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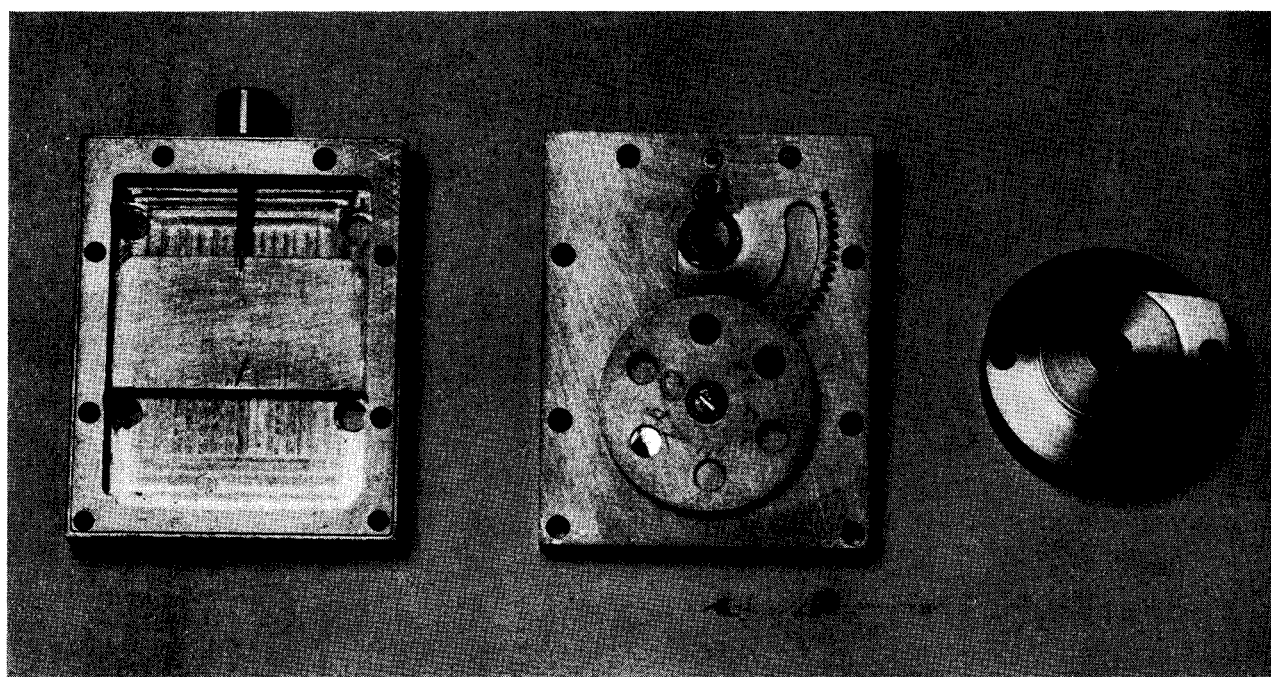
Safe X-Ray Shutter and Filter System

The shutter and beam filter systems on commercial x-ray diffraction equipment are relatively unsafe and inconvenient, especially where several pieces of equipment may be shared by several workers. When the shutter is closed the x-ray beam is not completely shielded and, as is well known, when certain cameras are used, stray radiation leaks from the forward end of the collimator. These leaks, besides being detrimental to other experiments, sometimes greatly exceed the maximum permissible level as set forth by the AEC and, for example, the New York State Department of Labor. The leaks are inconvenient because it is necessary to shut off the x-ray machine before inserting cameras, or specimens in cameras which do not have shutters at all, and often even when removing a camera. In addition, the inserting or

changing of a filter in the beam is often subject to the same inconvenience and hazard mentioned above. The shutters reported on here have been in use on our machines for some months, and although straightforward in design, they have proved safe and convenient, and easy to make in a shop. They also can be easily automated for time or push-button control.

The shutter assembly is essentially a brass box containing the shutter and filter wheel. A G.E. or Machlett x-ray tube is so designed that the shutter assembly may be fastened directly onto the tube. For Philips equipment, the assembly is fastened to the lighthouse. Since the assembly is not a part of the tube for Philips tubes, the filter wheel must generally contain the usual six filters. For G.E. or Machlett only an "open" and one

Figure 1 Opened assembly showing shutter, filter wheel, and gear on underside of face plate.



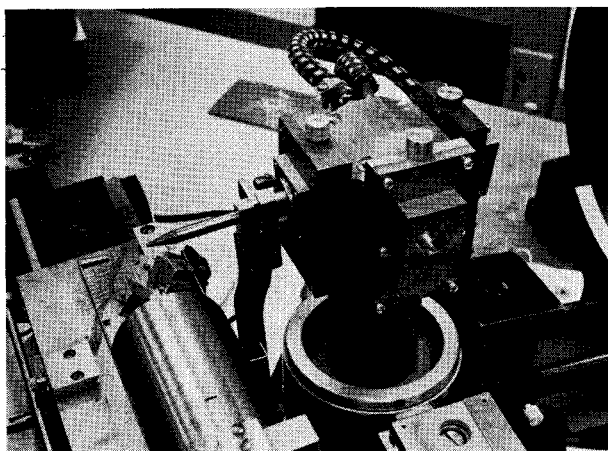


Figure 2 Front view of assembly in place on G.E. tube, showing filter knob and back reflection camera nose-cone piece; this piece is part of the camera rather than the shutter assembly.

filter position is required; however, we usually use a three- or four-position wheel and include a balanced filter pair.

The assembly is designed to accept a standard-base front piece "nose-cone" which serves to adapt a camera collimator or Sollar slits to the assembly. This nose-cone then essentially becomes a part of the camera and is removed from the shutter assembly when a different type camera or collimator is to be used. The system is so designed that the front end of the collimator is not essentially farther from the x-ray target than in present arrangements. In addition, the moving parts of the assembly are contained or located so that they do not restrict the positioning of cameras around the tube.

Figure 1 is an "opened" view of the assembly for an x-ray tube, showing the shutter, filter wheel, and matching gear on the underside of the face plate. Figure 2 shows the assembly in place on a tube. The nose-cone designed individually for a given camera type fits into a slightly larger recessed area in the face plate. This permits some degree of lateral adjustment to accommodate the camera while maintaining a reentrant geometry. The axis of the hole in the nose-cone is perpendicular to the front surface, which is cut so as to produce a six-degree take-off angle. Filters are changed simply by rotating the wheel below the nose-cone. This particular wheel has four detent positions in approximately one quarter of a turn. The gear ratios are such that an approximate

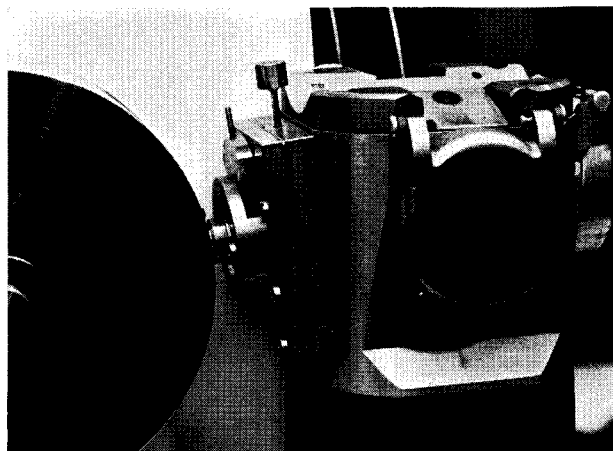


Figure 3 Side view of assembly in use on Philips equipment.

one-quarter turn of the outside knob gives 270° rotation of the filter wheel. The shutter itself is held in the open position by a detent, and as long as the assembly is vertical is "fail safe" in the sense that, except for a positive opening action, gravity will keep it closed. A spring may be used if a more definite closing action is desired. It is obvious that the shutter knob may be removed and solenoid control installed, or other modifications made. We have found it necessary to use a gasket of lead foil between the shutter assembly and x-ray tube head because of the lack of flatness of the tube faces. Such lead foils may be used between any of the flat pieces of the assembly if the machining is not fine enough to give a radiation-proof fit.

A shutter for the Philips x-ray lighthouse is shown in use in Fig. 3. The basic construction is the same as for the G.E., except that the filter control knob is on top and has six detent positions. The gear ratios are such that approximately a 90° rotation of the control knob gives a 300° rotation of the filter wheel. The properties of the shutter and nose-cones are identical to those already described.

The authors will be glad to supply detailed drawings to anyone interested in any of these assemblies.

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