

APPENDIX E.

RÖNTGEN RAYS.

- Röntgen rays.** The following short description of the necessary apparatus and method of working, when making examinations or taking radiographs, for surgical purposes, is inserted here, as it is thought it may be of practical use in the Service.
- A large amount of useful work of this description has been carried out in "Vernon," and the results obtained by Wehnalt interrupters extemporised by T. McGregor, Chief T.I., out of ship's stores have been most satisfactory.
- Apparatus.** The necessary apparatus is as follows:—Battery (or other source of electrical energy), Crooke's vacuum tube, induction coil, fluorescent screen, and, if photographs by this process (radiographs) are desired, photographic plates, and developers, &c.
- Coils.** The coil should be capable of giving a 6-inch spark at least, a 10-inch coil being preferable.
- Interrupter.** The usual magnetic interrupter can be employed, but an electrolytical one may be preferable.
- Electrolytic interrupter.** This can easily be constructed as follows, with ship's stores:—A glass container (about 6" x 6" x 6") is three-quarters filled with dilute H_2SO_4 (1 acid to 8 water), and into this are placed a flat lead plate (about the width of the cell, and fitted with a terminal on top), and a thin glass tube, sealed at its lower end round a small platinum wire, projecting about $\frac{1}{4}$ inch (the loops of a disused incandescent lamp can be employed), the tube is then partly filled with mercury, into which is dipped the wire lead from the positive source of supply.
- Pressure required.** A pressure of about 40 volts is required to work this interrupter, and, if the 80-volt mains are used, an inductive resistance should be inserted.
- A cut-out and switch should also be employed in addition to the switch on the coil.
- Joining up.** In joining up this interrupter the magnetic hammer of the coil should be screwed hard up, and care taken to join the positive to the platinum electrode. If correctly joined, a yellowish light will be obtained in the container, if wrong a blue one.
- A loud hissing noise accompanies the working of this Wehnalt interrupter, and is its greatest objection. Its efficiency, however, is very great.
- Tubes.** Focus tubes are exhausted to a high vacuum (about one-millionth of an atmosphere), and provided with two electrodes for connecting to the secondary wires. The cathode in the latest tubes is usually a cup-shaped piece of aluminium, connected to a platinum wire sealed through the glass to a brass cap outside.
- The cathode, being cup-shaped, brings the discharge to a focus a few inches from it, and at this focus is placed a small platinum plate mounted on aluminium, and connected to another terminal outside the tube.
- This piece of platinum is the anode, and directs the rays through the side of the glass confining them in the direction required.
- Were it not for this plate at the focus, the heat produced by the rays would burn out the glass opposite the cathode, and in some cases it is found necessary to switch off the current occasionally, to allow the anode to cool.
- If the tube is working properly the discharge should be apple green, and this will serve as an indicator that the tube is connected the right way, and the reversing switch of the coil, correctly placed.
- If, though correctly joined, the results are not quite satisfactory, reversal for a few seconds by the switch of the coil will probably rectify matters.
- Regenerative tubes.** With prolonged use the exhaustion of the tubes becomes intensified, and good results can no longer be obtained.
- To meet this, "regenerative tubes" are now constructed (with various means of restoring the initial vacuum), but such tubes require very careful manipulation.

The ordinary "penetrator focus tubes," costing 35 to 45 shillings each, can usually be depended on.

A suitable stand is necessary to support the tube. It should be made of ebonite, with a good solid base to ensure stability, and be fitted with a clip to support the tube with the aid of a cork washer (to prevent danger of crushing). Support for tube.

For purposes of inspection only a fluorescent screen is used. This consists of a piece of film or cardboard coated with a salt (usually platino-cyanide of barium), the salt fluorescing under the action of the rays. Fluorescent screen.

The rays pass through some objects with greater ease than others, and, consequently, if the hand (for instance) is placed between the screen and the vacuum tube, the shadows of the bones, &c., or foreign matter can be clearly observed.

Obviously, to obtain sharp definition, the screen should be as close to the hand as possible, but, although the hand should be fairly close to the tube, great care should be taken not to touch it whilst working, otherwise a very severe shock will be obtained.

For the purpose of taking a radiograph the sensitised plate should be placed in a black or brown paper envelope in the dark room, and must not be removed until required for developing. They should not be allowed in the same room as the tube until the latter has been adjusted, and everything is ready for use, unless contained in a closed lead box. Radiograph.

The apparatus having been joined up as shown in diagram, with the exception of the tube, adjust the coil to give the length of spark required (in the case of the Wehnalt interrupter a smaller spark gap than usual is necessary owing to the heavier discharge), clamp the discharge points at this position to act as a safety valve for the tube, and connect up the tube itself (switching off whilst doing so). Procedure.

Care must be taken that the leads to the tube are well clear of each other, and clear of the tube, otherwise they may spark into it and destroy it. All the points previously referred to should also be carefully attended to.

The patient is then placed in a comfortable position, and the part to be inspected placed between the tube and the fluorescent screen, or, if a radiograph is required, the envelope containing the plate is placed as rigidly and as near as possible to the part to be radiographed, the tube being on the opposite side of the body. There is, of course, no objection to placing the tube under the bed or table, and the plate on top; and there is no necessity to remove bandages, though sharper definition will be obtained by doing so.

The following table gives a rough idea of the exposures necessary, when using an 8-inch spark gap with magnetic interrupter. Exposures.

Hand or foot, tube 9 inches distance, exposure	20 to 40 seconds.
Leg or arm " 9 " "	1½ to 4 minutes.
Shoulder " 15 " "	10 to 15 "

With the Wehnalt interrupter much less time is required, but much always depends on the efficiency of the tube, &c.

When making long exposures care must be taken that the tube does not get too hot, the current can be switched off, and the tube allowed to cool, care being taken that the patient does not move in the intervals.

It is not necessary to darken the room when taking a radiograph, the plate being in a black envelope. Daylight.

Ordinary plates can be used for these radiographs, as well as rapid plates, but require a little longer exposure. This can, if required, be hastened by placing in contact with the face of the plate an intensifying screen coated with "Tungstate of calcium." Plates.

Plates should be developed in the usual way, but slowly, in order to obtain fullest detail. Developing.

The following hydrokinone developer has been found satisfactory :—

A.	B.	C.
Hydrokinone - 1 oz.	Carbonate of potash - 2 oz.	Pot. bromide 1 oz.
Sulphite of soda - 4 "	Water to make - 48 "	Water - 9 "
Water - - 48 "		

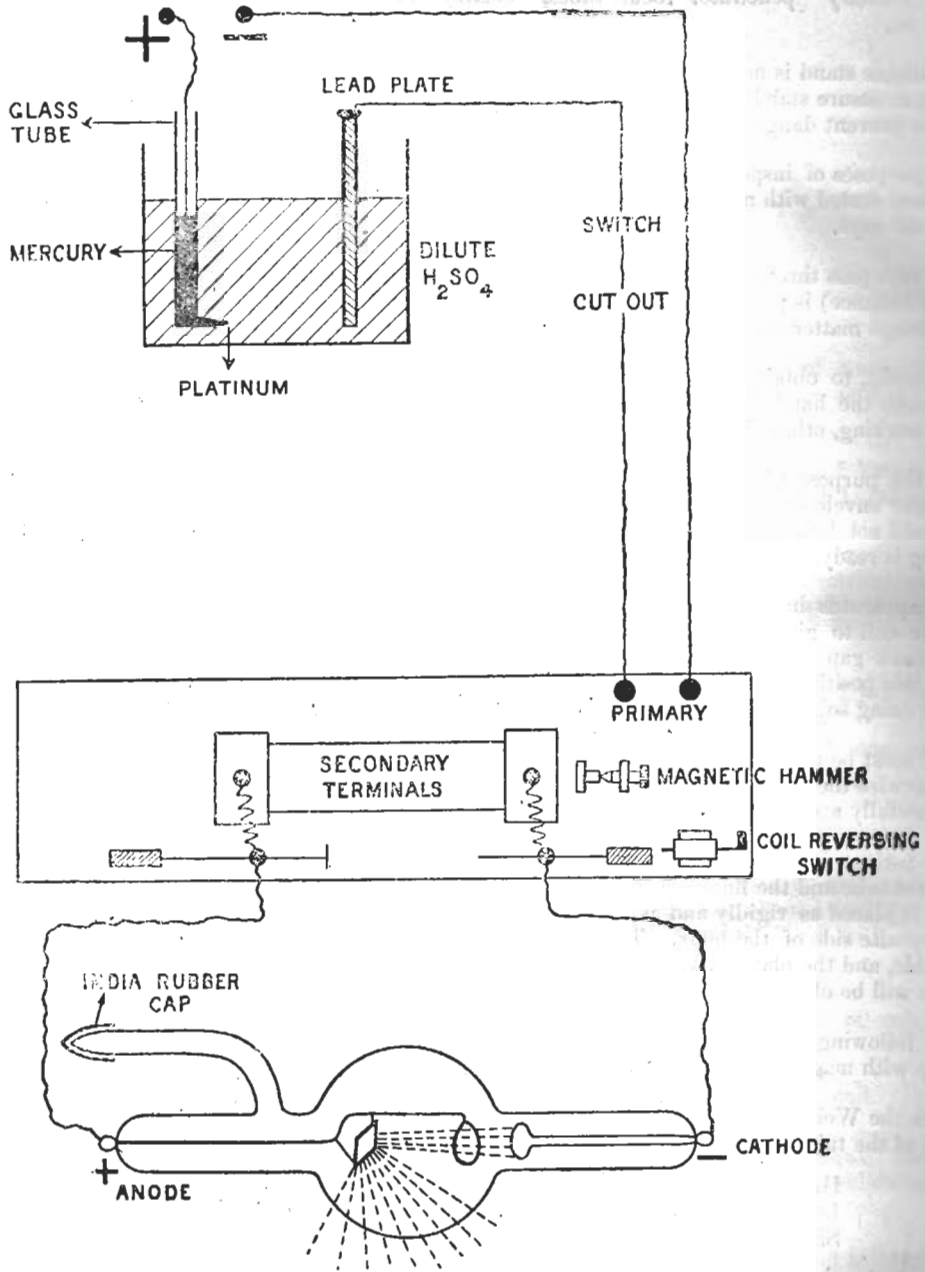
Take equal parts of A and B, adding a few drops of C, the plate being fixed in the usual manner.

1. If radiographing adjacent parts of different thicknesses, the thinner part can be protected by a plate glass screen, when it has been sufficiently exposed. Notes.

The screen should be moved to and fro to prevent shadows.

2. If using the Wehnalt interrupter, as shown in diagram, the magnetic hammer should be screwed hard up, care being taken not to break the connection of the primary circuit.

3. If using magnetic interrupter its contacts should be cleaned at intervals. About 12 volts will be required under these conditions for a 10-inch coil.



"PENETRATOR" FOCUS TUBE.

These tubes are marked for the spark gap they require.