effect of the rounded corners of the cone of light coming into the camera, but the effects of the index of refraction in the window. When glasses are an inch thick, the deflection of a ray, due to refraction, gets to be quite large. He also has to consider the actual pitch, roll and azimuth of the airplane and in some cases must even assume that the airplane may roll a little more than the limit in the design of the window; this brings up the case of vignetting. To the best of my knowledge a lot of cameras will stand a little vignetting from the window, but the designer has no way of finding this out. I should point out here for camera manufacturers that it would be very helpful to the airframe designer if he knew how much of the cone can be vignetted before trouble arises. The designer next has to attempt getting the CG of the camera as close to the window as is possible, to cut down the radius arc and to keep the window small. If he has a CG type stabilized mount and a camera which has a poor CG location, that is very high above the trunnions, he then must move his mount up and cause a longer radius of arc for the camera, which again boosts up the size of that window. Essentially the CG location for cameras should be on the same plane as the mounting provisions.

The other item which really causes great difficulty to the designers is the distance between the end of the cone and the lens element. Some cameras have anywhere from two to three inches between the end of the camera and the end of the lens. This will range upwards to possibly about eight inches. That moves the lens that distance from the window and makes a bigger window. I don't believe that these light shades are essential; you have a built-in structural light shade in most cases. If we get the lens closer we can make that window smaller.

Out of this the designer has to get the window design with the minimum weight that is possible. On most military airplanes for a set requirement of range and so forth, one pound of weight is worth anywhere from ten to fifteen pounds in the airplane. In other words, it takes that much to carry it. If you add too much weight, the performance of that airplane must be cut down; every pound cut out makes possible increasing the performance.

New Photo Installation Especially on New High Performance Aircraft

MR. HARRY ALTER,
Convair, San Diego, California

I REQUESTED an opinion on the implications of President Eisenhower's suggestion of exchanging military blueprints with Soviet Russia and its effect on aerial reconnaissance photography.

If such exchange of information were to take place, the analysis of reconnaissance photography would place great responsibility on the photo interpreter and would require accurate photographic copy. Excellent camera definition and stabilization would be needed to enable the interpreter to define exactly what the ground installations and objects in the photos represented. The airplane designer would have to achieve far greater accuracy and reliability in his camera installations than heretofore, especially because a mistake in interpretation, caused by poor photography, could cause a disastrous war.

The problems of high speed and high altitude make necessary the airplane configuration being kept as small as possible, with resulting crowding of various installations. Cameras, stabilizing mounts, and related equipment must be kept small, thus introducing problems in accuracy. At altitudes of sixty to eighty thousand feet, camera vibration can cause a blurred image which would be difficult to interpret; therefore, a high accuracy stabilized mount is desirable.

Some thought has been given to reconnaissance missiles and the problems that occur. Accurate guidance and stabilization present problems as well as changes of missile attitude, from vertical to horizontal flight. Change in gravitational forces during missile acceleration and when the missile enters outer spaces are also problematical. Some method of stabilization must be maintained through the missile flight and attitude changes to obtain satisfactory photographs.

Camera installations in vertical take-off (VTOL) airplanes present similar problems in that the airplane starts and hovers in a vertical position, and during flight assumes a level position. This requires a stabilized camera installation capable of taking accurate pictures while in horizontal flight, or while the airplane is hovering in vertical flight.

High-speed flight introduces additional problems brought about by aerodynamic heating. This causes deterioration of materials, as well as distortion and deflection of camera windows and mounts, due to expansion and contraction. The final accuracy of the photographs is reduced. The effects of heating are somewhat alleviated by air conditioning the camera compartment, a single-place fighter-reconnaissance airplane requiring refrigeration equal to that for a modern railroad refrigerator car.

Another problem presented by high speed airplanes is the result of high speed maneuvering. This, of course, increases the "*g*" load on the camera and mount, and to some extent curtails the camera field of view and again the accuracy. The need for high maneuverability is realized when it is considered that reconnaissance airplanes will be subjected to more intensive attack in the future than in the past. Heretofore, a single airplane was considered to be a reconnaissance airplane, and was only subjected to local interceptor action. Since Hiroshima, it has been recognized that any airplane could be carrying a nuclear weapon and, therefore, it will receive as much interception as an entire squadron.

To complete a mission the reconnaissance airplane must get to the target and return to base. After a bomber has dropped its bomb on the target and the interceptor has downed its target, their missions have been accomplished. In neither case does the fact that they are shot down afterward abort their missions. On the other hand, the reconnaissance airplane, to complete its mission, must return to its base, or pass the information it has collected on to the intelligence centers.

To avoid enemy action, the high speed reconnaissance airplane will be subjected to maneuvers putting exceedingly high "*g*" loads upon the airplane and camera installations. Camera mounts that can maintain stability in all attitudes are needed to permit accurate stabilized photography while the airplane is subjected to evasive action maneuvers.

Hypersonic speeds impose even greater problems in camera installations due to speed and altitudes. Present day cameras carry image motion compensation. However, present days speeds are far less than the ultimate speeds which are predicted for five or six years from now; the problems of accelerating the film and camera mechanisms to take care of ground speeds will then be more difficult. Aerodynamic heating of camera windows as well as adjacent structure may require new materials and processes.

Ex-Temporaneous Statement by Mr. Eldon Sewell

Engineer Research and Development Laboratories

MR. PALLME has asked how much value in photogrammetric work is improvement in the resolution. Everyone wants high resolution. We all have the problem of seeing what is on the ground. Mapping requirements for resolution differ very little, if any, from those of the photo interpreter. The photogrammetric mapper really is a photo interpreter. His method of presenting the interpreted data may be different and he may be interested in different kinds of data, but he fulfills all the requirements for a photo interpreter.

I will say a few words about vertical stabilization, to distinguish it from steadying. Even though the original purpose for gyro controlled mounts was vertical stability, it seems quite probable that their greatest use will be for improving resolution through steadying the camera. How-