dealt particularly with radiography in the laboratory of a steelworks. Radiography, he said, could be divided into three groups, namely, inspection, *ad hoc* problems, and investigations of manufacturing techniques. In the first, 100 per cent inspection is only justified if failure in service would cause destruction of a valuable engineering unit or endanger life. The chief economic considerations involved were briefly discussed. In dealing with *ad hoc* problems on which the X-ray department has come to the aid of the foundry, Mr. Peiser mentioned the determination in weld repairs of the extent of the defect and the quality of the repair when it has been made, and problems arising in the examination of inaccessible plant or equipment. In dealing with the investigation of manufacturing techniques, he said that this type of investigation is the most valuable economically and, in addition, from it better products usually result; he gave as an example from the hundreds undertaken the elimination of shrinkage cavities. Mr. Peiser concluded with some remarks on the economic operation of a radiographic department.

On the evening of July 3, Dr. O. Vaupel, of the Röntgenstelle, Material Prüfungsamt, Berlin, lectured on the subject of "The Standardization of Radiology in Germany". Dealing specially with X-ray and gamma-ray techniques, he said that new quality standards for X-ray and gamma-ray pictures would be published shortly under standard *DIN* 54110, which would replace the present standard *DIN* 1914. Dr. Vaupel next described the wire penetrameter, consisting of wires of the appropriate material embedded in thin rubber, four gauges being required to cover thicknesses up to 3½ in. Since none of the orthodox types of penetrameter is capable of showing up small differences in defect sensitivity because the gaps (for example, between adjacent wires) were too wide, E. A. W. Müller in 1942 invented a more accurate penetrameter known as the 'bacillæ test', an ingenious device in which short lengths of randomly distributed wires are contained in nine boxes embedded in low-adsorption material, the whole containing thirty-one wires of the same diameter, for example, 0·4 mm. The observer draws the positions of the wires as seen on the film and compares the result with their true positions. This is repeated for wires of different diameter, and the number of observed wires is plotted against the diameter, extrapolation giving the diameter necessary for thirty-one wires. On the subject of the standardization of magnetic crack testing, Dr. Vaupel said that the importance of this method can be judged from the fact that in 1944 there were in Germany as many magnetic crack detectors in use as X-ray equipments. The methods by which magnetism is induced in the specimen had been standardized as well as the direction of the resultant magnetism. There is also a standard test for magnetic inks. Dr. Vaupel also described the Berthold magnetic penetrameter which indicates the efficiency of a magnetic test.

The first paper at the morning session of July 4 was read by Mr. J. F. Hinsley, of Edgar Allen and Co., Ltd., and had the title "The Radiography of Castings". Starting with a review of the casting processes, the subsequent chain of events in the foundry was described. To talk with the foundryman the radiographer needs to understand his terms, and these were explained. The design of castings was next discussed, in particular the formation of defects during the solidification process, and it was shown how the radiologist can help in this connexion, as also in the feeding process.

The last lecture, on July 4, was given by Mr. G. T Harris, of William Jessop and Sons, Ltd., who spoke on "Non-Destructive Testing in a Steelworks", which for the purpose of his talk he divided into three sections, namely, identification, checking mechanical and physical properties, and the detection of surface and internal defects. In the first section can be placed the spectrograph and its simplification, the spark test with a grinding wheel; microhardness testers and thermo- and tribo-electric methods were also described. In the second section Mr. Harris spoke of automatic thickness gauges and then described the core loss comparator, in which, by placing a coil round the bar under test and measuring the core loss, quality differences are at once obvious. In discussing magnetic crack detection, the effect of the direction of the field was shown. Inspection by penetrating oil has been improved by using fluorescent oils, and an American method called 'Dy-chek' was referred to. Another method has the advantage of using a water-soluble oil which is easily removed. Electrolytic etching is widely used, said Mr. Harris, as it is a very sensitive method of detecting surface cracks. He discussed the correlation of the results of ultrasonic flaw detection and radiology, and stated that it is difficult to estimate the size of a defect by the ultrasonic method, though he thought that automatic scanning would be an advantage. Speaking of radiology, Mr. Harris said that developments needed are X-ray equipments able to penetrate ten inches of steel, scanning of large specimens by counters, Xero-radiography and the amplification of fluorescent images by image converters. B. N. CLACK

MECHANISM OF PHOTOGRAPHIC SENSITIVITY IN SILVER BROMIDE

IT has been shown recently by Loening[1] that pure silver bromide in the form of an aqueous sol has only a very slight sensitivity to light as judged after development. Sensitization can be achieved by adding silver ions or gelatine or substances such as sodium nitrite to the sol. Ordinary photographic emulsions have already the sensitivity conferred by gelatine, and there are three well-established methods[2] of obtaining further gains of sensitivity, depending on the addition of one of three substances: reducing agents, gold salts and sulphur compounds. These substances probably react with the silver bromide to form minute quantities of silver, gold and silver sulphide respectively at the grain surfaces: at any rate, that is the simplest supposition. All this refers to 'chemical' sensitization, as distinct from extension of spectral sensitivity by dyes.

According to the theory of the photolysis of silver bromide put forward in 1938 by Gurney and Mott[3], the absorption of a light quantum by silver bromide removes an electron from a bromide ion, leaving a 'positive hole'. The electron and the hole should both be highly mobile. If silver particles are present, they become negatively charged by trapping electrons and grow by attracting the mobile interstitial silver ions that are naturally present in the crystal (Frenkel disorder). This theory still holds the field, more recent attempts based on the assumption of Schottky disorder having now been abandoned[4]. As applied to the formation of latent images, however, the theory is incomplete: one has to explain how the positive holes are prevented from recombining with the electrons and how the first electrons are trapped if no silver is initially present. What is lacking is evidently a theory of sensitization, and the question arises: Do the sensitizers mentioned function as electron traps, or positive hole traps, or both?

In a lecture given on November 20 before the Scientific and Technical Group of the Royal Photographic Society, Dr. J. W. Mitchell described a series of elegant experiments on the point carried out by himself and collaborators in the University of Bristol. The complications of photographic emulsion work were avoided by using pure dry monocrystalline plates of silver bromide and applying the sensitizer (silver, gold or a metallic sulphide) directly in a very thin uniform surface-layer by vacuum evaporation. The plates were about 1 cm. square and 0·01 cm. thick, with the crystallographic [100] axis approximately perpendicular to the square face. An ordinary metol-hydroquinone developer was used, with a little gelatine added to prevent excessive fog. Unexposed unsensitized specimens gave only a slight irreducible fog in the form of small oriented silver crystals scattered over the surface, as observed in previous single-crystal work by Dankov[5] and Boissonnas[6]. Exposure to light produced no further developable effect, even when sufficient to produce visible (internal) separation of silver. A developable latent image was produced, however, by exposure under a solution containing a bromine acceptor.

By means of slits and masks, the deposition of sensitizing substances and the exposure to light were restricted to well-defined circular or rectangular areas of the specimen. Areas bearing 10^{15} silver atoms per sq. cm. (about one monolayer) were blackened by development without exposure, the edges appearing well defined. Specimens bearing 10^{14} silver atoms per sq. cm. gave only the normal irreducible fog without exposure, but were blackened in certain areas by development after exposure—that is, they were sensitized but not fogged by the deposited silver. This blackening or latent-image formation was expected to occur only in the areas both silvered and exposed to light, but the result was quite different. The blackening appeared only in the unexposed areas, and spread beyond the silvered areas, the spreading being greater at a greater distance from the exposed area: with sufficient exposure the entire unexposed area became blackened. Essentially the same phenomena were observed with gold and with arsenious, antimony and thallous sulphides (silver sulphide, not being stable enough for evaporation, was not tried).

If the sensitizers in these experiments acted mainly as electron traps, the blackening would presumably have been confined to the sensitized areas. It seems that the phenomena can only be explained by supposing that they act as positive-hole traps, that is, they react with the bromine, which is quite reasonable from a chemical point of view. If some of the bromine is removed in this way, a surplus of electrons remains, and apparently no special electron traps are then needed to ensure the formation of latent-image silver specks, for the latent image appears mainly on the naked silver bromide surface. The mobility of the electron being about twice that of the positive hole explains why the image is produced far from the exposed area, in which a surplus of positive holes will be left. The space charge produced by the electrons travelling faster than the holes would produce a field urging interstitial silver ions into the electron-rich regions. Dr. Mitchell did not, however, attempt to give a complete theory of the phenomena.

It appears then that silver, gold and metallic sulphides all sensitize by the same mechanism, that the function of each is to react with halogen, and that no special electron traps are needed for sensitivity. In the case of silver sensitization, the capture of positive holes by the silver permits the formation of new silver elsewhere by the electrons and interstitial ions, and one might say that in effect the latent image is formed by redistributing the silver initially present. These tentative conclusions, though they may not be directly applicable to the sensitization of ordinary emulsions, are of obvious interest to the photographic chemist and represent a radical revision of earlier thought on the subject.

[1] Loening, E. E., in "Fundamental Mechanisms of Photographic Sensitivity", 149, ed. J. W. Mitchell (London: Butterworths Scientific Publications, 1951); *Phot. J.*, **92**B, 126 (1952).

[2] Lowe, W. G., Jones, J. E., and Roberts, H. E., in "Fundamental Mechanisms", 112.

[3] Gurney, R. W., and Mott, N. F., *Proc. Roy. Soc.*, A, **164**, 151 (1938).

[4] Mitchell, J. W., *Sci. Indust. Phot.*, **19**, 361 (1948); *Phil. Mag.*, **40**, 249, 667 (1949); "Fundamental Mechanisms", 242.

[5] Dankov, P. D., and Kochetkov, A. A., *C.R. Acad. Sci., U.R.S.S.*, **26**, 785 (1946).

[6] Boissonnas, C. G., *Sci. Indust. Phot.*, **20**, 361 (1949); *Experientia*, **5**, 282 (1949); "Fundamental Mechanisms", 36.

THE FORESTRY COMMISSION

REPORT FOR THE YEAR 1950–51

THE thirty-second annual report of the Forestry Commission records the activities of the Commission for the year ending September 30, 1951*. During this time the passing of the Forestry Act 1951 took place, and the year also marked the end of the first post-war quinquennium. The progress of private forestry, and the dedication schemes and the acquisition of land during the year are worthy of notice.

The Forestry Act 1951 was passed during August 1951, and its main provisions, which relate to the maintenance of reserves of growing trees in Great Britain, came into force two months later. Since the beginning of the Second World War, fellings had been controlled by statutory instruments under Defence Regulation 68. This was not intended to be permanent; nevertheless, the timber resources of Great Britain in both conifers and hardwoods were alarmingly small, and unchecked felling could not be countenanced. The Forestry Commission is therefore charged by the Act with "the general duty of promoting the establishment and maintenance in Great Britain of adequate reserves of growing trees". To carry this out the Commission is required to consult with the Home Grown Timber Advisory Committee, consisting among others of those appointed on the advice of woodland owners and the timber trade. The Act also provides for the maintenance in each conservancy of a regional advisory committee, "certain members of which are appointed after consultation with the above organizations and with the forestry societies, for the purpose of advising the Commissioners as to the performance of their functions under the provisions of the Act relating to licensing and compulsory felling". The Act prohibits the felling

* Forestry Commission: Thirty-second Annual Report of the Forestry Commissioners for the Year ending September 30th, 1951. Pp. 82. (London: H.M.S.O., 1952.) 3*s*. net.