

The Use of High Speed Motion Pictures in Ordnance Research

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There have been many applications of high speed photography to research in the physical sciences. It is the intention here to discuss the application of the Western Electric 8 mm. Fastax Camera to ordnance research in small arms at Purdue University. For a detailed description of the camera, reference is made to Bulletin No. 1079, Western Electric Company, New York, New York.

Because of its unique construction, pictures can be made with this camera at speeds up to 8000 frames per second. Eastman 16mm. cine kodak high speed super XX panchromatic safety film has been used for all the pictures in these experiments. Pictures are taken on each half of the film and after development the film is split to give two 8 mm. films for projection.

The camera at Purdue University has been used only in connection with mechanism studies related to machine guns. Pictures were usually taken inside the firing ranges and artificial lighting has been necessary. Usually the elements of the guns selected for study were small and consequently the area to be covered in any picture was not great. Lighting for the pictures has been possible with 150 watt projector spot lights operated at 175-200 volts. A small step-up transformer was used to operate the lights from the 110 volt service line at the ranges. One of the lights operated at 175 volts will illuminate an area of about 4 inches diameter with sufficient intensity for pictures at 3000 frames per second if the camera is less than 6 feet from the object. Obviously, for greater distances or higher speeds the lighting must be increased. Projector flood lights and photo flood lamps have been used to supplement the spot lights, especially for background lighting.

The 150 watt PAR/SP 38 projector spot used for the experiments are rated at 120 volts. When operated at 175-200 volts the energy radiated from the spot light is increased considerably, but the efficiency of the light decreases sharply with time, and it has been found advisable to discard them after they have been in use about 15 minutes. No auxiliary reflectors are needed since the lights have a self-contained reflector. These lamps were chosen for the experiments because they were readily available, were relatively inexpensive, and required a minimum of auxiliary equipment to adapt them for the work.

The dark oxide-coated finish on all guns and gun parts adds greatly to the difficulties of photographing them when they are in motion. Painting or silver-plating the parts reduces light absorption and increases contrast and detail in the pictures.

The speed of the camera was controlled by means of a 115 volt variabel transformer (Powerstat type 1126, Superior Electric Company, Bristol, Conn.). The most useful speeds for the work have been 2000-3000

frames per second. Since the camera starts from rest, about 30-40 feet of film must run through the camera before full speed is attained. Figure 1¹ shows the relation between applied voltage and the number of pictures

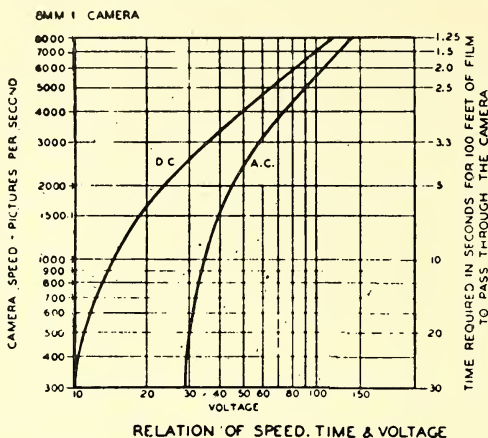


Fig. 1. Relation between applied voltage and the number of pictures per second.

per second. Another method for determining the speed is possible with a special timing unit which marks the film at regular intervals. This unit consists of a small argon glow lamp mounted inside the camera as shown in Figure 2¹. Light from this lamp passes through a minimum for each cycle of alternating voltage. The timing marks appear, therefore,

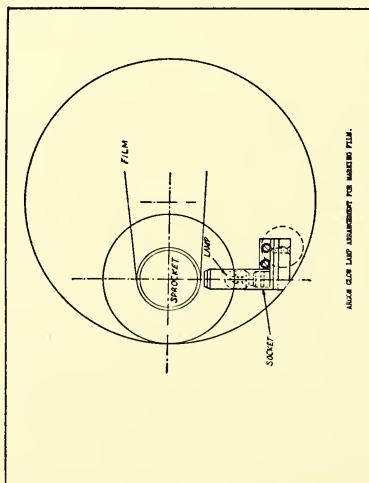


Fig. 2. Arrangement for mounting the Argon glow lamp in the camera.

¹ Courtesy of Western Electric Company.

as alternate bright and dark streaks about 1 mm. wide along the edge of the film and are situated so that they do not interfere with the picture. When the lamp is excited from the 110 volt, 60 cycle, lighting circuit the alternate marks are $1/120$ second apart.

Figure 3 shows an arrangement for taking high speed motion pictures of the gun barrel vibrations. In this picture the camera is about 5 feet from the gun. A scale (not visible in the photograph) is mounted on the board to measure the barrel displacement. One of the spot lights illuminates the barrel and the other lights were arranged to illuminate the scale and reduce the shadow.

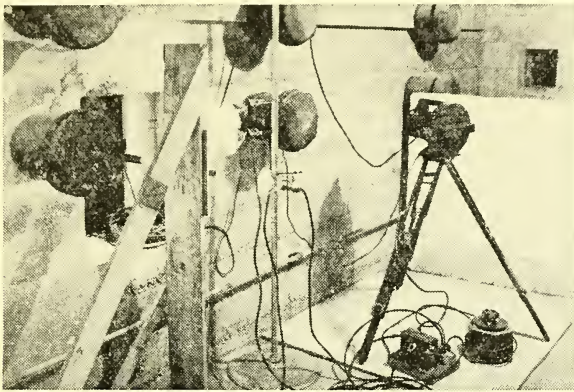


Fig. 3. Arrangement for taking high speed motion pictures of gun barrel vibrations.

A complete list of the studies made with the camera would be too tedious for this paper. A partial list would include the action of such parts as firing pins, cocking levers, ejector units, recoil springs, and the motion of belted cartridges into the feedway of the guns. Pictures of mechanisms taken at very high speeds and then projected at relatively very low speeds is one of the best methods known for studying the characteristic motions of the parts.