Comments and Communications

Development of the ER-55 Projector[1]

MR. BEAN has described the ER-55 Projector so well, that there is practically nothing to be added. Still, I can say something that he did not because of the modesty of an inventor. This is an extraordinary development. I would say even revolutionary, if this term has not been abused by commercial advertising.

What is so extraordinary about this? Is it not just another scaled-up model of the Multiplex projector? Yes, it is! But, it has its own foundation and special features which required an insight, imagination and organizational daring.

All these qualities were needed to make the engineering and managerial decision that it would be a good gamble, to design a Multiplex-type projector which would stand somewhere between the original Multiplex and its extremely ingenious modification designed by Kelsh.

There were two relatively easy ways to the solution of the design problem. If something in between seemed promising, the swinging light source, as used by Kelsh, could be adapted without major difficulties. The other approach could be to use a scaled-up Multiplex condenser. Mr. Bean rejected both available solutions because of good engineering reasons. He chose a third one, an entirely unexplored and unusual approach.

Some people may say that there is nothing unusual in utilizing an elliptical reflector as a condensing element. Correct! Elliptical reflectors have been used for a very long time, and one may add that off-axis aspherical reflectors, such as paraboloids, also have been used. But at least I do not know of any previous application of an off-axis ellipsoid as a condenser in a precision wide-angle system. Its incorporation in the illuminating system was a daring decision by the research and development section of the U. S. Geological Survey. This decision was made, so far as I know, despite some warnings by qualified optical men that the system may not produce satisfactory results. Even I, despite my curiosity for exploring the unknown, and my usual optimism, could not go in my discussions with Mr. Bean, any further than to say that, of course, the reflector will throw a large quantity of light on the diapositive, but this light would probably be distributed in zones which may not be tolerable. As we can detect now, there are some illumination zones in the projection plane. However, they are hardly perceptible in the image of the terrain. To me, a curious optical man, the most unfortunate fact is that these zones apparently originate from the optical imperfections of the glass of the bulb. I would like to break that bulb, just to see what the reflector does by itself.

With the excellent general background of this development, two minor critical remarks should not sound too discordant.

Mr. Bean said that it was obviously necessary to increase the size of the diapositive in order to obtain better resolution, and he referred to some computations substantiating this statement. I have not seen them, but I know that computations of this nature cannot be entirely reliable. The final proof should be in actual measurements. Quantitative data were not given in Mr. Bean's paper. This is a fault. However, I make this remark purely for its rhetorical value. Even without such data, we may expect that, provided a good optical system is used, the image produced by the ER-55 Projector should be better than we observe under the Multiplex. The major factor is the larger ultimate image scale of the former. Many recent investigations, particularly those conducted at the Boston University Optical Research Laboratory under the direction of Dr. Duncan E. Macdonald, indicate that many factors besides resolution of minute detail, are of importance for satisfactory recognition of images; among these factors, magnification occupies a place of prominence. It should not be forgotten that in using a photogrammetric system we are primarily concerned with the ability of the operator to detect and recognize significant detail rather than about some abstract evaluations of optical resolution.

My second criticism is directed toward the implication by Mr. Bean that an elliptical reflector has an inherent advantage over a refractive condensing system because the latter is afflicted with aberrations. Please be assured that the original Multiplex condenser is a system with an excellent correction of monochromatic aberrations, and that its chromatic aberrations have been reduced to an acceptable minimum. An elliptical reflector is inherently achromatic, but its monochromatic aberrations are not negligible when a source of substantial size is used.

Then why do we have more light with the ER-55 Projector? The answer is not simple. Forgetting some usual fallacies about condensing systems, the basic factors which determine the usable light in a projection system are: the magnification, the f-number, the transmittance losses, and the brightness of the source. The same source is used in both the standard Multiplex projector and in the ER-55. The product of the magnification and the f-number is the same for both. (The magnification of the U.S.G.S. Multiplex projector is 12, and its f-number is about 12; the magnification of the ER-55 is about 9, and its f-number is 16; the product is 144 for both.) The only factor that apparently can account for the difference in illumination is the different transmittance losses of the two systems. Another hidden factor may be in the possibility that the ER-55 utilizes a more favorable aspect of the source filament, with the resultant increase of the actual collected light. It would be an interesting project to investigate the theoretical and

[1] Based on a comment made at the 19th Annual Meeting, American Society of Photogrammetry, following an address by Russell K. Bean (see pp. 484–86 of this issue).

empirical causes of the increased amount of the projected light by the ER-55 Projector. And, of course, it would be highly desirable to have quantitative data.

Mr. Bean properly gave the credit to all those who participated in the development of this new unusual device. For historical interest, I may add that several years ago the possibility of utilizing an elliptical reflector was discussed with me by the members of the Engineer Research and Development Laboratories at Fort Belvoir, and that I was rather pessimistic about this idea. However, the Fort Belvoir project did not envision an off-axis ellipsoidal reflector such as Mr. Bean had in progress. As I understand, the project was never given sufficiently high priority and eventually was abandoned.

I may emphasize also the very excellent work done by the Corning Glass Company in overcoming the difficulties involved in producing a very satisfactory glass blank; by the Fecker Company in finishing the blank to an accuracy usually unobtainable for such products in ordinary manufacturing practice; and by the Silver Shop in producing replicas of excellent optical quality.

Summarizing, I may say that this is a new development which may become another milestone in the history of optics and of photogrammetric instruments.

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A Scintillation Counter for the Measurement of Weak β Rays

Recent publications (*1–4*) have emphasized the value of the liquid scintillator technique for the measurement of β rays in general, but more especially of those emitted by C^{14} and H^3 whose detection and counting was, up to now, a painstaking job. A description of the counter that we have been using for several months may be of interest to those attempting to systematize the method.

Our assembly (Fig. 1) consists essentially of a movable brass chassis in a light-tight brass box. The chassis is provided with a plywood receptacle into which a small cylindrical brass container with Pyrex or quartz faces can be fitted. In the off position one can either put the container into or remove it from the receptacle, while no light falls on the photomultiplier tubes. In the on position one finds the container between the sensitive areas of the tubes and, with proper electronic circuitry, gets only coincidence pulses from the system. The box is built in such a way as to permit adjustment of the space between the tubes.

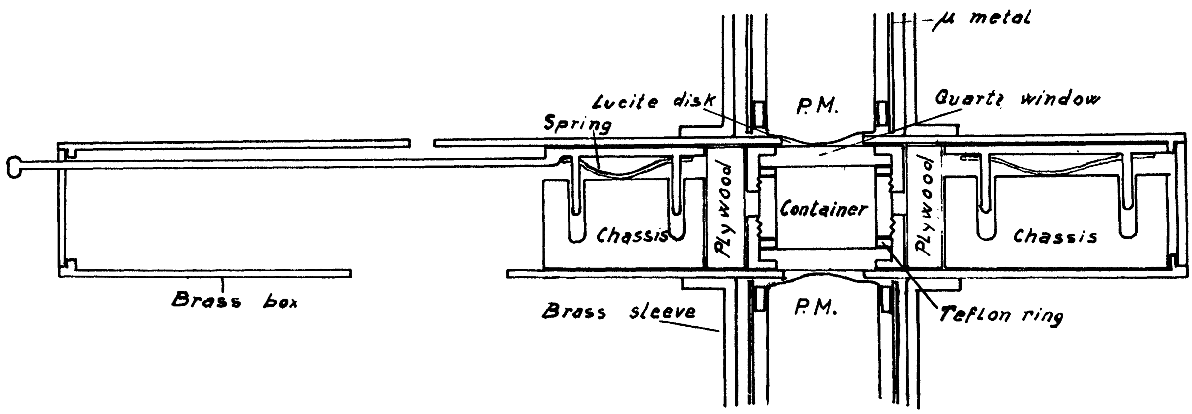

Fig. 1.

We had to face three main problems: (*a*) Making a liquid-tight container, with due regard to the fact that it would hold powerful organic solvents; this difficulty was overcome with Teflon flat rings. (*b*) Getting good optical transmission from the container to the photocathodes; this was partly achieved by means of a lucite disk carved on one face to fit the tube head of the photomultiplier and stuck to it with Canada balsam. (*c*) Getting the proper chemicals which, to our knowledge, are produced neither in France nor in Germany; thus far we have used the rather inefficient α-naphthylamine dioxane mixture for the measurement of HTO samples with, however, encouraging results.

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