III.

THE STUDY OF THE INFANT'S BODY AND OF THE PREGNANT WOMB BY THE RÖNTGEN RAYS.

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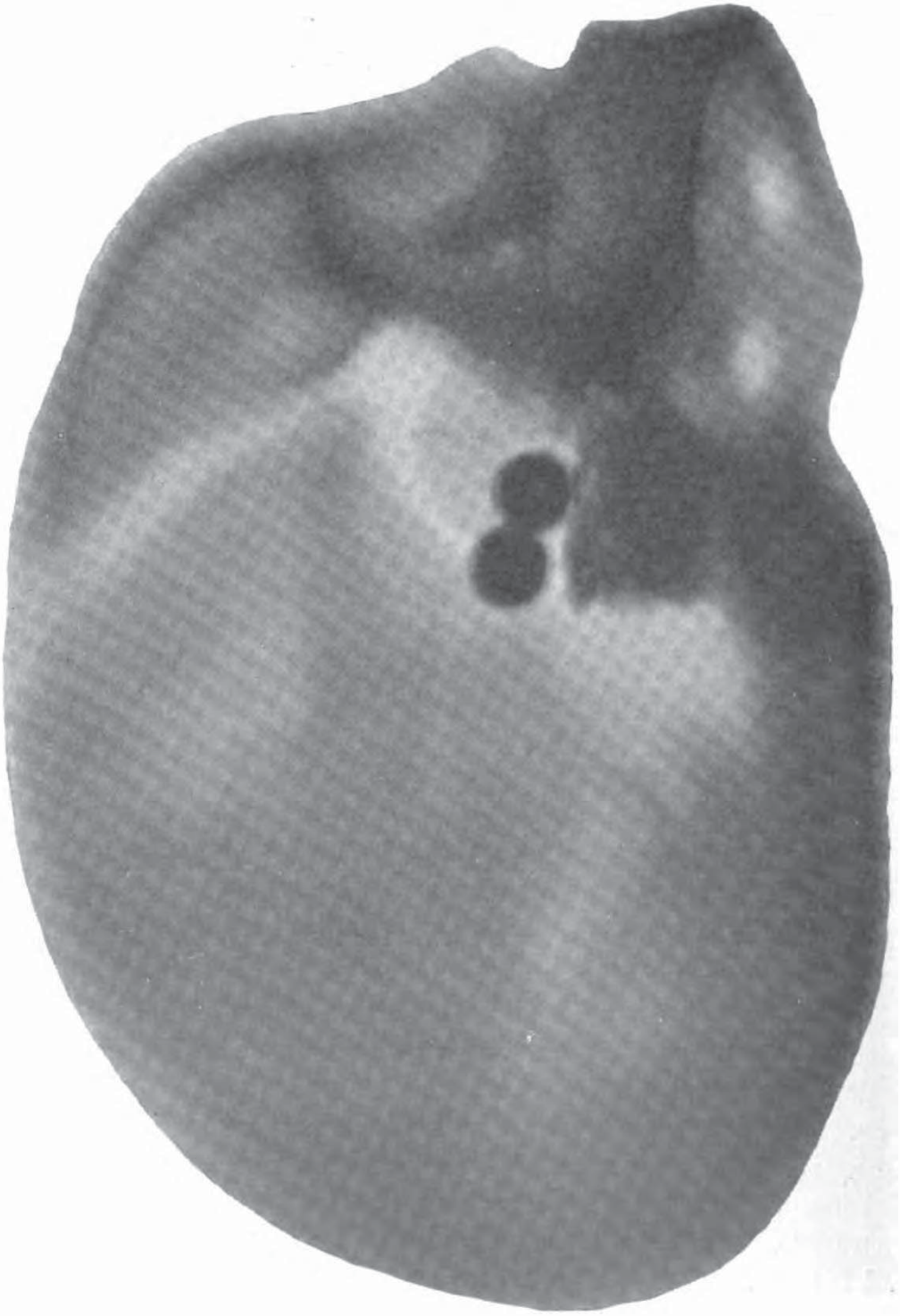
The body of the infant and pregnant womb present conditions alike favorable and unfavorable for investigation by this method. The body of the infant contains a skeleton so much less completely ossified than that of the adult that it is scarcely to be expected that the same clear shadows can be obtained with the apparatus at present at our command. The problem naturally presents itself, Can the skeleton of the fœtus be recognized by this method within the mother's womb? To ascertain the relative density of the pelvis and fœtal skull to the rays, the following experiments were undertaken:

The skull of an infant at term was placed in a female bony pelvis upon a sensitized plate completely sealed in a pasteboard box. The pelvis was placed in such a position that it rested upon the plate upon the tuberosities of the ischia and the coccyx. The skull was laid obliquely in the pelvis. To secure as much definition as possible a lead diaphragm was interposed between the tube and the pelvis. An exposure of one and one-half hours was made to test thoroughly the various portions of the skull and pelvis subjected to the rays. The result is appended in Fig. 3. Reference to this illustration shows the fact that the greater portion of the fœtal skull gives but a very faint shadow under the action of these rays. The base of the skull is darker, while the temporal region scarcely gives a reaction. In marked contrast to this is seen the black coccyx, which rested upon the plate, and also the rami of the pubes and the spines of the ischia.

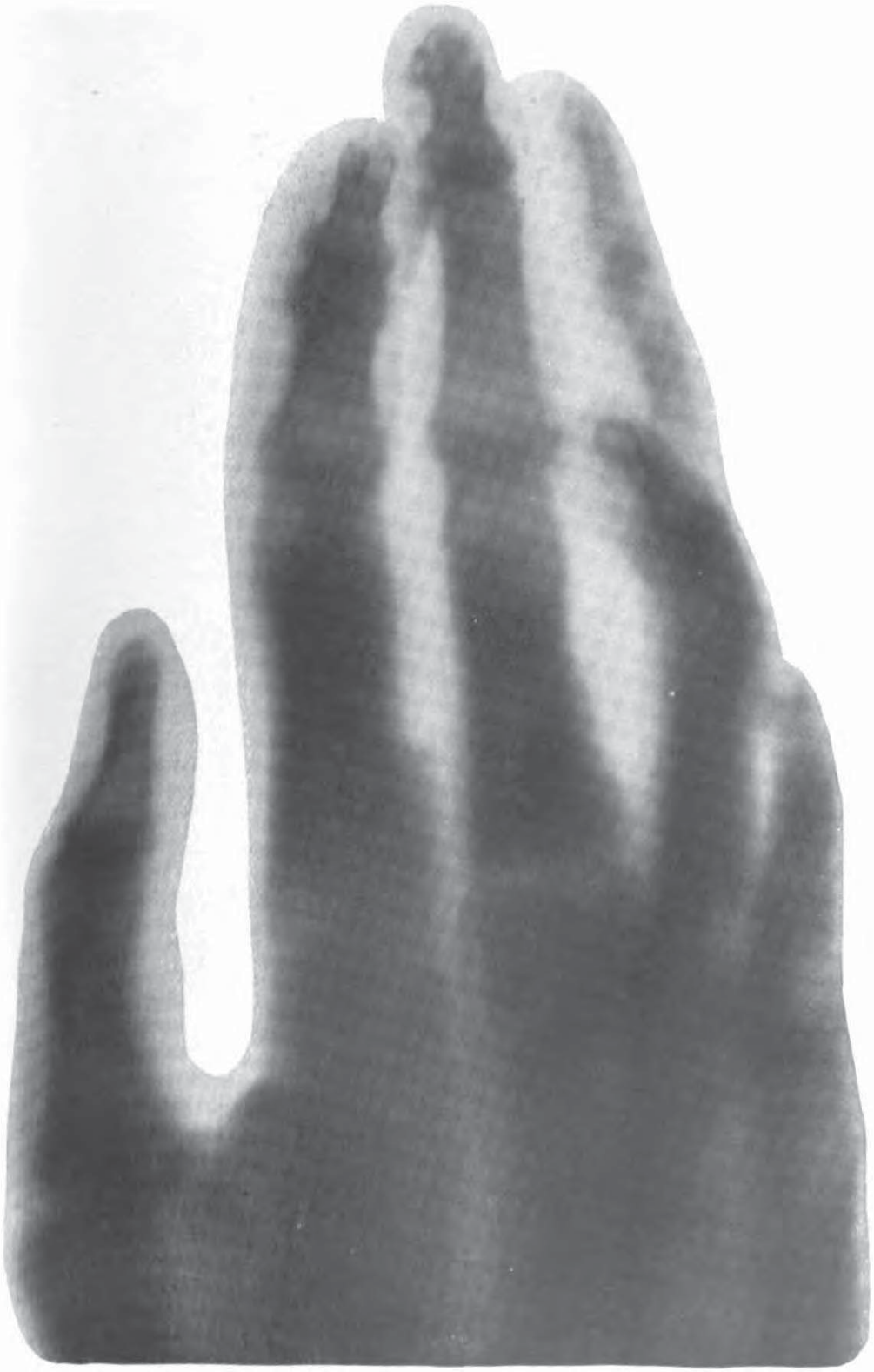
A further test was made of the permeability of the fœtal skull by placing the skull upon its parietal surface upon a sensitized plate, and by dropping into it two buckshot, which rested upon the lower parietal bone. In order to reproduce these shot the rays traversed both sides of the fœtal skull. An exposure of one hour was made, with the use of the lead diaphragm. The accompanying illustration (Fig. 4) shows again the transparency of the temporal portion of the skull, and the fact that the lead bullets are clearly seen through the skull. It was next determined to investigate the action of the rays upon the bones of the fœtal skeleton. To ascertain this the skiascope of Magie was employed with direct inspection. In a darkened room, and with the head of the observer covered by a camera-cloth, the foot of an infant three days old, born at term, was held against the skiascope, exposed to the rays of the tube.

FIG. 4.



Fœtal skull containing buckshot.

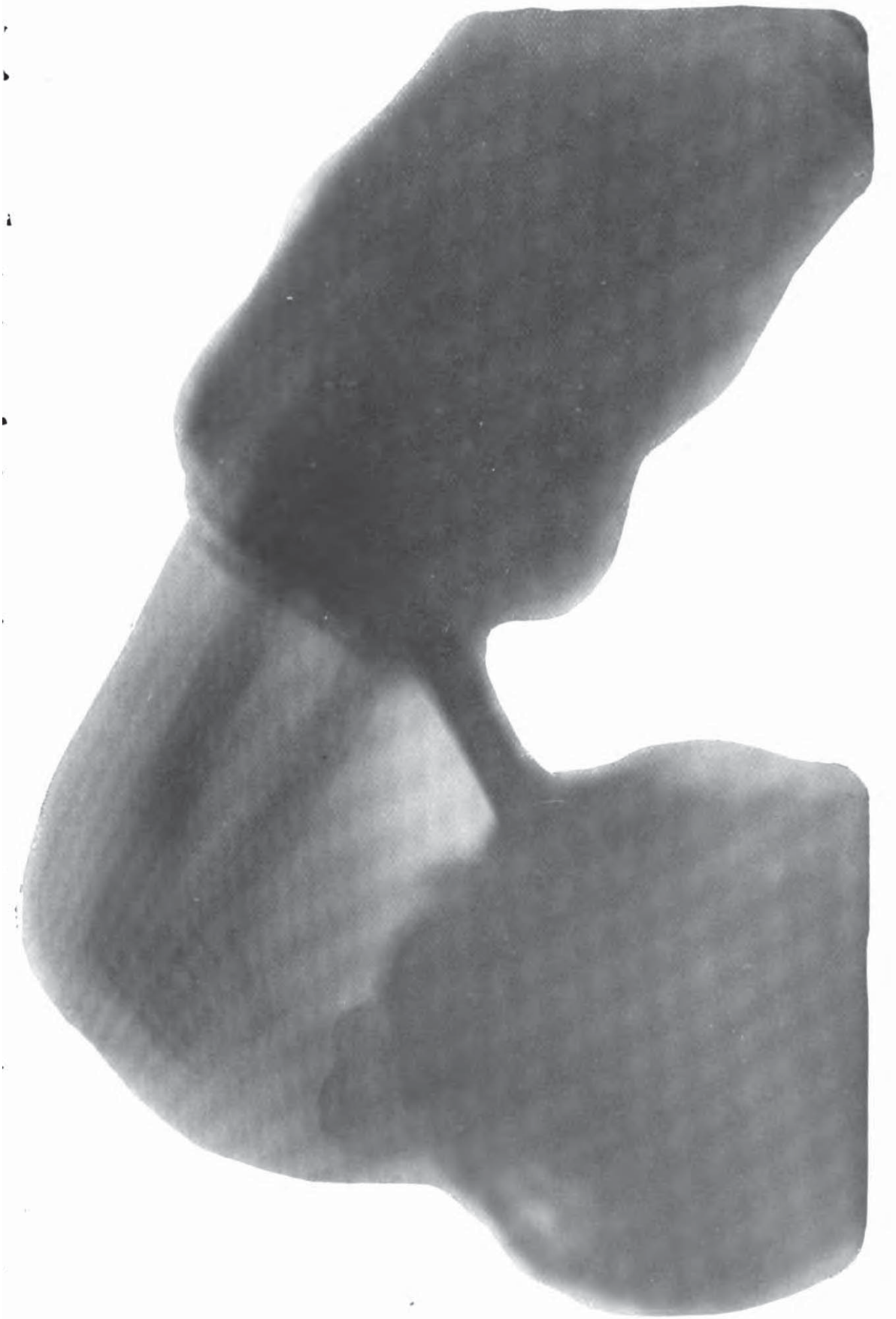
PLATE I.



Hand with anchylosis of all fingers and deformity of little finger from a burn on the dorsum of the hand. Exposure twenty minutes. Carbutt extra sensitive plate.

Tubercular disease of elbow-joint. Exposure one hour and twenty minutes.

Intercondyloid fracture of humerus. Exposure one hour and thirteen minutes.

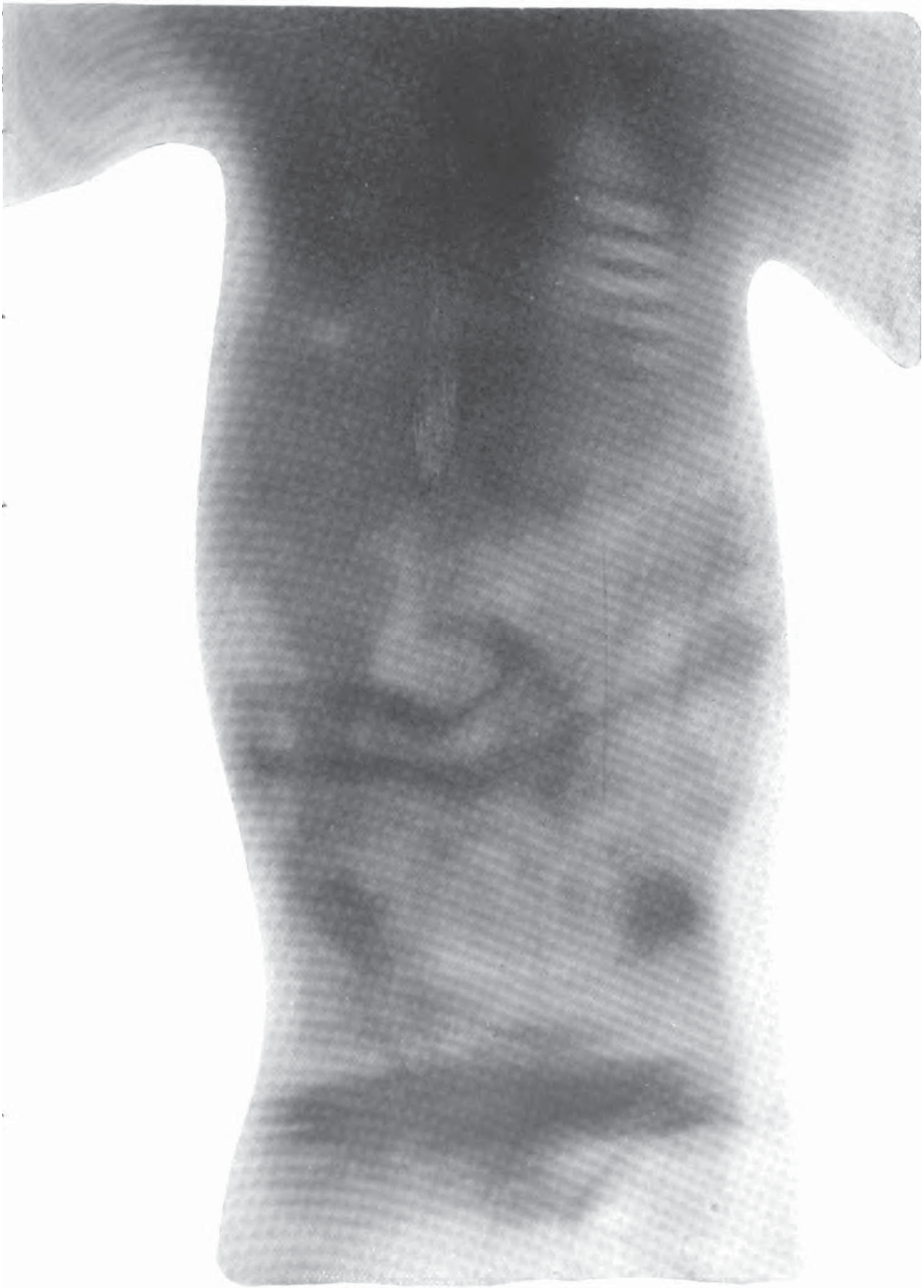


Resection of elbow. Plaster-dressing to arm and forearm, with iron cross-bar between. Skiagraphed through the dressing and bandage. Exposure one hour and ten minutes.

Hand and wrist of an uninjected cadaver, into palmar aspect of which a needle and two buckshot were thrust.

The same hand as Plate V., to show the bones of the wrist and forearm.

Hand with painful stump of phalanx.



Skiagraph of infant's body.

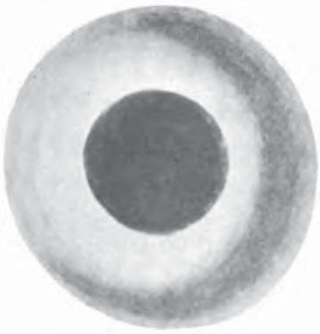
FIG. 5.

Sketch of living infant's foot, from skiascope.

FIG. 6.

Sketch of living infant's knee, from skiascope

FIG. 7.



Sketch of orbital plate and eye, living infant's head, from skiascope.

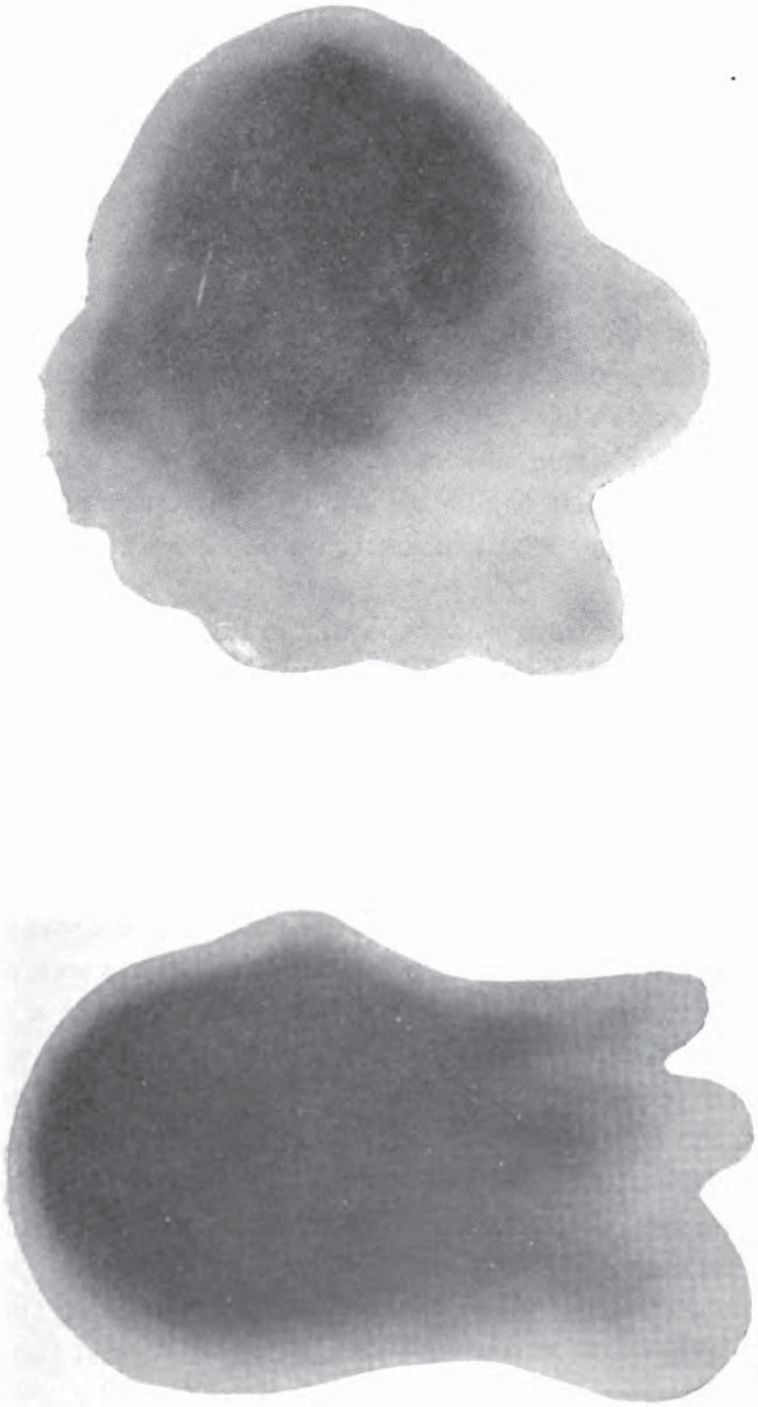
The bones of the tarsus and metatarsus and the outline of the foot were readily seen by three observers. One of these, Mr. W. H. Alcott, an artist in attendance, immediately made a sketch of what he saw. The accompanying illustration is a reproduction of his sketch. (Fig. 5.) The knee of the same child was next investigated in the same manner, and a sketch made of what was seen. Here it will be observed that the cartilaginous portions of the joint offer no shadow by the passage of the rays. (Fig. 6.)

The skull of the infant was next turned, with its temporal region toward the tube, and an effort made to appreciate the passage of the rays through the skull by direct inspection with the skiascope. Here again the temporal region and the brain gave no shadow upon inspection. Upon moving the instrument toward the orbital plate the outline of the border of the orbit and the eyeball appeared, as shown in the accompanying illustration. (Fig. 7.) This led to the question as to the permeability of the eye to these rays. Dr. G. E. de Schweinitz very kindly subjected a pig's eye to direct inspection with the skiascope, and found that the eye does not cast so deep a shadow as do the adult bones, but that the eyeball does not transmit the rays as do the soft portions of the body. The eye was inspected in its longitudinal axis, and also transversely. When the rays pass longitudinally the eye seemed more permeable than when the rays traverse the sclerotic. To test further this question, Dr. de Schweinitz sent me two bullock's eyes, of which a skiagraph was taken by direct exposure to the rays for half an hour. A considerable mass of fat and connective tissue was adherent to the eyes, as they had been removed at the slaughter-house and had not been dissected. It will be observed that this fatty tissue is much more permeable than is the eyeball. In one of these the rays passed through the eye transversely and in the other longitudinally. (Fig. 8.)

The direct inspection of the trunk of the fœtus with the skiascope revealed the fact that the rays permeate the trunk of the newborn child with facility, but that the skeleton casts but a faint shadow. It was possible to appreciate by direct inspection the passage of the rays through the body of a child weighing five and a half pounds, three days old, and born in the ninth month of gestation. The infant was held with its back toward the tube, while the skiascope was applied directly to the chest. The infant's body was not exposed, but remained covered by two thicknesses of light flannel. It was impossible, however, to outline the skeleton clearly or to observe movement in the internal organs.

An investigation of the trunk of the infant by passing the rays directly through the body of the child to a sensitized plate resulted in a very interesting demonstration; the child was clothed in two flannel garments, making four thicknesses which the rays permeated. The umbilical cord

FIG. 8.



Skiagraph of bullock's eyes.

had not separated, and at the umbilicus there was a considerable area of granulating tissue with a slight extravasation of blood, occasioned by pulling upon the cord when the belly-band was taken off for the inspection of the child. The stump of cord remained wrapped in its dressing of aseptic cotton. The child was bandaged upon a sensitized plate, with its back toward the plate, very much as the Indian papoose is fastened to its board. The bandage was the ordinary surgical roller, and entirely covered the trunk of the child's body. It was then exposed to the direct action of the rays, the tube being ten inches from the body, for forty-five minutes. The child remained quiet, did not seem annoyed by the crackling of the tube, and experienced no apparent discomfort. (Plate VIII.) Reference to the accompanying illustration shows the faint outline of the ribs, a dark shadow given by the sternum and underlying spinal column, a trace of the vertebral column, dark shadows cast by the crests of the ilia upon each side, and a shadow given by the stump of umbilical cord, which lay obliquely across the body toward the right, and by the granulating tissue at the umbilicus. The shorter exposure was made in this case from the belief that in very permeable objects too great an exposure may result in losing an outline which could otherwise be obtained.

The attempt to secure a skiagraph of the fœtus *in utero* was naturally attended with great difficulty. The usual timidity of pregnant women, the difficulty which a pregnant patient experiences in sitting or lying in a fixed position, the thickness of the tissue to be permeated, the respiratory movements of the mother, and the fœtal movements, necessarily complicated the experiment. A previous attempt had been made to secure an outline of the spinal column in an adult man, with an exposure of two hours. A newly invented sensitized plate was used for this experiment, with a negative result. A similar plate was employed in the case of a girl, aged eighteen years, pregnant eight and a half months, her fœtus occupying the usual position in the womb. She was placed in a comfortable position upon a clinical table, the abdomen covered with a sheet, and the patient attended by a nurse. A sensitized plate recently devised by Carbutt was placed against the abdomen upon the patient's left side. The lead diaphragm was interposed between the Crookes' tube and the right side of the patient's body, and any danger of the transmission of shock to the patient was obviated by connecting the diaphragm with a gas-fixture. The tube was placed vertically, and the patient subjected to the action of the rays for one hour. The plate was uniformly acted upon by the rays, but without definition.

A second attempt was made with the same patient, using the Eclipse plates, which we have found most successful, without the use of the lead diaphragm, and with an exposure of one hour and fifteen minutes. It was interesting to observe on both occasions that the proximity of the

electric apparatus seemed to have no perturbing effect upon the patient. She was informed that an effort would be made to ascertain the position of the child by the use of the electric light; she readily consented to the attempt, and, aside from slight fatigue from remaining quiet in one position, she seemed rather to be soothed by the constant sound of the apparatus, her pulse not varying through the entire time. The result of this second effort to investigate the pregnant uterus shows a difference in the permeability of the fœtal body and limbs from that of the uterine wall and amniotic liquid. By reference to the negative it was seen that the faint outline of the trunk of the fœtus could be recognized, the darker shadow of its pelvis occupying the upper right-hand portion of the plate, while projecting downward at about the centre were irregular white masses showing the situation of the fœtal limbs. The head of the child was so hidden by the mother's pelvis that no definite indication of its presence was obtained. While this experiment failed to outline distinctly the skeleton of the fœtus, it offers information which may be of value in further attempts. There has not been the slightest evidence that the passage of the rays through the uterus has affected either mother or child.

From our study of the pelvis and skull, and from our investigation of the living patient, it seems probable that information of practical value regarding the position and attitude of the fœtus may be obtained with the future development of this method. It seems probable that the contour of contracted pelves may also be recognized in future. An abnormal condition of the fœtus, such as a tumor, or an accumulation of fluid within a cavity of the fœtal body, might be recognized by the abnormal contour of the tissues. The presence of more than one fœtus in the uterus could possibly be appreciated. That a distinct outline of the individual parts of the fœtal skeleton is to be obtained seems scarcely probable with our present knowledge and the apparatus at present at our disposal. The attempt to obtain information by this method is certainly a justifiable one, as it requires no exposure of the patient, no vaginal manipulation, and puts her to no essential discomfort.

In concluding our account of these studies there are some general observations which may prove of value to clinicians in adopting this method. From Magie's description of the apparatus, it is evident that a well-equipped hospital, lighted by electricity, can readily add to its resources a clinic-room for this investigation. The ten patients whom we examined experienced no discomfort during the application of this process. Where the hand is to be examined, the patient is most readily accommodated in a comfortable chair, with the hand resting upon a table. Where a child's limb is to be investigated, it is best to lay the child upon a comfortable table, and to bandage the sensitized plate upon the limb. We find that surgical dressings, cotton, and the ordinary

bandage interpose no essential obstacle to the passage of the rays. The four children subjected to examination by this method gave us no trouble by restlessness, and, after the first crackling noise of the apparatus became familiar, were not in the least disturbed. This method can be readily applied to bedridden patients. It would be necessary to secure a proper holder for the Crookes' tube, so jointed that the tube can be raised or lowered and extended over the body. The patient could be brought to the examining-room in his bed, the sensitized plate bandaged upon the portion of his body to be examined, and the tube suitably adjusted. The services of a practical electrician and of an expert photographer are necessary for the application of this method.[1] The electric current can be obtained from the Edison Lighting Company, and an additional apparatus could be supplied by the hospital. As dry plates are used, the photographer's apparatus need not be elaborate. A small dark-room adjacent to the clinic-room would be required, with running water.

By the use of the skiascope, at the present stage of our knowledge, the fingers and hands are open to limited investigation. During these studies we had occasion repeatedly to examine the bones in our fingers, and to recognize the metacarpal bones. It was also possible to observe the rays coming between the radius and ulna by looking directly through the arm, and to observe the penetration of the rays behind the trachea by placing the skiascope just behind the larynx. A more extended application of this method depends upon chemical and physical research as outlined by Magie.

It is evident, however, that at present we may obtain by this method valuable information regarding the terminal portions of the skeleton, and regarding the contour of various portions of the body. The presence of metallic substances in the body may be demonstrated. It remains for physical laboratories to furnish the clinician with improved apparatus for the further application of this method of clinical research. It remains for the physiologist to supply us with indices to the permeability of the various normal tissues of the body, and for the pathologist to furnish us similar information regarding the effect of the rays upon diseased tissues. So far as our observation goes, bacteria exposed to the action of the rays are not influenced by them.

[1] We desire to express our obligation to Walker & Kepler, electricians, and especially to Messrs. George Teffeau and Redmond, for their kind and efficient assistance in this investigation. We are also greatly indebted to Mr. F. E. Manning and to Mr. John F. Reese, photographer, for constant and intelligent work with us.