Radio-Electronics

HI-FI TEST REPORT

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Radio-Electronics

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

SPECIAL TEST EQUIPMENT
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ALL ABOUT SCOPES
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NEW COLOR TV CAMERA
Now You Can Make Your Own

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Stop Burglars Fast

OPERATIONAL AMPLIFIER IC's
See How They Work

PA SYSTEM PROBLEMS
Solve Them Effectively

GERNSBACK PUBLICATION

PLUS
Jack Darr's Service Clinic
Lab Tests Of New High-Fidelity Gear
Step-By-Step TV Troubleshooting Charts

BUILD

this COLOR TV CAMERA for about $400

Having only two channels of video, this camera produces remarkable color pictures. Any amateur or experimenter can build it for about $400

by GARY DAVIS

INCREASING INTEREST IN CLOSED-CIRcuit TV and the public acceptance of color have created a need for a low-cost color camera. A complex, high-quality broadcast color camera can cost $90,000 or more. Although recent developments have brought the cost down for educational and industrial use, prices are still out of range for most amateurs and experimenters.

The camera described in this article was developed on the premise that an advanced experimenter or amateur could build a color camera without getting into extremely complex mechanical, optical, or electrical problems. All parts are easy to obtain. The two vidicon tubes are standard low-cost black and white types. Color filters are low-cost and available at any glass company. To keep the cost, weight, and size to a minimum, a small black and white TV set is used to supply all voltages and scanning signals to the camera head. The camera uses only 12 transistors in addition to the black and white TV set. The optical system is extremely simple. The cost of the camera, excluding the case, is approximately $400.

Color processing

There is a little known process of using only two colors instead of three to generate color images. This theory dates back to 1914 when William F. Fox and William H. Hickley patented a color motion picture process involving a red filtered scene shown alternately with a green filtered scene projected in black and white only while the red filtered scene was projected through a red filter. The effect was later independently re-discovered by Dr. Edwin H. Land in 1955. This phenomenon has since become known as the Land Color Theory after articles by Land appeared in the proceedings of the *National Academy of Science* in 1959 and the May, 1959 issue of *Scientific American*. Dr. Land found that the human eye can perceive scenes in full color when the image is filtered through long- and short-wavelength filters, then recorded separately on black and white photographic film.

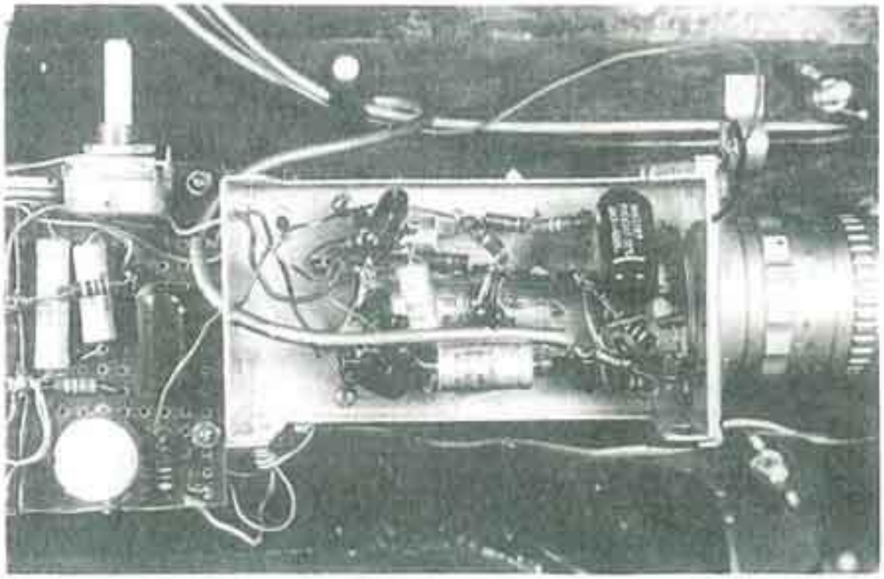
To recover the scene in full color, it is then only necessary to project the scene recorded on the two separate photographs, with a long wavelength light source illuminating the long wavelength photograph, and a short wavelength light source illuminating the short wavelength photograph. In Land's process, the colors in the scene arise not from the choice of wavelengths, filters, or overall brightness levels, but rather from the interplay of longer and shorter wavelengths over the entire scene.

My camera system is similar to Land's process. The two color filter wave lengths correspond to the wave length or combination of wave lengths, generated by the three illuminating phosphor colors in a conventional color picture tube. The filter for the long wavelength image, centered at approximately 650 millimicrons, is red. The short wavelength filter, centered at approximately 475 millimicrons is cyan, a bluish-green. In effect the two color channels are a combination of the three primary colors. Inputs to the green and blue color difference amplifiers of the color monitor are combined, allowing the blue-green phosphor dots to produce cyan, corresponding to the cyan or short wavelength filter in the camera head. The red color difference amplifier and the red phosphor dots of the color monitor handle only the signal from the red or long-wavelength tube.

Colors hold true over a wide range of different red, green and blue images due to the interplay of the red and cyan signals. In fact, the only camera operating color controls are the red and cyan lens iris adjustments. The receiver contrast control may also have to be re-adjusted depending upon lighting conditions. The color receiver tint and color-level controls have no effect in this arrangement since the signal is not encoded to a NTSC signal.

Tests indicate that NTSC color encoding can be done by feeding the cyan signal to the combined blue and green color inputs, and sending the red to the normal red input of a commercial NTSC color encoder. With this arrangement, the camera output could be video taped or transmitted by a ham TV transmitter.

Extensive testing of both the conventional three-tube color system and the simpler two-tube system indicates of course, that the two-tube system cannot duplicate three-tube performance in all respects. The main difference being some averaging of colors along the junction point of the blue-green spectrum, some difficulty with shades of yellow and some hues of magenta. However, the system produces surprisingly good color. The colors are rich and vivid. Blues are blue, greens are green, and reds are red. Complex colors such as skin tones, browns, hair colors, etc. are reproduced well.



Close-up view of one of the preamplifier circuits that are mounted over the vidicon tubes.

The advantage of using only two tubes instead of three, at least for the home experimenter or low-cost application, far outweighs the relatively minor additional color discrepancies encountered with the two-color process. These advantages include:

Camera registration, the art of overlapping images to perfectly coincide, is much simpler.

The camera can be built with one-third less parts.

Camera sensitivity is greater since light must be divided only two ways instead of three.

Optics are much simpler allowing the use of a simple cube prism to split the incoming light in two directions.

How it works

Figure 1 is a block diagram of the entire camera system. Light from the scene first passes through a cube prism. The prism itself absorbs approximately 40% of the light. Approximately 50% of the remaining light is bent 90 degrees to the red lens. The prism is available from Edmunds Scientific Co. The cyan camera lens gets a straight through view of the scene. Both camera lenses are Cosmicar 25 mm, available from Denson Electronics Corp. The prism must be placed before the objective lens so the glass in the prism won't affect the focal length of the lens. The color filters are placed between the lens and vidicon face plate. The cyan filter consists of two layers of Plexiglas green No. 2414. The red

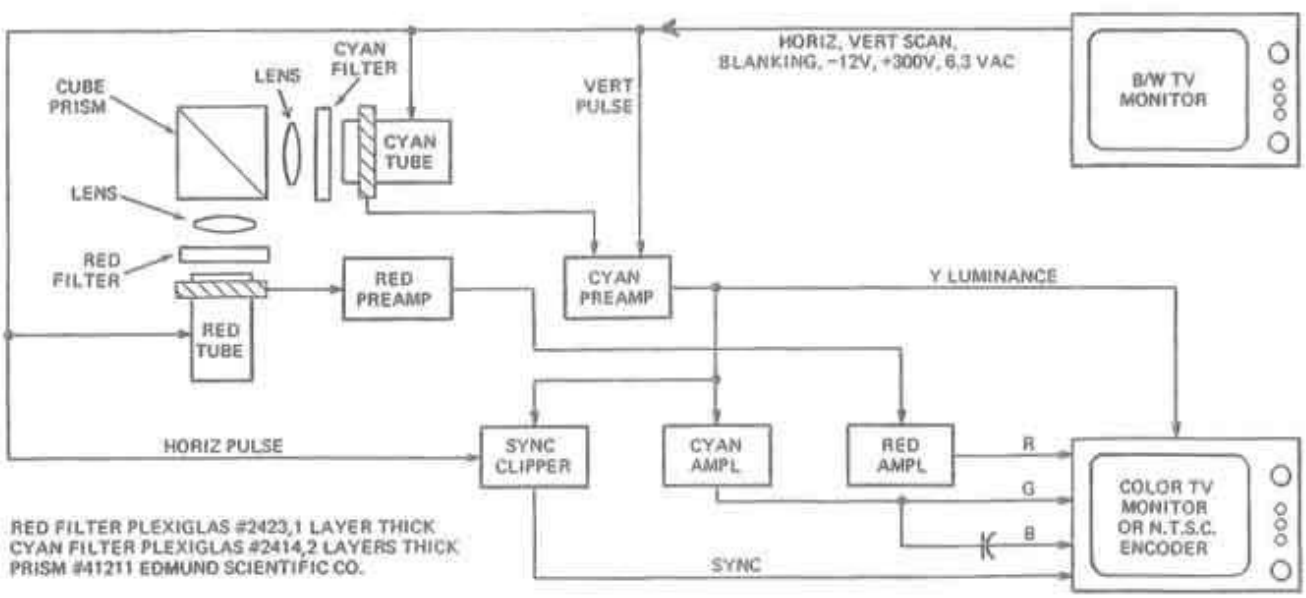
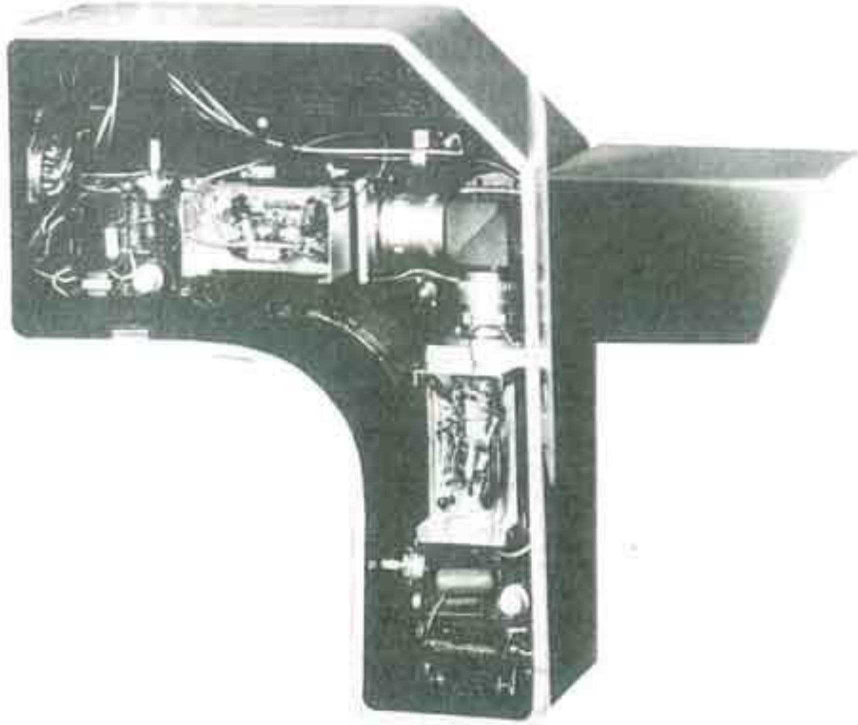


FIG. 1—BLOCK DIAGRAM of the camera head. Operating voltages and sync signals are supplied by a black-and-white TV receiver.

filter is Plexiglas red No. 2423, one layer thick. Both yoke and focus coil assemblies are available from Denson Electronics. This assembly also contains the alignment magnets which are used to register the two images. These yokes are built to very close tolerances and register well. Don't be tempted to substitute another type of yoke.

Again, referring to the block diagram, the black and white TV feeds horizontal, vertical, scan, blanking, −12 volts, +300 volts, and 6.3 VAC to the camera heads. The output of the cyan vidicon is fed to the cyan preamp. A vertical sync pulse is added and the video amplified to approximately 1 volt VP-P. This output also forms the luminance signal and is fed to the color monitor's luminance amplifier to provide the black and white information. The cyan preamp also feeds the cyan amplifier where the signal is inverted and raised in amplitude to drive the grids of the G − Y and B − Y amplifiers. The grids are coupled together with a .5 μF capacitor.

The cyan preamp output is also fed to the sync clipper where the vertical sync pulse is inverted and sent to the color monitor's sync separator. The horizontal sync pulse is fed separately to the sync clipper in order to prevent contamination of the blue and green amplifier in the monitor. The red preamp output drives the red amplifier which in turn drives the R − Y amplifier. The sync clippers, cyan amplifier, red amplifier and a −18 volt power supply are located in the color monitor so that all signals may be sent to the color monitor on a single 4-conductor cable. A multi-conductor cable is used between the black and white TV set and the camera head. This 2-piece configuration also allows the camera to be used hand-held. The camera head weighs 18 lbs.

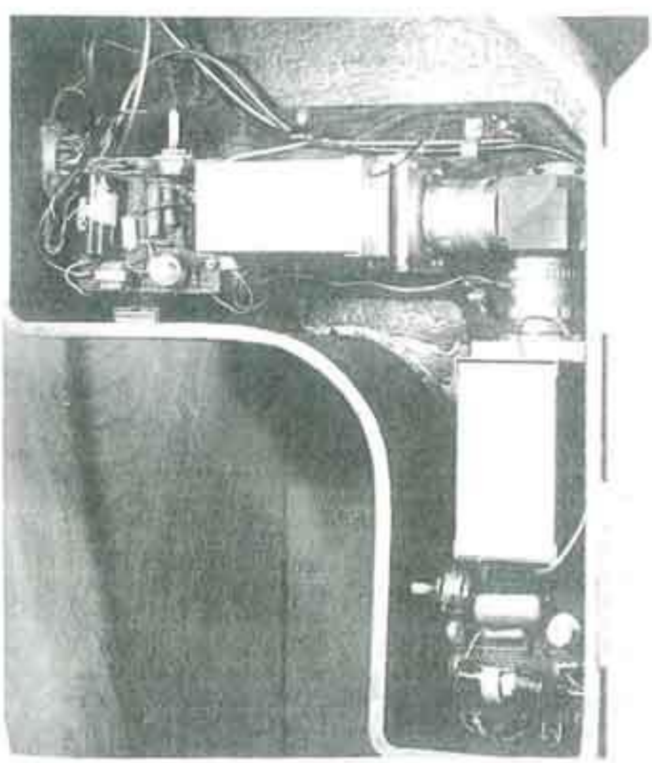


LAYOUT OF THE CAMERA HEAD is shown. Camera case was constructed from sheet metal.

Many camera builders will want to include the small black and white TV in the camera case to act as a view finder. The horizontal sync will have to be re-applied to the TV sync separator for operation as a view finder. Do not use an AC-DC type TV with this project because of the shock hazard involved. A square sun shade on the front of the camera prevents stray light from striking the prism in bright sunlight. Paint the inside of the camera case black. The camera case is not commercially available and may be constructed out of sheet aluminum.

I found the easiest method of mounting the parts for mechanical alignment is to build each camera head as a separate unit. After both heads are tested and operate correctly, lay both heads and the prism on a wood mounting board. The camera is initially registered and adjusted mechanically, optically, and electrically while laying on its side. Remember, for good registration, every optical and electrical parameter—focal length distance, scan amplitude, yoke alignment, optical and electrical focus adjustments—must exactly match the other channel. Finally, when all electrical adjustments and tests are complete, screw down the heads and mount the prism. The whole camera assembly is then placed inside the camera case. All camera tests and registration adjustments are made using a standard TV test pattern with a series of vertical color stripes glued to the top of the test pattern. The colors I use are red, orange, yellow, dark green, light blue, dark blue, and magenta.

Next month we will cover the camera heads, circuit details, modification of the two TV sets, adjustments registration, and final check out. R-E



CLOSE-UP VIEW of camera head shows details of layout and optic system.

BUILD this COLOR TV for about

This month the circuit
head adjustments are
we'll show you how to connect

by GARY DAVIS

LAST MONTH WE PRESENTED THE color processing, block diagram, and general layout of a low-cost color TV camera. This month we will cover the camera heads in detail, including adjustments and registration.

The vidicon tube

Each camera head consists of three basic units. The vidicon-tube assembly, the video preamp and the deflection components. Before we discuss the camera circuitry, let's briefly examine the operation of a vidicon image pickup tube. The tube contains a signal plate of a conducting metallic film, so thin that it is transparent. One side of this plate is coated with a thin layer of photo-conductive material, such as amorphous selenium. The optical image is focused on the opposite side of the signal plate. The photo-conductive material is scanned with an electron beam originating at the vidicon cathode.

The scanning beam deposits just enough electrons on each spot that it touches, to reduce the potential of that side of the metallic film to the cathode potential. However, during the interval

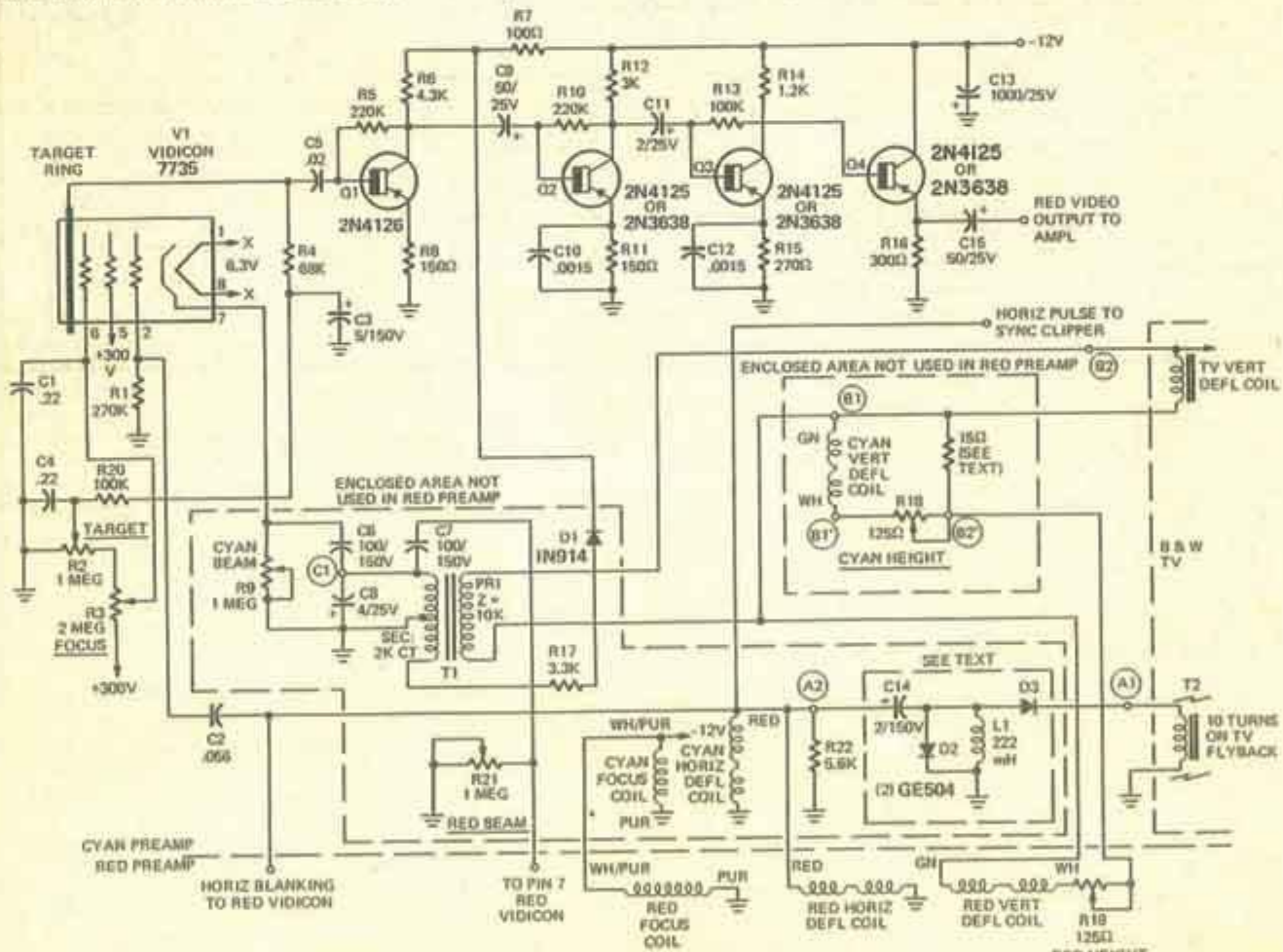
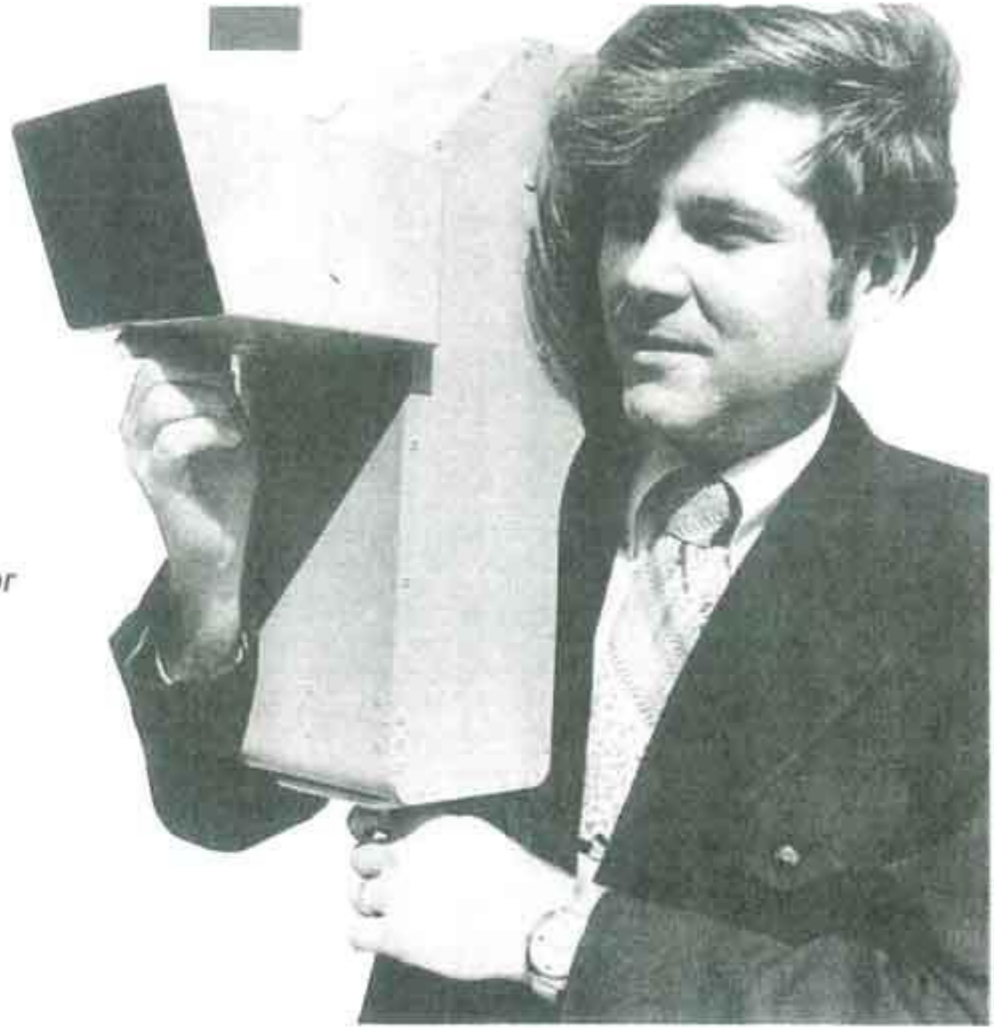


FIG. 2—PREAMPLIFIER for the cyan and red video channels. All components above the dotted line, except where noted, are duplicated for red video channel. A black-and-white TV receiver supplies the operating voltages, sync and blanking signals to the camera head.

CAMERA
$400

etails and camera
overed. Next month,
ne camera head to a color monitor



between successive scans, a charge leaks through the photo-conductive material in proportion to the illumination. The charge deposited on any particular spot of the photo-conductive material the next time it is scanned, is enough to replace those electrons that have been lost by leakage since the last passage of the beam. The total current of the electron beam and the capacitance of the photo-conductive material is in series with the external load resistors.

The preamp

In this camera so much light is absorbed by the color filters and prism, that only a very low level of light actually strikes the vidicon photo-conductive surface. Therefore, the video amplifier must work with a very low signal-to-noise ratio. The schematic diagram of the preamp circuits are shown in Fig. 2. Transistor Q1 should be a low-noise type 2N4126, and may have to be individually selected for low-noise content after the camera is in operation. One should not be satisfied with the signal-to-noise ratio until with sufficient illumination, the pictures are about as noise-free as those received from a local commercial TV station. It will probably not be necessary to individually select the other amplifier transistors.

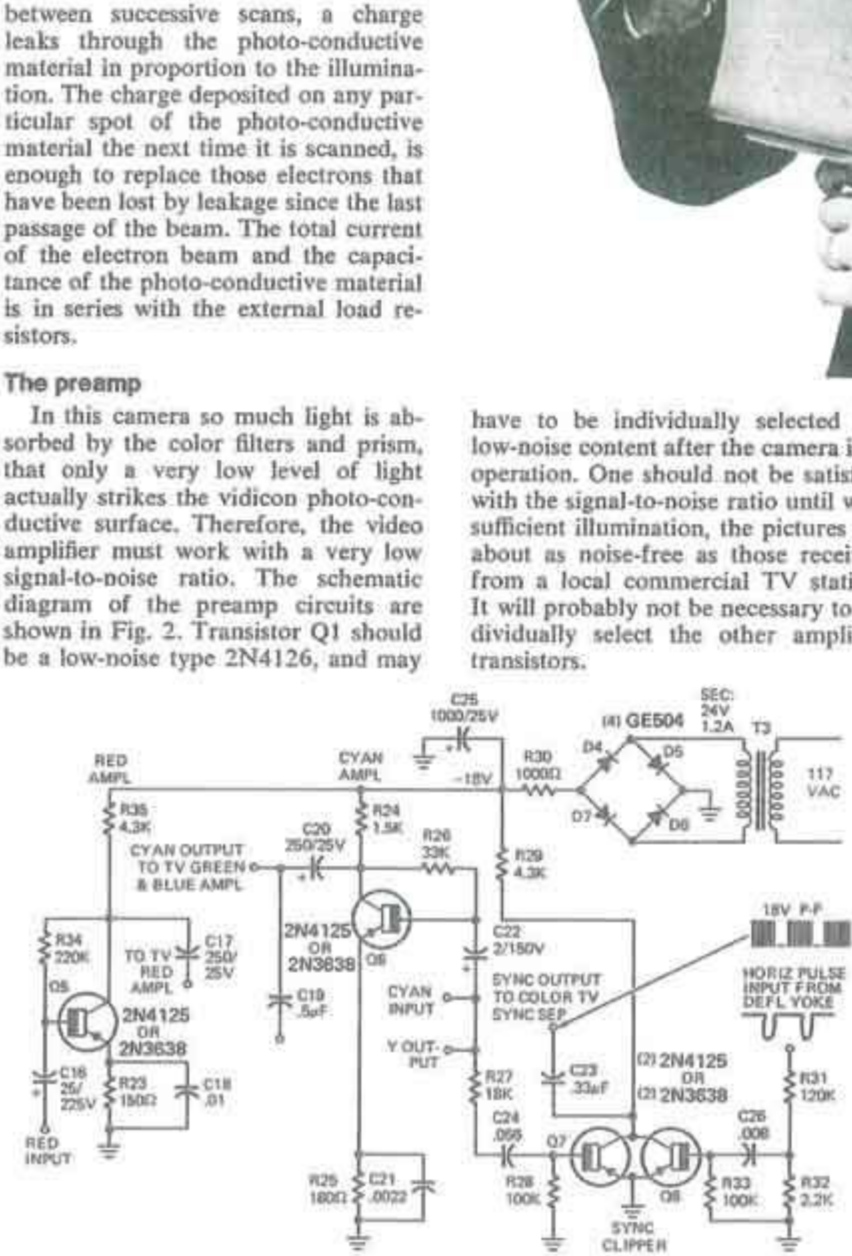


FIG. 3—COLOR AMPLIFIERS and sync circuit. The video and sync outputs are connected directly to the color difference amplifiers and sync separator of the color monitor.

The video amplifier should be mounted inside a metal box to shield the amplifier from extraneous signals. It is important to use short leads and the amplifier should be mounted on the focus coil assembly so that the signal lead from the vidicon target connector to the video preamplifier input is no longer than one inch in length. In dealing with low signal levels at the vidicon output, ground loops and sufficient grounding between components becomes extremely critical. A general rule would be to ground everything possible with short ground leads, including the lens mount and the lens. Good results with my camera were obtained with an unshielded wire for a target lead. However, in metropolitan areas or areas with strong RF signals, a shielded wire may be necessary.

Vertical sync is added to the cyan signal through diode D1 at Q1. The addition of vertical sync slightly tilts the video waveform. However, it has negligible shading affect on the picture. Capacitors C10 and C12 boost the high-frequency response to increase the upper frequency limit of the entire video amplifier. Low-frequency negative feedback is introduced to each stage individually by connecting the bias resistor to the collector load resistance. This arrangement further enhances the relative high-frequency response of each stage. The entire video amplifier has a voltage gain of approximately 100. The color amplifier and sync circuits are shown in Fig. 3.

Deflection and focus assembly

Due to the fact that the red camera head sees a mirror image of the actual scene, the phase of the deflection signal to the red yoke must be taken into consideration. Focus coil windings for both vidicon tubes should have the purple wire grounded (see Figs. 2 and 4), and the white/purple wires connected to −12V. On the vertical windings, yellow is not used. White wires are connected to their respective height controls R18 and R19. The green wires are connected together and common to T1. On the horizontal windings, the red wires are connected together. The cyan black wire is connected to point A2. The red channels' black wire is grounded. Both gray wires of the electrostatic shield should also be grounded. The blue wires are not used. With this wiring arrangement, the deflection assembly should be mounted with the focus coil lead exit-holes for the cyan channel opposite the mounting board. The red-channel focus coil lead exit holes should be next to the mounting board. This arrangement applies to type CY101-1547 deflection assembly available from Denson Electronics.

The vertical deflection coils require 6 V P-P for proper deflection as shown on waveform B1. Each horizontal deflection coil requires 30 to 40 V P-P as shown on waveform A2. It should be noted that for proper operation, the camera requires waveforms and voltage amplitudes as shown. They are supplied by a small B/W monitor.

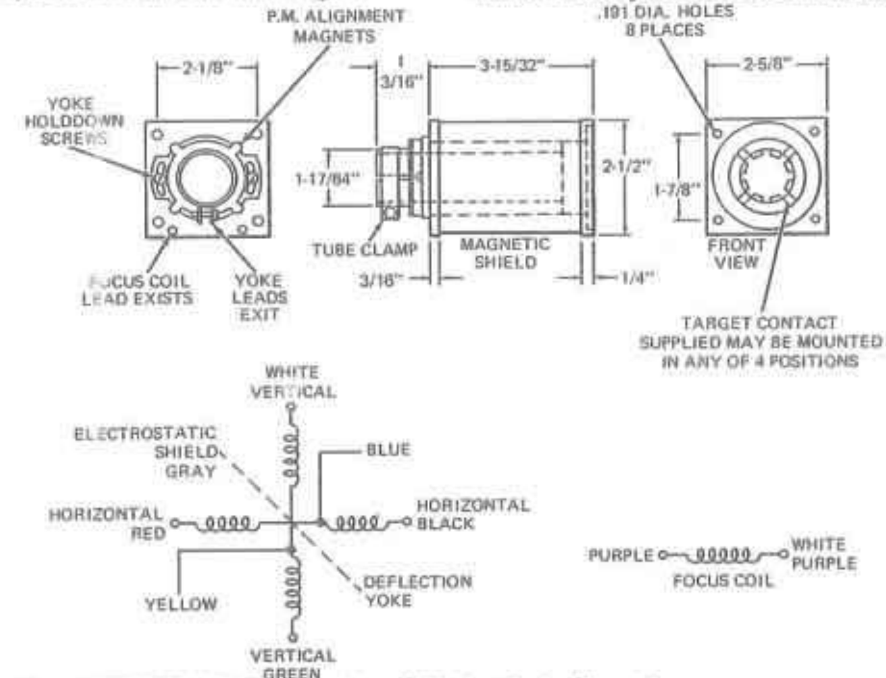


FIG. 4—DEFLECTION ASSEMBLY of type CY101 for 1-inch vidicon tubes.

Blanking and sync

Transformer T1 supplies both the vertical sync and the vertical blanking signal. The center tap of the 2K secondary is grounded. Phasing should be observed with an oscilloscope insuring that the positive going pulse is applied to test point C1. Capacitor C8 stretches the pulse and sets the amplitude to 7 V P-P. Capacitors C6 and C7 then apply the blanking pulse to cut off the vidicon cathodes during vertical retrace. C8 may have to be selected for use with some types of vidicons if black retrace lines appear in the picture. The other half of the secondary feeds a negative-going vertical sync pulse to diode D1. Polarity of diode D1 should be observed as shown on the schematic. A horizontal sync pulse is taken from point A2 and fed to the monitor separately.

Initial vidicon tube adjustments

The following adjustments are made with all voltages and scanning signals applied to the camera from the B/W monitor. Potentiometer R3 serves as a focus control. Initially, the beam control R9 should be adjusted for maximum resistance. The target control should be adjusted for about 40 to 50 volts at the center terminal. The focus control should be set about midway. The beam control should be adjusted until blobs of light and dark areas ap-

(continued on page 74)

PARTS LIST

All resistors are ½-watt 10% unless noted

*R1—270,000 ohms
*R2, R9, R21—potentiometer, 1 megohm, linear taper
*R3—potentiometer, 2 megohms, linear taper
*R4—68,000 ohms
*R5, *R10, R34—220,000 ohms
*R6, R29, R35—4300 ohms
*R7—100 ohms
*R8, *R11, R23—150 ohms
*R12—3000 ohms
*R13, *R20, R28, R33—100,000 ohms
*R14—1200 ohms
*R15—270 ohms
*R16—300 ohms
R17—3300 ohms
R18, R19—potentiometer, 125 ohms, wirewound
R22—5600 ohms
R24—1500 ohms
R25—180 ohms
R26—33,000 ohms
R27—18,000 ohms
R30—1000 ohms
R31—120,000 ohms
R32—2200 ohms
*C1, *C4—.22 µF, 300V
*C2, C24—.056 µF, 200V
*C3—5 µF, 150V, electrolytic
*C5—.02, 100V
C6, C7—100 µF, 150V, electrolytic
C8—4 µF, 25V, electrolytic
*C9, *C15—50 µF, 25V, electrolytic
*C10, *C12—.0015 µF, 25V
*C11—2 µF, 25V, electrolytic
*C13, C25—1000 µF, 25V, electrolytic
*C14, C22—2 µF, 150V, electrolytic
C16—25 µF, 225V, electrolytic
C17, C20—250 µF, 25V, electrolytic
C18—.01 µF, 50V
C19—0.5 µF, 200V
C21—.0022 µF, 50V
C23—.33 µF, 150V
C26—.0082 µF, 150V
D1—1N914 diode
D2-D7—400PIV, 2.5A rectifier (GE504 or equal)
*Q1—2N4126 transistor
*Q2, *Q3, *Q4, Q5-Q8—2N4125 transistor
L1—222 mH inductor
*V1—7735 vidicon tube
T1—10K-2K impedance matching transformer (Radio Shack No. 2731378 or equal)
T2—10-turns on TV flyback (see text)
T3—117V primary; 24V, 1.2A secondary
Vidicon filament transformer 117V primary; 6.3V CT, 3A secondary

***Two each of the components are required to construct both video channels.**

MISC—two 4 × 2½ × 1⅝ in. aluminum mini-boxes (Bud no. CU3002A) ½ in. plywood mounting board, aluminum sheet metal for camera case, lenses, yokes, deflection coils, lens mounts, vidicon sockets, color filters, prism, wire, solder, etc.

NOTE: the following parts are available from Denson Electronics, P.O. Box 85, Longview St., Rockville, CN 06066. Two yokes and focus coils no. CY101-1547, two vidicon sockets, two Comsicar 32939 lenses, two size C lens mounts. The following parts are available from Edmund Scientific Co., 91 Edscorp Bldg., Barrington, N.J. 08007. One 2x2 in. Plexiglas red no. 2423 color filter, two 2x2 in. Plexiglas green no. 2414 color filters, one cube prism.

(continued from page 44)

pear on the monitor screen. Adjustment of the focus control R3, the optical lens focus and the target control R2, should bring the scene into sharp focus with sufficient contrast. Due to the series arrangement of R3 and R2, some interaction will be encountered. The focus control should always be the last one adjusted. In normal operation, only the focus controls will have to be re-adjusted.

Initial adjustments of the deflection assembly

If the camera images appear off-center and cannot be brought into registration with the PM alignment magnet adjustments (see Fig. 4), the yoke windings must be demagnetized. Momentarily, connect the yoke windings across a variable DC voltage power supply set to about 12 volts. Reverse the leads and lower the power supply setting about 1 volt. Keep reversing the windings and momentarily magnetizing the yoke at decreasing 1 volt increments. At below the 1 volt point, the residual magnetism that remains should be within the corrective range of the yoke PM alignment magnets. The objective of this process is to get the magnetism levels at a low enough point so that all registration and centering adjustments for both the yokes can be made by simply rotating the alignment rings. With both camera heads in proper focus optically and electrically, it will be necessary to loosen the yoke hold-down screws, Fig. 4, to allow rotation of the yoke within the focus coil, to correct for vertical axis errors. It should also be remembered that exact positioning of the lens mount will alter the axis of the lens, changing the apparent vertical or horizontal centering in relation to the other channel.

The best construction approach will probably be to simply build each camera head as a black and white unit, thoroughly testing it without using the prism or color filters. When results are satisfactory, initial color registration can be attempted. Insert the color filters behind the lens mount. The edges can simply be taped in place. Be sure to allow the camera to warm up sufficiently before performing registration adjustments. Place the test pattern in front of the prism at the minimum distance at which you want the camera to focus. Adjust both lenses for nearest focus. Slide the cyan vidicon tube back and forth until the sharpest focus is attained. Re-adjust the electrical focus for sharpest image. Then using the adjusted cyan image as a reference, slide the red vidicon back and forth for best focus. Tighten the vidicon tube clamp (see Fig. 4). Adjust red electrical focus for sharpest image. Adjust the red alignment magnets to bring both images in register. It will be necessary to rotate yoke, adjust vertical scan amplitude and perhaps select values for resistor R22 for best registration. It will be necessary to repeat adjustments several times initially. The above adjustments can be made while viewing the picture in either cyan or red. When it is necessary to view a single channel, simply close the iris on the undesired channel.

Final color adjustments

As mentioned last month, the easiest way to adjust color is by adjusting the lens iris controls on a white test pattern with color stripes. Both images together should produce a good white from the test pattern. When the proper levels are set, the other colors should appear in the correct order. The only discrepancy will be with yellow, which may appear as a yellowish-beige. To insure good color fidelity, the red, blue and green controls on the color monitor must be adjusted to produce a perfect gray raster with the camera on and operating, but with both iris controls closed. These adjustments will of course, be critical due to the fact that the tint control has no effect with this particular set up. Due to the high amount of light loss through the prism (each tube receives only 30% of incoming light), a very high amount of illumination will be required for good color fidelity. I use No. 2 photo-flood blubs. If the scene has a slight pinkish cast, or the yellow appears too pink, it is possible the light bulb is too close to the subject. The camera sensitivity could be greatly increased with a higher efficiency prism or perhaps a mirror optic system which would overcome much of the light loss encountered with the present prism.

It is anticipated that some camera builders may be able to locate high efficiency prisms or low light loss semi-silvered mirrors. It is possible by using a more complex mirror arrangement to put both camera heads in line, thereby making a somewhat smaller and more compact camera. Inasmuch that this is the first known home experimenter or amateur type of live color camera, it is recognized that many modifications, changes and improvements could be incorporated by individual camera builders. For example, by using the camera in conjunction with a commercial N.T.S.C. color encoder, some inherent color deficiencies may be correctable.

Next month we will cover construction of the color monitor sync circuits, red and cyan amplifiers, as well as modification of the two TV sets for use with the camera. **R-E**

Ultrasonic measurement system will aid medical researchers

A new ultrasonic measuring system developed recently by RCA will provide medical researchers with previously unavailable precise measurements of ultrasonic diagnostic devices. In so doing, it may increase and speed up the use of ultra-high-frequency sound in detecting malignancies in human tissue.

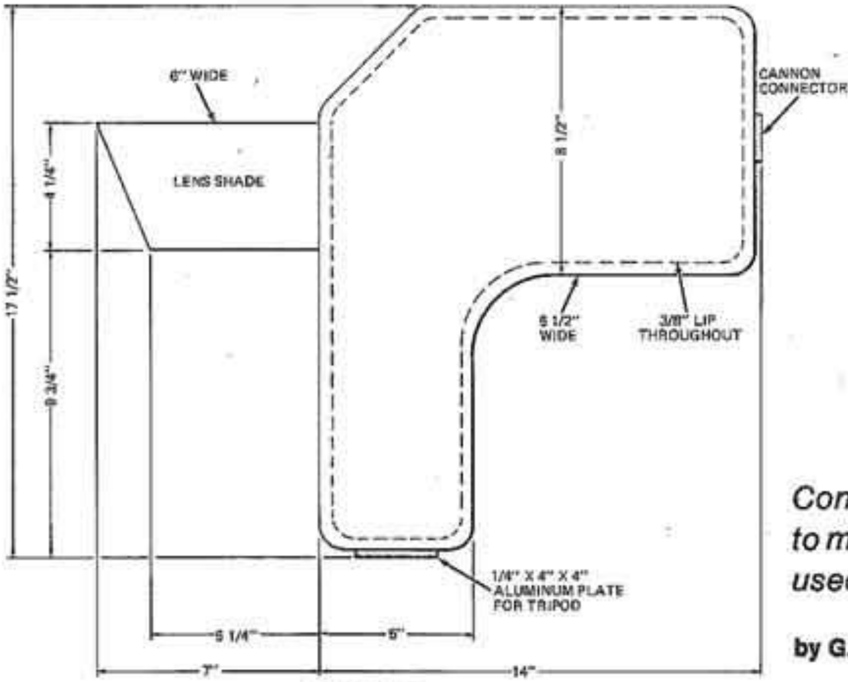
Ultrasonic techniques have been preferred for many types of research because they enable body tissue features to be observed that can't be seen by X-ray or optical techniques. But up to now, researchers had no way of knowing precisely the intensity of the waves they were using. This created difficulties in determining exactly what effect increasing or decreasing the intensity or frequency of the sonic waves had in detecting malignancies or tissue malformations.

To measure the output of an unltrasonic transmitter with the new technique, it is placed in a water tank containing a gold-plated pellicle 15-cm in diameter and a few millionths of a meter thick. The pellicle, or membrane, is so thin as to be transparent to sound and follows exactly the microscopic motions of the water that make up the sound waves passing through it, vibrating in proportion to the intensity of the sound waves reaching it.

Its motions are sensed by scanning a laser beam across the pellicle horizontally and vertically. The reflected beam is minutely altered (phase-modulated) by the pellicle's vibrations. An interferometer compares the modulated beam with an unmodulated reference laser beam and produces electric signals that can be measured by conventional electric meters.

When the system is used to measure ultrasonic waves passing through tissue, the waves are transmitted through or reflected from the specimen and imaged, or focused, onto the pellicle by plastic acoustic lenses. The pellicle is so tightly coupled to the water that its vibrations at any point are determined by the amount of sound that reaches that point. That amount depends on how much sound was imaged through the specimen. Mapping the small motions of the pellicle with the laser interferometer technique provides an image of the specimen on the cathode-ray display tube.

With a 15-milliwatt laser, the system has a potential sensitivity of about 5 nanowatts-per-square-centimeter, corresponding to a membrane displacent of .007 angstroms at 1.5 MHz. The system has a wide frequency response—about 0.5 MHz to approximately 10 MHz. **R-E**



LEFT SIDE VIEW

Build this COLOR TV CAMERA

Concluding this series, we show you how to modify the two receivers that are to be used as the sync source and color monito.

by GARY DAVIS

LAST MONTH WE DISCUSSED THE CAMera head, as well as adjustment and registration of a low-cost color TV camera. This month we will conclude this series by examining the modification of the two TV sets for use with this camera. The camera requires 6V P-P of vertical sawtooth drive, a suitable vertical blanking pulse, −12V DC, +300V DC, 6.3V AC, and a horizontal drive pulse with 70 to 80V P-P amplitude. All these voltages are supplied from the black and white monitor.

The set I use for this purpose is a Panasonic Model TR-900IM. The modifications for this model can serve as a guide in modifying your own set. However, you will have to experiment with your set until you can generate the voltages and waveforms described. The vertical sweep signal is taken from the TV set by simply adding a 15-ohm resistor in series with the TV vertical deflection coil. The sawtooth voltage developed across the resistor is sufficient to drive the camera vertical deflection coil directly. Should the camera picture appear upside down, the two wires to the 15-ohm resistor coming from the camera should be reversed. The vertical blanking pulse is obtained from the normal pulse developed across the set's vertical yoke and applied directly to transformer T1. If the pulse is greater than 100V P-P, a voltage dropping resistor should be placed in series with the primary of T1. The −12V DC signal was taken directly from the set's −12V busline. The +300V DC signal is generated from an extra unused winding tap on the flyback transformer. (Suitable horizontal pulse voltage may be available at the agc keyer winding.) The 300V P-P

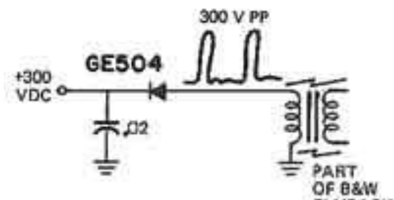


FIG. 5—METHOD OF DERIVING the 300 volt DC supply voltage from the black-and-white TV receiver.

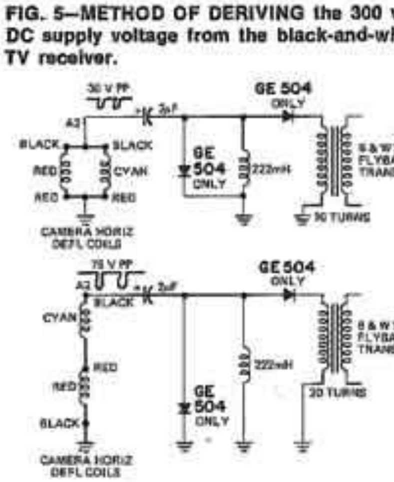


FIG. 6—TWO POSSIBLE APPROACHES for deriving the synchronizing signals from the black-and-white TV receiver.

horizontal pulse is simply rectified and filtered as shown in Fig. 5. Voltage dropping resistors may be necessary in some sets, and of course, a separate +300V power supply could be incorporated if necessary. Since my set did not have a 6.3V AC signal available, a filament transformer was added to power the vidicon tube filaments. **This 6.3V AC signal was also sent to the vertical blocking oscillator base through a .22 μF coupling capacitor.** This locks the vertical oscillator to the power line frequency thereby eliminating any 60-Hz hum wiggles in the picture.

The horizontal yoke drive-pulses are obtained from a second unused winding tap on the flyback transformer. This tap provided the correct waveform, but at double the needed amplitude. As the flyback transformer on this set is a sealed unit with only the taps exposed, the camera horizontal yokes were wired in series and connected to the tap through a 2 μF capacitor. On other sets, different approaches must be taken. Two possible approaches are shown in Fig. 6. Transformer T2 consists of ten turns of well-insulated hook-up wire, loosely wound around the flyback. On most sets the voltage amplitude is approximately 4V P-P per turn. The voltage at the output of T2 must be exactly correct, as added resistive elements such as width controls would alter the horizontal waveshape. The horizontal deflection coils could be connected in parallel, or by doubling the number of turns on transformer T2, they could be wired in series. Each horizontal deflection coil requires 30 to 40V P-P for proper deflection. Figure 6 should serve only as a starting point. Some added experimenting may be necessary. All generated waveforms should be checked with an oscilloscope to observe amplitude and waveform polarity. All waveforms should be close to those shown on the waveform chart before proceeding. It is important that the modifications do not affect normal operation of the TV set, as it can be used as a monitor until you are ready to modify the color receiver. It is also convenient if the set can still be used as a regular TV when the camera head is disconnected. Details of the sheet-metal case are shown above.

(continued on page 73)

BUILD A COLOR TV CAMERA
(continued from page 36)

Color monitor

The color receiver I use is a RCA CTC31 chassis. All part references mentioned can be found in the *RCA Field Service Guide for RCA Color-TV Receivers 1969-1970, Volume 3, #ERT-202*. The modifications described here cover the RCA CTC31 chassis only. However, they outline the general procedure necessary to modify a typical color receiver so that it may be used as the color monitor.

Four separate signals are fed to the receiver; cyan video, red video, horizontal sync and vertical sync which is mixed with the cyan video in the camera head. The cyan video signal serving also as the luminence signal is connected directly to the set's video path immediately after the video delay line. This is point AE on the circuit board PW700. The second video IF amplifier tube V204 should be removed from the set to prevent noise from the tuner from mixing with the added luminence signal.

The cyan signal is amplified and inverted by transistor Q6 to drive both the G-Y and B-Y amplifier grids simultaneously. The grids are joined together by a .5 μF capacitor so the signal arrives at pin 9 of both 6GH8-A tubes, V701 and V704-a. The red signal is amplified and inverted by transistor Q5, then sent to the grid of the R-Y amplifier-pin 9 of V707-a.

Sync circuits

The negative-going vertical sync pulses contained in the cyan signal saturatès transistor Q7 (see Fig. 3). This inverts the pulse and provides an 18V P-P vertical sync signal. Transistor Q8 is saturated by the incoming horizontal sync pulse fed separately from the camera head. The common collector load resistor R29 provides the 18V P-P composite sync signal which is applied to the sync separator tube grid—Pin 9 or the 6GH8-A, V206-b.

Although many sets will accept signals similar to those described above, other sets may require signals of different amplitude and color signal phase. A general guide when modifying your set would be to simply observe correct amplitude and picture phase with an oscilloscope while the set is tuned to a commerical color TV station. Then try to insert the red, cyan, and sync signals from the camera and amplifier unit at similar amplitudes and phases at their respective points. Single stage phase invertors may be added in the red, cyan, and sync circuits if necessary, or the signal amplitudes may be altered as required for your particular set. **R-E**

letters

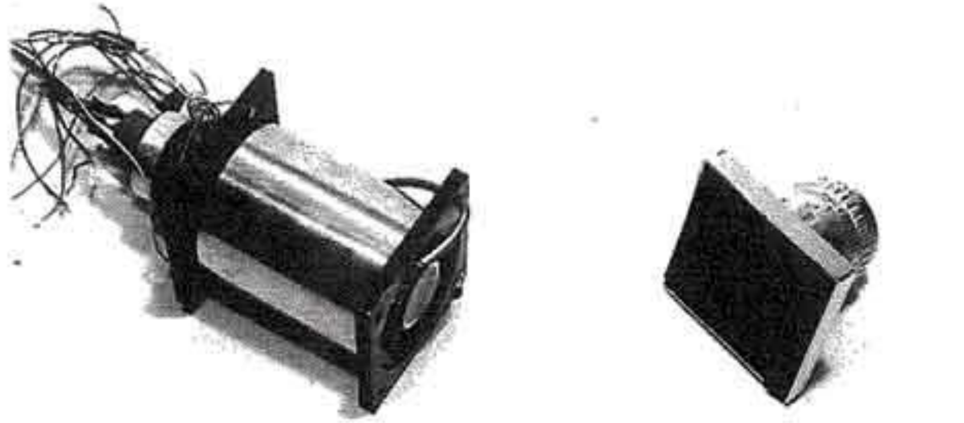
COLOR TV CAMERA

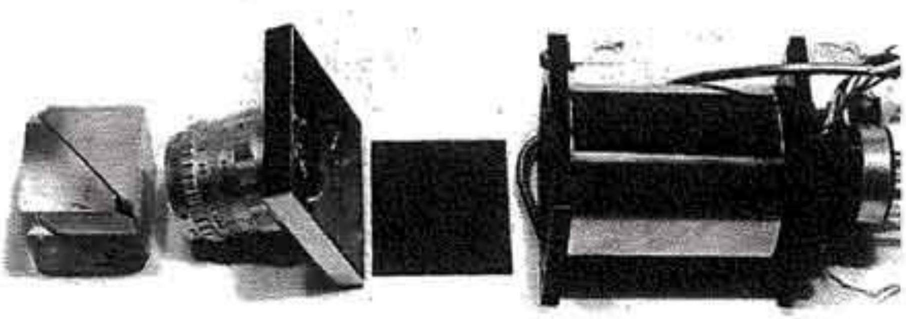
I have finished reading the first two parts of the construction article on building a color TV camera that appeared in the July and August, 1975 issues of **Radio-Electronics.**

I already ordered the parts and am waiting for them to arrive. The assembly looks fairly easy and not to complicated. However, there is one area that is not fully clear. This is the assembly of the vidicon, deflection yoke, lens and filter. The interior photos in the July issue shows the preamp assembly mounted over this assembly. Can you help?

Thanks for another interesting and useful project.

C. A. STROBEL
New York, N. Y.





You are absolutely right! The interior photos do not show this assembly and there is nothing in the third and final part of this article that will help clarify this. So, we contacted Gary Davis and he was kind enough to provide some photos. They appear above.

How about the rest of our readers. Drop us a line and let us know how you're making out with this project.—Editor

Courtesy of Gary Davis