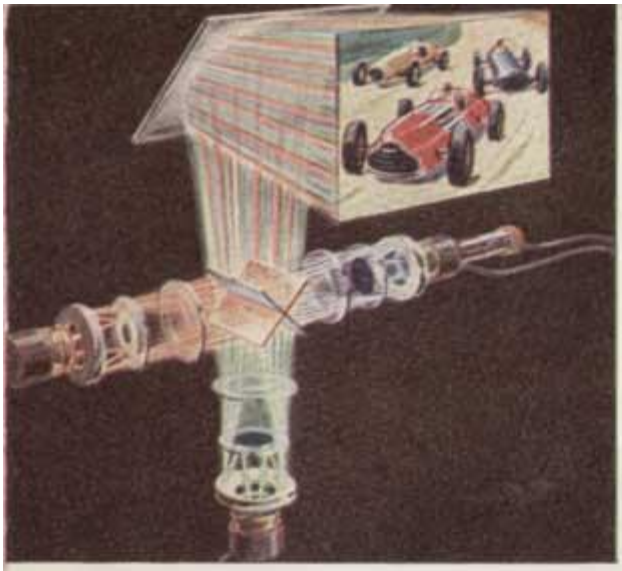
Rainbow on the TV Screen

Above, two stars of black-and-white TV, Kukla and Fran Allison, go into their act in front of an RCA color-television camera during the demonstrations in Washington. Below, these photos of an RCA color receiver in operation give you a sample of what you will see at home when television converts to color

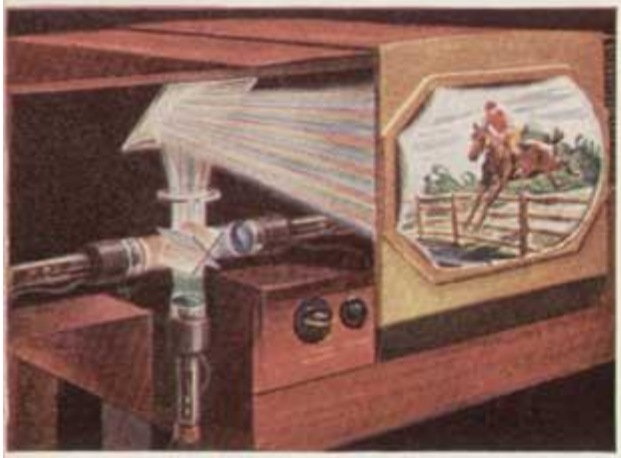
By Richard F. Dempewolff

IN THREE Washington, D. C., hotels last fall, harried television engineers bustled around a collection of ordinary-looking TV sets, tinkering and making adjustments. Seated in rows of chairs before the sets, hordes of newspapermen, radio and FCC executives stirred and chatted noisily. Suddenly, on each screen, light flashed. "Television," someone announced, "brings you a package of rainbows."

A hush fell over the audiences as the video sets came alive with a parade of programs in brilliant full color. Dancers in pastel gowns whirled across multihued set backgrounds. Brilliant yellows, reds and blues of a puppet show leaped from the screens. Some audiences saw a football game; watched the tan pigskin travel back and forth across the white-marked greensward, while red and blue jerseys of the players stood out with such clarity that they seemed almost to have a three-dimensional quality—a phenomenal characteristic of this new miracle. What's more, people look human—even in close-ups.



Above, drawing of RCA projection system, with its three kinescopes. The two dichroic mirrors, center, superimpose the three colors to form a single image



Above, RCA converter changes black-and-white sets into color receivers. Estimated cost: $145 to $195

The RCA receiver at left has direct view instead of projected image. Two dichroic mirrors superimpose the images from three tubes so they are seen as one

For 10 years, color on the TV screen has been an established fact in the laboratories of several large radio companies, while an eager public drools with anticipation. Its sin was in being born so close on the heels of black-and-white TV which today, comprising some 2,500,000 set owners and 87 stations, represents a staggering investment of millions of public and business dollars. The Gordian knot of the industry has been to produce a system of color that will not make obsolete all the black-and-white equipment now in existence.

Now, three companies—RCA, CBS and Color Television, Inc.—claim they have licked the problem of "compatibility." The Washington demonstrations before the FCC were aimed at determining which system is most practical.

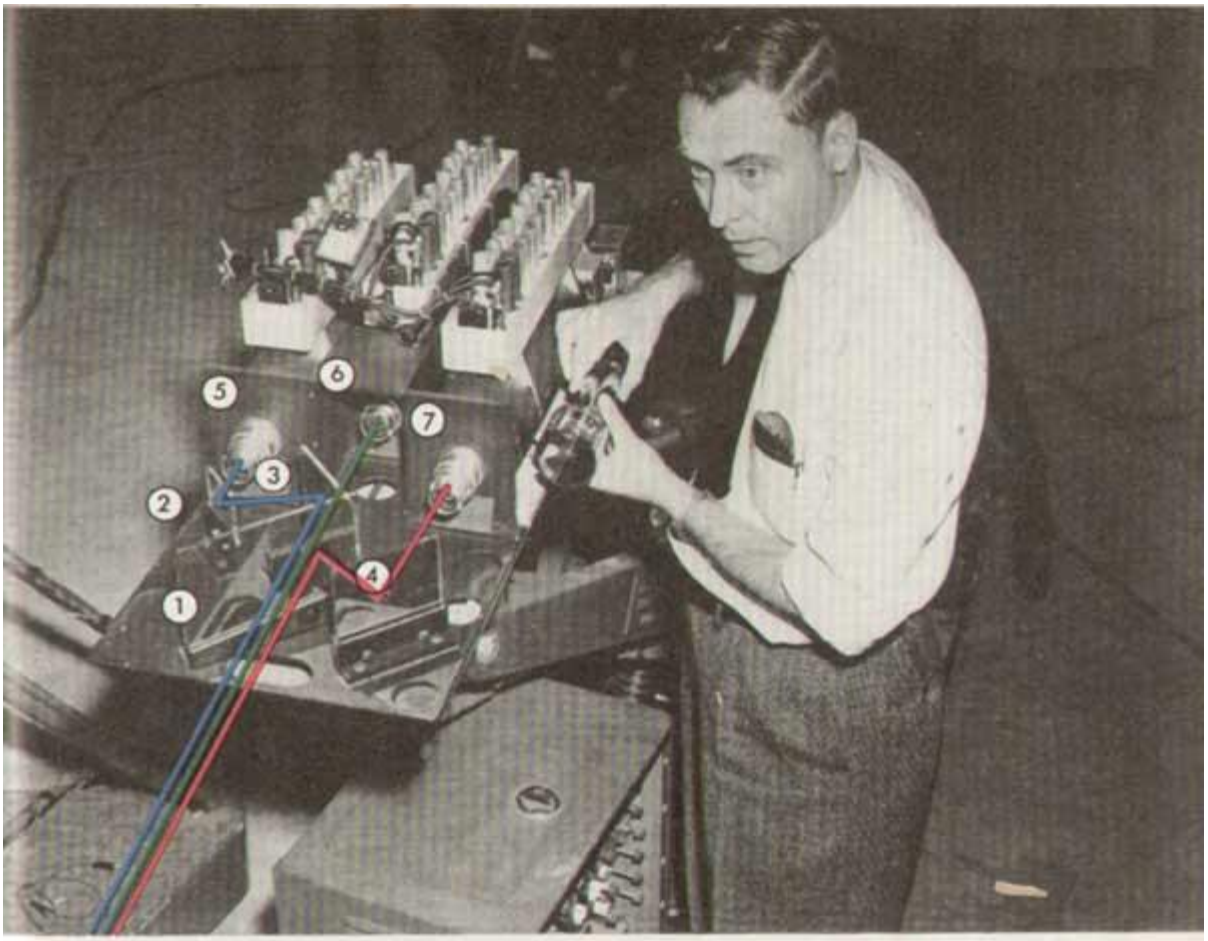
How do these systems differ and how do they work? Few people, even today, know what makes the picture on their black-and-white video screen. Actually, it is not a solid mass of light and shadow at all, but is made up of a series of lines—like old woodcuts.

In television, the lines are "etched" by a single ray or "flying dot" of light, about the diameter of a pinhead. This ray moves back and forth, progressing downward across the screen of the cathode-ray tube, at a speed so incredible that to the eye it appears like a solid square of light, the size of the screen.

In 1/60 second it makes a trip of 262½ lines, then repeats it in another 1/60 second. On the second trip, it covers the spaces between the first lines of light. This is known as "interlacing," and its purpose is to minimize flicker.

That tiny pin point of light, as it moves along, literally paints the picture on the screen. In the studio, a camera is "scanning" the scene in similar lines, and as light or shadow is picked up by the scanner, it is translated into electrical impulses, which in turn are transmitted and picked up by the receiver in your living room. These impulses make that "flying dot" of light in your own set get brighter or dimmer in just the right places, as it flies along. In black-and-white TV you get a completely new picture of 525 lines every 1/30 second. Result: wireless movies.

In all color systems, the same flying dot is used—but the electronic geniuses have rigged special devices which make it paint colors instead of just shadows and highlights. CBS' device is a mechanical color wheel. Newer, but still undergoing development, are the electronic systems about



RCA's color camera without cover. Blue rays go through dichroic mirror 1, are reflected by dichroic mirror 3 and regular mirror 2 into lens 5. Red rays bounce off dichroic mirror 1 and regular mirror 4 into lens 7. Green rays pass through both dichroic mirrors, 1 and 3, directly into lens 6 in the center of the camera

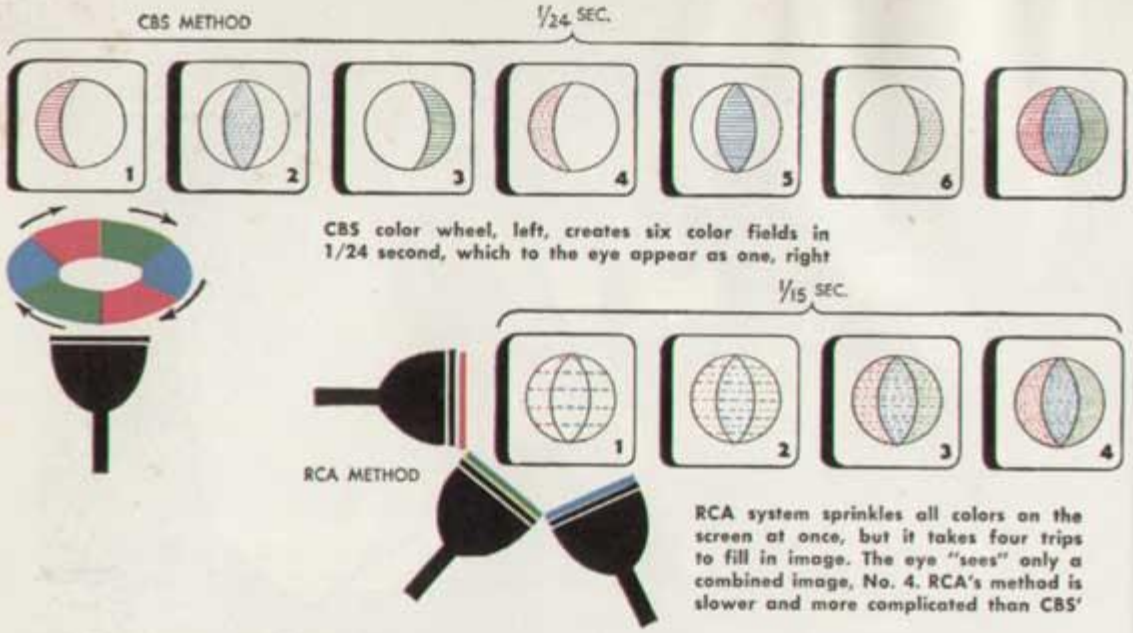
which there is much controversy. Let's look at both methods.

Dr. E. W. Engstrom, vice president in charge of research at RCA laboratories, introduced a purely electronic color system which makes the flying-dot "paintbrush" do everything but turn handsprings. Magicians of the system, he explains, are "time multiplex transmission," adapted to television from radio telegraphy, and the complex "electronic sampler." Those are just words; in a minute you'll see what they do.

The camera, developed by a tall, handsome RCA engineer named Dick Webb, has three lenses—one for each of television's three primary colors — green, red and blue. Suppose the camera is focused on the brilliantly colored stage on which Kukla, the puppet, and Ollie, the green dragon, cavort for the TV audience. All those colors pour into the open front of the camera. But suddenly they start bouncing around. A tricky system of dichroic mirrors, which transmit some colors, but reflect others, permits only green to enter the center lens. Red is bounced off one mirror and reflected into the right lens. Blue bounces off another and is reflected into the lens on the left.

Now, three scanner tubes, one behind each lens, are scanning three pictures of Kukla and Ollie—one showing only the red in the scene; the others only the blue and green.

And here's where the sampler comes in. It actually samples the color intensity picked up by each of those three scanners as it moves along. It samples in sequence—first the green, then the red, then blue, and the speed of its sampling is clear out of this world. Each color is sampled 3,800,000 times a second, for a total of 11,400,000 color samples a second. The green sampler dot, for instance, may be just starting its trip across the first line of the picture field. It samples the picture for green, and exactly nine hundred-millionths of a second later the red is sampled, and so on. Now, in these microscopically split seconds, each color signal is turned into an electrical impulse, which goes out over the time multiplex transmitter—an ingenious device that times and synchronizes the sequence of all those impulses and sends them out as one signal — and is unscrambled and



CBS color wheel, left, creates six color fields in 1/24 second, which to the eye appear as one, right

RCA system sprinkles all colors on the screen at once, but it takes four trips to fill in image. The eye "sees" only a combined image, No. 4. RCA's method is slower and more complicated than CBS'

changed back in reverse order on your home receiver. Out come Kukla and Ollie in gorgeous full color.

It's not as simple as that, of course. In the RCA system, the receiving unit contains three kinescopes, each receiving an image from a flying dot painting the picture in its own color. All these dots are flying along at the same relative position as samplers in the studio, and each is splattering the screen with millions of specks of its own specific color, one after another. So each line on the screen is actually made up of a whole string of color specks; green, red, blue, green, red, blue, ad infinitum.

Besides coming back to "interlace" lines, Doctor Engstrom's flying-dot paintbrushes also jog sideways a hair each time the field is covered so that the color specks also "interlace" every 1/60 second. The result is the biggest mess of color specks you ever saw in your life and so fully is the image "covered" that no human eye in the world can detect a flicker. Even looking close up, the picture seems to be made up of solid masses of color, with just a faint swirling motion like the movement of wind across a wheat field.

Doctor Engstrom points out that with this system, people with current black-and-white sets would be able to get black-and-white reception of the color programs without doing a thing to the sets they own. To receive color, they would have to buy a converter unit.

Actually, black-and-white reception from RCA's color cameras beats anything you're seeing now. Engineers, sweating out the FCC demonstrations at the RCA studios in the cellar of the Wardman Park Hotel in Washington last fall, proved this to everyone in the audience by accident.

The color demonstrations dragged on too long and the regular scheduled telecast time was creeping up. Black-and-white TV cameras must be warmed up before use, but all the engineers were too busy that day on an important color demonstration to get the black-and-white cameras ready. Finally, the color program ended—simultaneously with starting time for the scheduled network telecast. "There was only one thing to do," explains an RCA engineer. "We turned the color cameras on the black-and-white set, prayed and let fly. Five minutes later phone calls began to come in from points as far as Cleveland. They all said the same thing 'Hey, this is the best definition and brightest reception we've ever had. Why can't we get it this way all the time?' "

What will RCA color cost? Set manufacturers have estimated that converter units to make present black-and-white sets

RCA's two-color receiver is cheaper than the three-tube models, but it can't give true-to-life colors

spew color, would cost from $145 to $195 installed. New sets would cost you from $400 to $1000, depending on how lavish you want to get.

The only other all-electronic system up before the FCC is one devised by Color Television Incorporated, a West Coast organization that veils its technique in mystery. In many ways, it resembles the RCA system except that the flying dots lay down the color sequences by lines instead of specks. In split seconds, red, green and blue lines of color follow each other down the screen, painting as they go. Since the company has held no public demonstrations, few people know what the pictures look like.

Oldest and most tried color TV system is the one developed by Dr. Peter Goldmark of CBS, an earlier version of which was fully described by *Popular Mechanics* in April 1941. It employs standard black-and-white-transmission apparatus and a single receiving tube. Its secret is a couple of disks with red, green and blue filters. One, with 12 color filters, turns at 720 revolutions a minute in front of a pickup tube in the camera. The other, with six filters (to cut down size) turns at 1440 revolutions a minute in perfect "synch" with the camera disk, in front of the receiving tube on your set. When the red filter is in front of the tube, the red elements of the picture being "shot" appear on the screen. The disk is so timed that, in the split second it takes the flying dot to make one tour of 441 lines down the screen, the wheel has turned to the next color, blue, and the flying dot paints the blue in the picture on the screen. Then the green dot goes down the screen. Now the red comes back and interlaces. This goes on and on at a rate of 29,160 lines of color per second, or somewhat faster than you can count them. Twenty-four color pictures appear every second.

This is a CBS color-television receiver. It uses a projection system to fill its giant 21-inch screen

Actually what is happening is that single-color pictures are being laid down one on top of another at a speed so great that the human eye can't follow them and they merge into one full-color picture. In effect, it is like a three-color printing process.

Because of the rotating disks, the CBS system has become known as mechanical, much to the annoyance of the engineers who point out that the actual transmission of impulses is just as electronic as any other system.

An interesting feature of Columbia's system is the tremendous control achieved by the man at the "color mixer." By turning dials, he can

With the CBS color camera focused on Patty Painter, known as "Miss Color Television," technicians get ready to shoot a scene at the FCC hearings

produce almost any lighting effect desired on the scene being televised. By increasing blue he can make a sunny day gloomy. By adjusting red, scenes shot in the studio can be made to look like outdoors on a sunny day. Auras of blue, red, green, purple can be cast over an orchestra or dance team for "mood" setting.

The brightness of the CBS color pictures is almost uncanny whether the light at the scene of televising is good or bad. To demonstrate this, CBS engineers in Washington televised a girl under full studio lighting. Then they began to douse the lights, one bank at a time, until the light level was too dim to read by. In spite of this, the pretty model gleamed 15 times brighter on the receivers than in the studio.

This odd but handy quirk would be a boon in televising outdoor sports, CBS points out. To prove it, they televised a football game on a rainy day in Washington. The players' jerseys were so bright on the screen that, for all the audience could tell, the sun was shining.

What happens on current black-and-white screens when Columbia color cameras are televising? A shapeless gray mass of shadow appears. Adapter units to make black-and-white reception possible would cost $20 to $50 or a handyman can build his own. Converters to make present sets bring in color would cost from $75 to $80 and new color sets from $250 up.

Which brand of color TV will be approved by the FCC, nobody knows at this writing. Most set owners don't care, as long as they get rainbows on their screen. But the value of color TV goes much further than that.

Last year, CBS, in cooperation with Smith, Kline and French, pharmaceutical manufacturers, demonstrated beyond doubt that its system works and has a terrific potential in science and industry as a teaching medium. At Atlantic City, Denver and Chicago medical conventions, adaptations of CBS equipment, built for the pharmaceutical house, were used to televise surgical operations.

The unique camera, specially designed by CBS for teaching surgery, can be focused so the screen image is actually bigger than what the surgeon sees. Hooked to one end of a six-foot steel arm and balanced at the other end by a metal box containing the scanning equipment, the camera sits high on an upright standard and peers directly down on the patient. Students, instead of craning necks from distant seats in an amphitheater, sit back in easy chairs and see every detail as though they were looking over the surgeon's shoulder.

So graphic were the pictures on the screen, that six members of the audience fainted during an eye operation. No details escaped the color camera. When a surgeon severed the wrong blood vessel, the audience leaned forward tensely, heard him cry, "This never happened to me before," and watched every motion of his swift hands as he called for instruments and quickly sutured the vessel.

The fact is that color television is here. One by one, the problems are being solved. Recently, Dr. Willard Geer of the University of Southern California announced that he had a new receiver that can pick up telecasts transmitted by any of the systems known—including present black-and-white. The heart of the set is a single tube, which shoots out three separate flying dots from three little electron guns in its base. They will paint colors on the screen one after

If you own a black-and-white set and CBS color is authorized by FCC, all you will need to pick up pictures in full color is an adapter like the one this girl is sliding in front of the set. Circular case contains a color wheel. Cost of unit: About $75

another, all at once or, simply by turning a switch, all the guns will get the same signal and black-and-white will result.

At this writing, the FCC, watchman of the airways, is testing color receivers of CBS, RCA and Color Television, Inc., to be sure the public gets the best system as soon as possible. Whatever the outcome, most experts feel that within two years the chances are good that you'll be watching color on your video screen.

Left, the diagram shows how the CBS color system works. Above, the color camera picks up the image and breaks it down into sequential impulses. An engineer at the control panel feeds these impulses to the transmitter and they are then broadcast, the same as black-and-white, to color receivers. Set shown here has the color adapter in front of it. Of course, color sets can be made with color wheel built in

Already, CBS color TV has proved its value to surgeons all over the country. Right, at St. Luke's Hospital in Chicago, the TV color camera, center, telecasts an operation for study by surgeons who see it on receivers on the other side of town. That's the control panel at the left of photo