FEBRUARY 1972 60 CENTS

Popular Science

THE What's New MAGAZINE

UNIRAY

A New Kind of Color Tube
- Brighter
- Cheaper
- More Reliable

THE GREAT DOME BOOM
Mushrooming Geodesics Answer Demand for Inexpensive Homes

Your Buying Guide to the **NEW POCKET TAPE RECORDERS**

TEST REPORT ON THE '72 PINTO, VEGA, GREMLIN

Can Your **BRAIN WAVES** Reveal Your IQ?

BOATING '72: Choose Your Own Fun Afloat

LIQUID CRYSTALS New Electronic Show-Offs

THOSE RUST REMOVERS Work Okay If You Learn How to Use Them

...plus 21 more great articles and projects, What's New Digest, and a dozen regular features

SEA KNIFE—Wild Boat for Wild Water

SIMULATED TV RECEPTION

UNIRAY—Amazing One-Gun

With just a single electron beam, this tube is brighter, cheaper, far more reliable

By RONALD M. BENREY

At long last, the complicated, finicky, and expensive "shadow-mask" color-TV picture tube may be heading toward obsolescence.

Late last year I viewed the prototype of a revolutionary color picture tube—the brainchild of David Sunstein, a Philadelphia engineer—scarcely more complex inside than a black-and-white picture tube. I saw a bright, sharp, full-color image that impressed me as the equal of the best picture produced by any 1972 color TV. Yet Sunstein's tube:

- Has but a single electron beam inside to "paint" the picture across the screen—not the *three* beams of a conventional color tube.
- Needs no "convergence" circuitry—magnets, coils, controls—to bring the electron beams into alignment.
- Can live with a simpler high-voltage power supply because it operates at a lower beam current.
- Has no hard-to-make perforated steel shadow mask (we'll explain its function in a conventional tube shortly), and doesn't need a high-precision faceplate.
- Is not particularly sensitive to magnetic fields, so the shielded loudspeakers and elaborate automatic demagnetizing ("degaussing") devices of conventional color sets aren't needed.

Total all these minuses. The result is a big plus: The "Uniray" tube (as Sunstein calls it) can save money all along the line.

One industry expert I queried estimated that manufacturing savings—in both tube and chassis—could cut big-screen color-TV prices by as much as $100. Your service tabs will probably be lower, too—first, because periodic reconvergence (to eliminate color fringing in the image) isn't necessary; second, because the simpler chassis circuitry may be more reliable. And, of course, replacement picture tubes will be cheaper to buy and install—maybe as much as $75 less.

But, cost aside, Uniray has several other significant advantages:

- Because it has a single electron gun (to produce the single beam) and no precisely positioned shadow mask, the new tube is more rugged than conventional models. Sunstein told me that he has discussed using his tube in the cockpits of jet fighters for data displays.
- Because the tube is built very much like a black-and-white tube, it can be made shallower than conventional color picture tubes, so sets can be less bulky. The trick here is a wide-beam deflection angle (the angle the beam sweeps through as it moves across the screen). The standard big-screen color deflection angle is 90 degrees; it should be possible to design Uniray with the 114-degree angle used in black-and-white tubes.
- Because there's no shadow mask to absorb more than 80 percent of the total beam current, the beam that strikes the phosphors on the screen is very intense. Thus, the image is exceptionally bright. Sunstein's prototype tube was built in the mid '50s—using old phosphors—yet its picture brightness rivals the latest "ultra-bright" TV tubes made with high-efficiency phosphors. These same new phosphors in a Uniray tube would produce a picture more than twice as bright.

[*Continued on page 140*]

Comparison photos show Uniray's advantage

These side-by-side photographs, made simultaneously during a daytime broadcast, compare the Uniray tube (right photos) with a top-line 1972 set equipped with a superbright picture tube (left photos).

The top pair of photos shows a well-adjusted picture on each tube. The old-fashioned rounded-corner shape of the Uniray tube reflects the prototype's late-1950s heritage. And the somewhat different image coloring is caused by different phosphors. Bottom pair of photos contrasts the effect of a powerful magnet on each image. Note that the colors of the shadow-mask tube image (left) are mangled, while the Uniray picture is almost undisturbed.

How the Uniray and

The conventional shadow-mask color picture tube creates an image by illuminating hundreds of thousands of tiny colored phosphor dots on its screen. The scanning lines, caused by the sweep of the electron beams across the dot screen, are visible in the enlarged photo (middle right) of part of a complete picture. The extreme blowup (far right) shows the dot structure: Note that red, green, and blue phosphor dots are arranged in triads. Tiny dot size permits detailed, high-resolution images.

The Uniray tube creates an image that seems to be made out of tiny squares (see magnified portion, middle right). This is because a single scanning beam sweeps across a vertical array of phosphor stripes. The extreme blowup (far right) shows the structure of red, blue, and green phosphor stripes. Although the Uniray tube has been criticized by some engineers as having inferior resolution capabilities, note fine image detail in middle enlargement.

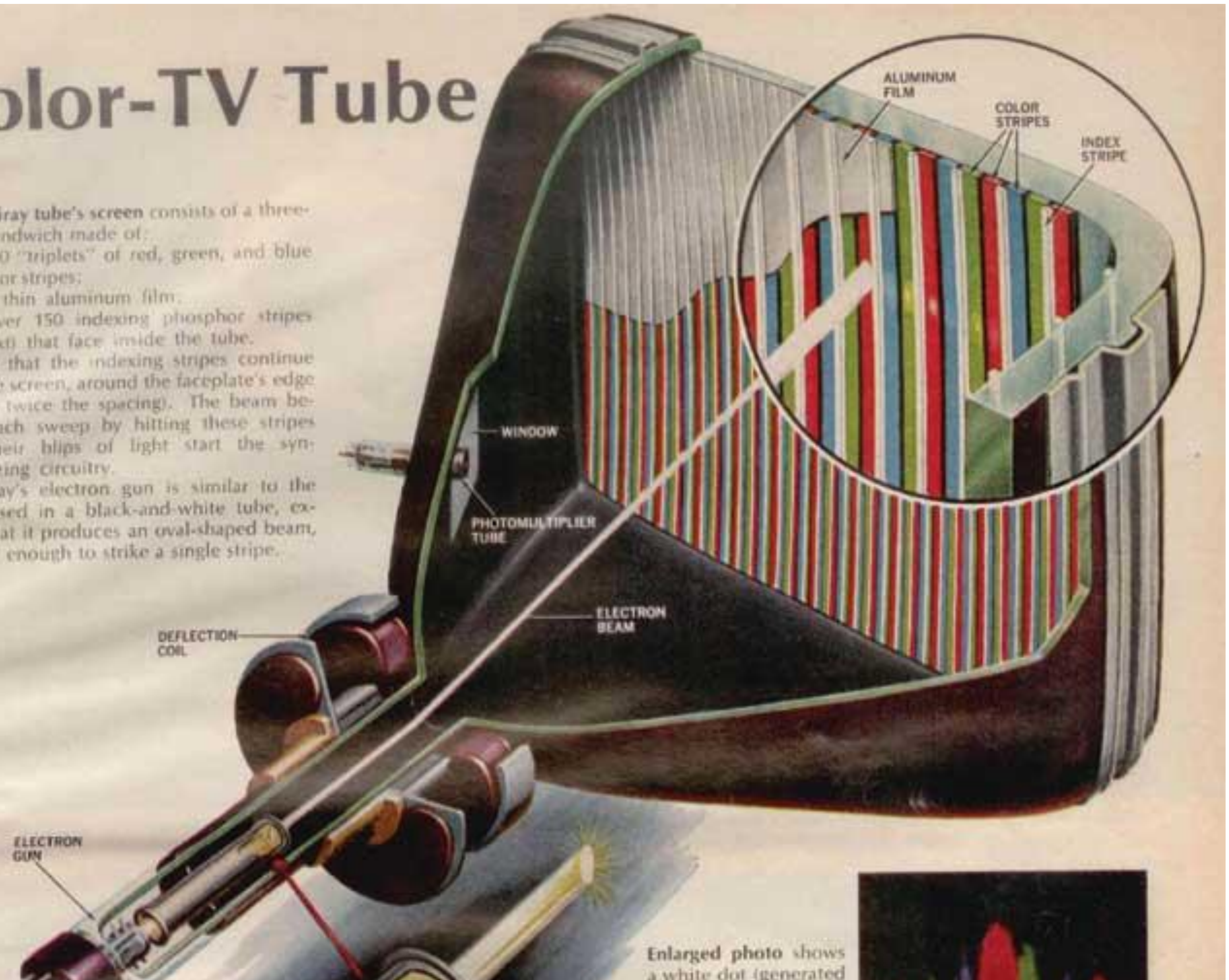
Color-TV Tube

The Uniray tube's screen consists of a three-layer sandwich made of:

- 300 "triplets" of red, green, and blue phosphor stripes;
- A thin aluminum film;
- Over 150 indexing phosphor stripes (see text) that face inside the tube.

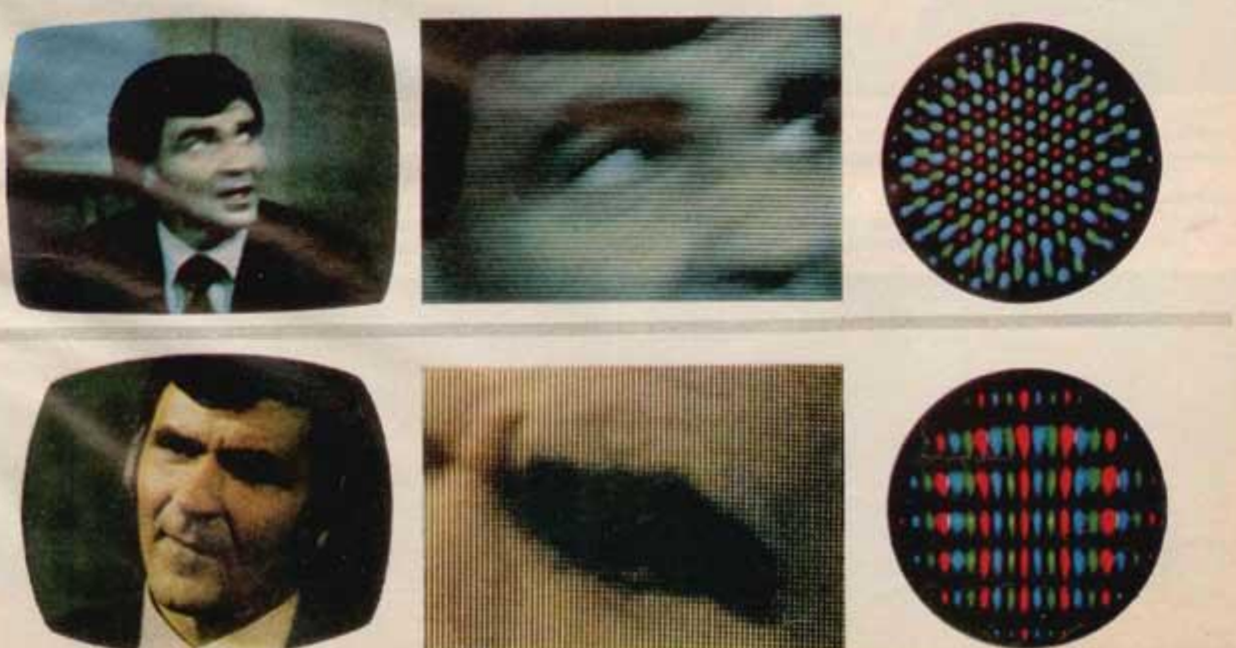
Note that the indexing stripes continue past the screen, around the faceplate's edge (but at twice the spacing). The beam begins each sweep by hitting these stripes first—their blips of light start the synchronizing circuitry.

Uniray's electron gun is similar to the kind used in a black-and-white tube, except that it produces an oval-shaped beam, narrow enough to strike a single stripe.



Enlarged photo shows a white dot (generated electronically) on Uniray screen. It is really an almond-shaped blob of red, green, and blue segments your eye combines.

conventional shadow-mask color-TV tubes differ



Uniray—Amazing One-Gun Color-TV Tube

[Continued from page 64]

There must be a better way! That's what most people say when they look inside a conventional shadow-mask TV tube for the first time. Essentially, the tube displays three overlapping images—one red, one blue, and one green—that your eye merges into a full-color picture.

The screen of the tube is covered with a neat pattern of hundreds of thousands of tiny red, green, and blue phosphor dots. Three electron guns inside the tube's neck spew out a trio of pencil-lead-thin electron beams that zigzag across and down the screen in unison and make the dots glow.

The instantaneous intensity of each beam varies in step with the received TV signal so that relative brightness of the dots at each point on the screen varies to create different apparent colors.

Just behind the phosphor-dot array is a thin perforated-steel plate, called the shadow mask, that performs a critical function: It blocks the field of view of the three beams so that each can hit phosphor dots of only one color. One beam strikes only the red dots, one beam only the blue dots, and one beam only the green dots.

Incredible precision is necessary for this system to work satisfactorily; tiny flaws will ruin the picture you see.

If the steel shadow mask becomes magnetized, the beams will be pulled off course, creating color shifts—or impurities—on sections of the screen. The cure is the automatic degaussing gear we mentioned earlier.

The three beams must track together perfectly, or the three colored images won't overlap—you'll see color fringes in the picture. Keeping the beams converged (or intersecting) at

How the Uniray color picture tube works

A single electron gun, positioned in the neck of the tube, produces a stream of electrons. The gun structure is designed to produce a tall and narrow oval-shaped beam, rather than a circular beam as in all conventional tubes. We'll see why shortly.

A set of deflection coils around the tube's neck generates a constantly changing magnetic field that deflects the beam back and forth across the screen in a zigzag pattern that moves from top to bottom.

These coils are similar to the kind used in a black-and-white TV, although they are made with more care to insure a uniform beam deflection pattern.

The face of the screen is covered with an array of red, blue, and green phosphor stripes—approximately 300 of each color, creating a total of about 300 red/blue/green triplets. A thin black divider fills the gap between adjacent color stripes.

A thin layer of aluminum is deposited across the rear surface of the phosphor-stripe array. Electrons can pass through this layer without difficulty, but light cannot. Its function is to prevent light produced by the phosphor stripes from entering the picture-tube bell.

Atop the aluminum layer is a set of index phosphor stripes, intended to produce blips of light within the tube as the beam scans across the screen. These index stripes are positioned atop every other one of the black dividers that separate adjacent colored stripes.

Note that there are also index phos-

the surface of the shadow mask requires the complex convergence circuitry that is the hallmark of a conventional color TV.

RCA developed the shadow-mask tube about two decades ago, and since then hundreds of millions of dollars have been spent all around the world trying to come up with a simpler replacement. But, like the old-faithful reciprocating gas engine, it's durable: None of the many contenders has been able to knock it out of the box.

"This could be the one." A senior engineer at one of the major color-set makers told me that the Uniray is the first real potential challenger to the shadow-mask tube that he has come across. There are still problems to be solved, but the basic Uniray concept seems practical.

Most of the shadow-mask tube's woes stem from its three separate beams. The Uniray has only a single beam that scans across a screen covered with vertical phosphor *stripes*, arranged in sequences of red, blue, and green stripes.

The one beam must do the job of three as it makes each tiny element of phosphor glow with a different brightness to create the apparent full-color picture you see. This means the beam must become the "red beam" when it passes over a red phosphor stripe; it must be a "blue beam" when it hits blue phosphor; and it must be a "green beam" when it strikes a green stripe.

Back in the set's chassis, an electronic switching circuit sequentially connects the beam drive circuit (the stage that controls the beam's intensity) to the red, blue, and green signals derived from the incoming TV signal.

Continued

phor stripes on the bell wall adjacent to the left edge of the screen (as viewed from the front). These starting stripes are scanned by the beam before the beam reaches the screen. They are spaced three times as far apart as the index stripes.

As a single scan—or sweep—of the beam begins, the beam first strikes the starting stripes and creates a series of light blips within the tube. These blips are "seen" by a photomultiplier tube that "looks" through a window in the bell of the tube.

This window is a small area where the tube's black-carbon conductive coating has been scraped away.

The photomultiplier tube is an exceptionally sensitive light pickup, which generates a small output pulse each time it sees a blip of light.

These output pulses are used to synchronize the beam-switching circuitry, as explained in the text. The starting stripes are more widely spaced than the index stripes, to insure that the beam switching circuitry starts in precise step with the scanning beam.

As the beam moves across the colored phosphor stripes, it makes the area struck on each emit a pinpoint of colored light. In one scan, the beam "paints" one line of the picture you see. An image is completed in 1/30 second.

Note that the shape of the beam matches the shape of the phosphor stripes: The tall and narrow beam strikes a single stripe at a time, without "overlapping" onto adjacent stripes.

As we've said, the beam sweeping across the index stripes as it scans across the face, generates a continuous chain of light blips within the tube that keeps the beam-switching circuitry synchronized with the beam motion.