with the integration between our camera and mount and the other systems of the aircraft. In general there are two ways of supplying the vertical reference for a stabilized mount. One is to put it right on the mount itself. The second is to make use of a vertical reference which exists in the aircraft for some other purpose, and let it perform double duty. The second method is very attractive in attempting to achieve maximum performance in high density aircraft. It, however brings in other problems. There are losses in accuracy due to deformation of the structure of the aircraft between the location of the vertical reference and the location of the camera mount. This must be accurately calculated and kept below tolerable limits. Then, if the camera mount is supported on vibration isolators, these must be designed so that their deflection is uniform and does not introduce an angular error.

These are some of the problems concerned with integrating all of these components together to form a good, efficient, well-performing system. Also, there are a few things which should always be given emphasis and considered. One is "accessibility." It may not be easy to design all these parts so they work together and fit together in such a way as to provide plenty of accessibility—plenty of room to get at the parts one has to get at periodically. I cannot overemphasize the tremendous importance of good accessibility in any system. Many times a maintenance man suspects a little trouble; if the accessibility is good he will make a thorough investigation; if he has to go and get a tool and take something apart, he is likely to let it go, with the usual result of failures.

Problems in Connection with Installing Cameras Inside the Pressurized Compartment

MR. RAYMOND I. BECK,
Douglas Aircraft Co.

THE airframe designer falls heir to the unhappy task of putting all these mounts and cameras into an airplane. He is faced with quite a problem. It may sound simple to place a window in an airplane, but before he can do this he must consider the design and shape of the camera as to the distance between the trunnion, or mounting mount, and the ends of the camera, the distance of the lens to the end of the camera, the camera CG, and the mount CG, to determine where his pivot points are, and from his pivot points he then has to crank in pitch, roll and azimuth and try to establish a window.

Now, if we had a nice big airplane where the camera could move and do whatever these various manufacturers like to do to get a high performing amount, it would be very pleasant; but you can't do that. First of all, in a lot of these airplanes the surrounding structure at the window is very limited; the same is true of the area around the magazine and at these two extreme places we like to have a lot of freedom. The next thing which bothers airframe installations is whether or not the compartment is pressurized, and whether pressurization is from 3.3 to 7.5 psi. When you get to 7.5 psi—as you probably have read in regard to the Comet—there are quite a few problems. The other matter that he must consider is whether the windows are recessed with external doors to clean up the airplane and cut down his drag going to and from the target. Also, whether he has in-flight cleaning. This would be paramount in importance for inhabited airplanes where the crew can get to the windows. It has been shown in operational squadrons, in-flight cleaning capability can actually cause a mission to be accomplished rather than aborted.

Out of all this the designer has to obtain the minimum window size and weight, to cut down the stress problems in the structure and also to provide a capability for taking a high performing picture with the mount and camera. To do this, the designer not only must take into account the 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

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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 prob-