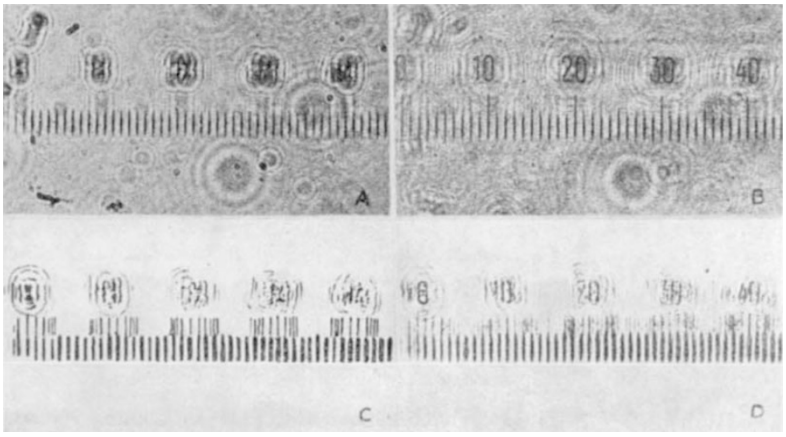
The Black and White Hologram

It has been shown[1] that there exists an analogy between a Gabor diffraction 'hologram' and a zone plate. This idea led immediately to the following experiment, which has been successfully carried out.

A bromide enlargement from a hologram (*A*) (part only is reproduced) was taken and all the important lines (as judged by the operator) were inked in with indian ink using a mapping pen. Attention was confined, so far as possible, to the fringes produced by the object (a micrometer eyepiece scale), those due to extraneous dirt being omitted. The silver image was next removed from the print with a Farmer reducer, leaving a black-and-white representation of the hologram (*C*). A transparency was then made from this for use in the reconstruction apparatus.



(*B*) shows a direct reconstruction from the original hologram (*A*) using the technique previously described without any intervening auxiliary lens. It is, in fact, a particular Fresnel diffraction pattern of *A*. (*D*) is a similar reconstruction from (*C*). It will be seen at once that (*B*) bears a close resemblance to the original microscope scale, as anticipated, and (*D*) bears a more distant but still recognizable relationship.

In comparing (*D*) with (*B*) the following differences between (*A*) and (*C*) should be borne in mind. (1) We have replaced a continuous-tone photographic representation by an abruptly changing black-and-white line drawing. (2) Owing to the difficulty of drawing the outer fringes (which are very fine) the system has in general been terminated at the third or fourth fringe. (3) Small errors in placing the lines on the fringes are, humanly speaking, impossible to avoid, especially where the 'wanted' fringes are partially obscured by 'unwanted' fringes.

In view of the first of these changes, search was made for possible 'high-order' images, as suggested in the previous communication. None was found.

Practical and theoretical work is at present in hand to ascertain whether the possession of a harmonic series of focal lengths is a special property of linear and circular zone plates of definite symmetry, or whether it may be expected in holograms in general.

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[1] Rogers, G. L. [*Nature*, **166**, 237 (1950)].

Internal Pair Creation in Magnesium-24

The theory of quantum electrodynamics predicts the occasional emission of an electron-positron pair from an excited nucleus in place of a hard γ-ray. The probability of this event, or the 'pair conversion coefficient', has been calculated by Rose[1]. It is dependent on the quantum energy and on the multipole character of the nuclear transition.

We have examined the simultaneous emission of three particles (a decay β-ray and an electron-positron pair) from a sodium-24 source and made a measurement of the pair conversion coefficient for the 2·78-MeV. γ-line. Internal pair creation in such a source could be due to either of the two γ-rays of magnesium-24, but the probability for the 1·38-MeV. line would be very small as compared with that for the 2·78-MeV. line.

Three Geiger counters (20th Century Electronic *B*6 type) were arranged symmetrically around a sodium-24 source, and the number of triple coincidences was determined. When corrections for random coincidences were made, the remaining triple counts exceeded those attributable to $\beta_{\gamma\gamma}$-coincidences by a factor of 10. An order of magnitude of 10^{-3} was estimated for the pair conversion coefficient after all corrections were made. It did not seem possible, however, to make a quantitative determination with this method, because the solid angle and efficiency of the counters could not be estimated with sufficient precision, particularly without knowledge of the energy distribution of the pairs. A previous study of this type by Bradt *et al.*[2] using thorium C″ was made difficult by internal electron conversion.

In a second experiment the emission of the positrons of the pairs was observed by detecting annihilation radiations. The positrons were stopped in a plastic material surrounding the source and the annihilation quanta were detected by two photomultiplier tubes (E.M.I. 1-in. aperture type; naphthalene–anthracene crystals). These were placed in coincidence (resolving time $1{\cdot}5 \times 10^{-7}$ sec.) and on opposite sides of the source at 65 cm. distance. With this small solid angle (10^{-4} of 4π), coincidences due to the cascade γ-rays of sodium-24 are fewer than those due to pair conversion positrons. Annihilation coincidences were easily distinguished from all others by displacing the source out of the straight line joining the two detectors. A correction for the pairs created in the plastic material by the 2·78-MeV. γ-ray was made by substituting a thickness of aluminium having the same electron stopping power, and repeating the measurement. From the Z^2 law and the observed increase of positron counts, a probability of 3×10^{-4} was calculated for the creation of pairs in the plastic.

The sodium-24 sources (= 70 C.) were measured after decay on a Geiger counter previously calibrated with another sodium-24 source the strength of which had been determined absolutely by the method of βγ-coincidence. The positron-detecting efficiency of the apparatus was measured with two standards. The first consisted of 900 C. of radiothorium in a small lead cylinder; in this, positrons are both created and annihilated. Its effective positron strength