CURRENT TECHNICAL DEVELOPMENTS IN THE FIELD OF TRAFFIC LAW ENFORCEMENT

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SYNOPSIS

In the past ten years, the fields of science have been opened to law enforcement in many ways Much progress has been made in adapting technical procedures to the solution of traffic problems. Many police departments now conduct simple enforcement surveys to determine how well traffic regulations are observed and to ascertain what measures should be taken on complaints which are reported. Training among police officers has been broadened to include numerous subjects of a technical nature. Among the devices which have been developed to assist in the field operations of traffic control are those used to measure speeds. The Kansas City speed meter, mirror boxes and more recently, the radar speed meter have all found increasing use among police departments. More and more, police are making preliminary studies to determine reasonable and safe speeds and then making periodic checks to determine how well speed limits are being observed.

To assist police in making computations for pre-accident speeds based on skidmarks, the Federal Bureau of Investigation has developed a simple speed calculator which eliminates the necessity for long, complicated mathematical computations This device consists of two concentric circular disks with logarithmic scales. It is a simplified slide-rule adapted to the special use of police officers.

Although some progress has been made in the development of scientific instruments for field operations, greater progress has been made in the scientific examination and analysis of evidence from hit-and-run accidents. Among those instruments which prove especially valuable for such examinations are the spectrograph, spectrophotometer, the X-ray diffraction spectrometer, the petrographic microscope, the comparison microscope and refractometers The spectrograph is used to determine the quantity and type of metallic elements contained in a substance The spectrophotometer discloses unknown dyes and coloring agents Each dye or coloring agent is identified by a particular transmission curve, determined by this examination The X-ray diffraction spectrometer supplements the analysis of evidence by assisting in the identification of crystalline material By studying the curves obtained with this instrument, the crystalline substance can be identified

By means of the petrographic microscope and refractometers, rocks, rock-forming materials and soils are classified and identified In addition to these instruments, the standard binocular microscope and the comparison microscope are used extensively to aid in examinations made with the above instruments and to examine and compare hairs and fibers found on a suspect automobile with those obtained from the victim. The progress which has been made in laboratory equipment and procedures is indicative of the progress which can be expected in field operations when the principles of science and other related professions are applied to the everyday problems of the police officer.

Only a few years ago two-way radio was a novelty in police systems. Today it has become standard equipment in nearly all departments. Just as the radio has proven its value to law enforcement in broadening the field of hearing and communications, so have many other scientific instruments and procedures enlarged the vision of law enforcement and improved its efficiency In the past ten years the fields of science have been opened to law enforcement in a variety of ways The work of qualified and skilled scientists in the laboratory has provided police with one of their most effective weapons against the serious violators of law. What has been done for law enforcement in the laboratory by the scientist, can be done in the routine enforcement of regulations in the field as more and more scientific developments are made which can be applied to the daily work of the officer on the street.

It is the purpose of this paper to summarize briefly a few of the current technical develop-

ments which are being applied by law enforcement in the field and laboratory to provide better enforcement of traffic laws and regulations.

TECHNICAL STUDIES

In recent years much progress has been made in adapting technical procedures to the solution of traffic problems. Many police departments are now conducting simple enforcement surveys to determine how well traffic regulations are observed. Such studies as stop sign or signal observance, speed observance, volume counts, and special accident studies are commonly used by police departments to determine what improvements should be made in traffic control. For example, in one midwestern city, a stop sign observance study at a high accident location revealed that many motorists were failing to stop before entering the intersection. When the facts were known, enforcement was increased, violators were issued citations for their offenses, and accidents were eliminated at that location.

In a southern city, the police department had determined from studies that many of the all-day parkers in a business district were merchants or business employees The congestion on the narrow main street was acute, and the department recommended elimination of parking on one side of the street This was opposed by the business and property owners The police department presented the results of its studies which showed that the available parking space was being used largely by employees in the business district. With these facts at hand, several of the most prominent business leaders who had previously opposed the recommendation then gave their full support to the proposal and the change was made.

Indicative of the application of scientific principles to traffic problems is the procedure adopted by many departments to obtain factual data and information on traffic complaints. Those departments which follow this practice have studies conducted to determine the existing traffic conditions before action is taken on the complaints. If accident studies are necessary, these are conducted as a part of the procedure. When all of the facts are available the complainant is then advised of the results and the action to be taken.

A large number of police departments now make extensive analysis of accident data The information thereby obtained is used to help engineers and educators, as well as to assist in the supervision of the traffic enforcement program. The assignment of personnel and the direction of enforcement effort are based, insofar as possible, on the results obtained from such studies. Furthermore, the police use the information thus obtained in traffic safety educational activities.

Another evidence of the use of technical facilities is that police are today making use of services which can be performed by local and consulting traffic engineers Police traffic training has also been broadened in many respects to include training on subjects which are of a technical nature. These and many other progressive steps prove conclusively that police are greatly interested in developing new technical procedures and utilizing every opportunity to apply technical developments which are available to them.

INSTRUMENTS FOR DETECTING SPEEDS

Speed measuring devices have been used in some departments for many years Generally they have been used for survey purposes to study the speeds of traffic and to determine how well motorists observe speed limits A few departments have used them specifically for enforcement purposes and have made charges against violators observed traveling in excess of the speed limits

Probably the most commonly used method of measuring speeds is that which utilizes two mirror boxes placed at a known distance apart and so arranged that the observer can see the image of a car as it passes these two points. By measuring the elapsed time, the speed is determined. This procedure has had only limited use for enforcement purposes, but many departments now use the mirror boxes to study prevailing speeds at hazardous locations or to determine the observance habits of motorists.

The Kansas City, Missouri, Police Department has for several years used a speed meter which automatically checks the time elapsed while a car passes between two rubber hoses placed across the roadway. The results of these tests are used for survey and enforcement purposes Motorists are allowed a reasonable tolerance in such measurements, and those found violating the law are cited for their offenses

The radar speed meter is one of the most

recent speed measuring devices which has been made available for traffic enforcement purposes. It has been used by some law enforcement agencies for at least two years, and it is proving to be an effective means of measuring and enforcing speed limits Thus far it has been adopted and used by only a limited number of departments.

Law enforcement agencies have used the meter for several different purposes. One of its principal uses has been to obtain information on prevailing speeds at high accident locations or on highways where such information might be used to aid the administrator in an effective assignment of his personnel. Since the unit can be operated inconspicuously, the observations give a true representation of actual speeds Furthermore, it is possible to measure the speeds of nearly all vehicles on a highway carrying less than 1000 cars per hour. The results of these surveys are, therefore, highly reliable.

Most agencies which have used the speed meter have attempted to use it for educational purposes as well as for enforcement purposes Some departments, after having selected a number of sections of highways which are particularly hazardous or where high speeds are common, have designated those locations as "radar control zones," and have had them so marked on the pavement surface The radar equipment is then moved from one location to another for short periods of observation. The painted signs on the streets are reported to have a psychological effect upon all motorists whether or not the equipment is in operation Those departments which have used this technique report that traffic speeds are appreciably reduced in such areas, and that motorists seem to exercise more caution in their driving The value of such marked zones, unless supplemented by rather frequent enforcement checks, may be open to question. Local motorists are likely to disregard them after a period. Some law enforcement agencies have used the speed meter primarily to detect violators, and then warn them of their violations This has been done either by stopping them at the time and advising them of their violations, or subsequently sending a post card to each violator telling him that his speed was observed, that it was in excess of the limit and requesting his cooperation

When using the meter to detect violations and make apprehensions, it is usually necessary to have two officers on duty, one being stationed about one eighth of a mile from the checking location. Reports which have been received indicate that prosecutions based on this evidence have proven successful. From the standpoint of enforcement efficiency, however, there may be some question as to the advisability or desirability of using two officers to check speeds at a single location when they might otherwise be on patrol over a rather wide area.

Those agencies which have used the meter report that it is accurate and effective; that the public generally is opposed to the indiscriminate use of it and that it is very effective in survey studies of speeds. The progress which has been made in developing instruments to measure speeds is indicative of real progress in technical developments for field operations.

THE SPEED CALCULATOR

Another development which promises to be of assistance to police in the investigation of traffic accidents is the "Speed Calculator" developed by the Federal Bureau of Investigation The primary purpose of this device is to provide a simple method of making computations for pre-accident speeds based on the length of skidmarks and other factors. The "Speed Calculator" merely eliminates the necessity for long, complicated mathematical calculations which in the past have proven so difficult for police to use.

The device consists of two concentric circular discs with three dials or scales One of these is smaller than the other, and both are pivoted together at their centers so that the overall diameter size of the calculator is approximately 4 in , although larger or smaller sizes can be made to fit the special needs of a department. The simple instructions written directly on the face of the calculator, make its use possible with little previous training.

The dials are simplified logarithmic scales which have been adapted to the special use of police officers in making these computations The outermost dial, marked as "Scale A," is for skidding or braking distances (feet). The middle dial, marked as "Scale B," is used for speeds (miles per hour) These are the only two dials which are used when the accident vehicle can be driven for test skids at known speeds.

The third dial, or innermost dial, is marked

as "Coefficient of Friction, Scale C." It is used when a calculation is to be made from the coefficient of friction and the length of the accident skidmarks. The calculator also has a transparent plastic indicator with a hairline running lengthwise through it. The purpose of this hairline indicator is to line up the numbers on the dial and simplify the reading of the dials. (See Fig 1)

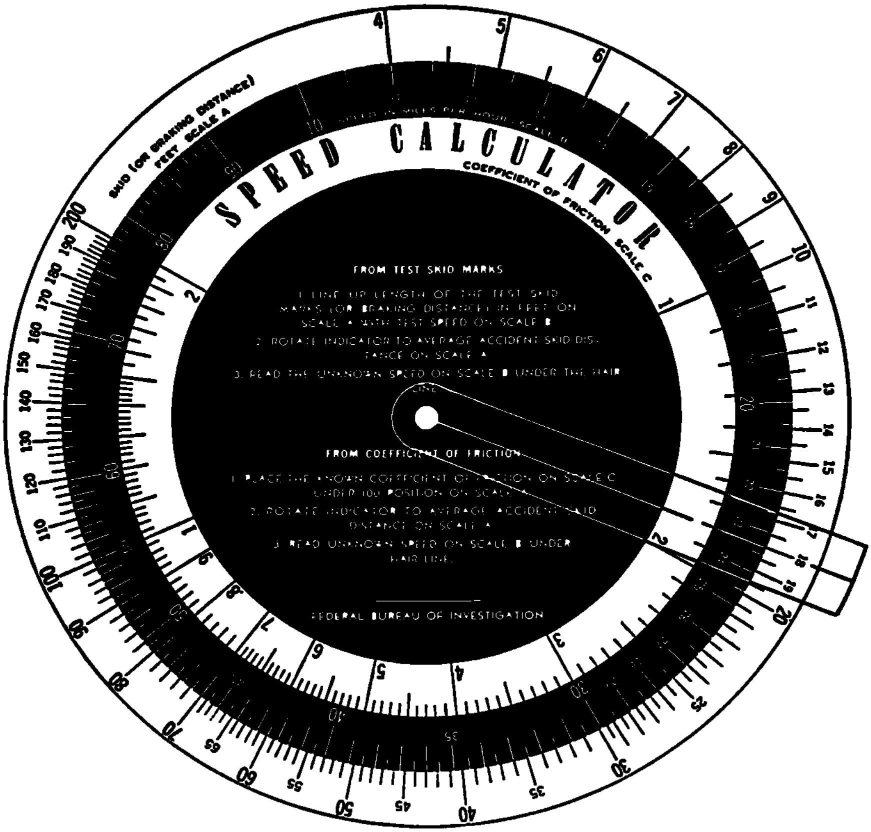

Figure 1. Speed Calculator

The same care must be exercised in collecting the data, measuring the skidmarks, and conducting test runs, as would be required if mathematical calculations were to be made. Although the calculator eliminates lengthy mathematical calculations, the results should be checked and testimony in court should be based on mathematical calculations and presented by one qualified to explain the technical application of the principles of physics to these problems.

SCIENTIFIC AIDS IN THE EXAMINATION OF EVIDENCE

Although some progress has been made in improving the work performed in the field operation of traffic law enforcement, much greater scientific progress has been made in the laboratory to aid the investigator in the examination and analysis of evidence In the field of traffic law enforcement, such examinations are usually made on evidence obtained from hit-and-run accidents In the following pages, typical pieces of scientific equipment which are commonly used for such examinations are described briefly and the application of such examinations is illustrated by citing specific instances in which the FBI Laboratory has been used to aid police in the solution of these cases.

Spectrograph—The spectrograph (Fig 2) is the instrument used to determine the metallic

elements present in an unknown substance. It is an optical instrument consisting essentially of an electrode stand, narrow slit, a prism, and a photographic plate (Fig 3)

The stand holds the electrodes The substance to be analyzed is placed in a small cavity in the lower electrode An electric arc causes the substance in the electrode to burn or give off energy The narrow slit allows a thin beam of light from the burning sample to fall on one face of the prism The light, in passing through the prism, is fanned out or separated into its component parts The different components of the light are registered as black lines on the photographic plate. The examiner,

Figure 2. Spectrograph

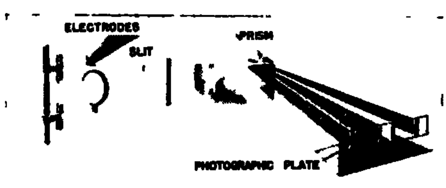

Figure 3. Diagram of Spectrograph

by studying the position and intensity of these lines, can qualitatively list the elements present and quantitatively determine the amount of each element present in the sample which was burned.

It is possible to determine the elements which are present in a given sample because it is an established fact that all elements have their own characteristic spectral lines. When any element is properly excited or burned it will give off light that is peculiar to itself For example, if the element sodium is burned, a series of lines will appear on the photographic plate—no other element will give off spectral lines in the same position as these sodium lines Copper, lead, gold, tin, and all the other elements can be excited so that they emit spectral lines which are peculiar to themselves.

This means that two small chips of paint, for example, which the investigator can observe to be similar only in color, may be observed by the spectrographer to be similar in color and to contain similar amounts of the following elements—chromium, lead, titanium, iron, calcium, aluminum, magnesium, and manganese. By using the spectrograph, small portions of evidence which tell the eye very little, yield reliable investigative information and become valuable in the presentation of the case in court.

A few months ago the FBI Laboratory received a small chip of paint from a midwestern police department. The chip of paint had been found at the scene of a hit-and-run accident in which a young man had been struck and seriously injured. An examination of this paint chip disclosed that it consisted of separate layers of paint and that the car was then painted a light blue-gray color The examiner determined that the automobile had been repainted at least three times and that the original finish was a light gray enamel which appeared in the sixth layer of the paint specimen. Furthermore, he was able to determine that this finish was most similar to the original finish used in 1941 Ford and Mercury automobiles at the time of manufacture. This information was determined from a comparison of the original finish with paint specimens in the National Automotive Paint File which is maintained in the FBI Laboratory This file is kept current at all times and contains reference specimens of all paints used by automobile manufacturers throughout the United States.

Supplied with this information, the police soon located a suspect. Four samples of paint were obtained from the suspect's car and forwarded to the Laboratory for comparison with the paint chip found at the scene of the accident. The samples of paint from the suspect's automobile also consisted of seven separate layers of paint in the same order as that in the chip found at the scene.

Microscopic, microchemical and spectrographic comparison examinations of the seven-layer paint chips found at the scene and those obtained from the car revealed all of them to be similar in colors, types, texture, layer structure and composition These examina-

tions disclosed that the paint chip found at the scene could have come from the same area of the car as two of the samples, which were submitted.

In the examination of this evidence not only were the separate layers of paint distinguished, but each was separated and spectrographically compared with the corresponding layer in the paint taken from the suspect's car.

The spectrograph is also used in the examination of other types of evidence from hit-and-run accidents. The examination of glass fragments, too small or too fragmentary to "match up" with other glass found on the suspect's car, may be accomplished by means of the spectrograph. This has been used in numerous instances. Fragments of glass from parking lights, fender markers and mirrors are often examined and good circumstantial evidence thus developed.

Small fragments of metal, not otherwise identifiable, may also be examined spectrographically to determine if a broken fragment at the scene could have come from a damaged or broken part of the car.

Spectrophotometer—The spectrophotometer is the optical instrument used to study color and coloring agents. It, too, has helped to solve many cases.

Basically, how does the spectrophotometer operate? A strong incandescent lamp acts as the source of spectral energy. This energy or light contains a mixture of all the visible colors. The light from the incandescent lamp is focused on the face of a prism. The prism spreads the light out to form a continuous spectrum which is similar in appearance to a rainbow. The different colors are then paraded individually through the solution under examination and the instrument records on a graph or chart the percentage of each color which goes through the solution. Curves obtained in this manner are known as transmission curves. Reflectance curves, for example, may also be obtained by reflecting the various colors from a painted surface. Figure 4 shows the examiner placing a solution in the spectrophotometer to obtain a transmission curve. Figure 5 illustrates the type of curves obtained from such an examination. These curves have been referred to as the "signatures of the dye."

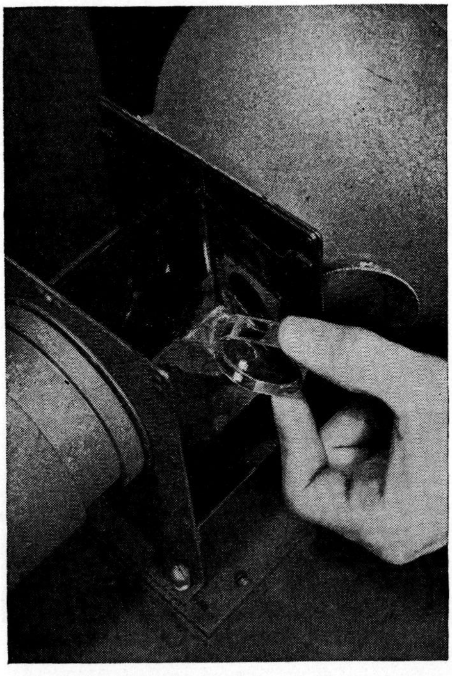

Figure 4. Placing Solution in Spectrophotometer

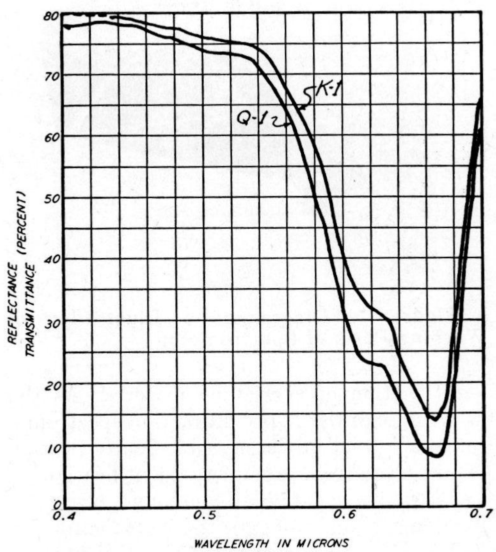

Figure 5. Transmission Curves from Spectrophotometer Examination

The spectrograph enables the examiner to see the elements present in minute particles of evidence; and the spectrophotometer assists the examiner in the identification of unknown dyes and coloring agents.

The coloring agent in a minute particle of

paint may be determined from a spectrophotometer examination. If a fragment of paint found at the scene of a hit-and-run accident has a coloring agent similar to that in one taken from a suspect's automobile, and the specimens are comparable in other respects, this may be good evidence that the two came from the same automobile.

X-Ray Diffraction Spectrometer—The X-ray diffraction spectrometer further supplements the analysis of evidence by assisting in the identification of crystalline material. As the name implies the X-ray diffraction spectrometer is operated in the invisible X-ray portion of the spectrum. Complete identification of an unknown crystalline compound often answers many questions for the investigator.

Figure 6. X-Ray Diffraction Spectrometer

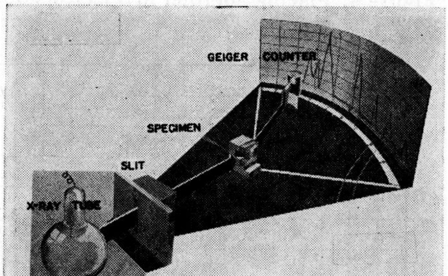

Figure 7. Diagrammatic Illustration of Working Parts of Spectrometer

The working parts of the X-ray diffraction spectrometer pictured in Figure 6 are illustrated diagrammatically in Figure 7. The X-rays generated in the X-ray tube are directed through a narrow slit. The unknown crystalline material bends or, technically diffracts the X-rays in a manner depending on the size and shape (geometry) of the crystals. The manner in which the X-rays are bent serves to identify the unknown crystals. Two different crystalline compounds will not bend or diffract the X-rays in a similar manner. The invisible X-rays are detected by a Geiger-Mueller tube which walks along a steel quadrant at the same rate of speed that the paper chart of the electric recorder unfolds. As the Geiger-Mueller tube encounters diffracted X-ray beams it furnishes electrical energy to the recorder which is proportional to the intensity of the X-ray beam and a series of peaks are recorded on the chart. By studying the curves and referring to an index file, the crystalline substance can be identified.

In a recent case which was submitted to the Laboratory, broken fragments of a rear view mirror were submitted for comparison. Some of the fragments had been found at the scene of a hit-and-run accident and others were obtained from a vehicle suspected to have been involved in the accident. A microscopic examination of the mirror fragments revealed that they consisted of three components, namely; glass, a silver backing and a thick coarse protective coating over the silver backing. One of the examinations conducted on these fragments was an X-ray diffraction study of the coarse protective coating on the back of the mirror. As a result of this examination it was established that the principal crystalline ingredient of this backing was the same for all mirror fragments which had been submitted. Examination of the other components also indicated that all of the fragments submitted were probably of common origin.

Petrographic Examinations—Petrography is the branch of the science of geology which deals with the systematic classification and identification of rocks, rock forming materials and soils. This science has been applied in the FBI Laboratory in the examination of soil deposits which may be dislodged from a hit-and-run vehicle at the time an accident occurs. An examination of such deposits may show that the soil is similar in composition to the soil later found on a suspect's car and that it is dissimilar to the native soil found at the scene of the accident.

Although to the lay mind, all soils may seem to be the same, soil samples from different locations are not identical. A survey was con-

ducted at one time to determine the similarities of soils along a 13-mile section of road. The samples were taken at approximately one-tenth mile intervals and from 6 to 8 ft. from the road bed. The samples were analyzed and compared and not one sample was found to be identical to any of the others. These results along with the hundreds of analyses of soils in the FBI Laboratory and throughout the United States, tend to show a wide variation in soils.

One of the scientific instruments used for the examination of soils is the petrographic or polarizing microscope. The primary purpose of the petrographic microscope is to determine the optical properties of non-opaque or transparent crystalline substances and glass. The most distinctive features of the petrographic microscope are the polarizing analyzing prisms plus several accessories such as the Bertrand lens, mica plate, gypsum plate, and quartz wedge. The microscope is adapted for the ordinary examination of minerals in plane polarized light. Since all crystalline substances have distinctive optical characteristics, such as the index of refraction, it is possible to identify those substances by these optical properties. Thus it is possible to determine from a qualitative and quantitative examination whether a clump of dirt found at the scene of a hit-and-run accident could have come from the undercarriage or fenders of a suspect automobile.

Two other instruments used to assist the determinations for the index of refraction are the Abbe Refractometer and the Precision Refractometer. These precision instruments greatly simplify the otherwise difficult task of determining the index of refraction of an unknown substance.

Typical of the many cases in which soil examinations are useful in solving hit-and-run cases is one which occurred in a western city about two years ago. Four witnesses who observed the accident differed in their statements pertaining to the color of the car that was involved although they agreed that the automobile was a Packard. A clump of soil dislodged by the impact of the car was the only item of evidence found at the scene. A suspect was subsequently located, and samples of dirt from under the fenders of the car were forwarded to the Laboratory. A petrographic examination of the soil found at the scene and that taken from the suspect's car disclosed that they were identical in every respect. Furthermore, the samples, both those from the scene and from the car, were found to have numerous items of foreign material, which had apparently been accumulated in an industrial area. The foreign material in the samples were also compared and found to exist in the same quantity and quality in each sample. Approximately thirty different substances were found to exist in each sample, indicating quite conclusively that the soil found at the scene and that obtained from the automobile came from the same place.

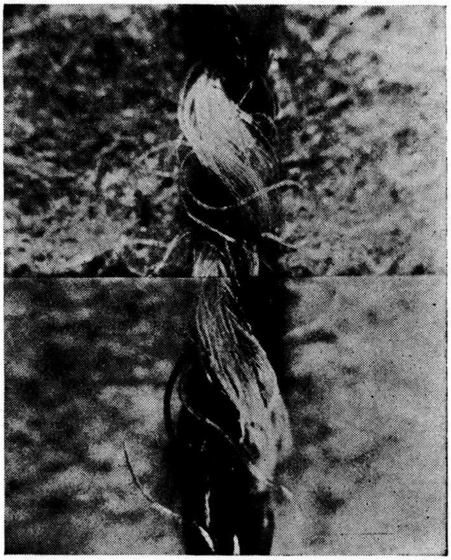

Figure 8. Two Fibers Under Comparison Microscope

Microscopic Examinations—In addition to the petrographic microscope and the standard binocular microscope which are used in many laboratory examinations, a third type of microscope has proven extremely valuable in many examinations. The comparison microscope is used for a wide variety of visual and photographic comparisons. This instrument is composed of two compound microscopes connected to a single eyepiece by means of a series of prisms and lenses. Objects placed on the two stages of the comparison microscope are optically cut in half in such a manner that the forward part of the object on the left stage may be readily compared with the rear portion

of the object on the right stage to form a composite image from portions of the two objects. The two objects are brought into focus through one eyepiece having a circular field which is divided in the center with a fine line separating the images from the two stages. The stages of the microscope are mechanical to permit manipulation and are provided with spindles for rotation of the specimens

This instrument may be used, for example, in the examination of fibers of clothing, or marks and striations on a fragment of metal which may have been broken from a hit-and-run car. Figure 8 is a photograph of two fibers being examined under the comparison microscope. In the examination of these two fibers it was found that the fiber found on the car, represented in the upper half of the photograph, compared in several respects with a fiber from the victim's coat. Both threads were found to be similar in size and type of fiber; both were composed of the same number of strands with like compositions. Tests indicated that the same type of dyestuff was present in both threads.

Scratches and marks which may be found on a broken radiator ornament may, for example, be examined under the comparison microscope to show whether or not the broken piece did or could have come from the car in question These and many other uses are made of the comparison microscope in the Laboratory.

This discussion will serve to illustrate some of the scientific developments which have been made in the laboratory and which are being applied daily in the field of law enforcement. Obviously, there has been much greater progress in the application of science to laboratory examinations than to the solution of problems arising in field operations. The progress which has been made in the laboratory is indicative of what progress can be expected in the handling of field problems as soon as the principles of science and other related professions are fully applied to the everyday problems of the police officer

DEPARTMENT OF SOILS INVESTIGATIONS

HAROLD ALLEN, *Chairman*

INVESTIGATION OF A SIMPLE METHOD OF IDENTIFYING BASE COURSE MATERIAL SUBJECT TO FROST DAMAGE

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SYNOPSIS

This paper is concerned with the identification of base course materials that are subject to softening by supersaturation as a result of freezing and thawing conditions The necessary investigation was prompted by widespread damage to bituminous pavements, in northern Arizona, as a result of this phenomenon

The research was based upon accepted principles of excessive water accumulation in materials through frost action The principle here involved is that the capillary pores must be small enough to hold free water against the force of gravity and the expulsive action of traffic. It is reasoned that the above property can be determined by simply compacting the material at a moisture content in excess of optimum and observing whether it is firm, or soft by reason of excessive pore pressure

The test procedure adopted was based upon the standard AASHO density test, T 99, with certain modifications involving free drainage at the base of the mold and compaction at moisture contents above the optimum Observations and tests were made on the stability of the material, in its complete grading range, when compacted at relatively high moisture contents

The correlation with field performance was made by taking samples from eight projects that had a history of frost distress in the base, one project which had suffered no appreciable damage but on which there is evidence of borderline susceptibility to damage by frost and six projects which were unquestionably