The relatively high cost of x-ray film and the time consumed in and complexity of its processing are important disadvantages which detract from the value of roentgenography as a diagnostic method. Considerable importance must therefore be attached to a new electroroentgenographic method, which is free of these disadvantages. It is based on the photoconductivity of semiconductors, a latent electrostatic image being created. The developed image is reproduced and fixed on ordinary paper.

With the exception of the exposure, the entire process for the production of the electroroentgenogram is effected in the electroroentgenographic apparatus ÉRGA-M, which has been developed by the Research Institute of Electrography.

Charging (sensitization) of the selenium plate in the charger of the apparatus occupies 10 sec. In the process of charging the plate is sensitized by the linear passage of a corona wolfram filament over it. The corona discharge is produced by delivery of a high-voltage current to the filament, which has the effect of ionizing the surrounding air, and positive ions stream over the surface of the plate, transferring their charges to the layer of amorphous selenium. After charging, the selenium plate is sensitive to visible light.

Exposure is effected in the same way as with x-ray film. The parts of selenium on which roentgen radiation falls become conducting, and the charge held on the surface of the selenium flows away (in proportion to the dose of radiation) into the metal base layer of the plate. The charge remaining on the selenium plate represents an electrostatic image determined by the size, shape and radiation density of the objects exposed to the radiation; it is a "potential relief."

The latent electrostatic image is rendered visible by a "dust cloud" method in a developing chamber, the process requiring an average of 30 sec. The developer used is a positively charged, finely dispersed black powder which is distributed in accordance with the potential relief, in inverse proportion to the magnitude of the electrostatic charge. The particles of the developer are injected into the chamber from a bunker.

Fig. 1. Roentgenogram (a) and electroroentgenogram (b) of the ankle joint.
by the vibrations of a rubber diaphragm, are dispersed in the air space, and are charged by the counter-electrode of the developing apparatus, to which a high-voltage current is fed.

Transfer of the powder image from the selenium plate to a sheet of ordinary paper takes about 5 sec, and is effected by corona discharge of the electrifier of the charging apparatus. Before transfer of the powder image, the plate is given a "replenishing charge" in the charging apparatus, and potential of opposite sign is delivered to the corona filament at the moment of transfer.

The powder image is fixed on the paper by melting the developer particles in the chamber with acetone vapor (10 sec). This completes the process for the production of the electroroentgenogram.

The finished electroroentgenogram can thus be obtained less than two minutes after exposure. The powder image left on the selenium plate is removed by the rotating hair brushes of the cleaning unit. After cleaning, the plate is again ready for use.

It has been calculated that the cost of a 30 × 40 cm electroroentgenogram is 2.33 kopeks, and that of an ordinary roentgenogram of the same size, 26.15 kopeks. Maximum output in a 5-h working day is reckoned to be 25 roentgenograms, but 100 electroroentgenograms. The annual output of a radiological laboratory is 3065 films, but an electroroentgenographic apparatus will produce 18,380 pictures. In a year one apparatus will save 1600 m² x-ray film, 35 kg silver and 40 kg of photographic gelatin. One selenium plate can be used for not less than 1000 exposures, developing and transfer, after which it can be returned to the factory for renewal of the selenium layer.

An important advantage of electroroentgenography is that work can be carried out without a photographic laboratory. This is a purely physical, "dry" process, which is not dependent on water supply or on the length of time the selenium plates have been kept. The use of a noninflammable material, which is not affected by ionizing radiation is another advantage of the method.

Electroroentgenography was first used for medical purposes in 1954–1955 for the diagnosis of pathological conditions in bones and joints [1-3]. In this country the first examinations of the bones of the extremities were made in experiments with electroroentgenography by engineers I. I. Zhilevich, A. I. Kaminskas, S. M. Likhtin and V. G. Chepenko. In 1964 and 1965 A. M. Martsinkyavichius et al. and N. R. Paleev et al. carried out some experimental and clinical trials of the new graphic method (examination of peripheral arteries and of changes in bone and joints).

Within the last few years the Institute of Electrography has succeeded in increasing the sensitivity of the selenium layers considerably, so that it has now been possible to proceed to an extended clinical trial of the method. Dosimetric examinations have shown that visceral electroroentgenography increases the skin dose by 15%.

The author's material includes more than 2500 electroroentgenograms. Because of the high resolving power of the selenium plates (20–30 lines/mm), the same picture provides information on the state of tissues lying at different depths; in addition to a finely detailed picture of bone structure, there are distinct images of subcutaneous layer, muscles and intermuscular septa, and hollow organs, the high degree of contrast produced in the selenium layers and the property of the developing powder of collecting in increased quantities at the boundaries of areas with different charges (marginal effect) produce very distinct outlines of organs and tissues (Figs. 1 and 2).

Disadvantages of the new method are:

1. The occasional appearance of artifacts in the electroroentgenograms, due mainly to unduly high potential of plate charge (they occur with particular frequency when the potential is increased to 6 kV); the diagnostic value of such electroroentgenograms is, of course, reduced.