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USE OF A GAMMA RAY PINHOLE CAMERA FOR IN-VIVO STUDIES

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INTRODUCTION

The pinhole camera method of taking gamma radioautographs, through it has been described in the literature,[1] has had very little use because of the long exposure times which are necessary even when the most sensitive radiographic films are used. This paper will describe an intensifying screen for use with the pinhole camera which has made it possible to considerably reduce the exposure time. The intensifying screen consists of a large, flat thallium activated sodium iodide crystal. The gamma rays produce scintillations in the crystal which in turn expose the photographic plate. This method has made it possible to take an in-vivo gamma ray pinhole radioautograph of a tumor containing 20 millicuries of I^{131}.

A drawing of the pinhole camera and intensifying screen is shown in Fig. 1. The operation of the camera is as follows: A gamma ray from the object being photographed goes through the pinhole and travels in a straight line until it enters the sodium iodide crystal where it may produce a Compton or photoelectric recoil. The recoil electron travels about a millimeter or less in the crystal. The light produced along the path of the recoil is emitted isotropically. The spreading of the light over the photographic plate and the consequent loss of definition is limited both by inverse square law attenuation and by total reflection from the glass-to-air boundary between

the crystal and photographic plate. The total reflection angle is about 35°. The light reflected from the glass surface passes back through the crystal and is absorbed by the black bakelite container.

There is a considerable loss in definition due to spreading of the light from the thick intensifying screen, even though it is limited as described above. In ordinary radiographic work this would not be permissible, but due to the relatively poor definition obtained from the pinhole camera, the additional loss in definition is relatively unimportant. In order to get good optical contact between the crystal and the glass window, and also to protect the crystal from the effects of moist air, it is contained in a bath of Monsanto Chemical Co. Aroclor No. 1248.

The camera was tested by taking autoradiographs of bottles of I^{131} solution. It was found that a concentration of about 1 millicurie per square centimeter and an exposure time of 1 hour were sufficient to give a faint but useable image of the source. This is about 20 times less exposure time than is necessary if Kodak No-Screen film is used with the lead foil intensifying screens customarily used for gamma-ray radiographs.

The exposure times given above are for the following conditions. The pinhole size was 1/8 inch; the pinhole-to-intensifying screen distance 7-1/2 inches; the intensifying screen was a 2 x 4 x 5/16 inch thick thallium activated sodium iodide crystal obtained from the Harshaw Chemical Company;[2] the photographic plate was a Kodak type 103a-O spectroscopic plate slightly overdeveloped in D-19 developer.

As mentioned before, the camera has been used to take an in-vivo gamma ray autoradiograph of an I^{131} bearing tumor. The tumor was a metastasis of a thyroid carcinoma. It was close to the skin, had a volume of 90 ml.

and an area of about 20 square centimeters. The picture was taken 24 hours after a therapeutic dose of 100 millicuries of I^{131} was administered to the patient. It was determined independently that 20 millicuries lodged in the tumor. A one-hour exposure was taken and the resulting picture is shown in Fig. 2b. The general outline of the area which took up the I^{131} is shown, together with the fact that it is concentrated in two main areas. An x-ray radiograph of the tumor taken from the same viewpoint is shown in Fig. 2a.

ACKNOWLEDGMENTS

The author wishes to acknowledge the consultation of Dr. C. A. Tobias and also the assistance of Dr.'s Frank Pierce and Enrique Strajman in supplying needed information about the patient. This work was performed under the auspices of the AEC.

BIBLIOGRAPHY

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2. The Harshaw Chemical Company, 1945 East 97th Street, Cleveland 6, Ohio.

Information Division
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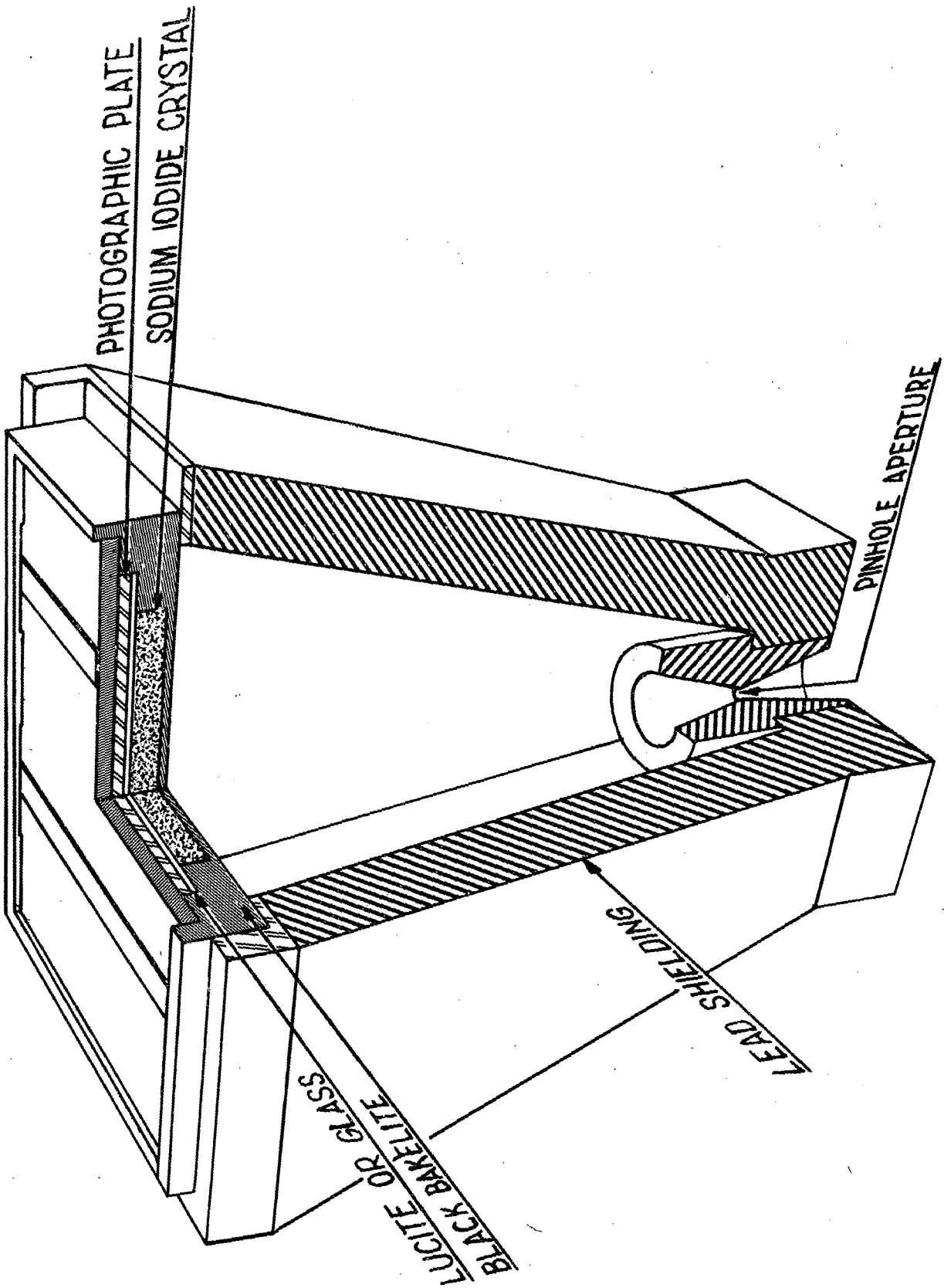
PHOTOGRAPHIC PLATE
SODIUM IODIDE CRYSTAL
PINHOLE APERTURE
LEAD SHIELDING
LUCITE OR GLASS
BLACK BAKELITE

Fig. 1

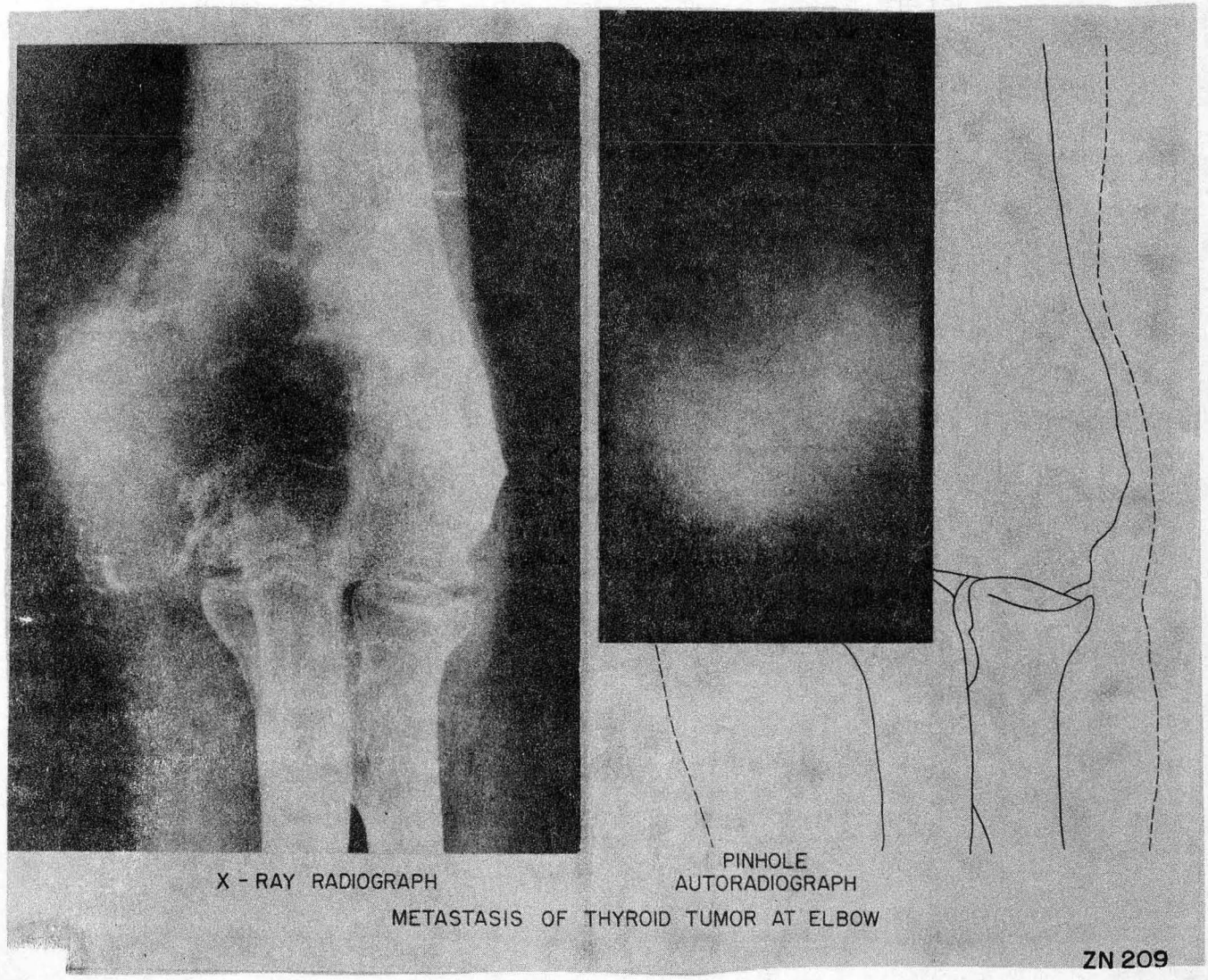
X - RAY RADIOGRAPH
PINHOLE
AUTORADIOGRAPH
METASTASIS OF THYROID TUMOR AT ELBOW
ZN 209

Fig. 2a

Fig. 2b