighting as it does an often uneven battle to protect society, has every reason in the world to keep in step with the development of science—at least to the same extent as do the criminals.