some mechanical device is provided. With this bed one nurse can manage the case single-handed without effort or strain. With the ordinary hospital bed a patient with a fractured spine can only be turned by the united efforts of two, three, or four nurses, and each turning movement is painful and risky. In addition to cases of spinal disease or injury, those of fractured pelvis are most conveniently treated on this bed. The pelvis and buttocks are firmly held when the patient is turned over.

The bed is made by Messrs. Nesbit Evans of Wednesbury, and can be obtained from Messrs. Down Bros., 21, St. Thomas Street, S.E.1.

THE PERMEABILITY OF THE BODY TO INFRA-RED RAYS

PRELIMINARY COMMUNICATION

BY

C. B. HEALD, M.D.

PHYSICIAN IN CHARGE OF THE PHYSICAL MEDICINE DEPARTMENT,
ROYAL FREE HOSPITAL

It is impossible to work with the Finsen light on lupus, or with the Kromayer lamp on tuberculous or other glands, without being convinced that clinically these apparatuses behave quite differently when compared with any of the ordinary methods of giving ultra-violet light to the body. The Kromayer lamp is essentially a mercury vapour lamp, and even when care is taken that the dose, as judged by skin erythema, is the same, the mechanical and physical differences between these two lamps are significant. In the Kromayer the rays emitted from the mercury arc travel through a very small air space, then through a circulating body of cold water; they then pass through quartz direct to the part to be treated, which is rendered as far as possible avascular by pressure. In the ordinary mercury vapour lamp the rays emitted pass through a relatively wide air gap before reaching the skin. The clinical differences observed must therefore be due either to the absorption of some ray in the air in the one case, to the removal of some other ray or rays by the water in the other, or to the greater permeability to some useful ray possessed by quartz and water in comparison with air.

Some three years ago Professor T. R. Merton kindly gave me the benefit of his technical advice on these observations, and pointed out that the water film cuts off all rays above about 11,000 Angström units, but that in the mercury vapour arc there is a strong band of infra-red rays between 7,000 and 9,000 units, and that it might be this band that accounted for the clinical differences, particularly in tissues below the skin. He supplied a filter that cut off the ultra-violet part of the beam, and experiments with this showed that his surmise was correct, and that reduction in glandular swellings could be effected without the production of the skin erythema associated with ultra-violet light irradiation. The drawback to the routine use of this filter lay in the fact that, while eliminating the ultra-violet, it also reduced the energy of the infra-red beam, and necessitated a greatly prolonged dose to produce adequate clinical response.

The production by the *Times* of their wonderful series of infra-red photographs reawakened my interest as to the possibility of using a similar process for taking photographs through the body, in the hope that, if successful, the rays would be found to penetrate tissues in a different ratio to x rays, and to show up structures not well delineated by the latter. They would thus form a complementary method for giving information about the internal condition of the body, particularly the soft tissues in and around joints.

PRELIMINARY INVESTIGATIONS

That rays towards the red end of the spectrum pass more readily through skin tissues is, of course, known to everyone who has held his hand to the bright sun and seen the pink appearance of the fingers. Carl Sonne¹ and Cartwright² have discussed the penetration of infra-red rays, and the latter, using a vacuum thermo-couple, took photographs of the spectrum on infra-red plates after passing a beam of light through the cheek. The diagnostic possibilities of the permeability of tissues to the infra-red rays do not, however, appear to have received attention, nor can any attempts be traced in the literature towards making these rays penetrate and emerge from the thicker parts of the body, and registering them on emergence.

With my experience of the Kromayer lamp, and the *Times* photographs in mind, I approached Mr. Bloch, Mr. Flower, and Dr. Harrison of Ilford Limited, who kindly endeavoured to obtain photographs through the hand, and, though these showed clearly that infra-red rays did go through the thickness of the fingers, the comparative insensitivity of the plates as at present manufactured so prolonged exposures that they made the method impracticable, even for such thin structures as the fingers, and quite impossible for the thicker parts of the body. I therefore asked Mr. Bloch if he would attempt to pick up the emergent ray on a photo-electric cell, and demonstrate its presence by a deflection, if any, on a suitable galvanometer. A diagram of the apparatus set up by Ilford Limited for picking up the emergent ray is illustrated in Fig. 1. It will be seen to consist simply of

a photo-electric cell particularly sensitive in the region of 7,000 to 9,000 Angström units, and a single-valve method of amplifying any alteration in the current flowing in the filament-plate circuit, such alterations being indicated by deflections on the galvanometer inserted in this circuit.

TECHNIQUE AND RESULTS

It then only remained to provide a source of infra-red light in such a position that the beam would fall upon the photo-electric cell. This was done by an ordinary 50-watt or 100-watt lamp in a light-proof casing with an infra-red filter upon the side facing the photo-electric cell. The cell was also encased in a light-proof metal shield, with aperture to admit the incident beam. The gap between the filter and the shielded cell was sufficient to admit a wrist or forearm, and also a movable screen opaque to infra-red rays. In the preliminary investigation a reflecting galvanometer was used, and the experiments were carried out in a dark room, so that stray beams of light should not be reflected off the skin and produce misleading deflections. These experiments showed that, with appropriate sensitivity in the amplifying instrument, a wide deflection of the spot of light could be obtained after the infra-red beam had been passed through

a wrist. The next step was to endeavour to obtain a permanent record of the deflection so that variations in normals and abnormals could be measured and possibly standardized. The electrocardiograph galvanometer and recording camera appeared to provide the possibility of doing this, and the leads for the galvanometer were carried to a pair of Einthoven leads of a standard Cambridge instrument apparatus kindly loaned by Dr. Jenner Hoskin. The procedure was then to put the fibre at a prearranged position on the scale, with the infra-red opaque screen in place, and turn on the source of infra-red light to make

FIG. 2.—H., male, aged 50. Left wrist-joint, with centre of beam between styloid processes.

sure that no deflection occurred. The wrist or forearm was then interposed and closely applied to the infra-red filter, so that all rays emerging through the filter were bound to fall upon the skin and skin only. The screen was then withdrawn, and the string of the galvanometer at once deflected and returned to its original position on replacing the screen. Photographs of this deflection were then taken by allowing the plate to fall in the

usual way, removing the screen, and replacing it a few times as the plate fell.

The accompanying graphs from three different individuals (wrists and forearms) with the same setting of the machine were then secured. It is not possible to state at this stage that the wide variations shown by these graphs are due entirely to differences in the permeability of the structures through which the rays

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 3.—M., male, aged 30. Wrist-joint, with centre of beam between styloid processes. Transverse diameter of this wrist was 3 mm. more than in Fig. 2.

FIG. 4.—M., male, aged 30. Right forearm, a few inches above wrist-joint.

FIG. 5.—H., male, aged 21. Left wrist-joint, with centre of beam between styloid processes. In this case the subject is of altogether more slender build than either of the other two cases. The deflection of the fibre is so great that the "B" position is unknown, being off the plate.

pass. It is only possible to state that repeat experiments yielded similar results. In the illustrations A indicates the position of the fibre with the screen inserted; B indicates the position with screen withdrawn.

DISCUSSION

These photographs can therefore be taken to establish the fact that infra-red rays of 7,000 to 9,000 Angström units can pass completely through the wrist and forearm. Also, as the source of energy was limited to a 100-watt lamp, and the sensitivity of the string of the galvanometer was only 3 mm. for 3 millivolts—that is, one-tenth of the sensitivity used in taking heart tracings—that, with greater incident energy and increased sensitivity of the galvanometer, thicker parts of the body than the forearm should be capable of penetration and the deflection of recording.

This preliminary communication is made in the hope that others will explore the wide field opened up by these records. Questions such as the following naturally occur:

1. Is there a "normal" for parts of a given diameter?
2. What factors influence variations from the normal other than physical thickness of the part—for example, age, sex, etc.?
3. Is there any variation in disease? For example, does an arthritis of one wrist produce a deflection different from that obtained by the wrist of the other side?
4. With increasing power and sensitivity of recording, what are the limits of thickness of the body to the passage of the infra-red ray?
5. Can anything be done to increase the speed and sensitivity of plates and films sensitive to these rays, and thereby obtain direct photographs?

Other questions also naturally suggest themselves, but I am endeavouring more particularly to obtain further information on Questions 1 and 4.

It would not be appropriate to close this communication without again extending my grateful thanks to Messrs. Ilford and their technical staff, Mr. Bloch, Dr. Harrison, and Mr. Flower; to Dr. Jenner Hoskin; and last, but not least, to Mr. Holt, whose technical knowledge and skill has materially assisted in obtaining these records.

REFERENCES

- ¹ Sonne, Carl: *Arch. of Phys. Ther., X Ray and Radium*, March, 1929, x, No. 3, p. 93.
- ² Cartwright, C. H.: "Infra-red Transmission of Flesh," *Journ. Optical Soc. Amer.*, 1930, xx, No. 2.

RADIUM BURNS

BY

J. MERVYN THOMAS, M.D., B.Ch., B.Sc.

RADIUM REGISTRAR, CARDIFF ROYAL INFIRMARY

The incidence of radium burns during or following surface radiotherapy by the plaque method is not often mentioned when quoting cases, but it must, of necessity, be proportionately high where a biological unit of radium exposure has not been attained. With the object of helping the radiotherapist, therefore, the following brief account has been compiled.

No statement would be adequate unless some clinical method for calculating the dosage were stated. It has been found that the skin undergoes certain changes during irradiation, beginning with an erythema towards the third day, and passing through an oedematous stage to tissue necrosis somewhere about the sixth to tenth day. The oedematous stage should be the aim of the therapist during treatment; it occurs rapidly in the course of twenty-four hours. All treatment should then cease, as the skin has reached its limit of tolerance. When this simple rule is applied the skin rarely ulcerates.

The caustic action of the β ray is too often neglected during treatment. The β ray is not tolerated nearly so well by normal tissues, and destruction must follow when the areas are exposed to high intensities for short periods or to low intensities for long periods. The burn may be immediate or latent. If the former, it develops during treatment or at any time up to three months, and may vary in form from a simple erythema to desquamating patches and finally definite ulceration. Later these may become excavated areas with a yellowish grey slough and persistent discharge (purulent or watery). Pain is usually severe and healing obstinate. The delayed burn occurs any time after three to six months, and is manifest by an ulceration of the skin following some irritation or friction.

PREVENTION AND TREATMENT

The following details have been tabulated for clearness:

1. Radium treatment should not be given to patients suffering from cachexia, anaemia, a white cell count under 5,000 per c.mm., diabetes, nephritis, extreme obesity,