3. TELEVISION

3-1 RECEIVERS

A number of projects relating to separate functions of a color television receiver, which were begun in 1953, were brought to a conclusion in 1954. Among these were studies of automatic chroma control, a triode demodulator, and the use of a round-nosed i-f amplifier with compensation in the succeeding video stages. With these studies as a basis, two parallel projects, one in the Princeton laboratories and the other in the Industry Service Laboratory, were carried out to produce simplified color television receivers. These complete color television receivers are described in the following paragraphs, together with a resume of the related projects.

Experimental Color Television Receivers

In order to further the development of color television receivers in the direction of commercial design, two experimental receivers were developed and constructed during 1954. These two receivers are a continuation of the series of receivers developed during the previous year, which paralleled the evolution of the color television signal specifications. In order better to evaluate certain circuit innovations as well as new apparatus, such as the twenty-one inch shadow-mask color kinescope, additions and alterations were made in the experimental laboratory test receiver. This apparatus was also used to test a concept of color receiver operation involving the control of the reproduced color gamut as determined by the degree of saturation.

The first of the two experimental receivers was developed primarily to serve as an indicator of the simplifications which might be accomplished in color receiver circuitry and design, while still maintaining a high degree of performance. The resulting receiver operated a fifteen-inch shadow-mask color kinescope and used a total of 23 tube envelopes.

The second experimental receiver embodied other approaches to the simplification of circuits which would still make use of the full I-Q information in the transmitted signal. Innovations included a demodulator and matrix combination utilizing crystal diodes; a color synchronizing circuit involving one tube envelope and operating in accordance with the features of both an injection lock system and a crystal-ringing system; a simplified color disabler circuit; and a new type of automatic chroma control.

References:

PEM-415, "Color Gamut Control as Determined by Saturation," by D. H. Pritchard.

PTR-410, "A Simplified Color Television Receiver," by D. H. Pritchard.

For further information refer to:

D. H. Pritchard.

A Simplified High-Performance 21-Inch Developmental Color Television Receiver

During 1954 a simplified color television receiver using the RCA 21-inch color kinescope, 21AXP22, was developed and demonstrated to RCA licensees.

Figure 1—28-tube 21-inch color receiver.

The over-all degree of simplication attained is reflected in the relatively low total power consumption of 295 watts, and a total of 28 tubes, including the color kinescope, three tubes in the combination VHF-UHF tuner, and three high-voltage rectifiers.

In the evolution of this receiver, emphasis was placed on attaining in the color circuitry the same high degree of stability which the public has come to expect in the operation of black-and-white receivers. This was achieved through the use of new circuits including color demodulators which are stable with changes in operating voltages and variations in tube characteristics. Stability of color phase was assured by the use of color sync circuitry which made almost all tuned circuits common to both the chroma and color sync circuits. To give maximum ease of operation, automatic chroma control was provided. In the same way that automatic gain control (a-g-c) maintains the luminance output independent of variations in picture carrier field strength, so automatic chroma control (a-c-c) maintains the chrominance output constant with variations in the color subcarrier.

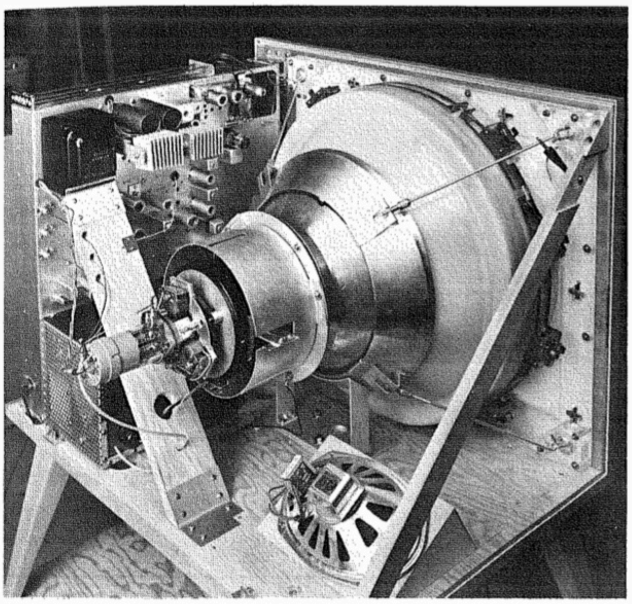

Figure 2—Chassis and kinescope-mounting arrangement in the 28-tube 21-inch color receiver.

A full-bandwidth i-f amplifier was employed to obtain flat amplitude response and constant time delay over the region occupied by the chrominance signal. In addition to the resulting improvement in color fidelity and reduction in color cross talk, tuning was made less critical.

To enhance the stability of both the gray scale and color reproduction, the high-level chrominance demodulators were coupled directly to the three kinescope grids. These demodulators provide the same degree of stability and linearity for the chrominance channel that a high-level diode detector provides for the luminance channel.

The magnetic convergence circuitry employed was simplified and stability improved by the elimination of tubes in this section of the receiver.

Service accessibility was facilitated by vertical chassis mounting alongside the kinescope, and by an integral cabinet unit removable to expose all parts of the receiver chassis and the kinescope. Convergence and other set-up controls are available at the front of the cabinet behind a subpanel.

Reference:

LB-962, "A Simplified High-Performance Developmental 21-Inch Color Television Receiver."

For further information refer to:

E. I. Anderson or E. M. Hinsdale, Jr.

Automatic Chroma Control

The FCC color television signal specifications prescribe the amplitude ratio between the chrominance and luminance information at the transmitter. In practice a number of things may happen so that the amplitude levels in the receiver chrominance and luminance channels do not have the correct ratio. To facilitate operation of the receiver, the correct ratio should be established automatically rather than manually as was the practice in earlier receivers. In the course of the development of color television receivers, various approaches to chroma control were investigated.

One approach was to compare the relative amplitude of the chrominance and luminance outputs, and automatically to adjust the gain of the chroma channel such as to maintain the correct ratio. The circuit required a differential d-c amplifier to compare a rectified burst signal with a rectified sync signal. This system can accommodate any change in either chrominance or luminance gain. In this method no special effort was made to design simple and economical circuitry, but rather to analyze automatic chroma control and to consider its various aspects.

Another approach was used in the simplified developmental 21-inch color receiver. In this receiver the luminance output was assumed to be constant through the use of keyed a-g-c. The automatic chroma control therefore was merely required to keep the chroma output constant. This was done by sensing the amplitude of the burst signal on one side of the balanced phase detector and using this voltage to control the gain of a common burst and chroma amplifier. This system provided effective automatic chroma control without additional tubes.

In connection with these investigations the CT-100 receiver was used to evaluate methods of sensing the amplitude of the burst signal to be used as the control signal. Some of the methods investigated included: sensing of the plate current of the burst amplifier, sensing of the screen current of the burst amplifier, and sensing the output of the phase detector as was done in the simplified receiver described above. Conclusions were reached as to the range of chrominance signal variation which should be compensated. This range appears to be approximately a 4:1 decrease in signal and a 2:1 increase in signal as compared to the correct luminance-to-chrominance ratio. However, none of these circuits was actually incorporated in the CT-100 or the ensuing CT-55.

Rather than varying the gain of a tube to change the chroma signal as was fundamental to the systems mentioned above, the response curve of the receiver i-f amplifier can be altered such as to favor the chrominance signal and thus vary the relative gain between the chrominance and luminance signals. Altering the response curve not only compensates for amplitude variations, but in addition compensates for variations in frequency response in both the luminance and chrominance channels. A circuit designed to investigate this approach to the problem was incorporated in the 24-tube experimental television receiver. Through the use of Miller effect the response in the vicinity of the chrominance carrier was varied by changing the bias on the last i-f amplifier stage. Bias was obtained from the detected amplitude of the separated burst. This system accomplishes automatic chroma control with the addition of a crystal diode.

References:

PTR-386, "Automatic Chroma Control in Color Television Receivers," by K. Karstad.

LB-962, "A Simplified High Performance 21-Inch Developmental Color Television Receiver."

For further information refer to:

K. Karstad, A. Macovski, or D. Pritchard.

Improved Triode Demodulator for Color Television Receivers

The triode demodulators described in the 1953 Research Report were simplified to the point where the entire chroma decoder required two triodes rather than the original three. This was accomplished through improved stabilization of the d-c operating point such that the tube drop was relatively independent of both drive and supply voltages. This made it possible to take the G-Y signal through a common cathode connection of the B-Y and R-Y demodulators rather than requiring a third demodulator.

Reference:

LB-959, "A High-Level Triode Color Demodulator."

For further information refer to:

A. Macovski.

Color I-F Amplifier

Most black-and-white television receivers built today use a "round-nose" type of intermediate-frequency pass band. An i-f amplifier providing that type of characteristic is more economical to build and generally easier to align than one having a flat top. Deficiencies in high-frequency response of a round-nose amplifier can be at least partially compensated in following video stages. On the other hand, most color receivers built to date have used a flat-top i-f in order to avoid attenuation of the color information carrier at the high-frequency end of a color television transmission channel.

An investigation was undertaken to determine the feasibility of the use of round-nose i-f characteristics in color receivers having "boosted-high" gain in following video stages to restore the composite luminance and chrominance information to proper over-all balance.

Such an i-f characteristic with complimentary video circuits is being incorporated in some recent color receiver designs.

For further information refer to:

W. L. Carlson.

Cross-Modulation

A project started in 1953 on the evaluation of cross-modulation type of distortion originating in heterodyne converters was completed early in 1954. Quantitative data on cross modulation for a number of tubes and semiconductors were obtained. For tubes operated with grid-leak-type bias, the use of extremely high values of grid-leak resistance reduced cross modulation. However, no generally effective solution to the problem was found, and it appears that major improvements in the future would be most likely to come from tube or semiconductor developments.

Another project was the development of equipment and techniques for measuring cross modulation in television i-f tuners and i-f amplifier units.

References:

PTR-380, "Heterodyne Mixer Cross-Modulation Tests," by J. E. Eckert and E. O. Keizer.

PTR-382, "Cross-Modulation in Television Tuners," by L. L. Burns, Jr., J. E. Lindsay, Jr., and E. O. Keizer.

For further information refer to:

E. O. Keizer.

Operation of 1950 RCA Color Television Receiver on Standard Color Signal

During the past year, some members of industry committees have denied the fact that the color television signal proposed by RCA in 1949-1950 differs only in slight details from the signal specifications now approved by the FCC. In order to illustrate clearly the similarity between the color television signal as adopted by the FCC, and the RCA color signal employing 120-degree sampling as proposed in 1949, a 1950-built direct-view receiver containing three 10-inch 70-degree deflection kinescopes and two dichroic mirrors was chosen for a demonstration. It employed the high-level sampling technique in vogue at that time, and was substantially the same as the receivers demonstrated at the color television hearings in 1949.

The only modifications carried out were as follows: