101

STATE OF OHIO)
) SS:
CUYAHOGA COUNTY)

IN THE COURT OF COMMON PLEAS
Criminal Branch

No. 64571

STATE OF OHIO,

PLAINTIFF

vs.

SAMUEL H. SHEPPARD

DEFENDANT

AFFIDAVIT of PAUL LELAND KIRK

PAUL LELAND KIRK, of lawful age, being duly sworn, states that he resides at 1064 Creston Road, Berkeley, California; that he was graduated with the highest honors from Ohio State University in 1924 with a degree of Bachelor of Arts in Chemistry; that in 1925 he was awarded a degree of Master of Science in Chemistry by the University of Pittsburgh; that in 1927 he received a degree of Doctor of Philosophy in Biochemistry from the University of California; that he was an assistant in Chemistry at the University of Pittsburgh during 1924 and 1925; taught biochemistry at the University of California 1926 and 1927; was Research Assistant in Biochemistry at the University of California in 1927 and 1928; Research Associate at the University of California 1928 and 1929; Instructor in Microchemistry in the Biochemistry Division from 1929 to 1933; Assistant Professor of Biochemistry at the University of California from 1933 to 1939; Associate Professor of Biochemistry from 1939 to 1945; on leave to the Radiation Laboratory directed by Ernest O. Lawrence from 1942 to 1943. This was the first organization devoted to atomic energy research; from there he was transferred to the Metallurgical Laboratory of the University of Chicago, in 1943 to 1944, which was a branch of the Manhattan Project, concerned with the development of plutonium; Technical Specialist, Hanford Engineering Works, Richland, Washington, 1944 and 1945, in charge of Microchemical, Research and Development in connection with the manufacture of the atomic bomb fuel, plutonium, (explosive) used at Nagasaki, Japan; Professor of Biochemistry and Advisor in Criminalistics from 1945 to 1948; Professor of Biochemistry and Criminalistics in the University of California from 1948 to 1954; Professor of Criminalistics, School of Criminology, at the University of California from 1954 to the present time; member of the Medical School Faculty of the University of California from 1927 to 1950; Associate Professor in Physiology, Hopkins Marine Station (Stanford University), 1935; Investigative work in Criminalistics in 1935 for the Berkeley Police Department in California, and investigation for the District Attorney of Alameda County, California, who was Hon. Earl Warren, now Chief Justice of the United States Supreme Court; Continual Investigative work in Criminalistics for various public bodies and individuals until 1942, when the work was discontinued due to services required in the Atomic Energy Research Project; from 1945 continuous investigative work for district attorneys in Alameda and San Francisco Counties and other counties throughout the northern part of the State of California, this investigative work being principally on behalf of agencies of the State.

Affiant further states that prior to World War II he was placed in charge of the training program in Criminalistics of the University of California and wrote the curriculum; that after the War he renewed his activities in criminalistics; that he was consultant to numerous agencies, including the State Crime Commission of California, the Army, Atomic Energy Commission, and numerous industrial concerns with investigative problems, and private individuals.

Affiant further states that he has been accepted as an expert witness in Criminalistics for various Federal and State Courts, including the Federal and State Courts of California, Federal Court of Nevada, Federal Court of Oregon, State Court of Arizona, Federal Court of Idaho, and the State Court of Louisiana.

Affiant states that Criminalistics is the application of the techniques and principles of the basic sciences, particularly chemistry and physics, to the examination and interpretation of physical evidence; that he is in charge of the Criminalistics portion of the School of Criminology of the University of California, which school is concerned with the training of police laboratory technicians, crime laboratory technicians, and the scientific investigation of crime; that the persons entering and studying in said School come from all parts of the United States and from all over the world; that many of the State Crime Laboratories are staffed with graduates of said School, which gives a degree of Bachelor of Arts and Bachelor of Science, and Master of Criminology.

Affiant has been the author of at least 150 original papers in scientific literature and many of said papers are on Criminalistics; that he is the author of "Quantitative Ultramicroanalysis", 1950, publisher, John Wiley & Company; "Density and Refractive Index" - "Their Application to Criminal Identification", 1951, publisher, Charles C. Thomas Company; "Criminal Investigation", 1953, publisher, Interscience Publishing Company. This work has international circulation among state and governmental agencies in the United States and foreign countries, and is a guide to the use of physical evidence by persons engaged in law enforcement.

Affiant is Associate Editor for Police Science of the Journal of Criminal Law, Criminology and Police Science, which is the official publication of the International Association of Arson Investigators, the Illinois Academy of Criminology, the Society for the Advancement of Criminology; Associate Editor of Mikrochimica Acta, which is an international journal of microchemistry, published in German, English, French and Italian.

Affiant is Vice President of the Microchemical Commission of the International Union of Pure & Applied Chemistry; a member of the National Research Council Committee on Analytical Chemistry; a member of the American Chemical Society Committee on Weights and Balances, a member of the Belgian Royal Academy, the American Chemical Society, the American Association for the Advancement of Science; the American Society of Biological Chemists, and the Society for the Advancement of Criminology.

Affiant states that he came to this County (Cuyahoga County, Ohio) at the request of William J. Corrigan, one of the attorneys for the defendant; that he arrived on January 22nd, 1955, and departed on January 26, 1955; that his purpose in coming to this County was to examine the physical evidence that was connected with the murder of Marilyn R. Sheppard; that he examined the premises at 28924 West Lake Road, city of Bay Village, Ohio; that he was informed that the house in which Marilyn Sheppard was murdered on the morning of July 4, 1954, had not been disturbed by anyone connected with the defense; that he was to make a careful appraisal of the technical evidence involved in said murder.

Affiant further states that said attorney agreed to pay this affiant his expenses and such other necessary fees as would compensate him for the time he would devote to his examination, investigation and research, but with the specific understanding that his work in this regard was to be entirely objective and his determinations would be without bias or prejudice to the case of the State of Ohio or the defendant, and that his work was to be on no other basis. He further states that no instructions or suggestions were made to him as to what to find, or what not to find, by the attorney representing the defendant, or by any other party interested in the cause of the defendant; that his investigation, examination and research would be strictly impersonal, and that the facts would be reported exactly as he found them to be.

Affiant states that with this understanding, he made an examination and investigation of the physical and technical evidence in the case and of the premises in which the murder was committed, and thereafter performed a number of experiments in his laboratory at the University of California, testing the significance of the facts which he found established in his examination and investigation during the period from January 22nd to January 26th, 1955, and made an interpretation of said evidence.

Affiant states that in order to properly interpret the evedence disclosed by his investigation and examination, and to arrive at ultimate facts, he examined the evidence presented in the case and determined the relation of such evidence to the facts disclosed by his examination, investigation and research.

Affiant states that he examined certain physical materials of possible evidential value, as follows:

1. Premises of the defendant, Samuel H. Sheppard, 28924 West Lake Road, Bay Village, Ohio, on January 23 and 24, 1955.
2. Materials introduced as exhibits in the case of the State of Ohio vs. Samuel H. Sheppard, and held in custody of the Criminal Prosecutor of Cuyahoga County, Ohio, on January 25, 1955, in the presence of Mr. Parrino.

Items collected and removed from the premises of the defendant on January 24, 1955, follow:

a. Top cover (ticking) of the bed on which Marilyn Sheppard was murdered. This was cut with a razor blade around the outside stitched junction.
b. The bottom sheet from the adjoining bed, carrying blood spatter.
c. The yellow pillow-case from the adjoining bed, showing blood spatter.
d. A pair of nylon stockings from the wardrobe in the defendant's dressing room.
e. Debris swept from the carpeting of the murder scene, between the bed of Marilyn Sheppard and the adjoining east wall of the room. This was removed with a vacuum sweeper and special filter attachment.
f. A number of samples of carpet fibers pulled from selected regions of the carpeting in the same general area.

Additional items received at or about the same time were a set of photographs, copied from court exhibits, 16 books of transcript covering technical and some other testimony, a copy of the inquest report, a copy of the autopsy report, certain copies of written statements made by witnesses but not part of sworn testimony, and some miscellaneous papers.

On February 18, 1955, there were received by registered mail two samples of dried blood, collected from two previously identified spots on the wardrobe door of the murder room.

On March 9, 1955, there was received by special delivery mail one package containing an envelope with cotton and two bottles of nail polish, one Revlon's "Cherries in the Snow", and one "Bachelor's Carnations".

Examinations and Results

Detailed analysis of the blood pattern in the bedroom in which Marilyn Sheppard was murdered constituted the bulk of the analysis of physical evidence. It is in this room and only here that the story of the actual murder is written.

Evidence introduced in the trial was examined at the County Prosecutor's office. Only visual examination was possible since no alteration whatever of the materials there was allowed, and

no samples were allowed to be removed. Numerous items in custody in that office should be examined thoroughly which apparently was not done previously. These include particularly:

a. The lower bed sheet from Marilyn Sheppard's bed.
b. Pillow slip from Marilyn Sheppard's bed.
c. Teeth fragments.
d. Nail polish. This latter item was not found. The container (Ex. 44) so labeled was searched with magnification, and was apparently completely devoid of anything that could be identified as nail polish. The same was true of the slide allegedly containing nail polish from under Marilyn Sheppard's finger nails. (See discussion of nail polish elsewhere.)
e. Defendant's trousers.

Numerous experiments were also performed to allow reliable interpretation of certain observations. The complete absence of careful interpretation shown in the trial transcript leaves nothing tangible, only inference. Experiments designed to test the reliability of interpretation but not dealing directly with materials involved in the case itself are appended to the affidavit, not written into it. The actual investigative details and results are broken into suitable categories which follow, along with a discussion of the status of the case as it was presented by the prosecution and on which the present guilty verdict rests. It is considered important to review these matters because they are either indicative of guild as accepted by the jury, or they are a fabric of errors of omission, commission, or both.

****

TECHNICAL EVIDENCE OF THE PROSECUTION

Careful appraisal of the technical evidence presented by the prosecution shows it to be completely worthless as proof of the guilt (or innocence) of the defendant. Only the autopsy and pathology findings are really pertinent to the case. With two minor exceptions, it shows no circumstantial value whatever. There are:

(a) Water under defendant's watch crystal.
(b) Loss of T shirt.

The first point, (a), is self-contradictory. If the watch was in the lake after the murder, fresh blood on it would have been removed to a degree which would make any effort to group it completely futile. (See APPENDIX A). Since it was considered to be sufficient for grouping, the watch could not have been in the lake after the murder, and the water must have been under the crystal previously.

Point (b) has no ready explanation which can be shown so definitely. It is consistent with the story told by the defendant, as well as with the version presented by the Prosecution. It is not impossible that the murderer removed the T shirt to be used in cleaning blood from his own person. An unbiased observer would surely be struck by the fact that the defendant, if he removed his T shirt because it was bloody, would surely put on another one to cover the loss of the first.

Other Semi-technical points of the Prosecution that deserve comment are:

a. The claimed drying of blood on Mrs. Sheppard's wrist before her watch was removed; and
b. Drying of blood on defendant's watch before it was inserted in the green bag.

These items are equivalent since both involve the time necessary for freshly shed blood to dry. Naturally, both temperature and humidity influence the rate of drying, and these are

not known with certainty for the early morning of July 4, 1954. It is known that blood dries rapidly when in thin layers or small drops. Curvature of a small drop markedly increases its vapor pressure, and a thin layer exposes a great deal of surface for a very small volume.

Experiments to check this point are reported in Appendix B. The time necessary for blood to dry under reasonable conditions is certainly short enough that it could well have heppened between the time of the murder and the time that the stage was set to simulate a burglary. In fact, unless some large drops or thick layers were involved, the time becomes reasonable if the watches were removed about immediately after the commission of the crime.

BLOOD TRAILS

The presence of blood trails throughout the premises has no bearing whatever on the guilt or innocence of the defendant. Whoever the murderer may have been, these would have occurred to a similar extent and degree. The fact that only five or six spots of blood were proved to be human in origin, and that these would or may have alternative explanations make it extremely doubtful if any of the blood trails, with the possible exception of spots on the main stairway, were in any way connected with the murder.

Experiments on these points are appended (See Appendix C) and show clearly that the blood trails claimed probably have no connection with the murder and could not have been used properly to prove the guilt or innocence of any accused person.

Ways in which blood might have been transported throughout the house by the murderer are by the:

A. Clothing. Blood spatters do not drop from clothing unless the cloth is water repellent, in which case the loss of liquid blood is almost instantaneous. (See Appendix D). Blood in the alleged trails did not come from this source.

B. Weapon. An occasional drop of blood may fall from some weapons some time after the weapon is immersed in it. Most of the excess blood drains almost immediately but when the wet surface is large, the slow drainage of the viscous blood allowed distances as much as fifty feet to be covered in normal walking before the last blood was lost. Most objects tested as weapons lost the last drop within fifteen(15) feet of normal walking. Blood may adhere to a static or swinging weapon for as much as forty-five (45) seconds after dipping in fresh blood. In every instance, the blood is lost as a few large drops, unless the weapon is shaken vigorously to dislodge the smaller accumulations. (See Appendix E). No such large drops were found anywhere in the alleged blood trails. It should be noted that blood is so viscous and sticky that unless a weapon is actually dipped in it, or carries comparable amounts of blood, the latter is removed only by shaking and will not drip spontaneously. A vigorous movement will displace small drops, but carrying it normally displaces either nothing at all or large drops, depending on the amount of the accumulation. If any of the blood were shaken from the weapon after leaving the room, it still is not reasonable that this process would continue to the basement, the garage, etc., and in any instance, it tells exactly nothing about the hand that held the weapon.

C. Skin, of hands (or face, etc.) Blood drops from an immersed hand in the same manner essentially as from a weapon. All considerations of B. above, apply.

D. Shoes. Tracking of blood on the shoes is a highly probably method of leaving a blood trail. Such trails may persist visibly as far as

fifty feet (50), (See Appendix F), after stepping in an actual puddle of blood and walking at normal rate. The appearance of the trail is very different from the small spots claimed, and in no case could such spots be placed on the risers of stairs, as shown to have occurred. Heel smears containing blood might be placed in careful descent of stairs with bloody shoes. No definite record of such bloody smears is found in the testimony. In summary, the shoes are the most probable carriers of blood, but no evidence was adduced that remotely indicated this origin of any of the trails. Also, the presence of such trails would indicate the passage of the murderer but give no indication whatever of his identity. One further point of great importance - if any significant amount of blood was transported on shoes by the murderer, the shoes, even after soaking in water would be expected to show evidence of the original presence of blood. (See Appendix G). No such indications were claimed in testimony, and inspection of the shoes did not reveal the slightest indication that blood was or had been present on them. It should be noted that the amount of blood would in any case be too small for extensive tests, but there should be enough around stitching and in small recesses to allow chemical blood tests to yield positive results.

GREEN BAG AND CONTENTS

Clearly, the presence of blood on the green bag is not indicative in any way of the guilt or innocence of any accused person, because it may be presumed to have been put there by the murderer regardless of who he may have been. This is equally true of all of the contents of the bag, since it must be accepted that the murderer stripped from both the victim and the defendant the items in the bag.

If the defendant was the person doing the stripping, two facts require explanations: (a) The presence of a four-inch tear in defendant's trousers below the right side pocket; and (b) the damage to the watch band of defendant's watch. Both of these items are things that are highly improbable if defendant stripped the key chain and the watch from himself. It would have been next to impossible for him to tear the pants as they are torn in removing the key chain since the only movement of his hand that is possible without contortion is upward and outward, not downward as required. Regardless of how excited or disturbed one is, he also tends to protect his watch, from sheer habit, if for no other reason. Ordinary removal would be normal, and damage during it would have to have an accidental origin. This assumes that the damage to the watch band was not a pre-existing condition caused by an earlier accident. It is difficult to accept the idea that a person would remove his own watch so violently as to damage the band to the extent that exists.

Regardless of interpretations that may be placed on any of this evidence, it clearly has no value of proof of the guilt of the defendant, and actually is better interpreted in the contrary terms.

BLOOD ON DEFENDANT'S CLOTHING

The comparative absence of blood on the clothing of the defendant is highly significant. It is entirely certain that the actual murderer received blood on his person, and no portion of his clothing that was exposed could have been exempt from blood staining. The amount on his person would not probably be very great. (See Appendix H) His face and hair were probably spattered also in some degree, and his hand would have to be quite bloody, almost certainly

from the blood of the victim and from his own blood (see elsewhere in this affidavit).

Complete washing in the lake would unquestionably to sufficient to remove the blood from the skin, and possibly from the hair, but only if the hair was well washed. Whether all blood would be removed from the clothing is doubtful, though it is possible that it might be removed from the trousers to a point of being undetectable. It would not be expected to be completely removed from the shoes, as indicated above, and crevices around belt buckles or similar recesses might well persist.

The presence of blood on the knee of defendant's trousers is particularly significant, because it appears to be hemolyzed blood, and restricted to the single relatively small area. Had other blood on his trousers been washed out completely by the lake water, this also would have been. If his wet trousers were placed against blood on the sheet in the bedroom as is strongly indicated by the examination of the sheet, such blood would have hemolyzed and spread throughout a restricted region, thinly and rather uniformly as is found.

SUMMARY

Analysis of the technical evidence offered by the prosecution shows it to be superficial, incomplete, and erroneous in interpretation. Little if any of it had a direct bearing on the guilt or innocence of Dr. Samuel H. Sheppard. At the most, it establishes that the victim was beaten to death by a weapon of unknown type; that there was some blood found in various places in the house; that the murderer attempted to give an impression of a burglary; that it was so amateurish and clumsily performed as to fool nobody; and that certain details appeared to be inconsistent with the story told repeatedly by the defendant. Even these apparent inconsistencies were so minor as to be of little value if correct, and no certainty of the correctness of interpretation was established. Briefly, no actual proof of a technical nature was ever offered indicating guilt of the defendant, and the facts that were established and offered are even more readily interpreted in several respects in terms of another murderer than the defendant.

****

THE MURDER SCENE

The bedroom in which the murdered body of Marilyn Sheppard was found is shown in approximate scale diagram in accompanying photograph No. 1. The diagram represents the condition at the time it was examined by the undersigned. The two twin beds and bureau, shown in the drawing are in the same position as indicated in prosecution photographs. The drawing omits the rocking chair in the northeast corner of the room, which carried no visible blood or other significant evidence, and the small telephone stand between the two beds which did not figure in testimony, or in this investigation.

Blood Distribution. By far the most significant evidence to be found was the blood distribution in the murder room. Proper interpretation of this distribution must give the reconstruction of the crime because every blow struck placed its signature in the room in blood. It is also the most significant, and possibly the only significant evidence that can be offered based on blood studies. It was virtually disregarded by the earlier investigators as determined by examination of the trial transcript.

Blood spots were present on every wall of the room, and were distributed over all of the defendant's bed. The extent of blood on the floor, and on the items of furniture could not be determined at the time of this investigation, but some indication is available from testimony and exhibits of the prosecution.

Distribution on the walls. The east wall of the room, and particularly the wardrobe door and the open hall door at the south end of that wall showed blood spatters in very large numbers, as indicated in trial exhibits and in accompanying photographs. The distribution was most significant, being roughly triangular on the two doors, and discontinuing completely at the north end of the wall for a distance of nearly four feet. Nearly all spots on the wardrobe door were below the level of the door handle. On the open hall door, the spots ranged almost to the top of the door on the edge nearest the hall. The approximate limitation of blood spots on the doors is shown in photograph No. 2. The last of the blood spots north of the wardrobe doors are approximately eight inches from the door jamb facing. A photograph of the most concentrated portions of these spots is given in No. 3. No spots were present on the north portion of the east wall for a distance of about four feet.

The south wall had on it a limited but considerable number of spots which were heaviest in the vicinity of the head of the bed on which the victim was found.

The west wall had almost no spots except that the window blind on that side of the room had a few small ones. This was not because many drops did not start in that direction as indicated by the very large number on the adjoining bed, but merely because of the considerable distance which allowed only a very few high velocity droplets to reach that far.

The north wall was very significant in respect to blood spots. On the west offset there were approximately ten spots which were relatively large and retained high velocity up to the time of impact. They had been thrown ten feet or more. A similar number was also present and scattered over the east side offset on the north wall (see photograph No. 4). The spots in both locations showed the beading around their periphery that is characteristic of a drop impacting with a considerable velocity. On the extreme east end of the wall, past the offset, for about two feet there was an area containing no spots, and a continuation of the corresponding space on the east wall.

This single region in the entire periphery of the room in which no blood had traveled through the air must by necessity be the region in which the attacker stood, since it is the only place in which the blood drops have been intercepted. It is shown in the photograph of the sketch of the room, appended No. 1, and in photographs No. 5 and 6. Close to the edge of the bed and slightly overlapping it, the width of the cone would be about two feet which approximates the width of a man's body. It placed the attacker very close to the foot of the bed on the east side. Other details of the analysis will place him more precisely.

Defendant's bed. At the time of viewing this bed, the covers had been arranged to correspond with the arrangement shown in the exhibits of the prosecution, vis. the bloody side of the pillow upward, the pillow occupying the blood-free region of the lower sheet, and the top covers turned back so that all the exposed area showed blood spotting. On the bed, chiefly on the exposed portion of the lower sheet, and the turned-back portion of the upper sheet, and on the top of the pillow, were a large number of small blood spots. On the side nearest to Marilyn's bed there was a region of larger spots, none over ¼ inch in diameter. Over the remainder of the bed the spots were much smaller, and showed by their shape that the droplets were moving at relatively high velocity and numerous drops moved in an arc approaching the horizontal. Many of them had dropped more nearly vertically, representing higher arcs of flight.

The Radiator. On top of the radiator were several blood spots. All of these had approached nearly horizontally and at high velocity. One in particular had been at so low an angle and with so high a velocity that it had "skipped" like a stone on water, leaving a series of about eight spots extending in a line one food three and a quarter inches in length. (1' 3¼").

Point of Origin. Because of the characteristic shape of blood spots striking in different directions and at different velocities, it is possible to trace the direction of a drop through the air, and to estimate the velocity with considerable certainty. Utilizing the spots on the defendant's bed, it was noted that all those that gave elongated patterns had originated at a single center of origin which corresponded exactly with the region of Marilyn's mattress on which the blood intensity was greatest, and which was occupied by her head at the time she was found. It can therefore be stated with certainty that her head was in essentially the same position during all of the blows from which blood was spattered on the defendant's bed. This distribution is illustrated in Photographs Nos. 7 to 11.

One further point is evident from the blood on the defendant's bed, viz. Marilyn Sheppard's head was on the sheet during most, if not all of the beating that led to the blood spots. This is shown by the presence of nearly the same intensity of blood on the lower edge of the pillow on the defendant's bed, below the seam, as above the seam. The pillow must have been in normal position, with this position forming an actual undercut on the end surface, or there would be folded regions free of blood on the top, which do not occur. For blood to spatter to this portion of the pillow requires that the head be close to the same level as the mattress. The conclusion is further confirmed by the "skipping" effected drop on the top of the radiator. Since the blood travels in a trajectory which is essentially parabolic, its rate of drop due to gravity would be considerable at the distance of the radiator (about eight feet). To give the "skipping" effect would require an angle of incidence on the radiator of less than 15 degrees which could only occur if the origin of the trajectory were lower than the radiator top. No blood drops were present on the ceiling, nor were there any high on the walls with the exception of a few on the hall door that were close to the top of the door.

Blood spots on the north wall, the spots that were thrown to both the east and west offsets in that wall, were examined for their trajectory and origin. They also originated at the same point as the spots on the defendant's bed, or very close to that spot.

Blood spots on the south wall (some spots illustrated in Photograph No. 12) were of more than one origin. Many of them were direct spatter from impact, and these aligned also with the position of Marilyn Sheppard's head when found. Others were thrown at a flat angle to the wall, and did not originate from impact spatter, but impinged tangentially to the arc of the weapon.

Blood spots on the east wall were exceptional in their indications. Nearly all of them contrasted sharply with other spots in the room in that they were placed by low velocity drops. Most of them impacted the wall nearly at right angles to it as is clearly demonstrated from their essentially round shape (Photograph No. 13), and the fact that the edge of the open door shows an exact pathway of one drop whose impact point is also clearly shown on the other door. Other drops in a minority, impacted at a variety of angles, and without any clear pattern, such as is shown by nearly the entire remainder of the room. (Photographs Nos. 14 and 15.)

These drops with low velocity and mixed pattern of impact predominantly horizontal, could not have originated in the same manner as the remainder of the blood in the room, and gives the clue to the entire pattern of the event.

Extensive experiments show that many, and probably nearly all of the blood drops on the east wall, were thrown there by the back swing of the weapon used, since this is the only method by which low velocity drops could have reached that wall, and it is the only way in which they would have been predominantly at right angles in impact direction. It can be stated very positively that they did not originate as impact spatter, which is the source of most of the drops that impacted other parts of the room. The low and triangular distribution of the drops on the two doors corresponds with the swing of the weapon which started low in a left hand swing, rising through an arc, and striking the victim a sidewise angular blow rather than one brought downward vertically. The absence of blood on the ceiling at a time when blood was thrown in

other directions from the weapon demonstrates that no vertical "chopping" blows were used. A swing similar to that used with a baseball bat with a left handed batter is the only one consistent with the blood spot distribution.

Cause of Distribution. It is established where the attacker stood during the murder. It is also established that Marilyn Sheppard's head, which was the source of most of the blood in the room, was down on the bed throughout most of the beating, and that its position was essentially constant during that time. It follows that any reconstruction of the crime must account for all of the blood spot distribution on the basis of the physical events that threw blood. It must also account for the location and character of the wounds insofar as they are independent of the exact nature of the weapon, which is not known.

Extensive experiments on the nature of blood thrown by different events were made (See Appendix 1). It was shown that fine, high-velocity drops were formed ahead of some bloody weapons when they were used to strike an object. These were from throw-off from the rapidly moving weapon. They were also formed from a certain set of conditions as impact spatter, in front of the weapon when struck vertically, or in the direction of movement of the weapon when struck angularly. At no time were any significant numbers obtained on the opposite side of an angular blow. The predominance of such fine, high-velocity drops that struck the defendant's bed, the radiator, and even the window shade at the opposite end of the room means that the blows were struck toward that end of the room, regardless of the particular origin of the fine spatter. Such blows could be struck in two ways only:

1. By a right handed person striking vertical blows, and situated slightly to the left of Marilyn Sheppard's head, i.e., toward the hall doorway. This is not possible, because the attacker did not intercept blood spots at this location; and vertical blows would have placed some blood on the ceiling.
2. By a left handed person, situated at the known position of this attacker, striking either angular or vertical blows (The latter excluded). This is completely consistent with observed facts.

It was further shown that large drops (predominantly less than $\frac{1}{4}$ inch diameter) could be formed by:

1. Impact spatter of any type of weapon. The direction of flight is determined by the shape of the weapon and its relation to the surface struck. A flat object like a hammer, striking a flat surface throws such drops in every direction. A bar throws them only to the right, and left, etc. The great preponderance of the blood thrown by impact consisted of low-velocity, large drops which were thrown from a few inches up to about two feet from the point of impact. So much more blood constituted this local low-velocity spatter than traveled in any other way as to be striking. Some weapons produced almost nothing else. This corresponds to most of the blood in the immediate vicinity of the head, excluding the blood which simply flowed from the wounds to the bed, leaving a pool.
2. Throw-off from weapon. Large drops were regularly formed when a bloody weapon was swung through an arc, the predominent throw-off occurring at the ends of the stroke. The less energetic back stroke threw backward the largest drops at the lowest velocity. The vigorous movement of striking an object rarely threw large drops, and any drop thrown was at high-velocity. The spots on the doors in the bedroom are predominantly the size described above, most of which correspond only with back-throw of a weapon, or with local low-velocity spatter. The latter is ruled out completely by the distance between the location of the victim's head and the door (about seven feet). The distance from the weapon to the door on the back-throw is only about one and a half feet which allows low-velocity throw-off to travel readily to the door.

Assumes only practical - this group of blood drops delivered on the bed)

High-Velocity relatively large drops could be formed in one of two ways:

1. Impact spatter from a very low angle or from a very flat impact by the weapon. These were always ahead of the direction of movement if the surfaces did not meet flat (e.g., hammer head on flat block).
2. Throw-off in a violent movement of a very bloody instrument. This is difficult to produce because most of the blood is removed in the back-throw, and the necessary velocity of movement is difficult to get on any but a forward throw. In attempting to get these spots, usually the large drops leave at low-velocity on the back-throw, and small, high-velocity ones are only formed on the forward. Blood spots, relatively large (about 1/8 inch diameter) on the north wall offsets correspond to high-velocity impact spatter from a left handed blow. Both their direction and distribution are different than could be obtained by a right handed throw-off spatter by a right-handed blow.

Very large spots (greater than 1/2 inch diameter) were not obtained by weapon throw-off, even from a weapon dipped in blood and swung while still dripping, though a scoop shaped weapon might collect and hold enough blood if properly applied. Such spots were never accumulated from impact spatter at greater than about one foot from the point of impact.

The only method by which such very large spots could be placed was to take blood into the cupped hand and toss it at low-velocity. In no case was it possible to obtain a very large spot from higher velocity blood because the larger volume broke up into smaller drops. The requirements for obtaining very large spots are:

1 Accumulation of relatively large volume - greater than will adhere to a surface, however, irregular; and
2 Movement which imparts only a low-velocity, and delivered very near to the surface impacted by the blood. No large volume of blood can be thrown far, because higher velocities break up the drops, and a low velocity blood volume does not travel far. One or two feet is about as far as it can be kept intact and delivered.

One very large blood spot was present on the wardrobe door. (Photograph Nos. 14 and 16.) It measured about one inch in diameter at its largest dimension. It was essentially round, showed no beading, and had impinged almost exactly perpendicular to the door, i.e., horizontally and at right angles to the door. This spot could not have come from impact spatter. It is highly improbable that it could have been thrown off a weapon, since so much blood would not have adhered during the back swing for so long a distance, and then separated suddenly at just the right moment to deposit as it did. This spot requires an explanation different from the majority of the spots on the doors. It almost certainly came from a bleeding hand, and most probably occurred at a time different from the time that hand was wielding a weapon. The bleeding hand could only have belonged to the attacker. The origin of the injury is dealt with elsewhere, as is supplementary confirmation of the different origin of this spot. It should be noted that this spot is probably not unique in origin, and other spots on the east wall and possibly elsewhere may have had the same origin, but this spot was unique in size and appearance and was consequently selected for more extensive study.

****

BLOOD GROUPS AND INDIVIDUALITY

No serious question can be raised that the origin of most of the blood in the murder room came from the victim. This assumption was evidently made by the prosecution investigators who did little or nothing toward analysis of blood in that room, assuming that all of it was from the victim. It was established by them that the victim was of universal group O, and carried the M factor. It should be noted that nearly half the population is of group O, about 40 to 45%,

and that a large majority, about 80%, carry the M factor. At no time was the group of Dr. Sam Sheppard determined or mentioned as determined during the trial. His group was determined as to A and B factors in this investigation. It was found that Dr. Sam is group A, probably M. The subgroup is inferred only from the weakness of the reaction when inhibition of agglutination by dried blood extract was used in the grouping. Only dry blood could be studied under the available circumstances.

Blood removed from the mattress, unquestionably the blood of the victim, was grouped and found to be devoid of A and B factors. Further, the blood was readily soluble in distilled water, and agglutination after treatment with anti-serum and cells was immediate as compared with controls of anti-serum and cells alone. The same results were found with a second rather large spot (½ inch diameter) (Photographs Nos. 14 and 14A) from the same door panel as the very large spot discussed above. There was no sign of delayed agglutination, and solubility of the blood was excellent.

Grouping of the large spot was performed simultaneously with the same sera and cells and in identical manner. Several differences were immediately apparent. The blood from the very large spot was definitely less soluble than that from the small spot, or from controls from the mattress. In running the agglutination tests, in every instance and with tests for both A and B factors, agglutination was much slower and less certain than the controls. The fact that delayed agglutination occurred indicated clearly that this blood was also O group, but its behavious was so different as to be striking. These differences are considered to constitute confirmtory evidence that the blood of the large spot had a different individual origin from most of the blood in the bedroom.

It may be of interest that blood on both watches was stated to contain M factor but was never assigned a universal group in the prosecution testimony. This would be entirely understandable if the blood on those items was from the same source as the large spot on the wardrobe door. Since A and B factors are ordinarily more readily determined in dry blood than is the M factor, the testimony is inexplicable otherwise.

Tooth Fragments

The fact established by the prosecution that one medial incisor tooth of the victim was broken completely across and that two other chips of considerable size were also found is one of the most significant facts established. Curiously, no attempt was apparently ever made to explain it in testimony during the trial, though it absolutely demanded explanation.

The tooth fragments were examined in the prosecutor's office. The large fragment represented the entire lower portion of the medial incisor, broken approximately to the gum line on the front, and the break tapered downward at the rear, so that a sharp projection from the root would remain on the lingual side. The broad dimensions of the fragment were 5/8 x 1/4 inch. The smaller fragment from the bed was 3/16 x 1/8 inch and the fragment from under the bed was 5/32 x 1/8 inch.

It is well known to every one that teeth do not fracture to this extent except under very unusual stress, or people would be spitting out teeth all the time. A strong blow to the teeth would be capable of breaking them, but would inevitably injure the lips seriously. No indication of such a blow was ever found according to the testimony, the autopsy report, or the photographs of the victim's face. The prosecution witnesses left the matter totally unexplained, and by doing so admitted their inability or lack of desire to explain it.

Two points are highly significant in the explanation:
1. The teeth were found outside her mouth, not inside, or in her throat as would be expected if broken by an external blow; and

2. The medial incisor fractured at an angle that is consistent only with a pull outward, not a blow inward. Because it was not stated in the testimony, it is not clear what portion of the additional teeth contributed the two smaller fragments. If they were chipped from the labial surfaces, as they appeared to be, this could hardly happen from a blow. It seems very clear that the teeth were clamped on something that was forcibly withdrawn with removal of the fragments completely from the mouth. The only reasonable article would be the attacker's hand, possibly placed over the mouth to prevent an outcry - which is consistent with defendan's story, and the fact that nobody heard such an outcry, including Chip in the next room. It is certain that she did not bite the weapon used to beat her. It is highly improbable that she wasted time biting clothing. It is entirely reasonable and highly probable that she bit her attacker's hand. It is equally certain that a bite of this ferocity would have left distinct injury to such a bitten member, and that blood would have been shed. This is not pure speculation but a reasoned approach to the established facts, and it must represent at least a close approximation to the truth. Blood shed from the hand after being bitten could have placed the large blood spot on the wardrobe door, and in fact flowing blood from a wound is about the only reasonable manner in which this spot could have been placed. Certainly the murderer did not take time or trouble to scoop up blood in his hand and gently toss it to the door. If blood was flowing freely, as he pulled his hand away and swung it back, the rapid accumulation of blood during the swing could have and very probably did deposit as the large spot discussed. If this is true, it explains the definite differences shown by this blood and other blood at the scene; and it explains how so large a spot could have been placed with the required low-velocity and large volume. It is the opinion of this examiner that the murderer had a definitely injured hand or finger on July 4, 1954.

Blood-stained Bedding

Examination of the mattress top, (Photograph No. 17) as well as superficial examination of the under sheet and pad of the bed on which the victim was murdered shows certain interesting and possibly pertinent facts not developed in the above discussion of the blood spot pattern.

Examination of the bedding shows the presence in considerable quantity of a fluid other than blood, most heavily concentrated in the lower portion of the bedding, and forming a large part of the large central bloody area. This fluid was urine, probably voided at or shortly before death. It was probably hypotonic, i.e., less concentrated than the blood for it appears to have produced hemolysis of the blood corpuscles as it mixed with the blood. The lighter portions of the large central bloody area represent a dilute solution of blood in this urine, which soaked into the bedding, spread laterally and finally dried. It is of interest to the investigation in an indirect manner only, as will be developed below.

On the east side of the bed, visible on the lower sheet, corresponding to the edge of the mattress, and just south of the center point of the sheet is visible a region which appears bloody, but with very dilute blood. This spot is nine inches wide at its widest point, the south edge being three feet, three inches from the south edge of the sheet, and the north edge three feet, nine inches from the north edge of the sheet. Examination of this spot visually and with magnification (in the prosecutor's office) showed the blood to be highly dilute, and almost certainly hemolyzed. This could happen by mixing the blood with any dilute water solution or water itself, as well as with urine. Its position, shape and size are most consistent with it having been made by a wet knee placed against the sheet. Inspection of the spot shows that blood was present in spattered drops before the other fluid was present, since the blood has been carried laterally with the flow of fluid, and original blood spots are still present, only partially displaced by the diluting fluid. It is clear that the diluting fluid was definitely placed on a region carrying whole blood spots.

The obvious and probably correct interpretation of this finding is that the defendant placed his knee at this position after coming from the lake. The water from his wet pants would have produced exactly the effect observed. It is to be noted that this region did not show in the mattress directly below, or on the pad below the sheet. Thus, it is shown that the amount of diluting fluid was quite limited, such as would be carried by a single layer of cloth.

The single alternative explanation would be that the murderer dipped his knee in the pool of urine (containing blood), lifted it out carefully enough that no smear of the material was left on the sheet, and placed the spot as a separate act. This could have happened, but would be expected to leave indications at the point of dragging the knee from the pool of urine. No such indications are present. It is also likely that the amount of liquid carried in this case would be great enough to soak further into the bed than is observed. The position of the spot is also inconsistent with the known position of the murderer. This explanation can be checked by testing the area on the sheet for the presence of urine. If urine is absent, it shows that the first explanation is correct, and that the blood on the defendant's left knee was acquired after coming from the lake, - not before.

A further observation of the blood pattern on the sheet is significant. This consists of an area approximately twelve to eighteen inches to the right of the wet spot discussed in the above paragraph, and eighteen inches from the edge of the sheet to the center of the area. This area contained numerous original, undiluted blood spots which had been strongly smeared in the north - south direction, or lengthwise with the bed. The area involved was at the exact spot that the attacker must have occupied to intercept the blood spots on the walls as they were intercepted. It lies just where a knee would have to be placed to balance him during the wielding of the weapon. It also seems indisputable that these smears, which do not occur elsewhere on the bed, accurately depict the position of the murderer's knee and confirm the previous analysis of his position. It indicates that he had one foot on the floor, the opposite knee being on the bed, so that his body was actually over the northeastern portion of the bed. This detail of position allows also some inference regarding the length of the weapon, and its closeness of approach to the east wall of the room on the back swing, all of which are important considerations in the over-all analysis of the crime.

The Weapon

Some indications of the nature of the weapon are available from consideration of the details of the crime, as well as from the nature of the wounds. When a person is struck in the region of the face, they automatically and instinctively lower and turn the head away from the blow as a protection for the face and especially the eyes. Further, they automatically and instinctively raise the hands in a protective gesture to shield the face, and they may grab other objects in the vicinity that may add to the shielding. The evidence is completely clear that the victim's hands were employed in this manner, resulting in severe injury to them. It is because of this fact that a straight type of weapon like a bar is most improbable, since the injuries to the victim's forehead are parallel to the axis of the head which would require that she face the attacker directly and without defensive reflex action - a virtual impossibility.

This fact, and the nature of the wounds, indicates that the actual edge that cut through the scalp was at approximately right angles to the axis of the weapon. If the victim's head were turned to her right, essentially as she was found, and assuming this type of injuring edge, nearly every one of the injuries visible in the photographs of the autopsy photographer can be accounted for on the basis of left hand blows. They cannot, on the basis of right hand blows, though some of them are consistent with right handed blows only if her head were turned sharply to her left. The latter idea is inconsistent both with her final position, and with some of the injuries, notably those on the right of her head.

The weapon was short, as shown by the reconstruction diagram (Photograph No. 18). Having fixed the position of the attacker and knowing the position of the victim's head, the length of arc is exactly what would be true of a man's arm wielding a weapon less than one foot in length, i.e., about thirty-six inches. Naturally, the torso and arm lengths influence weapon length calculation, because the distance that can be established is the sum of the arm and weapon length. Even with a short arm, the length of one foot covers the available and necessary distance.

This investigator did not view the woulds themselves, and the photographs of them are possibly misleading. It is still clear that the injuring edge of the weapon was more or less angular, or possibly rounded with a small radius. This is necessary to produce the injuries as described in testimony, which are not sharply cut, but were parted through to the bone, and beyond. A small bar type instrument could have produced this effect, but only if bent at a sharp angle from its axis. The necessary narrowness of such an instrument argues against it having enough weight to shatter the skull and separate the individual bones at the sutures.

A larger cylindrical instrument like a piece of pipe flared on the end is more reasonable, and consistent with the type of injury and the reconstruction of its mode of application.

If the weapon was carried into the room to be used as it eventually was used, a wide variety of possibilities exist. If it was acquired at the time it was needed, it would have to have been present in the bedroom prior to the murder which is improbable. A third possibility exists viz. that it was an object carried for another purpose, but serving as a murder weapon when needed. Such an item is a heavy flashlight, several designs of which fill nearly all of the necessary specifications. The most serious argument against this possibility is the (presumed) absence from the room of glass which would be likely to have broken. A plastic lens might answer this objection. There still remains a puncture type would on the right side of the victim's head which is difficult to explain unless the rim had collapsed so as to form a sharp angle which could puncture.

With the available limited information, it is not possible to infer an exact weapon, but certain of its characteristics are quite definite and can be safely assumed.

MISCELLANEOUS ITEMS

1. Victim's Slacks. The blood pattern on the victim's slacks is definitely significant in the over-all interpretation of the crime. Her legs were probably drawn up, also a defensive act, as indicated by the fact that when she later relaxed, they straightened out so as to protrude under the crossbar of her bed. Whether the legs were drawn up or not, the most exposed portion of the slacks if on the victim, were the tops of the thighs and it is inevitable that this region would have accumulated the greatest amount of blood. Examination of the slacks and of photographs of them shows that this was not the case, the bottoms of the legs having the strongest blood spotting. This shows quite definitely that the slacks had been removed partially from the victim before the murder, and substantiates the idea that the crime started as a sex attack, rather than as a murder.

2. Top Sheet of Victim's Bed. The statement of the defendant that he spread the sheet over the victim's lower quarters is reasonable, both because of the appearance of the sheet at the time of photographing, and the apparent scarcity of blood spots from the top of the sheet as photographed. Naturally, portions of the sheet would have contacted the pool of diluted blood on the bed, and the pattern of blood is highly confused. It would be extremely difficult to reconstruct the position of the sheet during the murder, though the opportunity to examine it carefully in terms of the reconstruction and the available photographs would assist in this effort.

3. Pillow. The pillow from the victim's bed indicates far more than was stated or implied in the testimony regarding it. Solid regions of blood stain are present on both sides of the pillow case. One of these can be explained by contact with the pool of blood on the bed which seems to have spread far enough to be soaked up from the sheet. Blood spatter from the blows themselves show that the side opposite to the alleged instrument mark was upward during the beating. That it was earlier in contact with liquid blood in quantity is shown definitely by the large bloody area on that side which could not have been placed during the beating had the pillow remained as it was found. It is certain that the pillow was either used to prevent outcry earlier, or that the victim attempted to shield herself by holding the pillow on her face or head. In either case, the pillow had to be moved at a subsequent time, and was probably doubled down on itself and folded in such a manner as to produce a mirror image blood impression later interpreted as an "instrument" impression. It is hoped to conduct experiments to check this point.

4. Nail Polish Fragments. Exhibits stated to contain nail polish (Ex. 44, and a set of slides) and examined in the Prosecutor's office in Cleveland appeared to be devoid of any such material at the time of examination, even when examined with reasonable magnification. Whether the material was in some way overlooked, or whether it has been lost since the time of the trial is not known. Numerous small fragments similar to nail polish were, however, recovered from the rug in the bedroom at the time of this affiant's investigation. They were compared with samples of nail polish which were sent to the affiant by Dr. Richard N. Sheppard, which were represented to be the nail polish used by Marilyn Sheppard. The relative opacity of the materials found on the floor as compared with nail polish raised a strong presumption that the material actually is not nail polish, but is a red lacquer such as is used to coat small objects, and which is available commercially in many stores, and could conceivably be chips from the weapon.

5. Leather Fragment. A leather fragment, approximately triangular in shape and measuring about 1/4 x 1/4 x 3/8 inches on the sides was examined in the Prosecutor's office. It appeared to be leather rather than a synthetic substitute. It also appeared to have been torn off recently, as indicated by the fresh appearance of the torn surface. It significance cannot now be interpreted since its origin was not successfully traced by the prosecution investigators, or by this investigator.

RECONSTRUCTION

From the known and demonstrable facts of the case, a reconstruction of the murder is possible. A limited amount of inference is unavoidable, but in the main, the facts are clear, and the conclusions inescapable.

1. The original motive of the crime was sexual. Examination of the slacks in which the victim was sleeping shows that they were lowered to their approximate final position at the time the blood spatters were made, as discussed above. Leaving the victim in the near nude condition in which she was first found is highly characteristic of the sex crime. The probable absence of serious outcry may well have been because her mouth was covered with the attacker's hand.

2. The victim was not moved after being beaten. This follows from the fact that her head was at the same point as the center of the blood spot pattern. Since her legs protruded under the lower crossbar of the bed, it follows that she had drawn up her legs in a defensive action, and moved downward during the early stages of the struggle. At the time of death or unconsciousness, her muscles relaxed and the legs straightened to a position similar to that in which she was found.

Nice fig - false rigor

3. At some point in the activities of the attacker, the victim obained a firm grip on him with her teeth. His defensive reaction of jerking away was violent enough to break two or three of her teeth. The evidence indicates that blood welling from the resulting wound to the bitten member was thrown as a very large drop to the wardrobe door. Where's the blood on his teeth + skin?

4. Presumable inflamed by the resistance and pain, the attacker utilized some available weapon to strike the victim down. She instinctively turned her head (probably to her right) and shielded it with her hands which were in turn severely injured in the beating that ensued. She may also have grabbed a pillow as a shield, pressing it in front of her head, and depositing much blood on it. Whether an early blow produced unconsciousness or whether her head was held down with the other hand of the attacker is uncertain, but one of these two events must have occurred.

5. She was beaten by a weapon held in the left hand, swung low in rapid and vicious blows to her head after it was puddled with blood from earlier injury, and possibly after her actual death. Whether any beating occurred after death or not, her head was certainly beaten for some time in almost exactly the same position - the one in which it was found.

6. The weapon was almost certainly not over a foot in length, and had on it an edge, quite blunt but protruding. This edge was almost certainly crosswise to the axis of the weapon and could have been the flared front edge of a heavy flashlight. It was not similar in any serious respect to the alleged impression of a surgical instrument on the pillow case, nor to any of a large variety of possible weapons that have been suggested by the Prosecution.

7. During the beating, the attacker stood close to the bottom of the bed and balanced himself with one knee on the bed. The weapon swung to about 1/2 foot from the wardrobe door in this position.

8. After the commission of the crime, the attacker faked a very clumsy attempt to indicate that a burglary had been committed. This included removing watches, keys, etc. and stuffing them in a bag (the green bag) which was later thrown away during the retreat; upsetting the papers from the living room desk; disarranging the den; breaking the trophies, etc.

****

DEFENDANT'S ACCOUNT

No crime reconstruction is complete or reliable unless it is at least consistent with all the known facts. Several obvious inconsistencies are certainly present between the reconstruction and the theory that the defendant was the attacker. It remains to show that the reconstruction is consistent with the version of the events given by the defendant.

His account is vague, with few details. It is not a well thought out story such as might be expected of an intelligent person who was faking the account. The vagueness itself is a characteristic which must be consistent with the known facts, if the account is to be considered true. That a true account would necessarily or probably be vague is indicated by the following known or claimed facts:

(a) The defendant was asleep on the couch when last seen by his visitors, the Aherns. A person suddenly awakened from a sound sleep often is confused and at a loss to act or understand what is happening, especially if it is not commonplace and customary.

(b) Sworn testimony is available to indicate that he suffered a dislocation or other injury to the vertebra of the neck, sufficient to inhibit his normal reflexes. Sworn testimony is

also available to indicate that he suffered a blow to the face sufficient to loosen teeth, and cause swelling and discoloration around the eye. These circumstances strongly imply the probability of unconsciousness, which is certainly consistent with vagueness.

(c) On one special point, it was possible to conduct an experiment to determine whether vagueness was consistent with the fact, viz., the "light form" in the bedroom. The night light in the dressing room was turned on with a 50-watt light. All other lights in the house were extinguished. This investigator went downstairs after placing a subject in the bedroom in the position of the attacker. The subject had on a white shirt and dark trousers. After closing the eyes for a short time, this investigator ran upstairs as rapidly as possible to the bedroom door. In the very dim light a whitish region was seen corresponding to the white shirt. The head could not be distinguished, nor could the portions below the lower limit of the shirt. The boundaries of the shirt itself could not be distinguished, and what was seen was as precisely what was described by the defendant as could be imagined.

The experiment was repeated with the night light on 100-watts. Again the results were similar though now the boundaries of the shirt could be dimly distinguished. It was still not possible to see anything but the white shirt.

It remains to determine whether other specific points of the account of the defendant are consistent with the interpretation of this investigation. Numerous points emerge from the consideration:

1. It was entirely possible that the defendant was struck on the back of the neck by the same weapon used to kill Marilyn Sheppard. If the weapon was of the type indicated by the studies made, and was a cylindrical object with a flared end, all that must be assumed is that it was the cylindrical portion that contacted the back of his neck rather than the flare. It may be pointed out that in the experiment described in the above paragraph, the subject on one occasion merely moved around as the investigator arrived at the door, and delivered a light blow to the back of the neck without the movement being seen or anticipated by the investigator.

2. The method and clumsiness of removal of the watch and key chain from the defendant's pocket certainly appears to be the work of another person. As pointed out earlier, it would be difficult and completely unnatural for a person to rip his trousers pocket downward in removing a key chain, but this would be extremely probable if someone else stripped it from a prone body. It is also unlikely that a person removes his own watch so as to damage the band, even if he were faking a burglary.

3. The abandonment of the green bag in the woods is not the work of a person who is deliberately setting a scene as it was postulated that the defendant did. If he took time to wash off all the blood, to sponge the stairs and take the other precautions attributed to him, he would not carelessly throw away the green bag where it would not reasonably be in a real burglary. Rather, its abandonment was the act of a person in an unnatural hurry, as would be true of an intruder being pursued as claimed by the defendant.

4. One portion of the account given by the defendant can be accurately confirmed, viz., the return to the bedroom with wet clothing, and leaning over the bed (water spot on the sheet).

5. Another point of importance that was apparently not fully developed before is the question of the amount of sand in the defendant's shoes. If he waded out into the lake to wash off blood, he would not sink into the wet sand very far, and would pick up in the shoes minimal quantities of sand. Also, he would not pick up any sand in the pockets. If he were lying on beach, as he stated, he would accumulate large quantities of sand in his shoes, and some in his pockets, as was the case. Further, the toes of his shoes had pressed into the insoles and

linings much more sand than the heels of his shoes. While this scarcely constitutes proof that he lay face down in the water and sand, it at least is more consistent with that idea than with any alternative, for the sand would work down into the does and inevitably more would remain there than in the heels.

6. It is not reasonable to believe that the defendant would deliberately break his own and his wife's trophies, as occurred. Under no conditions, would this assist in establishing the event as the work of a burglar, for it is equally unreasonable for a true burglar. It is completely consistent only for someone who hated the Sheppards, or who was jealous of their athletic tendencies and abilities.

7. It is not reasonable that the defendant would mistreat his surgical and medical equipment, as was done. Even to establish the event as the work of a burglar, a doctor who likes his work (as it appears he did) would have faked the theft from the bag entirely differently, rather than merely upsetting it in the hallway, disrupting the contents of his desk, etc.

8. By no stretch of the imagination can it be conceived that the injuries to the defendant were self-inflicted. As a person who was fully aware of the danger associated with a blow to the back of the neck, and faced with the almost insurmountable difficulty of delivering such a blow at all, and certainly of doing it under control, no doctor would ever risk trying it. It is also peculiarly difficult to deliver a blow of any force to one's own face. Neither of these injuries can be reconciled with self-infliction.

9. It is equally ridiculous to assume that thse injuries were sustained in falling from the landing platform at the beach. That type of fall would inflict many abrasions, bruises and secondary injuries to the limbs, with the serious possibility of broken bones. It could not under any circumstances select the back of his neck and his face for the only injury. No satisfactory explanation except THAT GIVEN BY THE DEFENDANT has been advanced for his injuries.

10. The type of crime is completely out of character for a husband bent on murdering his wife. In such instances, the murder does not start out as a sex attack with the single exception of an unfulfilled and frustrated husband, which is completely contrary to the indications of this event.

11. Tests of the large spot of blood on the wardrobe door which were conducted by this Affiant establish in Affiant's opinion that it is human blood, that it is not the blood of the Defendant, Dr. Samuel H. Sheppard, and that it is not the blood of Marilyn Sheppard, the murdered woman.

There is attached hereto and made a part hereof as though fully rewritten herein Appendices "A to J" referred to in this Affidavit. There is also filed herewith photographs numbered "1 to 45", all of which photographs were taken by this Affiant and all the negatives of said photographs were also developed by this Affiant.

PAUL LELAND KIRK

SWORN TO before me and subscribed in my presence, this 26th day of April, 1955.

WILLIAM J. CORRIGAN

STATE OF OHIO)
) SS
CUYAHOGA COUNTY)

IN THE COURT OF COMMON PLEAS
Criminal Branch

No. 64571

STATE OF OHIO,

Plaintiff

vs.

SAMUEL H. SHEPPARD,

Defendant

APPENDIXES A TO J
IN SUPPORT OF THE AFFIDAVIT OF
DR. PAUL LELAND KIRK

APPENDIX A

Blood on Watch Band

Fresh blood on a smooth non-absorptive surface dissolves and washes away rapidly in water. In order to determine how long blood would remain on an expansible metal watch band under these conditions, such a band (Photograph No. 19) was daubed liberally with freshly shed blood in two separate experiments. In the first instance the blood was allowed to remain twenty minutes after deposition and the band was then dipped in fresh water and moved slowly back and forth. In the second, the blood was allowed to dry for 1 ¼ hours and treated similarly. In both instances, the blood dissolved rapidly and was essentially gone in less than one minute. In the latter experiment, a bit of clot in a recess in the band persisted for about three minutes but was washed colorless in less than two minutes. In no case could the blood have been grouped after one minute in the water, and less than half a minute removed approximately 90% of it. This experiment emphasizes the great importance of the type of surface on which blood is deposited because it is very difficult to remove blood completely from absorptive surfaces. It also is conditioned by the fact that the amount of blood necessary for grouping is far in excess of that necessary for detection, and greater than is required for precipitin tests.

APPENDIX B

Time of Drying of Blood

The same watch band illustrated in Appendix A was daubed liberally with fresh blood from a punctured finger. The time was taken at the moment of wetting the band, and the temperature and humidity were recorded. The temperature was 68 degrees F. - humidity 56% relative. Blood on smooth surfaces was completely dry in 1½ minutes. Blood which collected in the recesses between the individual bars of the band required longer but was completely dry in less than ten minutes.

Blood from the same source was smeared over the back of the hand (Photograph No. 20) and the same observations were taken under the same conditions. Within 2 ¼ minutes, the blood was completely dry.

APPENDIX C

Blood Trails

It will be shown in succeeding Appendicies that long trails of blood are not be be expected if the blood is carried on the weapon, the clothing, or the shoes which are the three most likely ways in which blood might be transported and deposited on other objects by dripping.

Blood, or any fiscous liquid, will shake off an object in small droplets. It will not fall spontaneously in small drops but only after enough has collected to form a large drop. Had any significant blood trails been left by the murderer in the house the blood would not have been predominantly on the risers of the stairway, but would be on the treads in far greater quantity, regardless of the manner of its removal from the person and regardless of the object or material from which the blood was removed. The explanation that the blood was washed from the treads and horizontal surfaces after the murder but that the risers were missed is the only explanation consistent with the case of the prosecution. That this is not a sufficient explanation can be shown.

The steps throughout all of the house were varnished or bare wood with the exception of the treads of the steps from the kitchen to the landing. They had been worn enough to leave indentations and irregularities in their surfaces. Blood dropped on them and washed up, unless most thoroughly done, would inevitably have left deposits in these irregularities and also washed areas which would have yielded the luminol test at least. This would reveal washing of the blood, which was never demonstrated, though quite possible to do. Some blood would be expected on the main staircase, certainly on the treads and possibly on the risers. Beyond this, the murderer would be unlikely to leave more than the most occasional and minute samples. It is noted that it was the main staircase that yielded nearly all of the spots that were proved to be human as well as being proven to be blood. If it can be assumed that the spots on the stairs to the basement were left by the murderer, the only reasonable explanation is that his injured member started bleeding, since the distance and the time required to get that far are too great to allow liquid blood to be carried from the murder room. Even more important it appears that no comparable blood spots were located between the main staircase, the steps to the basement. This is fully consistent with the idea that the blood on the basement steps was freshly shed by the murderer, since the intervening space would certainly have accumulated more of the victim's blood than would a place so remote from the crime. The only reasonable explanations are either that the blood in that location was not connected with the crime, or that it was freshly shed by the murderer.

APPENDIX D

Shedding of Blood from Clothing

Cloths may be considered as predominantly absorptive or repellent of aqueous solutions, including blood. Cottons and regenerated cellulose fabrics tend to be absorptive, though not invariably so. Wools, silks, and a variety of synthetics such as nylon tend to be repellent as a rule. Regardless of the type of cloth worn by the murderer, loss of blood by dropping from the clothing after leaving the murder room is extremely improbable. Absorptive cloths would soak it up but not drop it unless they approached saturation which is almost impossible in the existing circumstances. Repellent cloths would rapidly shed most of the blood, holding and absorbing only the residue that was not drained or shaken off immediately, the following experiments were performed to test this concept.

A series of cloths, five in all, and including a variety of cottons, wools, rayons, and silk (Photograph No. 21) were suspended and liquid human blood was thrown against them by means of

a brush dipped in blood. It was applied plentifully so that much of it flowed immediately from the garment. The time was taken when the blood was applied and measured until the last drop fell spontaneously from any of the garments. The condition of the cloths and the three or four drops that fell after the first rapid drainage are illustrated in Photograph No. 22. The three or four drops fell within 2½ minutes after which no further drainage occurred and the remaining blood dried on the clothing. Shaking of a cloth after application of liberal amounts of blood caused the removal of nearly all of the excess immediately. Thus, whether clothing is shaken by the movement of its wearer, or allowed to stand completely quiet, no blood drains after a short interval of time, and that which is retained is either absorbed by the cloth (Predominates) or dries in a crust on the surface.

APPENDIX E

Spots from Weapon

The weapon is the only object which is certainly in contact with fresh flowing blood from the wounds inflicted. It is not dipped, but the side that contacts a region carrying much blood can be considered as having a comparable amount of blood on that limited surface.

Two series of experiments were performed with a variety of objects which would illustrate effects similar to some common weapons. They were:
1. A large bread knife, with a roughly triangular blade eight (8) inches in length and a breadth at the widest point of one and a half (1½) inches.
2. A large monkey wrench, fifteen (15) inches in length, with a jaw one and three-quarters (1 3/4) inches deep and a maximum opening of four (4) inches.
3. A brass bar, eleven and three-quarters (11 3/4) inches in length, three-quarters (3/4) inches wide and one-eighth (1/8) inch thick.
4. A bar of soft wood, twenty-three (23) inches long, one inch wide and seven-sixteenths (7/16) inch thick.
5. A small ball pean hammer, with a head length of two and a half (2½) inches and a face three-quarters (3/4) inch in diameter.

The first experiment involved dipping the objects in liquid blood, removing them and holding them over paper with recording of the time necessary for all blood to drain as drops from the object. This was supplemented by a similar timing while the objects were swinging at a moderate rate in the hand.
1. Bread knife, immersed two inches. Static, it lost four drops, the last drop of which required twenty-eight seconds. Swinging, it lost nine drops, also requiring twenty-eight seconds for the last one.
2. Wrench, immersed to cover the main jaw. Static, it lost seven drops requiring forty-two seconds; swinging, nine drops requiring forty seconds.
3. Brass bar, immersed two inches. Static, it lost two drops in thirty-five seconds, swinging seven drops in thirty-three seconds.
4. Wood bar, immersed three inches. Static, it lost two drops in forty-seven seconds, swinging six drops in eighteen seconds.
5. Hammer, entire head immersed. Static, it lost five drops at intervals of one, two, thirteen, twenty-one, and forty-three seconds. Swinging, it lost two drops at four and fifteen seconds. Repeated, swinging it lost four drops at one, two, seven and twenty seconds.

It is clear that the time of drainage controls the time lapse before the last drop. Swinging speeded up the first drops but not the last. Violent shaking removed all blood much faster by the force applied.

In order to determine in the more tangible terms of distance, a similar set of experiments were made with three of the objects above, nos. 1, 2 and 3, in which the dripping weapon was carried

APPENDIX C

Blood Trails

It will be shown in succeeding Appendicies that long trails of blood are not be be expected if the blood is carried on the weapon, the clothing, or the shoes which are the three most likely ways in which blood might be transported and deposited on other objects by dripping.

Blood, or any fiscous liquid, will shake off an object in small droplets. It will not fall spontaneously in small drops but only after enough has collected to form a large drop. Had any significant blood trails been left by the murderer in the house the blood would not have been predominantly on the risers of the stairway, but would be on the treads in far greater quantity, regardless of the manner of its removal from the person and regardless of the object or material from which the blood was removed. The explanation that the blood was washed from the treads and horizontal surfaces after the murder but that the risers were missed is the only explanation consistent with the case of the prosecution. That this is not a sufficient explanation can be shown.

The steps throughout all of the house were varnished or bare wood with the exception of the treads of the steps from the kitchen to the landing. They had been worn enough to leave indentations and irregularities in their surfaces. Blood dropped on them and washed up, unless most thoroughly done, would inevitably have left deposits in these irregularities and also washed areas which would have yielded the luminol test at least. This would reveal washing of the blood, which was never demonstrated, though quite possible to do. Some blood would be expected on the main staircase, certainly on the treads and possibly on the risers. Beyond this, the murderer would be unlikely to leave more than the most occasional and minute samples. It is noted that it was the main staircase that yielded nearly all of the spots that were proved to be human as well as being proven to be blood. If it can be assumed that the spots on the stairs to the basement were left by the murderer, the only reasonable explanation is that his injured member started bleeding, since the distance and the time required to get that far are too great to allow liquid blood to be carried from the murder room. Even more important it appears that no comparable blood spots were located between the main staircase, the steps to the basement. This is fully consistent with the idea that the blood on the basement steps was freshly shed by the murderer, since the intervening space would certainly have accumulated more of the victim's blood than would a place so remote from the crime. The only reasonable explanations are either that the blood in that location was not connected with the crime, or that it was freshly shed by the murderer.

APPENDIX D

Shedding of Blood from Clothing

Cloths may be considered as predominantly absorptive or repellent of aqueous solutions, including blood. Cottons and regenerated cellulose fabrics tend to be absorptive, though not invariably so. Wools, silks, and a variety of synthetics such as nylon tend to be repellent as a rule. Regardless of the type of cloth worn by the murderer, loss of blood by dropping from the clothing after leaving the murder room is extremely improbable. Absorptive cloths would soak it up but not drop it unless they approached saturation which is almost impossible in the existing circumstances. Repellent cloths would rapidly shed most of the blood, holding and absorbing only the residue that was not drained or shaken off immediately, the following experiments were performed to test this concept.

A series of cloths, five in all, and including a variety of cottons, wools, rayons, and silk (Photograph No. 21) were suspended and liquid human blood was thrown against them by means of

a brush dipped in blood. It was applied plentifully so that much of it flowed immediately from the garment. The time was taken when the blood was applied and measured until the last drop fell spontaneously from any of the garments. The condition of the cloths and the three or four drops that fell after the first rapid drainage are illustrated in Photograph No. 22. The three or four drops fell within 2½ minutes after which no further drainage occurred and the remaining blood dried on the clothing. Shaking of a cloth after application of liberal amounts of blood caused the removal of nearly all of the excess immediately. Thus, whether clothing is shaken by the movement of its wearer, or allowed to stand completely quiet, no blood drains after a short interval of time, and that which is retained is either absorbed by the cloth (Predominates) or dries in a crust on the surface.

APPENDIX E

Spots from Weapon

The weapon is the only object which is certainly in contact with fresh flowing blood from the wounds inflicted. It is not dipped, but the side that contacts a region carrying much blood can be considered as having a comparable amount of blood on that limited surface.

Two series of experiments were performed with a variety of objects which would illustrate effects similar to some common weapons. They were:
1. A large bread knife, with a roughly triangular blade eight (8) inches in length and a breadth at the widest point of one and a half (1½) inches.
2. A large monkey wrench, fifteen (15) inches in length, with a jaw one and three-quarters (1 3/4) inches deep and a maximum opening of four (4) inches.
3. A brass bar, eleven and three-quarters (11 3/4) inches in length, three-quarters (3/4) inches wide and one-eighth (1/8) inch thick.
4. A bar of soft wood, twenty-three (23) inches long, one inch wide and seven-sixteenths (7/16) inch thick.
5. A small ball pean hammer, with a head length of two and a half (2½) inches and a face three-quarters (3/4) inch in diameter.

The first experiment involved dipping the objects in liquid blood, removing them and holding them over paper with recording of the time necessary for all blood to drain as drops from the object. This was supplemented by a similar timing while the objects were swinging at a moderate rate in the hand.
1. Bread knife, immersed two inches. Static, it lost four drops, the last drop of which required twenty-eight seconds. Swinging, it lost nine drops, also requiring twenty-eight seconds for the last one.
2. Wrench, immersed to cover the main jaw. Static, it lost seven drops requiring forty-two seconds; swinging, nine drops requiring forty seconds.
3. Brass bar, immersed two inches. Static, it lost two drops in thirty-five seconds, swinging seven drops in thirty-three seconds.
4. Wood bar, immersed three inches. Static, it lost two drops in forty-seven seconds, swinging six drops in eighteen seconds.
5. Hammer, entire head immersed. Static, it lost five drops at intervals of one, two, thirteen, twenty-one, and forty-three seconds. Swinging, it lost two drops at four and fifteen seconds. Repeated, swinging it lost four drops at one, two, seven and twenty seconds.

It is clear that the time of drainage controls the time lapse before the last drop. Swinging speeded up the first drops but not the last. Violent shaking removed all blood much faster by the force applied.

In order to determine in the more tangible terms of distance, a similar set of experiments were made with three of the objects above, nos. 1, 2 and 3, in which the dripping weapon was carried

over long strips of paper at ordinary quick walking speed, and the distance was measured to the last drop that fell.

1. The bread knife was immersed two inches in the blood. It lost three drops to the paper strip, the last of which was fifteen feet, five inches from the origin.

2. The wrench was immersed so as to cover the entire upper jaw. Because of the great irregularity of surface and the presence of horizontal suface as carried, it retained more blood and for longer than the others. The last spot was lost after walking fifty feet, though the next to last drop was lost after only about thirty feet.

3. The brass bar, immersed three inches in the blood lost the last drop at ten feet. A second trial with the same bar lost the last drop at fourteen feet.

Two significant points must be mentioned. No weapon for a murder would be nearly so loaded with blood as these objects were, and the blood would be undergoing clotting whereas the blood used here was not, and was therefore less viscous, allowing it to drain more completely from the object. It is also to be noted that the number of drops was always small.

One major point of difference was noted as compared with the alleged blood trails at the murder scene: All drops lost were large (approximately $\frac{1}{2}$ inch diameter spots) because the adherence of the sticky blood to the object could not be overcome until enough blood had collected to give a heavy drop. This could only be altered by shaking of the object to throw off the smaller accumulations. Perhaps as important was the fact that in dropping approximately two feet from the object to the floor, the large drop on impact separated to form a large central spot with several smaller surrounding spots and in every instance formed a very irregular outline. Not a single drop was ever described in the trails in the Sheppard house that indicate it to be comparable in size or appearance with the drops formed in this experiment.

APPENDIX F

Transport of Blood by Shoes

By far the most probable method of leaving a trail of blood is transport on the bottoms of shoes. The amount of the blood so carried is necessarily small because the first few steps serve to press out and deposit all but the residual film of blood and liquid held in recesses of the surface of the shoe.

Test of the distance through which blood will be carried by this method was performed by stepping repeatedly in a region of heavy bloodspots on a floor until the shoe soles were thoroughly blood-smeared. The subject then walked normally along a strip of wrapping paper until no more visible blood could be seen on the paper. The last footprint showing any visible trace of blood occurred fifty feet from the origin. The first shoe print is shown in Photograph No. 24. Minute amounts of blood detectable chemically may, naturally, be carried further than the last visible print.

The important aspect of this experiment is that the bloody footprint is not a series of drops or spots as claimed in the Sheppard house, but rather a diffuse area of thin deposit, retaining a semblance of the shape of the shoes' contact with the surface. It must also be remembered that the murderer may have stepped in very little blood as compared with the rather large amount used in this experiment.

APPENDIX G

Blood Removal from Shoes

In order to determine the likelihood that all blood would be washed from Dr. Sam Sheppard's shoes by his alleged washing in the lake, a shoe with leather sole and stitching was daubed with about two dozen spots of freshly shed human blood. (Photograph No. 25) Most of this was placed along the stitching, but various spots were placed at random on the leather of the sole.

The shoe was allowed to stand for thirty-five minutes to allow complete soaking of the blood into the leather and complete drying which actually required a very short time. The shoe was then immersed in water and forced back and forth in the water to simulate the washing action of water movement for five minutes. At the end of that time some of the spots had disappeared, and all were reduced in size but sixteen spots could still be observed with the eye, as shown in Photograph No. 26. Because the treatment used did not apply mechanical action to remove the blood spots as would walking, the wet spots were rubbed vigorously with paper toweling until no actual spots could be seen as such. The shoe was then returned to fresh water for five more minutes, after which it was removed and allowed to dry.

Inspection with magnification revealed that blood was still visible in three places, twice where it had soaked into the stitching, and the largest visible quantity was in a small cut in the sole of the shoe.

This experiment shows that blood adhere to surfaces into which it can soak, with considerable tenacity, as has been previously shown with clothing, and in contrast to the behavior on smooth, non-absorptive surfaces such as metal watch bands. It is very probable that even the visible blood would have disappeared with walking, but certainly not to a point at which chemical blood test methods would not have revealed its original presence.

APPENDIX H

Amount of Blood Spatter on Clothing

Without knowing the details of a weapon and the exact conditions of its use, it is not simple to predict the amount of blood that might spatter on the person wielding the weapon. In the series of experiments reported in Appendix I, and discussed briefly in the Report, a wide variety of objects of various sizes, shapes, weights, and configuration were used to spatter far more blood than was spattered in the commission of the Marilyn Sheppard murder. During the entire series of experiments, the same set of coveralls was worn without washing or disturbing blood on that garment.

The appearance of the garment is shown in Photographs Nos. 27, 28, and 29. The surprising thing is that the amount of blood that was spattered backward was uniformly less than that spattered sidewise or forward, even though the blows were delivered in a number of ways and under all the variations listed above. While the amount of blood is definitely significant, it shows that the murderer could well have escaped without having accumulated enough blood to drip or leave any blood trail whatever from that source. If his garments were as absorptive as the garment used in these experiments, it is very certain that they would not have lost blood by dripping at any time.

APPENDIX I

Nature of Blood Spots from Different Origins

In order to determine the nature and appearance of blood spots resulting from spatter under

different condistions, from throw-off by objects simulating weapons and similar questions, a considerable series of experiments were conducted. A wooden block was taken as approximating the hardness of a skull. Over it was placed a layer of sponge rubber 1/8 inch thick which approximates the thickness of the subcutaneous layer of the forehead and scalp, and over this was placed a sheet of polyethylene plastic to simulate the skin which is impermeable to liquids. The arrangement so prepared (Photograph No. 30) was placed on a stool of wrapping paper to collect blood spatter. Around the region was built a rectangular wall carrying removable paper strips to collect all flying blood on the sides and in front of the swings of the object used as a weapon. Similar paper strips were placed over the top to collect blood flying upward as well. Only on the operator's side was the structure open, the operator collecting the blood that traveled backward, as discussed in Appendix H.

The objects used as weapons included the small ball pean hammer described in Appendix E, a metal two-cell flashlight with a flared rim, and three metal objects illustrated in Photograph No. 31. The shortest is an inch steel bar, fifteen inches long; the second is a brass rod about twenty inches in length and bent on the end to an approximate right angle; the longest and heaviest is a brass bar, 3/8 inch in diameter and two feet in length.

Blood was puddles on the top of the plastic cover of the sponge sheet, to the extent that it just did not flow off. This required about three to four ml. at the beginning, and frequent renewals with one or two ml. of blood. Heavy enough blows were dealt that at least with one object, the heaviest bar, the plastic sheet and rubber sponge were cut completely through to the underlying wood. One such cut is shown spread with forceps in Photograph No. 32. The paper strips were removed from the walls after each series of blows of a certain type and object, and photographed.

It was found that the character of the spattered blood from impact varied somewhat in direction and velocity as well as size of drop formed as the conditions were varied, as would be expected. However, certain regularities emerged and were found to be invariably true:

a. Large drops formed by impact spatter do not have enough velocity to travel more than one or two feet.

b. "All high velocity drops which traveled up to twelve feet, and in some instances traveled almost straight up were medium to very small, i.e., not more than 1/8 inch diameter for the largest. Clearly, it is possible that some set of conditions might be found that would throw spatter drops that are larger, and it is also true that the higher velocity drops would spread more on impact with the receiving surface than would slower drops. It can be stated unequivocally that spatter drops that travel more than a couple of feet will never be very large."

c. The smallest, high-velocity spatter droplets occurred to some extent with most blows, and tended to occur ahead of the direction of stroke, and in front of the impact point, i.e., away from the person wielding the object. When the spatter included both high and low flying droplets, the higher flying included a much higher percentage of the small drops as shown by comparing high spots in Photograph No. 33 with lower flying ones from the same blows in Photograph No. 34. These drops were formed by use of the flat surface of the ball pean hammer, and drops were thrown as far as twelve feet from the origin and as high as seven feet in the air at the point of impact. If the wall had not intervened, they would have traveled as far as about twenty feet. The smallness of drops ahead of the object is illustrated in Photograph No. 35, which were made by the heavy brass bar.

Photographs No. 36 and 37 show that the spatter from use of a flashlight is comparable in characteristics with spatter spots from other objects.

The other significant regularity that must remain undisputed, is that large spots, $\frac{1}{4}$ inch or more, will only be obtained at any distance over a very few feet by throw-off from the weapon.

To test this, various objects were dipped in blood and the blood thrown from them in various ways:

a. In front of an object thrown forward violently as in delivering a blow, the spots were predominantly small and high velocity, as was true of many spots on Dr. Sam's bed. They often could not be distinguished from the small spatter spots, which also tended to move in the same direction. A typical range of sizes is shown in Photograph No. 38 showing forward throw-off from the light bent bar. These included as large spots as are to be expected with this motion if delivered with the violence of a true blow.

b. Throw-off on the back stroke was different in that the velocity of the object was invariably smaller. An object dipped in blood and thrown back as in preparing for a blow deposited large drops, mixed with a considerable proportion of small ones. Photograph No. 39 shows this effect with the hammer; 40 shows it with a bar, and 41 shows it with a flashlight. It will be noted as being of interest that the flashlight produced back-throw spots most nearly like those on the east wall of the murder room, ranging almost, but not quite up to ¼ inch diameter, and down to very small spots. It will also be noted that the roundness of the drop was readily duplicated by the back motion postulated in this report and used in this experiment. The distance from the paper wall was close to that known to have occurred in the bedroom. While this does not prove that a flashlight was the weapon used, it does show that an object of that general shape and size produces the results found. It is also demonstrated quite definitely that the spots on the east wall could only have come from back swing of the weapon, which in turn requires a left handed blow. One further conclusion depends on the fact that by every means that could be devised, no spot as large as the single one discussed at length in this report was ever approached by throwing blood from any type of object like a weapon, nor by any type of impact spatter.

It can be concluded from these experiments that the interpretation and analysis of the blood spot pattern in the murder bedroom is (a) fully consistent with the demonstrable facts; and (b) that any other interpretation is not consistent with the result of experiment.

APPENDIX J

Breaking of Teeth

Two questions suggest themselves with regard to the broken teeth of Mrs. Marilyn Sheppard.

1. Is the shape of break consistent with and only with a fracture of the tooth by a pull outward?
2. What is the magnitude of the force necessary to break a tooth completely off close to the gum?

To answer these questions, a considerable number of human teeth were collected from dentists who had extracted them. Only a portion of some fifteen or twenty teeth were incisors, and the condition with respect to decay and dental repair was quite variable. Seven incisors were chosen for experimentation as shown in Photographs Nos. 42 and 43.

To anchor the roots of the teeth solidly as in the jaw, holes were drilled in a heavy brass bar A hole was filled with molten "Woods" metal, an antimony alloy that melts below the boiling point of water, the root was held in the liquid metal until the alloy was solid and all teeth so mounted could not be moved until the metal was remelted. The method of breaking the teeth varied but usually consisted of pulling steadily on them by means of a hooked notch cut in a brass bar as illustrated. (Photograph No. 44)

The force necessary to cause fracture was in general greater than the maximum capacity of the largest spring scale available, i.e., greater than ten pounds and at least one tooth required a very heavy pull. One badly decayed tooth broke with a relatively light pull. It can only

be concluded that the force necessary to break the tooth is primarily a function of the tooth's condition. Some further tests were made to break an unmounted tooth with the bare hands. These were not successful with any of several teeth tested.

Most significant of the findings of this study was the manner of fracture. All but one tooth was broken with the force from the lingual toward the labial surface. In every instance the fracture was diagonal and similar to the tooth found in Marilyn Sheppard's bed. (Photographs Nos. 44 and 45) The one tooth broken with a blow delivered to the labial surface (Photograph No. 46) yielded the fracture in the opposite manner. It was complicated by a splitting of the tooth but verified the indication given by the fractures in the opposite.

A limitation on the experiment was the fact that tests were made on incisors similar in size to the tooth from the bed. These were few in number in the series available for study.