Subcommittee No. 3

MINUTES, MAY 3, 1953 MEETING
TELETHERAPY EVALUATION BOARD - SUBCOMMITTEE NO. 3
ROTATIONAL METHODS AND PROCEDURES

Members Present: Dr. Sidney Rubenfeld -- New York University School of Medicine
Dr. Arthur C. Guyton -- University of Mississippi
Dr. William H. Riser -- Medical College of Alabama
Dr. Carl E. Nurnburger -- University of Tennessee
Dr. George Cooper -- University of Virginia
Dr. Marshall Brucer -- Oak Ridge Institute of Nuclear Studies

1. Current Status of the Construction of High Curiage Machine:

The present status of designing and building the high curiage machine by the W. F. & John Barnes Company was outlined and the subcommittee discussed in detail the design features which permit automatic operation with the central axis of the beam always focused at a central point of a spherical orbit circumscribed by rotation. The subcommitee studied engineering prints and expressed approval of specific features for obtaining tilt, vertical, horizontal, and azimuth motions for rotational therapy procedures as visualized by subcommittee members.

The subcommittee was informed that original design specifications did not call for field loading of replacement radioactive sources; however, at this stage of design it was believed that the most desirable design of the shielding head provides for field loading.

Dr. Riser asked if the design provided for rotation on a continuously variable radius up to a given maximum. The subcommittee was informed that the original design had specified such operational features; but, because complicated control machinery made such a motion impractical, the Subcommittees on Source Evaluation and Shield Design approved a change in design and accepted the following source-skin distances for rotational therapy:

$Cesium^{137}$ ---------- 90, 70, and 50 cm

$Cobalt^{60}$ or $Europium^{152}$---------- 100, 80, and 60 cm.

Members of Subcommittee No. 3 expressed approval of these changes in design specifications.

Dr. Brucer outlined studies showing the necessity for an automatic wedge filter. The subcommittee discussed the many problems of moving a wedge filter into the field, from any direction, to maintain homogenous tissue dosage under rapidly changing conditions. The filter

must move in three directions, under control of the "computor", and must be fully automatic to be satisfactory. Dr. Nurnburger discussed the necessity of a filter completely covering the beam and its relationship to the shape of the isodose lines. Dr. Guyton questioned the necessity of locating a filter close to the source; and, offered for discussion an opinion that inasmuch as the unit would not contain a point source it would be practicable to use a filter at the far end of the collimator.

The wedge filter is designed so that the thickest edge is always close to the central axis of the angle of suspension. If the angle of rotation is identical with the angle of suspension, control of the wedge filter is simple; but, as the angle of rotation moves away from the angle of suspension, the wedge position becomes related to the position of the rotating head and the position of suspension mechanism, therefore, making automatic control more complicated.

Dr. Cooper summarized and questioned the necessity for all automatic motions designed into the experimental unit. Also, Dr. Rubenfeld asked if head motions could be simplified by designing the treatment table with some movements. It was pointed out that Subcommittee No.1 had raised the same questions and after full discussion had voted to have maximum freedom of movements designed into the experimental. It will be a simple matter to omit unnecessary movements once the preliminary studies have been completed. The subcommittee agreed with the actions of the Subcommittee on Shield Design.

The subcommittee discussed the design of the variable aperture diaphragm which was approved by the March 29th Meeting of Subcommittee No. 1. The mechanism consists of 12 triangular units forming an iris diaphragm closing to less than 3 cm diameter and opening to a maximum 15 cm diameter. It was explained that this mechanism would not give irregular or rectangular portals; however, these patterns are obtainable by using the diaphragm as a holding device for cones. The subcommittee was informed of design problems in providing a supporting device and shielding between the head and variable diaphragm. The present status of design visualizes a series of telescoping steel cylinders providing adequate shielding when the diaphragm is extended to maximum distance from the head. The subcommittee did not find any design features objectionable for rotational therapy techniques.

The subcommittee approved in principal the present design status of the light localizer which cannot be greater than 2 cm in diameter. The system consists of an external light source with a collecting lens focusing the light beam through a lucite channel to an expanding lens which transmits the beam to a reflecter, thereby simulating a beam equal to the radioactive source and appearing to be coming from the surface of the source. Dr. Guyton suggested using a slight concave reflecter to better collect and collimate the light beam received from the expanding lens.

The subcommittee studied Dr. Richardson's work on the design of cones most suitable for reducing the build-up of secondary electrons. It was pointed out that lead, with its desirable shielding properties, also contributed to the build-up of undesirable secondary electrons. It was suggested that brass or brass-lined cones would greatly reduce these electrons and that brass filters at the portal would further reduce the electrons. Dr. Rubenfeld requested information regarding the suspension of the filter which would permit indication of penumbra by visible light. The subcommittee was informed that an adequate holder has been constructed of lucite and brass which emits a rectangular light beam around the edge of the brass shim simulating the penumbra. The inside edge of the light beam is an indication of the 100% isodose line with the outer edge dropping off to the approximate 12% to 20% isodose line depending upon the size of the field.

Dr. Brucer discussed the design engineer's study of shutter mechanisms and informed the subcommittee that cost and space requirements made impracticable such devices as a continuous rotating motor utilizing centrifical force to rotate the source wheel 180°, various slip clutches such as the magnetic clutch, magnetic oils, Borg-Warner overdrives. Dr. Brucer then described the pneumatic system currently under study by the Barnes company.

2. Present Status of the Construction of the Small Curiage Machine:

The small source unit is not designed for rotational therapy; however, Dr. Brucer informed the subcommittee of the current design status of a prototype unit. The subcommittee discussed the design features as outlined in the Minutes of the April 12th Meeting of Subcommittee No. 2. The subcommittee was informed that the original cost estimates were approximately $12,000 for construction of the small therapy unit, but simplification in design had reduced the cost estimate to less than $10,000 including supporting mechanism. The subcommittee discussed installation requirements likely to be encountered at different medical schools.

A. Installation of a unit on a top floor corner room, with beam directed toward the outside corner, would require shielding on two sides and floor.

B. Installation of a unit in a basement, with four sides of the room surrounded by earth, would require shielding only for the ceiling. The subcommittee was informed of a ceiling shielding design, by Dr. C. C. McClure, Vanderbilt University, whereby maximum shielding directly above a unit is carried on a suspension track and moves with the unit.

C. A third possible mount is indicated by Dr. Carl Braestrup, Francis Delafield Hospital, New York. This design has a

source mounted on one end of an arc circumscribed by an angle of 180° and a heavy shielding surface mounted on the other end of the arc in such a manner that the shield always remains directly in the path of the beam.

Dr. Cooper, Dr. Rubenfeld, and Dr. Nurnburger discussed the adequacy of the shielding provided in the design of the small therapy unit. Dr. Brucer listed the approved standards of radiation exposures (.3 r/48 hours, total body; 1.5 r/48 hours, hands and arms; 1.5 r/48 hours, feet) and informed the subcommittee that calculations and tests indicate that exposure can be within these limits at reasonable cost.

3. Control Panel of High Curiage Machine:

The subcommittee was informed of the preliminary design studies of the automatic control panel consisting of a double magnetic amplifier on a thyroton system providing equal opposing forces on each electric motor. An increase or decrease in bias, applied to opposing forces, permits movement in the desired direction and at a rate of speed maintainable with a high degree of accuracy. Patterns of motions are controlled by a multiple cam system; shape and eccentricity of each cam determines functional patterns of the therapy unit.

The teletherapy unit should be designed with two control systems: fully automatic controls on the panel in the control room, and semi-automatic controls on the yoke of the suspension mechanism for the mechanical positioning of the unit. The switch for mechanical operation breaks the automatic control circuits from the control room and the closing switch permits automatic operation with the unit returning to rest position directly over the table before starting therapy cycle. The manual control system permits single portal therapy.

Existing regulations for an x-ray therapy unit suggest an indicator for showing which filter is in position. This regulation was established to inform the operator of the half value equivalent of the x-ray beam. The factor is constant on a teletherapy unit utilizing radioactive isotopes; therefore, such a device was omitted on the prototype unit. Also, existing regulations suggest indicators showing the position of an x-ray head. Dr. Brucer informed the subcommittee that the control panel might possibly have indicators for degree of tilt, lateral motion, and azimuth motion, but the necessity for this has been questioned.

4. Photographic Isodose Curves of Co^{60} Rotations:

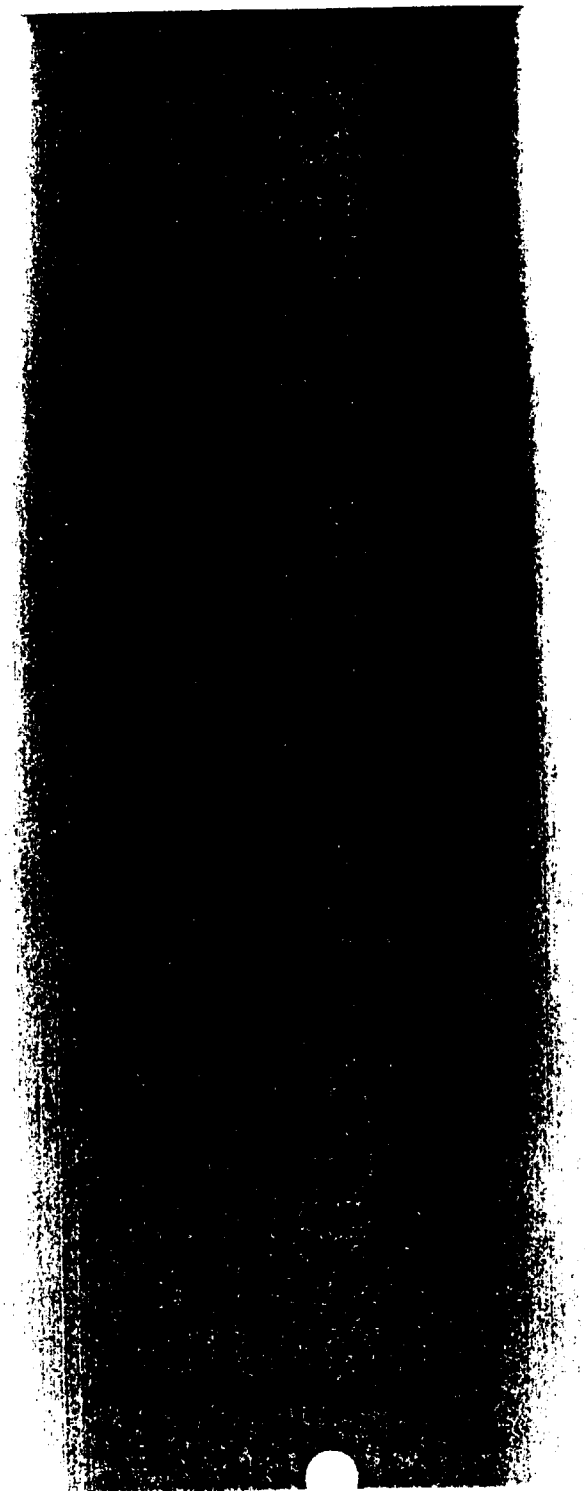
Dr. Brucer outlined preliminary studies of isodose curves from a rotating beam in an attempt to point out some of the factors involved. Simulated conditions were established by keeping the O.R.I.N.S.-M.D. Anderson Co^{60} therapy unit in a fixed position and rotating a phantom

in the beam of radiation. The phantom consisted of a molded cylinder of paraffin of approximate torso dimensions. This phantom had been cut crosswise and lengthwise, and two pieces of Type M Industrial X-Ray Film placed at 90° with respect to each other. Films were obtained with the Co^{60} beam striking the film in increments of 10° angles from angle of suspension.

It was emphasized that photographic dosemitry was very unrealiable; however, the following factors were demonstrated by the studies. (See attached figures.) Some angles of suspension and rotation give an acceptable pattern of major dose. The tumor dose will not be uniform throughout the tumor area unless a wedge filter is positioned within the beam. This wedge must be of dimensions maximized at approximately 45° and minimized at 0° and 90° angle of insidence to the tumor. Not shown on the attached figures but demonstrated on other studies were figures showing the infinite possibilities of distorting the shape of the focal area by changing the cross section of the cone.

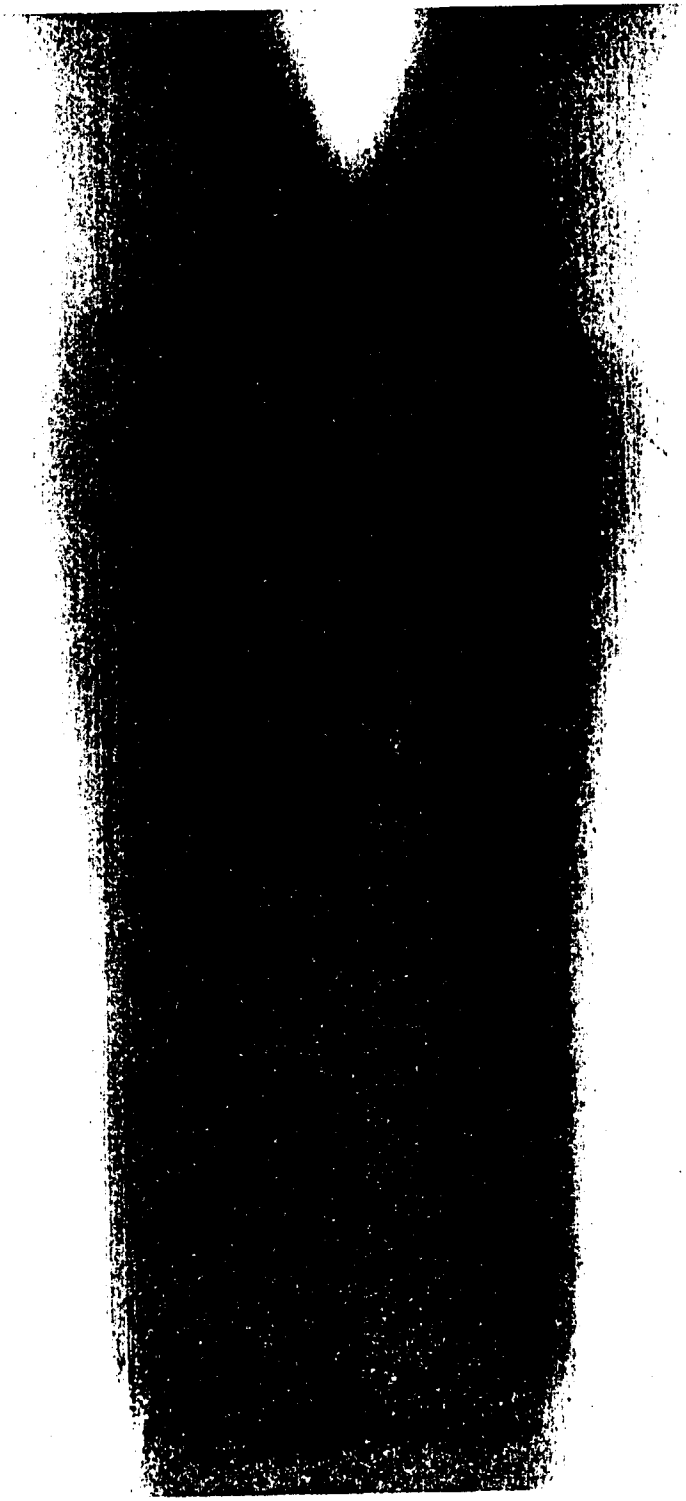
Following this detailed discussion of the design characteristics and capabilities of the large teletherapy unit, the subcommittee held an exploratory discussion of possible rotational therapy patterns. The subcommittee was in unanimous agreement that an infinite number of patterns were possible and that rotational therapy patterns should not be attempted until the unit is in operation and isodose curves accurately determined. The subcommittee discussed such factors as three dimensional dosage pattern, integral tumor dose, critical dose in and around normal body organs, etc. The subcommittee members suggested that another meeting be held late this lear for a more detailed discussion and formulation of therapy procedure.

Marshall Brucer, M.D.
Chairman, Executive Committee



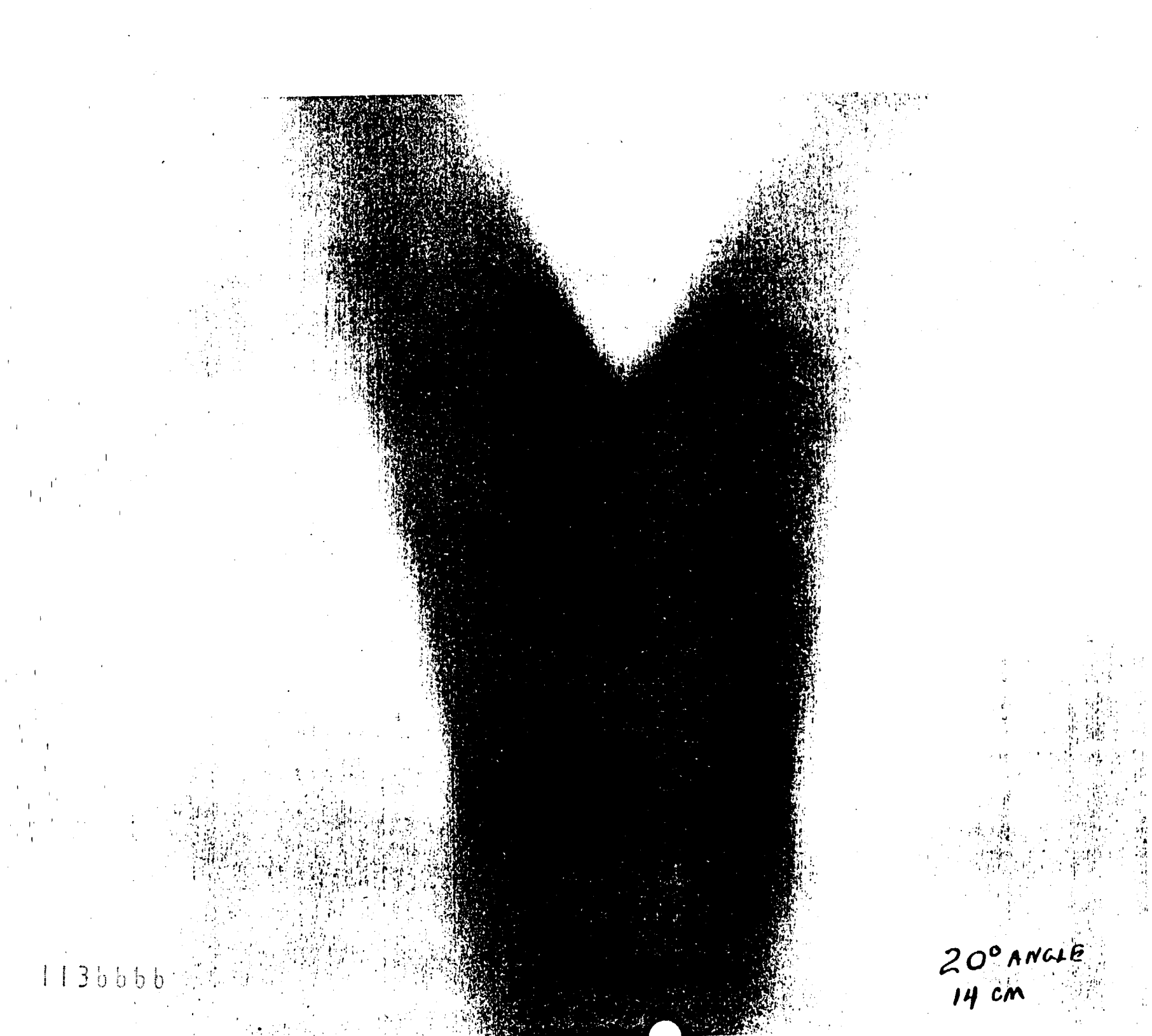
1136664

0° ANGLE
14 cm



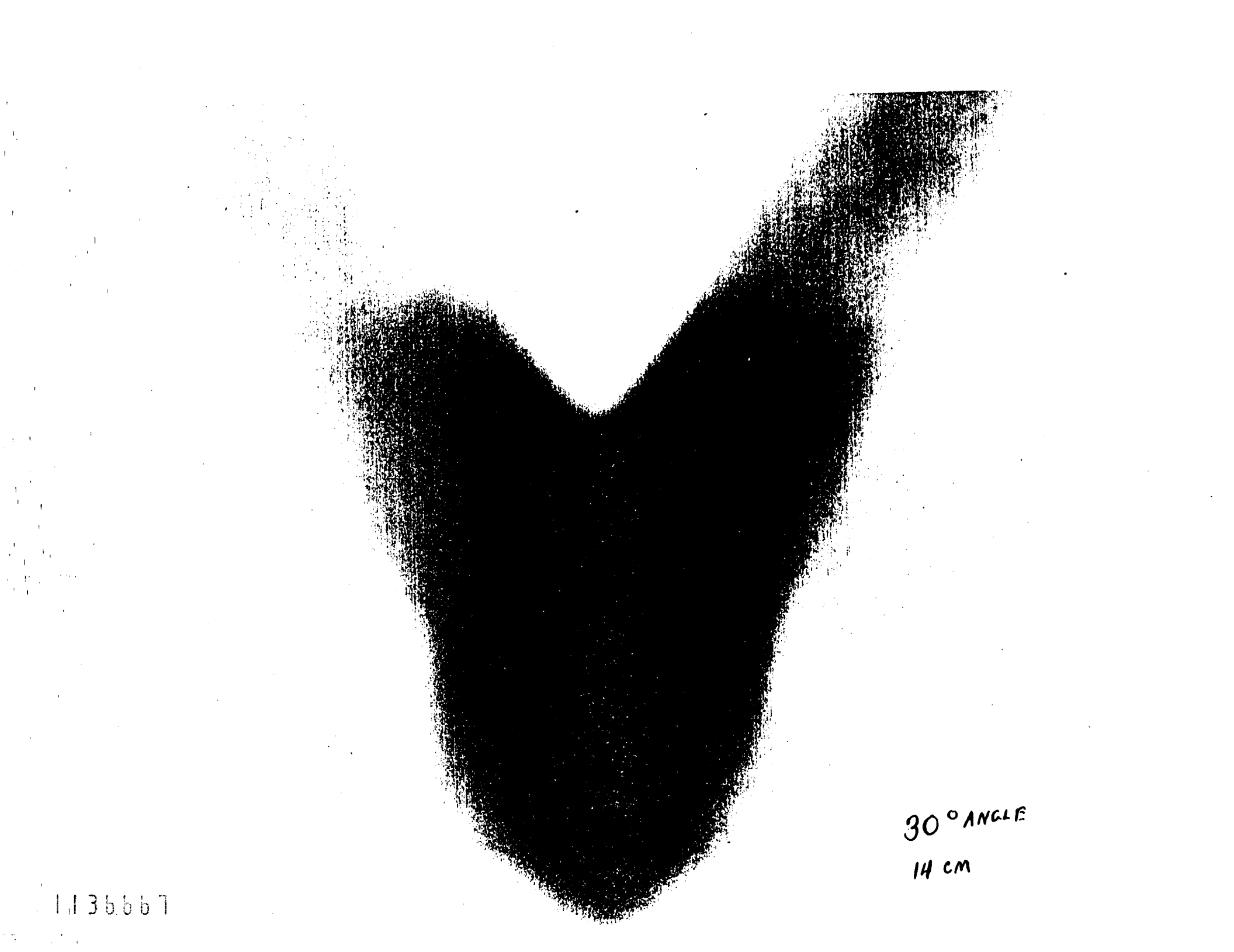
10° ANGLE
14 CM

1136665

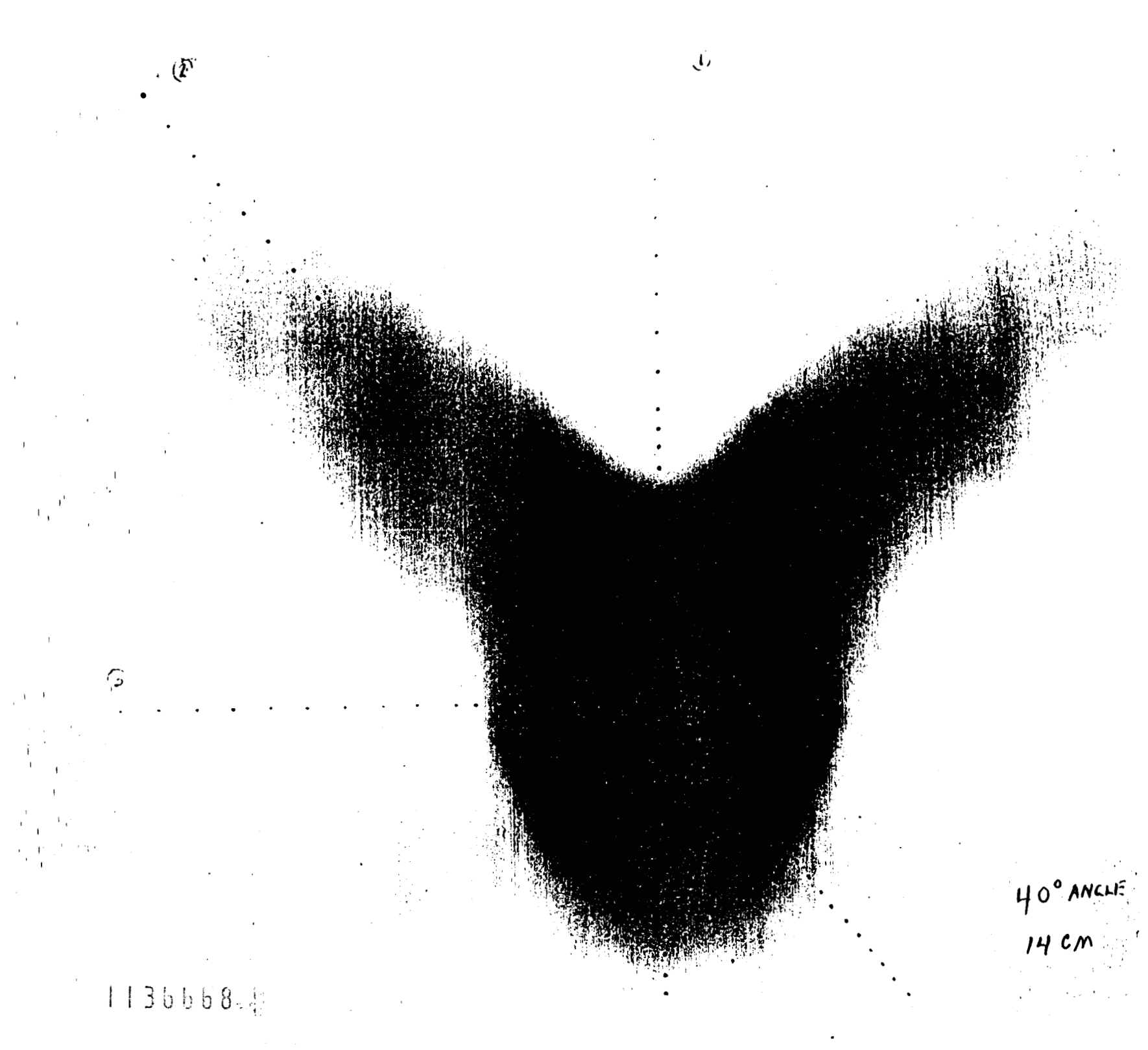


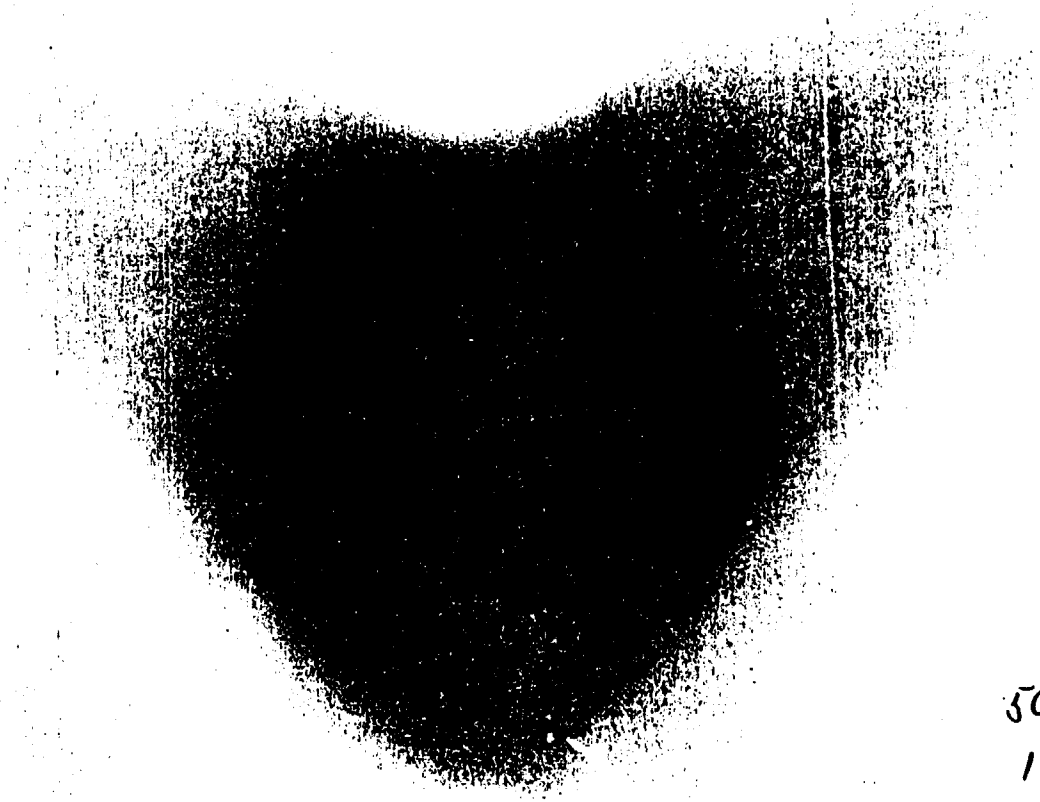
113666

20° ANGLE
14 cm



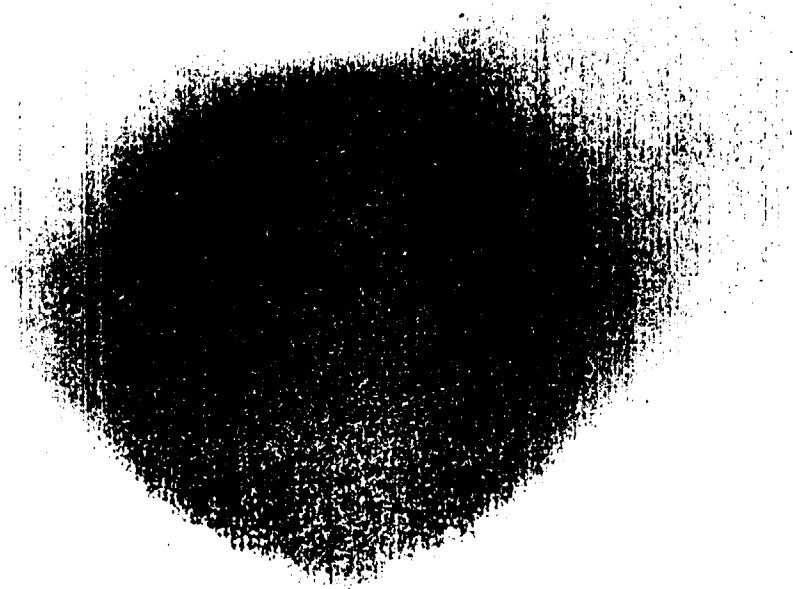
1136667





50° ANGLE
14 CM

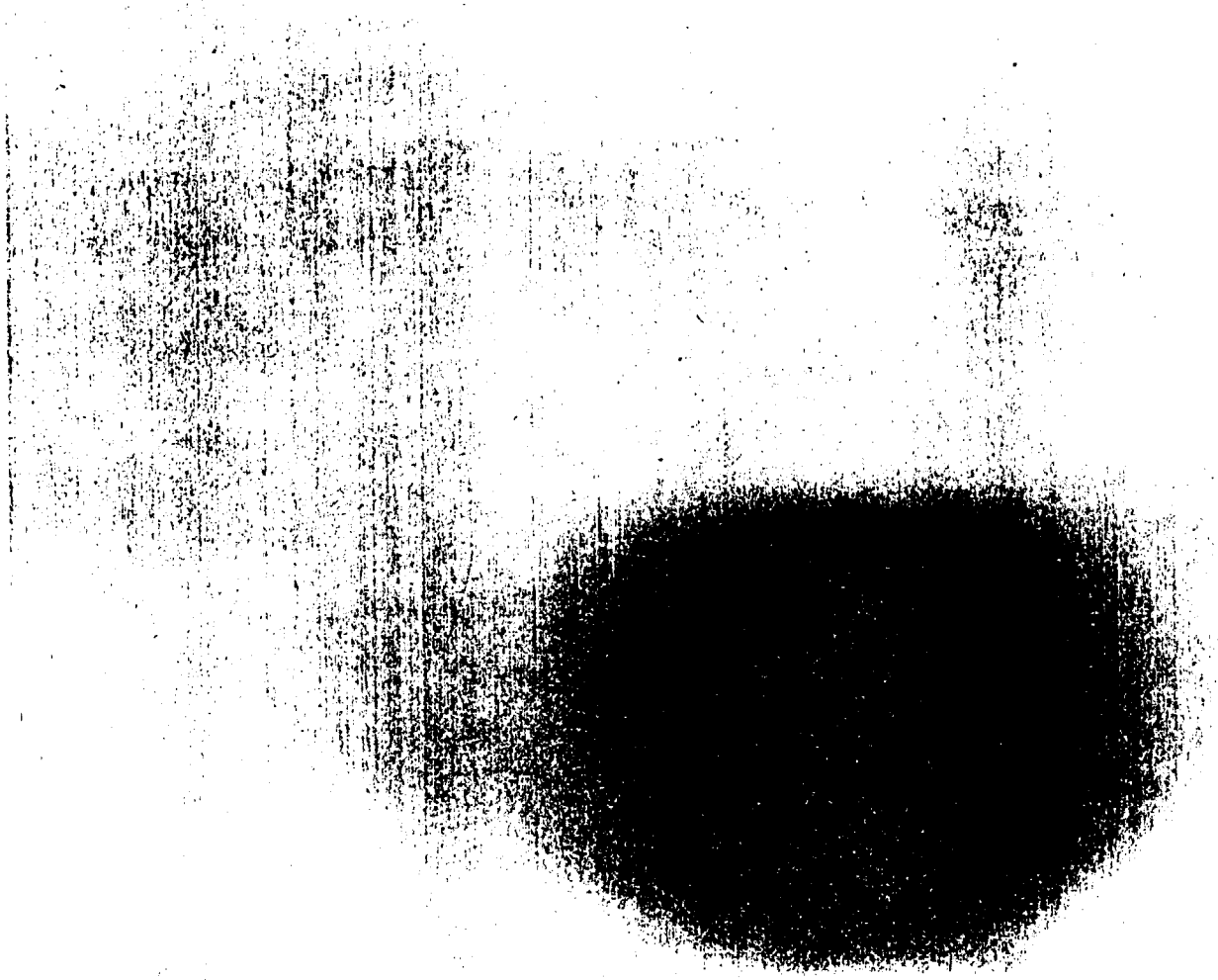
1136669



60° ANGLE

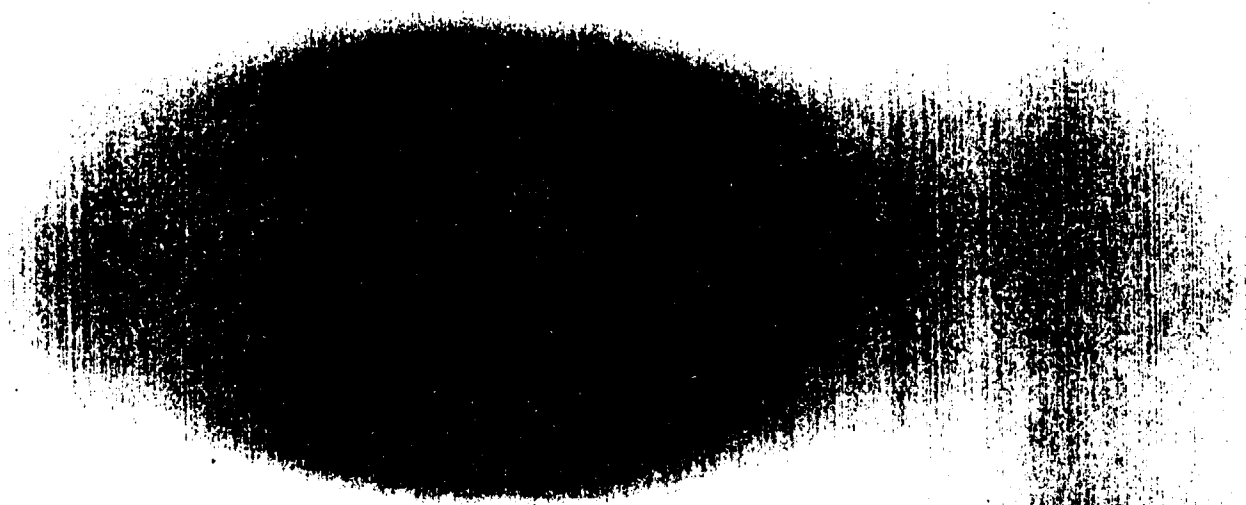
15.5 cm

1136610



80° ANGLE
16 CM

1136672



90° ANGLE
16.5 CM

1136613

April 27, 1953

MEMORANDUM TO: SUBCOMMITTEE NO. 3 - ROTATIONAL METHODS

Meeting May 3, 1953 - 9:00 a.m.

AGENDA FOR MEETING

1. Current status of the construction of the high curiage machine.

2. Present status of the construction of the small curiage machine.

3. Control panel of the high curiage machine and the construction and movement problems on various patterns of rotation.

4. Photographic isodose curves cobalt^{60} rotation.

The meeting is called for 9:00 a.m. Sunday, May 3. We hope to be through by 3:30 that afternoon.

Will you please send telegram to Mrs. Nelda Edwards giving time and mode of arrival so that we can make reservations at the hotel and arrangements for transportation from Knoxville?

Marshall Brucer By: M.E.
Marshall Brucer, M.D.

1136674