AD-A161 619 DEVELOPMENT OF SHEAROGRAPHIC IMAGING SYSTEM(U) 1/1
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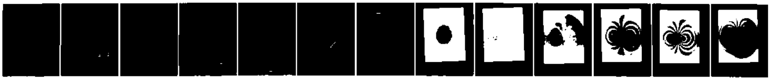

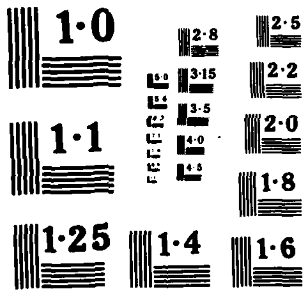
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DEVELOPMENT OF SHEAROGRAPHIC IMAGING SYSTEM

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Second Periodic Report

Principal Investigator: Dr. D. K. Das-Gupta

Associate Investigators: Dr. K. Doughty and Mr. S. M. Farrington

School of Electronic Engineering Science,
University College of North Wales,
Dean Street,
BANGOR, GWynedd LL57 1UT, United Kingdom.



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## 1. INTRODUCTION

Since the submission of the First Periodic Report no significant progress in these laboratories was made until the delivery of a 50 mW. helium-neon laser from Spectra Physics together with a spatial filtering unit. The present report gives details of the adopted experimental arrangements and also includes photographs of the shearographic fringes obtained for a number of displacements of a stainless steel sample.

## 2. EXPERIMENTAL

The basic arrangement for image shearing is shown ~~in Figure 1~~ in schematic form. In our arrangement the 1 degree optical wedge covering half the field was mounted in the filter-holder of a Toyo-View Model 45E Plate camera fitted with a 150 mm. f5.6 compound lens.

The test samples employed in the present work were stainless steel discs of 0.15 mm. thickness and 80 mm. diameter. One surface of the disc was sprayed matt white using a cellulose-based can of automobile 'touch-up' paint in order to increase the reflectivity of the sample surface. Also drawn on this white surface were two fine intersecting lines, one in the horizontal plane and the other in the vertical plane.

The sample was mounted on a block of aluminium which had a central cut-out through which a point force could be applied. In the original arrangement the sample was trapped between the aluminium block and a collar which was bolted to the block around its circumference. This had the effect of securing the sample in place but as it was only clamped at its rim it was free to move throughout most of its area under the influence of an applied force. In the final version the clamping collar was removed and the sample bonded firmly to the aluminium block at all points using cyano-acrylate adhesive which provided excellent adhesion with a glue thickness of about 2 micron.

The optical arrangement for the production of a shearogram is shown in Figure 2. The laser beam was spatially filtered by an X40 objective lens and pinhole (30 $\mu$m) arrangement in order to produce a smooth gaussian intensity profile. This 'clean' beam was then opened out sufficiently to span the width of the sample. In the present arrangement the sample was oriented at 45 degrees to the laser beam although it was found that this angle was in no way critical. The camera was always perpendicular to the sample and in the same plane as the laser beam. Its position was varied in order to produce the largest, most complete image of the laser profile on the viewing sceen and ultimately the photogeraphic plate.

The first exposure of the sample was for zero displacement (and force). The exposure time for this grade of photographic plate (Agfa-Gevaert Holotest 10E75) was 5 seconds when the separation of laser and sample was 0.92 m. A second exposure of 5 seconds was made of the same plate after the centre of the sample had been displaced by a specific distance in the range 2 to 60 micron. The displacement was produced by rotation of a micrometer screw although the actual distance was read directly off a digital gauge in order to avoid the possibility of moving the apparatus inadvertently in attempting to read the micrometer barrel. The plate was then developed using Ilford FQ Universal developer.

Reconstruction of the shearogram was performed using the arrangement drawn schematically in Figure 3. In this case the wedge was removed from the camera lens and replaced with an aperture of 4 mm. diameter displaced from the central maximum by 6 mm. in order to provide nigh pass Fourier filtering. For reconstruction an exposure time of 8 seconds was found suitable in general although longer times were required for original shearograms with greater optical densities.

## 3. RESULTS

The original shearographic plates produced by double exposure contained a fringe pattern consisting of two sets of asymmetric rings resembling a butterfly. However, the pattern was generally difficult to observe due to the strong background blackness of the plate. This problem could be overcome quite easily by using the high pass Fourier filtering reconstruction technique which effectively removes the general laser (low rrequency) profile to reveal well-defined fringes.

When the original edge clamping of the sample was employed the rings were found to be incomplete and passed through the circumference of the sample at right-angles. This was due to the particular boundary conditions imposed by the clamping arrangement and clearly demonstrated that the fringe pattern was sensitive to stress as well as to displacement. A copy of this plate is shown in Figure 4. Figure 5 shows a similar plate obtained when the sample was incompletely bonded to the aluminium block. In this case, the individual fringes are very distorted and an asymmetric stress pattern can easily be assumed.

Figures 6-9 show enlarged fringe patterns obtained after reconstructing for properly bonded samples subjected to central displacements of 6 micron, 12 micron, 16 micron and 22 micron respectively. It may be observed that the number of rringes increases as the displacement increases. Using the present laser system (He-Ne) a maximum of 60 micron displacement can be employed if the fringes are still to be resolved.

Reconstructed fringe patterns have been obtained for a wide range of displacements and when a force transaucer is available an analysis of stress gradients will be possible based on the separation and curvature of the fringe lines.

It is now necessary to replace the optical camera with a TV camera together with the peripheral electronic systems for real-time display of the strain gradients.

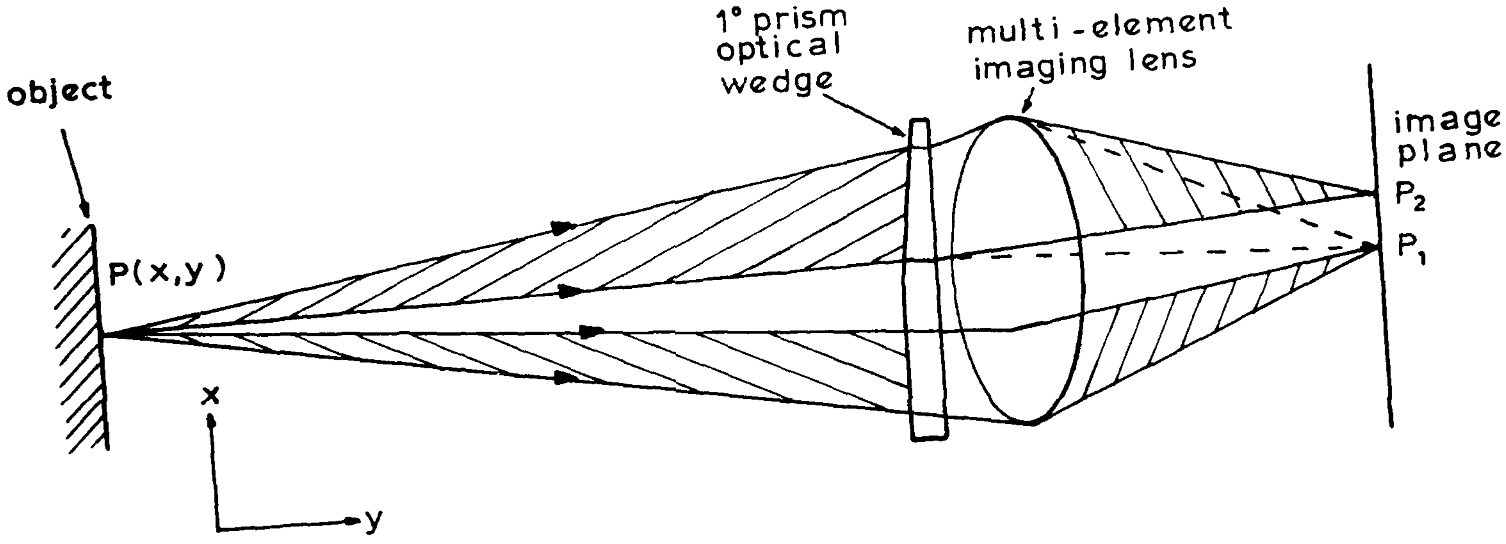



Figure 1. Schematic diagram of shearography.

Figure 2. U.C.N.W. shearographic imaging system.

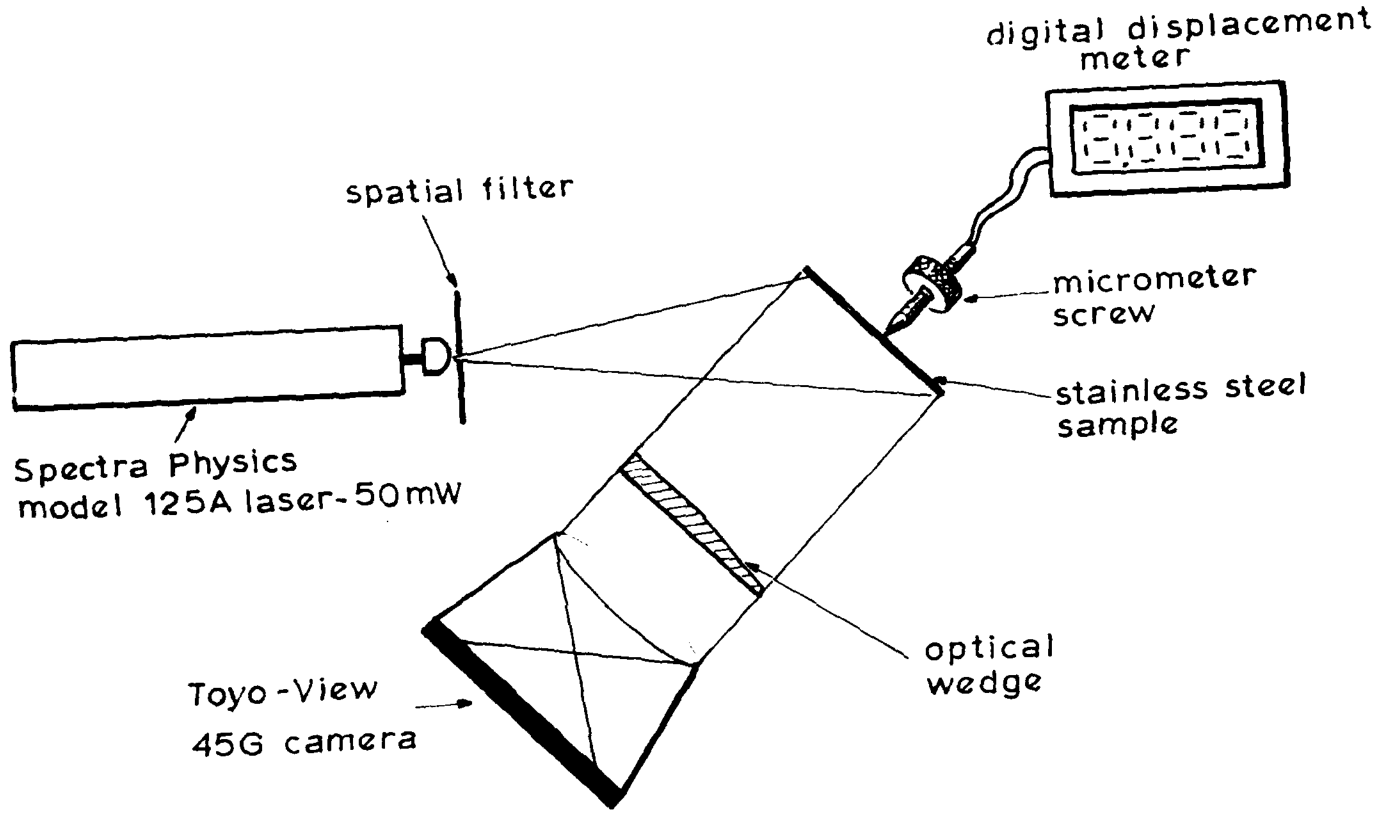
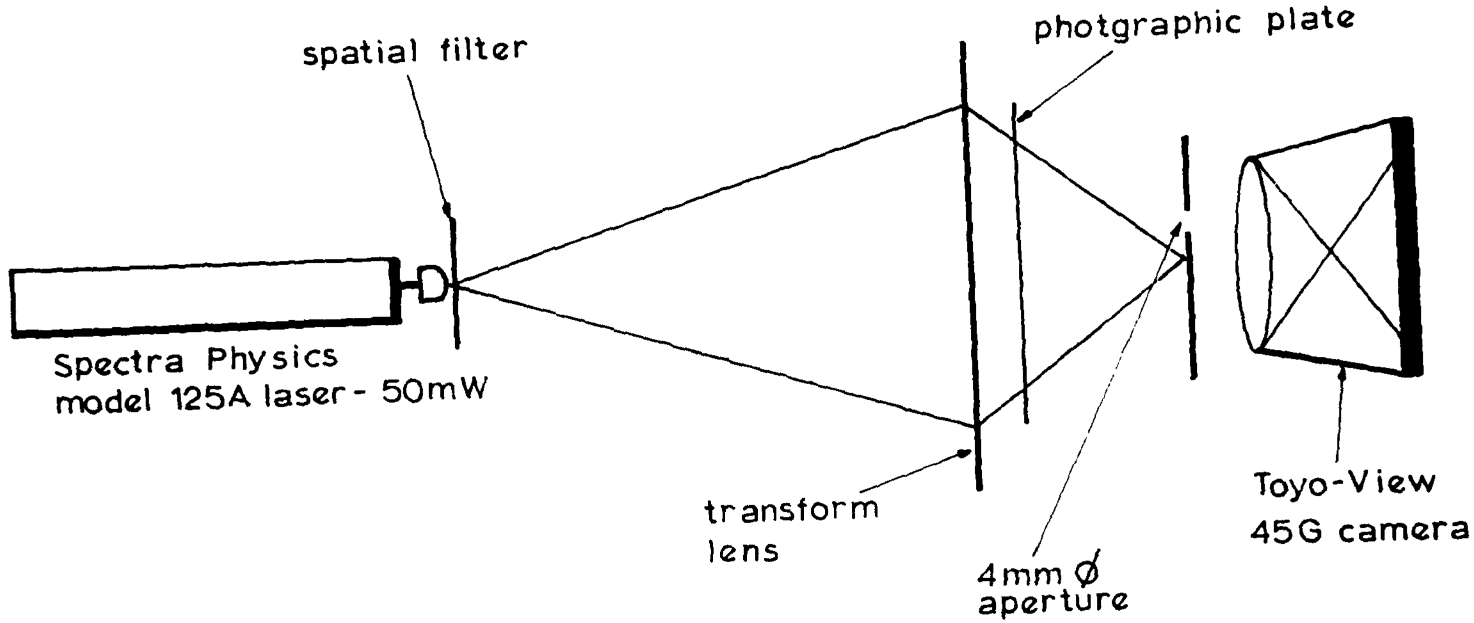


Figure 3. U.C.N.W. shearographic image reconstruction arrangement.



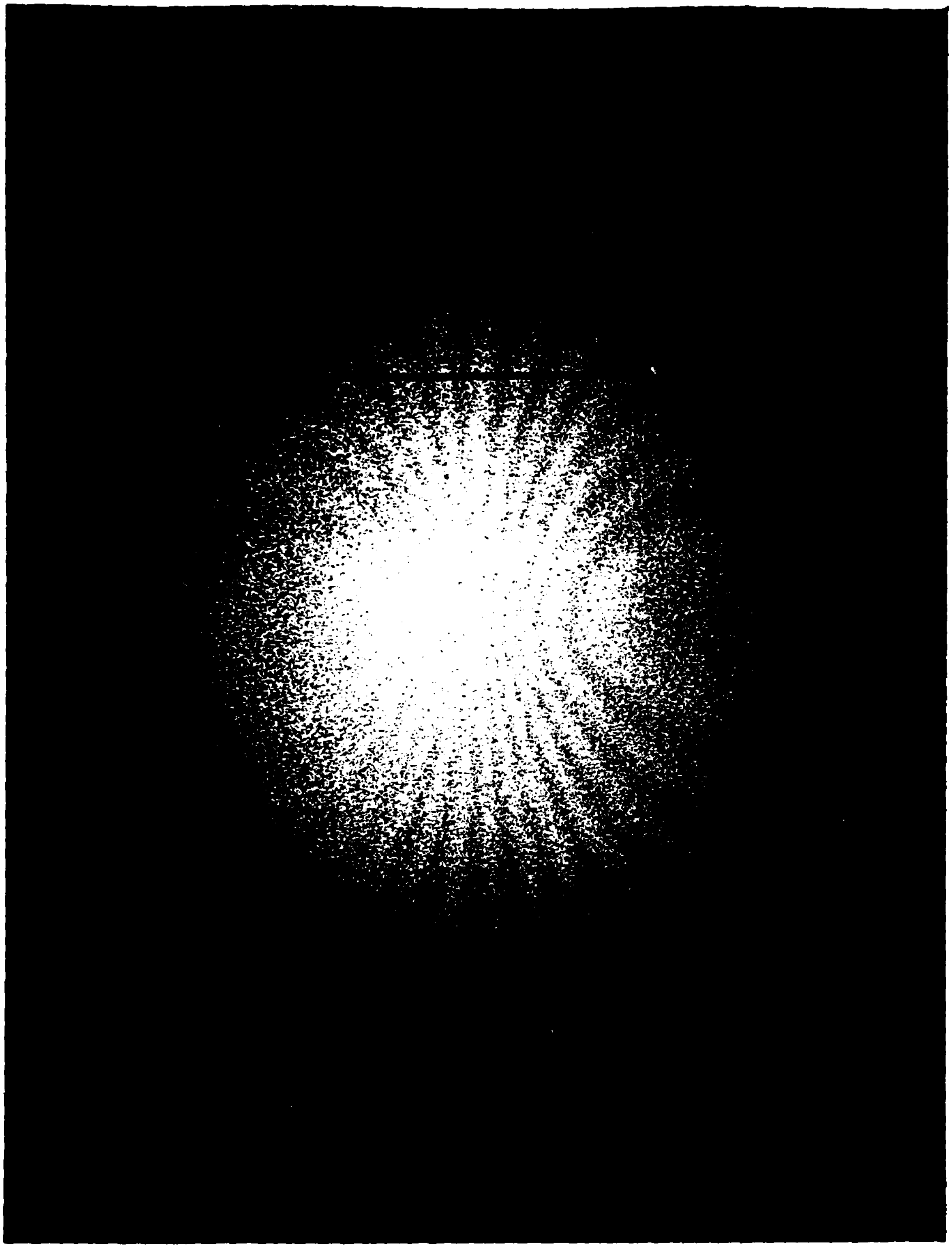


FIGURE 4 :  Original Shearogram of sample clamped at its rim.

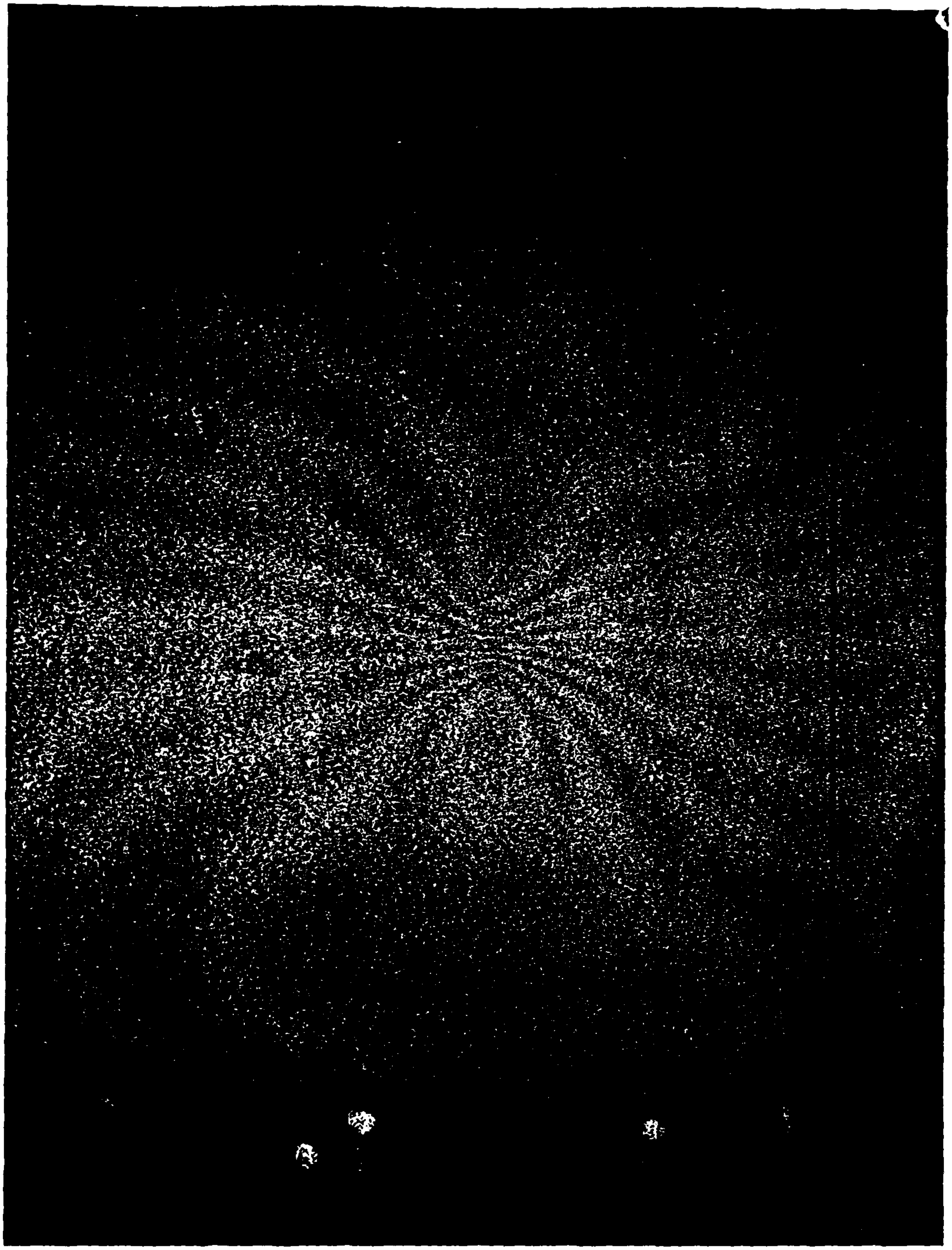


FIGURE 5 : Original Shearogram of sample improperly bonded to backing.

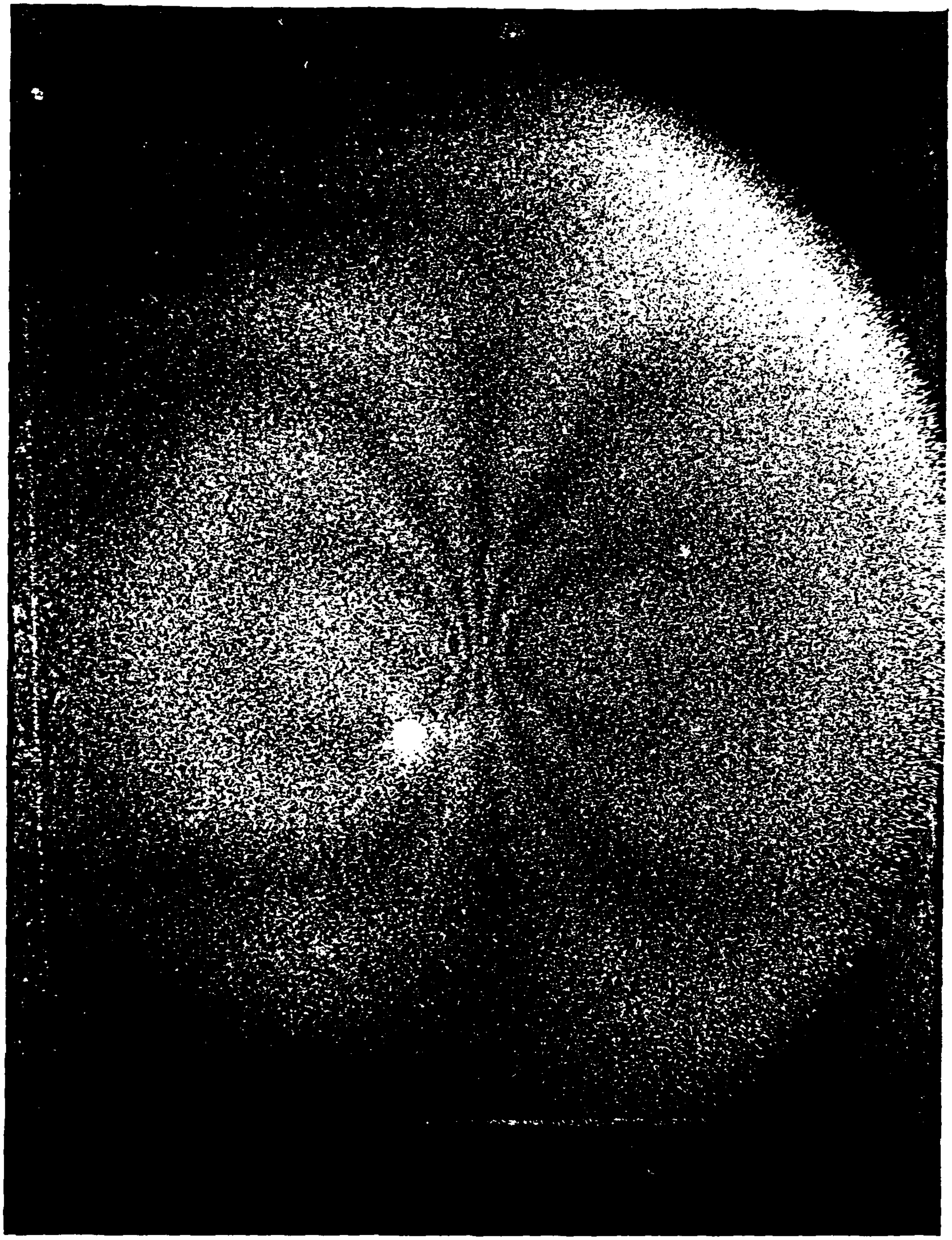


FIGURE 6 : Reconstructed Shearogram of sample displaced by 6 micron.

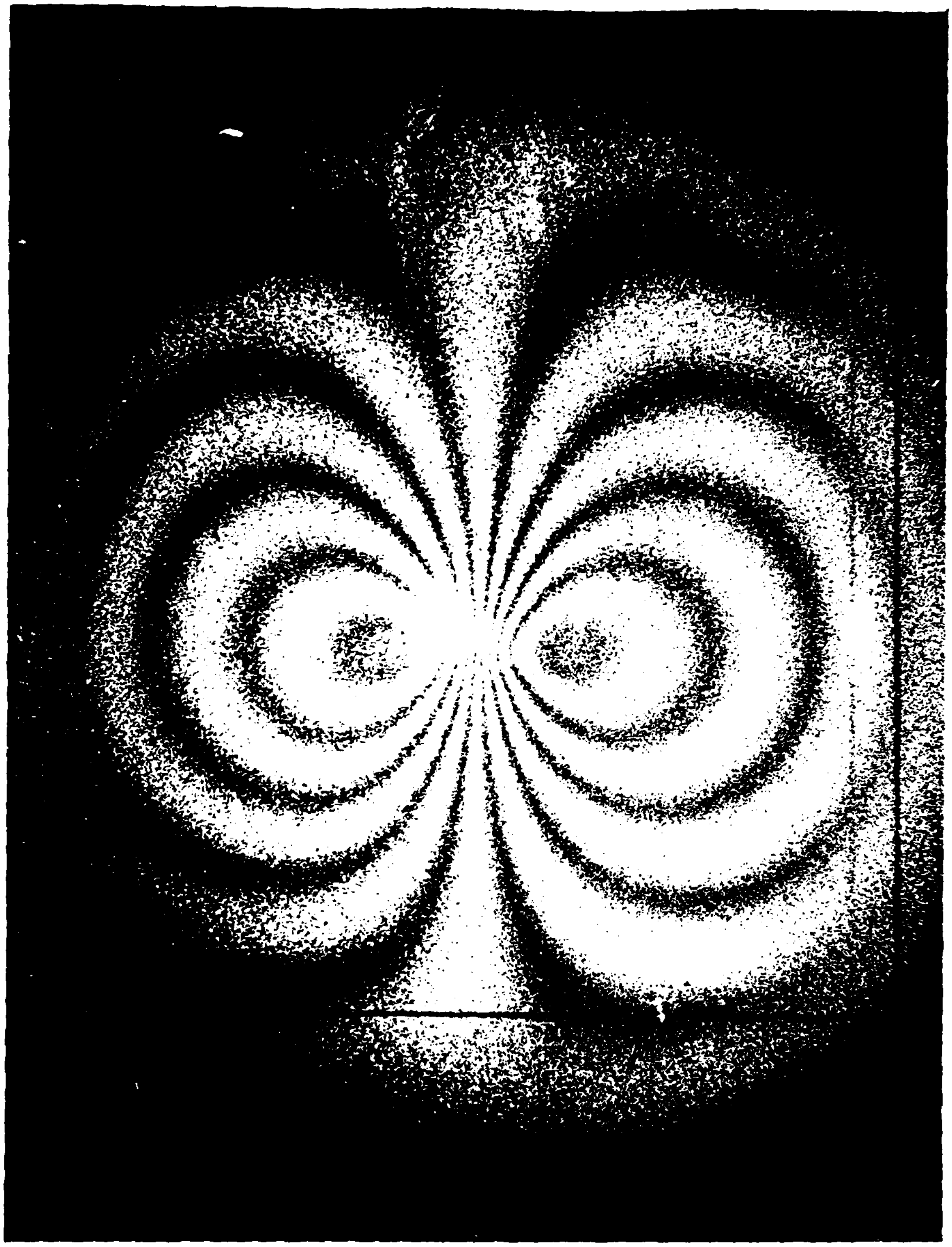


FIGURE 7 : Reconstructed Shearogram of sample displaced by 12 micron.

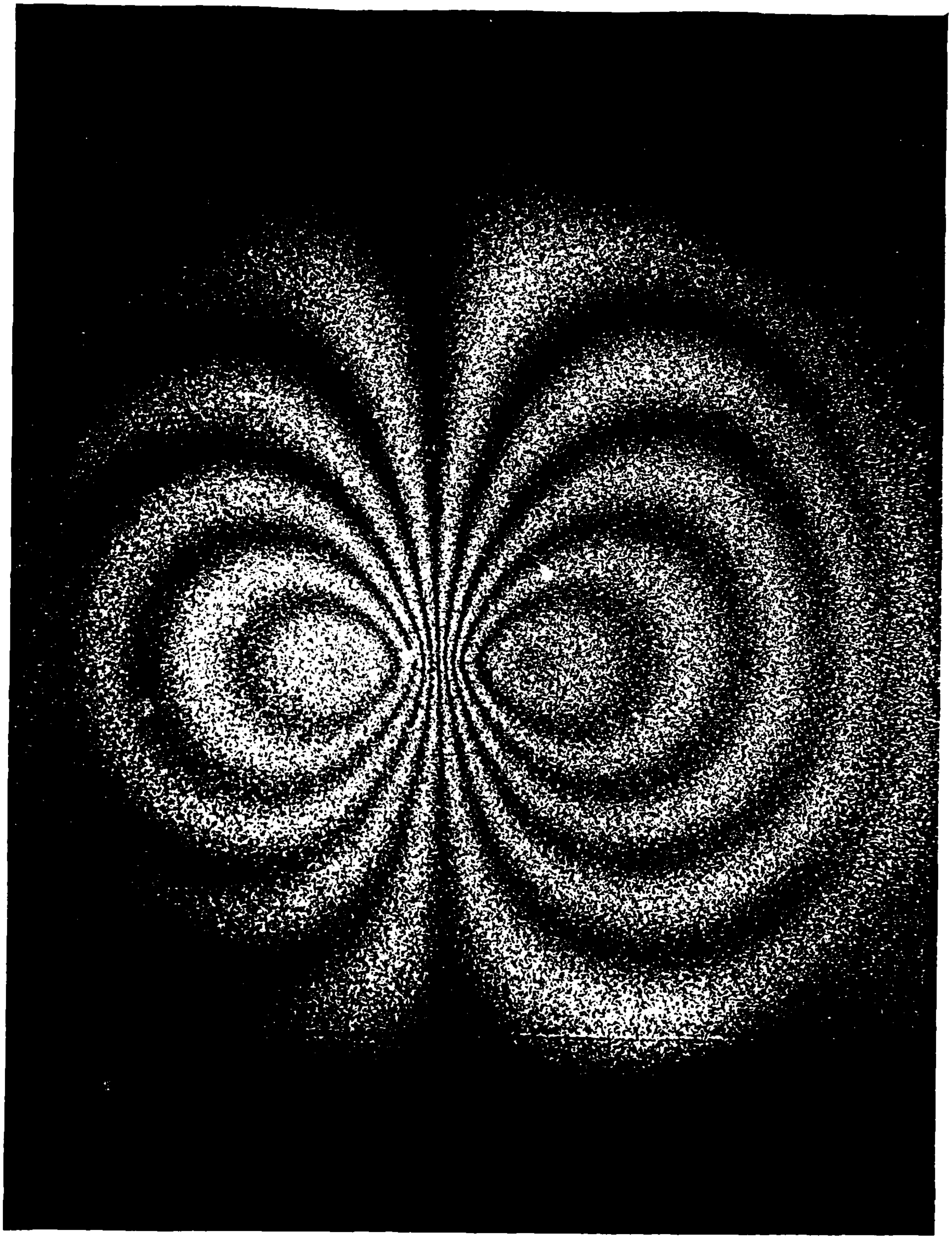


FIGURE 8 :  Reconstructed Shearogram of sample displaced by 16 micron.

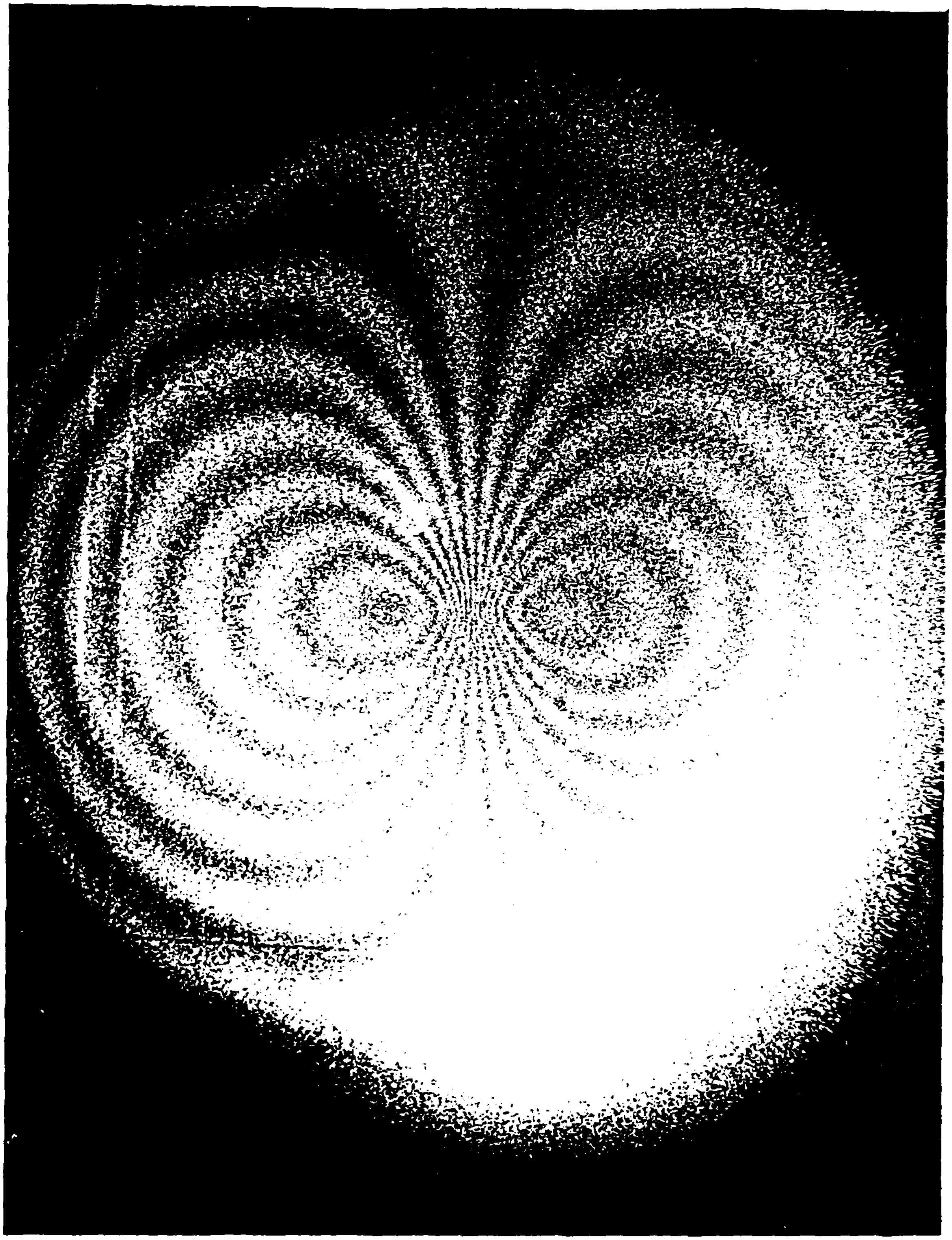


FIGURE 9 : Reconstructed Shearogram of sample displaced by 22 micron.