RADIOLOGY (IN ARDUIS FIDELIS).

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For several years after their first discovery, the practical application of X-rays was confined almost entirely to the medical profession. Of recent years, more and more use has been made of their application to numerous industrial and trade processes.

The production of the rays is in all cases on similar lines, but the handling of the object to be radiographed, together with the positions and procedures necessary, vary much in each particular case. Hence, it is obvious that the actual design and arrangement of the component parts of each radiological department depend upon the conceptions of its own particular specialist; in the case of the medical radiologist, they are based on a knowledge of physics, anatomy, anatomical shadows, pathology and the various clinical and dental procedures. The subject of radiology has a language of its own; the distinctive terms in this country invariably begin with radio-, while in America roentgen- is used in preference. There has been for some time considerable laxity in the use of technical terms. The non-specialist as well as the specialist officer requires a knowledge of the correct terminology. The use of such an expression as “let me have an X-ray,” should be discontinued; to help this object a list of the common terms is here inserted:

Radiology: The study and practice of X-rays and radium as applied to medical and other sciences.
Radiologist: One skilled in radiology.
Radiogram: A sensitive plate or film on which a shadow has been produced by X-rays.
Radiograph: To make a radiogram.
Radiography: The art of making radiograms.
Radiographer: One who makes radiograms.
Radio-diagnosis: A diagnosis made by means of radiograms.
Radiability: The property of an object to transmit X-rays.
Radio-parent and radio-parency: Offering no barrier to the X-rays.
Radio-lucent and radio-lucency: Offering slight resistance to the X-rays.
Radio-opaque: Impervious to the X-rays.
Radio-therapy: The application of X-rays and radium rays in medical and surgical treatment.

In the Army, the medical radiologist has to work under entirely different conditions from the medical radiologist in civil life; conditions that will be referred to hereafter in these articles collectively as “Military Medical Radiological.” The conditions of service in the Army require the adoption of systems applicable to all military hospitals and medical units, whether at home, abroad or in the field. The same factors that govern the per-
sonnel, accommodation and equipment of the existing system of military hospitals and medical units, must necessarily apply to any special branch of the military medical machine, such as the military medical radiological department. The main function of an army on a peace footing is training for war. Any system employed and taught in peace in military hospitals must be identical with that suitable for use in war.

The personnel trained under these conditions would have such a detailed knowledge of their duties and apparatus, that they could reproduce their previous standards under the varying conditions of a radiological department in war—working in wards, in tents, in huts, or in the open. But it must be kept in view at all times that mobility is the first principle of war organization. Any methods of instruction, any methods of technique, any methods of design and construction must fulfil this first principle.

To accustom the radiologist and his radiographer to work under the constant conditions of a civil hospital is fatal to rapid work under the varying conditions of war. Therefore the requirements of a military medical radiological department are:—

1. Adequate training.
2. Mobility.
3. Standardization.
4. Safety first.
5. Efficiency.

1. Training.—Personnel is changing constantly; this cannot be avoided, but by adopting better methods of standardization and definite systems of training, efficiency will be attained.

2. Mobility.—(a) The apparatus should be made so that it can be packed in suitable weights for handling and transport. No package should weigh more than forty pounds. (b) The apparatus should be easy to erect and to dismantle, and should be mobile within the hospital.

3. Standardization.—At present, apparatus and the fitting up of the same vary so much throughout the Service that this is not fulfilled. Unity of effort is one of the maxims of war but unity of effort will not be possible in the military medical radiological department until unity of training, design, and equipment is reached. Standardization will solve the problem of providing spare parts and replacements with economy and rapidity.

4. Safety First.—In all radiological work, the highly specialized knowledge of the medical officer is essential. For the protection of the patient and the operator the findings of the X-ray and Radium Protection Committee are available in their revised report, December, 1923, which is republished in this number of the Journal. In medical radiology, however, the object to be radiographed, i.e., the patient, often requires operation or special examination, and this demands that the designer of a medical radiological department must have an intimate knowledge of ordinary and special clinical procedures, operations, and the administration of anaesthetics.
(5) Efficiency.—(a) Apparatus: This depends on the original design, and upon the conditions, local, climatic, etc., under which it may have to be worked. The apparatus selected should be that found and proved by the military medical radiologist himself to be the most satisfactory. Standardization of apparatus is intimately bound up with this question. 

(b) Department: The military medical radiological department must, as in the United States Army, be recognized as a separate entity of the military medical machine.

(6) Low Cost.—This always must be taken as the maximum efficiency at the minimum cost, but does not mean the cheapest article, although low cost is and can be compatible with efficiency.

The following conceptions, based on these requirements, are suggested as meeting the necessities of the military medical radiological department. The first M.M.R. conception should relate to the suitable methods of generating the high-tension current, but this is of necessity left over until a later date, as the various types of apparatus are under review by the War Office Committee at the present time.

**FIRST CONCEPTION: HIGH-TENSION LEADS.**

The following system of high-tension leads has been designed primarily as suitable for military hospitals at home, or abroad, in peace or in war. In the tropics, this system is specially advantageous in view of the extreme height of the roofs, the presence of ceiling cloths, fans, punkahs, etc. The system would be equally efficient in civil hospitals, but the military medical radiological requirements do not apply, hence more elaborate fixed types are permissible.

Fig. 1 shows a transformer set and fig. 2 a coil-set in elevation with the position of the wooden gallows supports and the fixed rigid half-inch brass rods, each supported on two short vulcanite stems. From the ends of these brass rods coronaless rheophores carry the current to the X-ray tubes above or below the table; the details of the above- or below-table holders are omitted as anyone can easily erect them. In order to minimize the length and angle of the coronaless rheophore wires, the table remains freely movable and the X-ray tube stand need never be moved along the table, as the patient can be placed head or feet towards the generator according to the part requiring examination. On the ends of the high-tension rods, brass balls are soldered, and if Coolidge tubes are to be used a piece of cab tyre flex can be run inside the negative rod to carry the second wire from the filament heater to a suitable terminal. In the latter case, it would be useful to have the ends of the negative rod finished in the female half of a screw type lampholder, or similar device, instead of a brass ball in order to take the male half of the lampholder, etc., attached to the double rheophore; a good contact would thus be made. The screw or plug...
type is better than the bayonet catch for this contact, as with four or five amperes passing through the filament heater, simple contacts are not satisfactory.

In place of the two central brass balls shown on each rod in the figs. 1 and 2, the short vulcanite supports might be made heavier and square, and have holes the exact size of the brass rods drilled therein; this would function better, as the rods would not only be well insulated, but fixed without any soldering at all. If occasion demanded, the rods could be moved a little towards either the table end or the upright screening end, or one rod alone could be moved as shown in fig. 3 where the lay-

out of the room at right angles would be more suitable than all the apparatus in a line. The cost of this system is very small and is about one quarter that of the regular civil hospital system of "fixed to the roof" overhead rods, and it is within the scope of any practical radiologist or radiographer to erect these anywhere.

The following is an estimate for erecting this type:—

"The estimated cost of this type is £3. It consists of 2 inches by 2 inches deal fillet, framed together to form carriers, fixed at the base with 14 S.W.G. sheet iron brackets; the brackets are screwed to the fillet, and held in position with dowel and thumb screws. Ebonite supports, 2 inches by $\frac{3}{4}$ inch by 6 inches long, are fixed to the ends of the fillets to
carry the \( \frac{1}{4} \) inch brass tubes; the tubes are fitted at the ends with brass balls 1\( \frac{1}{2} \) inches in diameter. A stretcher of two inches by one inch deal, fitted with light sheet iron angle plates and fixed with thumb screws is required to keep the carrier rigid. Should the height of the carrier exceed five feet, the fixing at the base would need stiffening at a small increased cost."

This system has been tried at the Queen Alexandra Military Hospital, Millbank, and found in every way safe and efficient.

Fig. 3 shows the plan of the transformer room at the above hospital. Special attention is drawn to the free area at the distal end of the table for the anesthetist, who is frequently present during a radiological examination in such cases as pyelography, setting of difficult fractures, and extraction of difficult foreign bodies, etc. In such cases I consider it essential, especially when giving ether in a closed dark room, to have the anesthetist as far from any high-tension rods or wires as possible and to have any additional suction fans, etc., behind the anesthetist’s area. The position of the control operator behind his lead screen is satisfactory for any work and with one pair of rheophores no two pieces of apparatus can be live with
high-tension current at the same time. With this wooden gallows arrangement very safe and satisfactory fixation or replacement of valve tubes, oscilloscopes, milliampermeters, etc., can be made, and a good cab tyre flex is as good as anything for this rigid upright arrangement. The whole "live" part of the apparatus is well out of reach of anyone in the room. The apparatus, likewise, can be moved away from any adjoining overhead electric lamps as the proximity of high-tension currents is disastrous to the filaments thereof, although the risk of this sequel can be guarded against by placing a small coil of thin wire round the lamp globes. There is absolutely no danger area round the apparatus, as no live wires are in any proximity to either operator or patient.

SECOND CONCEPTION: THE COUCH.

The following short note complies with the six M.M.R. requirements applied to the table:

A plain three-ply table top, about 6 feet by 3 feet, on four legs with good castors, without any metallic or other attachments is all that is needed, as with a good tube-stand a complicated table is unnecessary. In the late war this lesson was learnt, and a stretcher on iron trestles frequently fulfilled all requirements.

THIRD CONCEPTION: THE PORTABLE TUBE STAND.

In the late war no tube stand fulfilled the M.M.R. requirements, and the following recently devised type approximates so far as possible to these conditions. No single part of the tube stand weighs over forty pounds. The weights for the base of the stand consist of the generating
apparatus or accumulators. The essential here is adaptability in order that the stand may be used easily under the varying conditions at the bedside of a helpless patient. The stand is rigid, adaptable for over or under-table work, and allows for a wide range of movement for routine work, dental radiography, or general fluoroscopic work. The necessary arrangement for stereoscopic work is likewise provided.

The design is such that no metal arm projects behind the tube stand to get in the way of high-tension wires, when the tube-holder is moved nearer the upright. The cost is low, especially if made in considerable numbers; the present estimate is £40. The cost should be considered along with the low cost of the couch as the two pieces are inseparable. The stand can be
taken from ward to ward, as required for those cases who are too ill to be moved to the radiological department.

The design is based on the movements of the human body, using the trunk as the upright, the arm—with “elbow” bending either way—as the extension, and the hand as the tube-holder. The stand consists of an upright nickel-plated steel tube, with a horizontal jointed arm and protective shield; the arm and shield are balanced by a counter-weight working inside the steel tube stand. The adjustments in a vertical plane are made by means of a hand wheel. The steel pillar is secured by means of a robust flange to a substantial flat base, having a free area approximately nineteen inches by sixteen inches, upon which a coil or accumulator, etc., can be placed and used as the base weights. The whole base is mounted on substantial castors, permitting it to be moved easily; a locking device or screw is fixed therein to keep it steady when once in position. The tube-carrying arm consists of a main body girder casting, provided with a substantial elbow-joint, permitting the tube shield to be placed where required, either below or above the table. It also allows a rotary movement on the horizontal plane which is especially convenient in fluoroscopic under-table examinations.

The protective shield is a specially constructed cylindrical type for holding ten or thirty milliampere radiator Coolidge tubes, the protection afforded having a lead equivalent to two m.m. This shield is mounted in a pair of ring supports enabling the tube to be rotated about its long axis, and is further provided with an angular adjustment working in a horizontal plane. These two movements together thus permit the beam of rays issuing from the tube to be set at any required angle or direction. The shield is provided with a cylindrical diaphragm, and an anode finder is fitted to the sides of the shield.

An adjustment for stereoscopic radiography is also provided on the horizontal arm with the stereoscopic movement either across or with the table. The stand further includes a spreader at the top of the stand with a pair of cab tyre cables going down to the coil high-tension terminals on the base. The spreader itself is provided with a pair of coronaless rheophores for making the connexions to the X-ray tube. The leads are kept clear of the metallic arms by means of two single adjustable smaller spreaders.

The photograph shows the first finished sample of the new design.

In the designing and construction of this tube stand, I gratefully acknowledge the great help given me by Mr. E. E. Burnside, of Messrs. Newton and Wright, who placed the resources of their electrical engineering department at my disposal.

(To be continued.)