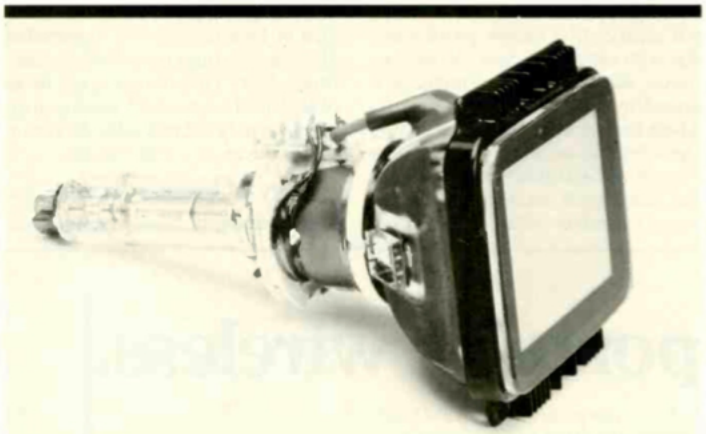
INDEXTRON:
A New Beam-Index Picture Tube

Using beam indexing instead of a metal plate to focus the electron beam, this new picture tube development makes possible a picture 70 percent brighter than conventional tubes.



The newly developed Indextron beam-indexing picture 'ube.

By Robert Rivlin, Editor

When Sony engineers set out to design a high-brightness picture tube for the company's new Vidimagic video projector, they turned to an old idea: the beam index tube. This type of tube had never been mass-produced before. But by using the latest semiconductor technology, a newly-developed phosphor material, and several advanced manufacturing concepts, the engineering team developed Indextron—a beam index tube whose peak brightness, at 1600 footcandles, is six to eight times that of a standard tube.

In the conventional delta gun shadow mask TV picture tube [see the story on TV Tubes in Raster Graphics elsewhere in this issue], three electron guns (one each for red, green, and blue) are arranged in an equilateral delta pattern corresponding to the triangular arrangement of phosphor dots on the front of the screen. As the electron beams from the three guns shoot towards the phosphor clusters, they pass through a shadow mask—a metal plate with extremely fine perforations (approximately 1.0 mm in diameter) spaced some 0.60 mm apart. The mask serves to focus the beams so that, theoretically, only one cluster of phosphors is illuminated by the three beams at a time, allowing the beam modulated by the red signal current to strike only the red-sensitive phosphors; the same occurs with the green and blue beams.

The problem with shadow mask technology, however, is that there is no one-to-one relationship between where the mask is placed during manufacturing and where the phosphor clusters are

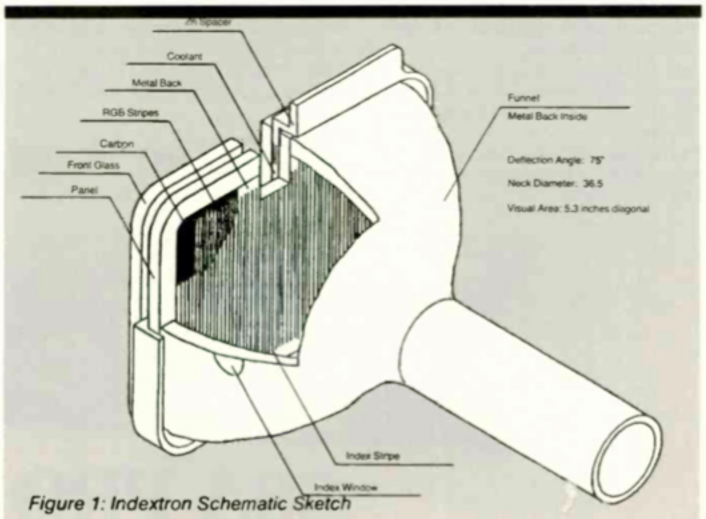


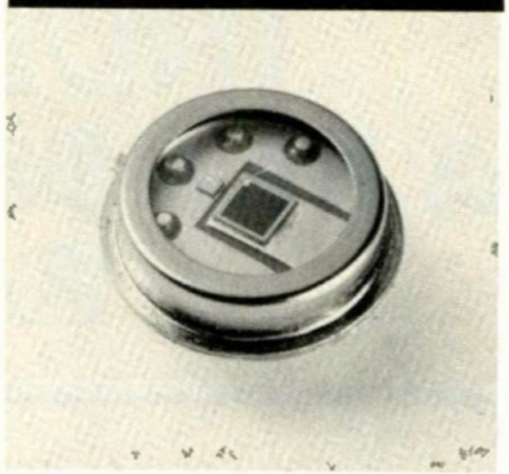
Figure 1: Indextron Schematic Sketch

deposited on the screen. This means that, in the worst case, it is possible for a mask to be completely out of phase with the phosphor clusters, thus totally blocking every other cluster and leaving it dark.

It is necessary, therefore, that the diameter of the beams must be increased so they illuminate at least two dot clusters at once, decreasing image resolution.

Another problem with the shadow mask is that it only permits some 20 percent of the electron energy from the guns to pass through the holes to the phosphors—meaning that huge beam currents are required to generate a usable picture, and that the mask absorbs a considerable amount of heat. In terms of image quality, the heat buildup causes deformation of the metal plate and its holes, leading to decreased resolution. Still another problem with the delta gun and shadow mask is the extremely precise registration needed to converge all three guns at the shadow mask plane.

The Indextron tube, on the other hand, completely does away with the metal shadow mask. The three beams of the standard picture tube (and the three stripes of the Trinitron tube) are replaced by a single high-precision electron gun; and the phosphor dot clusters are replaced by vertical stripes of red, green, and blue phosphor material separated by narrow guard bands and with indexing stripes. As the gun moves along the raster pattern, it is sensed by a high-speed photodetector which instantaneously sends a control signal back to the gun causing it to advance to the next index position. Thus, the beam needs no focusing mechanism, but relies instead on semiconductor technology in the control circuit to accurately position the beam to fall on successive phosphor stripes. The lack of a metal mask in Indextron leads to several key advantages. For one, it means that enormously high beam currents can be used without fear of warping the metal mask and causing loss of resolution. Higher beam current is also coupled with far greater efficiency: 78 percent of the beam current strikes the phosphor stripes as opposed to 20 percent in the shadow mask design. This leads to the 1600 fc peak brightness mentioned earlier—six to eight times that of a conventional tube.



The new high-speed photodetector which makes beam indexing feasible.

Beam indexing also offers excellent resolution thanks to the extremely small electron beam size (it no longer has to be wide enough to accommodate two phosphor clusters at once). For the tube, Sony engineers designed a new type of high-performance unipotential electron gun with a triode cathode electronic lens. This design leads to an oval-shaped beam whose maximum diameter is only 0.2 mm at the maximum beam current of 2 milliamperes.

History of beam indexing

As mentioned, beam indexing is an

old idea, and work on developing a beam index tube began simultaneously with the development of the shadow mask type. Philco, in fact, had an experimental beam indexing tube in the 1950s which used X-rays as the indexing mechanism.

In 1978, Matsushita developed a five-inch prototype beam indexing tube, eyeing the potential market for battery-powered home television receivers. But it never went through with plans to build the tubes or the sets.

More recently (1983), Hitachi began building a black-and-white version of the beam index tube for use in the viewfinders of its home video cameras—a design also incorporated in RCA's home video cameras. But the vertical stripe structure is considerably coarser than in Indextron, and would not suffice for picture viewing outside the viewfinder.

In 1981, Sony had developed an experimental 32-inch beam index tube using much of the same technology that was incorporated into Indextron, but with important differences, particularly in the structure of the indexing stripes. In the original tube, the pitch of the indexing stripes was approximately four times the pitch of the phosphor stripes. With the new technology, however, the pitch of the indexing stripes has been reduced to only two times that of the phosphor stripes, leading to more accurate positioning. Further, microprisms have been incorporated into the glass face plate of the tube to "fill in" areas in the picture occupied by the guard bands separating the phosphor stripes. In this way the apparent resolution of Indextron, though it uses only 256 groups of vertical phosphor stripes, is considerably heightened, and the vertical stripe structure of the picture is not noticeable.

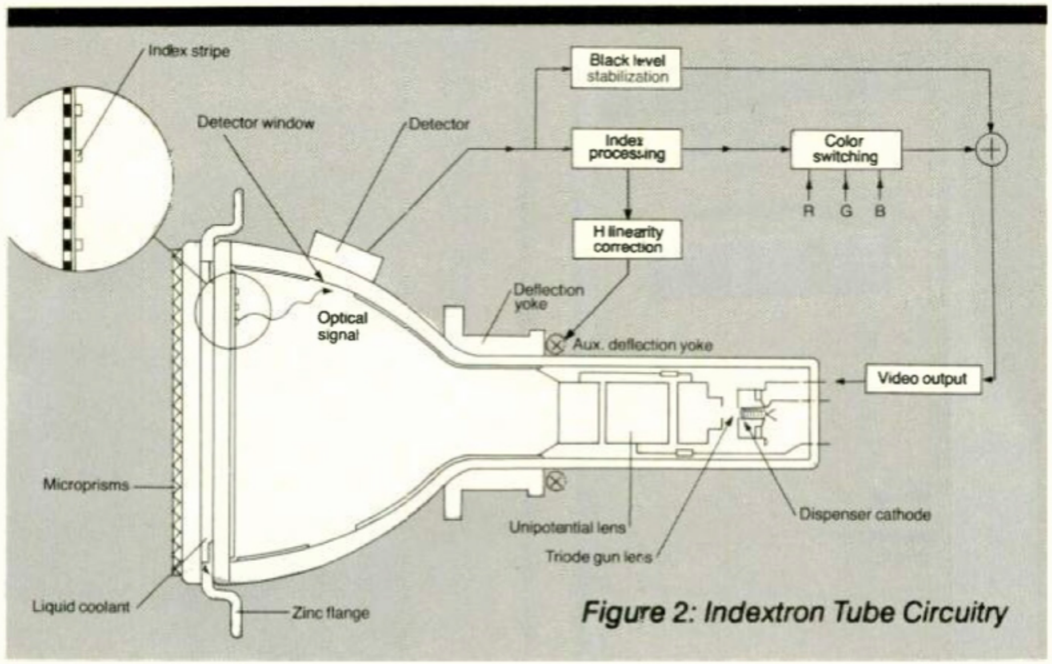


Figure 2: Indextron Tube Circuitry

New cooling system

We have thus far mentioned both the high-efficiency electron beam and the high-speed photodetectors as crucial in the development of the new Indextron

The Indextron tube alongside Sony's new Vidimagic projector.

tube. There are several other technological advances as well which contribute to the new tube design.

The most important is a new liquid cooling system. Because there is no metal mask to absorb heat and deform, extremely high beam currents can be used. Average beam currents as high as 550 microamperes, accelerated to 31 kilovolts by the gun, can pump up to 17 W into the 5.25-inch faceplate. To handle this load, a layer of ethylene glycol and water is placed between the tube's faceplate and the cover glass, transferring the heat to zinc flanges from which it dissipates by convection.

Still another development in Indextron is a new green phosphor material, brighter and more responsive than what was previously available.

What all this means for video projection is that, for the first time, a single high-brightness tube with a single projection lens can be used, whereas before it was necessary to split the video image into three separate red, green, and blue pictures, display each on a small CRT separately, project all three images, then converge them on the screen. The equipment to do this is bulky. And moving the projector from one location to another almost always requires extensive re-alignment and refocusing of the three separate projection lenses.

Using Indextron, the new Sony Vidimagic projector is light enough (weighing under 35 lbs. fully configured) and small enough (10 x 9 x 26 inches) to be transported in a canvas carrying case, and set up as easily as a movie projector. The operator simply points the lens at the screen, selects an image size from 30 to 200 inches diagonal, and focuses the single lens. Light output from Indextron is high enough so images can be projected onto a wall, and the projector small and light enough so it can be tilted up and the image projected onto the ceiling.

At present the projector is being marketed to industrial users for sales presentations, meetings, and so forth. Packaged with a 181-channel TV tuner, a built-in Beta format player/recorder, a remote controller, and a PA system, it is currently being sold for $2995. A version without the Beta deck is available for $2150. Future plans include the possible exploration of the home market; video software distributors could rent out the projector at the same time that they rent the cassettes, in the same way that many now rent out VCRs.

An even more interesting future potential, however, lies in the possibility of Sony developing a flat screen version of the beam index tube, for use in computer terminals and other displays. The current version of the tube is considered too bright for incorporation into standard TV monitors. But with the flat tube display, the high-efficiency beam can be put to excellent use. This large market could also serve to drive down the price of the beam indexing tube technology even lower than current levels. **BM/E**