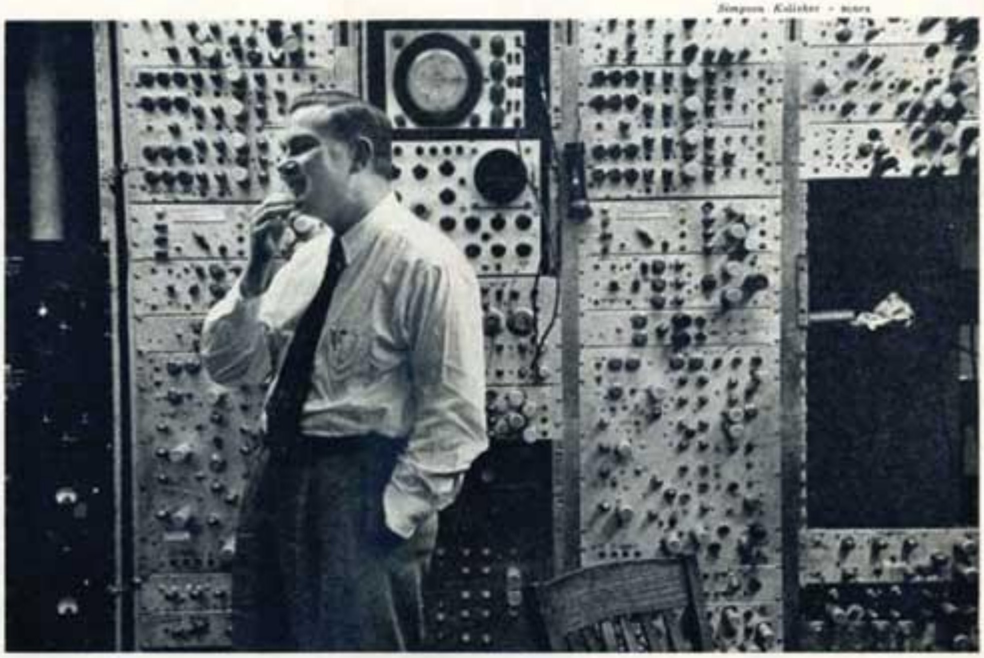
Simpson Kalisher



The industry-wide effort that turned the stupendous trick of color TV is told here for the first time. R.C.A., which has spent $65 million on color, is ready to start cashing in this winter.

Color TV: Who'll Buy a Triumph?

by Francis Bello

Many Americans who recall the awesome experience of listening to their first crystal radio set ("like in the next room!") will soon be seeing color television for the first time. It can be predicted that while these viewers will be impressed, even moved to buy color sets at high prices, they will not respond with the same breathless excitement that the primitive radio evoked. This relative apathy is understandable in a generation that has come to take for granted its color movies and black-and-white TV. Yet the apathy is ironical, since color television represents a monumental technical achievement, embodying more research and engineering at the time of its debut than any other product offered to the public. Indeed, anyone who troubles to learn anything of the obstacles that had to be overcome cannot fail to view a color-television set with immense respect.

Ten years ago engineers had only a few vague ideas on how an all-electronic color system might be built. The only operating systems then in existence used a strictly mechanical "addition" of color to black-and-white images by means of rotating color wheels at the camera and at the receiver. No one dreamed that the color signal ultimately would have to be compressed into the same channel space in the radio spectrum as that allotted to black-and-white, and most engineers probably would have bet that it simply could not be done without destroying picture quality. To require, in addition, that the color signal produce a good monochrome picture on black-and-white sets would have seemed preposterous. Yet by early 1953 the engineers had worked out an all-electronic, high-fidelity, compatible color-television system. The story of this accomplishment has never been fully reported in terms intelligible to the layman. It is a story of sparkling ingenuity, and—in the final stages—of unprecedented cooperation within the radio and television industry.

At the moment, however, the industry faces a problem more perplexing in its own way than the strictly technical ones so recently overcome. The problem: how to get people to buy color receivers. When the FCC approved the present color-television system nearly two years ago, many in the industry thought the public would snap up color sets as fast as they could be produced. It was predicted that by 1955 annual output would reach one million sets. Actual 1955 sales probably will not exceed 35,000, and the total number of color sets operating by year's end will be under 50,000.

What happened? One industry vice president answers with another question: "Where are the Texas millionaires?" R.C.A., C.B.S., Motorola, and a few others, all introduced large-screen color sets a year or more ago, priced between $900 and $1,100, fully expecting that there would be a brisk, if limited, demand. The demand was practically zero. The public might be irrational, but evidently not so irrational that it would buy color sets to see black-and-white programs. "You couldn't sell Jaguars," says one R.C.A. distributor, "if you had to tell people they could only drive for one hour every other Tuesday."

Sol Libsohn

Three architects of color TV are these engineers who won the Zworykin Television Prize of the Institute of Radio Engineers. Bernard D. Loughlin, far left, of Hazeltine Corp., won it in 1952 for his outstanding contribution to theory, understanding, and practice. Alda V. Bedford, center, of R.C.A., won it in 1954 for demonstrating that color information need not be sent in great detail provided brightness is sent in detail. Harold B. Law, right, of R.C.A., won it this year for his work on the "shadow-mask" tricolor picture tube, the only type in commercial use. The 1953 winner, not shown, was Frank Gray, of Bell Telephone Laboratories, whose 1929 work indicated how a color signal could be fitted into gaps in a black-and-white signal.

This fall, however, both N.B.C. and C.B.S. announced an impressive schedule of color programs amounting, in all, to about fifteen hours a week. In the schedule were the World Series, four big college football games including Army-Navy, and a glittering variety of evening shows, including *Our Town*, *Cyrano de Bergerac*, *The Caine Mutiny Court Martial*, the Sadler's Wells Ballet company, and the American première of Laurence Olivier's *Richard III*, a film that reportedly cost N.B.C. $500,000 for one showing.

Simultaneously, R.C.A. has launched its first intensive promotion ("Big Color Is Here"), featuring its two twenty-one-inch color sets, at $795 and $895. The new sets, simplified versions of a model first marketed a year ago, were shown to dealers in June. In addition, about a dozen other well-known set manufacturers (notable exceptions are G.E., C.B.S., and Zenith) are also offering color sets using the R.C.A.-type color picture tube—in some cases even an R.C.A.-built chassis—but not many have reached dealers' floors. Except for R.C.A. and a few other firms, the industry is pessimistic about the demand for sets at $695 and up. And even R.C.A. is having trouble firing up its dealers.

R.C.A. accepts the lack of industry enthusiasm as the repetition of a familiar story. At the end of World War II much of the industry was quite happy meeting the pent-up demand for radios until R.C.A. began beating the drum for black-and-white TV, and offered to provide competitors with full details on its developments. "Someone has to kick these things off or they won't happen," says Robert A. Seidel, R.C.A.'s executive vice president for consumer products. "We've had a lot of experience and we think we know what we're doing. When the public realizes the price of color sets is not going to drop rapidly, then the sets will sell in the same volume as Cadillacs, mink coats, or any other luxury." Seidel probably refers to Cadillacs advisedly, for Cadillac expects to produce 156,000 cars next year, and this may not be far from R.C.A.'s private forecast for its own color TV sales.

What has kept the rest of the industry upset is the possibility that someone will come up with a simple color picture tube substantially cheaper than the "shadow-mask" type (diagramed on page 139) that R.C.A., Sylvania, and one or two others are selling to manufacturers for $100. This is five times the price of a twenty-one-inch black-and-white tube; following the rule of thumb that the price of components must be tripled to arrive at a list price, the shadow-mask tube represents $300 in the final price of a color set.

The first tube in production, of course, automatically gets a big jump on potential rivals, for costs should drop as volume rises. R.C.A. predicts its tube eventually will cost only $10 to $15 more than a black-and-white tube. Familiarity also brings confidence. The industry was horrified when it first learned how much precision was needed in the shadow-mask tube. In the present model (to which C.B.S.-Hytron contributed importantly) the shadow mask contains some 350,000 pinpoint holes, each lined up in proper register behind a million-odd phosphor dots, about 350,000 dots for each of the primary colors.

While the shadow-mask tube can produce pictures of excellent quality, many in the industry doubt it can ever be made to produce pictures as bright as those obtainable with present black-and-white tubes. However, the shadow-mask tube even now is bright enough for viewing in subdued light, and R.C.A. believes that brightness can be further improved. R.C.A., which has spent at least $10 million of its research money on tubes alone, also believes it knows more about alternative designs—and their limitations—than anyone else in the business. "We are still working on tubes," says Charles B. Jolliffe, R.C.A. vice president, "but the shadow-mask tube is the best tube in sight at a reasonable price. There is nothing else on the horizon."

"It's still a horse race"

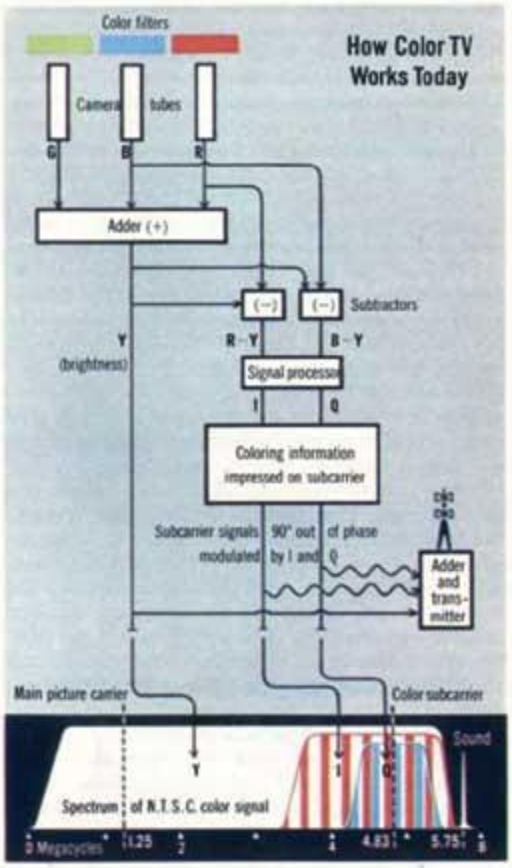
Dr. Jolliffe notwithstanding, there are at least three other color tubes that show substantial merit (see diagrams and descriptions, page 139):

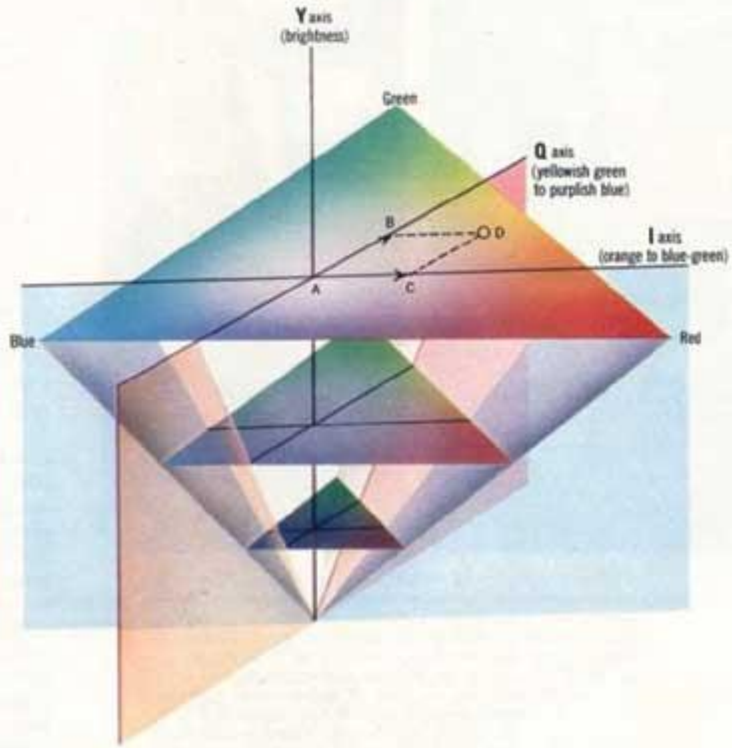
- The Lawrence tube, or Chromatron, conceived by Ernest O. Lawrence, inventor of the famous cyclotron. The Chromatron's pictures are bright, but they probably cannot yet match those of the shadow-mask tube in color quality and detail. There are also manufacturing problems to be solved.
- The General Electric post-acceleration tube, first demonstrated to the industry in September. The tube produces very brilliant pictures but these too are less sharp than the shadow-mask tube's. G.E. freely admits it still has design and manufacturing problems to solve and that commercial production of the tube is perhaps a year away.
- The Philco "apple" tube. Not yet publicly demonstrated, the "apple" is the simplest color tube, but it is at least as far from commercial usefulness as the G.E. tube.

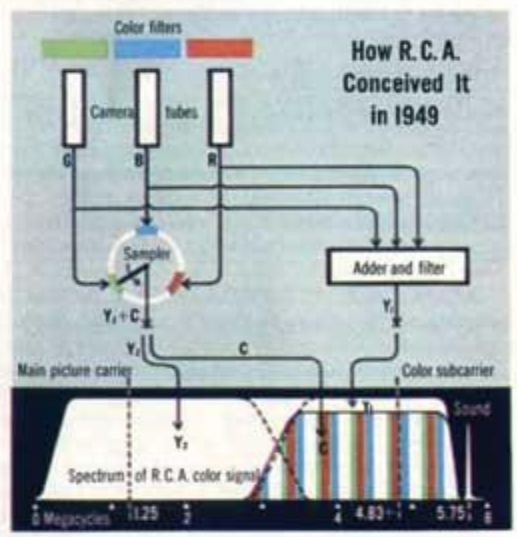
"It's still a horse race," says David Smith, Philco's research vice president. "No one knows which tube will win out. The initial tooling on a color tube will cost several million dollars. You have to be sure you're right before you go ahead." Only R.C.A. has tooled up for volume production

Text continued page 201
Overleaf: how color TV works

Transmitting Color Is a Problem Solved . . .







To R.C.A. goes the credit for first demonstrating, in 1949, a compatible color-television system that could fit into the bandwidth allotted to black-and-white, i.e., six megacycles. R.C.A.'s experimental equipment, built under heavy pressure, embodied new and puzzling concepts, and the FCC found its pictures unsatisfactory. Bernard Loughlin of Hazeltine Corp., a research and development firm in Little Neck, New York, then showed that the R.C.A. signal contained two useful kinds of "information": a brightness signal and a "chrominance" signal (carried by a subcarrier). Chrominance means coloring information that must be added to a brightness picture to create a color picture. This clarifying concept led to a better apportionment of signal elements. The diagrams above include refinements added by the industry's National Television System Committee and adopted by the FCC in 1953.

The three-dimensional abstraction, upper right, shows how a color signal can designate any color in the spectrum by assigning values to each of three axes: Y, I, and Q. The Y establishes a brightness axis, along which lie a series of color triangles. I and Q—the "chrominance" axes—define the hue and saturation of any particular color—as AB and AC define D. Saturated colors (i.e., containing no white) lie at the edges of the triangles; unsaturated ones lie inside.

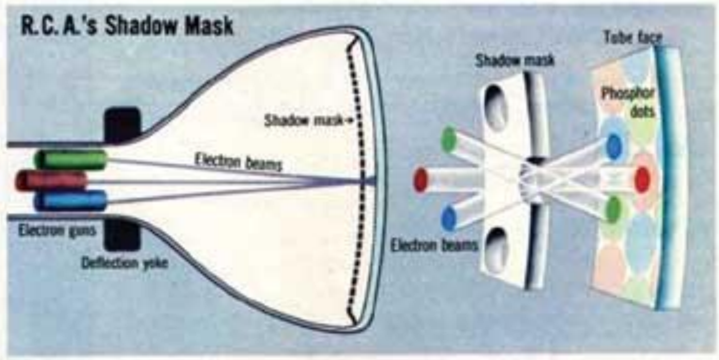
The diagram above shows a system for obtaining Y, I, and Q. Y is essentially the standard black-and-white signal. I and Q are derived by electronic juggling of red, blue, and brightness signals and represent a set of coloring directions keyed to exploit the eye's low acuity for colors lying between yellowish-green and purplish-blue—colors on the Q axis. The eye has relatively high acuity for colors lying between orange and blue-green—the I axis. Thus Q can be given least channel space, as shown in the spectrum diagram. In a picture containing fine color details, Q drops out first, leaving only I-axis colors—which are enough to satisfy the eye. In very fine details even I colors disappear, but again the eye is fooled for it cannot see these details in color anyway. These details show up only as brightness (i.e., black-and-white) variations. I and Q information is "interleaved" in gaps in the Y signal by a secondary signal called a subcarrier.

This R.C.A. color proposal of 1949 laid the basis for the present signal. It "interleaved" color (C) in gaps in the brightness signal (Y_1 and Y_2); it provided brightness in full detail; and it was compatible. A sampler or switch took 3,580,000 samples of each color every second. R.C.A. had trouble unscrambling the signal with accuracy, and early receiving techniques placed undesirable dots all over the picture. R.C.A. is confident its 1949 signal could have been made to yield very acceptable results.

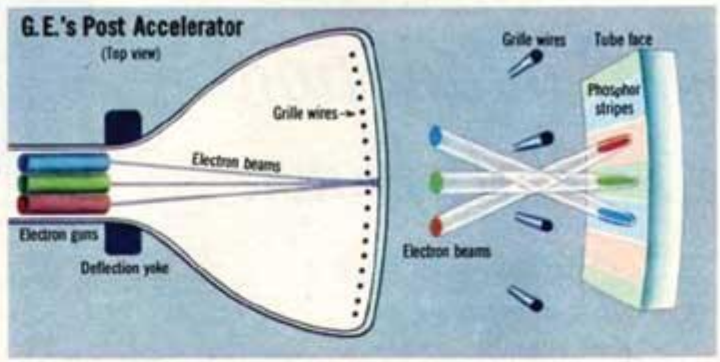
Diagrams by Max Gschwind

. . . Displaying It Best Is a Problem Still

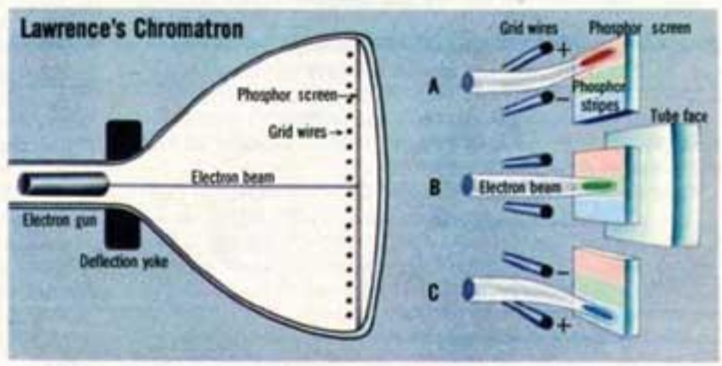
R.C.A.'s direct-view tricolor picture tube is the only type now in commercial use. It contains three electron guns, each "sighted" to strike phosphors of only one color. (The dots are actually colorless; they generate red, green, or blue light when struck by electrons.) The tube face contains some 1,050,000 dots, 350,000 for each of the three colors. Each electron gun is screened off from the 700,000 dots it must not strike by a shadow mask containing 350,000 holes, each one-third the diameter of a pin. The first R.C.A. tubes carried the dots on a flat glass plate inserted back of the tube face. The dots were laid down by a silk-screen process. Later C.B.S.-Hytron came up with a curved shadow mask and showed how to apply the dots directly to the curved tube face by a photographic process using the mask to create the dot images in precise register.



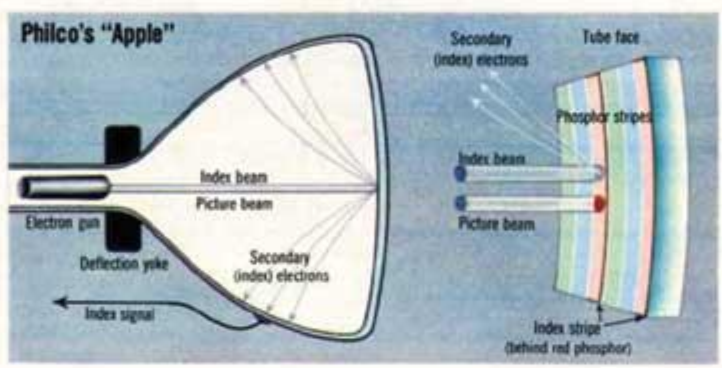
G.E. showed its post-acceleration color tube to the industry for the first time in September. If manufacturing problems can be solved, it may be ready for market next fall. G.E. has pushed research on its tube because it considers the R.C.A. tube deficient in brightness. In the R.C.A. tube, brightness is limited by the shadow mask, which prevents about 85 per cent of the electrons generated from ever reaching the screen. G.E. replaces the shadow mask with grille wires, which intercept only about 15 per cent of the electrons. The wires alone, however, would not confine the beams to their appropriate phosphor stripes, so G.E. provides a voltage rise between the wires and the tube face. This accelerates the electrons and focuses them at the same time. (Note that the G.E. tube is shown from the top; all others are shown in side view.)



Ernest O. Lawrence, Nobel-prize-winning physicist of the University of California, conceived the Chromatron about five years ago. Since 1951 it has been under development by Chromatic Television Laboratories, Inc., 50 per cent owned by Paramount Pictures. In the Lawrence tube the electron beam from a single gun is made to strike the desired stripe of phosphors by a circuit that switches the polarity of alternate wires in a grid of some 600 wires. Since electrons are repelled by a like charge, they bend away from wires charged negatively. This is shown happening in A and C of the diagram, right. When the wires are charged alike, as in B, the beam goes through undeflected, but is sharpened as in the G.E. tube. The Chromatron's one-gun design permits some important circuit simplifications not available to three-gun color tubes.



Philco's tube, code-named "apple," differs so little from an ordinary black-and-white tube that it is potentially the cheapest of the four shown here. It may need, however, six to twelve more vacuum tubes in its supporting circuit than a three-gun color tube. In the "apple" the electron beam moves without constraint. Thus if it is crossing a "green" stripe when the broadcast signal calls for "red," the circuit waits a fraction of a microsecond until the beam has reached "red" before turning up the beam current. To produce yellow, the beam "illuminates" red and green in sequence. The circuit "knows" where the picture beam is by monitoring the secondary electrons given off by the index beam as it strikes special stripes. The index beam is pulsed some fifty million times a second so that its secondary electrons—similarly pulsed—can be distinguished from those generated randomly by the picture beam.



Fortune, November 1955

Courtesy of Wayne Bretl