

I. INTRODUCTION

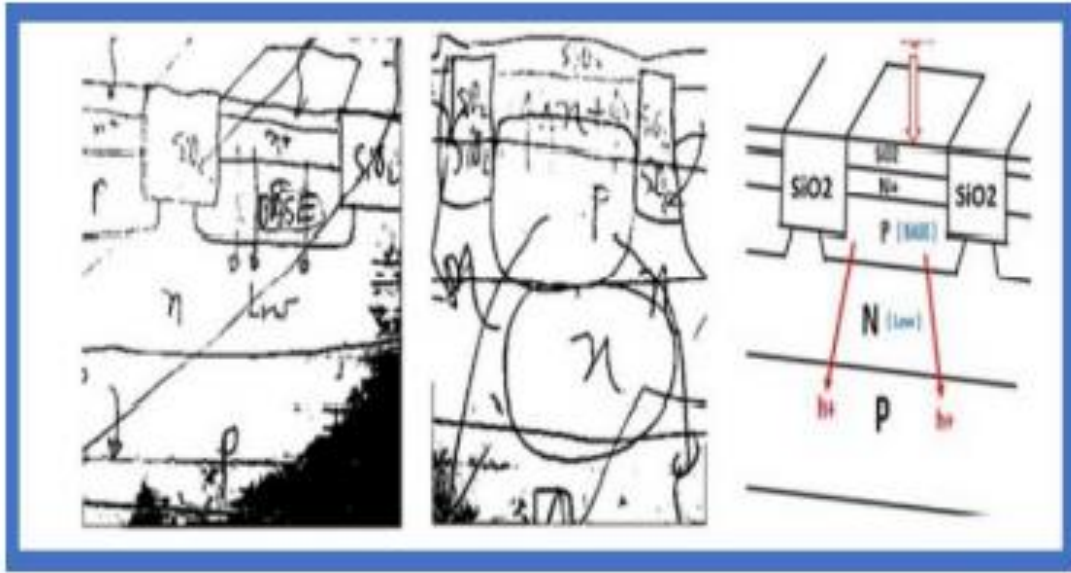


Fig. 3 Hagiwara March 1975 Lab Note, sketching N+PNP triple junction type Dynamic Photo Thyristor type Pinned Buried Photodiode with the vertical overflow drain (VOD) function with the electrical Shutter function capability.

However, presently the high definition digital CMOS image sensors have replaced the CCD image sensors completely. The reason was very clear. The CCD/MOS type dynamic photo capacitors are formed with the metal-like polysilicon electrodes which do not let the short-wave blue light pass thru. Historically, Sony once used in early 1980s the thin polysilicon electrode for the CCD/MOS dynamic photo capacitors with the CCD type charge transfer device (CTD) [1]. See Fig. 2. Sony in 1980 commercialized the all-CCD type video cameras with the completely free-image-lag feature for fast-action and snapshot digital still pictures. However, the surface electric field under the CCD/MOS electrode induced the serious surface dark current and generated many white defects, causing serious chip-yield problems. Hagiwara proposed in 1975 a triple junction type Photodiode with the vertical overflow drain (VOD). See Fig. 3.

For the high-definition (HD) picture size of 8000H x 6000H pixels and more in our digital TV era, we would need to have at least $8000+6000=24000$ charge transfers if the CCD type charge transfer device (CTD) was used. Since 0.001% times 24000 gives 24%, the significant percentage of the signal charge would be lost, and pictures would be buried in the noise. Therefore now, the CCD type charge transfer device (CTD) was replaced completely by the low-power digital-CMOS type CTD for modern digital high definition cameras in our digital HD TV era.

- [1] Y. Kanoh, T. Ando, H. Matsumoto, Y. Hagiwara and T. Hashimoto, "Interline Transfer CCD Image Sensor", Technical Journal of Television Society, ED 481, pp. 47-52, Jan 24, 1980.