RCA News

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RCA ANNOUNCES BREAKTHROUGH IN LIQUID CRYSTAL FIELD; DEMONSTRATES THIN-SCREEN DISPLAYS OF PRINT, PICTURES, MOVING IMAGES

New Development In Materials Research Leads To Electronic Units Viewed By Reflected Light; Advance Can Lead To Solid-State Electronic Clocks, Watches, Dashboard Instruments, And Eventual Pocket TV Set

A revolutionary new type of electronic display for print, pictures and moving images, based on a breakthrough in research on liquid crystals, was announced today by RCA.

A number of experimental devices that can lead to potentially important new electronic products were demonstrated to the press for the first time by scientists of RCA Laboratories at the company's headquarters here. Among them were an all-electronic clock with no moving parts and a high-resolution picture display that was described as the electronic equivalent of a printed page.

Dr. George H. Brown, Executive Vice President, Research and Engineering, said that the new technology may have a profound effect upon the long-range growth of the electronics industry by altering many present techniques and opening the way to entirely new ones.

"The liquid crystal display gives promise for the first time of a practical thin-screen competitor to such vacuum tube displays as the oscilloscope used in radar, the 'Nixie' tube used to display changing letters and numbers, and, perhaps eventually, the picture tube used in television sets," said Dr. Brown.

Dr. James Hillier, Vice President, RCA Laboratories, said that liquid crystals are inherently cheap, their power requirements are extremely small, and they lend themselves to use in conjunction with solid-state and integrated circuitry. He pointed out that these features can lead to a broad range of entirely new electronic display products. As examples, he cited electronic clocks and wrist watches, automobile dashboard displays, scoreboards, stock tickers, and, ultimately, pocket-size television receivers that could be viewed in bright sunlight.

Dr. Hillier added that since liquid crystal displays are read by reflected light, in the manner of a book, rather than emitting their own light, as in television, a picture on a liquid crystal television screen or other device would gain in brightness as its surroundings became brighter.

The research program which led to the new technology was conducted at RCA's David Sarnoff Research Center, Princeton, N. J. Dr. George Heilmeier, who led the effort, said that the new liquid crystal screen resulted from the application of two discoveries:

1) That certain liquid crystals can be made opalescent and hence reflecting by the application of an electric voltage;

2) That the temperature range over which this occurs -- originally confined to only a few degrees at high temperature -- can be expanded with new materials to cover a range from below freezing to the boiling point of water.

He described liquid crystals as organic compounds whose appearance and mechanical properties are those of a liquid, but whose molecules tend to form into large, orderly arrays akin to those that make up such solid crystals as mica, quartz, and diamonds.

He said that liquid crystals are classed according to the type of array into which they form. The type used by RCA, he added, is of the class known as "nematic," in which the molecules form into parallel lengths like a bundle of sticks.

Dr. Heilmeier gave the following description of the new display technique:

A sandwich is formed of two clear glass plates, separated by a thin layer of clear liquid crystal material only one thousandth of an inch thick. A reflective mirror-like conductive coating is deposited on the inside face of one plate, in contact with the liquid. On the inside of the other is deposited a transparent, electrically conductive coating of tin oxide.

When an electric charge from a battery or a wall outlet is applied between the two coatings, the liquid crystal molecules are disrupted and the sandwich takes on the appearance of frosted glass. The frostiness disappears, however, as soon as the charge is removed.

In order to display stationary patterns such as letters, symbols, or still images, the coatings are shaped in accordance with the desired pattern. To display motion, the conductive coatings are laid down in the form of a fine mosaic whose individual elements can be charged independently, in accordance with a scanning signal such as is used for facsimile, television, and other electronic displays.

Dr. Heilmeier said it is also possible to make both coatings transparent and to provide a light source at the edge of the screen in order to make the images or patterns visible even in a dark room or at night. Or, he added, it is possible to reflect a strong light from the liquid crystal display and to project its images, enlarged many times, onto a wall or other surface.

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FACT SHEET

From: RCA
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LIQUID CRYSTAL DISPLAYS

RCA scientists have developed flat, low-power, low-cost displays using a newly discovered electro-optical effect in liquid crystals. The displays can reproduce any graphic data electronically and can be addressed and driven by solid-state, integrated circuits. They are simple to operate, have no moving parts, and are compact and rugged. Another advantage is their thinness and portability.

What Are Liquid Crystals?

Liquid crystals are organic compounds having the mechanical properties of a liquid -- they can be poured -- and the regular molecular arrangements characteristic of a polycrystalline solid. They come in three forms -- nematic, smectic and cholesteric -- and appear relatively frequently in nature. In fact, approximately one out of every 200 organic compounds is a liquid crystal.

History Of RCA Work

Early research at RCA Laboratories, Princeton, N.J., disclosed that certain transparent, nematic liquid crystals at high temperatures became milky white when exposed to electric fields, but returned to their transparent condition when the electric field was removed. Since then, new materials

that exhibit this behavior at room temperature and over a range from 0° to 212°F have been developed.

The liquid crystal displays were developed by a research team headed by Dr. George H. Heilmeier, and including Louis Zanoni, Dr. Joel Goldmacher, Joseph Castellano, and Lucian Barton. The team worked under the supervision of Dr. Henry R. Lewis, Director of the Electronic Research Laboratory, RCA Laboratories.

Theory Of Operation

When an electric field is set up on a nematic liquid crystal, its presence creates ions that travel through the material. These traveling ions then produce an effective turbulence that causes a dynamic scattering of light and gives the liquid crystal its milky white appearance.

How To Build A Liquid Crystal Display

To construct a display, a thin film of liquid crystal only one one-thousandth of an inch thick is placed between two sheets of thin glass. The inner face of each sheet is coated with an electrode. At least one of the electrodes must be transparent so the display can be seen. This electrode is usually a conductive species of tin oxide. The other electrode may also be transparent, or it can be reflective, in which case it is ordinarily an evaporated film of metal such as nickel or aluminum. In effect, the display is a parallel plate capacitor with the liquid crystal acting as the dielectric.

Thus far, RCA has made liquid crystal displays up to 3 x 4 inches. However, there appears to be no reason why they cannot be made substantially bigger. Obviously, if there were no other way, very large displays could be formed from mosaics of smaller ones.

Electrical Requirements

Liquid crystal displays have a grey scale that varies with the intensity of the applied voltage, which ranges from 6 to 60 volts. The power required for a reflective display is one milliwatt per square inch and can be either DC or pulsed. Pulsed power is used when the effect of motion is desired, the pulses being addressed to minute areas in proper sequence through integrated circuits.

Life

Operating tests of experimental liquid crystal displays thus far have shown that they last in excess of 3,000 hours.

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Additional Technical Data

Efficiency (Whiteness compared with white bond paper)	50 to 60 per cent
Resolution	500 lines per inch
Speed	Turn on in 1 to 5 milliseconds. Turn off in about 30 milliseconds Will accept information at a 60 microsecond rate.
Contrast	15 to 1 (independent of ambient light)
Temperature Range	0^{o} to 212^{o}F (Compound remains a nematic liquid crystal over entire range. Above 212^{o} it becomes an isotropic liquid; below 0^{o} it becomes a solid. The transition from one state to another is sharp, reproducible, and reversible.)

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(For additional information, contact Al Pinsky, Laboratories, Princeton, N.J., 08540, Area Code 609 - 452-2700, ext. 2532.)

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A LIQUID CRYSTAL EYEFUL -- RCA researcher, Lucian Barton, squeezes a few drops of liquid crystal onto a glass plate having a reflective, mirror-like coating. The transparent glass plate, held in his other hand, will then be placed on top to complete the experimental liquid crystal display. When an electric voltage is applied between the two plates, the liquid crystal material becomes frosty and forms a display of letters, numbers or full photographs.