A NEW COLLIMATOR AND BEAM TRAP FOR
THE PHILIPS 114.83 mm. DIAMETER X-RAY
DIFFRACTION POWDER CAMERA

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[Read 4th November, 1960]

ABSTRACT
A new collimator of 0.3 × 2 mm aperture and a beam trap have been made for the Philips 114.83 mm camera. As a result of this, longer spacings can be recorded (d~35 Å with Co Kα, with scope for further improvement by slimming the beam trap) the resolution of the camera has been improved, the background scatter is considerably reduced, and the exposure time is reduced by about one-third, in comparison with the standard collimator of 1 mm diameter.

INTRODUCTION
A Debye-Scherrer camera capable of recording low-angle reflections is necessary for studies on clay minerals and similar materials. Modifications to the beam trap of the Philips 114.83 mm diameter X-ray diffraction powder camera to enable it to be used for this purpose have been described by Martin Vivaldi, Girela Vilchez and MacEwan (1959), and, quite independently, the same camera has been modified, both as regards the collimator and the beam trap, at the Building Research Station. These modifications, which are described below, not only enable the recording of long spacings (θ=1.5°, or d=35 Å with Co Kα, with scope for further improvement by slimming the beam trap), but also give improved resolution, permit exposure time to be reduced by about one-third (compared with that required using the 1 mm pinhole collimator), and give considerably less background scatter on the film.

COLLIMATOR
It was observed that the part of the X-ray beam that misses the specimen is possibly the largest contributor to background air scatter. The figure in Table 1 show that a 1 mm pinhole collimator, as provided by the makers, utilizes some 19 per cent. and 28 per cent. of the beam only, for specimen diameters of 0.2 mm and 0.3 mm, respectively. For the new collimator, with an aperture of 0.3 × 2 mm, the beam utilization factor is raised to 50-75 per cent.

Test films with the new collimator show that the reduction of background scatter is quite noteworthy. The divergence of the beam is
Table 1—Dimensions of collimator, beam trap and primary beam.*

<table>
<thead>
<tr>
<th></th>
<th>Colimator inner aperture</th>
<th>Beam trap entry aperture</th>
<th>Beam utilization for specimen dia.</th>
<th>Size of primary beam on the film at $\theta=0^\circ$ (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width (mm)</td>
<td>Height (mm)</td>
<td>Width (mm)</td>
<td>Height (mm)</td>
</tr>
<tr>
<td>Standard:</td>
<td>1-0</td>
<td>1-0</td>
<td>2-0</td>
<td>2-0</td>
</tr>
<tr>
<td>X-ray beam:</td>
<td>1-28</td>
<td>1-30</td>
<td>1-46</td>
<td>1-65</td>
</tr>
<tr>
<td>New:</td>
<td>0-30</td>
<td>2-0</td>
<td>0-9</td>
<td>5-0</td>
</tr>
<tr>
<td>X-ray beam:</td>
<td>0-34</td>
<td>2-1</td>
<td>0-45</td>
<td>2-5</td>
</tr>
</tbody>
</table>

*The primary beam was measured by impression left on a film held in an appropriate position.
smaller, which results in better resolution of lines. On a film for a
greywacke taken with the new slit, for instance, a doublet at $\theta = 40.685^\circ$
and $40.755^\circ$ and a triplet at $\theta = 49.145^\circ$, $49.325^\circ$ and $49.470^\circ$, were
readily measured, whereas with a 1-mm pinhole collimator these
lines were not resolved. Also the $\alpha$ doublet of Co K radiation is
clearly resolved at $\theta = 44^\circ$ with a 0.2 mm diameter specimen of Portland
cement clinker. For the same specimen conditions films of com-
parable legibility may be obtained by reducing the exposure time by
about one-third. A greater reduction would be obtained relative to
a 0.5 mm slit collimator, also supplied with the camera. The ex-
posure-time comparison was made with an X-ray tube with large
focal spot; with a smaller focal spot more appropriate to the slit
(say, 0.4 mm wide) a further reduction would be expected.

The increased height of the collimator has one disadvantage,
namely, that the lines broaden away from the equator. However,
the height of 2 mm (B.S.1693:1950 proposes 2.5 mm) seems a reason-
able compromise, because the trumpet-shaped appearance of the
lines does not cause difficulties in measurement even at $d = 22\,\AA$
(Cu K$\alpha$, silver palmitate).

A 0.4 $\times$ 2 mm collimator aperture was also tried, but although the
resultant film was more intense, the resolution and background were
not as good as with a narrower slit, and such a wide slit seems un-
necessary unless much thicker specimens have to be used.

**Beam Trap**

To reduce background due to scattering of X-rays by air, the beam
trap should come as close as possible to the specimen. Subject to
mechanical strength it can be made of fairly thin metal, and its
dimensions need not be much larger than the primary beam it is to
contain. A new beam trap was made of thin brass bent into a wedge-
shaped channel of 0.9 $\times$ 4 mm aperture 15 mm from the specimen,
and broadening to some 3 mm externally at the base. A shorter
beam trap, as suggested by Martin Vivaldi, Girela Vilchez and Mac-
Ewan (1959) for recording longer spacings, produces much stronger
background. This was shown by comparing a photograph taken
using, not a spacer piece as suggested, but the beam trap supplied
with the Philips small 57.54 mm diameter camera.

From the actual cross-section of the primary beam, and the
mechanical quality of means of location of the collimator and beam
trap, it seems that too generous a clearance was allowed, and a nar-
rower beam trap and a smaller rectangular film punch could be made. This should enable lines at, say, \(\theta = 1^\circ\) to be recorded without shortening the beam trap.

**Fabrication**

There are several ways of making a collimator and a beam trap. The simple method adopted was as follows.

A collimator body was turned on a lathe to fit the port-hole of the camera and the collimator locking nut. A slot 1.5 mm wide was cut 8 mm deep; this was followed by another cutter 1.0 mm thick (Fig. 1). A step of 0.2 mm on each side was thus formed to make a scatter guard. Then the outside of the collimator was tapered on two sides as shown. The collimator was placed in a V-block and viewed end-on by a low-power microscope, such as is used for centring single crystals. Any asymmetry was corrected by bending. After centralization the collimator slot was clamped down on two spacer strips 0.3 mm thick, separated by a central gap 2 mm wide at the beam exit end. The spacer strips had been previously tinned, and now the assembly was soft-soldered by careful heating. The remaining gap was externally sealed by a soldering iron. Also under the microscope the thin edges of the collimator were bent to form the step required for an efficient beam guard. The limiting aperture at the front of the collimator was made of a 0.3 mm wide slot cut in a lead disc and fixed in place by adhesive. Centring and lining up parallel to the other aperture were performed under the microscope.
A location pin was also provided, similar to that on the slit collimator supplied with the camera.

The beam trap was made by soldering the wedge-shaped channel of thin brass described above to a plug which fitted into the exit port-hole in place of the usual beam trap (Fig. 2). Centring was carried out under the microscope and a simple jig held it in place during soldering. A location pin was also provided.

Acknowledgements—The author would like to acknowledge much help received from colleagues in the laboratory and workshop. The work described is part of the research programme of the Building Research Board of the Department of Scientific and Industrial Research, and is published by permission of the Director of Building Research.

REFERENCES
