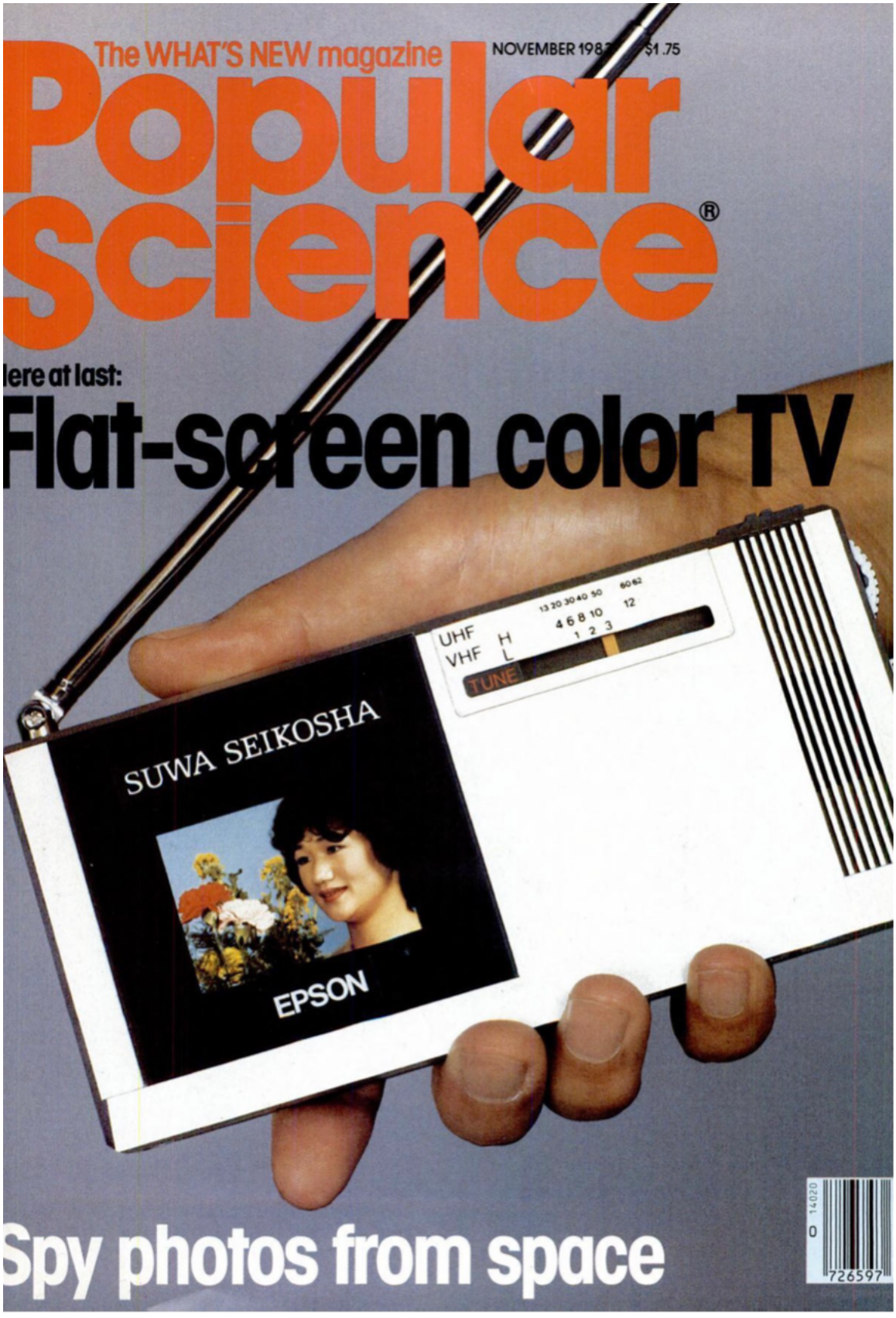
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Hand-size, but here at last:

flat-screen color TV

Pocket-size TV sets using a flat screen and liquid-crystal displays are already in the stores. But they have monochrome (single-color) displays. Now, breakthroughs by a team of Seiko engineers in liquid-crystal chemistry and transistor design are finally going to bring flat-screen *color* TV to the marketplace. The Japanese engineers have created new fast-response liquid crystals and thin-film transistors that overcome the major problems of LCD color TV. The Seiko Pocket Color TV should be on the market in about six months. A PS editor visited Seiko's research and development headquarters in Suwa, Japan. He found picture quality highly satisfactory. Although the colors were not as crisp as the very best produced by cathode-ray tubes, they were bright in daylight, and resolution was sharp and clear.

By HERBERT SHULDINER

SUWA, JAPAN

The image was clear and the colors were bright as I watched a baseball game on the tiny screen of a TV set small enough to slip into my jacket pocket. But the fact that the athletes were Japanese wasn't the only thing different about this TV picture. I was viewing the world's first flat-screen liquid-crystal color television announced for sale.

LCDs aren't new, of course. Many of us have calculators or watches with the displays. And black-and-white LCD TV sets are already on the market, including a tiny wristwatch TV [PS, April]. So why all the excitement about this new system? And why have a handful of Japanese companies, including Hitachi, Matsushita (Panasonic), Seiko, and Toshiba been in a race to be first to market this type of TV? Each one of the companies has demonstrated prototypes at electronics trade shows. In addition, Mitsubishi has exhibited a large-screen LCD color TV designed for industrial displays. Now Seiko has announced plans to market the first consumer LCD color TV. It will be on the market in about six months.

The Seiko TV is a prodigious engineering achievement. A color LCD TV is much more difficult to make than a black-and-white one. The Seiko Pocket Color TV required the use of a new type of liquid crystal, which responds twice as fast as conventional LCs, and virtually invisible thin-film field-effect transistors. The use of thin-film transistors had been limited to exotic flat-screen displays made for the military.

I visited the Seiko research and development center in Suwa to preview the new color-TV system. I also interviewed the three engineers who headed a 20-man research team that developed the system over a period of approximately five years.

"The principle is very simple," Toshiaki Saito, director of Seiko's research and development division, told me as he held the 1.1-pound TV set in his hand. "The system is much the same as that used in an LCD watch," he continued. "Liquid crystals are sandwiched between two panels of glass. When the LC spots are excited by a voltage, the spots turn black, just as they do in an electronic watch."

But there are significant differences between a watch and the color-TV set, Saito says. Besides the new LCs and thin-film transistors, a color filter is used to create an entire spectrum of hues for the TV image.

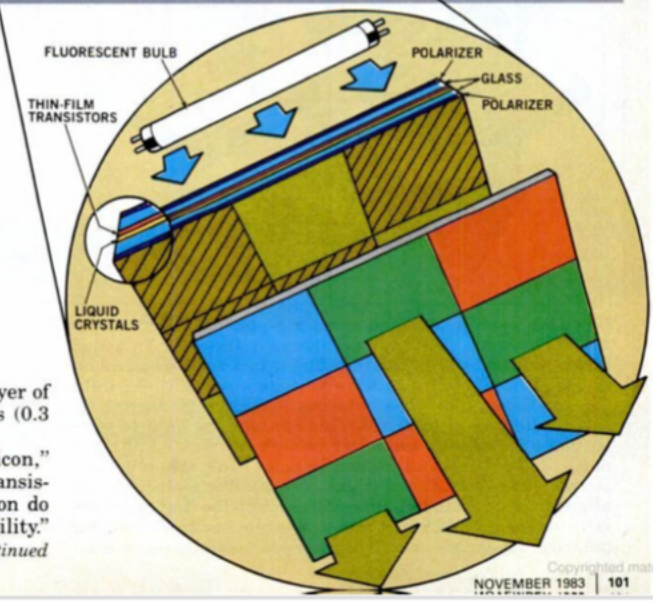
Twisted crystals

The new liquid crystals used in the Pocket TV resulted, Saito says, from organic-chemistry research carried on by Seiko. But he refused to specify how they differ chemically. "We use twisted-nematic-mode LCs [see drawing on last page of article] because they have high contrast and low power consumption, and they respond in less than half the time of conventional LCs—less than 50 milliseconds compared with about 100 milliseconds." The rodlike, twisted-nematic-mode LCs are used in virtually all calculator and electronic watch displays made today.

Shinji Morozumi, manager of Seiko's research and development department, explained why LC response speed is critical in a TV set: "When you see a baseball game on a screen made of conventional liquid crystals, the image flows. A thrown or batted ball looks like a comet." There was no indication of this, however, as I watched the videotaped ball game on the Pocket TV screen. I could see the ball clearly, and when players ran they could be seen distinctly, without any blurring. To make sure this wasn't due to the fact that I was watching a specially selected tape, I asked Morozumi to tune in a real-time broadcast. He immediately disconnected the VCR cable and extended the set's telescoping antenna. He handed me the little TV, and I tuned in a Japanese soap opera. The colors were still bright, and moving images remained stable. There was no blurring whatever.

The LCs in the Seiko Pocket TV are encased in a 43.2-mm-by-34.2-mm (1.7-by-1.3-in.) glass-sandwich panel (see illustration on opposite page), which is divided into 57,600 pixels, or picture elements. Driving each pixel, Morozumi explains, is a matching thin-film transistor. The transistors, made in a Seiko integrated-circuit plant near here, are virtually invisible, as I found when I examined a screen panel not

leart of Seiko's new Pocket Color TV is the panel hown above. It's a sandwich encasing liquid crys- ıls and a vast array of thin-film—virtually invisible -transistors. Liquid crystals form 57,600 matching ixels, or picture elements. Combinations of primary ed, blue, and green elements form different colors. he exploded drawing at right shows how the green olor on the screen is created. Varying voltages can hange pixels from black to transparent. Black ixels (red and blue in diagram) block light; trans- arent ones allow light to pass and hit color filter. 'hen the voltage is off, the green pixels are trans- arent; they allow light to pass and strike green lements on color filter. The result is green color n the screen. By turning voltage on and off in var- ıus combinations of primary colors, the overall olor picture on screen is obtained.



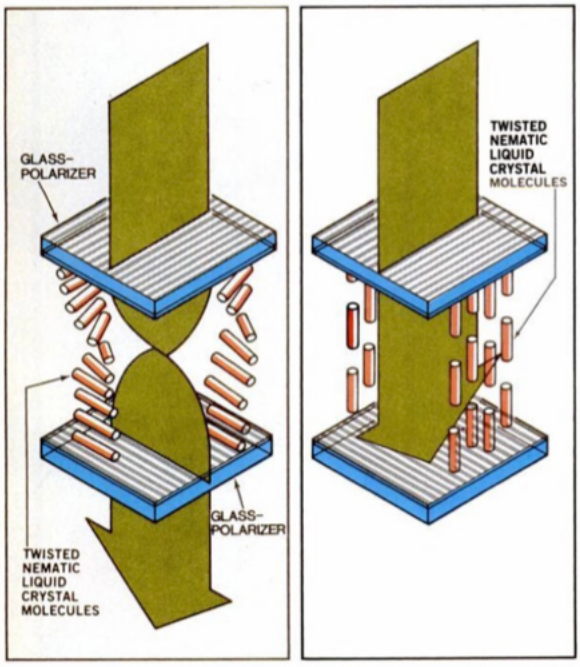
nclosed in a case. The transistors are made on a layer of olycrystalline silicon only about 3,000 angstroms (0.3 ıicron) thick.

"We made the transistors of polycrystalline silicon," Morozumi said, "because conventional thin-film transis- ors made of cadmium selenide or amorphous silicon do ot have sufficient stability, reproducibility, or reliability."

Continued

Tiny Seiko TV is slightly more than one in. thick. Measurements of the prototype are 6.3 by 3.15 by 1.1 in. It weighs 17.6 oz. Playing time is four hours on four AA alkalines.

How LCs are used to make a TV picture



New fast-response, twisted-nematic liquid crystals are sandwiched between glass light polarizers in the color-TV panel and activated by adjacent thin-film transistors. When an individual pixel is off, with no voltage applied (left), light passing through the first polarizer is twisted 90 degrees by the liquid-crystal material. This enables the light to pass through the second polarizer (which is oriented at right angles to the first) and to strike a color filter. When voltage is applied to the LC cell (right), the rodlike molecules are aligned. As a result, light passing through the first polarizer is no longer twisted 90 degrees and is blocked by the second polarizer layer. LCs in watches work in much the same way.

Additionally, polycrystalline silicon transistors have high contrast. "A conventional LCD does not have sufficient contrast," Morozumi said.

Overall, the picture on Seiko's tiny screen is adequate once you get used to squinting at such a small image. Close-ups, as in soap operas, are easier to view than distant shots. The colors, though not as bright and crisp as those on a conventional cathode-ray tube, are more than adequate. The reds seemed especially good.

Compared with the Sony Watchman [PS, Nov. '82], the Pocket TV's picture is more pleasing because of the color. Resolution appears to be about the same, even though the Watchman is a flattened CRT and not an LCD. Seiko claims the resolution of its Pocket TV is about 200 horizontal lines (seven lines per millimeter).

The Pocket TV picture is more easily viewed than that of the wristwatch TV that Seiko also makes. I haven't had an opportunity to view either the Casio LCD black-and-white TV that went on sale recently or the EXP Research shirt-pocket LCD TV ["What's New in Electronics," PS, Aug.] scheduled to go on sale shortly.

The Casio LCD screen is slightly larger than that of the Seiko Pocket Color TV—2.75 inches versus 2.13. Screen size of the EXP model is only 1.5 inches. The Casio unit has a backlight made of electroluminescent materials instead of the fluorescent tube used in the Seiko. The backlight is needed to provide uniform illumination during the day and for night viewing. Liquid crystals merely reflect light, and when the viewing area is dark the display cannot be seen without a backlight.

Plummeting prices

Sony started the pocket TV era with its Watchman, just as it launched the tiny-portable-stereo era with the Walkman. The Watchman is certain to get considerable competition from the Casio model, which is bound to drive prices down. The Watchman lists at $350; Casio has announced a price of $299 for the TV-10. EXP Research will price its unit at $275. The Seiko TV wristwatch sells for $495.

Seiko's Saito says the Pocket Color TV will be priced at between $400 and $500 when it goes on sale in mid-1984. Who will buy that kind of device for that kind of money? "We expect it to be a popular gift item," Saito said.

Many industry observers believe, however, that LCD TVs represent more than just another fad potential. There's considerable speculation about whether these small models could eventually lead to an enlarged flat-screen television you could hang on the wall. I asked Saito whether Seiko plans to build a new generation of LCD hang-on-the-wall televisions.

"Right now, we could build a five- or six-inch flat-screen TV," he told me. But he admits that the company hasn't yet done so. The reason? "It would be extremely expensive to do and would not be competitive with other types of TV," he explained. What about eventually building a large-size flat-screen TV with pocket-TV technology? "We could build a 12-inch screen for alphanumeric display at this time," Saito said. "You don't need the response speed for an alphanumeric display. But it is quite difficult to achieve a hang-on-the wall television using this kind of technology." As he thought more about it, Saito admitted: "It would be almost impossible to fabricate thin-film transistors on such a large area. Projection TV is an easier way to achieve a hang-on-the-wall TV."

At the same time, however, Saito told me: "We have yet another way to achieve the large screen area. It uses an altogether different technology, but I can't tell you about it now," he said teasingly. "Perhaps it will take five years—or even more—to achieve this large-area television." PS