Mr. McCamy, at the conclusion of a witness' testimony before this committee, he is entitled to 5 mintues in which to explain or in any way expand upon the testimony he has given this committee. I, at this time, extend to you 5 minutes, if you so desire.

Mr. MCCAMY. I have no comments.

Chairman STOKES. All right.

We thank you very much for your testimony here this morning, and you are excused, sir.

Mr. GOLDSMITH. Thank you, Mr. McCamy.

Chairman STOKES. Mr. Blakey.

Mr. BLAKEY. Thank you, Mr. Chairman.

The photographic analysis was, of course, only an underlying fact from which the trajectory analysis could proceed. The trajectory analysis itself was a joint effort between the committee and the National Aeronautics and Space Administration. An engineer with NASA's Space Project Division, Tom Canning, constructed the final product from information provided by the committee from its various panels.

Mr. Canning received a B.S., cum laude, in mechanical engineering and an M.S. in aeronautics from Stanford University. Since joining NASA in 1943 as an aeronautical research scientist, he has been the Branch Chief of the Hypersonic Free-Flight Branch, Group Leader of the Probes System Group of Pioneer-Venus Mission, and currently he is Staff Engineer of the Space Projects Division.

Mr. Canning received the NASA Medal for Exceptional Scientific Achievement for his work in atmosphere entry body research for Mercury, Gemini, and Apollo. During his 23 years of work with the Hypersonic Free-flight Branch he has conducted and supervised research in the flight trajectory and stability of high speed projectiles and missiles. He has published numerous papers in that field.

Mr. Chairman, it would be appropriate now to call Mr. Canning.

Chairman STOKES. The committee calls Mr. Canning.

Sir, would you please stand and raise your right hand to be sworn?

Do you solemnly swear that the evidence you will give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Mr. CANNING. I do, yes.

Chairman STOKES. Thank you.

You may be seated.

Mr. Goldsmith?

Mr. GOLDSMITH. Thank you, Mr. Chairman.

If I may have a moment.

For the record, sir, would you please state your name and occupation?

TESTIMONY OF THOMAS CANNING

Mr. CANNING. I am Tom Canning. I am Staff Engineer for the Space Projects Division of NASA Ames Research Center.

Mr. GOLDSMITH. Mr. Canning, I would like to ask you to move the mike somewhat closer to you and to speak directly into it.

Thank you.

Would you define for the committee what the concept of trajectory is?

Mr. CANNING. Trajectory is simply the path taken by a missile as it travels through space.

Mr. GOLDSMITH. Do different missiles or projectiles have different types of trajectories?

Mr. CANNING. Yes, they do. If we, for instance, have a missile that travels a great distance, its position will be strongly affected by the gravitation of Earth. If it is flying through an atmosphere, it will be affected by the aerodynamic forces on it.

Mr. GOLDSMITH. What type of trajectory is involved in the case of a bullet that travels a distance of less than 100 yards?

Mr. CANNING. For a high-speed bullet the effects of the aerodynamics and of the gravity are very small, so that we can consider the trajectory essentially a straight line.

Mr. GOLDSMITH. How is this kind of trajectory specified or characterized?

Mr. CANNING. We can specify any particular straight line simply by locating two points in space that are on that line.

Mr. GOLDSMITH. And once you have located those two points, for purposes of referring to the trajectory, would you refer to it by direction?

Mr. CANNING. Yes; one would specify for convenience a direction which would be, say, northeast, southwest, whatever, and then one would specify the slope along which the projectile or missile traveled relative to the horizontal.

Mr. GOLDSMITH. So that the two basic ways to characterize the trajectory then I take it are by slope and direction.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. And what basic information is necessary to determine a trajectory?

Mr. CANNING. We must first identify where the two points are in space so that we can then construct that line.

Mr. GOLDSMITH. At this point I would ask that the witness be given an opportunity to examine JFK Exhibit F-361, which is the aerial photograph on the left, and JFK Exhibit F-133, that is, the survey map.

Would you identify that survey map, Mr. Canning?

Mr. CANNING. The survey map was the one that was prepared for us, on contract. It served to verify the postion of all of the important structures in Dealey Plaza.

Mr. GOLDSMITH. Is the survey map shown an accurate scaled drawing of the Dealey Plaza area?

Mr. CANNING. Yes, it is.

Mr. GOLDSMITH. Where on that map is the Texas School Book Depository located?

Mr. CANNING. It is where Mrs. Downey is pointing, up there, at the top of the figure.

Mr. GOLDSMITH. Mrs. Downey, I would ask you now to refer to the other exhibit, and show where the Texas School Book Depository is located.

Thank you.

Is the height of the depository building accurately indicated?

Mr. CANNING. For our purposes, we wished to identify a particular level for reference on the building, and that was done correctly.

Mr. GOLDSMITH. Now referring to the survey map, I take it then that the height of the building is accurately indicated on the survey map?

Mr. CANNING. Yes.

Mr. GOLDSMITH. What is the height of the sixth floor, specifically?

Mr. CANNING. It is just slightly over 60 feet above the street level.

Mr. GOLDSMITH. Is this the map that you used for your trajectory analysis of the bullets that hit President Kennedy and Governor Connally?

Mr. CANNING. Yes, it is.

Mr. GOLDSMITH. What specific information, in addition to this map, did you need to determine the trajectory of these bullets?

Mr. CANNING. We needed first and foremost an accurate identification of the inshoot and outshoot wounds and their exact locations.

Mr. GOLDSMITH. Did you need any information about the location of the limousine?

Mr. CANNING. We needed to know the location of the limousine, and we needed to know the location of the people in the limousine, and, in two cases we needed to know the actual angular orientation of the people in the limousine.

Mr. GOLDSMITH. At this time I would ask that the witness be shown what has been marked for identification as JFK No. F–146.

Mr. Canning, I would ask you to read that exhibit and to indicate whether the prerequisites necessary to determining the trajectory of these bullets are accurately summarized on this chart.

Mr. CANNING. Yes, those are precisely what one needs to do the job.

Mr. GOLDSMITH. Fine.

How was all of this information made available to you, sir?

Mr. CANNING. It was made available from a variety of sources. The forensic pathology panel supplied the wound information. The USGS survey map that we have on the right was another source, and then the photographic record made by the various amateur photographers in the plaza were used to supply most of the third.

Mr. GOLDSMITH. How many trajectories did you attempt to determine for the committee?

Mr. CANNING. Three.

Mr. GOLDSMITH. My understanding is, at least according to the present record, only two bullets struck the President and the Governor, one striking the Governor, two striking the President.

Why is it that you determined three trajectories?

Mr. CANNING. We determined three trajectories in order to examine the validity of the single bullet theory that has received so much attention.

Mr. GOLDSMITH. What specific trajectories did you attempt to construct?

Mr. CANNING. A trajectory based on the two head wounds in the President, a second trajectory based on the two wounds, one in his upper back and the other near the center of his neck, and the third

trajectory was based on the hypothesis that the projectile which came out of Mr. Kennedy's neck passed into the back of Governor Connally.

Mr. GOLDSMITH. You made reference a moment ago to the President's two head wounds.

By that, what were you referring to?

Mr. CANNING. I was referring to the wound in the back of his head which was caused by entry of a rifle bullet and a wound forward of that and to the right where the bullet exited his head.

Mr. GOLDSMITH. Did the committee express any reason to you for why it wanted more than one trajectory to be constructed?

Mr. CANNING. Yes, they did. The rationale was that we would like to find out if the trajectories corresponded to one or more launch locations or firing locations.

Mr. GOLDSMITH. Fine.

From which of these trajectories, Mr. Canning, did you have the best photographic evidence available to assist you?

Mr. CANNING. The head wound case had perhaps the most unequivocal photographic evidence.

Mr. GOLDSMITH. Would you summarize now what evidence was available?

Mr. CANNING. The key evidence for this case was a motion picture frame taken from the Zapruder film, Frame No. 312, and there were two additional motion pictures taken at that time, one by Nix and another by Muchmore, which aided in the interpretation of those movies.

Mr. GOLDSMITH. In what way was this photographic evidence better than the photographic evidence that was available for the other shot?

Mr. CANNING. In large measure simply because we knew the time at which the President's fatal wound occurred very precisely. In addition the head provides a rigid reference system, while the rest of the body's relatively flexible structure is capable of movement and distortions.

Mr. GOLDSMITH. Now, I notice that from this chart labeled "Elements to Determining Trajectory of the JFK–JBC Bullets" the first step in determining the trajectory is to establish the wound locations.

Referring now to the trajectory that you constructed for the bullet that hit the President's head, how was the information about the President's wounds given to you?

Mr. CANNING. That was given as physical descriptions, word descriptions, including the dimensions of the inshoot and outshoot wound locations.

Mr. GOLDSMITH. By "dimensions," I take it then that you were given quantified information about the location of the wounds?

Mr. CANNING. That is true.

Mr. GOLDSMITH. Why was it necessary to quantify the locations?

Mr. CANNING. Again simply because we must establish those wound locations in space, and therefore we must have actual numbers in centimeters where the wounds were actually found to be.

Mr. GOLDSMITH. Do you know on what basis the location of the wounds was quantified?

Mr. CANNING. It was established by measurements from X-rays and from photographs made during the autopsy of the President.

Mr. GOLDSMITH. At this time I would ask that the witness be given an opportunity to examine what has been marked as JFK No. 147 and JFK No. 137.

I should correct myself. That is F-147 and F-137.

Mr. Canning, examining these two exhibits, one of which is marked "Location of Head Wounds in President Kennedy," actually they are both marked the same way. They just show it from a different perspective.

I would ask you whether the wounds are accurately represented in these exhibits in the manner that you used them in your trajectory analysis.

Mr. CANNING. Yes, the positions are accurately represented there as I used them.

Mr. GOLDSMITH. Are these diagrams drawn to scale?

Mr. CANNING. The diagram on the left is actually generated from a tracing of a premortem X-ray that had been taken of the President's head, so that one is a true scale representation of the President's skull.

Mr. GOLDSMITH. That is the one that shows the right lateral view?

Mr. CANNING. That is the right lateral view; correct.

Mr. GOLDSMITH. And what about the one on the right, sir?

Mr. CANNING. The diagram on the right is based on a tracing taken from a textbook; the actual measured positions of the wounds are indicated by the dimensions shown in the diagram.

Mr. GOLDSMITH. Which textbook was that drawing taken from?

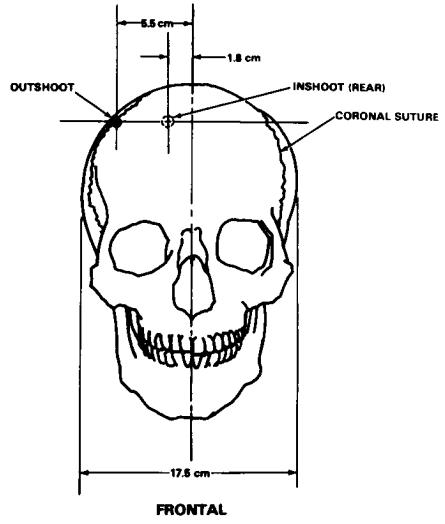
Mr. CANNING. That was drawn from Gray's Anatomy.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of these two exhibits.

Chairman STOKES. Without objection, they may be entered into the record at this point.

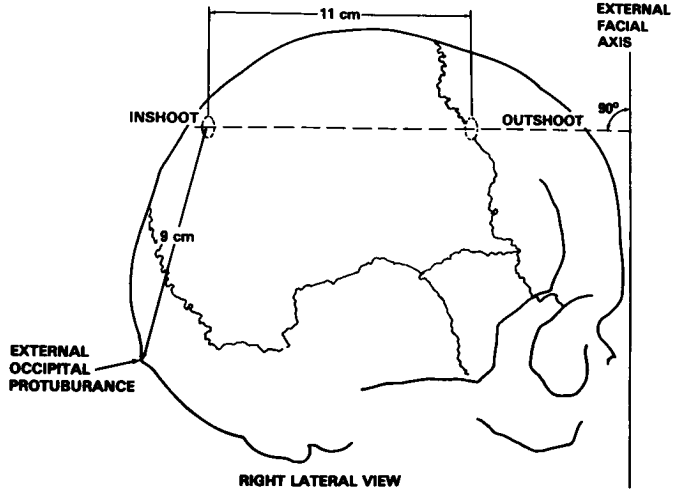
[The information follows:]

LOCATION OF HEAD WOUNDS IN PRESIDENT KENNEDY



JFK EXHIBIT F-147

LOCATION OF HEAD WOUNDS IN PRESIDENT KENNEDY



JFK EXHIBIT F-137

Mr. GOLDSMITH. Mr. Canning referring to these two exhibits, I would ask you to describe the location of these wounds, the President's wounds as they were quantified for you.

Mr. CANNING. The inshoot wound as shown in the right lateral view was determined by the forensic pathology panel to be 9 centi-

meters above the external occipital protuberance which is a little pointed structure at the base of the skull.

That inshoot wound was shown, and it is dimensioned in the right-hand figure, the frontal view, as being 1.8 centimeters to the right of the mid-plane of the skull.

The outshoot wound was shown to be 5½ centimeters to the right and to lie on what is called the coronal suture.

The outshoot wound is 11 centimeters forward of the inshoot wound. If one draws a line straight from the inshoot wound forward through the outshoot wound in the right lateral projection, it turns out to be very close to 90° relative to the external facial axis as determined from a study of the relative tissue thicknesses, of American males.

Mr. GOLDSMITH. Mr. Canning, what frame of the Zapruder film was used as the basis for determining the trajectory of the bullet that hit the President's head?

Mr. CANNING. Frame 312.

Mr. GOLDSMITH. Mr. Chairman, at this time I ask that the witness be given an opportunity to examine what has been marked for identification as JFK F–134.

Mr. Canning, would you identify that exhibit or that item?

Mr. CANNING. This is an enlargement of an enhanced photograph, an enhanced reproduction of the Zapruder Frame 312.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this exhibit, and also for the admission of JFK F–146.

Chairman STOKES. Without objection, they may both be received.

[The information follows:]

JFK EXHIBIT F–134

Elements to Determining Trajectory of the JFK-JBC Bullets

1. **Establish Wound Locations**

2. **Establish the Location of the Presidential Limousine.**

3. **Establish the Orientation and/or Relative Alignment of the Limousine Occupants.**

JFK EXHIBIT F-146

Mr. GOLDSMITH. Now why was this specific frame used to determine the trajectory of the head shot bullet?

Mr. CANNING. Because it was taken such a very short time before the fatal bullet struck the President.

Mr. GOLDSMITH. Are you able to indicate more precisely how short a time?

Mr. CANNING. The shortest time that it is likely to have been is about a 35th of a second. It may have been slightly longer than that.

Mr. GOLDSMITH. Is this the frame on the Zapruder film that is immediately before the one that shows the President's head exploding?

Mr. CANNING. That is correct.

Mr. GOLDSMITH. I would refer your attention now, Mr. Canning, to the survey map.

Mrs. Downey is going to point out to you the location of the limousine at frame 313.

Now at this time I would like to refer you to the testimony of Mr. McCamy earlier this morning.

Were you present for that testimony?

Mr. CANNING. Yes, I was.

Mr. GOLDSMITH. Do you understand how the limousine was placed in that position for frame 313?

Mr. CANNING. Yes, I do.

Mr. GOLDSMITH. Did you use frame 313 for your analysis?

Mr. CANNING. No. I used it only as a basis for a calculation of where the car must have been at 312.

Mr. GOLDSMITH. So on what basis did you move the limousine from its position at Frame 313 to its position at Frame 312?

Mr. CANNING. I found the speed of the automobile down Elm Street by the study of the whole record, and then adjusted the position of the limousine accordingly for one-eighteenth of a second.

Mr. GOLDSMITH. What was the adjustment that you had to make to the determination made by the U.S. Geological Survey?

Mr. CANNING. A little less 1 foot.

Mr. GOLDSMITH. Once the limousine had been located in Dealey Plaza, how was the orientation of President Kennedy's head at the time of the head shot determined?

Mr. CANNING. It was determined by studying features in the photograph of his head, actually the photograph in exhibit JFK F-134.

Mr. GOLDSMITH. What is the first step in determining this orientation?

Mr. CANNING. It is to find what the relationship is between President Kennedy's head and the line of sight from the camera.

Mr. GOLDSMITH. By "camera" now, you are referring to Zapruder's camera?

Mr. CANNING. To Zapruder's camera; that is correct.

Mr. GOLDSMITH. Could you define what you mean when you say that the orientation of President Kennedy's head must be established relative to Zapruder's line of sight?

Mr. CANNING. It is a matter of determining the angular relationship, how far the President is turned away from looking straight at the camera, for instance, how far his head is nodded forward, how far his head is tilted away from the camera.

Mr. GOLDSMITH. I would ask Mrs. Downey now to go to the survey map, and would you indicate for her, Mr. Canning, where Mr. Zapruder was standing at the time that Frame 312 was shot?

Mr. CANNING. He was standing on the concrete pedestal, at the west end of the wide stairs in front of the arcade. The pedestal appears as a black rectangle in the exhibit.

Mr. GOLDSMITH. How was that determined?

Mr. CANNING. That was determined by his own testimony and also by the photographic record of many other photographers in the plaza at the time.

Mr. GOLDSMITH. Thank you, Mrs. Downey.

Now I understand from your testimony then that the first step is to determine the orientation of the President's head relative to Mr. Zapruder's camera.

How did you proceed to make that determination?

Mr. CANNING. We did it by means of what I call calibration photographs of an anthropometric replica of the President.

Mr. GOLDSMITH. At this time I would ask that the witness be shown what has been marked for identification as JFK No. F-141.

Mr. Canning, would you identify this exhibit, and after doing so, please explain what you mean by "calibration photograph"?

Mr. CANNING. This is a photograph of a likeness, not intended to give the appearance but to have the same geometric form as the President, and it was photographed with reference markers adjacent to it so that we can make accurate interpretations of the photograph.

Mr. GOLDSMITH. Are those reference marks indicated in the photograph?

Mr. CANNING. Yes. The essence of the reference system is shown by that vertical line at the extreme right of the photograph with the little bead that is on it. That is a vertical line made with a plumb bob.

Mr. GOLDSMITH. Was this the only calibration photograph that you made?

Mr. CANNING. We made a large array of photographs taken from angles like this but different by several degrees, both sideways and up and down.

Mr. GOLDSMITH. What is the basic purpose of taking calibrated photographs?

Mr. CANNING. The purpose is to make direct comparisons of frame 312 and the calibration photographs. The positions of various features relative to one another are studied in various combinations.

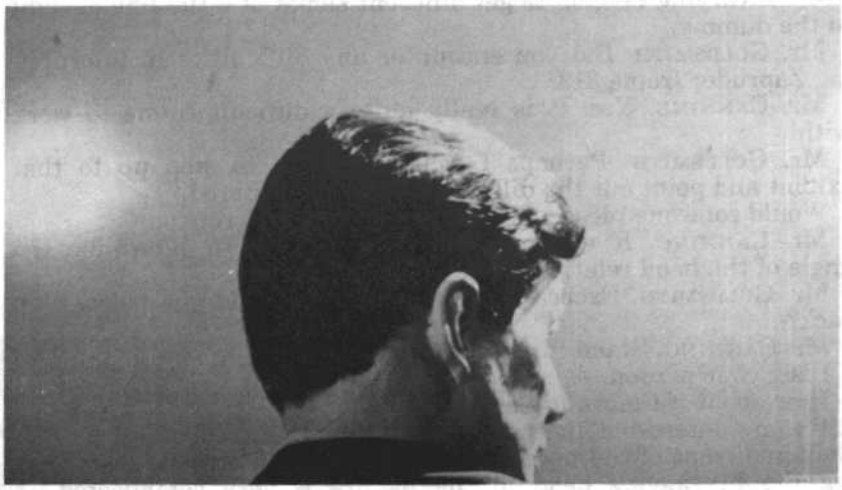
Mr. GOLDSMITH. Does a calibrated photograph facilitate measurement?

Mr. CANNING. I would hesitate to make that measurement any other way. It would call for just simply "eyeball" estimates to do it any other way that I know of.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission into the record of JFK F-141.

Chairman STOKES. Without objection, it may be entered into the record.

[The information follows:]



JFK EXHIBIT F-141

Mr. GOLDSMITH. Mr. Canning, you made reference to an anthropometric replica that was used for this calibrated photograph.

By whom was this replica prepared?

Mr. CANNING. The replica was prepared by the Physical Anthropology Section of the Federal Aviation Administration.

Mr. GOLDSMITH. What information did they use to prepare the replica of the President?

Mr. CANNING. They used a large array of photographs that were obtained from the Archives of the United States. These photographs were all taken during the last 2 or 3 years of the President's life.

Mr. GOLDSMITH. Did they also rely upon X-rays?

Mr. CANNING. No.

Mr. GOLDSMITH. Why was an actual replica of the President's head necessary?

Mr. CANNING. Because we wanted to have an objective model which showed the relative positions of all of the various features which one can actually see such as the back of the head, the position of the ear, which is very important, the projection of the nose beyond the rest of the facial profile, the shape of the brow, features of this sort.

Mr. GOLDSMITH. You have indicated that the series of calibration photographs were taken.

Would you describe somewhat the procedure for taking these photographs?

Mr. CANNING. The dummy was placed in the middle of a large photographic studio on a pedestal and illumination was provided which gave at least a fair simulation of the sunlight illumination on the President's face at the time of the assassination.

An array of camera positions was marked out on the floor of the studio in a large circle, and points on that circle were marked to establish the required directions from which pictures were to be taken. The camera was then positioned above these points on the floor at varying heights to get different slopes of a the line of sight to the dummy.

Mr. GOLDSMITH. Did you encounter any difficulties in interpreting Zapruder frame 312?

Mr. CANNING. Yes. It is really quite a difficult frame to work with.

Mr. GOLDSMITH. Perhaps I would ask you to step up to that exhibit and point out the difficulties you encountered.

Would someone please hand Mr. Canning a microphone?

Mr. CANNING. It was quite critical in order to determine the angle of the head relative to the camera——

Mr. GOLDSMITH. Excuse me, Mr. Canning, would you please step back?

Mr. CANNING. Stand further back?

I beg your pardon.

How about if I move to here?

We are interested in the relationships of such features as the back and front of the head and the ear. The background surrounding the President's head in the picture is very complicated. It contains elements of whatever object makes this blue feature between his face and Mrs. Kennedy's. There are pink regions which correspond to Mrs. Kennedy's suit, and then there are very dark regions which correspond to the lapel of her blouse. In inferior reproductions which are much more common than good ones, we are simply unable to locate the President's with precision. The immediately preceding Zapruder frames are similar in this regard.

Mr. GOLDSMITH. Mr. Canning, you mentioned that this was an enhanced photograph. I realize this is an enlargement of that enhancement.

Could you indicate generally what type of enhancement work was done in this photograph.

Mr. CANNING. The principal effort was to achieve edge enhancement. This is a technique which I am not expert in, the techniques used.

The other feature of the reproduction process was the very careful attention paid to color. Both edge enhancement and the clear colors provide the vivid indication of his facial features.

Mr. GOLDSMITH. Thank you, Mr. Canning.

Please resume your seat.

Now after taking these calibration photographs and studying frame 312, what did you determine the orientation of President Kennedy's head relative to Zapruder's line of sight to be?

Mr. CANNING. That is most easily portrayed by going through the motions of establishing the relationship as I describe the process.

Let me put myself in the position of being the President, and you, Mr. Goldsmith, in the position of Mr. Zapruder. I start out looking straight foward at you, then turn my head to my left like this, by 115°, namely, about 25° past a perfect profile view, then if I nod my head forward by about 11° and then tilt my head away from you by about 15°, that gives you the right perspective. So let me go through those motions so it will be clear what I mean.

Mr. GOLDSMITH. Please do.

Mr. CANNING. First, the 115° turn like this, then a nod forward like this, and then tilt the head away like this.

Mr. GOLDSMITH. Thank you.

At this time I would ask that the witness be given the opportunity to examine JFK F-138.

Mr. Canning, I am going to ask you to step up to the easel again. I am sorry.

Actually this is a combination of two exhibits, and I would ask, Mr. Canning, that you identify the information contained in this exhibit.

Mr. CANNING. The major part of this exhibit is a scaled reproduction of the topographic survey with a lot of detail removed for clarity. The position of the Presidential limousine at the time frame 312 is indicated. The insert is a scale representation of the rear portion of the limousine and the position of the President in the limousine is shown for the time of frame 312.

Mr. GOLDSMITH. Where specifically in that exhibit is the President's orientation at 312 shown?

Mr. CANNING. The emphasis is placed on showing that in the inset drawing, as we see him from directly above.

Mr. GOLDSMITH. And what is the purpose of the other part of that exhibit?

Mr. CANNING. It is to illustrate the angular position of the President's head relative to the line of sight from Mr. Zapruder's camera.

Mr. GOLDSMITH. Now looking at the smaller limousine, I notice that there is a line going back to the book depository and there is also a line going in the other direction——

Mr. CANNING. Yes.

Mr. GOLDSMITH [continuing]. Approximately 85°.

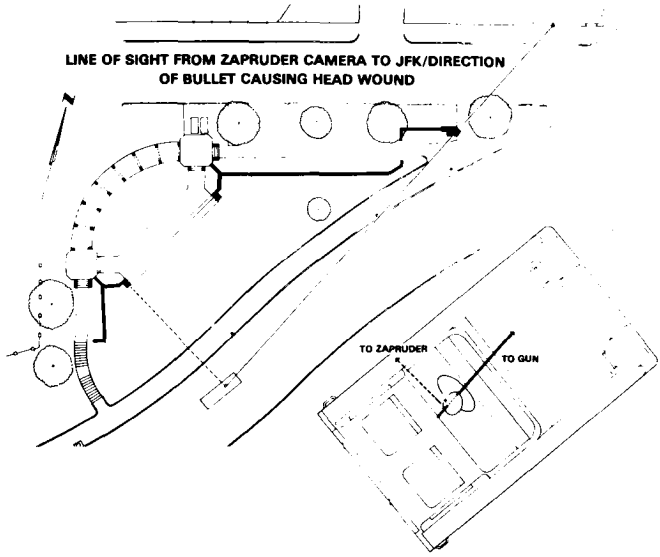
Where is that other line heading toward?

Mr. CANNING. This is the location of Mr. Zapruder with his camera, and this is the location of the President's head at that time.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this exhibit.

Chairman STOKES. Without objection, it may be received into the record.

[The information follows:]



JFK EXHIBIT F-138

Mr. GOLDSMITH. Mr. Canning, I ask that you remain standing for the time being.

Would you explain now what is the second step that you went through after having determined the orientation of the President's head relative to the Zapruder camera? What was the next procedure that you had to go through?

Mr. CANNING. The next step is to identify the position of the wounds in his head, which are shown essentially at the ends of the solid lines shown in exhibit JFK F-138. This illustrates the positions of the wounds.

Mr. GOLDSMITH. Once you have the wounds and you also have the orientation of the head relative to Zapruder's camera, are you able to determine the trajectory?

Mr. CANNING. Yes. We can determine from the information here the direction of the trajectory by simply determining the angular difference in this plan view between the line from Zapruder's camera to the President's head and the line that is generated by drawing a straight line between the inshoot and outshoot wounds.

Mr. GOLDSMITH. In effect, by doing that, are you determining the orientation of the President's head to the entire Dealey Plaza area?

Mr. CANNING. This establishes the direction relationship between line of sight from Zapruder's camera and the bullet's trajectory.

Mr. GOLDSMITH. Is it necessary to determine the orientation of the President's head not just to the line of sight of Zapruder's camera, but to the entire Dealey Plaza area?

Mr. CANNING. Yes, it is.

Mr. GOLDSMITH. And how is that done?

Mr. CANNING. That is done by locating the limousine, as was done using the U.S. Geological Survey analysis of the limousine's position. We can then determine the position of the camera's line of sight relative to Dealey Plaza at time of frame 312.

Having determined that, we can then fix the direction of the line representing the trajectory direction.

Mr. GOLDSMITH. I see.

Mr. Canning, please remain standing, and at this time I would ask that you be given an opportunity to examine what has been marked as JFK No. F-139.

Would you identify that exhibit, sir?

Mr. CANNING. This is a side view, an elevation view, a good deal like an architect's drawing, which is consistent with the view that we have just been looking at, which was the plan view.

Mr. GOLDSMITH. Is that diagram drawn to scale?

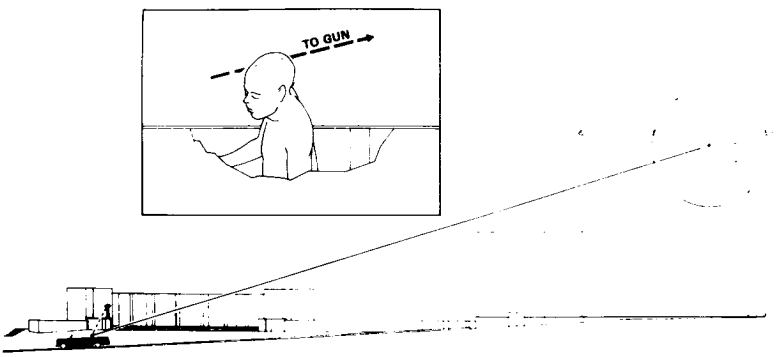
Mr. CANNING. Yes.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this exhibit.

Chairman STOKES. Without objection, it may be entered into the record at this point.

[The information follows:]

LINE OF SIGHT FROM ZAPRUDER CAMERA TO JFK/SLOPE OF BULLET CAUSING HEAD WOUND



JFK EXHIBIT F-139

Mr. GOLDSMITH. Mr. Canning, at this time I would ask you to refer to both of the scaled diagrams before you, and explain the results of your trajectory analysis.

Mr. CANNING. Going back to the previous exhibit, the direction from which the bullet came to strike the President, the rear of the President's head, and come out the right side, is portrayed in the Dealey Plaza. The indication is that the bullet started near where the trajectory line intercepts the face of the School Book Depository.

Mr. GOLDSMITH. Now earlier this morning you testified that a trajectory is characterized, or at least this kind of trajectory is characterized, by direction and slope.

Are you now referring then to the direction aspect of the bullet's trajectory?

Mr. CANNING. That is correct.

Mr. GOLDSMITH. And what does the other diagram indicate?

Mr. CANNING. Exhibit JFK F-139 indicates the slope of the trajectory based on the relative vertical positions of the inshoot and outshoot wounds and the position and attitude of the President's head. The line that is drawn through those two wounds terminates at a spot on the face of the Texas School Book Depository building as shown in the exhibit.

Mr. GOLDSMITH. Now I notice that there is a circle drawn around the spot on the face of the building that you were just referring to.

What does that circle signify?

Mr. CANNING. That circle is intended to indicate the relative precision of the overall analysis.

Mr. GOLDSMITH. In effect, then, does that reflect the margin of error?

Mr. CANNING. Yes.

Mr. GOLDSMITH. How did you determine what the margin of error was with regard to this trajectory?

Mr. CANNING. I simply went through each stage of a trajectory analysis and made a point-by-point estimate of how accurately I could make that step. Having done that, I then made a simple analysis which indicated how those errors might combine, and the end result is shown here.

Mr. GOLDSMITH. Would you summarize what steps you went through?

Mr. CANNING. Well, the steps again go back essentially to the elements of determining the trajectory, as was shown on the earlier chart. It was difficult to determine the position of the outshoot wound with great precision. This was an important source of potential error. To establish the orientation of the President's head is the other part that gave great difficulty.

Mr. GOLDSMITH. So I take it then that No. 2, locating the limousine, does not account for much error.

Mr. CANNING. Very, very little. It is an unimportant source of error.

Mr. GOLDSMITH. Fine.

At this time I would ask that what has been marked as JFK No. F-122 be displayed.

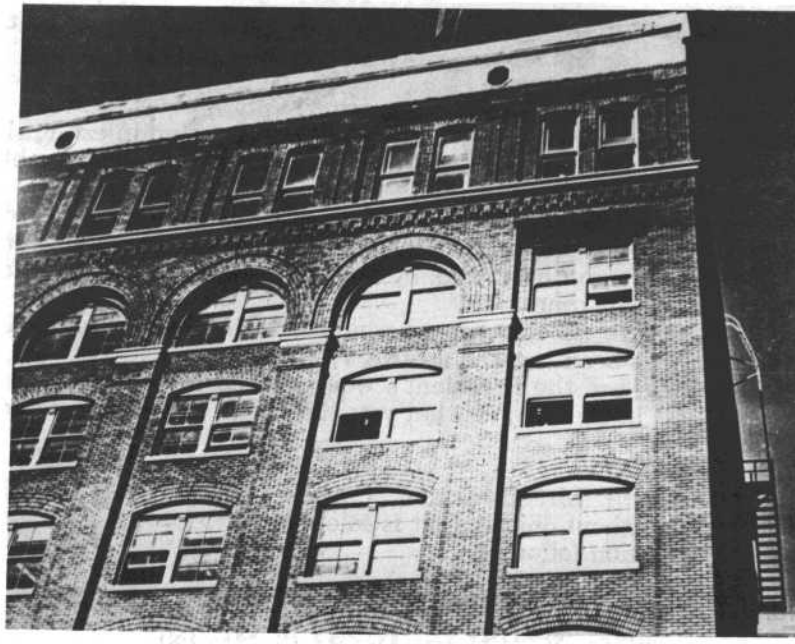
Mr. Canning, can you identify this item?

Mr. CANNING. This is a photograph of the upper floors of the southeast corner region of the Texas School Book Depository building.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this item.

Mr. DODD. Without objection, it is so ordered.

[The information follows:]



JFK EXHIBIT F-122

Mr. GOLDSMITH. Mr. Canning, I would ask you now to indicate where in that building the circle reflecting the margin of error would be shown?

Mr. CANNING. That is shown in an overlay which I prepared this morning. This is an approximation of that other circle. The reason that it is oval is because the perspective of this picture is very different from that in the drawing in exhibit JFK F-139.

Mr. GOLDSMITH. Essentially that circle covers the top four floors of that building; is that correct?

Mr. CANNING. Yes; it includes one, two, three, four floors and the roof of the building. It extends slightly beyond the building at the southeast corner and extends over to the edge of the photograph here.

Mr. GOLDSMITH. Thank you, Mr. Canning.

Please resume your seat.

After completing the trajectory of the bullet that struck the President's head, what was the next trajectory that you attempted to derive?

Mr. CANNING. The trajectory based on the back and neck wounds in the President.

Mr. GOLDSMITH. And again I take it the first step would have been to establish the location of these wounds.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. What information were you given by the committee's forensic pathologists with regard to the location of these wounds?

Mr. CANNING. I was given the distances of the wounds relative to good reference points in the body.

Mr. GOLDSMITH. Was the location of the wound actually quantified for you?

Mr. CANNING. Yes, it was.

Mr. GOLDSMITH. Why was this necessary?

Mr. CANNING. Again simply because of the first step in establishing a trajectory is that we must know as precisely as is reasonable the positions of those wounds.

Mr. GOLDSMITH. How was the location of the wounds quantified?

Mr. CANNING. It was determined from photographs that were taken during the autopsy and by measurements and notes that were taken at that time.

Mr. GOLDSMITH. At this time I would ask that Mr. Canning be shown what has been marked as JFK F-376.

Mr. Canning, are the President's wounds accurately represented in this exhibit in the manner that you used them in your trajectory analysis?

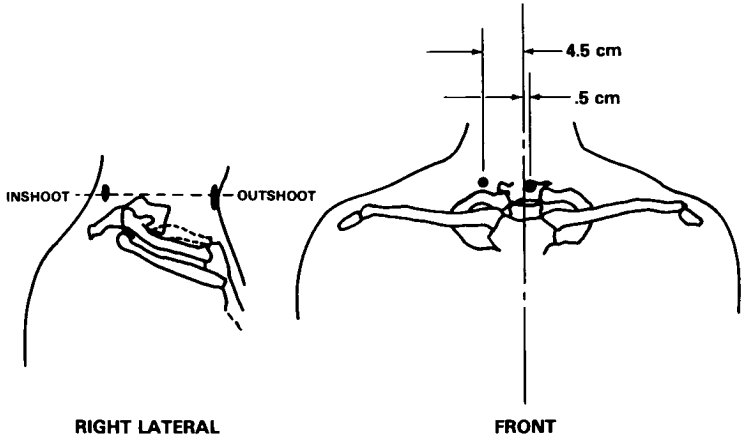
Mr. CANNING. Yes.

Mr. GOLDSMITH. Mr. Chairman, I move to admit this exhibit.

Mr. DODD. Without objection, it is so ordered.

[The information follows:]

J.F.K. WOUND LOCATIONS DEDUCED FROM PATHOLOGY PANEL REPORT (AUTOPSY POSITION)



JFK EXHIBIT F-376

Mr. GOLDSMITH. Thank you.

Would you now indicate where the President's back and neck wounds were located?

Mr. CANNING. The inshoot wound using the right lateral view in that figure showed that the wound was very high in the shoulder, just below the base of the neck at the back, and the projectile passed very close to the seventh cervical vertebra and near the first thoracic vertebra. The outshoot was through front of the neck.

Mr. GOLDSMITH. You are now making reference—excuse me for interrupting—to the right lateral view?

Mr. CANNING. That is correct.

Mr. GOLDSMITH. And on the other part of that exhibit is a frontal view; is that correct?

Mr. CANNING. And in the frontal view, the lateral positions of the two wounds are shown. The entry wound on the back was 4½ centimeters to the right of the mid-plane of the body, and the neck wound was a small distance, about one-half centimeter to the left of the mid-plane.

Mr. GOLDSMITH. Mrs. Downey, would you go to that exhibit and point to the location of the wounds?

Mr. CANNING. The inshoot wound is as shown in the exhibit. It appears as the left-most wound in both diagrams.

Mr. GOLDSMITH. And the outshoot in that?

Mr. CANNING. And the outshoot is represented by the dark spot low in the neck and slightly to the viewer's right of center.

Mr. GOLDSMITH. Thank you.

Are these diagrams drawn to scale?

Mr. CANNING. No. These diagrams are taken from Gray's Anatomy. They are tracings of parts of figures in that textbook. The dimensions are the key information.

Mr. GOLDSMITH. Did you have to make any adjustments to the information that you were given concerning the President's wounds in order to construct your back neck trajectory?

Mr. CANNING. Yes, I did.

Mr. GOLDSMITH. Why was this necessary?

Mr. CANNING. Because the President, when these wounds were identified and measured, was lying in the autopsy position, which was very unlike his normal posture.

Mr. GOLDSMITH. How did you actually proceed to make the adjustments?

Mr. CANNING. I worked with the people at the FAA in Oklahoma City, the anthropological group there, and we made measurements of typical skin mobility. We studied this in order to find out how the wounds moved when the President was manipulated from his position and posture at the time he was wounded to the position and posture during the autopsy.

Mr. GOLDSMITH. What actual adjustment did you eventually make with regard to these wounds?

Mr. CANNING. The major adjustment was that during the autopsy, the President's head was pointed straightforward and was tilted back, so that he was essentially "looking at the sky," as a way of thinking of it, by about 35°. And when we return him to a normal posture, by lowering his chin, that wound, the neck wound, moves down about a centimeter. When the wound was inflicted, it has been concluded that his head was turned sharply to his right and that resulted in a small movement of the neck wound to Mr. Kennedy's right at the time. Also he was observed to have his right shoulder elevated in order to place his elbow on the side of the car. This didn't affect the position of the neck wound but it did elevate the position of back wound slightly.

Mr. GOLDSMITH. Did you have to make similar adjustments in the case of the President's head wound?

Mr. CANNING. No.

Mr. GOLDSMITH. Why not?

Mr. CANNING. Because the upper part of the head, is a rigid object, so wounds are not displaced by changes in position or attitude.

Mr. GOLDSMITH. Fine.

Now as I recall, you used frame 312 of the Zapruder movie to construct the head shot trajectory.

What frame of the Zapruder movie did you use for the back neck trajectory?

Mr. CANNING. I related the back neck trajectory to the positions at Zapruder frame 190.

Mr. GOLDSMITH. At this time I ask that JFK F-226 be shown to the witness.

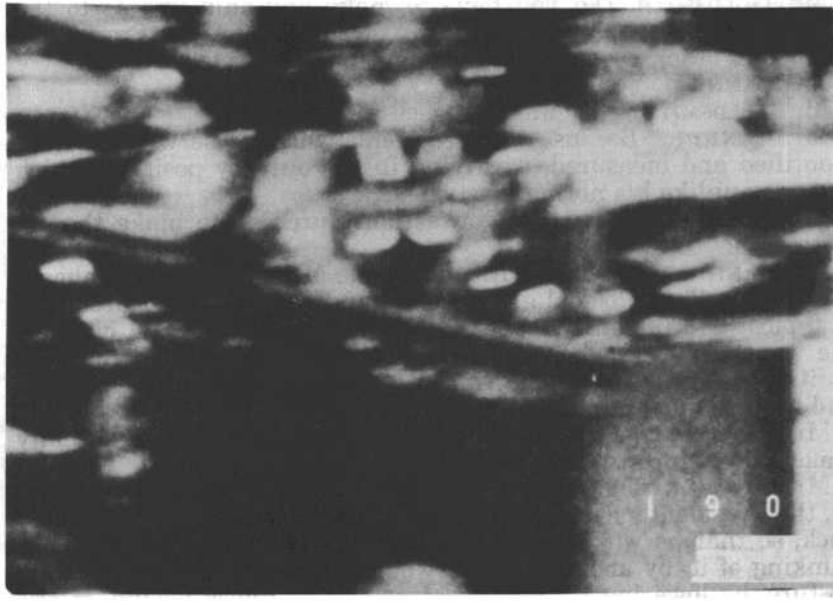
Can you identify that item?

Mr. CANNING. That appears to be frame 190.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this exhibit.

Chairman STOKES. Without objection, it may be entered into the record at this point.

[The information follows:]



JFK EXHIBIT F-226

Mr. GOLDSMITH. Thank you.

Why was this specific frame used to determine the trajectory of the back neck shot?

Mr. CANNING. During the investigation several weeks ago, there were indications that suggested this would be a proper time to consider for a first wound, in particular the investigations of the acoustics panel led to selection of this for our study at that time.

Mr. GOLDSMITH. Did you also rely upon any input by the photographic evidence panel? I am referring now specifically to the jiggle analysis that was performed by them.

Mr. CANNING. Yes, those two studies went on at the same time, and I tend in my own mind to sort of equate them, not that they are necessarily interchangeable.

Mr. GOLDSMITH. You did not participate in the acoustics study or in the jiggle study, did you?

Mr. CANNING. No.

Mr. GOLDSMITH. So you were simply given that information.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Mrs. Downey is going to refer your attention to the survey map, and I believe that the USGS indicated what the location of the limousine was for frame 193.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Why did they give you frame 193, do you know?

Mr. CANNING. As I understand it, it was because they got superior alinements of reference points for that.

Mr. GOLDSMITH. What adjustment, if any, did you have to make to locate the limousine in frame 190?

Mr. CANNING. I moved it, I moved the limousine, to the rear in order to account for its motion between frames 190 and 193.

Mr. GOLDSMITH. Approximately how great a distance did you move the limousine?

Mr. CANNING. A little less than 3 feet.

Mr. GOLDSMITH. Pardon me?

Mr. CANNING. A little less than 3 feet.

Mr. GOLDSMITH. What is your estimated margin of error for relocating the limousine?

Mr. CANNING. Oh, perhaps 6 inches.

Mr. GOLDSMITH. In addition to the Zapruder film, Mr. Canning, what photographic evidence did you rely upon with the back neck trajectory?

Mr. CANNING. The key photograph on which I relied was a photograph taken by Mr. Robert Croft.

Mr. GOLDSMITH. I would ask that JFK No. F-135 be displayed. Would you identify this item, Mr. Canning?

Mr. CANNING. This is a photograph that was provided me by the staff that had been taken by Mr. Croft.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this exhibit.

Chairman STOKES. Without objection, it may be entered into the record at this point.

[The information follows:]

JFK EXHIBIT F-135

Mr. GOLDSMITH. Did you rely upon any other photographic material, Mr. Canning?

Mr. CANNING. Yes, there were other photographs taken during this period which were quite useful, in particular a photograph taken by Mr. Willis.

Mr. GOLDSMITH. I would ask that JFK No. 155 be shown to the witness and entered into the record.

Chairman STOKES. Without objection, it may be entered into the record.

[The information follows:]

JFK EXHIBIT F-155

Mr. GOLDSMITH. Would you generally indicate, Mr. Canning, for what purpose you used these two photographs?

Mr. CANNING. I used these to determine the posture of the President and his orientation relative to his surroundings.

Mr. GOLDSMITH. What frames of the Zapruder film did these photographs correspond with?

Mr. CANNING. The Croft picture corresponds with frame 161. The Willis photograph corresponds with frame 202.

Mr. GOLDSMITH. How were these determinations made?

Mr. CANNING. They were determined by establishing lines of sight, in the case of the Willis photograph, between the photographer Willis and the photographer Zapruder. Zapruder can be seen over the left shoulder of the Secret Service agent standing on the following limousine, and in the Zapruder frame 202, one can see the photographer Willis taking his picture.

I think you also asked for the determination of how the other one was taken. It was done by similar methods but it was not quite so direct, to determine the time of the Croft picture.

Mr. GOLDSMITH. Was this information given to you by members of the photography panel?

Mr. CANNING. Yes.

Mr. GOLDSMITH. Would you step to the easel now, Mr. Canning, and indicate how the orientation of the President at the time of the back neck shot was determined?

Mr. CANNING. The principal data which we have to establish the position of the President is this photograph. There are many others that give his general habit of sitting, but this one is particularly useful. It shows the form of his shoulder fairly clearly. We don't

see his far shoulder because of the photographic aspect, so we know that he has not turned sharply to his right. He is looking forward, but the key information here is the way in which he is seen to hunch forward. There is a considerable curvature of his back. Despite his torso leaning forward, he held his head in an essentially level position.

Mr. GOLDSMITH. Now you indicated that this photograph corresponds approximately with the Zapruder frame 161.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Assuming that the back neck shot occurred at frame 190, what would be the time differential between the time this photograph was taken and the time that Zapruder 190 was exposed?

Mr. CANNING. At 18 frames per second, we are talking about a difference of almost 30 frames, so it is slightly over 1½ seconds.

Mr. GOLDSMITH. What additional information did you obtain from the Willis photograph on your right, Mr. Canning?

Mr. CANNING. Essentially from the Willis photograph, which corresponds to frame 202, we obtained confirmation that the President's head was turned rather sharply to his right, and a further suggestion that his shoulders have not turned very much during the period between the Croft picture and the Willis picture.

Mr. GOLDSMITH. Thank you.

Please resume your seat.

What frames of the Zapruder movie, if any, did you rely upon in determining the President's orientation?

Mr. CANNING. I relied on several frames between 160 and 200 largely those selected for clarity.

Mr. GOLDSMITH. Did you conduct any photo calibration study with regard to this trajectory analysis?

Mr. CANNING. No.

Mr. GOLDSMITH. Why is it that you conducted one in the case of the head wound but not in the case of the back neck wound?

Mr. CANNING. Because the head is a relatively rigid object and is not subject to deformation due to changes in position, whereas the body is, and we did not want to build an anthropometric dummy that would give a false impression of precision or knowledge.

Mr. GOLDSMITH. Would you summarize now what you determined the President's orientation at the time of the back neck bullet to be?

Mr. CANNING. Largely from this picture and from the subsequent study of the Zapruder pictures, I concluded that he was hunched forward somewhere between 11 and 18 degrees forward of vertical, in the upper torso, and that his shoulders were either facing straight ahead in the car or were turned slightly to the right of straight ahead.

Mr. GOLDSMITH. At this time I would ask that the witness be shown JFK F-140 and F-142.

Mr. Canning, I am sorry to do this to you, but I am going to ask you to step to the easel again.

For the record, the exhibit marked JFK F-140 is entitled "Direction of Bullet Causing JFK Back Neck Wound," and the one marked 142 is entitled "Slope of Bullet Causing JFK Back Neck Wound."

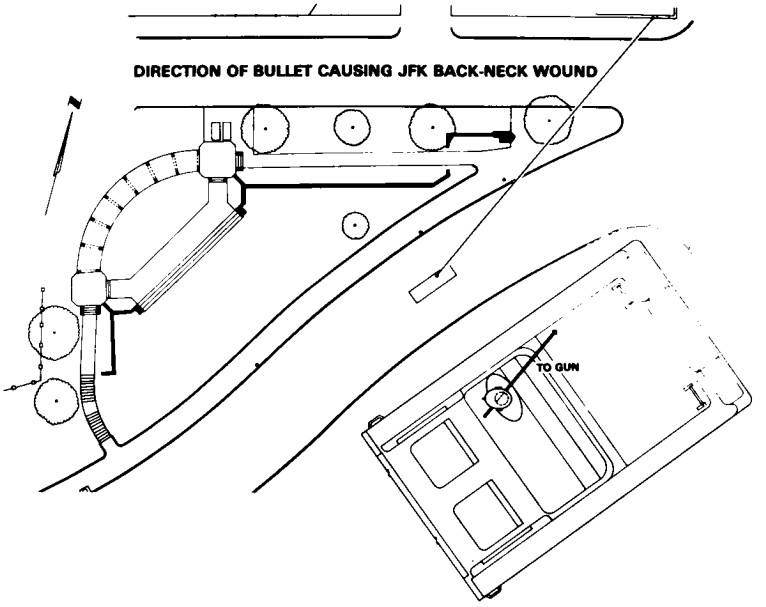
Mr. Canning, would you identify these two exhibits?

Mr. CANNING. The one on the direction of the bullet causing the back neck wound is the one here on our left.

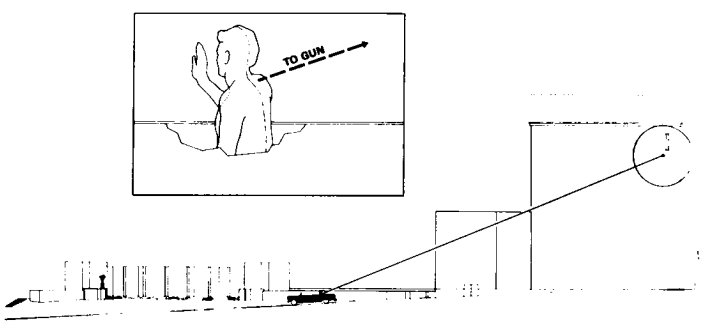
Mr. GOLDSMITH. Mr. Chairman, I move for the admission of both of these items.

Chairman Stokes. Without objection, they may be entered into the record at this point.

[The information follows:]



JFK EXHIBIT F-140



JFK EXHIBIT F-142

Mr. GOLDSMITH. Again I take it that by referring to the trajectory by means of direction and slope, that is simply consistent with your earlier testimony.

Mr. CANNING. That is true.

Mr. GOLDSMITH. That is how trajectory is characterized.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Fine.

Would you proceed now to summarize your results of the back neck bullet trajectory?

Mr. CANNING. The position of the wounds in the President are shown at this small scale in this highly schematic form as entering just to the right of his neck, just to the right of his center plane, and exiting the forward part of his neck, and we then can establish a line like that shown in the inset relative to the limousine. The angular position of his torso, as I mentioned, was very slightly to the right of forward, perhaps straightforward. We can't be more precise than that.

Then transferring this information into the small image of the limousine placed in the plaza for frame 190, and keeping the same angular relationship between the wound line and the line along the side of the car, we can then draw a line showing the direction of the trajectory back up toward the school book depository.

Mr. GOLDSMITH. Mr. Canning, when you made reference to keeping the same angular relationship with respect to—what were you referring?

Mr. CANNING. I was referring to the angular relationship between this arrow and the side of the limousine, this line and the side of the limousine.

Mr. GOLDSMITH. And would you point to the end of that trajectory, in other words, where, in the building, that took you?

Mr. CANNING. This point on the face of the building is slightly to the west of the first window, at the southeast corner of the building.

Mr. GOLDSMITH. Fine.

Would you now explain the slope of the trajectory based upon the JFK back neck wound?

Mr. CANNING. Here again we see where the back wound was. We can see in the insert sketch of JFK F-142 some of the key information regarding the position of his shoulders. His right shoulder appears to be slightly elevated relative to his left, as determined from Zapruder's pictures, between frames 160 and 200. We include the wound position data interpreted from the forensic pathologist report as modified to account for change in the President's posture and movement of his torso. The resulting difference in height of his back and neck wounds relative to the car gives us the slope relative to the car. Then we place the car on the sloping street in Dealey Plaza and maintain this same angular relationship between this line labeled "To Gun" in the exhibit and the line along the side of the limousine body.

Mr. GOLDSMITH. Mr. Canning, are these two exhibits drawn to scale?

Mr. CANNING. Yes.

Mr. GOLDSMITH. What is the margin of error indicated by the circle drawn around the end point of the trajectory?

Mr. CANNING. I believe the radius of the circle is about 13 feet.

Mr. GOLDSMITH. How was that determined?

Mr. CANNING. This was determined as before on the head wound case simply by making an estimate of the contribution of error at each stage of the analysis, and then combining those in order to obtain an estimate of the overall accuracy.

Mr. GOLDSMITH. Why was your margin of error less in this case than in the case of the head shot?

Mr. CANNING. In considerable measure because the distance from the limousine to the termination of this line was shorter.

Mr. GOLDSMITH. At this time I would ask that the witness be shown JFK No. F-122.

Would you indicate on this exhibit, Mr. Canning, where that margin of error circle would be shown?

Mr. CANNING. That margin of error circle is shown again in the handwrought curves produced this morning as this red ellipse in the overlay over the photograph.

Mr. GOLDSMITH. What was the most significant factor in this particular margin of error? In other words, what was your greatest difficulty?

Mr. CANNING. Essentially in determining, in making an estimate of the rotation of the President's shoulders relative to looking straight ahead, and in estimating what the inclination of his torso was from that one photograph.

Mr. GOLDSMITH. Mr. Canning, what impact would it have on your analysis if you were to reconstruct this trajectory based upon Zapruder frame 197? For example, that is when the acoustics panel says that the President may have been shot. If you were to reconstruct the trajectory at that frame, what effect would that have?

Mr. CANNING. I should have the plan view exhibit marked "JFK F-140" as well.

The relationships that we established in this exhibit gave us a line indicating the direction of the trajectory relative to the limousine itself. We have no good information that says that this relationship changed importantly with time. Therefore we would simply move the limousine to the new position and allow the trajectory line to travel with it; the result would be that the end point would move a short distance to the left in the figure and slightly upward as well, because the car is moving away from the building. So this point will not only move to the west, but it will rise, but it won't rise more than just a few feet.

Mr. GOLDSMITH. Thank you, sir.

Would you resume your seat now?

Mr. CANNING. Yes.

Mr. GOLDSMITH. At this time, Mr. Canning, I would like you to discuss the single bullet theory trajectory that you constructed.

My first question, is, again going by that chart, "Elements to Determining Trajectory," what information were you given about the location of Governor Connally's wounds?

Mr. CANNING. I was given the information that was generated by the medical reports at Parkland Hospital where his surgery was done, and more recently I examined the information in terms of the reported damage to his fifth rib.

Mr. GOLDSMITH. Of the wounds incurred by Mr. Connally, which did you rely upon for your analysis?

Mr. CANNING. Just the entrance wound.

Mr. GOLDSMITH. Why is that?

Mr. CANNING. Because of the considerable likelihood of larger deflections of the bullet's path in passing through him, since it hit his rib. The likelihood of deflection is greater than in the case of passage through the soft tissues of Mr. Kennedy's neck.

Mr. GOLDSMITH. What two points were you using to construct this particular trajectory?

Mr. CANNING. I was using the construction of a line based on the exit wound from Mr. Kennedy's neck, and the entrance wound as the bullet went into Mr. Connally's back.

Mr. GOLDSMITH. Was any attempt made to quantify the location of the entry wound in Mr. Connally's back?

Mr. CANNING. Yes.

Mr. GOLDSMITH. Why was that considered to be necessary?

Mr. CANNING. It is again necessary for step No. 1. We must know where those wounds are located in order to do the job.

Mr. GOLDSMITH. To what extent did you rely upon this information?

Mr. CANNING. I used the Parkland Hospital information.

Mr. GOLDSMITH. You stated you used the Parkland Hospital information. To what extent did you also rely upon, if you did at all, the information given to you by the committee's autopsy panel?

Mr. CANNING. I received information from the committee's autopsy panel on Sunday morning, September 10, 1978, this last Sunday, and I examined it to see if it was consistent with the early information, and I could find no important discrepancy.

Mr. GOLDSMITH. At this time I would ask that the witness be shown what has been marked for identification as JFK No. F-377.

Mrs. Downey, would you assist us by pointing to that exhibit at Mr. Canning's direction?

Referring to this exhibit, Mr. Canning, is Governor Connally's entry wound represented in the manner that you used it in your analysis.

Mr. CANNING. Yes, that is correct.

Mr. GOLDSMITH. Would you indicate now where those wounds are indicated?

Mr. CANNING. The wound was just inward, just toward the center plane of his body from his armpit, and it was high enough so that it could be consistent with a projectile striking his fifth rib.

Mr. GOLDSMITH. Mrs. Downey is now pointing to the entry wound?

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Thank you.

Thank you, Mrs. Downey.

Is this exhibit drawn to scale?

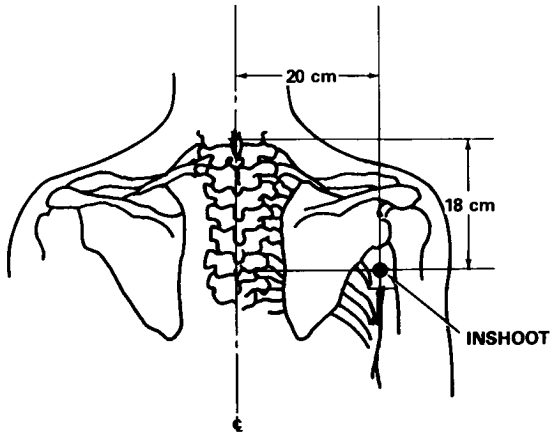
Mr. CANNING. It is dimensioned properly. It is actually a drawing that is based on a figure in Gray's Anatomy.

Mr. GOLDSMITH. Mr. Chairman, I move for the admission of this item into the record.

Chairman STOKES. Without objection, it may be entered into the record.

[The information follows:]

LOCATION OF INSHOOT WOUND IN BACK OF GOV. CONNALLY



JFK EXHIBIT F-377

Mr. GOLDSMITH. You testified earlier, Mr. Canning, that you had to make adjustments in the locations of President Kennedy's wound, President Kennedy's back neck wound, I understand.

Did you have to make a similar adjustment in the case of Governor Connally's entry wound?

Mr. CANNING. No; I didn't note any major change from the position shown.

Mr. GOLDSMITH. What frame of the Zapruder film did you use to construct the single bullet theory trajectory?

Mr. CANNING. I used the same time of the frame 190 as I used for the back neck wound.

Mr. GOLDSMITH. So are you saying that the only thing that changed is that you now had to work in Governor Connally's wound locations in his orientation?

Mr. CANNING. That is correct.

Mr. GOLDSMITH. So the position of the limousine was the same.

Mr. CANNING. Yes.

Mr. GOLDSMITH. Did you do any additional work on President Kennedy's orientation?

Mr. CANNING. I did no additional work on the President's orientation.

Mr. GOLDSMITH. How was Governor Connally's alinement relative to President Kennedy determined?

Mr. CANNING. It was determined from the photographic record, from the Zapruder pictures and others.

Mr. GOLDSMITH. At this time I would ask that the witness be shown what has been marked as JFK F-136 and F-143.

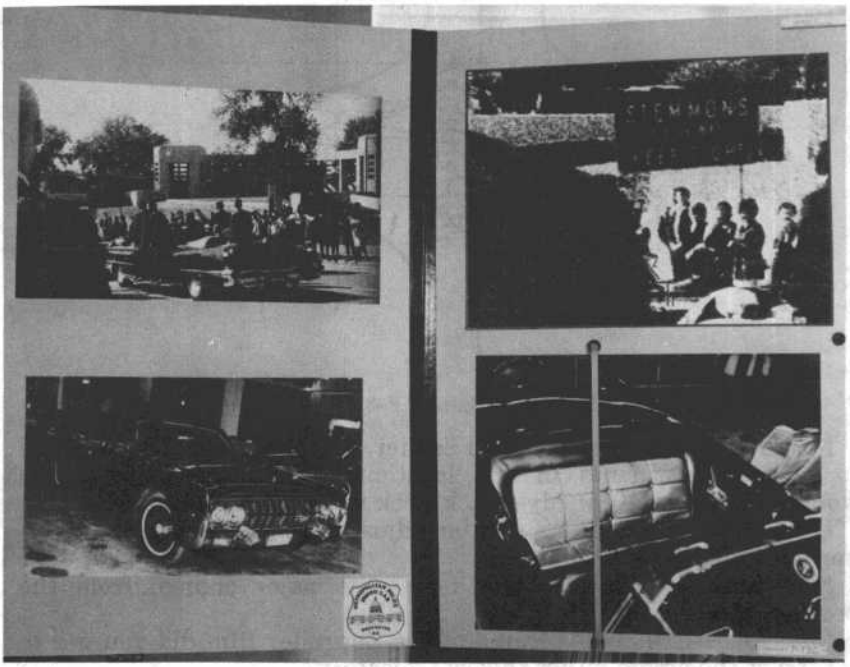
F-136 is an enlargement of a photograph taken by the photographer named Betzner, and F-143 is a scaled sketch that depicts the relative alinement of President Kennedy and Governor Connally as

that relative alinement has been deduced from the photographic evidence.

I move for the admission of these two items, Mr. Chairman.

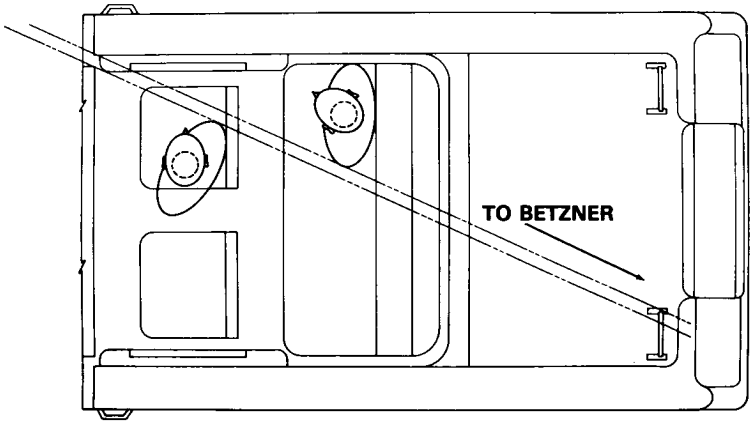
Chairman STOKES. Without objection, they may be entered into the record at this point.

[The information follows:]



JFK EXHIBIT F-136

RELATIVE POSITIONS OF PRESIDENT KENNEDY AND GOVERNOR CONNALLY AS DEDUCED FROM PHOTOGRAPHIC EVIDENCE



JFK EXHIBIT F-143

Mr. GOLDSMITH. Mr. Canning, I would ask you to step to the easel again.

Before I ask any further questions I should correct my earlier statement.

F-136 actually has four pictures in it. The one at the upper left is the Betzner photograph, and the one in the upper right is a partial enlargement of a section of that Betzner photograph. The two photographs at the bottom are photographs of the Presidential limousine used on that day.

Mr. Canning, do you know with what frame of the Zapruder film the Betzner photograph corresponds?

Mr. CANNING. That corrresponds with frame 186.

Mr. GOLDSMITH. And was that determined by use of the same method to which you referred earlier?

Mr. CANNING. It was determined by precisely the same method sighting over the shoulder of the Secret Service agent to the photographer Zapruder.

Mr. GOLDSMITH. Now using the two exhibits that are before you, sir, I would ask you to indicate to the committee how the relative position of Governor Connally to President Kennedy was determined.

Mr. CANNING. This involves working our way from the big picture, if you will, into small details, and then relating those to a drawing, the drawing of the limousine.

Let me start by identifying a few features just for orientation.

We see the well-known Stemmons Freeway sign here, the photographer Zapruder. You can see the President's head down here highlighted by the sun, and we can see a bright spot here, which is the siren on the Secret Service vehicle which is following the Presidential limousine.

Going to the greatly enlarged inset, we see again the Stemmons Freeway sign. We see the siren, and we again see the President's head.

Now going further into this picture, looking for minute detail, we see, for instance, the spare tire enclosure on the Presidential limousine, and then looking very carefully we can see a rectangular object here. That rectangular object is a handhold which is on the trunk lid of the limousine. It is intended for the Secret Service men to hold on to when they are riding on the rear of the car.

Another feature that we see in this photograph is a diagonal feature here labeled No. 2, and this diagonal feature is the frame of the small window which was in front of and slightly to the right of Governor Connally. We can see that frame, and there is nothing to obstruct our view of it. So what we can do is to draw a line of sight from Mr. Betzner's camera, past the corner of the handhold over to the frame, let me show what that does on the photograph of the Presidential limousine.

One item in the large picture which I did not mention is, a man in the foreground; his shoulder and arm are obscuring everything to the left. That is what the dark object is. So we do not see Governor Connally in this picture. But the photograph puts a very stringent limit on how far to the right in the automobile the Governor can be sitting; that is, it says that the Governor must be sitting to the left of the line of sight past the man in the foreground.

Now to make this quantitative, we have drawn in, on a scale drawings of the limousine, the line from Mr. Betzner's camera past the inboard corner of the Secret Service handhold, and extended it forward to the position that is seen in the photograph. We also notice that in the Betzner photograph the line of sight passes right by the tip of the President's left shoulder. It is remarkably clear that that is the case. So we have drawn the President in this position with his left shoulder along that line of sight.

Since we know that we can see to the left of that by a short distance, and by careful triangulation, based on the known distance between the right-hand handle and the left one, we can then find out how much farther across toward the left we can see along this line of sight. We then constructed this line, and we know then that Governor Connally was to the left of that line at the time of the Betzner picture. This graphical reconstruction fixes the relative positions of the men quite satisfactorily.

Mr. GOLDSMITH. So in essence the line of sight from Mr. Betzner to the limousine establishes the point, furthermost point, to the right in the limousine in which the Governor could be sitting.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Now why did you place the Governor in that plan view diagram as far to the right as you did?

Mr. CANNING. The Zapruder pictures tell us that he is not very much farther away, and so in order to make a clear and conservative analysis, I placed him in that position.

Mr. GOLDSMITH. Thank you.

Please resume your seat, Mr. Canning.

Mr. Canning, before I ask you to resume your seat, I would like you to review some frames in the Zapruder movie with us.

At this time I would ask that Mr. Canning be shown what has been marked as JFK Nos. 223, 229, 232, 236, and 240. These correspond with the Zapruder Frames No. 187, 193, 196, 200, and 204.

Did you rely upon these frames in your analysis, Mr. Canning?

Mr. CANNING. Yes.

Mr. GOLDSMITH. Would you indicate in what manner you relied upon them to determine the Governor's orientation?

Mr. CANNING. The principal information we have on the Governor from these pictures is shown extremely clearly in this frame. We can see that his head is facing essentially straight, perpendicular to the line of the car, and we can see rather clearly his necktie, which indicates that his torso is turned somewhat past the line of sight from Mr. Zapruder's camera at the time. This then is a basis for an estimate of the angular orientation of his torso. We follow those same features, sometimes good pictures, sometimes blurry pictures, and we find that his orientation changes, but he is always turned substantially to the right during this time period.

Mr. GOLDSMITH. Mr. Canning, referring now to the Croft photograph behind the Zapruder frames, Mrs. Downey, could you possibly move that forward?

Mr. CANNING. That is a good idea.

Mr. GOLDSMITH. Thank you.

As part of your trajectory analysis, Mr. Canning, did you have to determine the distance between the President and the Governor?

Mr. CANNING. Yes. The distance between the President's neck and the Governor's back is an important part of the trajectory determination.

Mr. GOLDSMITH. Do you recall what that distance was measured to be?

Mr. CANNING. It is about 60 centimeters.

Mr. GOLDSMITH. And did you have to determine the relative height of the two men?

Mr. CANNING. Yes. It is apparent from the photograph that the President is sitting considerably higher than the Governor, and analysis was made to make that as quantitatively as accurate as possible.

Mr. GOLDSMITH. What input, if any, did the committee's photographic evidence panel have in assisting you with those measurements?

Mr. CANNING. The photographic panel did the analysis which gave the height difference between the men.

Mr. GOLDSMITH. Did you use any calibration photographs in attempting to determine the orientation of Governor Connally?

Mr. CANNING. No.

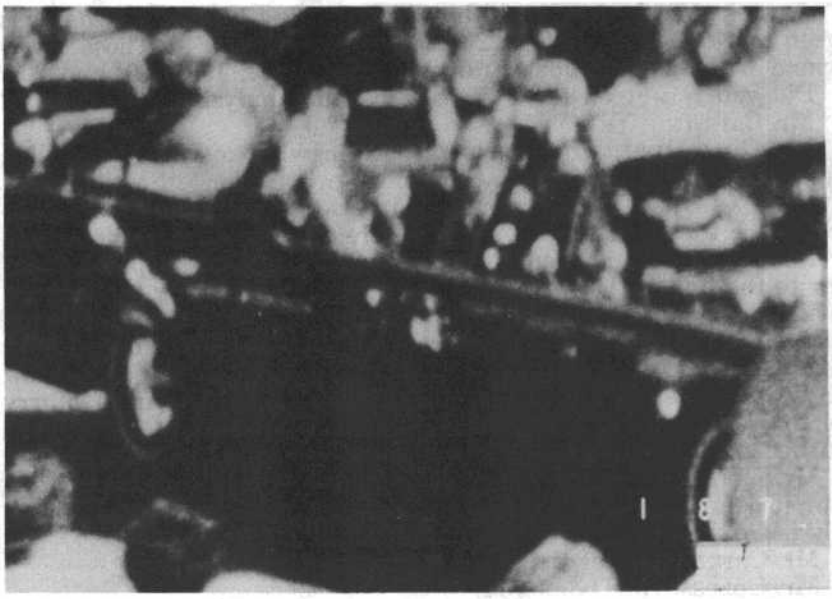
Mr. GOLDSMITH. Why not?

Mr. CANNING. It was not particularly important to determine the actual conformation of the Governor's body; only his body's position was critical.

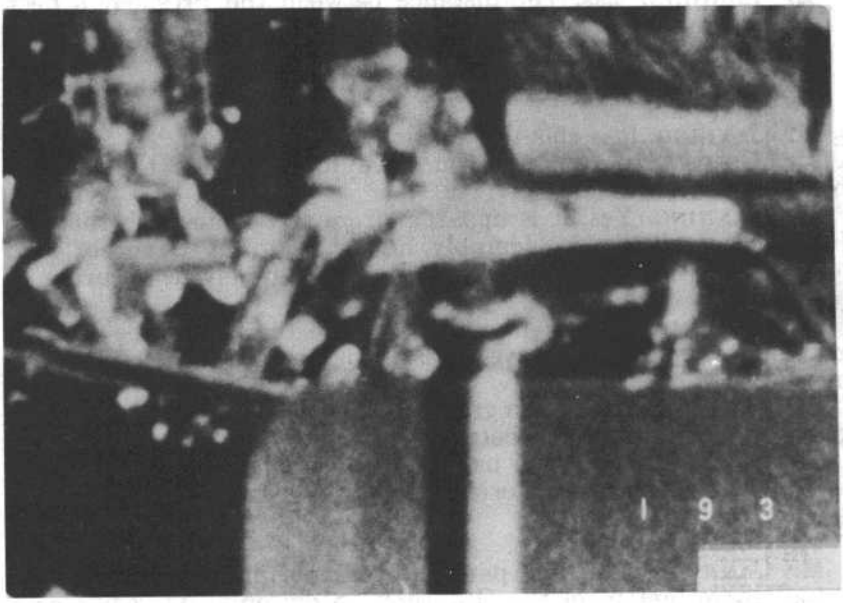
Mr. GOLDSMITH. Mr. Chairman, at this time I move for the admission of JFK Nos. F-223, F-229, F-232, F-236, and F-240.

Chairman STOKES. Without objection, they may be entered into the record at this point.

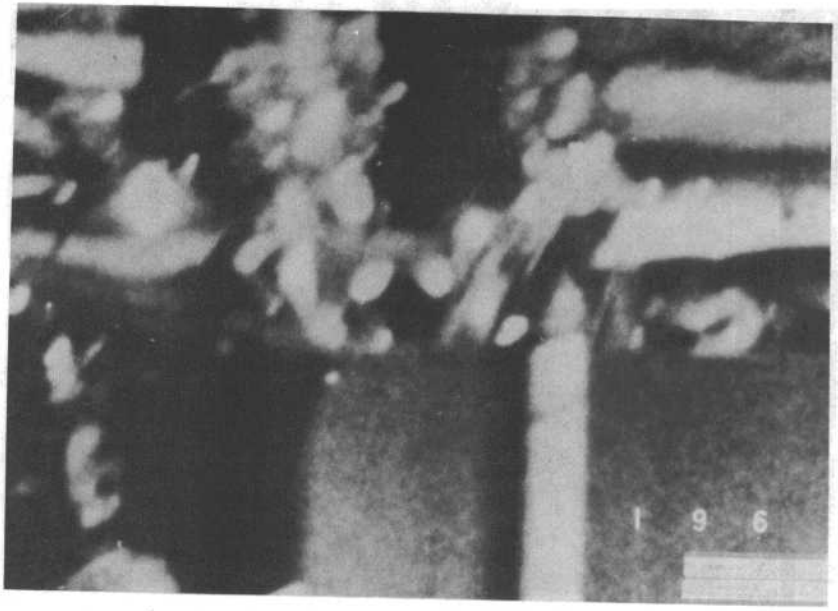
[The information follows:]



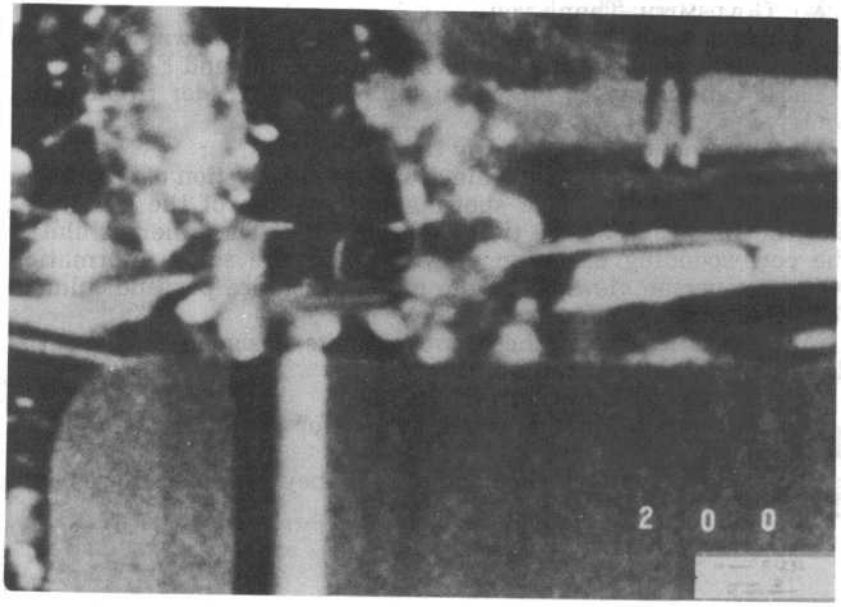
JFK Exhibit F-223



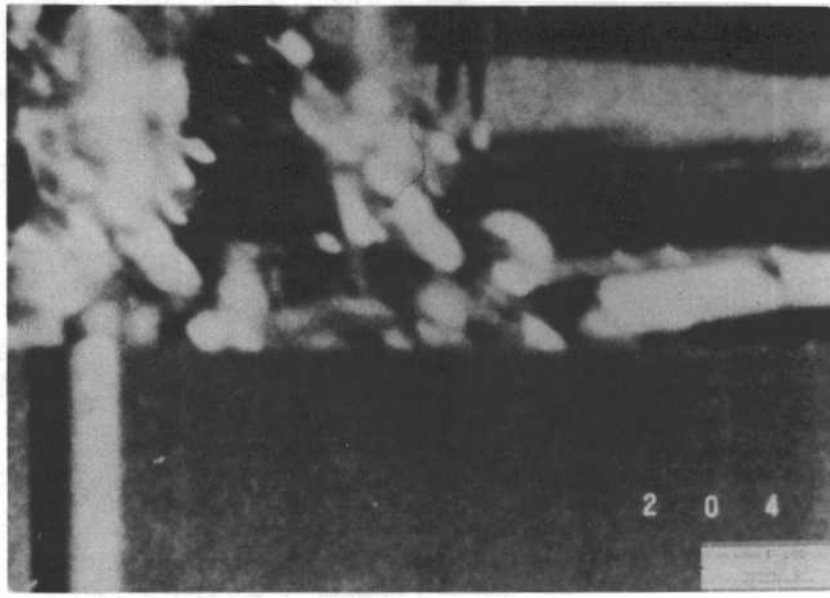
JFK Exhibit F-229



JFK Exhibit F-232



JFK Exhibit F-236



JFK EXHIBIT F-240

Mr. GOLDSMITH. Thank you.

I would ask at this time that the witness be shown what have been marked for identification as JFK Nos. F-144 and F-145.

Those can simply be placed on top of the Zapruder frames that we have.

Mr. Canning, can you identify these two items?

Mr. CANNING. These are scale drawings of a portion of the limousine, and of Dealey Plaza showing the position of the structures and the limousine at the time of Frame 190. The other exhibit is the corresponding elevation view showing the same information seen by a person viewing it from a great distance perpendicular to the trajectory direction line.

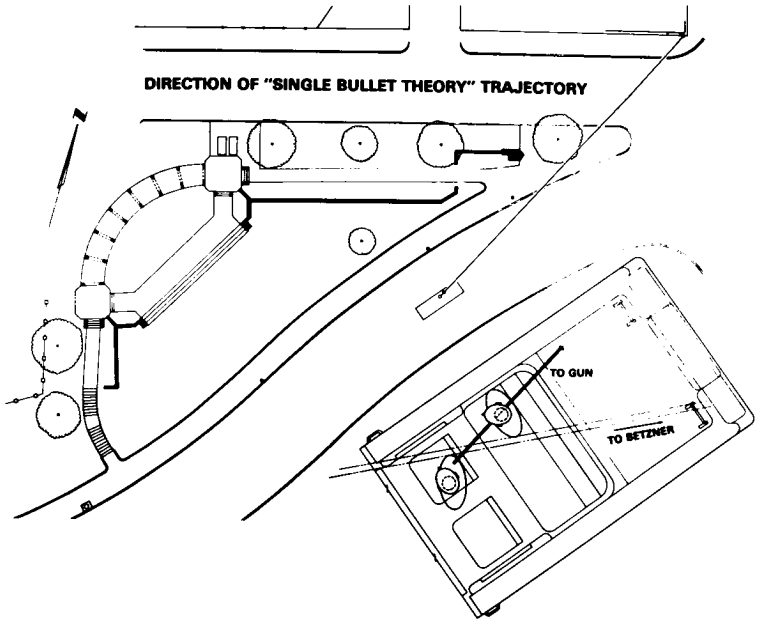
Mr. GOLDSMITH. Are these two exhibits designed to show the direction and slope of the trajectory?

Mr. CANNING. That is correct.

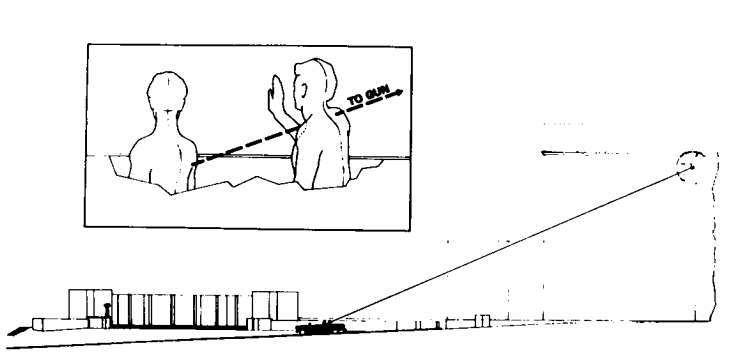
Mr. GOLDSMITH. Mr. Chairman, I move for the admission of these two exhibits.

Chairman STOKES. Without objection, they may be entered into the record.

[The information follows:]



JFK EXHIBIT F-144



JFK EXHIBIT F-145

Mr. GOLDSMITH. Mr. Canning, at this time I would like to ask you to explain your analysis of the single bullet theory trajectory, in light of these two exhibits.

Mr. CANNING. The inset is simply a replica of the drawing which we had before with the two lines established as lines of sight from Mr. Betzner's camera, with the President in the position that that analysis determined, the Governor in the position that that analysis showed, and then we have indicated schematically where the Governor's wound would show, and where the President's neck wound would show, to establish a line relative—again in the frame of reference of the limousine now, which would extend to the gun.

We then take this drawing and reduce it in size and place it in the correct position and angular orientation in the plaza, and take this same line with the same angular orientation relative to the limousine, and extend it to show the direction of the single bullet theory trajectory.

The side view picture using in large measure the information from the Croft photograph illustrates again the position of the back and neck wounds. We do not use the information for the President's back wound, just the information from his neck wound, and for Governor Connally's back wound and the relative positions and relative heights are registered in this drawing.

We simply draw a straight line from Governor Connally's inshoot wound through the President's outshoot wound and extend the line toward the point from which the gun was thus deduced to have been fired.

The side view of the limousine is shown as if it were on level ground. Therefore when we show it in the main part of the exhibit we preserve the angular relationship between the trajectory slope line and the body of the car. When this line is extended in the main part of the exhibit, it intercepts the face of the Texas School Book Depository as shown in exhibit JFK F-145.

Mr. GOLDSMITH. What is the margin of error indicated on this particular diagram, Mr. Canning?

Mr. CANNING. It is a little bit over 5 feet in radius.

Mr. GOLDSMITH. How was this margin of error determined?

Mr. CANNING. It was determined in the same manner as before, simply by estimating the contributions to uncertainty contributed at each stage of the trajectory determination.

Mr. GOLDSMITH. Why is this particular margin of error so much less than the others?

Mr. CANNING. This is illustrated by JFK F-145. The distance between the two men, about 60 centimeters or 2 feet, is about five times as great as that between the President's back and neck wounds. Therefore there can be much larger errors in determining relative positions of the wounds without increasing the resulting angular errors. The same contrast applies also to the accuracy of the single bullet trajectory relative to that of the head wounds case.

Mr. GOLDSMITH. Mr. Canning, to what extent, if any, would your results be different if you were to reconstruct the trajectory based upon the limousine's location in Zapruder Frame 197?

Mr. CANNING. Again the effect would be exactly the same as it would be in the case of the back neck wound. The final point would move, to the east and would rise slightly by just a matter of a few feet.

Mr. GOLDSMITH. Would it move to the east or to the west?

Mr. CANNING. It would move to the east and up.

Mr. GOLDSMITH. And would you indicate in that diagram which direction is east?

Mr. CANNING. East is to our left in this diagram.

I beg your pardon.

Mr. GOLDSMITH. Wouldn't that be the west?

Mr. CANNING. It is west. I knew I would blow that one. I said west one time and it was almost funny.

Yes, that is correct. This is to the west, and I think I said east earlier as well. That should be corrected.

Mr. GOLDSMITH. Thank you.

Mr. Canning, you may resume your seat now.

I am going to ask Mrs. Downey to work the overlay on exhibit No. 122.

Thank you.

Mr. Canning, would you describe the margin of error as indicated on the overlay of exhibit 122?

Mr. CANNING. That is the smallest oval which I generated this morning for the single bullet theory. It is black in the overlay.

Mr. GOLDSMITH. Mrs. Downey, would you point to that oval, please?

Thank you.

Mr. Canning, each of the three trajectories that you constructed had different slope, different direction, and a different margin of error.

What consequence, if any can you attribute to these differences?

Mr. CANNING. The differences may well arise simply because all measurements are imprecise, and it would simply be unrealistic to expect the slopes and directions to be identical.

Mr. GOLDSMITH. Thank you very much, Mr. Canning.

I have no further questions.

Chairman STOKES. The procedure at this point will be that the Chair will recognize the gentleman from Michigan, Mr. Sawyer, for such time as he may consume, after which the committee will operate under the 5-minute rule.

The Chair at this time recognizes Mr. Sawyer.

Mr. SAWYER. Thank you, Mr. Chairman.

If I understand the procedure that you went through, you did not attempt to force the end of the line pointing toward the gun.

You let it fall where it may, starting from the wound, in effect, the position of the limo and the assumed posture based on the best evidence you could get.

Mr. CANNING. That is correct.

Mr. SAWYER. I am still a little puzzled why the marked improvement in the margin of error on the last diagram. You didn't change the angle through the President or the line of flight, presumed line of flight, of the bullet?

Mr. CANNING. Yes, those two angles are different. The line of sight that one obtains by using Governor Connally's back wound and President Kennedy's neck wound is slightly different from the angle which is determined by using the President's wounds alone.

Mr. SAWYER. So then by taking into account then the wounds on Governor Connally forced some kind of a caused alteration in either the line of the bullet or the posture of the President?

Mr. CANNING. Well, I want to be sure that I am responding to your question. I am not saying that the bullet's travel itself was affected. What I am saying is that our interpretation of the data tells us that if we were to determine one trajectory based on the two pieces of information, one the Governor's wound, and the President's neck wound, that that will give us one line.

The other wound, the other wound pair in the President, will give us a second line. Those two lines do not coincide simply

because of experimental error. We cannot expect to make all of the myriad of measurements such as wound location, body position and limousine position with absolute perfection. Therefore we expect slightly different answers. The two trajectories should be close enough so that they fall within a reasonable error of one another, which is what we found.

Mr. SAWYER. If we were to start at the other end then and assume that a bullet were fired at the approximate time we have determined from the sixth floor of the depository, would it have of necessity given the wounds in the President, would it of necessity, based on what you have determined as to locations somewhat, also have hit Governor Connally?

Mr. CANNING. The bullet would have had to have been substantially deflected by passing through the President in order to miss the Governor. It seems almost inevitable that the Governor would be hit with the alinements that we have found.

Mr. SAWYER. So that if we assume, as apparently is the fact, that this jacketed bullet did not hit anything solid in the way of bone in the President but only traversed the soft tissue of the neck, and presuming the approximate location of the limousine at the time and the posture as nearly as can be determined of the President at that time, that in your view then, absent a deflection of that bullet, it could not have missed Governor Connally.

Mr. CANNING. That is my view, yes.

Mr. SAWYER. I think that is all.

Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Thank you, Mr. Chairman.

I wonder whether or not you listened to the narration of Mr. Blakey with regard to the test done by the Warren Commission, a test trying to determine trajectory back in 1964.

Are you familiar with the process the Warren Commission went through?

Mr. CANNING. Yes, I have read the Warren Commission report, the summary volumes.

Mr. DODD. Could you comment? There has been a lot of criticism over the years on whether or not that was the best kind of an examination and test that could have been used at the time to determine trajectory.

Would you care to comment on the type of test that the Warren Commission used in that year to determine trajectory?

Mr. CANNING. Well, in a sense I feel that they were not testing the ability to determine a trajectory. They were testing the inconsistency of a trajectory with a hypothesis. The hypothesis was that a bullet was in fact fired from the southeast corner of the school book depository at the sixth floor, and that they were then observing the consistency of the facts with that hypothesis.

Mr. DODD. In other words, they had reached a conclusion and they were trying to determine or prove that conclusion.

Mr. CANNING. That is the way I read it, yes.

Mr. DODD. And from what I understand from listening to your testimony this morning, you assumed no particular position but

rather took the three elements that you outlined in the beginning, and then worked backwards to a possible location.

Mr. CANNING. That is correct. To the best of my ability, I put myself in the position of assuming that no gun was found and simply say where would I look?

Mr. DODD. Could I ask for exhibit, I think it is, No. 312?

It is the enhanced enlarged photograph.

Could I ask that to be placed up, as well as the—what is the proper word you used to describe the recreation?

Mr. CANNING. The calibration photograph.

Mr. DODD. Yes, the calibration photograph, the calibration photograph as well.

Mr. Canning, could I ask you to go over there near both of these exhibits?

I looked down, while you were testifying, and took a closer look at them again. I realize I am looking at them from a layman's point of view. But when I look at the President's head in the enhanced photograph on the left and then at the calibrated photograph on the right, I get—and again I am prefacing my remarks by saying I am a layman—but I see a much more severe pitch to the President's head in the enhanced photograph than I see in the calibrated photograph and I wonder if you could explain.

I detect what I see as an ear and an eye in the enhanced photograph, and maybe the images are playing games with me, and if they are, I would like you to straighten me out.

Mr. CANNING. I can assure you the images play games with you. There are many complicated details in the part of the photograph surrounding the President's head. For instance, the dark lapel of Mrs. Kennedy's blue blouse has a notch which is in close juxtaposition with the President's nose. The notch makes it look as if the President's nose extends much farther than it really does.

Mr. DODD. That is correct. That is how I saw it.

Mr. CANNING. On the other hand, when we account for where other pink and blue elements are and behind the President's face we conclude that his facial profile is well to the left of its apparent position when only a cursory examination is the basis. The interpretation of these features is certainly one of the major sources of potential error in the analysis.

Mr. DODD. In your analysis?

Mr. CANNING. Yes.

Mr. DODD. As I understood your testimony about light, you tried to recreate the sunlight on the President's head that day. That looks like an awfully large ear, in the enhanced photograph, but if that is not, obviously that is not the size of his ear. But it would appear to me that the reflection of light is giving what would appear to be a larger image than is actually the case, and yet in your other photograph over here, you don't seem to indicate the same degree of light on his ear as you do in the enhanced photograph.

Mr. CANNING. That is correct. We have a problem of in the first place spatial resolution, actually fixing the size of something.

Mr. DODD. I am sorry, I didn't hear what you said.

Mr. CANNING. We have a problem of fixing the exact size of a small object in a blurry photograph. I might point out that frame

312 is one of the better ones, but it is still difficult to work with. I am getting a little bit outside of my area of expertise but I know enough about it for this purpose I think. The image of the President's ear is very brightly overexposed where the sunshine fell on it, and so it appears larger than it would appear if it were not overexposed; that is to say the size of this ear does not look right. On the other hand, if we were to have a print of this that was of diminished intensity, then the image of the ear would look somewhat smaller. It doesn't change its position, however.

Mr. DODD. I am tempted to ask you, just on your last statement, the fact that this is the one area that could change the conclusions that you have reached, to what degree? Did you at all try to calculate by moving around the President's head in the enhanced photograph, allowing for a degree of error in your calibrated photograph, and then make a calculation as to how far off you would be?

Mr. CANNING. Essentially what I did was I to take measurements of the various image features in the enhanced versions of frame 312 and compared them with those same measurements taken from the calibration photographs that were taken at adjacent angular positions. I then made an effort to find out to what degree I could have interpreted this picture wrongly. I concluded that I could be off by easily 2°, and 2° translates into quite a large change in the overall trajectory error.

Mr. DODD. Let me jump ahead. Two degrees, 2°, what does that do to the yellow line? That is the area I presume you are talking about?

Mr. CANNING. Yes, this yellow line——

Mr. DODD. Which exhibit number is that?

Mr. GOLDSMITH. That is No. F-122, Congressman.

Mr. DODD. Thank you.

What does that do to that yellow line?

Mr. CANNING. Well, it is a major part of the size of the largest error oval in the exhibit marked JFK-122. I do not try to recollect the precise number that I attributed to the interpretation of that photograph, but it was a substantial fraction of the total accuracy.

Mr. DODD. Is it possible that we would move away from the Texas School Book Depository into another building?

Mr. CANNING. All that would happen if we were to estimate a larger potential error is that this largest circle would get bigger. The position of the center doesn't tend to move, but it allows more possibilities; that is, only the size of the circle is affected. You see, it is conceivable that the bullet came down from an adjacent building, if one is to take a literal interpretation of the largest area; that is, this yellow pattern. It is conceivable that it was fired from anywhere in this circle.

Mr. DODD. Thank you.

Thank you very much.

Chairman STOKES. The time of the gentleman has expired.

I will let the doctor get back to the table. I have just one question, and it has to do with the slope.

Isn't the reason that there is a different slope because different points are being used through which you drew the trajectory line, that is, the back neck trajectory uses the JFK back wound as Point 1, and the JFK neck wound as Point 2, and under the single bullet

theory the trajectory uses the JFK neck wound as Point 1, and the Connally entry wound as Point 2? Is that understanding correct?

Mr. CANNING. That is exactly right.

Chairman STOKES. Thank you.

The gentleman from Indiana, Mr. Fithian.

Mr. FITHIAN. Thank you, Mr. Chairman.

Mr. Canning, by your calibration, how much higher is the top of President Kennedy's head than Governor Connally's head at the crucial time?

Mr. CANNING. There have been several measurements of that made. Using the Croft photograph I made one determination, but this is not my special field, and so we had a representative of the photographic panel do the job. His determination was that the President's head was 8 centimeters above the top of the Governor's head relative to the limousine, and then since the limousine is going down a slope, that increases the relative height difference slightly as well.

Mr. FITHIAN. So you are saying it would be 8 centimeters plus the tilt of the limousine determined by the slope?

Mr. CANNING. That is correct, the slope and the distance between the two men's heads.

Mr. FITHIAN. And did anyone on the panel working with the pathologists or X-rays or whatever, make any further analysis of what I would call the anatomical differences of the two men, that is, longer neck or larger head or whatever would throw the bullet off?

Mr. CANNING. I accounted for those differences, and the principal difference which will introduce an effect on the trajectory is well recorded in the Croft photograph. The Governor's head is quite a lot taller from the top of his shoulders to the top of his head than that of the President. At a glance this is not particularly noticeable, but the difference is substantial, and so to that extent I did account for that. I had no input from the forensic pathology panel on that point.

Mr. FITHIAN. That was your own computation?

Mr. CANNING. Yes.

Mr. FITHIAN. Let me just see if I can understand one additional thing.

Let's take the head shot wound, the length of the distance, I think you had at least one part of the measurement that was 11 centimeters?

Mr. CANNING. That is correct.

Mr. FITHIAN. If you are dealing with a segment of a line 11 centimeters long, and your estimate is one inch off at one end or the other, and you project that for 150 feet, how far off are you?

Mr. CANNING. Eleven centimeters in 1 inch? May I put it, if I were to make it 11 centimeters on 1 centimeter then I don't have to multiply by 2½.

Mr. FITHIAN. I don't think in centimeters. Let's start with inches.

Mr. CANNING. OK. If we had then an 11-inch baseline for a measurement——

Mr. FITHIAN. You would have something less than that for the head, right?

Mr. CANNING. Yes. It is on the order of 5 inches.

Mr. FITHIAN. Five inches, OK.

Mr. CANNING. Let's take 5 inches.

Mr. FITHIAN. A 5-inch line.

Mr. CANNING. If we were to miss by 1 inch——

Mr. FITHIAN. If you were to miss one end or the other 1 inch relatively.

Mr. CANNING. I can give an approximate answer. This would yield an error in location of the gun equal to one-fifth of the distance between the President's head and the gun. If that distance were 350 feet, the error would be about 70 feet.

Mr. FITHIAN. Now let me see if I get this correctly.

A 5-inch line with 1-inch error at one end or the other——

Mr. CANNING. Yes.

Mr. FITHIAN [continuing]. Projected over 150 feet.

Mr. CANNING. Oh, 150 feet, I beg your pardon, that would be then 30 feet.

Mr. FITHIAN. It would be a 30-foot error.

Mr. CANNING. Yes.

Mr. FITHIAN. And therefore the largest error that you allowed in your circles that you say was a 13-feet radius?

Mr. CANNING. No, it was about 23 feet as I recall. I don't have the numbers.

Mr. FITHIAN. Twenty-some feet radius.

Mr. CANNING. That large circle as I recall is a 23-foot radius.

Mr. FITHIAN. Twenty-three feet radius.

Mr. CANNING. I think it is.

Mr. FITHIAN. I am informed the distance would be about 250 feet; is that correct?

Mr. GOLDSMITH. That is correct, Mr. Congressman. At the time of the head shot the distance between the limousine and the book depository building is about 250 feet. At the time of the back neck shot it was approximately 170 feet or 150 feet. You are talking now about——

Mr. FITHIAN. The head shot.

Mr. GOLDSMITH. The head shot wound.

Mr. FITHIAN. Well, it seems to me, then that your calibrations of the location of the head would have to put the inshot and the outshot wound at considerably less than an inch in error.

Mr. GOLDSMITH. That is correct.

Mr. FITHIAN. It would have to be less than a third of an inch in error, which seems to me to be highly precise, highly precise. Otherwise if it is 1 inch in error, it gives you a circle with an 80-feet radius or 85 feet or something of that nature.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Ohio, Mr. Devine.

Mr. DEVINE. Thank you, Mr. Chairman.

Mr. Canning, I am extremely impressed with your testimony, the logic, the studies you have made, particularly since you have conducted and supervised research on the flight of trajectory and stability of high speed projectiles or missiles.

I would ask one question on your margin of error that you provided on that Texas School Book Depository that is partially covered.

One has a yellow circle. One has the red circle. In all of those margins of error that you have demonstrated, the window, the key window, in the Texas Depository is always included, isn't it?

Mr. CANNING. Yes.

Mr. DEVINE. So you do not exclude that in any of your——

Mr. CANNING. No.

Mr. DEVINE. Based on—you are classified of course as an expert in your field as an engineer.

And on the trajectory studies, would you say that your studies would reveal that it is consistent that there may have been a single shot that went through the President's neck and through the body of Governor Connally?

Mr. CANNING. I am confident that that is in fact the case.

Mr. DEVINE. You are positive?

Mr. CANNING. Well, positive is a very strong word.

Mr. DEVINE. I understand. But it is totally consistent with your studies; is that correct?

Mr. CANNING. Yes, it is.

Mr. DEVINE. Thank you very much.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Tennessee, Mr. Ford.

Mr. FORD. Thank you, Mr. Chairman.

I want you to know that I am leaning toward the single bullet theory myself.

Governor Connally was moving toward the center of the jump seat in the limousine, and the witness before you indicated that he made a sharp right turn of his head, while moving. I was wondering whether or not he would have been moving his body at the same time toward the center. If not, why do you think he would have been moving toward the center and not the door of the limousine?

Mr. CANNING. I think that Mr. McCamy was saying that he was moving toward the center of the car perhaps, and that he was rotating his body rather sharply to the right and turning his head even more sharply to the right during that period. That information is consistent with the observations that I have, namely, that in Mr. Betzner's picture the Governor's shoulder is not visible at the time.

Mr. FORD. So when he made that right turn of his head, he was moving his body, which carried it to the middle of the jump seat, the center of the car.

Mr. CANNING. Toward the center of the car, that is my impression, and it is again an impression, but take it for that, that he did not move his position on the seat but was simply rotating relative to his buttocks, moving off to his left, and rotating to his right, in order to look back around towards the President, but I don't think that he actually moved his position on the seat cushion on which he was sitting. I have no reason to believe that he did.

Mr. FORD. You are saying that there was enough speed behind that bullet, to travel 60 feet from the book depository, enter the back of President Kennedy, exit his neck, enter the back of Governor Connally, exit his chest, and cause damage to his wrist, and then lodge somewhere in his thigh. The speed of that bullet would have had that much power or force behind it.

Mr. CANNING. I am not an expert in that kind of ballistics. On the other hand, I have heard testimony from others and also read reports which indicate that that, yes, is in fact true.

Mr. FORD. No further questions, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Connecticut, Mr. McKinney.

Mr. MCKINNEY. Just one question.

You said that it would be fairly easy to do a line of trajectory from 197, frame 197.

Wouldn't that be difficult because of the violence of the movement on the part of the Governor between 190 and 197? In other words, wouldn't your single bullet theory and everything else depend on where the Governor was?

Mr. CANNING. Yes, it does depend on where he was, and we do not assume that he remained stationary. What we do is that we conclude that he made no large movements away from that general location. We did not find it possible to describe his movements more quantitative than that. I personally am certain that if he had moved enough to avoid the path of the bullet it would have been obvious in the photographs.

Mr. MCKINNEY. In other words, you have no evidence of such violent movement.

Mr. CANNING. He would have had to move practically against his wife in order to have that bullet pass him, and had he done so—if he had avoided the bullet which exited the President's neck, we have a problem of finding where did that bullet go?

Mr. MCKINNEY. One last question.

In your angle or slope of bullet, I have forgotten which exhibit it was, where we show the bullet going through the President and then into the Governor in a drawing, did you positively qualify to make sure that the back of the jump seat wouldn't have gotten in the way of that slope?

Mr. CANNING. The back of the jump seat shows in the photographs, and that portion of the Governor is slightly above the back of the jump seat. It was quite close.

Mr. MCKINNEY. Thank you very much.

I have no further questions.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Michigan, Mr. Sawyer.

Mr. SAWYER. It is just restating a bit or turning around the question of Mr. Devine with the observation that you confirmed made by Mr. Devine.

The lower right window on the sixth floor of the depository, speaking of right as you are looking at the building, is the only aperture on the front of that entire building that is within all three margins of error, isn't that correct?

Mr. CANNING. That is correct.

Mr. SAWYER. Thank you.

Chairman STOKES. The time of the gentleman has expired.

The gentleman from Connecticut, Mr. Dodd.

Mr. DODD. Thank you, Mr. Chairman, for letting me come back.

Following up on my colleague, Mr. Sawyer's question with regard to the margin of errors in response to Mr. Fithian's questions about assuming that the entry wounds taking the farthest shot first, the

head shot, could be off by an inch or a maximum, I guess, by the enhanced photograph, 2 inches, you allowed for a margin of error in the calibrated photograph of 2 inches, was that——

Mr. CANNING. I was speaking in terms of degrees.

Mr. DODD. Two degrees you said.

Mr. CANNING. Yes.

Mr. DODD. Could we put up that photograph, the aerial photograph of Dealey Plaza?

What I would like to get at here, if I could, and I realize this is going to be very difficult under the circumstances, but if I understood your response to Mr. Fithian's question with regard to the size of the radius that would expand, if you allowed for an additional margin of error in the head wound, could you approach that for me, and I realize this is going to be—maybe in fact the photograph may not be that good for our purposes.

What I am trying to get at, I thought we were going to see the face of the School Book Depository and we really don't. I am trying to see if it would expand further across the street, for instance, to that building adjacent to the Texas School Book Depository, or kitty corner to it, to that other building.

Is that the kind of margin of error that would be expanded to include some of those additional possible sights, or am I taking it much further than it should go?

Mr. CANNING. I think the first part of your hypothetical extension is quite reasonable, because the eastern sector of the error circle extends beyond the corner of the School Book Depository and therefore includes a little bit of the Dal-Tex Building—it would then clearly be the candidate, and there would be an area on the western part of the Dal-Tex Building which would then have to be included.

Do you think you would also possibly include that newer looking building?

Mr. CANNING. This is the Records Building.

Mr. DODD. Does that throw it off too much, laterally?

Mr. CANNING. That would really call for a very, very large ellipse, an error circle, to include it. It is conceivable, but I personally don't think that that is at all likely.

Mr. DODD. Mr. Chairman, would it be appropriate for me at this time to impose upon our witness, not obviously today, but to ask him if we couldn't get a photograph that would include the Dal-Tex Building, and draw an additional radius line that would allow for a margin of error of 2°, in the enhanced photograph?

I would just like to see specifically what that would include in that building or other possible sites. Is that appropriate?

Mr. CANNING. Two degrees yields roughly a 3-percent error, at a range of 250 feet; this is about 8 feet; another 2° would enlarge the ellipse only about 8 feet radially. It is not a major increase.

In describing these error circles, I think it is honest to say that I have done my very best to quote the highest accuracy—that is to say, the smallest circles—that I think at all justifiable. The natural conservatism of people who have worked in forensic pathology and ballistics, their natural conservatism, which I do not share, would yield considerably larger ellipses than I have shown. Allowing for

larger errors would not change the positions of the ellipses. All it would do is make them larger.

Mr. DODD. Thank you very much.

Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

Mr. FITHIAN. Mr. Chairman.

Chairman STOKES. Does the gentleman seek recognition?

Mr. FITHIAN. I thought I was trying to help you with your diet, Mr. Chairman, keeping you away from lunch.

Chairman STOKES. Mr. Fithian.

Mr. FITHIAN. Mr. Canning, were you able to project the path of the bullet or the major fragments of the bullet that struck the President's head, that is, on into where they would be imbedded or wherever they were actually located in the car?

Mr. CANNING. I made no attempt to do anything exact along those lines. I noted qualitatively that damage to the windshield of the car appeared to be in reasonable directional alinement but did not appear to be particularly in good slope alinement. But I did no quantitative work in that line.

Mr. FITHIAN. And the other part of that similar question is, someone, somewhere along the line before this committee, has made the statement that when the bullet exited the President's throat, it was rising. I am not sure who it was. But I take it from your testimony that you believe the bullet entered the President's back when he was tilted forward 18°, or something like that, from the perpendicular?

Mr. CANNING. The 18° figure was roughly the maximum that I thought was justified by the photograph of Croft.

Mr. FITHIAN. And given that zero to 18° tilt, and the path of the bullet unobstructed by any bone, you have no problem then putting it in Governor Connally's back at the place where it was located?

Mr. CANNING. The zero degree or slightly upward that you refer to is in relationship to the body in the autopsy position. But when we start making the adjustments in the autopsy, in the body confirmation, the hunching of the shoulders, the inclination, bringing the chin down, all of those tend to yield a dropping projectile as opposed to one that is traveling horizontal. My estimates of the inclination of his torso, "hunching" if you will, extended from about 11° to 18°. What we would call hunching—there is an additional effect resulting from the original observation of wound positions with the President's head "upturned."

Mr. FITHIAN. Thank you, Mr. Chairman.

Chairman STOKES. The time of the gentleman has expired.

Counsel for the committee, Mr. Goldsmith.

Mr. GOLDSMITH. Yes, Mr. Chairman. I have a few questions to ask for purposes of clarification.

First, may I ask Mrs. Downey to remove the exhibit showing the aerial view?

Mr. Canning, a question has arisen concerning the three exhibits that have been studied today that show the direction of the bullet. This is one of those three exhibits.

Drawing your attention to this exhibit, the lower right-hand section of it shows the President, and it has a line going from the President outward. Then moving up a bit toward the center of the

exhibit, there is the limousine itself and a line going from the limousine to the book depository.

What is the relationship between those two lines? Should they be parallel or is the appropriate thing to focus on the relationship between the line from the President in relationship to the limousine?

Mr. CANNING. The latter is correct. In order to fit in the largest reasonable illustration in the inset in at least one of the drawings, we allowed ourselves to rotate the position of the limousine relative to the position of the limousine in the street.

Mr. GOLDSMITH. So in those three exhibits I take it then there is no need for those two lines to be parallel to each other.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. Fine. Now one other question about the matter of the margin of error.

Drawing your attention to JFK F-122, that shows the three circles or ellipses drawn around different portions of the book depository.

When you determined the margin of error specifically now for the head shot trajectory as is depicted there, it is the yellow ellipse, did you take into consideration the possibility that you would have been off in determining the orientation of the President's head by as much as 2°?

Mr. CANNING. That was included in the analysis.

Mr. GOLDSMITH. So if that is correct, I take it that that yellow ellipse includes that possibility.

Mr. CANNING. That is correct.

Mr. GOLDSMITH. And it would not follow then that the ellipse would be moved, for example, to the right.

Mr. CANNING. No. If the error were estimated to be larger, it would move the right-hand side of the ellipse and the left-hand side of the ellipse outward relative to the center.

Mr. GOLDSMITH. Fine.

So in response to the questions that were posed to you by Congressman Dodd, I take it then when you said that the ellipse would move, you were talking about if there were additional error beyond the margin of error that you have estimated.

Mr. CANNING. It simply means the ellipse gets bigger.

Mr. GOLDSMITH. I understand, but please respond to the question I am addressing to you.

Mr. CANNING. I am sorry.

Mr. GOLDSMITH. Congressman Dodd asked you whether the ellipse would move to the right, for example, if the orientation of the head was—if your estimation of the orientation of the head was off by 2°. I believe your answer was, yes, it would move to the right.

My question to you is, when you determined that margin of error to begin with, did you take into consideration the possibility that your estimation of the orientation of the head was off by as much as 2°?

Mr. CANNING. Yes, I did.

Mr. GOLDSMITH. So there would not be a movement then, would there?

Mr. CANNING. There would be no movement of the ellipse, that is correct.

Mr. GOLDSMITH. The ellipse as I see it would move if your estimation of the margin of error was incorrect.

Mr. CANNING. Well, the ellipse—if my estimate—I am not sure I follow you.

Mr. GOLDSMITH. In other words, the response to Congressman Dodd, if your estimate of the margin of error was incorrect, was greater than you estimated it to be, then the ellipse would move.

Mr. CANNING. The ellipse gets bigger.

Mr. GOLDSMITH. Gets bigger.

Mr. CANNING. Yes.

Mr. GOLDSMITH. And if your estimation of the margin of error is correct, it would stay in exactly the same place.

Mr. CANNING. That is correct.

Mr. DODD. Would counsel yield on just that one point, since you are following that line of questioning, would you also take into consideration the questions by Mr. Fithian?

You relied pretty much on the exact location of the entry wounds as reported by the pathologist.

Mr. CANNING. That is correct.

Mr. DODD. Did you allow for any margin of error there?

Mr. CANNING. There was a small allowance for that. It was a couple of millimeters. That was quite well determined.

Mr. DODD. Did counsel want to pursue that same line of questioning with regard to that?

Mr. GOLDSMITH. Mr. Canning, I am not attempting to suggest any particular testimony on your part. I am only trying to clarify here.

Mr. CANNING. Yes.

Mr. GOLDSMITH. That ellipse as it is presently drawn, does that reflect the margin of error as you determined it to be?

Mr. CANNING. That is my estimate of the margin of error.

Mr. GOLDSMITH. No further questions.

Thank you.

Mr. FITHIAN. If the gentleman would yield, the reason the small blue circle is so much smaller is primarily because of the additional length of the line between the exit wound of the President and the entrance wound in Connally; is that correct?

Mr. CANNING. That is correct.

Chairman STOKES. The time of the gentleman has expired.

Professor Blakey.

Mr. BLAKEY. Mr. Chairman, it may be useful for those who have only tuned in today to recognize that additional evidence will have to be considered in evaluating the possibility raised by Mr. Fithian and Mr. Dodd that the gunshots could have come from another building; that evidence already in the record might include the following: the neutron activation analysis that indicated that the pieces of lead found in the car came from two and only two bullets; the ballistics evidence that indicated that both of those bullets could be traced back to the gun allegedly found in the sixth floor of the depository. Consequently, it ought to be noted that there is no additional evidence in this record that could be correlated with the hypothesis of a shot hitting the President not coming from the depository.

Chairman STOKES. Mr. Canning, at the conclusion of the witness' testimony before our committee, that witness is entitled to 5 min-

utes under the rules of the House to explain his testimony or make any statement he cares to make relative to his testimony before this committee.

I extend to you such time, if you desire it, at this time.

Mr. CANNING. Thank you.

I would like to make just one point that has occurred to me that may not have been amply clear, and, that is, in the case of the single bullet theory, we established with high reliability and precision, I believe, the rightmost position which Governor Connally could have been sitting in at the time that he was wounded. We did not establish how far to the left he could, with comparable of quantitative certainty. And with that in mind, there may be some small change that might come about in where the error circle for this case would lie if we were able to determine, for instance, that he was several centimeters to the left of where I placed him in that drawing, and what that would do is, that it would move the left-hand margin of the smallest ellipse, of that black ellipse, it would move it somewhat to the left, as we see it. It would move it to the west. But that change is not in my view an important change in the overall result.

Chairman STOKES. Thank you very much, Mr. Canning.

I certainly want to thank you for the testimony you have given here today, and I think I can say on behalf of the entire committee, you have certainly given some very impressive testimony, and we appreciate your appearance.

Thank you very much, and you are excused.

Mr. CANNING. Thank you.

Chairman STOKES. There are no further witnesses to come before the committee today. Therefore, at this time the Chair would adjourn these hearings until 9 a.m. tomorrow morning.

[Whereupon, at 12:40 p.m., the select committee was adjourned, to reconvene at 9 a.m., Wednesday, September 13, 1978.]