indicates a very close correlation between the average diameters of comets and their heliocentric distance, although the amount of variation is not as great as is commonly assumed. There seems to be no difference between the average diameter of a comet before and after perihelion at the same heliocentric distance.

In the following table N means the number of normal places entering into the solution, $\bar{r}$ is the mean heliocentric distance, and $\bar{D}$ is the average diameter at $\bar{r}$ using the normalizing assumption discussed above.

N	$\bar{r}$	$\bar{D}$	N	$\bar{r}$	$\bar{D}$
25	0.40	78.7	219	2.25	98.2
104	0.62	93.5	108	2.75	85.9
243	0.87	105.3	49	3.25	88.7
283	1.12	106.3	48	3.75	77.9
267	1.37	105.3	28	4.25	64.4
200	1.62	106.8	11	4.75	55.0
162	1.87	101.8			

The actual number of comets of average diameter between certain limits indicates a rapid increase from large diameters to diameter 50,000 km, and a sudden drop for still smaller diameters. This is interpreted as the result of observational selection, most of the smaller comets not being discovered.

*McMillin Observatory,
Ohio State University,
Columbus, Ohio.*

Burns, Jay, III, Hiltner, W. A. and Miller, Richard. Image converters with thin protecting foils.

During the past two years we have devoted some time to the solution of the problem of more efficient image formation by the direct recording of photoelectrons on a photographic emulsion (Burns and Hiltner 1955, Miller *et al.* 1956). This approach offers an opportunity of enhancing the rate of image formation by a factor near 100. The method in theory is, of course, very simple. A photoelectron is accelerated and focused on an electron sensitive emulsion. Instead of having an energy of only 2 or 3 electron-volts with which to render a silver grain developable, the photoelectron can be given an energy of many thousands of electron volts, say 20 kev. However, to solve the problem experimentally is difficult, primarily because of the extreme sensitivity of the photocathode to the presence of certain gases, such as oxygen and water vapor. Since the emulsion is laden with water a simple tube with a photocathode and emulsion is self destructive, with a uselessly short lifetime. There are several

approaches by which the "half-sensitivity" life can be increased. First, by cooling the photocathode to liquid nitrogen temperature in order to retard the rate of chemical destruction of the photocathode by water vapor. Quite recently Lallemand (1955) has gotten a useful tube life of one hour by this technique. A second approach, and the one we have followed, is that of inserting a molecular barrier. This barrier isolates the photocathode from the emulsion chamber. The thin aluminum foil of which the barrier is made is remarkably transparent to 20 kev electrons, but retards the diffusion of water vapor to the photocathode by many orders of magnitude.

Tests with a tube in which the above approach was followed gave a "half-sensitivity" life of 17 days, a speed of 50 times that of direct photography, and a resolution of 30 line pairs per mm. All these quantities can be further improved; the life of the photocathode can be further enhanced by refrigeration which is necessary for long integration times; the speed can be increased somewhat by a more efficient photocathode; and the resolution can be improved by superior electron optics and by decreasing the foil-emulsion separation.

However, field emission limits the tube to exposures of the order of one second. This field emission arises primarily from excitation of the photocathode by radiation from the fluorescent glass envelope. This fluorescence is a consequence of electron bombardment; the electrons are emitted by the first anode of the electron optics. The field emission must be reduced by at least six orders of magnitude. The emission at a surface is given by

$$J_f \approx 6.2 \times 10^{-6} \frac{E_1}{\phi} \times \exp \left(- \frac{6.8 \times 10^7 \phi^{\frac{3}{2}}}{E_1} \right) \text{ amp/cm}^2$$

where E_1 is the field in volts/cm and ϕ is the work function. Calculations show that two practical solutions exist: (1) Increase the work function by preventing cesium from adhering to the first anode and (2) by careful construction of the first anode in order to decrease the locally enhanced fields. It appears that either approach will reduce the field emission satisfactorily.

This work was sponsored by the Office of Ordnance Research, U. S. Army.