SPECIAL COLOR TV ISSUE

Radio-Electronics

DEC. 50c

TELEVISION · SERVICING · HIGH FIDELITY

A GERNSBACK PUBLICATION

HUGO GERNSBACK, Editor-in-chief

COLOR TV:

What's New In The '64 Sets?

Antenna and Booster Facts

Service? It's Not So Hard!

Color's Past and Future

The RCA CTC-15 Circuit Features /See p.4

Radio-Electronics

DECEMBER 1963 VOL. XXXIV NO. 12

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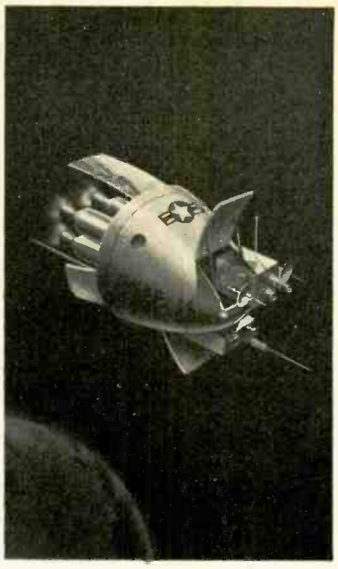

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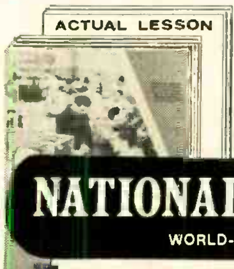

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NEWS BRIEFS

Gold May Superconduct At Lowest Temperatures

Gold may be a superconductor at very low temperatures, according to four physicists of the University of California. They cooled an alloy containing one part of barium to five parts of gold to 0.7° Kelvin (−457.7° F). At that temperature, the alloy became superconductive. The scientists believe that at even lower temperatures pure gold might superconduct, but did not have equipment to reach the necessary low temperature.

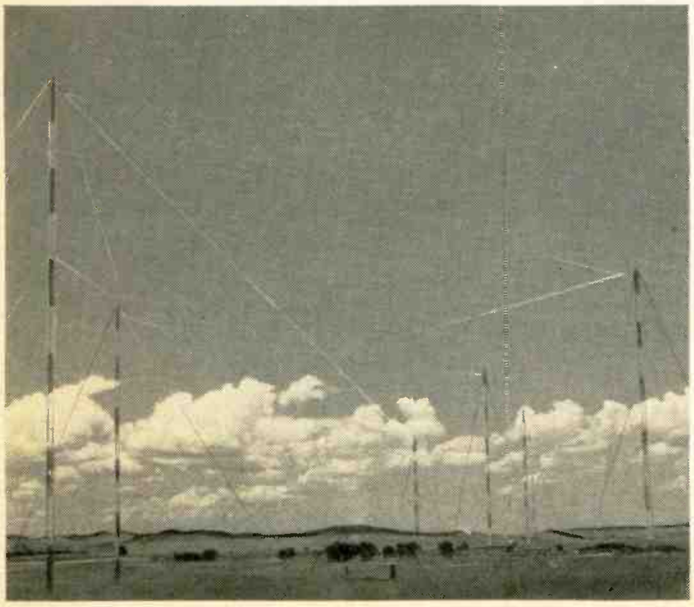
The work is part of a research program to determine whether most metals are superconductors. More than half of all metallic elements do lose all resistance when cooled to extremely low temperatures, and the scientists are interested in finding out whether this may not be true of almost all metals.

New Standard Stations On Lower Frequencies

Standard broadcast stations WWVB and WWVL have been added to the National Bureau of Standards facilities. WWVB at Boulder, Colo., operates at 60 kc and WWVL at 20 kc. At present, these stations are sending only frequency signals, but time signals will be added later. These signals will be much more stable and accurate than those transmitted by high-frequency stations WWV and WWVH.

Accuracy of the high-frequency signals is affected by changes in the height and density of the ionosphere, since they depend on multiple reflections to reach their destination. In the low- and very-low-frequency regions, the radio waves follow the curvature of the earth. The ionosphere acts as the upper limit of a gigantic duct rather than as a reflector. Thus its variations have little effect on the travel of the waves.

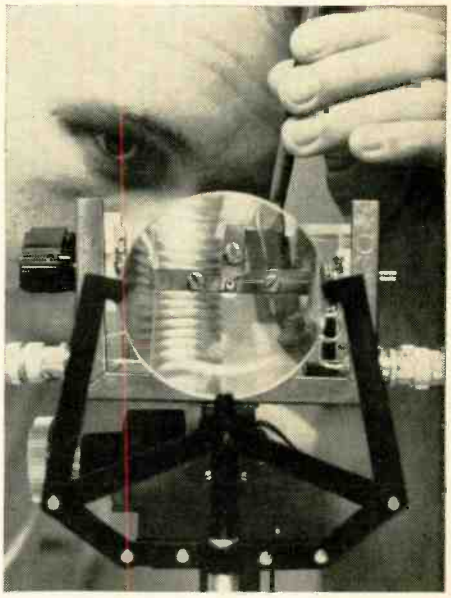
WWVB broadcasts with a radiated power of 5 kw. It is designed to serve the continental United States with more stable coverage at distances up to 2,000 miles, than its sister station WWVL with a radiated power of 1 kw. The 20-kc signal provides intercontinental reception, with a precision of one part in 10 billion in an observing period of approximately one day.



The antenna arrays for WWVB and WWVL. Towers are 400 feet high, arranged in a diamond 1,900 feet long by 750 feet wide.

Photoparametric Diode Detects 10^{-9} Watt

A single semiconductor diode, which is both a photodetector and a parametric amplifier, can boost receiver sensitivity of laser space communication and radar systems 100 times. Scientists at the Sperry Rand Research Center (Sudbury, Mass.) have detected and amplified less than one-billionth (10^{-9}) watt of light. It is hoped more advanced electronics for the device may make it possible for it to detect and amplify a quintillionth (10^{-18}) watt. As a detector of modulated light, it has a frequency range from direct current to about 2 gc.



The new photodetector–parametric amplifier is the small white dot framed in the lens. Sperry technician Curtis Potter is aligning the 1/8-inch diameter diode for a test in which a laser fires a beam from the position of your eye into the tiny aperture of the silicon semiconductor device.

New Electronic Pen Improves Oscilloscopes

A new electronic pen that writes a perfect hand at 100 feet a second may greatly improve the frequency range of recording oscilloscopes. Designed by Richard G. Sweet of Stanford University, the new pen squirts fountain-pen ink at the paper in tiny drops only 2/1,000 inch in diameter. With the new pen, signals or electronic impulses that operate as fast as 10,000 times a second can be recorded. Present mechanical stylus equipment used for recording signal impulses on paper can't record oscillations much faster than 100 per sec-

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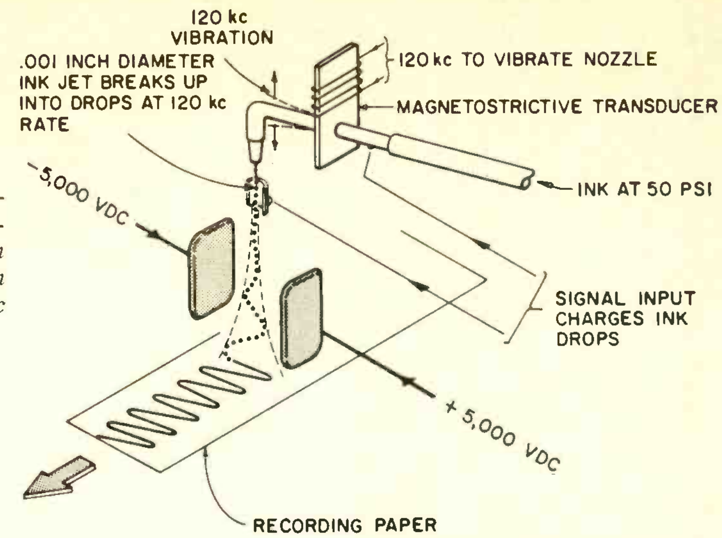


Tiny signal-charged ink droplets draw trace on moving paper in new electronic pen.

ond. Sweet has compared his new pen with the electron gun of a television tube. Instead of firing a stream of electrons, it shoots a fine stream of ink, .0013 inch in diameter, at the paper. At the same time, the drawn-glass nozzle of the "ink gun" vibrates 100,000 times a second. This breaks the stream into precisely equal blobs, .002 inch in diameter, delivered at the rate of 100,000 per second. As each of the drops is formed, it passes through a cylindrical electrode to which the desired input signal is connected. This gives each drop an electrical charge proportional to the signal at the moment of passage. The stream of drops then passes between deflection plates, held at a fixed voltage. These attract or repel the drops to one side or the other, according to the charge on each drop, causing them to write out the wave pattern of the signal on the paper.

Radio Pioneer Dies

Emil J. Simon, whose interest in radio began in 1903, died Sept. 14 at the age of 74. During the 1920's, as founder and president of the Intercity Radio Telegraph Co., he established stations in six cities. He was the inventor of the Simon Radioguide, a 30-lb direction finder used in military and commercial aviation in the 1930's. During World War II, he directed manufacture of military radio equipment for the Radio Navigational Instrument Co. After the war he worked as a consultant.

Color TV Owners Like Their Sets

Owners of color receivers are enthusiastic about their sets, according to Sylvania Market Research's Frank W. Mansfield. Sylvania's survey discovered that they were not satisfied, however, about the number of quality television programs.

The average repair bill was about $30.50 per year, which owners found reasonable. They were also satisfied with the ease of tuning, and 92% of the 17,000 families surveyed believed their color reception to be excellent.

Mansfield estimates that 872,500 color sets were sold from the time color TV started to the end of 1962. They expect that between 500,000 and 750,000 will be sold in 1963, and that the number will increase in 1964, with the number of sets sold likely to run over a million in 1966 or 1967.

CALENDAR OF EVENTS

EIA Winter Conference, Dec. 3–5; Statler Hilton Hotel, Los Angeles, Calif.

14th National Conference on Vehicular Communications, Dec. 5–6; Adolphus Hotel, Dallas, Tex.

1963 Fall Meeting, International Scientific Radio Union (URSI), Dec. 9–12; University of Washington, Seattle, Wash.

10th National Symposium on Reliability and Quality Control, Jan. 7–9, 1964; Statler Hilton Hotel, Washington, D.C.

1964 Southwestern Electronic Conference (SWELCON), Jan. 12–16, 1964; Baker Hotel, Dallas, Tex.

FM Wireless Microphones Legal

FM wireless microphones have been legalized on the 88–108-mc broadcast band under Part 15.201(c) of the FCC Rules adopted July 1, 1963. They must be type-approved commercial units and shall not be used for two-way communications. Details are covered in Section 15.212.

Emissions must be confined to a 200-kc channel centered on an operating frequency within the band. Field strength shall not exceed 50 μv per meter 50 feet or more from the transmitter. Outside the 200-kc channel, field strength must not exceed 40 μv at 10 feet or more.

Custom-built telemetering equipment for experimenting in educational institutions is also permitted under 15.201(c) of the Rules. Bandwidth, frequency and field-strength limitations are the same as for FM wireless microphones. The educational institu-

tion must supply the engineer-in-charge of the local FCC office (in advance and in writing) of the date and place where the equipment will be operated, the purpose for which it will be used, and a description of the device including operating frequency, rf power output and antenna. The notice shall be accompanied by a statement, prepared by a qualified technician, certifying that the equipment complies with the technical provisions of Part 15.212.

More Color Sets

Since the closing date for articles in this issue, three more companies have announced new color models.

A new color chassis by Setchell-Carlson—in several cabinet models—features unitized construction consisting of a master chassis with plug-in subchassis. Its plug-in chroma unit can be removed for servicing and the set will continue to produce a black-and-white picture. All maintenance controls are available from the front. All models have push-pull audio and twin front-mounted speakers.

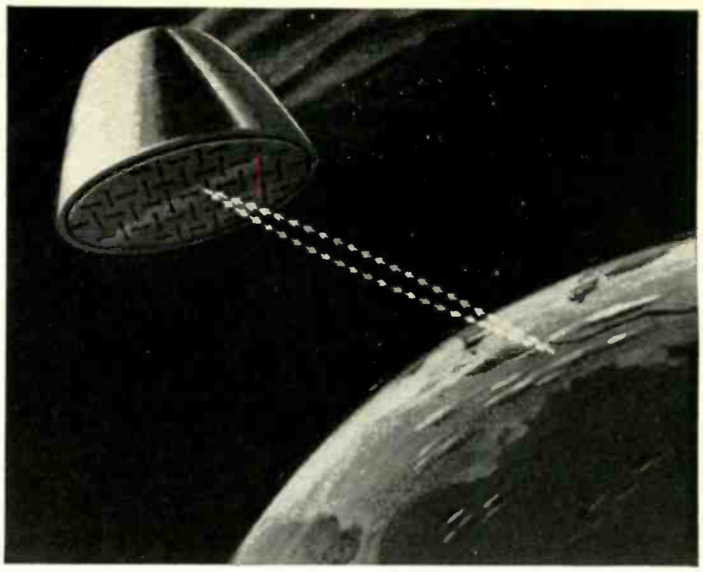
Andrea has a custom professional component color television set that can be installed in any 30 x 22-inch opening with 25-inch clearance behind the mounting surface. The set has 23 tubes plus picture tube (24 in uhf models) and can be fitted with a remote control.

Sylvania has announced the new 21-inch lowboy, model 21LC3, with a suggested list price of $529.95.

Electric Boomerang For Satellite Signals

The quality and quantity of information sent to earth by satellites has been substantially increased by a space communications system developed by Sylvania Electronics Systems. The boomerang is an electronic antenna system that automatically directs its radio signals to any earth station that requests information from the unit. The return signal follows the same path used by the ground station to request the information.

According to Walter Serniuk, director of engineering of Sylvania Electronic Systems, conventional satellite transmission systems must broadcast their signals over a large portion of the earth's surface to communicate with a specific ground station. The new system uses a set of satellite antennas which steer the beams electronically without altering the positions of the antenna or of the satellite. Thus the signals can be directed right at the target, with considerable "power gain." The new system uses tunnel-diode transceivers,



How the signal from the satellite is "boomeranged" back to earth along the same route as the triggering signal is shown in this artist's drawing.

which are about 100 times more resistant to the high energy of the Van Allen belt than transistorized units. The power required is very low, permitting the equipment to function with only 1/20th the number of solar cells required by conventional systems.

A model of the system, working in the S-band (1,550–5,200 mc), has been constructed for the Aeronautical Systems Division of the Air Force Systems Command at Wright-Patterson Air Force Base, Dayton, Ohio.

Canada Prefers FM To Color TV

The chairman of Canada's Board of Broadcast Governors, Dr. Andrew Steward, told the EIA of Canada that one of CBC's chief goals in 1964 was the expansion of its FM network service. Other aims include new FM (and AM) stations for areas not now covered, and expansion of CBC television.

Transistors Step Forward With Multiemitter Units

Transistors have made many advances in a field ruled completely by vacuum tubes up to a few years ago, but in one respect have lagged behind. Almost all transistors have been simple triodes. Now Plessy Co. (England) has introduced a transistor with *five* emitters. Thus we have multielement transistors as well as multielement tubes.

Not only will it be possible to combine more than one circuit with the multielement transistor as with its opposite number in the tube family, but the new transistor can do jobs not easily performed by multielement tubes. For example, one emitter can be used as it would be in a normal transistor. Another emitter can be used in the avalanche mode to behave, in effect, like a Zener diode connected to the base, while a third would act as a small base input capacitance. The new transistor actually takes over some of the functions of more complex integrated circuits.

Brief Briefs

New laser achieves a high pulse rate by arranging six lasers around a central axis and firing them in sequence like the barrels of a Gatling gun.

General Electric has announced a new rapid-charge nickel-cadium battery that can be charged in about one hour as against 15 hours for present types. The new battery is expected to be especially valuable as a power source for portable tools.

No less than 5 Japanese TV receiver manufacturers expect to be in full production with 16-inch color receivers early this winter. Most expect to export color sets to the United States, but they are not sure when.

Lasers, not so long ago the "farthest out" instrumentality in the electronics field, can now be bought from your favorite radio mail-order house. Prices are about $450 for calcium fluoride laser crystals, $1,125 for a gallium arsenide injection laser.

Radio WWVH, Maui, Hawaii, has eliminated its 34-minute silence at 1900 UT daily. The silent period from 15 to 19 minutes past each hour is being continued.

IBM scientists report that a new material, europium orthosilicate, is nearly 10 times as effective as previously known materials in rotating the plane of polarization of light when subjected to a magnetic field. This discovery may be very important in such applications as modulating lasers. END

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Correspondence

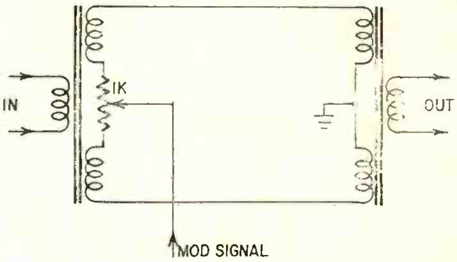
New Tricks with Diodes —Revisited

Dear Editor:

I've been getting many letters with requests for further information ever since my article "New Tricks with Diodes" was published (RADIO-ELECTRONICS, July 1963, page 36). One of the most frequent queries concerns the kind of transformers to use for T1, T2, T3 and T4. I recommend the UTC "Sub-Ouncer" type SO-13, which has a 500-ohm primary and a split secondary, 50 ohms each winding. It is widely available, one source being Newark Electronics Corp., 223 W. Madison St., Chicago 6, Ill. Its catalog number is 3F597, the price, $4.20 plus postage.

Another question: yes, it is all right to use a negative-ground supply. Only the battery polarity with respect to the transistors matters.

People also ask about parts toler-



ance. Resistor values are not especially critical, and even 20% tolerance is acceptable.

I suggest you use a 1,000-ohm balancing pot between split windings of the transformer, as shown in the diagram. This lets you compensate for transformer irregularities and other circuit imbalance for complete scrambling.

LEONARD E. GEISLER
Radio Astronomy Laboratory
University of Michigan

[Also see Mr. A. H. Taylor's letter in the October, 1963 *Correspondence* column (page 21). He pointed out ways of balancing and gave several references to articles on SSB and balanced modulators.—*Editor*]

Improved Power Resistor Substitution Box

Dear Editor:

Mr. H. L. Davidson's article, "Substitution Box for Power Resistors" in your April 1962 issue (page 64) interested me because most substitution

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boxes use only ½- or 1-watt resistors and are limited in usefulness.

I built the unit and added some features to it. The multirange resistors come in pairs. I wired the four sections of the extra MR2 in parallel, bringing each end to a binding post, which gave me a 5.5-ohm resistor. I wired the four sections of the extra MR5 in series for 50,000 ohms and brought the ends to another set of posts. I installed a midget 5,000-ohm 12½-watt rheostat, with its own set of terminals.

These additions extended the range of the unit and provide for an almost infinite variety of resistances, since many terminals can be connected in series or parallel combinations, with or without the rheostat.

H. FISK TARBOX

Darien, Conn.

Experiments on Horizontal Speakers and Reflectors

Dear Editor:

I have experimented with horizontally mounted speakers and reflecting surfaces and have observed the same improvement Glen R. Travis mentioned in his August 1963 article ("Add Depth to Your Speakers," page 28). Uncanny as it may seem, I have also developed an enclosure that duplicates, within a few inches, the one in Fig. 5 of his article. The only difference is in the speaker and position of the port.

Mr. Travis concludes that improvement is due to the speaker's relationship with the internal cabinet dimensions, but I can find no theoretical basis for this. I am convinced from observations that improvement is related to (1) location of the apparent sound source at an optimum point, about the height of the listener's head, (2) wider dispersion of high frequencies because of the reflecting surface, and (3) increase in the proportion of reflected to direct sound. I think the third condition is responsible for the new sound.

JOHN C. PEARSON

San Pedro, Calif.

Tube Data in Tear-out Form

Dear Editor:

Your *New Semiconductors and Tubes* section each month is very useful to me in setting up my tube tester and in figuring out new circuits I come across.

But I think it would be much more useful if you printed it with perforations so it could be torn out to make a tube data file.

A. M. LACEY

Manito, Ill.

[Thank you for the suggestion, Mr. Lacey. As it is, we can't perforate our pages because the high-speed presses we are printed on do not allow it. Still, we

(Continued on page 24)

Pardon us while we change you into Santa Claus

Do your Christmas shopping early at your G-E Distributor's. He has lots of wonderful gifts that you can get with the purchase of General Electric tubes . . . gifts for your family, friends and favorite customers. And there're some you'll want for yourself . . . such as a tube caddy that looks like fine luggage. You can also get Christmas cards designed only for service dealers . . . to mail to customers and friends.

See your General Electric Distributor and start packing your bag *today*. You're going to be a sensational Santa!

Start packing your bag!

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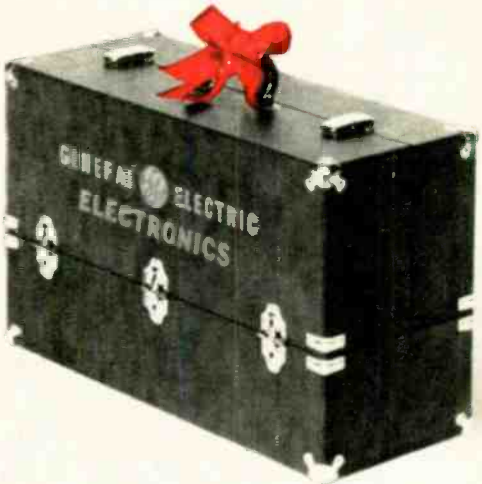
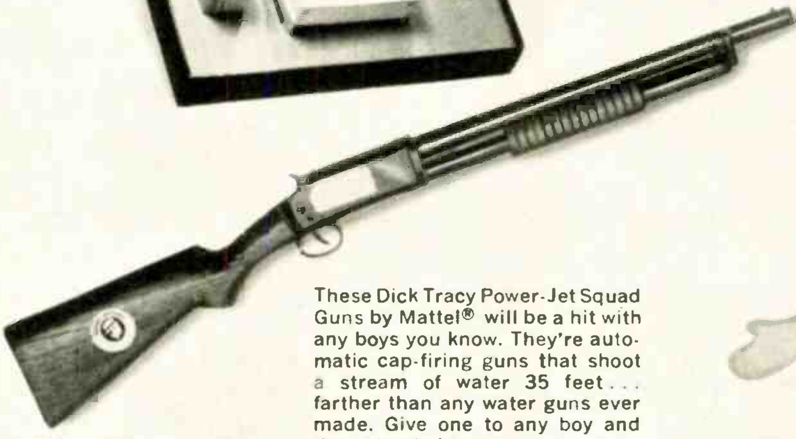
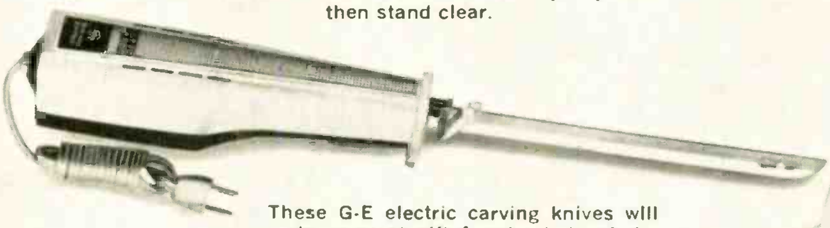


These Kodak Flashfun camera outfits include everything that young photographers need: Hawkeye camera, film, clip-on neck strap, batteries, flash bulbs and instruction manual. They're yours when you buy G-E tubes



Little girls will go wild over these Mattel® Sister Belle talking dolls. They're 17" tall and have a rag body and plastic head. Each one says eleven different things that little girls like to hear . . . like "Let's play house," "Give me a kiss." No batteries needed.

These Dick Tracy Power-Jet Squad Guns by Mattel® will be a hit with any boys you know. They're automatic cap-firing guns that shoot a stream of water 35 feet . . . farther than any water guns ever made. Give one to any boy and then stand clear.



These G-E electric carving knives will make a great gift for the lady of the house. They even slice through hot bread or hot meat with smooth precision. Get several from your G-E Tube distributor.

Get these Christmas cards . . . prepared especially for you. They're in color on heavy, high-gloss stock and show a cartoon of you adjusting a TV set to say "Happy Holidays." 50 cards and 50 envelopes to a box. Get yours now for early mailing.

ANOTHER ACCENT ON VALUE FROM G-E ELECTRONICS DISTRIBUTORS

Progress Is Our Most Important Product

GENERAL ELECTRIC

(Continued from page 21)

might compile data for all important tubes to the same length, so they could be cut out and filed conveniently.

Another problem is makeup (laying out a magazine is like assembling a jigsaw puzzle). It isn't always easy to back up the tube data section with an ad. But we'll experiment and see what we can come up with.—*Editor*]

Organ-Tuning Notes

Dear Editor:

In "Electronic Organ Tuning Made Easy" (RADIO-ELECTRONICS, July 1963, page 58), Mr. Korte suggests using a tuning fork to obtain the 440-cycle tone for the note *A*.

WWV transmits this tone at regular intervals and can be picked up by almost any good receiver that tunes to 10 and 15 mc. [And in the US, 2.5 and 5 mc.—*Editor*] At times the 10-mc signal will be better than the 15-mc. The advantage in using WWV is that the signal volume can be more nearly matched to the organ volume, and you can check the beat note for several minutes, instead of for just a few seconds with a tuning fork.

For a shop that plans to do a considerable amount of organ tuning, a Conn Strobotuner (made by C. G. Conn, Ltd., 1101 E. Beardsley Ave., Elkhart, Ind.) is a worth-while investment. With it, you can be certain of every note, and the professional equipment makes a good impression on musicians. (It is a good idea, in fact, to have the organist around to witness the tuning.) It takes much less time to tune an organ with a professional instrument than by the zero-beat method.

Get a service manual and circuit diagram before you attempt repairs to an electronic organ. Even if you are a good radio–TV technician, you can look rather uninformed if the organ trouble is not obvious. An impressive, confidence-inspiring job should be performed on such instruments, which cost from $550 to over $10,000. Tuning can be profitable. The standard fee should range from $10 to $25.

A. O. BURDEN

Medellín, Colombia

Hold It! Don't Start Yet

Dear Editor:

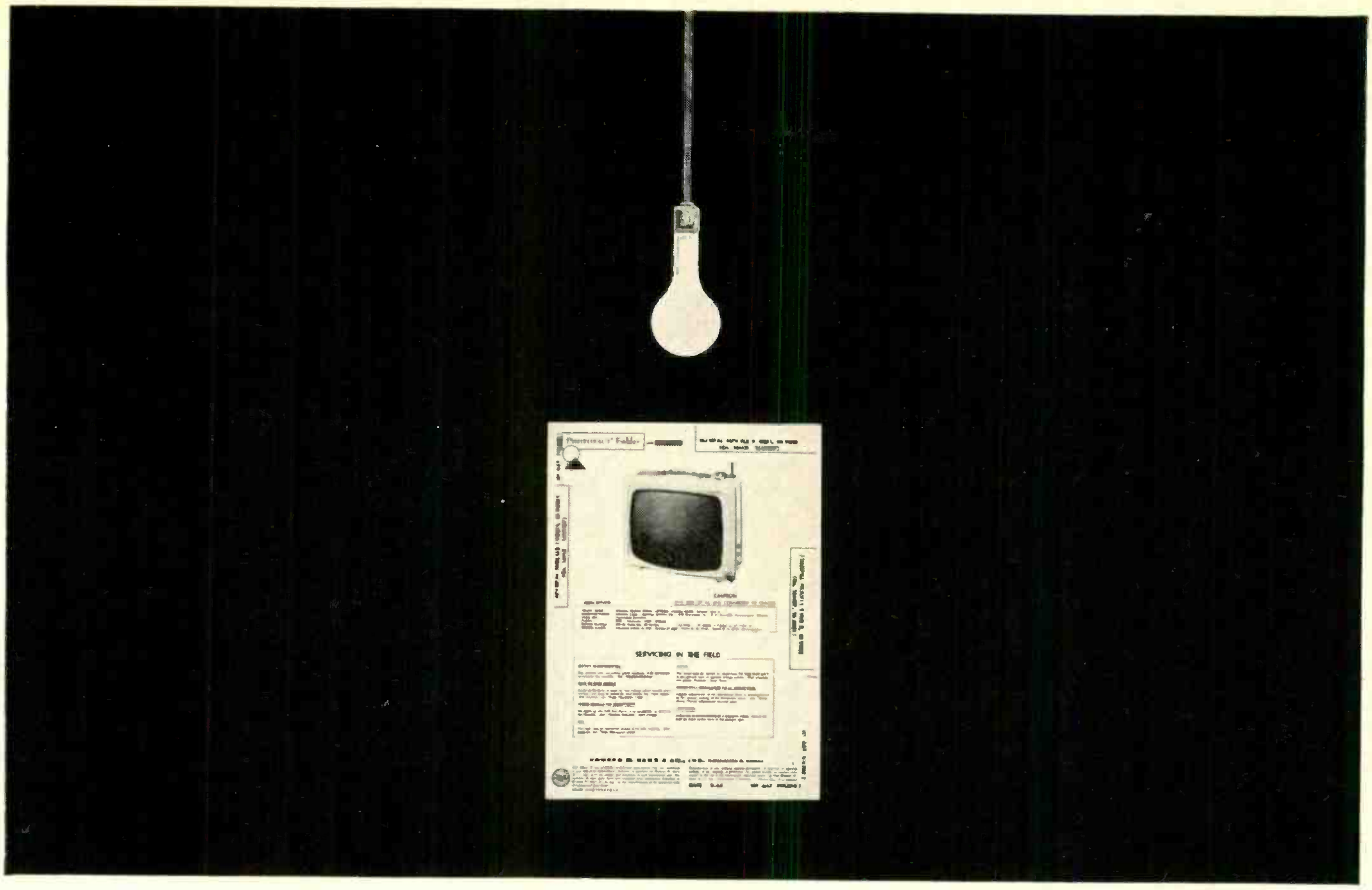
In "Start Service on a Shoestring" (July, page 46), the Old-Timer forgot one thing: a good TV service handbook that explains circuits and their troubles. He should find out *why* a tube shorted before he replaces it.

That, and a good electronics dictionary, will get him going. He'll get better use of your TV service notes and understand better the technical terms used today.

PETER LEGON

Malden, Mass.

END



"...like switching on the light in a pitch-dark room..."

Come to think of it, this is a pretty good way to describe PHOTOFACT. *We* didn't dream it up—it's part of a letter that came to us (unsolicited) from a PHOTOFACT user, a letter that goes like this:

"Opening a Sams schematic to me is like switching on the light in a pitch-dark room. It actually pinpoints the 'needle in the haystack'—many times in *one minute*."

Switching on the light is a great way to find what you're looking for in a hurry. There are over 40 illuminating features in every PHOTOFACT Folder which will help light your way to *fast* TV-radio troubleshooting. (The greatest, too, for pinpointing the "needle" in those tough-dog jobs.)

Users don't measure PHOTOFACT by its pennies-per-page cost. It's the *light*—the time-saving, profit-making light that counts.

Of course, you can get along without PHOTOFACT—a few do—and maybe they're making a living. But it's the hard way.

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Radio-Electronics

Hugo Gernsback, Editor-in-Chief

MICROMINIATURE COLOR TELEVISION

. . . TV on the Micro-molecular Level on the Horizon . . .

In this new era of microminiaturization, there is no longer any valid technical reason why television—particularly color television—should not benefit by the great electronic shrinking process now becoming well-nigh universal.

Indeed, if television and science keep in step, the next decade will record astonishing advances in TV, medicine, biology, technology and the sophisticated arts—applications undreamt-of today.

As our insight into life processes, down to the molecular and atomic levels, increases rapidly, we need new and exceedingly refined tools to unravel the secrets of nature and understand them.

The X-ray and the electron microscope have already pioneered the way into the micro-unknown, but the black-and-white photographs they produce are no longer sufficient to science, technology and biology. These instrumentalities must be linked to color TV. We need color X-ray and color electron microscopes as well as TV color motion pictures, the combination of which is not in existence today.

We have reported certain phases of microtelevision in an earlier issue.* Here is an excerpt from that issue:

> "We can use standard iconoscopes by attaching the recently developed *optical cables* to them. Made of flexible glass fibers, these standard cables can be less than 1/8 inch in diameter and conduct light readily. Each glass fiber, the thickness of a thread, transmits its own quota of light. When they are fashioned into a supple cable of hundreds of glass fibers, a strong light can be conducted around curves and corners.
>
> "Thus we can mount a powerful yet tiny electric light bulb directly behind the end of the light cable and illuminate the inside of an artery, look into the ear or other organ at will, via TV. Urologists urgently need such a tool which, inserted through the ureter, can view the kidney for lesions, stones, or similar disorders.
>
> "For other purposes we also require mini-TV transmitters. For surveillance at a distance, optical cables are useless – here inconspicuous tiny cameras that can be readily concealed are needed.
>
> "In missiles and spacecraft such as satellites, the weight of 1 ounce and the space of 1 square inch are often extravagant, and frequently not permissible. Hence micro-TV transmitters are vital here. How small can a TV camera shrink? No one knows."

To the above can be added important "bloodless" explorations into the human body, via veins, arteries and the various internal organs such as parts of the heart, glands, and even the brain. *This can readily be accomplished once our microminiature TV cameras have shrunk down to the size of the opening of a hypodermic needle.*

The great advantage of introducing color television cameras into presently inaccessible parts of the human anatomy is obvious. Just imagine color TV enlargements of electron microscopic images from 300,000 diameters upward of, say, an internal *starting* cancer, or a benign tumor, or other diseases!

Once we have such versatile tools, the entire human body, for all practical purposes, will have become as transparent as if it were clear glass or plastic! This includes not only the "soft" parts of the human anatomy, but the bony structures as well.

The scientist, the biologist, the geneticist, all will work in new light, *in color*, instead of in abysmal dark as they mostly do now when it comes to the inaccessible parts of the human body.

In technology as well as in biology the probing microminiature TV color camera will literally have thousands of new uses. Coupled with the X-ray and the electron microscope, such future cameras will ferret out points of weaknesses in electronic equipment and a high percentage of potential failures, not apparent otherwise.

Take only one example—our present-day rockets, missiles and our various satellites. Today's percentage of failure is intolerable. Its cost is well-nigh astronomical. Often failures occur once the space vehicle has been in orbit for a considerable length of time. *But most occur before they are off the ground.*

All these potential failures could be anticipated and overcome with miniature color TV probes *on the molecular level*. They would be cheap at *any* price. —*H.G.*

*"Microtelevision," Radio-Electronics, August, 1960.

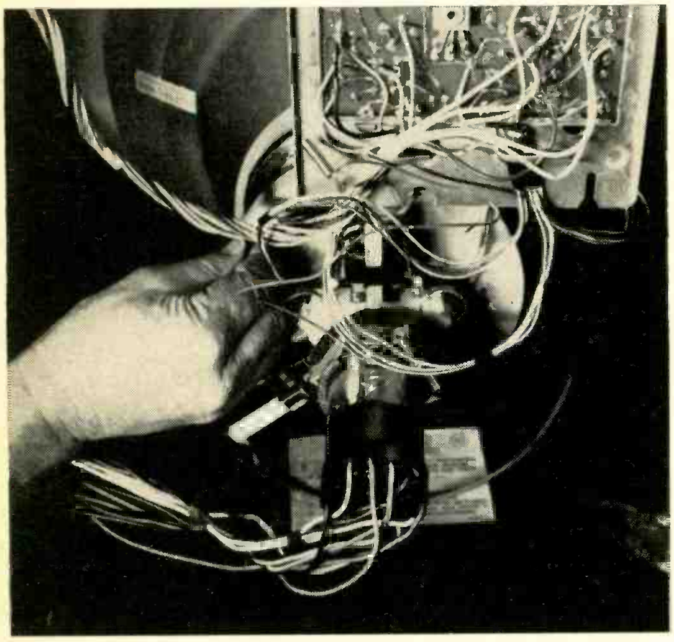
Merry Christmas—Happy New Year

The Staff of Radio-Electronics

By HOMER L. DAVIDSON

replacing your FIRST color TV tube?

Do it confidently with this step-by-step procedure



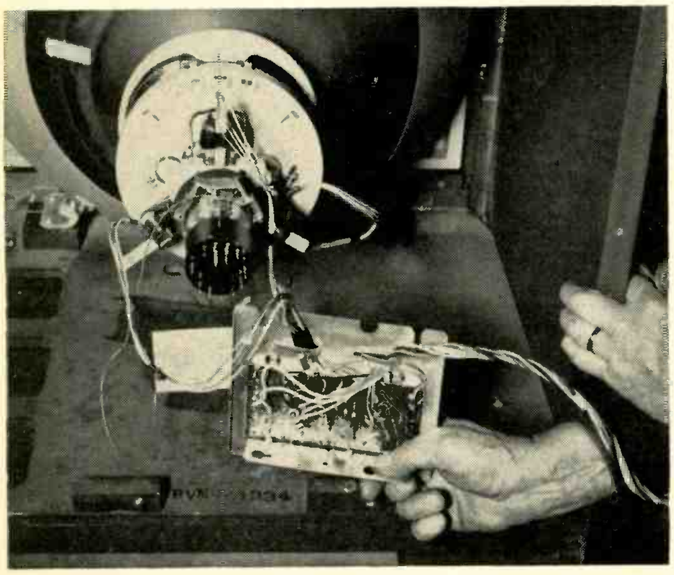
Unhooking leads from yoke assembly so set chassis can be removed.

WHEN A DEFECTIVE COLOR PICTURE TUBE must be replaced, don't throw up your hands in despair and wonder how you'll ever do it. This will be your first reaction—I remember the first color tube I ever replaced and I didn't know how to tackle the job. This article deals with the replacement step by step so that any service technician can do it. The photos show the exact settings of the units on the neck of the color tube and the text follows along the same lines.

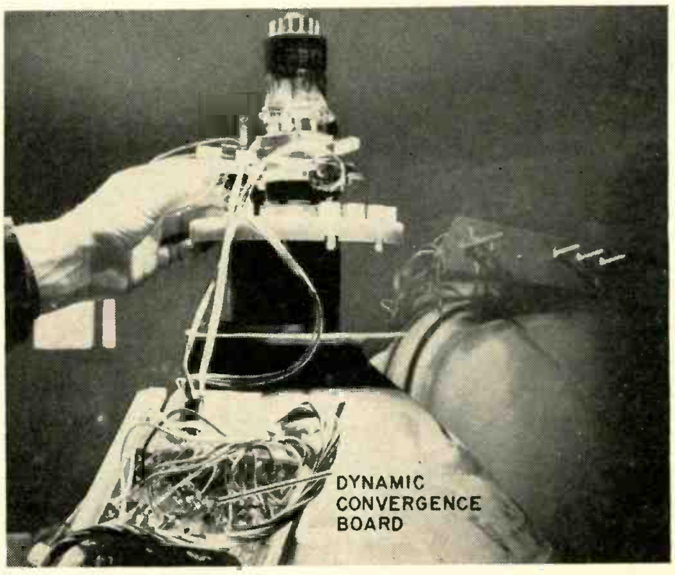
Installing a new color picture tube is a five-step procedure:

1. Removing the chassis and picture tube.
2. Removing components from the picture tube.
3. Installing components on the new picture tube.
4. Installing the tube and replacing the chassis in the cabinet.
5. Receiver convergence.

With the chassis removed only the color-CRT and the convergence chassis are left.



With color tube on bench, start removing yoke and convergence assemblies.



The receiver described in this article is a RCA set although replacing most other color picture tubes calls for the same procedure.

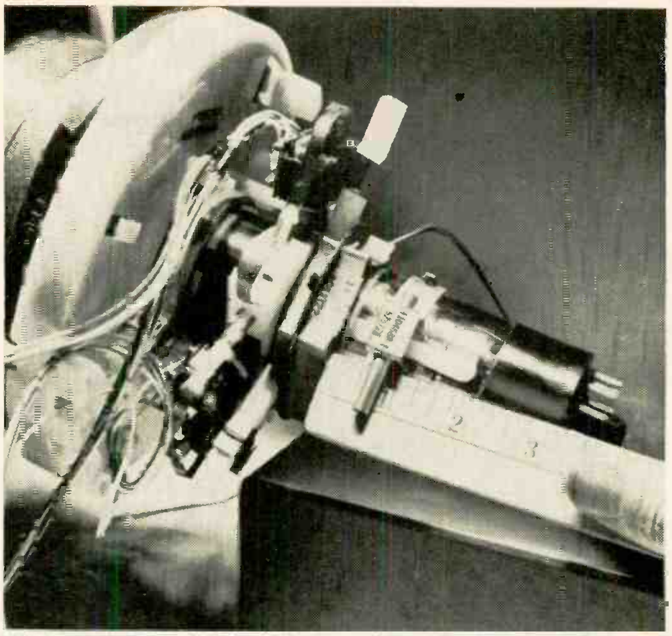
Removing chassis and CRT

After pulling off all front knobs and removing the rear cabinet cover, disconnect the high-voltage lead going to the picture tube. In older sets, this lead must be unfastened from the metal box before you open the box lid. Push down against the high-voltage connection with a long insulated screwdriver to discharge the high voltage. This lead will pull straight out of a pin socket. In newer sets, the high-voltage lead unplugs from the glass picture tube.

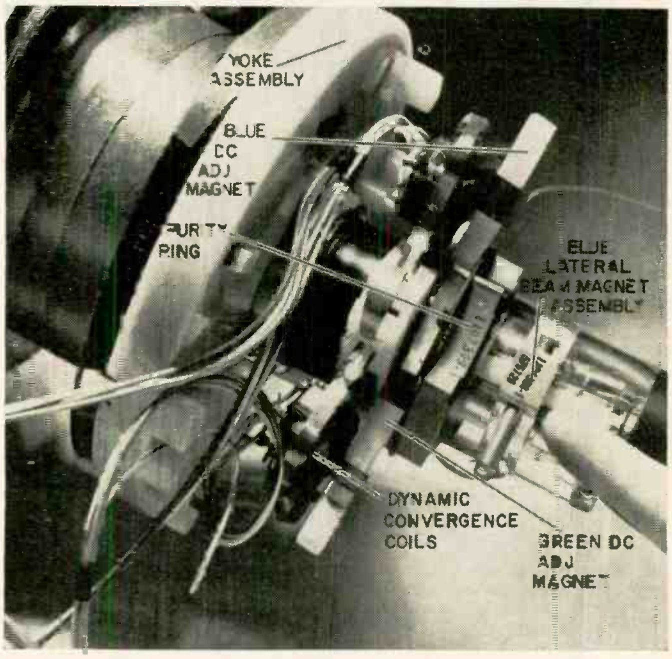
Now remove all wires connected to components on the picture tube. Remove the picture-tube socket and the yoke leads. All the colored wires going to the deflection yoke are marked on the yoke where they plug in. There is little danger of getting them wrong when replacing them. Unhook the blue lead from ground to the blue lateral magnet. Unplug the speaker cable. Unplug the convergence yoke cable from the top of the chassis and loosen the two ¼-inch bolts that hold the antenna assembly to the case. Slide the antenna assembly out and down.

One or two chassis bolts at the top of the chassis and two bolts in the bottom of the chassis must be removed. Now slide the chassis out about 3 inches and loosen the ¼-inch metal screw that holds the small-controls assembly down. Slide the unit back and then lift up. The chassis is now free and can be removed. After the chassis has been removed, it may be wise to turn the cabinet over on its face before removing the CRT—especially if the top and side of the set you are working on are not removable.

Four nuts hold the picture tube in

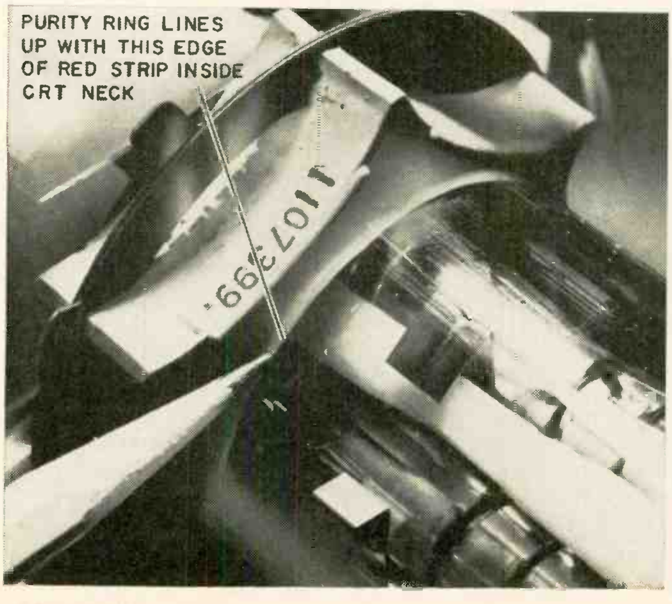


Measuring position of elements around CRT neck in relation of base of tube.

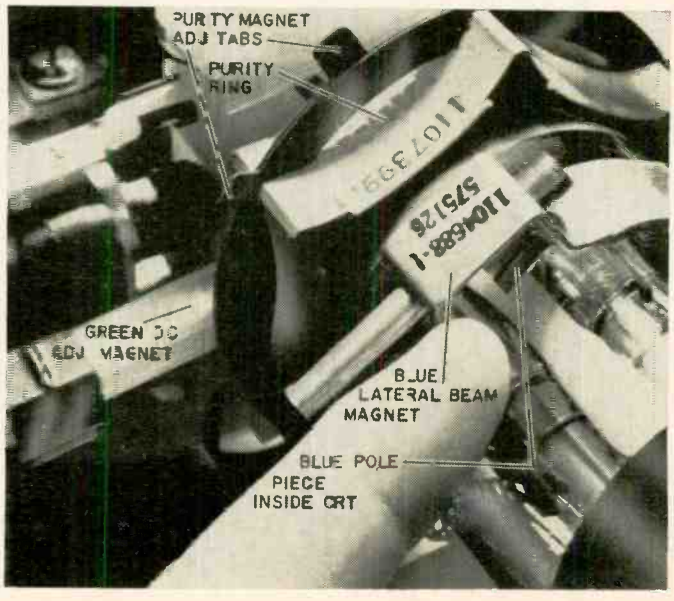


View of assemblies around the CRT neck.

Center purity ring is lined up with red stripe on neck of CRT.



Closeup shows greater detail of convergence elements.



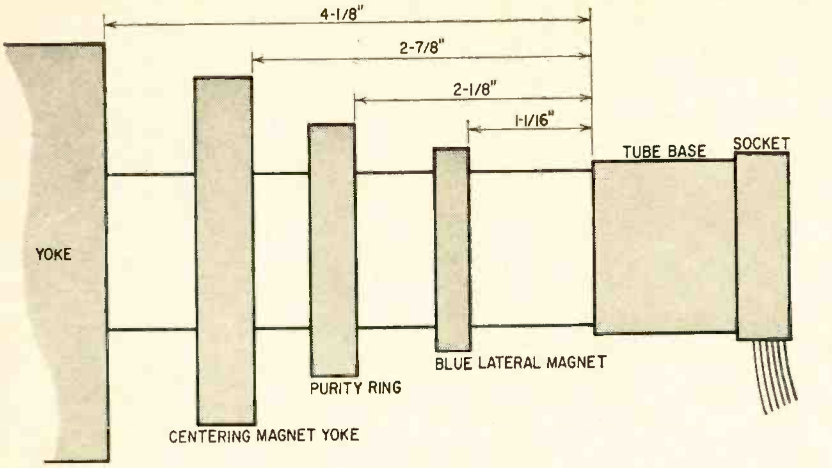


Fig. 1—Measure component spacing before they are removed from CRT neck. Measurements are approximate, but help when replacing parts on neck of new CRT.

place—two at the top and two at the bottom of the assembly. Loosen the bottom nuts first, then the top two. Two men should work together to remove the picture tube from the receiver cabinet. We have used only one man, but the cabinet starts to crawl and the picture tube is heavy too.

You can remove the components from the tube while it is in the cabinet or on the bench. I left everything on the color tube so pictures could be taken as each was removed.

Removing components from CRT

Place the kinescope face down on a drop cloth or newspaper to protect the face from scratches. To be sure that the components will be replaced on the new tube correctly, measure the settings, with a ruler, from the base of the kinescope. Fig. 1 shows the settings in inches for a tube I removed. When you remove the blue lateral magnet, you will notice that it sits right over a clip inside the picture tube.

The purity ring sets over the red ring marked inside the tube. Notice that the center adjustment magnet and convergence yoke are mounted at the opposite end of the red ring. Note that the blue wires from this yoke are at the top of the picture tube over the blue gun, the red wires at the right side and the green wires on the left going to the green dynamic convergence coils.

The large deflection yoke is loosened with a ¼-inch nut driver and slid off the end of the tube. It is heavy; don't be surprised into dropping it.

The masking must be removed from the front edge of the picture tube. On older sets, the mask extends several inches down onto the tube. Plastic tape holds or seals the joint of the mask section.

Replacing components

When placing the mask on the new picture tube, be sure that the center of the face mask (there is a mark on the new mask showing the center) is placed in line with the blue gun. The blue gun is always at the top of the screen. Use either plastic tape or masking tape to hold the mask in place. At this time, the new color CRT can be placed in the receiver cabinet.

First, be sure the safety glass has been washed and cleaned. Also, make sure there is no lint or dirt on the face of the new CRT. Then tip the picture tube and push it into the cabinet. Check to make sure that the blue gun is up and set the tube into its plastic holders. Help is needed here. At this time, check to see if any foreign matter has fallen into the front glass. If not, place the four nuts over the metal tube harness and tighten them.

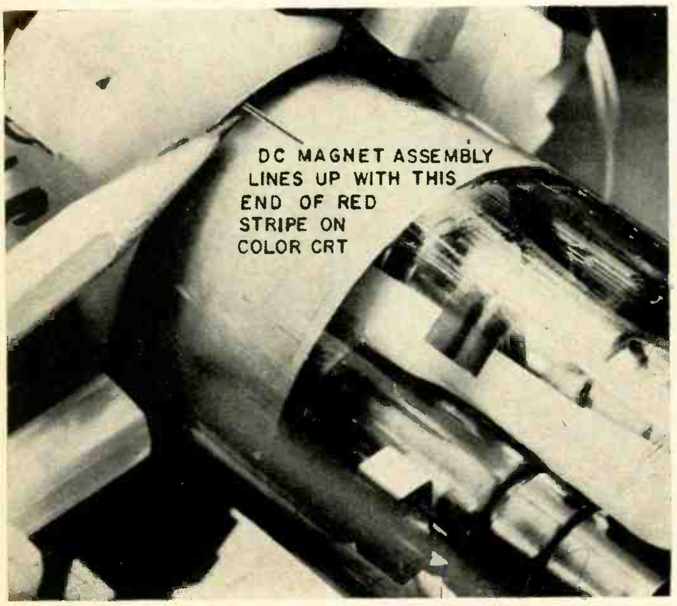
Now slide the yoke into place and tighten the ¼-inch bolt slightly. You should still be able to push the yoke back and forth on the picture tube neck. Install the other components, making sure they are in proper order and spacing them according to the measurements you made when you removed them from the defective tube. Now replace the TV chassis and reconnect all leads. Once everything is back in place, turn on the receiver and let it run for 15 or 20 minutes before converging the set.

Receiver convergence

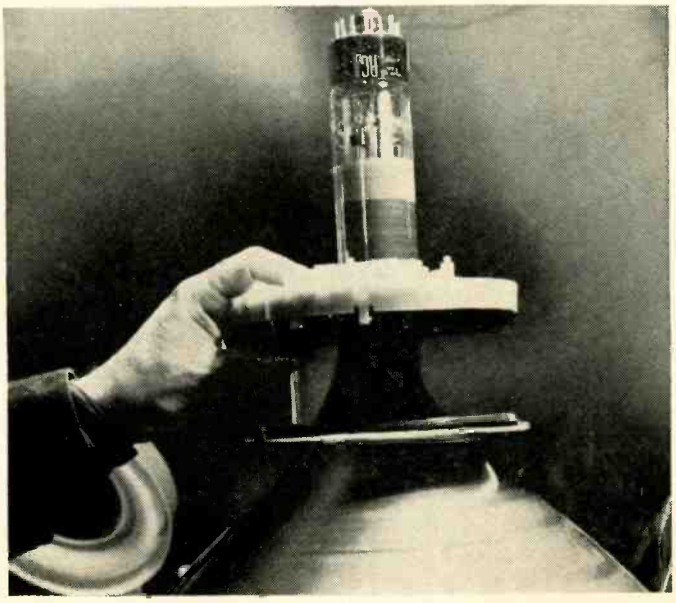
Before starting to converge the TV screen, turn the dot-bar generator on and let it warm up thoroughly. While it is stabilizing, take your degaussing coil and demagnetize the set. After degaussing, if you see any color shading anywhere on the screen, purity must be adjusted.

To start the purity adjustment, turn off the set and unplug the i.f. cable going to the tuner. Plug the ac interlock cord back in and, after the receiver warms up, short out the green and blue grids through a 100,000-ohm resistor. There are commercial kinescope grid-shorting

Dc magnet assembly is lined up at this end of red stripe on color CRT



Removing yoke from defective color CRT. Watch out, it's heavier than you think.



switch boxes on the market for this purpose. Now the screen is red. Adjust the center purity ring for a center red coloring. Then push the yoke back and forth and adjust the purity ring until the entire screen has an even red tint.

If this is done correctly, the green and blue shading will fall in line. It is always best to check each one separately by shorting the other two grids to ground through a 100,000-ohm resistor. If there is still shading or color at the edges, adjust the hairpin magnets at the outside or (on the older sets) bell of the tube to erase them. These magnets are not used on the newer sets. If a little shading persists, try degaussing the kinescope again.

At this point, check two things. Be sure the picture is level and in focus. The temperature and black-and-white adjustments generally are not too far off if these controls did not get bumped. Check receiver operation on black-and-white. If adjustment is required, follow the manufacturer's setup procedure.

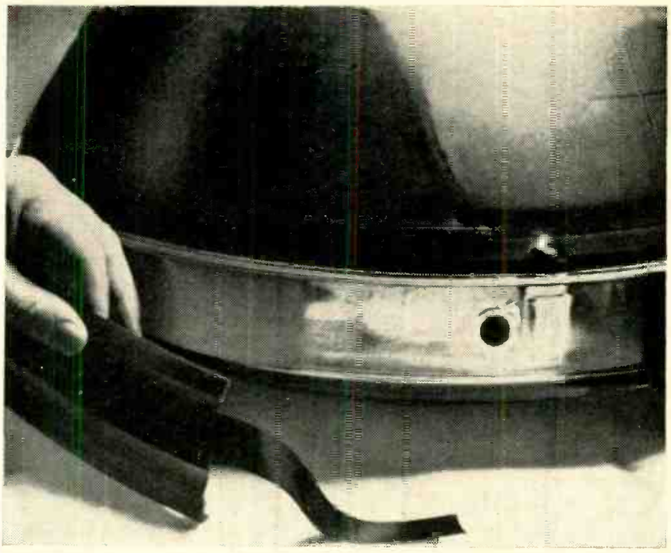
On later-model receivers, convergence adjustment is comparatively easy. Connect the dot-bar generator to the antenna terminals and set the generator to the same channel as the TV receiver. Remove the convergence board assembly from the back of the set and place it on the slots at the top and back of the receiver. Tighten the two metal screws so the board is solidly in place. Watch the wires that connect to this board and the yoke assembly so that they do not get hung up.

Do the vertical convergence first. If the receiver was properly converged when the picture tube went out, the dynamic convergence controls will need only a touchup. Put the dots on the screen and check down the center for a white dot. Short out the blue gun with the 100,000-ohm resistor. Bring the red and green dots together in the center of the screen, sliding the green and red beam center magnets to set the dots on top of one another. Check and readjust this setting several times to make sure it is right.

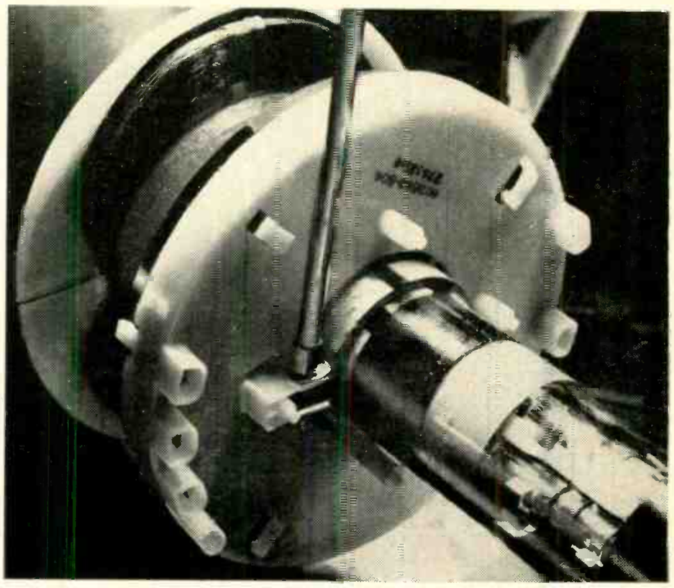
If they won't quite come together, rotate the red magnet a half turn and reinsert it, and the dots will come together. Once they are together in the center of the screen, short the green grid and line up the red and blue dots. The blue-beam center magnet moves the blue dot up and down. The blue lateral beam moves the blue dot horizontally. Place them on top of one another. Go back and check the red and green guns again. Now check all three dots, which should result in a white dot. The amplitude and the tilt controls should be adjusted unless the dots fail to drop in.

It is best to step back and take a look at the screen with a station tuned in, to observe the colors that are bleeding through. After this observation, switch the dots back on and check vertical convergence across the screen.

Removing front protective mask from face of tube.



Replacing the yoke assembly.



On later receivers, half the screen can be converged at a time. Short the blue grid to ground. Adjust RG1 (Fig. 2) to make the vertical dots converge on the left side. Then adjust RG2 to

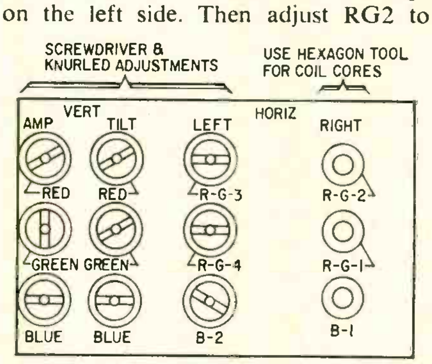


Fig. 2—Typical convergence adjustment board.

make the horizontal dots converge on the right side. Adjust RG4 to make the red and green horizontal dots converge on the left side of the screen. Go back and touch them up again.

Now short out the green grid and converge the red and blue dots. Check to make sure the red and blue dots converge down the center of the screen. Adjust coil B1 to make the blue dots fall on the red dots in the right side and adjust B2 to adjust the horizontal blue dots to fall on the red dots on the left side. If the blue dots are too high, lower them with the blue beam centering magnet. If they are to the right or left, adjust with the blue lateral positioning magnet. Remove the short from the green grid and white dots should appear all over the screen. It is impossible to get a 100% converged screen, although the new color sets are much easier to converge than those of several years ago.

Go over convergence adjustments several times. Be sure you are satisfied with the convergence. Check the focus of those dots, for changing the focus will throw the convergence off. Practice makes perfect, but be sure to fill out the warranty tag for the new color picture tube just installed. END

1964 / COLOR TV ROUNDUP

Now that there are more than just two chassis, you need a scorecard! **By WAYNE LEMONS**

ONE OF THE OUTSTANDING THINGS ABOUT color TV this year is the spirit of change. There are no longer just two chassis hiding behind a multitude of brand names. And, as in the early days of black-and-white, the color chassis is gaining individuality as each manufacturer incorporates new design ideas. Although there are no revolutionary developments in circuitry this year, the first rectangular color tubes, a 16-inch by Toshiba and a 23-inch by Motorola, are no doubt the harbingers of a new color era.

All chassis except Zenith and Toshiba use X and Z color demodulators followed by R — Y and B — Y amplifiers. The G — Y signal is then derived by picking off and mixing the right amounts of the reversed outputs of the R — Y and B — Y amplifiers.

Zenith uses "switch tube" high-level demodulation (as it has since its entrance into color) with no amplifiers between the demodulator and the CRT grids. Toshiba uses a slightly different method of demodulation than either of the above. They demodulate on the R — Y, B — Y and G — Y axes directly rather than deriving the G—Y in the amplifiers. This they do by taking a third phase axis from the 3.58-mc color oscillator (Fig. 1), and supplying all three of the demodulator grids with selected amounts of the color signal from the second bandpass amplifier. The cathodes of the color amplifiers which follow these demodulators use a common cathode resistor even though the G — Y signal has already been derived. This common connection is necessary so that blanking can be applied through the color amplifiers to all three color grids simultaneously.

The greatest design changes in color chassis this year have been in the black-and-white circuitry; different tuners, i.f. strips, sync circuits, etc. The convergence circuits, except for some refinements and slight rearrangement of controls in some models, are virtually unchanged. Convergence procedures are pretty much what they have been for the last 3 or 4 years.

Many companies are using turret tuners this year, and all but Toshiba (which uses a cascode type) have neutralized triode rf amplifiers. Admiral, Curtis Mathes, RCA, G-E and perhaps others use Nuvistor 6CW4 or 6DS4.

An almost universal design feature for 1964 is the inclusion of some method of controlling video response. Most designers have chosen a three-position switch but at least one (Zenith) has a continuous control. Fig. 2 shows the method selected by Admiral. By switching in different values of capacitance across the contrast control, the high-frequency response of the video amplifier can be reduced or increased at all but the maximum setting of the control.

The switch can be used to compensate for variations in transmission conditions, depending upon where the set is used and the program material that is transmitted. For example, in fringe areas, snow can be reduced by reducing the high frequency response. On the other hand, old films can be "livened up" by increasing the high-frequency response so that outlines stand out better against the background. Fig. 3 shows the continuous "video peaking" control used on Zeniths.

Power supplies

Another feature found on many sets this year is "boosted boost." This is an added voltage obtained from the flyback and normal boost circuit so that

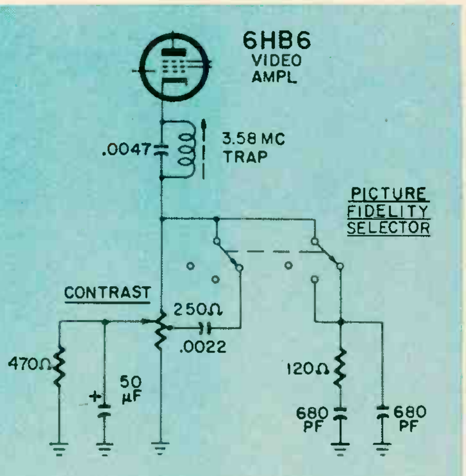
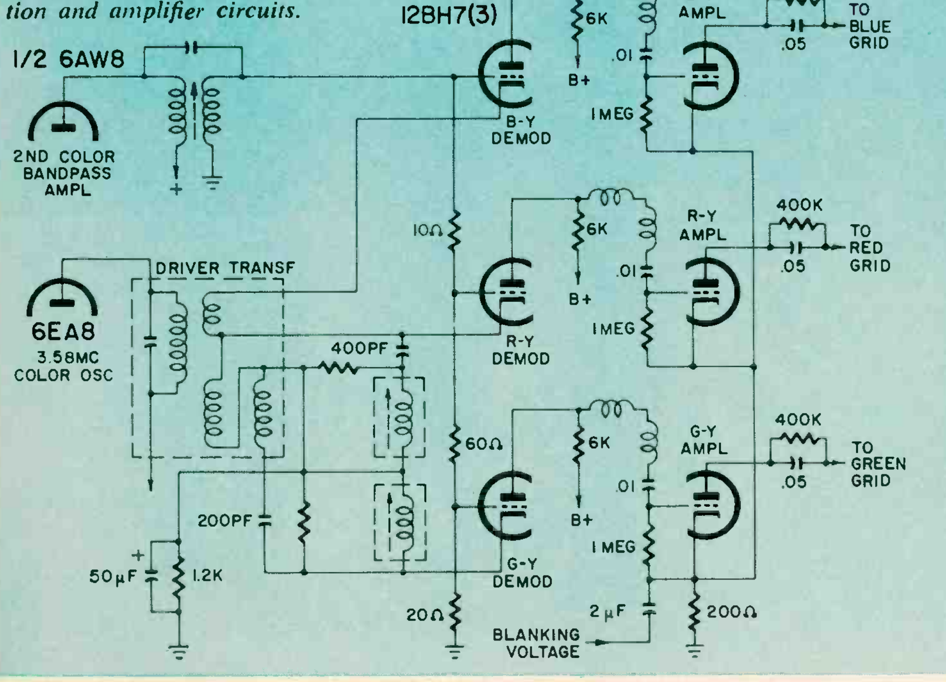


Fig. 2—Admiral's picture-fidelity selector varies response of video output stage.

Fig. 1—Simplified schematic of Toshiba 16WM color demodulation and amplifier circuits.



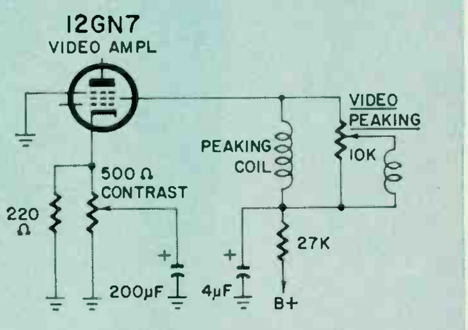
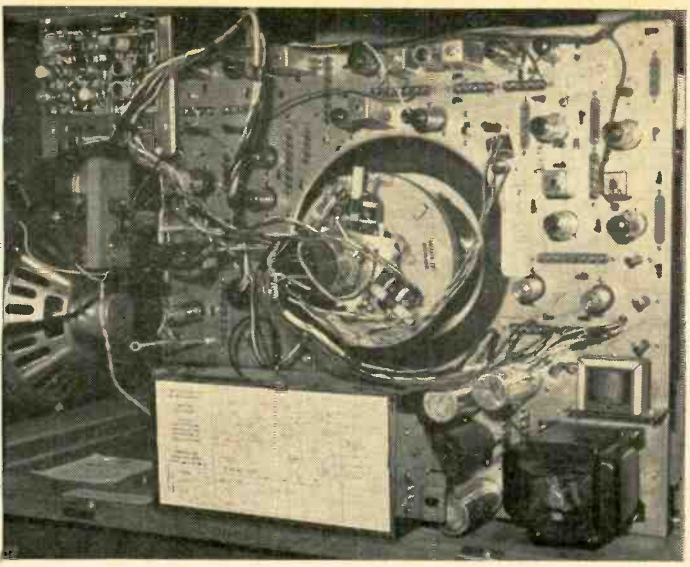
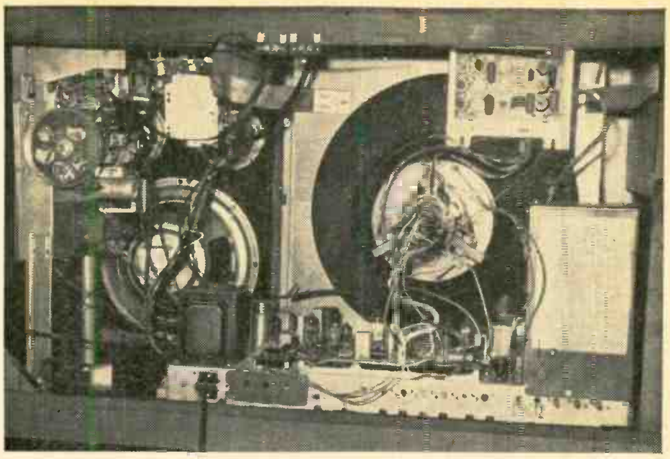


Fig. 3—Zenith's video peaking circuit inserts reactance in screen of video tube.





◀ *Fig. 4—Packard-Bell vertical "wraparound" chassis swings left, out for easy access.*

▲ *Fig. 5—Curtis Mathes combination: basic CTC 12 color chassis, plus AM–FM tuner and hi-fi audio.*

several hundred volts more is available for the screens of the color tube. This is said to produce both a brighter picture and somewhat better focus. The circuit used in Packard-Bell and RCA sets is typical. (See the RCA CTC 15 article in this issue, page 00.) A high-voltage *selenium* rectifier tapped up on the flyback develops an additional 420 volts over the normal boost supply.

One other feature popular this year is a high-voltage selenium diode as a focus rectifier instead of a 1V2 tube. This has the advantage that no sweep power is used to supply the focus rectifier filament. A circuit of this kind is also used by G-E, RCA and Philco.

Mechanical construction

Packard-Bell is building this year what is probably the first vertical "wraparound" color chassis. This is not as bad as it might sound. (See Fig. 4.) All adjustments are located on the rear side of the chassis with the execption of the convergence boards which is mounted separately (upper left). The beauty of this chassis is that, when underchassis service is needed, all you do is remove two nuts on the right and the chassis swings out, *over* the picture tube to the left, making all parts underneath accessible.

Most manufacturers have at least one or two models of color sets that also include radio, phonograph and hi-fi amplifier. Fig. 5 shows the rear view of a Curtis Mathes combination. This chassis is similar to RCA's CTC 12 except that no audio output tube is used. (You might think a tube is missing, since the socket *hasn't* been removed.) The sound from the quadrature detector is channeled through the radio–phono amplifier. Curtis Mathes markets color sets only in combinations.

Setup and convergence

A setup switch that sets the bias on the picture tube and at the same time kills the vertical deflection for making gray-scale tracking adjustments is a standard feature on all American-built sets. The Toshiba color set does not use this switch but does have individual gun killer switches mounted on the convergence panel (a "why not" feature that would be a welcome addition to any color set). The killer circuit is interesting and is shown in Fig. 6. Note that 100,000-ohm resistors are switched in but *not* in the control grid circuit. These are switched into the circuit to reduce the voltage on the CRT screens. This permits long leads without the possibility of video deterioration.

Several new sets (and many of last year's) use an H-bar plastic magnet holder for the dc convergence adjustments and a slightly different design for the blue lateral magnet. These changes are shown in Fig. 7.

Hv regulator changes

High-voltage regulator circuits are

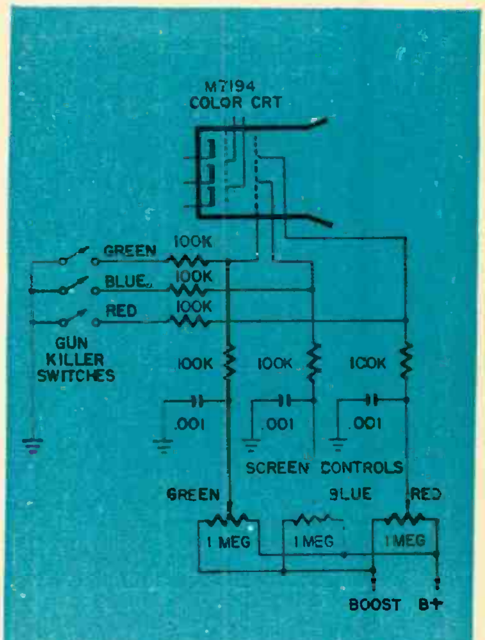


Fig. 6—Toshiba's setup switches kill individual color guns in unusual way.

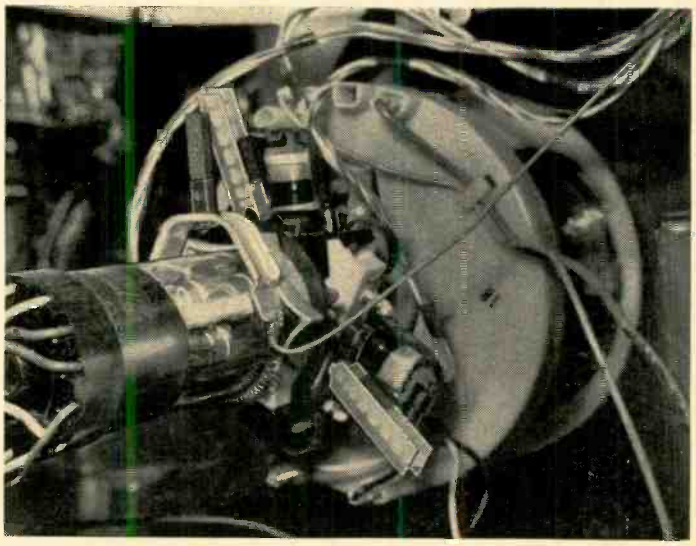


Fig. 7—Closeup of CRT neck shows "H" — cross-section convergence magnet holders and sliding blue lateral magnet.

1964 COLOR FACTS CHART

Make →	Admiral	Curtis Mathes	General Electric	Heath	Magnavox	Motorola	Packard-Bell	Philco	RCA	Toshiba	Zenith
Chassis Number	24A2, 24UA2, 24B2, 24UB2, 24C2, 24UC2, 24D2, 24E2, 24UE2	CMC12	CY	GR-53	43 Series	TS-908-00	98C7D	"M" Line	CTC 15	16WM	25LC20 25LC20QS
Tuner	Turret 6DS4 Nuvistor rf 6FG7 Mixer–osc	Turret 6DS4 Nuvistor rf 6FG7 Mixer–osc	Switch Type 6CW4 Nuvistor rf 6EA8 Mixer–osc	Turret 6DS4 Nuvistor rf 6FG7 Mixer–osc	Turret 6DS4 Nuvistor rf 6FG7 Mixer–osc	Turret 6DS4 Nuvistor rf 6FG7 Mixer–osc	Turret 6GK5 Triode rf 6CG8 Mixer–osc	Switch Type 6HA5 Triode rf 6HG8 Mixer–osc	Switch Type 6DS4 Nuvistor rf 6EA8 Mixer–osc	Turret 6D-HH13 Cascode rf 6M-HH3 Mixer–osc	Turret 6HA5 Triode rf 6GJ7 Mixer–osc
Video I.F.	6BZ6 6GM6 6JC6	6BZ6 6GM6 6EJ7	6JH6 6GM6 6EJ7	6JH6 6GM6 6JC6	6JH6 6GM6 6EJ7	6EH7 6EH7 6EJ7	6JH6 6GM6 6EJ7	6JH6 6GM6 6EJ7	6JH6 6GM6 6EJ7	6BZ6 6BZ6 6DK6	6EH7 6EH7 6EJ7
Video Ampl (Y)	6JC6 6HB6	6AW8 12BY7 (3 Stages)	6AW8 12BY7 (3 Stages)	½ 6GH8 (Pentode) 12GN7	6AW8 12BY7 (3 Stages)	½ 6AW8 (Pentode) 6HB6	½ 6AW8 (Pentode) 12BY7	6AW8, 12BY7 (3 Stages)	6AW8, 12BY7 (3 Stages)	½ 6AW8 (Pentode) 12BY7	½ 6HL8 (Triode) 12GN7
Sync—agc	6BU8 (Keyed agc)	6KA8 (Keyed agc)	6KA8 (Keyed agc)	6HS8 (Keyed agc)	6KA8 (Keyed agc)	6HS8 (Keyed agc)	½ 6GH8 Triode Sync ½ 6GH8 Pent Keyed agc	6KA8 (Keyed agc)	6KA8 (Keyed agc)	½ 6AW8 Triode Sync ½ 6CG7 Sync Output 6AU6 Keyed agc	⅔ 6BA11 Sync, Keyed agc
Burst Ampl	6EW6	6EW6	6EW6	6EW6	6EW6	½ 6BL8 (Pentode)	½ 6AW8 (Pentode)	6EW6	6EW6	6EW6	6EW6
Bandpass Ampl	½ 6GH8 (Pentode)	½ 6GH8 (Pentode)	½ 6GH8 (Pentode)	½ 6GH8 (Pentode)	½ 6GH8 (Pentode)	½ 6BL8 (Pentode) ½ 6BL8 (Pentode)	6AU6 ½ 6AW8 (Triode)	½ 6GH8 (Pentode)	½ 6GH8 (Pentode)	½ 6EA8 (Pentode) ½ 6AW8 (Triode)	½ 6HL8 (Pentode) ½ 6KT8 (Pentode)
Color Osc & Cont	6GH8	6GH8	6GH8	6GH8	6GH8	6GH8	6GH8	6GH8	6GH8	6EA8	6GH8
Color afc	½ 6JU8	½ 6JU8	½ 6JU8	½ 6JU8	½ 6JU8	6AL5	⅓ 6BN8 (Duo-Diode)	½ 6JU8	½ 6JU8	⅓ 6BN8	½ 6JU8
Color Demodulators & Ampls	"X" 6GY6 "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6GY6 "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6GY6, "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6GY6 "Z" 6GY6 1½ 6FQ7's R–Y, B–Y, G–Y	"X" 6GY6 "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6BL8, "Z" 6BL8 Also Used As R–Y, B–Y (Triode Sections) ½ 6BL8(Triode)G–Y	"X" ½ 12AZ7 "Z" ½ 12AZ7 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6GY6 "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	"X" 6GY6 "Z" 6GY6 1½ 6GU7 R–Y, B–Y, G–Y	½ 12BH7 R–Y ½ 12BH7 B–Y ½ 12BH7 G–Y	2 6JH8 (Switch Tube) R–Y, B–Y, G–Y Demods
Color Killer Det. & Color Killer	½ 6JU8 ½ 6GH8 (Triode)	½ 6JU8 ½ 6GH8 (Triode)	½ 6JU8 ½ 6GH8 (Triode)	½ 6JU8 ½ 6GH8 (Triode)	½ 6JU8 ½ 6GH8	Semiconductor Diode ½ 6AW8 (Triode)	⅓ 6BN8 (Triode) ½ 6GH8 (Triode)	½ 6JU8 ½ 6GH8 (Pentode)	½ 6JU8 ½ 6GH8 (Pentode)	⅓ 6BN8 (Triode) ½ 6EA8 (Triode)	½ 6JU8 ½ 6KT8 (Triode)
Sound I.F. & Demodulator	6EW6 6HZ6 (Quad Det)	6EW6 6HZ6 (Quad Det)	6EW6 6HZ6 (Quad Det)	6GX6 (Quad Det)	6EW6 6HZ6 (Quad Det)	½ 6BL8 (Pentode) 6DT6 (Quad Det)	½ 6GH8 (Pentode) 6AU6 6BN8 (Ratio Det)	6EW6 6HZ6 (Quad Det)	6EW6 6HZ6 (Quad Det)	6AU6 1st 6AU6 2nd Oual Diode (Ratio Det)	½ 6KT8 (Triode) 6BN6 (Quad Det)
Sound Output	6BQ5	Not Used (Hi-Fi Ampl)	6AQ5A	6GW8	6AQ5A Not Used on Comb	½ 6BM8 (Pentode)	6AQ5A	6AQ5A	6AQ5A	6AQ5	6BQ5
Vertical Osc & Output	6GF7	6EM7	6GF7	6EW7	6GF7	½ 6CG7 osc 6EZ5 Output	6GF7	6GF7	6GF7	½ 6CG7 osc 6AQ5 Output	⅓ 6BA11 osc 6HE6 Output
Horiz Osc & Control	6FQ7 "Synchrophase" "npn" Diode Control	6FQ7 "Synchrophase" "npn" Diode Control	6FQ7 "Synchrophase" "npn" Diode Control	6FQ7 Dual Selenium	6FQ7 "Synchrophase" "npn" Diode Control	6BL8 Coldpitts Horiz Osc and (Triode) Control	6FQ7 or 6CG7 Multivibrator "npn" Diode Control	6FQ7 "Synchrophase"	6FQ7 "Synchrophase" "npn" Diode Control	6CG7 "Synchroguide" osc and Control	6U10 (Triple Triode) React Control, osc, Discharge. "npn" Diode Phase Det
Horiz Output & Damper	6DQ5 6DW4	6DQ5 6DW4	6JE6 6DW4	6JE6 6DW4	6JE6 6DW4	2 6DQ6 6DW4	6JE6 6DW4	6JE6 6DW4	6JE6 6DW4	6DQ5 6AU4-A	6HF5 6DW4
Focus Rect & Focus Adj	1V2 Slug Adj	1V2 Slug Adj	Selenium Slug Adj	Selenium	Selenium Slug Adj	1V2 Slug Adj	Selenium Slug Adj	Selenium Slug Adj	Selenium Slug Adj	5642 250K Pot	1V2 or 1AU2 10 Meg Pot
Circuit Protection	Circuit Breaker	Circuit Breaker Heater Fuse Link	Circuit Breaker Heater Fuse Link	Thermal Circuit Breaker Thermistor	Circuit Breaker Heater Fuse Link	Circuit Breaker Thermistor Thermal B+ Delay Heater Fuse Links	Circuit Breaker Heater Fuse Link	Circuit Breaker Heater Fuse Link	Circuit Breaker Heater Fuse Link	2 5-Amp Line Fuses 3-Amp B+ Fuse	B+ Circuit Breaker Heater Fuse Links
Centering	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical	Centering Rings
Wiring	Printed	Printed	Printed	Printed	Printed	Hand	Hand	Printed	Printed	Hand	Hand
Picture Tube	21FBP22 (Unbonded) 21FJP22 (Bonded)	21FJP22 (Bonded)	21FJP22 (Bonded)	21FJP22 (Bonded)	21FJP22 (Bonded)	(23EGP22) 23" Rectangular	21FBP22 (Unbonded)	21FJP22 (Bonded)	21FJP22 (Bonded)	M7194 M7194A	21FBP22 21FKP22 21FJP22
Special Features & Comments	1. Pix Fidelity Switch 2. Setup Switch 3. Boosted Boost	1. Video Peaking Switch 2. Setup Switch 3. Boosted Boost Same as RCA CTC 12 Except Tuner and Audio Output	1. Video Peaking Switch 2. Setup Switch 3. Boosted Boost 4. "Video Controlled" HV Regulation Same as RCA CTC 15	1. Kit Form 2. Built-in Dot Generator 3. Vertical Chassis	1. "Color" Indicator Light 2. Setup Switch 3. Video Peaking Switch 4. "Video Controlled" HV Regulation 5. Boosted Boost Similar to CTC 15	1. 23" Rect Pix Tube 2. "Color" Indicator Light 3. Dynamic Pincushion Correction Ampl 4. Setup Switch 5. Varistor in Regulator Ckt 6. Boosted Boost	1. Pix Fidelity Switch 2. Boosted Boost 3. Setup Switch 4. "Swing Out" Chassis	1. Video Peaking Switch 2. Setup Switch 3. Boosted Boost 4. "Video Controlled" HV Regulation Same as RCA CTC 15 Except Tuner	1. Video Peaking Switch 2. Setup Switch 3. Boosted Boost 4. "Video Controlled" HV Regulation	1. 16" Rect Pix Tube 2. 100–110 V Power Trans 3. Individual Gun Killer Switches for Setup 4. Color Balance Control	1. Video Peaking Control 2. Color Off–On Switch 4. 3AT2 HV Rect

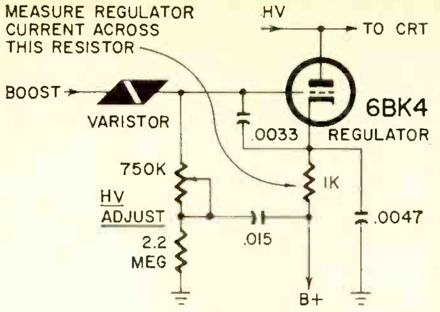


Fig. 8—Motorola circuit regulates high voltage with a varistor.

starting to feel the effects of refinement. G-E, Magnavox, Philco and RCA have a "video controlled" circuit. (You'll find a schematic of this, too, in the RCA CTC 15 article.) This circuit tends to reduce blooming when there is a large amount of white in the picture. Compensation is needed because the picture tube draws more current from the high-voltage supply when the white content of the picture increases.

The RCA circuit feeds a monitoring voltage from the plate of the video amplifier to the grid of the high-voltage regulator through a 12-megohm resistor. When white content is high, the plate voltage of the video amplifier is lower. This lower voltage lowers the regulator grid voltage slightly and the regulator tube draws less current, puts less load on the high voltage, and the high voltage rises.

Motorola uses a varistor in series with the boost voltage to the grid of the 6BK4 shunt regulator (Fig. 8). This voltage-dependent resistor tends to accentuate the effects of boost-voltage changes and so provides somewhat better regulation. An ordinary resistor here would pass the boost-voltage change to the grid in a 1-to-1 ratio while a varistor of this kind passes more current with an increase in voltage than you'd expect from Ohm's law. The resistor looks like less resistance in the circuit when the voltage is higher, and like more resistance when the voltage falls.

Pincushion correction

The 23-inch rectangular tubes are not without circuit problems. One major one is the more noticeable effects of pincushioning (lines bent) at the outer edges of the raster. Permanent magnets, as used with wide-angle black-and-white tubes, are not the answer in color because the magnets affect both convergence and purity. To whip this problem, Motorola developed a "Dynamic Pin Cushion Corrector" (DPCC) circuit. Fig. 9 is a simplification explaining how it works. A pulse from the plate of the vertical output tube is shaped and fed to the grid of the DPCC tube. In addition, a horizontal pulse is fed into both sides of the primary of the DPCC transformer (one side by way of the cathode of the DPCC tube). The secondary of this transformer is in series with the vertical yoke windings. The combinations of these voltages provide a method of speeding or slowing the scan at the upper and lower edges of the tube.

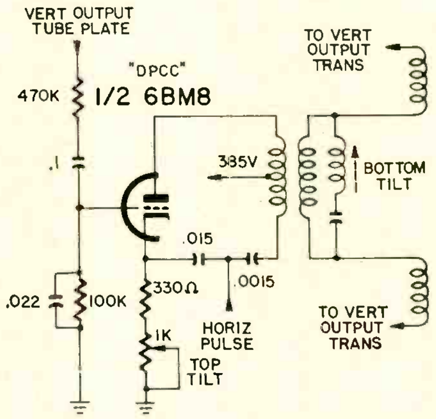


Fig. 9—Dynamic Pincushion Corrector circuit in Motorola 23-inch color set.

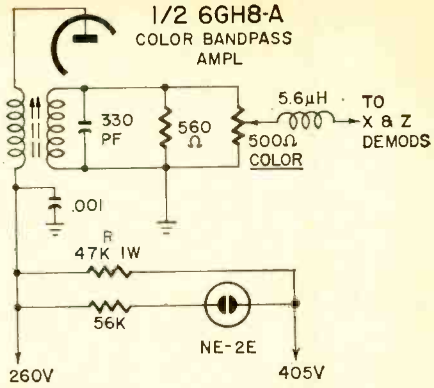


Fig. 10—Magnavox modified the RCA CTC 15 by adding a color program indicator light.

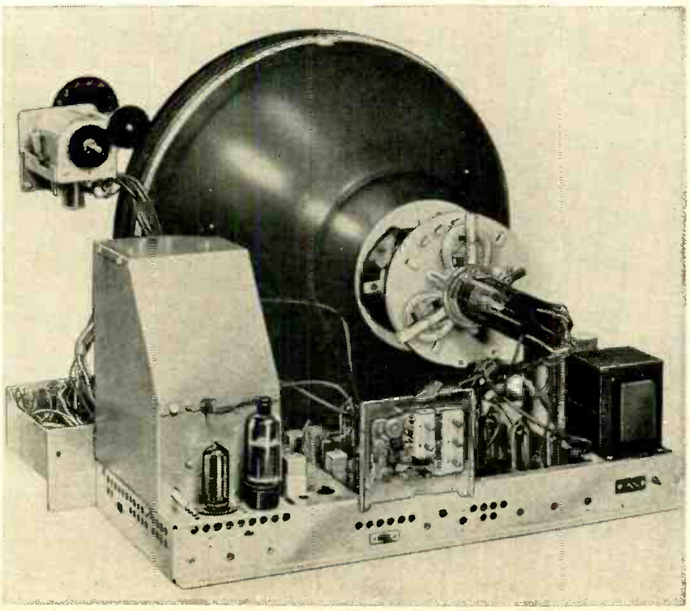
A control in the cathode circuit is simply adjusted for most correction (straightening of the bent lines) at the top of the picture while the slug-tuned coil across the transformer secondary is adjusted for best correction at the bottom of the screen.

"Color" indicator lights

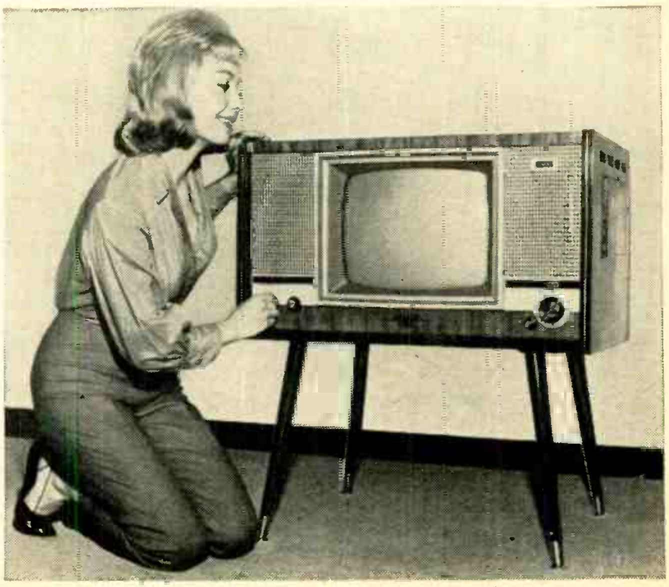
Motorola and Magnavox have lights to indicate that the set is receiving a color program. Fig. 10 shows how Magnavox modified the RCA CTC 15 chassis to provide an indicator. When no color program is being received, the color killer keeps the bandpass or "color i.f." stage cut off; this means there is no drop across R and the neon does not light. During a color program, the bandpass tube is on and the drop across the 47,000-ohm resistor exceeds the firing voltage of the NE-2E, which then glows.

The "1964 Color Facts Chart" shows you how the sets compare. Check it over to see what new tubes you may need to stock. [Too late to work it in here, we learned that Motorola has introduced a new chassis, the TS-912A-00, which has several new tubes and simplifying features. We hope to describe it in an early issue.—*Editor*] END

The 1964 Admiral color TV chassis.



Toshiba's 16WM has several new ideas, described in this article.



COLOR TV! Today & Tomorrow

By DAVID LACHENBRUCH

Color television's first decade—and a look at its future

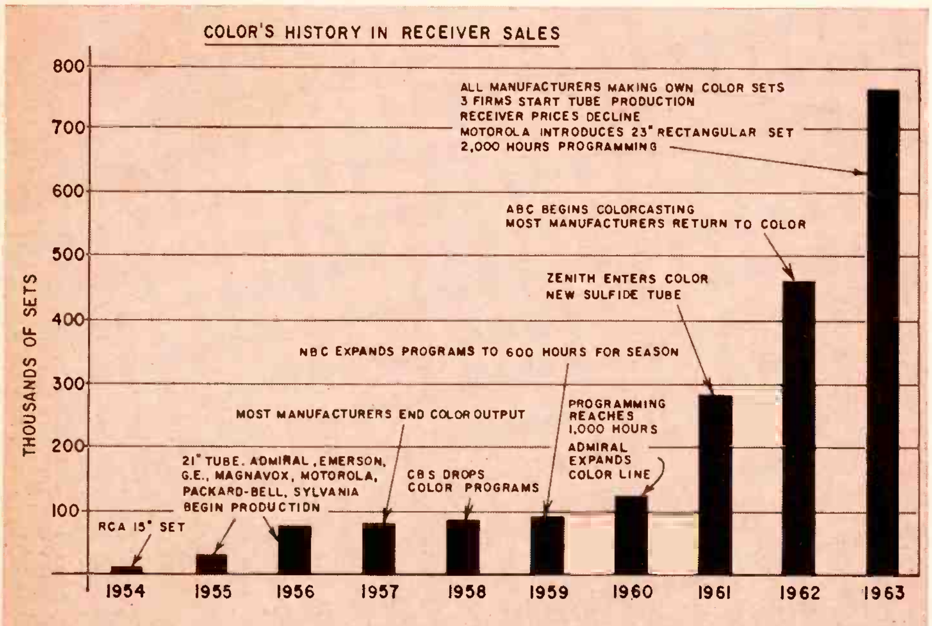
THE COLOR TELEVISION BOOM, EXPECTED almost continuously since 1954, is at hand. The tenth anniversary year of the commercialization of color TV—1964—will be the first year in which sales of color sets to the public will probably exceed one million. Commercial color broadcasting was officially authorized by the FCC on Jan. 2, 1954, and the first color receivers rolled off production lines on March 17 of the same year.

Industry forecasters expect color sets to account for about 14% of TV unit sales next year, and fully 30% of television sales dollar volume. And color will be contributing a continually increasing percentage of TV servicing revenues.

The saga of RCA's unflagging persistence, and its investment of more than $130 million in color, is a familiar one. As a result of this almost single-handed effort, the shadow-mask tube and associated circuits represent the only commercially accepted method of obtaining a color TV picture in the home to this very day.

Where does color go from here? What of the various inventions we have heard of since 1954? Are there new tubes, new circuits and new principles in the works which promise to simplify, improve and economize home color TV? Many of the clues lie in color's 10-year commercial history.

RCA quite frankly expected color television to catch fire from its very introduction in 1954. The American public had other ideas, and the first color set—the 15-incher which gave a 12-inch picture at about $1,000—laid an egg. People wanted a bigger picture, it was said.



This chart shows slow start of color television, and the sudden rise in the number of sets sold during the past two years. These are author's estimates, since there are no official statistics. Each year brought with it some significant event—sometimes negative, as in color's "bleak years" 1956–1959, sometimes positive, as in the years since 1959.

This condition was remedied the next year, when the 21-inch color set was born. It had a round tube, with 70° deflection, similar in appearance and principle to today's color tubes. Not only RCA, but Admiral, Emerson, General Electric, Magnavox, Motorola, Sylvania and others began color set production, some using RCA's 21-inch tube and others using 21- or 19-inch shadow-mask tubes produced by other makers.

Public response continued listless. Word spread that color sets were difficult to tune, almost impossible to keep in adjustment and that all you could see on them was purple people-eaters. By 1956, RCA cut list prices on its color sets to a low of $695 and then to $495, but color had a bad name. Most other set manufacturers—although affirming their faith that color was inevitable—ended production and liquidated their color inventory for what it would bring.

From 1956 through 1959, color sales leveled off at between 75,000 and 90,000 sets per year, as compared with 6 to 6.5 million black-and-white sets. In 1958, CBS ended all regular color broadcasts. Those were color's bleakest years. Nevertheless, NBC continually expanded its color broadcast schedule, and RCA engineers continued to engineer improvements into the color chassis and tube. These improvements were slow and gradual—there were no dramatic breakthroughs.

Color sales showed signs of more life in 1960, when they broke through the 100,000-set barrier, while network programs exceeded 1,000 hours for the first time. RCA and Packard-Bell were actually the only ones making color sets at the time, but Admiral was having some success in marketing sets built for it by RCA. The increase in programming and the improvements in color sets, together with RCA's advertising campaign, were beginning to influence the industry, particularly at the dealer level.

Color's real turning point came in

1961, with the dramatic announcement that RCA's arch-rival, Zenith, was preparing a line of color sets at the request of its dealers, to give them a "full line" to compete with anything other manufacturers had to offer. The remainder of the set manufacturers quickly fell in line. Most of them, however, had once been burned by heavy losses on color, and were unprepared—or unwilling—to set up for their own production. RCA was only too willing to help them by supplying complete color chassis or kits of essential parts.

The same year, RCA introduced a new version of its 21-inch round 70° color picture tube. Sulfide phosphors—of the same type used for black-and-white—increased brightness and contrast, and reduced color smearing and trailing. Sales more than doubled in 1962. The ABC television network edged into color broadcasting, although CBS was (and still is) holding out.

But color was still highly controversial. Manufacturers began to dust off and re-evaluate old color receiver systems they had developed in the early 1950's and shelved. Among major set manufacturers, Motorola was one of the few which had not re-entered color, insisting that the bulky, round 21-inch 70° picture tube made color cabinets too ungainly for most living rooms.

While color set sales boomed, the picture-tube controversy accelerated. Working with National Video Corp., a Chicago picture-tube manufacturer, Motorola developed and demonstrated prototypes of a 23-inch rectangular 90° picture tube, about 6 inches shorter than RCA's round tube. RCA countered with the announcement that it would change over to a new shorter color tube, still a 21-inch round, but with 90° (instead of 70°) deflection. Then, as 1962 neared an end, RCA Tube Div. told its set-making customers that it would be unable to deliver the new short tube because of "technical difficulties" and reliability problems.

Color roared into 1963, and sales this year are expected to end up between 650,000 and 850,000. Among these will be some using the new 23-inch Motorola rectangular 90° tube, which is based on the same shadow-mask principles as the RCA 21-inch. The glass bulb is basically the same as that used for 23-inch black-and-white tubes, but re-formed to color's more exacting tolerances.

This year saw the first reductions in the base price of color sets in 7 years. Admiral shocked the industry by introducing a table model at $399.95, and the rest of the industry came down to $449.95. Meanwhile, the year closes with three new manufacturers of color tubes—Sylvania, Rauland (Zenith) and National Video—in addition to RCA.

The old Apple tube, developed by Philco around 1956. Somewhat similar principles have been used in later inventions, including the recently announced Goodman tube.

Perhaps this year's most significant color action was RCA's decision to discontinue the manufacture of color chassis and kits for its competitors by the end of 1963. It needed the production capacity for itself. So, as 1963 ends, virtually every American TV manufacturer is building its own color sets.

Today there are probably 1.7 million color sets in use—about 70% of them sold within the last 2 years. (Since no color TV sales statistics are released, all figures in this article are unofficial estimates by the author.) Color sales are generally expected to exceed one million next year, with color sets in use passing the three-million mark early in 1965.

What of the future?

The current color TV set, despite many refinements and improvements, is basically a highly reliable and somewhat simplified version of the receiver built by RCA in 1955. What are the prospects for significant changes and completely new concepts in color receivers in the near future?

There's no question that the first important change will be in the picture tube. The 70° round tube is nearing the end of its cycle. Now being built by RCA, Rauland and Sylvania, it has perhaps another year or so to run. The industry is expected to standardize on a new color tube of the square-cornered rectangular type, with 90° deflection and measuring 25 inches diagonally. There may be an additional small color tube—a 19-inch rectangular, also with a 90° angle.

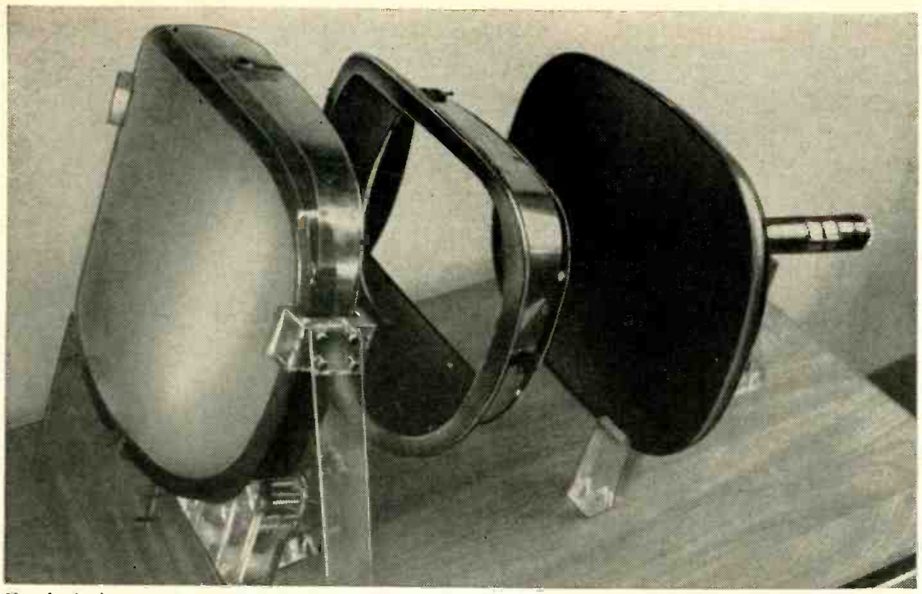
Glass bulbs for these new-size color tubes are being developed by Corning Glass Works. The new 25-inch rectangular color sets could reach the market in spring 1965—possibly as early as late 1964—completely supplanting the current round tube. (Motorola's 23-inch color sets are built to accommodate the 25-inch tube as a replacement.)

The 25-inch tube won't be new in its operating principles. It will use the same shadow-mask concept featured in all production color tubes since 1954. It will require relatively minor changes in chassis design. In fact, the new color chassis (CTC 15) introduced by RCA last summer already goes a long way toward accommodating this new 90° tube.

Revolutionary developments

Of all the other color TV tubes and receiving systems proposed in the early 1950's, the Chromatron, or Lawrence tube, has been the most durable. Paramount Pictures, which owns the rights to the tube, has periodically demonstrated to set manufacturers two versions—the single-gun Chromatron, claimed to make possible a color set at only 25% more than the cost of black-and-white, and a three-gun version, which provides more brightness than present color tubes.

No American manufacturer has recently shown an overwhelming interest in Chromatron. But Sony Corp., of Tokyo, has taken out a license with an eye to developing a portable color set using Chromatron principles. Sony offi-



Exploded model of Chromatron. Fine wire grid that deflects electrons onto correct color strip is held by center section, and cannot be seen in photo.

cials, however, say that they are still far from knowing whether they can, or will, produce such a set.

Another development of the mid-1950's, similar in principle to the Chromatron, was General Electric's post-acceleration tube. Of course, there's no way of knowing whether this development is being revitalized in G-E's labs, but there's no evidence that it is.

Philco's beam-indexing "Apple" system created a stir in color's early days, but it's not believed that company is pursuing it now. A New York inventor, David M. Goodman, recently received a patent for a system similar to Apple in many respects. Several set manufacturers have studied his development, but that's about as far as it has gone.

A new company, Video Color Corp., has been formed on the West Coast to develop a thin color tube based on the patents of W. Ross Aiken (thin tube) and C. Willard Geer (color tube). Its major efforts for the time being, however, will be devoted to military display devices.

Color projection systems have always had some appeal because they promise to eliminate the complex three-color direct-view tube. Projection in color, however, has suffered from the same failing which prevented projection from gaining widespread use in black-and-white—poor brightness. In addition, there are color registration problems.

Two color projection systems, which claim to overcome these shortcomings, have recently attracted attention as potential home TV devices. One, invented by J. H. Owen Harries (Harries Electronics Corp., Bermuda), is a low-cost system using a special plastic distortion-correcting lens and four projection tubes, claimed to result in possibly 50% greater brightness than the direct-view system.

Another projection system, developed for theater use, may eventually have potential for the home. It's G-E's Talaria light-valve projector, whose giant-screen version sells in the $50,000 range. Instead of cathode-ray tubes, this projector modulates a thin layer of fluid with two electron guns (one for green, the other for red and blue). A xenon light, beamed through the fluid, produces a color TV image of movie brightness. It's believed G-E is developing a smaller version of Talaria, but its cost probably will be well up in the thousands of dollars for some time, precluding use in the home.

The plain fact is that introduction of a radically new color receiving system is unlikely in the near future. The reasons are economic as well as technical. The tremendous costs of development and tooling of completely new systems would outweigh many of the advantages. Today's receiving system is far more than adequate. Any new system would have to promise markedly better performance or much lower cost to receive serious consideration. Even a system which could be proved to be slightly better or slightly cheaper would probably be rejected—and, to the best of our knowledge, nothing of this kind is in sight.

Nevertheless, you can expect many changes and improvements within the present approach to color TV reception. For the first time, color TV is competitive. "Ghost manufacturing" is past; every manufacturer makes its own sets. Finally there's a strong incentive for each to develop its own proprietary circuits and cost-reduction systems for better, more economical and more reliable receivers.

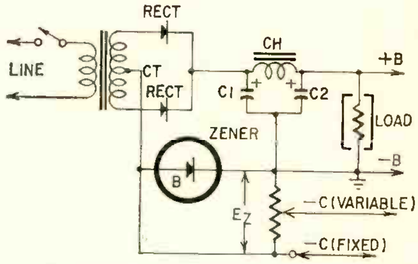
Color's decade of pioneering is coming to a close. The era of color TV in the home has begun. END

Zener diode bias supply

By RONALD L. IVES

IN A WIDE VARIETY OF AMATEUR, EXPERIMENTAL and industrial electronic assemblies, a stable low-voltage source of negative bias is necessary or desirable. Conventional bias supplies usually burn up several watts while supplying only milliwatts. Also, they are bulky.

With dependable Zener diodes, much of this bias supply difficulty can be eliminated, and a regulated fixed or variable bias voltage can be obtained from the plate supply circuit.



A typical Zener bias supply circuit is shown in the diagram. Here, the plate supply transformer center tap has been lifted from ground, and a Zener diode of the desired voltage (or higher) has been inserted between the transformer center tap and ground. The center tap is now negative, with respect to ground, by the Zener voltage E_z. Fixed bias can be taken from the transformer center tap, and will be regulated at the Zener voltage. For variable bias, shunt the Zener diode with a potentiometer and take the bias off at the arm.

Once the bias voltage is decided upon, calculate the wattage rating for the Zener diode by multiplying the maximum current in the negative return circuit by the rated voltage of the diode. Be sure that the current value is the true maximum. Select a wattage rating slightly higher than that called for.

Be sure to follow the manufacturer's instructions regarding heat sinks. Adequate heat sinks are *much* cheaper than replacement Zeners.

Where variable bias is required, the resistance of the potentiometer across the Zener diode can be almost anything from 50 ohms per volt to more than 1,000 ohms per volt. It doesn't matter much except where substantial currents are drawn from the bias tap. *However, at minimum current, the voltage drop across the potentiometer must be greater than the Zener voltage, or the Zener diode will not regulate.*

As should be obvious, the bias voltage we get this way is subtracted from the plate voltage. Where the loss (generally small) is important, it can usually be restored by increasing the value of C1, the first filter capacitor. END

COLOR TV SERVICE IS SIMPLE

It's like black-and-white plus a few new circuits — and they are not that new

By JOHN FITZGIBBON

I'M GOING TO MAKE A CONTROVERSIAL statement: Color TV is no harder to service than black-and-white! You do *not* need a Master's degree in electronic engineering and thousands worth of test equipment. You can even service color at the same service charges as black-and-white—and make money! Prove it? OK, I will!

Pause and consider this indisputable fact—each circuit in a color set uses tubes, resistors, capacitors and transformers. How many other kinds of parts are there? If you can find a leaky coupling capacitor in a black-and-white set, you can surely find one in a color set!

The really "complicated" troubles seldom occur. From your own experience, how many really rough jobs do you run into in black-and-white—percentagewise, I mean? About 5%, just like everyone else. All the rest are easy. Dead tubes, burned resistors, leaky capacitors, bad filters and so on. If you serviced nothing *but* color TV, you'd find exactly the same proportions; after all, they're *TV sets,* aren't they?

Example: one set's picture suddenly turned a bright green. Picture good, sound OK. Give me a diagnosis? Sure! Trouble in the green amplifier tube. Heater–cathode short, no bias, tube ran wide open, and the green drowned out the other two colors. Tube replacement and cure took less than 3 minutes. Many others are equally simple.

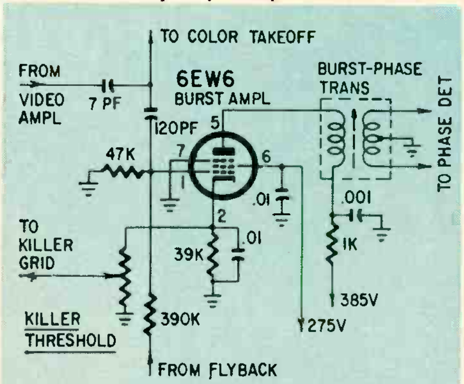


Fig. 1—Burst amplifier amplifies burst only, because it's keyed on grid with a flyback pulse. Input is from video stage.

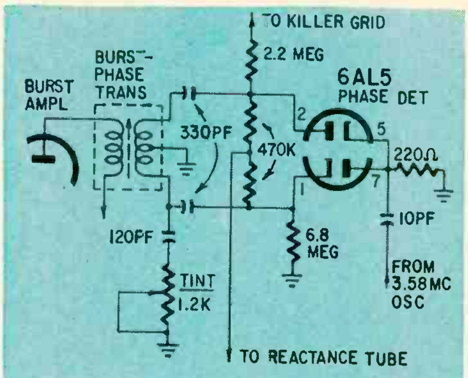


Fig. 2—Automatic frequency-phase control detector. You've seen circuits like this in FM radio and black-and-white TV.

In black-and-white servicing, what do we look for in the way of symptoms? What *is* there, and what *isn't* there—sound, video, sync, etc. From this, we make our first diagnosis and then proceed to check it out. We use the process of elimination to find out just which one of the many possible causes is responsible.

The same process will work in color. You're going to find that the great majority of troubles in color sets are *the same* as those in black-and-white—sound, sync, horizontal sweep, and so on—and you've been fixing those for years. There are only a few extra circuits, just as simple as the rest, and they will give you a very definite set of symptoms when they're not working right!

Color vs black-and-white

Are there any *new* circuits in a color TV receiver? Circuits that you've never seen before? Let's start at the video detector. Up to this point, the circuits are *exactly* the same as those in black-and-white: tuner, i.f., sweeps, sync, agc, power supply, etc. Let's go down the line and examine each color circuit.

1. The burst amplifier (Fig. 1). This is a standard pentode tube, with normal plate and screen voltages. The grid is keyed by a pulse from the flyback transformer, so that the tube actually conducts only during horizontal blanking intervals. So, what does it do? It amplifies the burst signal, which is on the back porch of the horizontal sync. How is this burst separated from the sync, video, etc. signal? How do we separate a 4.5-mc *sound* signal? Feed it through a sharply tuned transformer! See it in the plate circuit? This transformer has a center-tapped secondary, which feeds the . . .

2. Phase detector, sometimes called afpc and other complex names (Fig. 2). Don't let 'em fool you—it's just a plain old ratio detector, discriminator or whatever you want to call it! Compares the phase of the burst signal from the transformer with the signal being developed by the local oscillator, and develops a dc correction voltage to apply to the . . .

3. Reactance tube (Fig. 3), which certainly should be familiar to all the old-timers. The same circuit is used in lots of older TV sets, to control the horizontal oscillator! Afc, in other words.

The small dc control voltage from the phase detector is applied to the grid. This controls the phase angle of the control tube's plate voltage and current, making it behave like a reactance. Thus we can make the tube control the oscillator circuit automatically, by varying the amount of reactance it appears to be. The control comes from the correction voltage, which is in turn developed by the color signal itself. So, we keep the

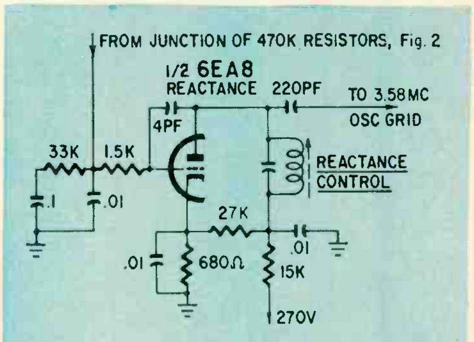


Fig. 3—Reactance tube thinks it's a coil or capacitor! Controls 3.58-mc oscillator. Some TV's used this to control horizontal oscillator.

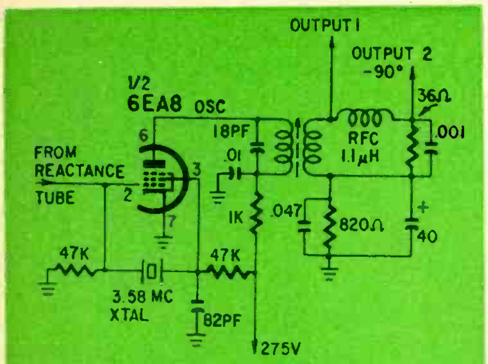


Fig. 4—Pentode Pierce oscillator generates 3.58-mc subcarrier. Same kind of circuit used with pentagrids in AM sets.

3.58-mc oscillator right on frequency.

4. The 3.58-mc oscillator. This is usually a standard crystal oscillator circuit. Sometimes it's even a Pierce, which is about as simple as you can get. Tube, crystal, and a few oddments like plate voltage and stuff. Fig. 4 shows a typical oscillator circuit, which, come to think of it, *is* a Pierce, the original version. This uses the screen grid as the oscillator plate, leaving the real plate free to take off the 3.58-mc signal. (Is this unusual? How about the oscillator circuit in some small radios where a pentagrid tube is used as mixer-oscillator? The screen's the oscillator plate, and the i.f. signal is taken from the real plate. Same thing.)

Control for this oscillator, which isn't needed too badly anyhow, comes from the reactance tube through the 220-pf coupling capacitor. Just enough to keep it right on frequency at all times.

Servicing? Measure the negative voltage on the control grid. If it's about 4–5 volts, the circuit is oscillating; if it's zero or positive, it isn't. About the only thing that can keep a Pierce circuit from oscillating is a dead tube or crystal! The coil in the plate circuit has no effect on the operating frequency; it merely provides a place to get the output signal from. Note the tiny rf choke across the secondary. This shifts the phase of part of the 3.58-mc output so that we can have two signals to use in our color detectors (one in phase with the burst and another 90° out). These signals are fed to the cathodes of the . . .

5. Color demodulators (Fig. 5). You'll find these called X and Z, I and Q, R and G, you name it—any combination of letters. They all do the same thing: separate the color information from the video signal. How? Phase detection. A good simile is the quadrature-detector circuit used in sound detectors with the 6DT6 or 6BN6.

How do we get the colors separated? Notice that a combination signal, with all colors in it, is applied to both grids. This signal comes from the bandpass amplifier, which we'll get to in a minute. The color signals are all in there, in the form of different *phases* of the basic 3.58-mc color *subcarrier* (which was removed at the transmitter to save postage—the 3.58-mc oscillator puts it back in at the receiver).

So, with all of the colors on the grids, we put a 3.58-mc signal from the oscillator on the cathodes. Now, each tube passes only the part of the color signal that's in phase with its cathode signal. Same principle as keyed agc. In the output, we get red in one plate circuit and blue in another. "Wait a minute!" somebody says. "Where's the *green?*" OK, we *make* it, in the . . .

6. Color Amplifiers (Fig. 6). Three simple triode amplifier stages. But, you still want to know, where does the *green* come from? We're putting our red and blue signals onto the grids of the top and bottom tubes. The cathodes are all tied together. So, the cathode voltage on the green amplifier is a combination of the other two colors. Now, the *whole* color signal is red + blue + green, isn't it? So, what would we have left if we

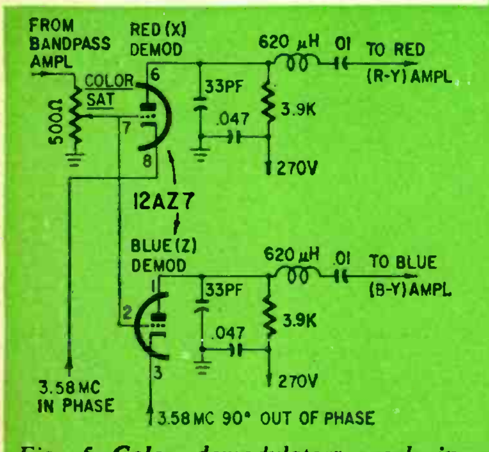


Fig. 5—Color demodulators work in quadrature, keyed by direct and 90°-shifted 3.58-mc voltage.

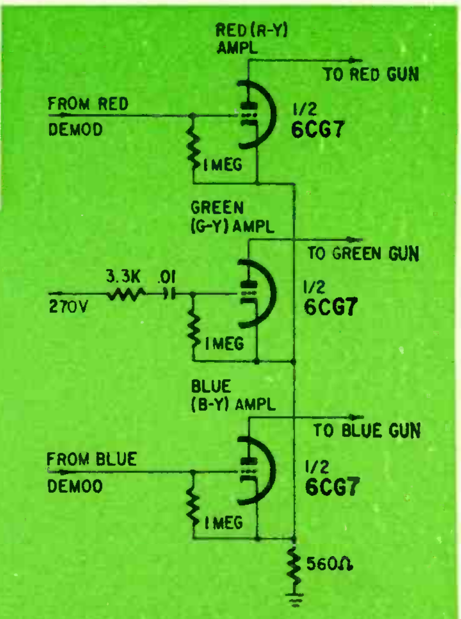


Fig. 6—Color amplifiers. Green signal is "made right in your own home" by subtracting red-blue signal from total color signal.

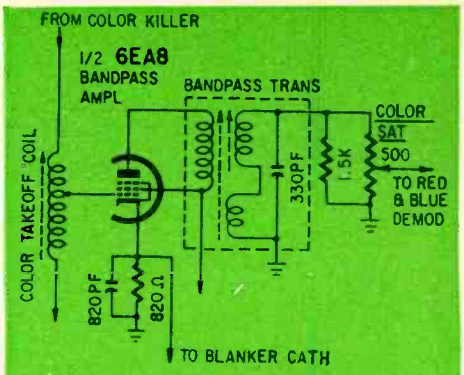


Fig. 7—Bandpass amplifier sounds mysterious, but is no different from typical AM, FM or TV i.f. stage.

subtracted red and blue? Green?

This is what takes place in this tube, because of the arrangement of the cathode and grid voltages. It becomes a sort of backward adding machine, and subtracts the red and blue signals, leaving the green. These are amplified and fed on to the green gun of the color picture tube.

Let's back up and get a few things we had to leave while we were following the color signal through the circuit to the picture tube. One of these is the bandpass amplifier we mentioned as feeding the color demodulator stages.

7. Bandpass amplifier (Fig. 7). Actually, this is hardly worth illustrating. If you've ever seen an i.f. stage in a radio or the sound i.f. in a TV set, you've seen the same circuit. Color signal goes to the grid from the color takeoff coil, and the plate feeds the "bandpass" transformer. This is used to clean up the color signals and keep out interference from other circuits. On the secondary of the transformer is a control usually called *saturation*, but which I think ought to be called a "color volume control," since that's how it works. It simply regulates the amount of color signal.

Since this stage handles the whole color signal, it's a good place to put the . . .

8. Color Killer (Fig. 8). What's this for? Its only purpose is to cut off the bandpass amplifier during black-and-white transmissions. Some men have had trouble understanding the thing, because it "works backward," in a way. During color reception, the killer is cut off, and the bandpass amplifier works. During black-and-white reception, the *killer* works (conducts, that is) and the bandpass amplifier's cut off.

This is basically a keyed stage; see the pulse being applied to the plate from the flyback? So, this tube conducts only during horizontal retrace time. Notice the "balance" circuit in the grid. We get −45 volts from the phase detector by connecting this to one end of the two 470,000-ohm resistors.

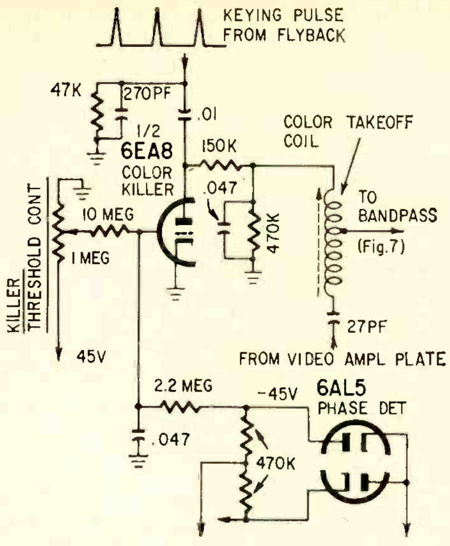


Fig. 8—Color killer. It, too is keyed by pulse from flyback.

(While a color signal is being received, a negative voltage is developed there. During black-and-white reception, this voltage disappears, because there's no color burst to make it show up.) The other end of the 10-megohm resistor goes to a source of +45 volts (the burst amplifier cathode in this case—all we need is a source of positive voltage at the right level). This is fed through the killer threshold control so that we can adjust the grid voltage on the killer stage.

If the killer tube is not conducting, we don't get any voltage drop across the 150,000-ohm resistor in the plate circuit. So, the bandpass amplifier is allowed to pass the signal, which is color. (Killer cut off, bandpass amplifier working.)

When the killer tube *is* conducting, the drop across the plate load resistor puts a negative voltage on the grid of the bandpass amplifier. (Killer working, bandpass amplifier blocked.) So, it can't pass any signal at all because it's

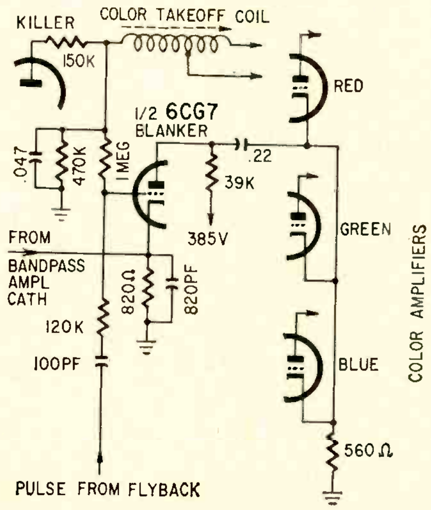


Fig. 9—Blanking amplifier—conventional vertical and horizontal retrace blanking, plus amplifier stage.

biased to cutoff. This keeps the whole color circuit from operating, since all of the color signals have to come through the bandpass amplifier. So, during black-and-white reception, we don't have colored snow on the screen, or "confetti", as they used to call it. This stage is as simple to service as any keyed stage. (You *can* fix keyed agc stages, can't you?)

9. The blanking tube (Fig. 9). Because there are so many signals going in so many directions around here, we don't want any trouble with retrace of either kind. So, we add the blanking amplifier stage, Fig. 9. This is nothing but amplified retrace blanking. Same circuit used in uncounted jillions of black-and-white sets, except that we are using a tube to be sure that the picture tube stays cut off during horizontal and vertical retrace times.

The delay line

The *video* signal (that is, the one we use in black-and-white containing only brightness signals) goes straight to the picture tube grids. The poor little color signal, on the other hand, gets chased around through all sorts of phase-shifting networks and stuff before it is allowed to reach the picture tube. We have to give the video a little "handicap" so that everybody will reach the finish line at the same time. Actually, this isn't much—usually about 1 microsecond!

The theory of a delay line is very complicated, but a practical delay line may be nothing more than an 8-inch piece of coaxial cable! It takes a signal slightly longer to get through the cable than it does in free space. (The velocity of propagation is lower.) If a greater delay is needed, sometimes a small coil is used inside the delay line, slowing the signal down still more. Only two possible troubles: a broken wire or a short to ground, both fairly easy to find. It isn't possible for the time constant to be changed by any defect.

So, there you have it. We've taken a black-and-white TV receiver and added the color circuits. (Up to the video detector, the circuits are exactly the same as in black-and-white, and subject to the same faults.) While we discussed nine functions, one popular make does them all with only seven tubes.

"But!" somebody says, "they don't all work that way!" So? How about black-and-white sets? Are they all alike? If they were, you could carry your Sams Photofact file in your shirt pocket! Naturally, there are differences. Circuits are changed and simplified all the time, just as in black-and-white. The earliest practical color set was a fat 24 inches on each side, weighed about 75 pounds and used 44 tubes. The latest is half that volume, uses 24 tubes and you can carry it in one hand.

Natural differences in approach are trivial. RCA, for example, uses a three-stage video amplifier. Zenith uses a single high-gain tube. What's the difference? Both circuits work, and work very well, and are equally easy to service.

Test equipment

"But," comes that same plaintive voice from the back row, "You've got to have so much *equipment* to service color TV"! Are you in again? I thought you'd left. Well, let's see. On how many black-and-white sets do you use a scope, sweep generator, marker-adder, flyback tester, capacitor tester, pattern generator? *About 5% or less.* Most of the troubles are *simple:* dead tube, bad capacitor and the like. You're going to find color *exactly* the same.

So you can use your present test equipment to service color. Later on, you can add color bar generators, etc. You must have them if you want a completely equipped shop. However, if you *can* service 95% of the sets with your present equipment, what better percentage do you want? The most useful piece of test equipment in the shop is that mass of gray mud between your ears!

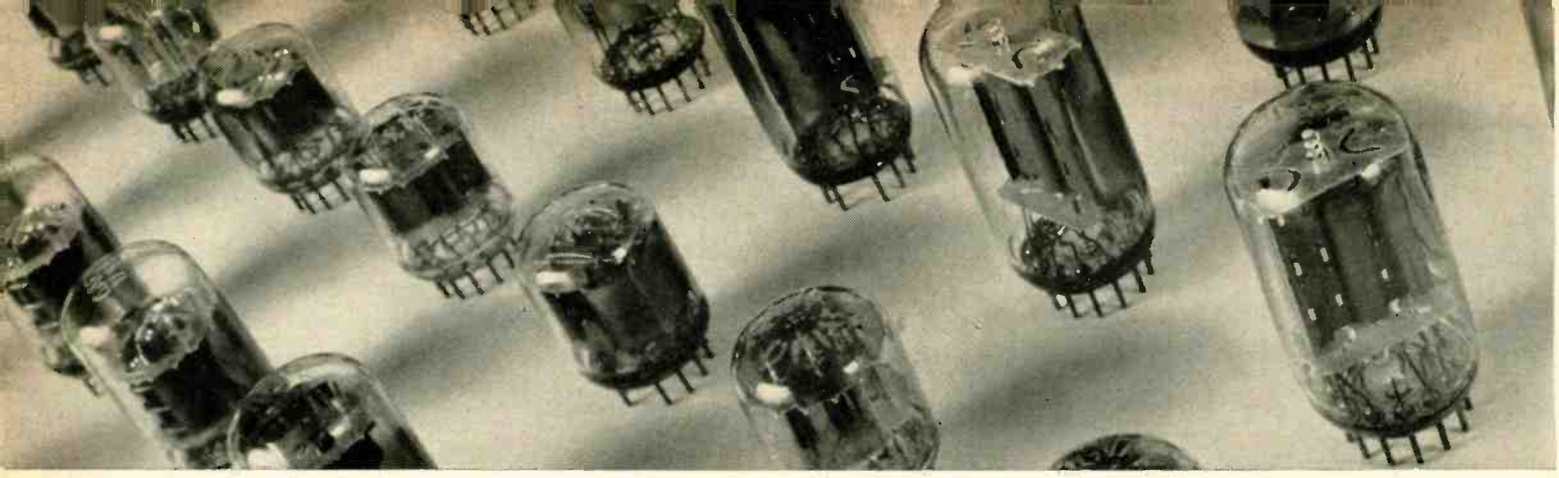
Service information

Fortunately for us, a mass of service information and help is available. Set manufacturers have spent millions printing color training courses, holding service meetings, and doing everything they could to get the basic idea of color over to us. We ought to be grateful to them, and most of us are.

While I have been mildly critical of them at some times in this discussion, it was intended to be helpful. Although they were the culprits at first in complicating things, they have begun to use the "simplifying" approach to the subject, and it is showing up in the increasing number of men who are happily and profitably servicing color TV.

I am firmly convinced, from associating with them for the past 35 years, and from being one myself, that the US electronics technicians are unequalled in all the world. From the simple circuits of radio, they tackled the infinitely more complicated apparatus of television, FM, hi-fi, etc., and mastered it. The difficulties we have had with color in the past have not been due to any lack of either ability or capability, but simply to that subconscious fear, the block set up by the *apparent* complexity of the circuits.

Once we realize that color television is *not* as complex as it might seem, we're well over the hump. After all, and always remember this—we're not *designing* these circuits: we're just *repairing* them! They did work once, and they can be made to work again. All we have to do is locate the defective part and replace it. Let's go! END



NEW TUBES for COLOR TV

Why all the new numbers? What's been improved?

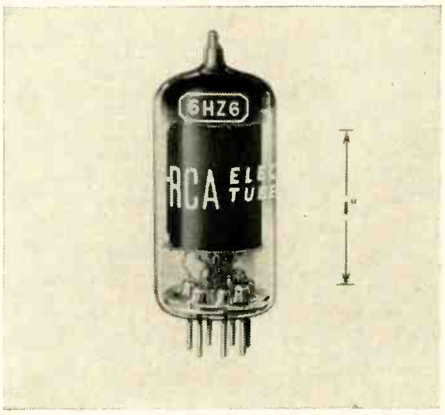
By PETER E. SUTHEIM
ASSOCIATE EDITOR

WHEN COLOR SETS FIRST APPEARED ALmost a decade ago, most of the tubes in them were familiar to anyone who had worked with TV. As in the earliest days of black-and-white, existing tubes were pressed into service–sometimes even strained to their limits–for new applications. Remember when the only damper tube was a 5V4-G? When 6L6's and 807's were used as horizontal output tubes?

But increasing demands brought special tube types for special needs, and now it sometimes seems that manufacturers develop a new type at the slightest provocation. Let's take a ramble through this bewildering welter of new tubes designed for color TV, and see if we can make some order out of it.

Rf and i.f. tubes

Since the signal requirements for color TV are stricter than for black-and-white, there has been a trend toward higher-transconductance, lower-noise rf amplifier tubes. The Zenith 25LC20 chassis is using two recent Amperex types: the 6HA5 and 6GJ7, as rf amplifier and mixer–oscillator tubes. They are among the highest-transconductance tubes today—20,000 μmhos for the 6HA5 and a conversion transconductance of 5,000 for the 6GJ7. The front-end gain with these two tubes is something over 200, with a low noise figure.



Though RCA has made no changes in its front-end complement, there is a new tube in the first i.f. amplifier socket —a stage that demands high gain with low noise and wide bandwidth. Where the CTC 12 used the 6BZ6—already a pretty "hot" tube—the CTC 15 has the new 6JH6. Similar to the 6BZ6 in most ways, it has a tightly controlled cutoff point intended to provide headache-free interchangeability with others of the same type. According to RCA engineers, there were problems with certain 6BZ6's in the agc'ed first i.f. stage, which is critical about its bias voltage. The new 6JH6 is said to introduce less cross-modulation distortion in areas where channels 6 and 8 are strong.

The newly introduced Heath color TV kit also uses the 6JH6 as first i.f. amplifier.

Deflection tubes

The husky 6DQ5 in the RCA CTC 12 chassis has been replaced in the 15 by the still-more-rugged 6JE6. Heath is using it, too. It has a nine-pin "novar" button base instead of a cemented-on bakelite base, to dissipate heat better than before and to eliminate soldered connections between elements and base —always a potential failure spot. Dual connections to control and screen grids raise the dissipation rating to 25 watts total. It has a lead-glass bulb, which reduces electrolysis and eventual gas contamination, and a copper-core plate structure to prevent "hot spots."

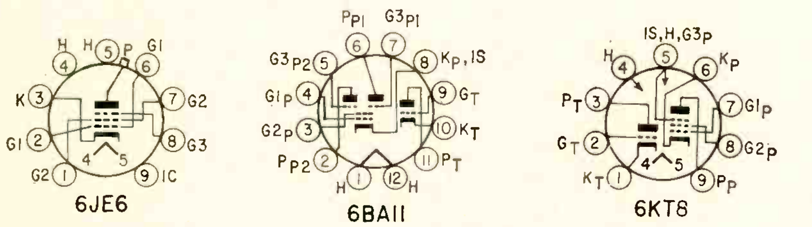
The Zenith 25LC20 chassis uses a 6HF5 compactron as horizontal output. Its plate and screen dissipation ratings are 28 and 5.5 watts, respectively, and it can withstand a peak cathode current of 1.1 amperes. Designed for a plate supply voltage (boost plus dc power supply) of 990, it should stand up well to the demands of high-energy deflection in color circuits.

In the vertical department, a 6GF7 makes its debut with RCA, replacing the older 6EM7 octal. The new tube is simply a novar-base version of the 6EM7—electrical characteristics are the same. A high-mu section is the oscillator, and the low-mu section is the vertical output stage.

A 6U10 triple-triode compactron is used in the Zenith chassis this year to simplify the horizontal oscillator and afc wiring.

Zenith uses a 6HE5 compactron as vertical output. It has a 12-watt plate and a 2.75-watt screen dissipation, and is more or less a compactron version of the 6EZ5 octal. The compactron base again offers greater reliability, like the novar. (The construction of the two base types is similar.)

The vertical oscillator in the Zenith



The only distinctly new base diagrams among the tubes mentioned here are those of the 6JE6 horizontal output tube, the 6KT8 triode-pentode, and the 6BA11 triode-dual-pentode. The 6U10 compactron is similar to previous triple-triode compactrons (6C10, 6D10, 6AV11, etc.) except that pin 8 is not used at all. Note the connection in the 6KT8 of the suppressor grid to one side of the heater.

is the triode of a 6BA11 compactron that also works as sync separator and agc amplifier. Besides the triode, it contains a dual pentode of the 6HS8–6BU8 type, with independent No. 3 grids and plates. Related functions were merged into one envelope to reduce wiring. According to Zenith, this made it possible to use the separate 6HE5 vertical output tube without increasing complexity.

Color circuits

A 6GH8-A has replaced last year's 6EA8 as bandpass amplifier and color killer in RCA's circuitry, to give higher drive levels to the color demodulators. The pentode section, used as bandpass amplifier, has higher gain than the earlier type. Base connections and ratings are identical for both. The 6GH8 has been around, and really only the "A" is new: it denotes the use of RCA's "dark

heater," to increase tube life and stability.

The red and blue amplifiers are the two sections of a 6GU7 nine-pin miniature, and the green amplifier and blanker are the two halves of another. The 6GU7's have replaced the 6FQ7's of the CTC 12 because the new CRT in the CTC 15 has higher drive limits. To take advantage of that, RCA engineers designed a tube with higher plate current, and point out that the combination of new CRT and new amplifiers gives better color brightness and contrast.

Zenith uses two color amplifier stages before demodulation: the pentode sections of a 6KT8 and a 6HL8. Both pentode sections feature transconductance of 10,000 μmhos and up, and are otherwise similar except for basing. Both are paired with triode sections in the same nine-pin miniature envelope. The 6HL8 triode section is a medium-mu tube (40) used as a cathode follower to present a low source impedance to the delay line and Y-amplifier. The pentode section's high gain gives the set greater ability to hold color under adverse conditions, according to Zenith engineers.

Previous Zenith circuitry used the pentode of a 6GH8 followed by a

6AU6 as color amplifiers, both of which have considerably lower transconductance than the tubes now used. The single-function 6AU6 has been replaced by the 6KT8 pentode-triode pair, again reducing cost and complexity of wiring. The high-mu triode section is the color killer.

The new 12GN7 pentode is used in both Zenith and Heath chassis as video output. It has very high transconductance (36,000) and was chosen to give adequate drive with good bandwidth.

Sound detector

The RCA CTC 15 uses a new gated-beam limiter and sound demodulator, the 6HZ6. Heir to the noble tradition of the 6BN6, which started it all about 10 years ago, the new tube offers greater audio recovery for the same FM deviation. Unlike the 6DT6 and 6GX6, both similar types, the 6HZ6 has a special screen-grid shielding construction to suppress uhf parasitics that cause trouble during uhf reception. This same tube is also used, incidentally, in RCA black-and-white sets with uhf.

High voltage

A new high-voltage rectifier is the 3AT2, used in the Zenith 25LC20 chassis as main high-voltage rectifier. It's a compactron with a heater-cathode and multiple connections for heater and cathode to simplify wiring. The tube has an internal corona shield connected to cathode and heater (which are electrically common to each other). In the Zenith, it produces 25 kv with no apparent strain.

Zenith also uses a new focus rectifier interchangeably with the 1V2, the 1AU2. It is a more rugged tube, and has a 1.1-volt 0.19-amp filament.

New color-TV tubes will be described as they appear, in the "New Semiconductors and Tubes" department of RADIO-ELECTRONICS.

So—there *are* reasons for these new tubes. The differences are often subtle and slight, but they are part of an overall trend toward refinement, "de-bugging" and greater reliability. Improvements like these help turn color TV from a risky, temperamental "plaything of the idle rich" into a practical, dependable home-entertainment medium. Stick around! END

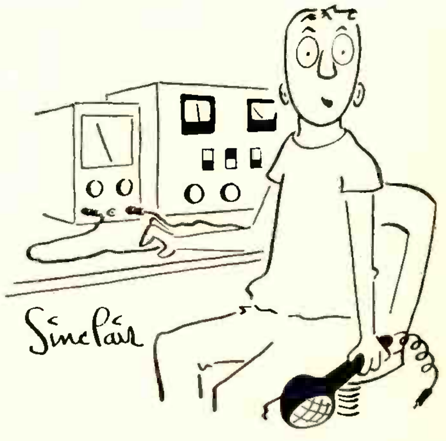
HOW WELL DO YOU KNOW YOUR UNITS?

BY TOM JASKI

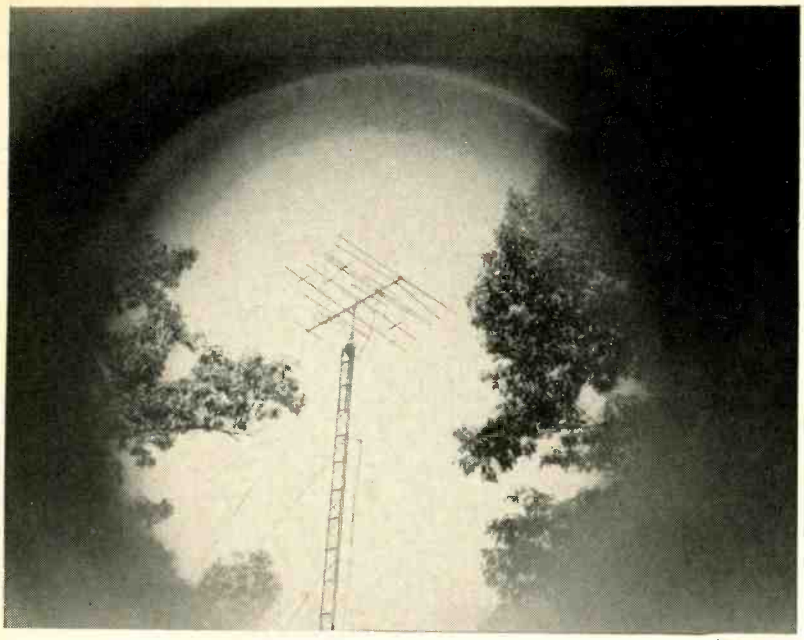
IN RADIO, ELECTRONICS AND HI-FI, WE make daily use of certain units of measurement. Do you really know what these units mean, what their precise scientific definitions are? Certainly, you can measure an ampere with an ammeter, and you know that if you send 1 ampere through a resistance of 1 ohm, you must have 1 volt to do it. But what are these units? See if you can answer these, then turn to page 77 for the correct answers.

1. Define a volt.
2. Define an ampere.
3. Define an ohm.
4. How much of what is a maxwell?
5. Ever hear of a gilbert?
6. Know what a joule is?
7. What do you think a myriawatt is?
8. Where will you find a weber, and what is it?
9. What are a dyne and an erg?
10. Ever hear of an oersted?
11. How much of what do we measure with a gauss?
12. Now for a tough one. What is a baud?
13. Tell us what a sabin is?

Answers on page 77. How did you do?



"Why, yes sir, your photoflash equipment is ready."



Winegard

ANTENNAS and BOOSTERS for COLOR TV

Signal strength can make the difference between good and poor color—or none at all!

By ARTHUR CUNNINGHAM

A COLOR TV SET WITHOUT THE RIGHT antenna is usually a color TV set without color. The cliché about the Cadillac that won't run without gasoline applies equally well to color TV. A thousand-dollar set can't make satisfactory color pictures without the right antenna.

The color antenna must have three things: good gain, ample bandpass and complete freedom from parasitic resonances. This last includes the entire system: antenna, transmission line and booster, if one is used. Pattern shape and front-to-back ratio are very important, in some applications, for maximum freedom from ghosts and interference.

These requirements are not hard to fill. Any *good* antenna will. Ordinarily, if an antenna gives really good pictures on black-and-white, it will be suitable for color.

Antenna troubles

The symptoms of antenna trouble in color reception are definite. 1. Excessive snow or confetti indicates that the signal level is too low. 2. Intermittent drift or sudden shift in colors is usually caused by parasitic resonances, called "dropouts" or "suckouts", in the antenna system. These cause standing waves on the lead-in, and cancel the color burst or shift its phase.

A good quick-check for this last condition is to disconnect one side of the lead-in as you watch a color program. If the color returns, though the picture goes down into the snow, standing waves are probably cancelling the burst. Wrap a small piece of tinfoil around the lead-in and slide it back and forth while watching the color. If you find a point where the trouble disappears, tape the foil there. This point may not be the same for all channels—you'll have to experiment.

A third trouble, found mainly in fringe areas, is multipath reception from distant stations. The delayed reception of the second signal causes wavering colored ghosts and color shifts because of phase differences between the two bursts. There is no foolproof remedy for this, but it is almost always temporary, lasting 2–3 minutes at most.

Primary-area troubles

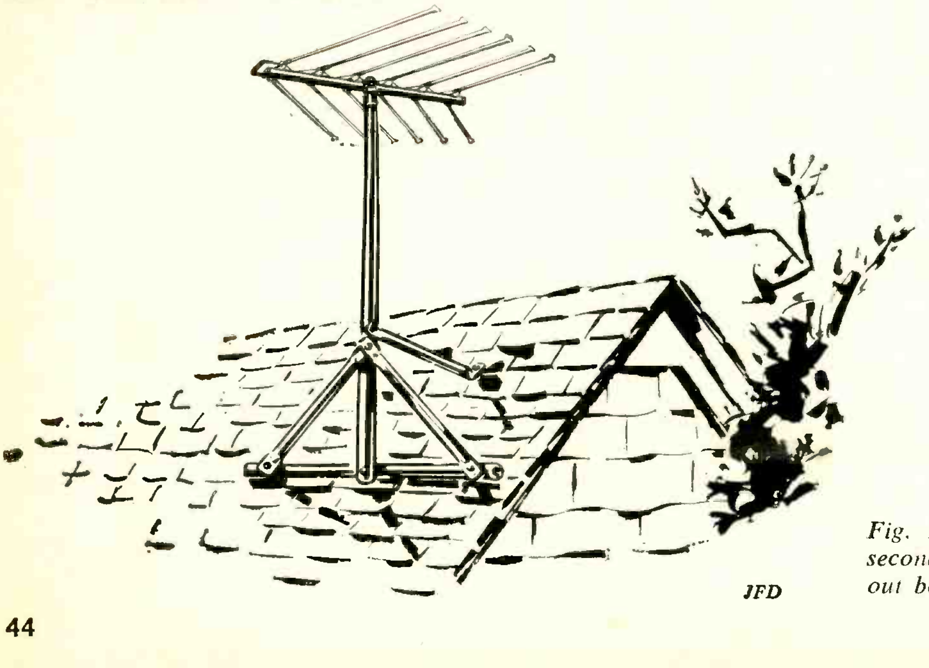
Primary areas also have their share of antenna troubles. If rabbit-ears or built-in antennas are used for color reception, field interference caused by people walking between set and station, reflections from steel-framed buildings or similar objects, can cause color trouble. This is usually in the form of a sudden loss of color. If the set can be placed on the wall of the room nearest the station, the effects will not be so noticeable.

A better remedy is to relocate the antenna. Mount the rabbit-ears on the wall above the set, or use a window or attic antenna. The method depends on the circumstances. A simple dipole in an interference-free area up in the eaves, for example, will often help. This should be cut to channel, of course.

In suburban areas, attic antennas are very useful. They are made in several types, some quite directional, with rotators, and are fastened to the underside of roof rafters. An easier installation can be made with the small roof-mount antennas such as the one of Fig. 1. They are made in several sizes, depending on the needs of an installation. The model shown has medium gain and directivity. Others have more elements, to give you a narrower pattern if you need it. This is often necessary to eliminate ghosts caused by reflections from nearby objects.

Signal levels

Too much signal can cause as much trouble as too little. Tuners in color sets are very sensitive, and very high signals can cause curve shift to the point where



JFD

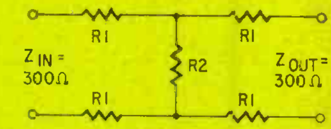
Fig. 1—Small roof-mount antenna for secondary areas may be sufficient without booster.

Table I
ANTENNAS FOR DIFFERENT AREAS

Area (miles)	Antenna type	Booster?
Primary: 0–10	Rabbit-ears, built-in, simple dipole, window-mount, attic-mount.	
Secondary: 10–50	Roof-mount: dipole-reflector, small combination types, broad-band, log-periodic. Conical with reflector.	Under some circumstances. Test for improvement in picture.
Fringe: 50–100	Broad-band Yagi, log-periodic. Same, with built-in booster. Rotator probably needed also.	Yes. Built-in or added later. Top-mounted or connected behind TV set.
Deep Fringe: 100–150	"Long" broad-band Yagi; multiple elements, with built-in booster. Individual Yagis, each with built-in booster, plus matching network.	Always. Every bit of signal needed here. (For long runs of lead-in, use low-loss open wire line. Never use coaxial lead-in; loss much too high.)

Table II

The diagram shows a balanced H-pad which can be used to attenuate too-strong TV signals. The two formulas are used to figure the two resistor values; A is the **number of times** the input signal is to be decreased—**not** the number of db. That is, to get an output equal to **half** the input, you decrease the input **two** times. Hence $A = 2$.



$$R1 = 150 \times \frac{A-1}{A+1} \qquad R2 = 300 \times \frac{2A}{(A+1)(A-1)}$$

In the 20-db pad of Fig. 2, the formula works out this way:

$$R1 = 150 \times \frac{10-1}{10+1} = 150 \times \frac{9}{11} = 123 \text{ ohms}$$

$$R2 = 300 \times \frac{2 \times 10}{(10+1)(10-1)} = 300 \times \frac{20}{99} = 60 \text{ ohms}$$

The nearest EIA ½-watt, 10% values are satisfactory for these pads. In our example, these would be 120 and 56 (or 68) ohms.

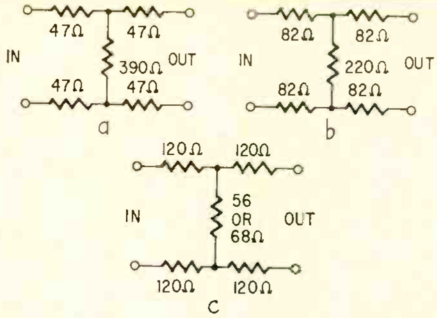


Fig. 2—Attenuator pads to prevent strong-signal overload: (a) is 6-db pad (½ signal voltage to set); (b) 10-db pad (⅓ signal voltage to set); (c) 20-db pad (1/10 signal voltage to set).

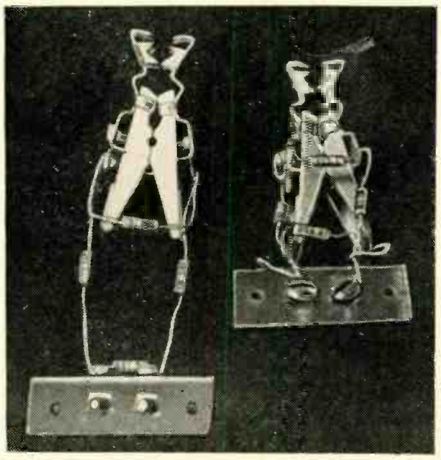


Fig. 3—Carry a few clip-on pads with you to check out suspected overload problems.

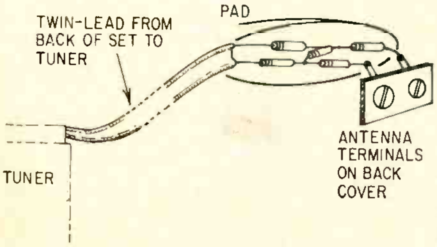


Fig. 4—Once you determine how much attenuation an overloaded set needs, wire the pad permanently inside the set, in the tuner input line.

color will be attenuated or pop in and out. This is due to Miller effect in rf and i.f. amplifier stages. The agc is unable to deal with such great overloads. The answer is to reduce the signal.

The simplest way is to add a resistive pad in series with the input. Fig. 2 shows resistance values for three typical pads. These will cover most situations. A quick way to find out which one you need is to make up one of each, attached to clothespin antenna clips (Fig. 3). These can be clipped in series with the lead-in.

After you hit on the right pad, make up a permanent one and attach it to the antenna terminals. A handy place for this is inside the cabinet. Unsolder the lead-in to the tuner, and connect the pad in series (Fig. 4).

The formula for computing other values of attenuation pads is shown in Table II. However, those in Fig. 2 will cover almost every situation, since the agc action of the receiver gives a great deal of latitude.

[Several manufacturers make printed-circuit resistor pads in several attenuation values, and some have "substitution box" devices, permitting you to switch in different amounts of attenuation before deciding on an optimum value. Check catalogs or your distributor.—*Editor*]

Secondary areas

In secondary area installations (within 50 miles of the station) many people try to use existing antenna installations. If they are more than 2 or 3 years old, they may not be good enough for color. Deterioration of the lead-in, corrosion at the antenna terminals, misorientation and many other troubles show up. The signal strength *must* be checked before making the color installation final.

Jerrold

Fig. 5—Best place for booster is at the antenna. Most boosters draw power through signal lead-in.

In cases where the existing antenna is fair but signal levels are low, the remedy is a booster. The newer transistorized boosters can be very helpful in these cases. Many of the later antennas include "built-in" transistor boosters, with gains up to 14 or 16 db, as in the type shown in Fig. 5. The best location for these is at the antenna terminals, as shown, but they can be used at the back of the set (Fig. 6) to avoid the time and expense of lowering and raising a tall antenna.

The simplest way to find out whether a booster will help is to try one. Many technicians carry one of the small transistor boosters, fitted with clothespin connectors, in their service kits. It may be snapped into circuit instantly to see how much improvement results. Performance will be slightly better with the booster installed at the antenna.

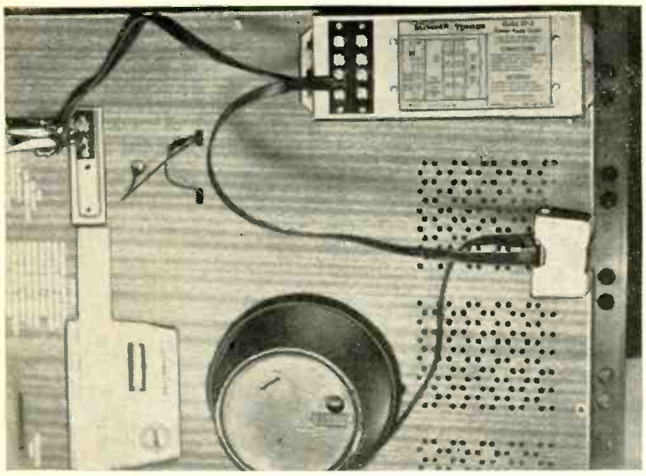


Fig. 6—Back of set is convenient place for untuned, broad-band booster.

Precautions: No booster can *make* a picture; this is the purpose of the antenna. Boosters can *improve* any picture, but a fair amount of signal must be there to start with. The major purpose of the booster is to clean up marginal signals, remove snow and give more positive color lock.

Fringe areas

The precautions needed in secondary areas are also necessary in fringe areas. Antennas must be the highest-gain types available, and the powerful boosters are also a must. Antennas of the type in the head photo may give reception over distances up to 150–175 miles under good conditions.

Absolute height is not the important factor that it was once thought, although it is decisive in some areas. In many fringes today, antennas are about 30 feet in height, instead of 100 feet or even more. Field testing disclosed that this was about the optimum height for good reception. Very careful installation techniques are necessary to keep these taller, heavier antennas up.

Amplified distribution systems

Color sets are often connected to amplified signal distribution systems. These may be community antenna systems in small towns, or systems in large apartment houses or hotels. The very broad-band amplifiers used with these systems give good reception, for there is no chance of clipping color bursts, as was once thought possible.

However, in high-signal areas, one peculiar trouble has been found: undesired direct pickup at the receiver. Since the signal suffers some delay in traveling through the coaxial cable of the distribution system, the direct pickup will be slightly out of phase. This phase delay results in color trouble, as usual showing up as cancellation of burst and sudden dropouts of color.

To test for this condition, remove the antenna connection and connect a temporary dipole or rabbit-ears antenna to the set. If there is enough signal to make even a snowy picture, there is a possibility of interference. The remedy is to shield the antenna connection. Use shielded 300-ohm two-conductor cable between the distribution system terminal box and the set. It may be necessary to replace the short link between the terminal board and tuner with the shielded wire.

Just as in all other branches of TV work, selection and installation procedure will vary with individual technicians. There are no hard and fast rules for success. Thorough field testing, with a careful evaluation of the results, will be the most helpful single factor. There is no such thing as the "*one* right antenna" for any area: there will always be a choice between types and makes. Select a well built, well designed one, and the chances of success are much improved.

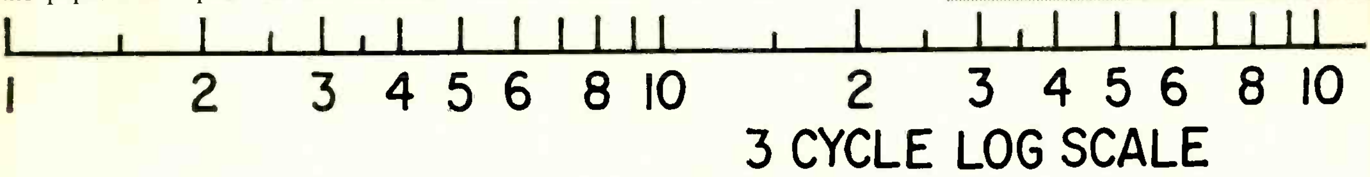
END

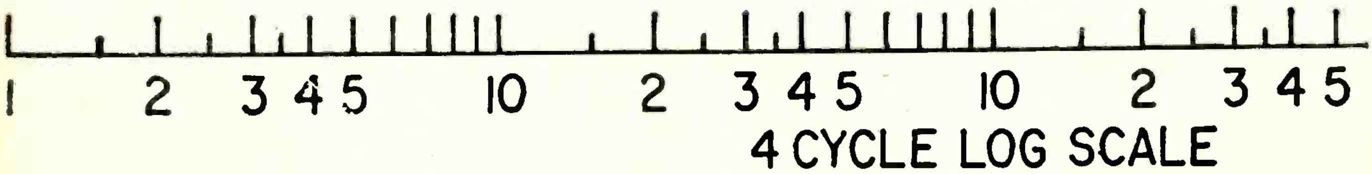
Handy Log Scales

Frequency response and other curves that use a wide range of units are generally constructed on semi-log paper. However, semi-log paper with more than 2 cycles is not always available. Here is a simple method to make your own. The table shows the logarithms of integers. Using an engineer's scale, or any scale with decimal units (a cm scale will also work), you can measure off the distances in the table. The result will be a log scale, and the number of cycles on the paper will depend on the divisions used. For example the 4-cycle scale below was made with 1/40-inch divisions and the 3-cycle scale with 1/30-inch divisions. Using 1/50-inch divisions would allow 5 cycles on 8½ x 11 paper. Having drawn the scale on one side of the paper, you can then draw your graph by using a T-square and triangle. These scales can be used under a piece of tracing paper to make a piece of log or semi-log paper quickly. For log-log paper use the same scale for both vertical and horizontal divisions.—*Tom Jaski*

Logarithms of Scale numbers

Numbers	Logs	Numbers	Logs
1.0	0000	6.0	77815
1.5	17609	6.5	81291
2.0	30103	7.0	84510
2.5	39794	7.5	87506
3.0	47712	8.0	90309
3.5	54407	8.5	92942
4.0	60206	9.0	95424
4.5	65321	9.5	97772
5.0	69897	10.0	100000
5.5	74036		

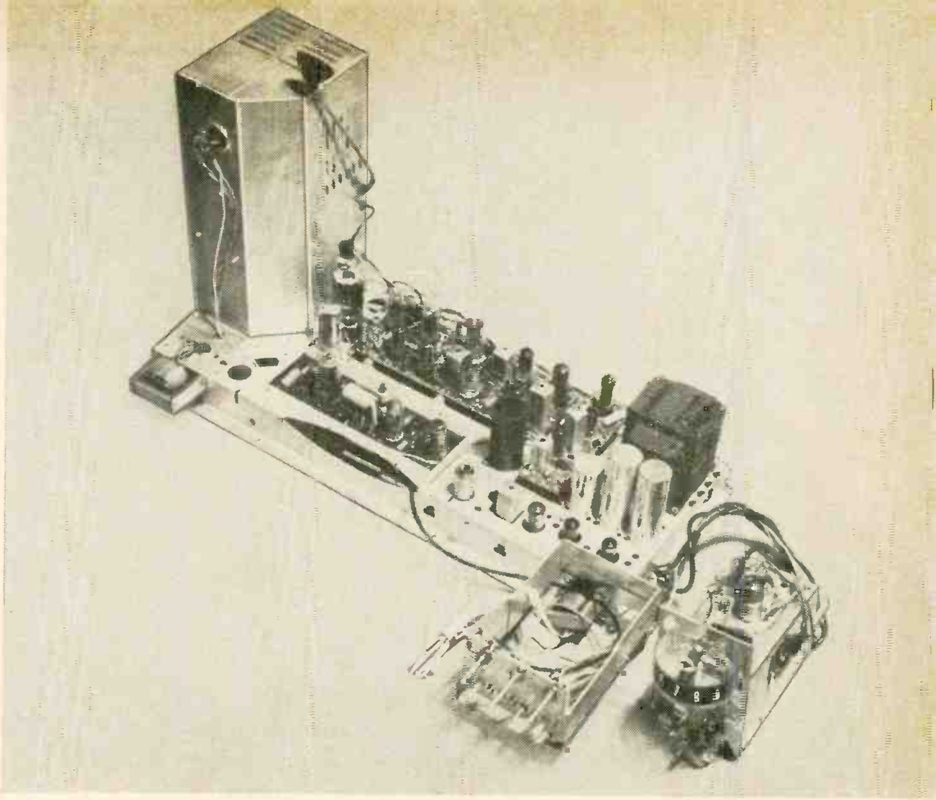




The sections of log scales above can be traced to make scales 10 inches long. The top drawings shows two cycles of a 10-inch, 3-cycle scale. On the bottom line we have two and one-half cycles of a 10-inch, 4-cycle log scale.

The CTC 15:

RCA'S **NEWEST COLOR** CHASSIS



Front view of CTC 15 chassis. Most service controls are on rear skirt.

A well-known circuit made more reliable and easier to adjust

By A. HILDERBRAND*

IN THE CTC 15, RCA'S NEWEST COLOR chassis, a great deal of emphasis has been placed on serviceability. Controls and circuit elements are precisely identified. Novar-base tubes offer high reliability, and special attention is given to chassis ventilation and heat dissipation.

The physical layout conforms generally to previous RCA color receivers. All circuit boards are mounted for good ventilation and easy access to all components and connections on either side of the board. The rf tuner can be mounted on the rear apron whenever necessary to transport the chassis.

The high-voltage compartment is designed to permit full accessibility to the components. The upper portion is well louvered for increased ventilation.

In the circuit

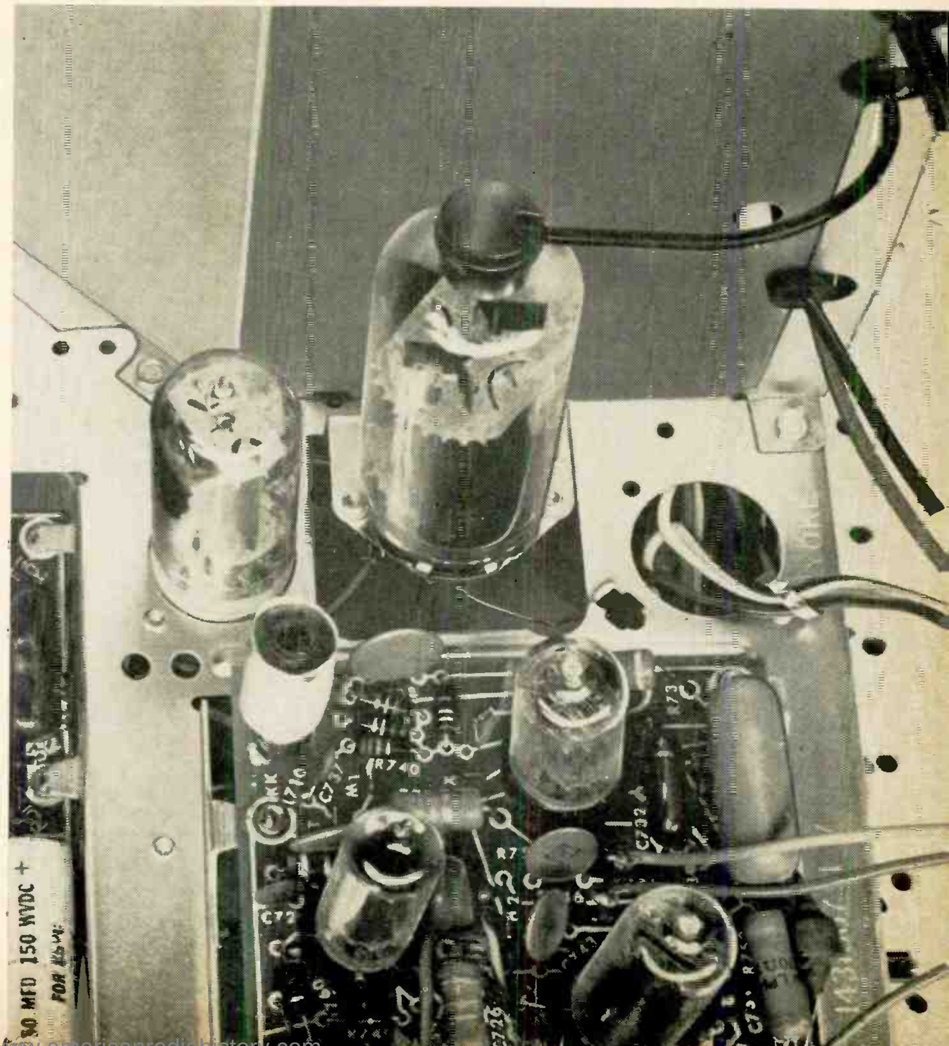
The horizontal output tube in the CTC 15 is a 6JE6, a tube with a novar base and a separate suppressor grid connection. A positive voltage applied to the suppressor grid in uhf versions minimizes the possibility of high-frequency radiation that could interfere with uhf reception.

This voltage is critical. Best results are obtained in the 40–50-volt range. Below 30 volts, the snivets are still present. Above 70 volts, the efficiency of the tube is impaired somewhat.

In the vhf chassis, the vertical output cathode is returned to ground through 3,900 ohms. In the uhf chassis, the resistor is removed and replaced by two series resistors of 2,200 and 1,800 ohms with the 1,800 ohm resistor connected to ground. The junction of these two resistors provide the necessary suppressor grid voltage at low impedance.

The 6JE6 has higher power sensitivity than previous horizontal output tubes and runs cooler. The socket for this tube is mounted on a raised portion of the chassis which provides additional ventilation by a "chimney" effect (Fig. 1). The tube operates almost 40°C below its maximum allowable operating temperature.

Fig. 1—Horizontal output tube, a 6JE6 (top of photo), is set on "shelf" with plenty of air circulation.



*Product Performance, RCA Sales Corp., Indianapolis, Ind.

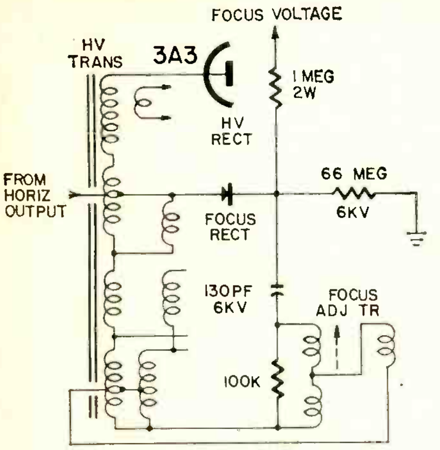


Fig. 2—Solid-state focus rectifier simplifies circuit and generates less heat than tube.

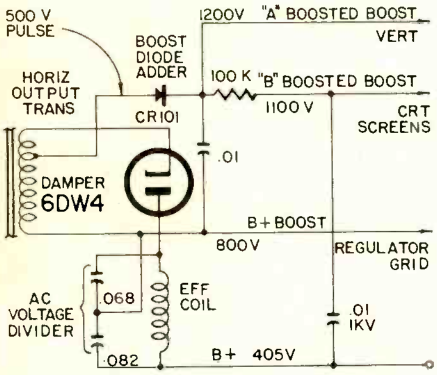


Fig. 3—Diode boost adder provides "boosted boost" level for vertical output and CRT screens.

Other novar-base tubes employed in the CTC 15 include the vertical oscillator–output tube, a 6GF7, and the damper, the 6DW4.

Another circuit arrangement for reliability and heat reduction is the use of a solid-state focus rectifier (Fig. 2). It has extremely long life and, since no filament voltage is required, there is less loading on the high-voltage transformer and less heat.

One of the most noteworthy features of the CTC 15 is its high picture detail. A very sharp raster is produced by operating the picture-tube screen circuits at a higher positive voltage than in previous chassis.

A new adder circuit, shown in Fig. 3, supplies to the picture-tube screens the higher voltages essential for the smaller spot size and the sharper raster. The 500-volt pulse produced by the collapsing field of the horizontal output transformer during flyback time is applied to CR101, the "boost diode adder", and effectively added to the normal B-plus boost of 800 volts. The higher "boosted boost" voltage of 1,200 is used for the vertical oscillator. A voltage divider derives the 1,100 volts for the picture-tube screens.

Another circuit refinement in the CTC 15 is the high-voltage regulation system (Fig. 4).

In addition to the usual shunt regulator circuit, the CTC 15 has a connection between the third video amplifier plate circuit and the shunt regulator grid. Normally, white areas of the picture load the high-voltage supply because of the additional beam current drawn by the picture tube. To compensate for this, video of the same polarity as appears at the picture-tube cathodes is coupled to the shunt regulator grid through a 12-megohm resistor. This tends to keep the high voltage at the same level when large white areas are displayed on the picture tube. The long time constant formed by the 12-megohm resistor and the .01-μf capacitor in the regulator grid circuit insures that only long-term video variations are coupled to the shunt regulator.

Another refinement in the CTC 15 is the video peaking switch (S103), mounted on the rear chassis apron. Three positions of the switch permit selecting three degrees of video peaking (Fig. 5).

The peaking switch is in the contrast control circuit in the cathode of the

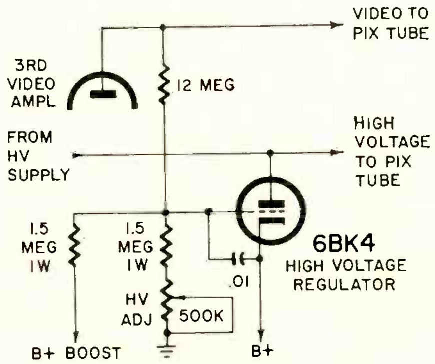


Fig. 4—Tie-in from video stage helps high-voltage regulator adjust to heavy current drain during "white" picture portions.

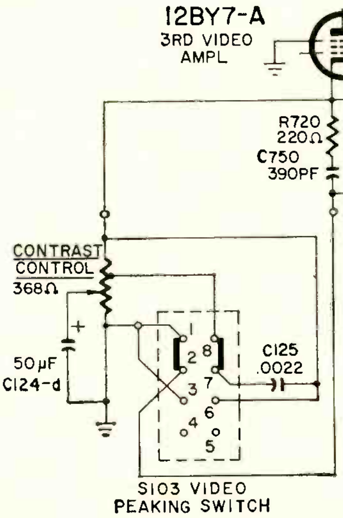


Fig. 5—Three degrees of peaking adjust picture to customers' tastes.

third video amplifier. It has maximum effect when the contrast control is near the three-quarters clockwise position. The peaking results in better transient response and sharper transition from black to white.

In Fig. 5, the upper position gives highest peaking. The combination of R720, C750 and C716 is connected (through points 1 and 2 of the switch) across the contrast control, and C125 is connected (through points 7 and 8) to the tap of the contrast control. In the middle position of the switch, C125 is out of the circuit (points 7–8 are open), and only the resistor–capacitor combination is connected. In the lowest position (least peaking), that combination is also out, leaving only the contrast control and C124-d in the circuit.

Color circuits

Complementing the high detail of the black-and-white picture, the CTC 15 produces higher color definition also. This is achieved largely by the same circuit refinements that improve the black-and-white picture, since the picture detector and first video amplifier are common to both black-and-white and color information. Additional peaking of the G–Y signal further enhances color performance (Fig. 6).

The picture tube itself is one of the most important elements producing high-quality color pictures. RCA's 21-FJP22 is used in all sets with the CTC 15 chassis. The 21FJP22 is a glare-proof bonded picture tube.

A picture-tube bias switch (Fig. 7) is provided on the CTC 15 to adjust for differences in picture tube characteristics. This three-position slide switch selects three values of plate load resist-

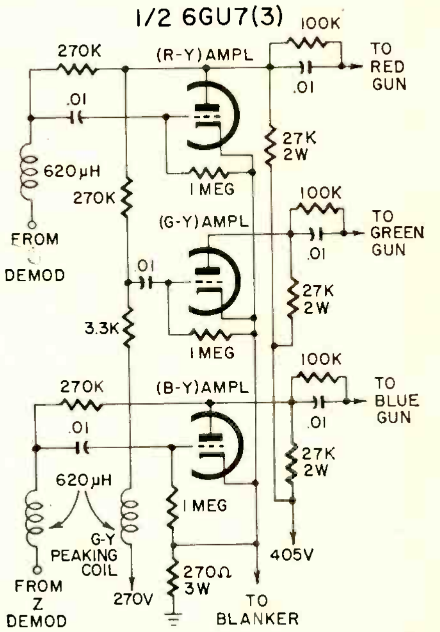


Fig. 6—Color amplifiers are very similar to CTC 12's. Note new tube type 6GU7 and extra peaking coil in G–Y amplifier.

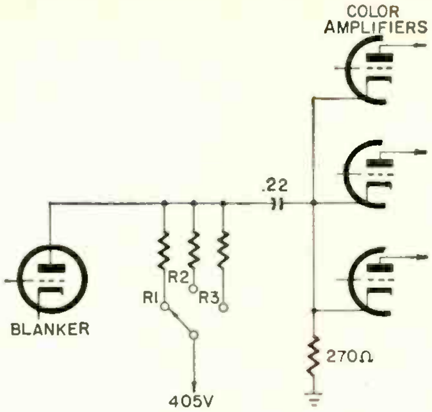


Fig. 7 (above) — Simplified schematic of switchable CRT bias, to compensate for different characteristics.

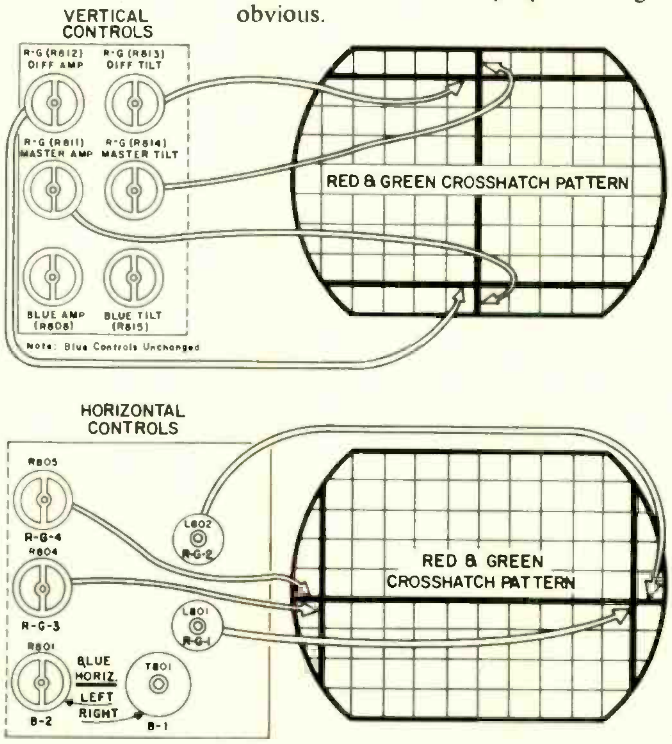


Fig. 8—The convergence controls and their effects on a crosshatch display.

ance for the blanking amplifier. This changes the amplitude of the blanking pulse fed to the common cathodes of the R−Y, B−Y and G−Y amplifiers, changing the average bias on these tubes with each position of the switch. This results in a plate-voltage change, and since the picture tube control grids are dc-coupled, it appears at the picture tube. This way, the cathode circuitry of the picture tube is undisturbed for any setting of bias. This allows for a constant load on the third video amplifier at any setting of picture-tube bias switch.

Setup and convergence

The setup procedure for the CTC 15 is very simple. A switch on the rear apron of the chassis removes vertical deflection when thrown to the SERVICE position. The three screen controls are adjusted until each *just* produces a line on the picture tube. This takes care of low-level tracking. When the switch is thrown to NORMAL, the blue and green video drive controls can be adjusted for a white raster. You can thus get black-and-white tracking over the entire usable brightness range.

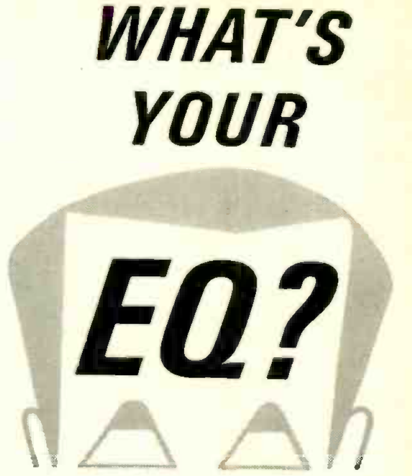
Converging the CTC 15 is also simple. The effects of each convergence control are easily identified when you watch a dot or cross-hatch pattern. The entire top row of controls is adjusted by watching horizontal lines of a cross-hatch pattern, and the entire second row by watching vertical lines on the pattern (Fig. 8). Blue vertical amplitude and tilt controls behave very much like the familiar height and linearity controls. And blue horizontal left and right controls influence the blue raster in their respective areas so that the proper setting is obvious.

Some of the sets using the CTC 15 chassis include RCA's Wireless Wizard remote-control feature. This is an all-transistor ultrasonic system providing up-and-down control of tint, color and volume, channel selection, and a "full off" position.

The rf tuners used in the CTC 15 chassis vary according to the cabinet style. However, all tuners use a 6DS4 Nuvistor rf amplifier and a 6EA8 oscillator–mixer. All 1964 RCA vhf color receivers are adaptable to uhf with a field conversion kit. Factory-built uhf models are also available.

A low-voltage overload circuit breaker, easily reset by the set owner, eliminates the need for service calls because of harmless momentary surges.

Complete details of the CTC 15 chassis including specifications, setup procedures, alignment procedures and circuit diagrams are available in RCA Victor Service Data file number 1963 No. T6, published by the RCA Sales Corp., 600 N. Sherman Drive, Indianapolis, Ind. END



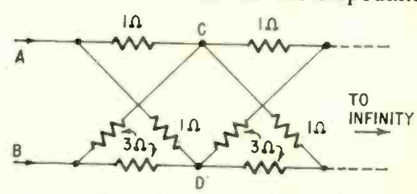
Three puzzlers for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especialy interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer Individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York 11, N. Y.—10011.

Answers to this month's puzzles are on page 70.

What's the Impedance?

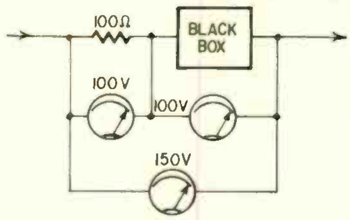
The network below is shown as an *iterative lattice.* What is the impedance



between A and B?—*B. F. Jacoby*

Complex Black Box

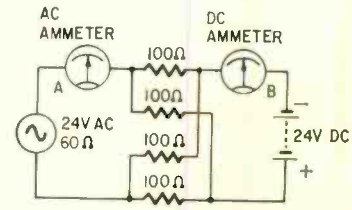
A voltmeter across the 100-ohm resistor shows 100 volts. Another 100



volts appears across the black box. Yet the voltage across the whole circuit is 150. What are the parameters of whatever is in that box?—*Peter R. Smith*

Mixed-up Currents?

Meter A reads ac and meter B reads dc. Each 100-ohm resistor naturally conducts both ac and dc. How



much dc flows through the ac ammeter? —*Kendall Collins*

By ROBERT F. SCOTT
Technical Editor

COLOR TEST EQUIPMENT FOR 1964

In the Big Year For Color, the right test equipment is going to be more important than ever. As usual, your regular test equipment will take care of most jobs, but it'll be the specialized color equipment that'll make the difference. Here are photos and brief descriptions of the latest.

The "bar-dot-crosshatch-color bar" generator is going to be the "vtvm" of color service. Both keyed rainbow and countdown types are crystal controlled for accuracy. They're a necessity for installations, and a big time-saver for home and bench service work. A scope can trace the easily-recognizable color-bar signal through all color circuits, making this job a lot easier. By showing the customer "colors", you won't have to waste time waiting for a color program to come on!

They come in all kind and prices; kits and ready-made. They range from the compact bar-generators to large and elaborate analysts, which furnish rf, i.f. and video signals. These can be used in black-and-white servicing, too.

The test equipment you now have will tell you what else you need for color service. A good bar-generator is a must. If you already have analysts and similar instruments, it'll be all you need. If you don't, the more elaborate instruments will be a good investment. The added versatility of these instruments makes them well worth the small extra cost, for everything but the color bars themselves can be used for both b/w and color servicing. Choose the one that will give you the most functions, to round out your test equipment setup for all kinds of service jobs.

B & K

Model 850 Color Analyst

Produces dot patterns, crosshatch, vertical lines, horizontal lines, burst signal and individual colors for fast, easy receiver tests and adjustments. Crystal-controlled and produces NTSC type signals. Pattern to be displayed on screen is shown in viewer on front panel for visual comparison and quick and easy setup of color set.

Automatic deconvergence feature eliminates need for continual static convergence adjustments. Automatically deconverges a white dot into color-dot trio or white vertical or horizontal lines into red, green and blue parallel lines for rapid dynamic convergence adjustments.

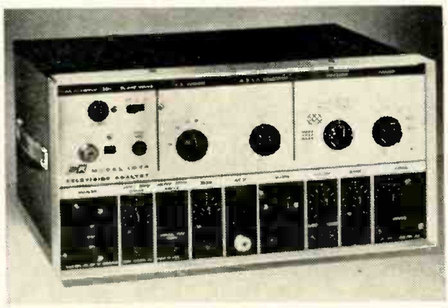
Has 15,750-cycle output jack for scope sweep during demodulator adjustments. Provides 4.5-mc sound signal for receiver tuning and sound-trap adjustments.

SPECIFICATIONS

Rf output: Channels 3, 4 and 5.
Test pattern: Dots, crosshatch, vertical and horizontal lines, green, cyan, blue, B — Y, Q, magenta, R — Y, I and burst—one at a time.
Size: 12¼ in. wide x 9 high x 8½ deep.
Price: $199.95.

Model 1074 Television Analyst

A compact, lightweight version of the 1076. Useful for black-and-white and color TV servicing in the home or shop. Has 15,750-cycle output for scope sync. Tests yoke and output transformer for shorts, opens.



SPECIFICATIONS

Rf output: Rf and i.f. video signals modulated by crosshatch, dots, or vertical or horizontal lines and tone audio-modulated. Green, blue, B — Y, R — Y and red bars—one at a time.
Video output: Any of four types of video signals at output jack, either negative or positive polarity.
Audio output: 4.5-mc FM signal modulated at 900 cycles.
Sync output: Composite sync with negative or positive polarity and amplitude variable to 50 volts.
Sweep drive: Separate vertical and horizontal grid and plate driving signals for checking sweep circuits.
Test patterns: Dot pattern, crosshatch, vertical and horizontal lines, color bars (green, blue, B — Y, R — Y and red) individually.
Size: 14½ in. wide x 7 high x 11 deep.
Weight: 13½ lb.
Price: $249.95.

Model 1076 Television Analyst

Universal test instrument for point-to-point signal injection when servicing and adjusting black-and-white and color receivers. Uses flying-spot scanner to produce test patterns. Includes adjustable negative and positive bias supplies for checking sync, agc and afc troubles. Provides agc keying pulse and high-level test signal for modulating CRT directly.

SPECIFICATIONS

Rf output: See model 1074.
Video output: White dot, crosshatch and crystal-controlled color-bar pattern. Adjustable-level burst and color signals, available at front panel for signal injection. Keyed rainbow color display and color-bar pattern for checking color sync and hue, and for aligning color demodulators.
Audio output: 4.5-mc FM signal with 400-cycle modulation.
Sync output: See model 1074.
Sweep drive: See model 1074.
Test patterns: 10 color bars, crosshatch and dots.
Size: 17 in. wide x 10¼ high x 10 deep.
Weight: 29 lb.
Price: $329.95.

B & K Mfg. Co., Div. Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago 13, Ill.

GC ELECTRONICS

Model 36-610 Color TV Test Pattern Generator

A low-cost, lightweight instrument designed especially for color convergence adjustments in the home. Not a replacement for the more elaborate color pattern generators used for troubleshooting and bench work. Feeds video pattern signals direct to CRT.

Color-gun killer switch disables any combination of the three color guns for fast purity and convergence checks without upsetting receiver's color controls. Bar and dot patterns locked in sync with signal from local TV station. Width and brightness of patterns are variable.

SPECIFICATIONS

Test patterns: 582 small dots for static convergence, 21 vertical or 23 horizontal bars for dynamic convergence adjustments.
Power: 117 volts, 50–60 cycles, 20 watts.
Size: 16 in. wide x 5 high x 8¼ deep.
Weight: 10 lb.
Price: $59.50.

GC Electronics Co., Div. of Textron Electronics, 400 S. Wyman St., Rockford, Ill.

HEATH

Model IG-62 Color Bar and Dot Generator

Designed for linearity, color and convergence adjustments. Color bars produced by offset-carrier method may be used for phase, afc and matrix adjustment.

SPECIFICATIONS

Rf output: Channels 2–6. Output voltage variable approximately 100–100,000μv. Crystal-controlled sound carrier (unmodulated) has off–on switch.
Video output: Crystal-controlled, positive or negative, variable from 0 to 10 volts p–p, open circuit. Impedance about 1,000 ohms.
Test patterns: 180 small (about 2 lines diameter) white dots, crosshatch of 12 vertical and 15 horizontal lines (less those lost in blanking), 15 horizontal bars, 12 vertical bars, 10 vertical color bars. Wide-bar crosshatch pattern with four brightness levels for screen and background adjustments.
Power: 117 volts, 50–60 cycles, 70 watts.
Size: 13 in. wide x 8½ high x 7 deep.
Weight: 10 lb.
Price: $64.95 in kit form.

Heath Co., Benton Harbor, Mich.

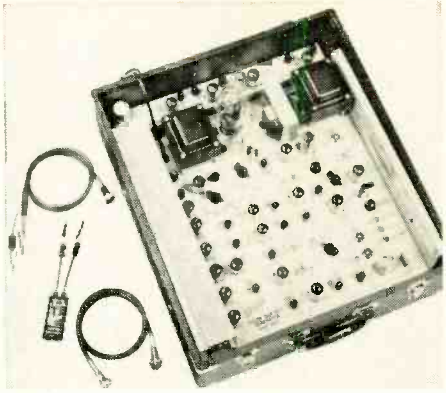
HICKOK

Model 656XC Color Bar/ White Dot-Bar Generator

Versatile generator producing the standard fully saturated NTSC color bar pattern and R – Y, B – Y and G – Y signals for chroma alignment. Also provides a choice of: crosshatch (20 vertical and 15 horizontal lines), horizontal lines only, vertical lines only and a dot pattern. All color signals locked to 315-kc crystal oscillator. Sound carrier permits correct adjustment of receiver's local oscillator frequency.

SPECIFICATIONS

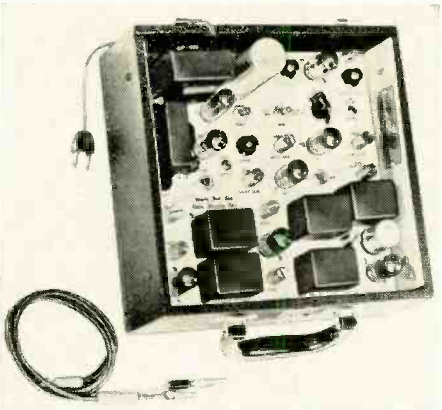
Rf output: Channels 2–6, modulated with choice of color signals. Separate output from 3.58-mc burst oscillator.
Video output: 0–2 volts p–p, open circuit, across 100 ohms with positive or negative output.
Test patterns: 3 primaries, 3 complementaries, plus black-and-white. All standard alignment signals.



Crosshatch: Choice of 20 vertical or 15 horizontal bars or both (less those lines lost in blanking region). 300 dots per frame (less those lost in blanking region). Minimum size of dots and lines, 2 scanning lines.
Power: 105–125 volts, 60 cycles, 40 watts.
Size: 16¾ in. wide x 18⅜ long x 7½ deep.
Weight: 34 lb.
Price: $549.50.

Model 660 White Dot-Bar Color Display Generator

Similar to model 656XC, but designed for fast in-the-home servicing of TV color receivers. All color signals crystal-controlled.



SPECIFICATIONS

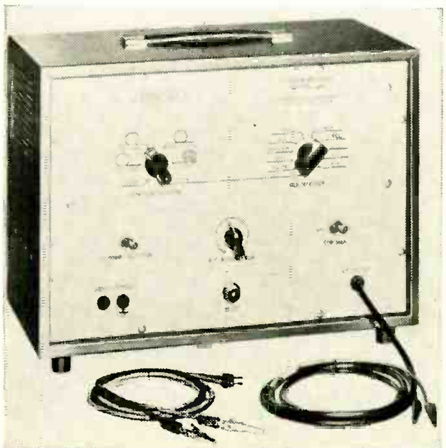
Rf output: Channels 2–6, .05 volt max, .001 volt min modulated 60% by video output.
Video output: 0–4 volts p–p across 300 ohms, black positive or negative.
Burst output: 1 volt p–p.
Test patterns: Six crystal-controlled color bars. Dots and crosshatch (see 656XC).
Ratio of sync to video: Variable 10% to 90%.
Power: 105–125 volts, 60 cycles, 40 watts.
Size: 10 in. wide x 10½ long x 5¼ deep.
Weight: 15 lb.
Price: $245.00.

Model 661 Chrom-Aligner

A white-dot and crosshatch generator that generates individual NTSC 100% saturated color adjustments in the home.

SPECIFICATIONS

Rf output: Channel 3 or 4.
Video output: 1.5 volts p–p across 75 ohms.
Test patterns: Dots and crosshatch (see model 656XC).



NTSC color signals: (1). Yellow—chroma 13°—luminance 0.89. (2). Red—chroma 76°—luminance 0.30. (3). Magenta—chroma 120°—luminance 0.41. (4). Blue—chroma 183°—luminance 0.11. (5). Cyan—chroma 256°—luminance 0.70. (6). Green—chroma 300°—luminance 0.59. Also provides R – Y, B – Y, G – Y and –(G – Y) for demodulator alignment.
Power: 105–125 volts, 60 cycles, 20 watts.
Size: 15 in. wide x 10 high x 7½ deep.
Price: $349.50.

Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

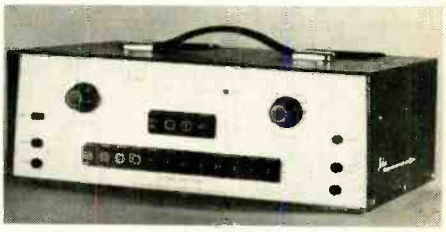
JACKSON

Model 800 Color Bar-Dot Generator

New pushbutton-operated, crystal-controlled instrument for purity, gray-scale, convergence and demodulator adjustments. Generates dot and crosshatch patterns, horizontal and vertical lines and eight individual color bars similar to NTSC specifications. Pushbuttons marked with pattern or color that will appear on CRT screen.

Gun-killer switch disables the color guns singly or in combination. A jack is provided for connecting a scope to view the waveform at each of the color grids.

Video signals without carrier are available with variable amplitude and polarity for signal tracing and injection.



SPECIFICATIONS

Rf impedance: 300 ohms.
Rf output: Channels 3, 4 and 5.
Video impedance: 1,000 ohms.
Video output: 0–1.25 volts; video plus sync 2 volts.
Test patterns: Crosshatch, vertical and horizontal lines, dots and yellow, red, R – Y, magenta, blue, B – Y, cyan and green bars.
Sync level at output jack: 7 volts.
Size: 13½ in. wide x 4¾ high x 9 deep.
Weight: 14 lb.
Price: $239.95.

Jackson Electrical Instrument Co., 124 McDonough St., Dayton, Ohio.

PACO

Model G-36 Color-Bar White-Dot Generator

SPECIFICATIONS
(See Precision E-450)

Size: 13 in. wide x 8½ high x 7¼ deep.
Weight: 12 lb.
Price: Model G-36 (kit), $119.95; G-36W (factory wired), $179.95.

PACO Electronics Co., 8000 Cooper Ave., Glendale 27, N. Y.

PRECISION

Model E-450 Color Generator

Displays 15 horizontal bars, 10 vertical bars or both in crosshatch pattern, and dot pattern for static and dynamic convergence. Ten color bars spaced at 30° intervals for checking and servicing color circuits in receiver. Provides white raster for color purity adjustments.

SPECIFICATIONS

Rf output: Prealigned on channel 3 with video carrier of about 20,000 µv and sound carrier (unmodulated) of about 2,000 µv. Tunable to channel 4.
Output impedance: 300 ohms.
Test patterns: Color bars, vertical bars, horizontal bars, crosshatch, dots and white raster.
Power: 105–125 volts, 60 cycles, 60 watts.
Size: 13 in. wide x 12 high x 8 deep.
Weight: 12 lb.
Price: $189.95.

Precision Apparatus Co., 8000 Cooper Ave., Glendale 27, N. Y.

RCA

Model WR-64A Color Bar/Dot/Crosshatch Generator

A compact, lightweight instrument including all facilities for adjusting color phasing, matrixing, linearity and convergence circuits.

Completely crystal-controlled, uses offset-subcarrier method to generate 10 color bars accurately spaced 30° apart. Brightness pulses are added to edges of each bar to check registration of brightness and color signals.

SPECIFICATIONS

Rf output: Prealigned on channel 3 with .05-volt (max) picture carrier. Sound carrier 10% of pix carrier. Tunable to channel 4.
Output impedance: 300 ohms.
Test patterns: Color bars, dots, crosshatch.
Power: 105–125 volts, 60 cycles, 40 watts.
Size: 13½ in. wide x 10 high x 8 deep.
Weight: 13¾ lb.
Price: $189.50.

RCA Electronic Components & Devices, 415 S. 5th St., Harrison, N. J.

SENCORE

CA122 Color Circuit Analyzer

Portable tester checks color receiver from tuner through picture tube. Generates every signal normally received from TV station, plus convergence and color test patterns. Signals can be injected into audio, video and sync circuits for trouble-shooting.

SPECIFICATIONS

Rf output: Channels 2–6.
I.f. output: 20–50 mc, variable for i.f. troubleshooting and alignment.
Rf–i.f. output levels: .002, .001 and 0.1 volt rms.
Output impedance: 93 ohms, rf and i.f.
Sound carrier: 4.5 mc away from pix carrier. Crystal-controlled, unmodulated.

Video output: 0–30 volts, positive and negative; 5,000 ohms impedance. Six modulated patterns.
Test patterns: 140 small dots, crosshatch of 10 vertical and 14 horizontal bars, 10 vertical bars. Shading bars with three shades of brightness (for background adjustments), 10 color bars (developed by offset-carrier method).
Audio signal: 900 cycles, 3 volts p–p.
External sync: 30 volts p–p, positive or negative, variable.
Power: 117 volts, 60 cycles, 45 watts.
Size: 14 in. wide x 9½ high x 7⅝ deep.
Weight: 15 lb.
Price: $187.50.

CG126 Color Generator

New low-cost color test instrument especially designed for service in the home. Crystal-controlled, develops keyed color bars with 30° phase change between each. Color output variable 0–20%.

SPECIFICATIONS

Rf output: Preset to channel 4. Tunable to channel 3 or 5.
Test patterns: 10 keyed color bars, 117 adjustable-size white dots, crosshatch of 9 vertical and 13 horizontal lines. 9 vertical bars, 13 horizontal bars.
Power: 117 volts, 60 cycles, 35 watts.
Size: 11 in. wide x 8 high x 6 deep.
Weight: 9½ lb.
Price: $99.50.

Sencore, Inc., 426 S. Westgate Dr., Addison, Ill.

SIMPSON

Model 434A Varidot White-Dot Gen.

Provides white dots for adjusting convergence in color receivers and checking linearity, frequency response, and sync stability in black-and-white and color sets. Features independent dot height and width controls with minimum dot size one line high and one line wide. Negative and positive polarity video output, vernier control of vertical sync frequency to check receiver performance on line frequency and

off-line frequency (as in some network programs).

SPECIFICATIONS

Rf output: Channels 2–6 variable to 50,000 µv open-circuit.
Output impedance: 300 ohms balanced and unbalanced for rf and video.
Dot width: Variable from 0.2 to .8 µsec at points 20% from pulse base.
Dot height: Variable from 1 to 8 lines high.
Vertical dot number: Variable from 6 to 12.
Horizontal dot number: Variable from 6 to 11.
Power: 115 volts, 60 cycles, 50 watts.
Size: 11½ in. wide x 9½ high x 9½ deep.
Weight: 11½ lb.
Price: $149.95.

Model 430 Color Bar Generator

Complete color signal generator for checking overall frequency response, matrixing, chroma levels, delay-line operation and other characteristics of a color receiver.

SPECIFICATIONS

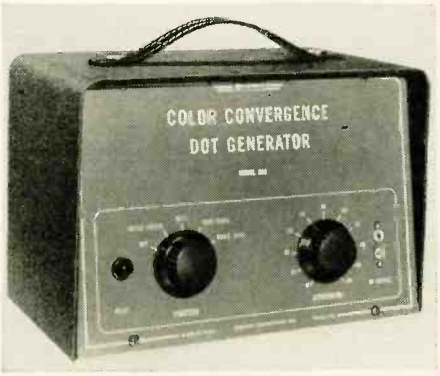
Rf output: Channels 2–6 on fundamentals, 7–13 on harmonics
Modulation or video output: Y, chroma, standard NTSC color pattern, I, Q, I/Q, R — Y, B — Y, R — Y/B — Y, G — Y (90° phase), burst/sync.
Color bar sequence: Red, yellow, green, cyan, white, magenta, blue, black. *Color chroma phase accuracy:* 5%. *Demodulator chroma phase accuracy:* ± 3°. *Attenuator range:* Video, 0–3.5 volts p–p. Rf, maximum output more than 10,000 µv on channels 2–6. 15-db control.
Chroma attenuator: Fixed −6, −15 db. Variable, −15 to +5 db.
Size: 14 in. wide x 17½ high x 19¼ deep.
Weight: 21 lb.
Price: $395.

Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

WINSTON

Model 250 Color Convergence Dot Generator

Provides all patterns needed for color convergence tests and adjustments.

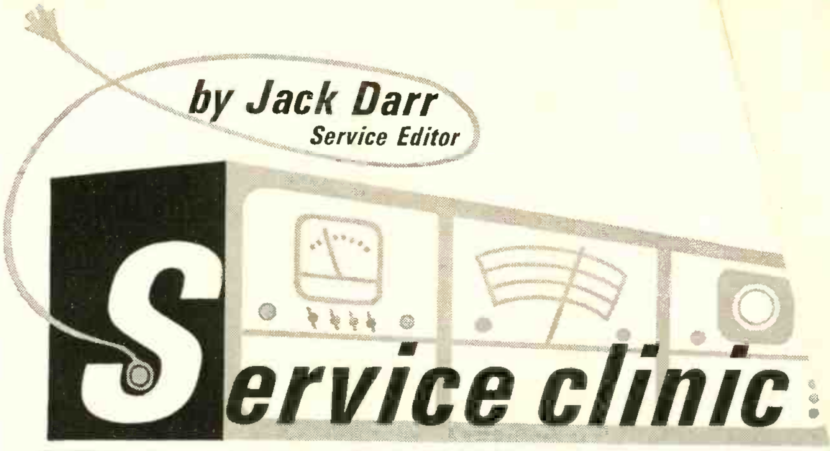


SPECIFICATIONS

Rf output: Preset to channel 2, but can be retuned to channel 3 in the field. Amplitude variable over 30 db.
Output impedance: 300 ohms.
Test patterns: White crosshatch of 18 vertical and 14 horizontal lines. White dots, 14 horizontal and 18 vertical rows, interlaced 2 lines high. White bars, 18 vertical or 14 horizontal.
Power: 105–125 volts, 60 cycles, 30 watts.
Size: 10½ in. wide x 7 high x 6 deep.
Weight: 9½ lb.
Price: $129.95.

Winston Electronics, Div. Jetronic Industries, Inc., Main & Cotton Sts., Philadelphia 27, Pa.

END



Service clinic

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envlope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

YOU CAN SEE SOME ODD COLORS IN COLOR TV sets. You can also hear some very odd and loud noises! Flashes of blue-white light, and perhaps smoke! The hysterical set owner is convinced the whole thing's burning up! Considering the cost, you can't blame him! So, our first task when we get there is to get him calmed down enough to tell us what's happened. After we get him down off the wall, we can usually find and fix the fireworks without too much trouble. Components in color TV high-voltage circuits are usually pretty well built, and they'll stand up to a pretty severe arc-over if it's caught in time.

This is sometimes due to high humidity, but more often to some trouble inside the set. With the very high voltages, color sets are more apt to flash over than black-and-white. Let's look at the circuits and see what's going on.

Clue: color sets are about the only ones using regulated high voltage. If

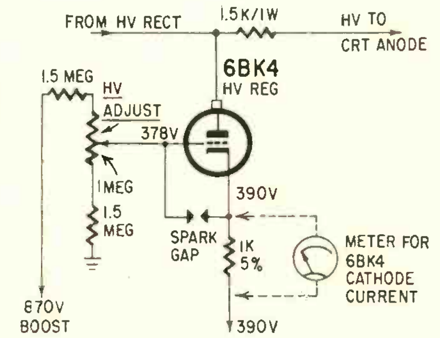


Fig. 1—High-voltage regulation circuit can have some critical values. Regulation depends on voltage divider in grid circuit of 6BK4.

the regulator tube opens up, or isn't working, the high-voltage will go up, since there will be no control on it at all.

In these flashovers, it is not the high voltage that is doing the arcing; it's usually the *boost*. In color circuits, this runs about 800 volts. The 6BK4's plate is connected directly to the 25-[illegible] line (Fig. 1). It usually draws a pres[illegible] amount of plate current, thus shunting the high voltage. The more plate current this tube draws, the lower the high voltage, because the tube acts as a shunt-load across it.

Now, we have to have a "signal" voltage on the grid, to tell the tube when to draw more current. This is the boost voltage. The total boost is fed to a voltage divider, and the regulator grid is tapped off that. B-plus goes to the cathode. If something happens (say, an increase in line voltage) the boost rises (goes more positive). This increases the positive voltage on the grid of the 6BK4, and it draws more plate current, reducing the high voltage because it makes more load across it. Simple, huh?

Now. In some sets (for instance the Zenith 25LC20 chassis), they have thoughtfully provided a spark gap in this circuit. This is just one of the regular solder-terminal boards used on these and several other makes—see Fig. 2. (This particular one is set close to the base of the 6BK4 tube, for obvious reasons.) Other terminals on the same board can be used to make tests; more on this in a minute.

Normally, flashovers *should* take place between 1 and 2 on this board. Most of the time, they will. However, in some cases, you'll see flashovers at the high voltage control on the back apron of the chassis. Because of the high voltage present, you'll find an arc-over from the end of the resistance element to chassis. If this is allowed to go on too long, a carbon path will form, and you'll have to replace the control to avoid a callback.

Most of these troubles start with a bad 6BK4. For example, if the heater burns out, we lose all regulation. This can cause a flashover, but if the air is pretty dry, you may see loss of focus, too much brightness, and similar symp-

[illegible]der. In the [illegible] ig. 2, disconnect the [illegible] connect the meter between terminals 3 and 4 on the same strip. The service data will tell you what the

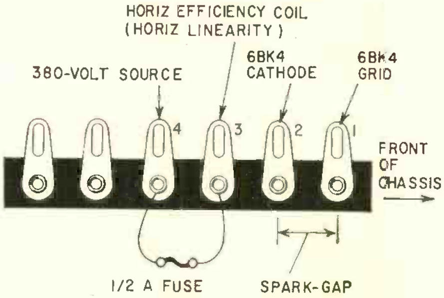


Fig. 2—Terminals 1 and 2 on this strip are used as protective spark gap on some Zenith models.

correct current is. In this set, it's 215 ma. If this current is very low, but B-plus voltages are normal, the horizontal output tube is weak and will have to be replaced. Leave the meter in place until you get the new tube in and working. Always check this cathode current whenever the output tube is replaced, just to be sure. It takes only a little while, and it's a big help in avoiding a callback!

Regulator action can be checked at this same terminal strip. In other chassis, test-points will be provided. Normal cathode current on this tube, with high voltage set at the correct value, about 24–24.5 kv, should be about 0.9 ma. In this circuit, you can read the dc voltage across the 1,000-ohm resistor in series with the cathode. In others, the meter is hooked into the cathode circuit, and the resistor opened. Follow the procedure given in the service data for whatever set you're working on.

If the current is low or high, adjust something. If the high voltage has been set at the rated value, and the current's too low, reset the horizontal efficiency coil (horizontal linearity) to bring it up. The horizontal-output tube's cathode-current meter should still be in the cir-

...mm ...control ...re pretty ...rease in any ...circuit beyond ...rol. For a horrible ...pper resistor decreased ...3K4 grid would go highly ...is would cause a great in- ...its plate current, and the result ...easily be a burned out 6BK4 and ...melted-down flyback! So check 'em!

Vertical retrace lines

In a G-E color TV chassis CW, it looks to me as if the retrace lines are too prominent. Shouldn't they be well blanked, especially in a color set?—R. G., Danville, Ill.

Yes, indeed, as in all sets, color or black-and-white. In this particular chassis, try reducing the series resistance in the vertical blanking network. This will raise the amplitude of the blanking pulse. Also, check the capacitor for any small leakage, since this will tend to broaden the pulse and at the same time reduce its peak amplitude. Fig. 3 shows the location of these parts.

Vertical blanking in this chassis is fed from the vertical output plate, pin 2

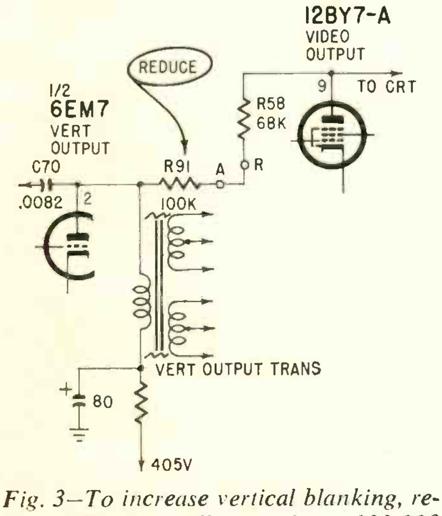


Fig. 3—To increase vertical blanking, reduce R91 in small steps from 100,000 ohms.

of the 6EM7, through a two-resistor network to the plate of the video output tube, the 12BY7A. Reduce the 100,000-ohm resistor in small steps until blanking is OK.

Bad color sync

In RCA CTC 5 chassis, I can't get any color sync; bars or program material just "run" all the time. Color seems to be pretty good—that is, it's bright enough, but no color lock action. Tubes and voltages all look pretty close.—M. G. A., Watkins Glen, N. Y.

Check the .022-μf bypass capacitor at the bottom of the grid winding on the ...st keyer transformer. This is shunted across a 1-megohm resistor. If it opens up, the grid impedance rises and seems

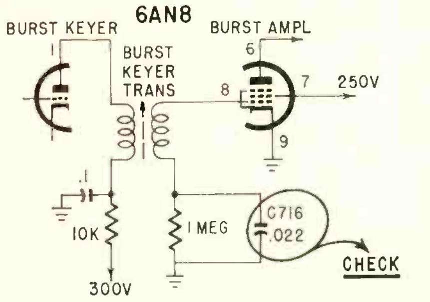


Fig. 4—Check circled capacitor if sync is poor.

to cut off the burst amplifier tube. At any rate, no color sync, or very badly reduced color sync, gets through to the color circuits. Fig. 4 shows where this capacitor is located.

Bloomin' highlights

We're getting a bad blooming in the highlights on an RCA CTC 7 color chassis, and we can't seem to find a setting on the color temperature adjustments that will stop it. Voltages all seem to be normal, and we have plenty of high voltage.—D. G., Bronx, N. Y.

This is most likely due to too much current in the 6BK4 high-voltage regulator. Try adding about 470,000 ohms to the grid resistor. This is a 1.8-megohm 1-watt resistor between the 6BK4 grid and boost voltage (R133 in the RCA's 1957 T18 manual and R131 in Sams 399-3). See Fig. 5.

Check the 100-megohm resistor between grid and cathode of the 6BK4,

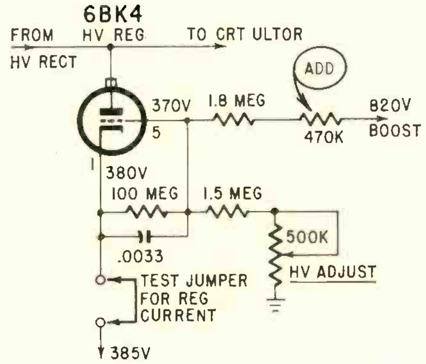


Fig. 5—If too-high hv-regulator current causes blooming, add 470,000 ohms to grid circuit.

also the 1.5-meg in series with the high-voltage adjust control. Be sure that the voltages on the regulator tube are OK, and check the current as specified in the instructions. This could also apply to any of several later chassis like the CTC 9, 10 and 11.

Weak picture and agc

While I was checking a CTC 12 color TV for what looked like agc trouble, all of a sudden I lost a lot of rf gain. Now my picture is weak, and the agc doesn't have as much effect. I thought I smelled a resistor burning, but I can't find one! Tubes all substituted, no change in gain.—H. G., New York, N. Y.

You did smell a resistor! This is a little bit "wild", but you'll have to watch out for it, in this, in the CTC 15 chassis and in all sets (even black-and-white) using frame-grid tubes in the video i.f.

In this chassis, a 6EJ7 frame-grid

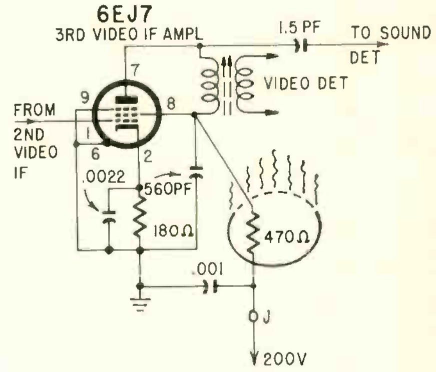


Fig. 6—Off-beat trouble in CTC 12 and 15 chassis is due to frame-grid video i.f.

tube is used as the last video i.f. amplifier. If the agc tube is pulled with the set on, this tube draws a very heavy plate current, because of the loss of bias. This overheats its plate dropping resistor, as shown in Fig. 6. These always seem to rise in value when this happens, cutting the plate voltage and, of course, the gain. Then you wind up with a weak picture.

So, always turn the set *off* when checking the agc or first or second video i.f. tubes.

Low brightness

I don't think the brightness is high enough in this RCA CTC 12, although it makes a pretty good picture. Can you suggest anything?—W. B., Huntsville, Ala.

You might check, and, if possible,

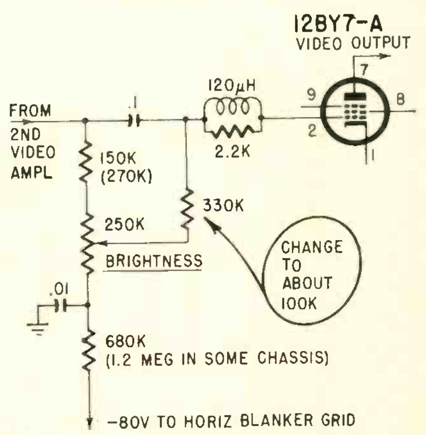


Fig. 7—More brightness in CTC-12 by making this change.

change the grid resistor of the third video amplifier tube, near the brightness control. This 330,000-ohm resistor is marked R158 in RCA's 1962 T7 service data, and R63 in Sams 640-3.

Try about 100,000 ohms here and see if it doesn't give you a bit more control over the brightness, and perhaps a little more total brightness. See Fig. 7.

Insufficient vertical tilt

I'm having trouble getting convergence on a CTC 10 color chassis. The worst thing seems to be a lack of range in the vertical tilt controls. The vertical amplitude could be OK, but I can't get enough tilt to cover the lines all the way down.—L. S., New York, N. Y.

This is probably due to low amplitude of the convergence waveform itself.

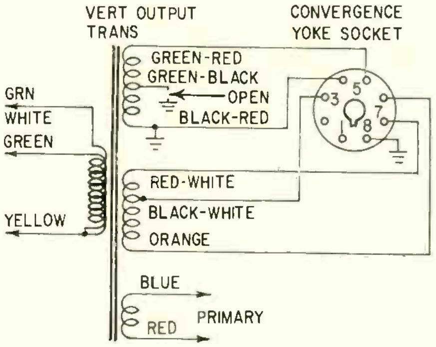


Fig. 8—Insufficient vertical tilt range can be fixed by moving ground on vertical output transformer.

This comes from the vertical output transformer, T104 in RCA's 1960 T5 service data.

Look at the transformer. If the green-black wire is grounded, change this ground to the black-red wire. This will give you a higher-amplitude waveform for application to the vertical convergence circuits, and should help out. Fig. 8 shows the change.

Poor horizontal hold in CTC 9

The horizontal hold action in this RCA color TV isn't very good. I get a pretty severe horizontal bend, and the picture isn't as stable horizontally as it should be. Tubes check OK and the voltages are almost normal. Grid voltage on pin 7 of the horizontal oscillator is low about —80 volts.—W. R., Okla.

Check some of the resistors around the horizontal oscillator and afc circuits. I think you'll find that one of them has drifted pretty badly (Fig. 9). The most likely suspect with the voltage readings you have would be R114, the 270,000-ohm; R115, the 1-megohm, or R112, the 680,000-ohm. Don't try to read these in-circuit (too many parallel paths). Lift one end of each and measure, to be sure.

Check the 390-pf capacitor for leakage. Even a very small leak here will throw your oscillator far off frequency.

Low brightness again

I'm not satisfied with the brightness I'm getting in an Admiral 25UD6 color set. My high voltage and everything else seem to check out OK, but I'm afraid to take it back to the customer unless I can get more brightness.—P. S., Short Islands, Neb.

This is probably due to incorrect bias on the video amplifiers, which, in this circuitry (with the dc coupling), can control the brightness directly. Check

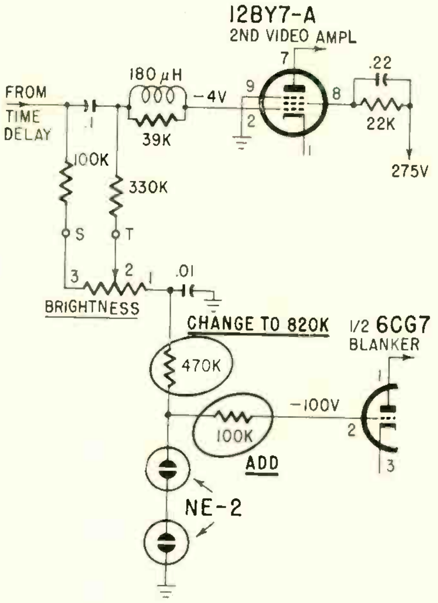


Fig. 10—Changes in brightness control circuit of Admiral 25UD6.

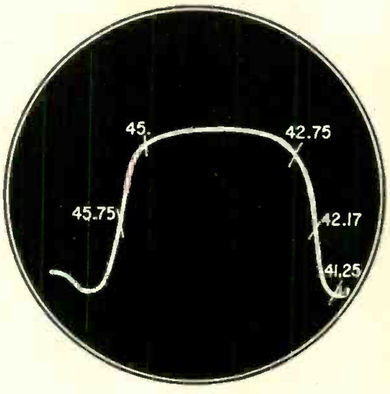
the voltage on the blanker grid, pin 2 of the 6CG7, V707B in Admiral's service data. If this is more than —150 volts, make the changes shown in Fig. 10 and you'll probably see some improvement.

If we have too much negative bias on the second video amplifier grid, we reduce brightness.

Poor definition

We have an RCA CTC 12 chassis on the bench, and are not satisfied with the picture definition. While the picture is almost all right, it's one of those annoying things: we feel that it could be better! Any ideas?—F. S., Newark, N. J.

RCA's field engineers recommend changing the i.f. alignment curve on this chassis, from that shown in the original service data (Fig. 11-a). The "hay-

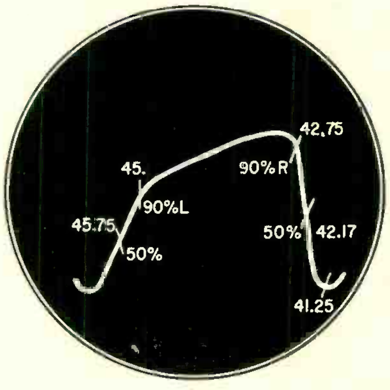


a

Fig. 11-a—Original CTC 12 i.f. curve can be improved for better definition as in (b) below. The adjustments do interact, and it may be necessary to line up each transformer a couple of times.

stack" curve doesn't seem to give the best picture definition.

Fig. 11-b shows the recommended curve. Set the first i.f., T302, to put the 45.75-mc marker at the 50% point on the left; the second i.f., T303, to get the



b

42.17-mc color subcarrier marker at 50% on the right side, and the third i.f., T304, to get the proper tilt to the top of the curve.

These adjustments all interact as usual, but you can get the proper curve with careful alignment. Be sure to set the 45.0-mc markers and the 42.75-mc markers at 90%, as shown on left and right shoulders of the curve. END

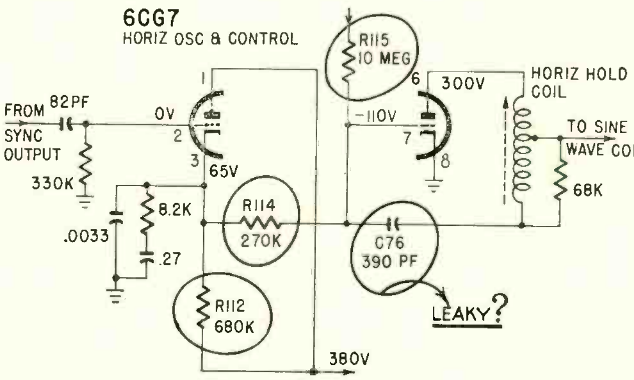


Fig. 9 — Check these parts in tracking down poor horizontal stability in CTC9.

automatic announcement reminder and alarm

Handy unit stops FCC violation tickets for "forgetting to sign"

By
RONALD L. IVES

AN INCREASING NUMBER OF NON-BROADcast commercial stations, and some amateur stations, frequently get little missives from the FCC on the general subject of "forgetting to sign". The standard reply to most of these is "mea culpa, mea maxima culpa," and a promise to do better next time. Things improve for a few days, then the operators become forgetful again, and pretty soon the postman brings another pink ticket.

What is needed is an automatic device to remind the operator when an announcement is due, and to remind him forcibly and insistently when an announcement is overdue. At many classes of stations, call letters must be announced every 10 minutes "or as soon thereafter as convenient." This means, in general, that a slight delay is permissible, but that a delay of 10 minutes more is technically a violation, and repeated delays of an hour or so, if and when detected by the FCC monitor, will bring a pink ticket.

This article describes an automatic announcement reminder and alarm that will help end this problem. It turns on a blinking reminder light every 10 minutes, and keeps it on until a release button is pressed. If the release is not pressed within 45 seconds, a buzzer goes off and stays on until the release is pressed. Although operators do not love "the %#"!:!# devil box," it effectively eliminates troubles caused by "forgetting to sign."

The unit consists of a repeating timer, an alarm lamp, a buzzer and an assortment of relays, indicators and power supplies. All components fit into a standard 5 × 6 × 9-inch utility case. The circuit is straightforward (Fig. 1). Power supplied by the line operates the 10-minute repeating timer continuously. Every 10 minutes, a microswitch cam follower is actuated, energizing a self-holding relay. This, in turn, switches off the operating (power) pilot, energizes a flasher circuit and the reminder lamp. It also energizes the heater of a 45-second thermal time delay. If the operator presses the reset button before 45 seconds have elapsed, the self-holding relay releases, the reminder lamp goes out and the operating pilot is re-energized. If, however, the operator is busy, negligent or asleep, the thermal time delay switches on a buzzer which operates until the reset button is pressed.

At first glance the buzzer circuit appears somewhat nonstandard, and seems to contain a lot of unnecessary components. Because the contacts of the thermal time delay used do not snap closed, they are backed up with a small double-pole relay, so no energy reaches the buzzer until the circuit is permanently complete. Because the rectified ac buzzer supply has poor regulation, the buzzer is shunted by a Zener diode, which stabilizes the applied voltage and prevents "yooping". Buzzer tone is lowered to prevent confusion with other annunciators by soldering a loading weight onto the armature. Rf output of the buzzer is minimized by shunting a

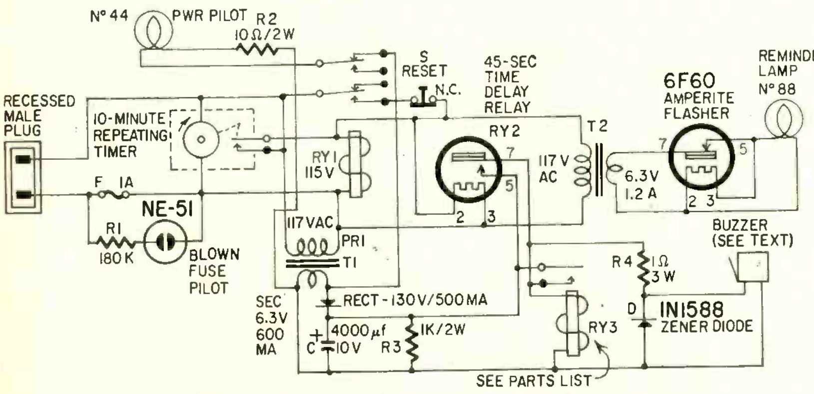


Fig. 1—Circuit of the announcement reminder.

R1—180,000 ohms, ½ watt
R2—10 ohms, 2 watts
R3—1,000 ohms, 2 watts
R4—1 ohm, 3 watts (Ohmite Series 88 or equivalent)
C—4,000 μf, 10 volts, electrolytic
D—1N1558, Zener diode
F—1 amp and fuseholder
RECT—130 volts, 500 ma (Sarkes Tarzian M-500 or equivalent)
RY 1—dpdt, 115-volt coil (Potter & Brumfield KA11-AY or equivalent)
RY 2—thermal time delay, 45 seconds (Amperite 115N045 or equivalent)
RY 3—spst, 3 volts dc (Sigma 41-F-200S-SIL or equivalent)
S—spst normally closed pushbutton
T1—filament transformer: primary, 117 volts; secondary, 6.3 volts, 600 ma (Stancor P-6465 or equivalent)
T2—filament transformer: primary, 117 volts; secondary, 6.3 volts, 1.2 amps (Stancor P-6134 or equivalent)
Pilot lamp, NE-51 and pilot-lamp assembly
Pilot lamp, No. 44 and pilot-lamp assembly
Pilot lamp, No. 88 and pilot-lamp assembly (see text and Fig. 2)
Buzzer, 3 volts (Johnson 114-400 or equivalent)
Flasher, 6 volts (Amperite 6F60 or equivalent)
10-minute timer (Western Electro-Mechanical Co. No. 1/10M1, 300 Broadway, Oakland, Calif.)
Case, 5 x 6 x 9 inches
Chassis, 5 x 7 x 2 inches
Miscellaneous hardware

.02-μf disc ceramic capacitor across its contacts.

The reminder lamp is housed in a meter case, which facilitates mounting, placement of the legend and arrangement of the light diffusers. Details of the lamp housing are shown in Fig. 2. The legend "Announce Call Letters and Time" is a film negative in which the letters are transparent. Reminder lamp and thermal flasher are operated from a separate low-voltage transformer.

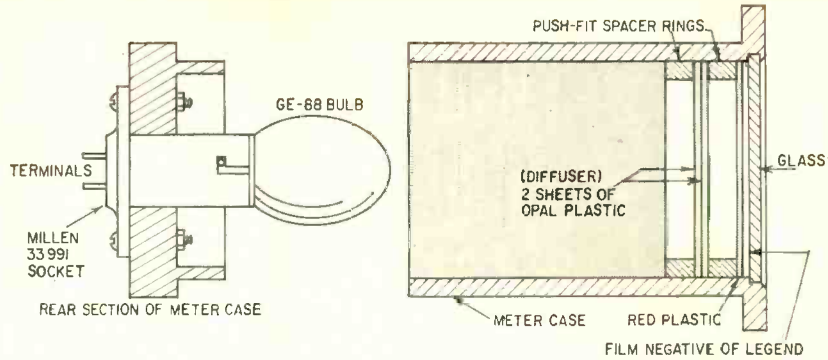


Fig. 2—Details of reminder-light assembly.

How to build it

Construction of this announcement reminder is fairly simple and noncritical, as neither high frequencies nor high voltages are involved. The chassis is a 5 × 7 × 2-inch unit, which exactly fits the case. All power connections are brought out to the rear. The photos show the parts layout. Other arrangements can be used, but be sure to arrange components so the relay contacts, timer cams, etc. are easily accessible for cleaning and adjustment. Also, bolt all components firmly in place, using lock washers, to prevent loosening in service and trouble.

To prevent connection pileups and to firm up the wiring, tie points are used at strategic locations, and wiring is cabled. Leave enough slack so that any component can be demounted and swung out of position for testing or servicing without disconnecting it. Bolt the buzzer firmly to the end of the chassis so it will resonate, enhancing the tone and volume. Use insulated sleeving liberally to protect and isolate the various terminals and connections. Use grommets in all chassis holes to prevent abrasion of insulation and resultant shorts to chassis.

Labels indicate the function of each control and exposed component, and the proper replacement information for those likely to fail (fuse, pilot lamps) is cemented to front and rear panels.

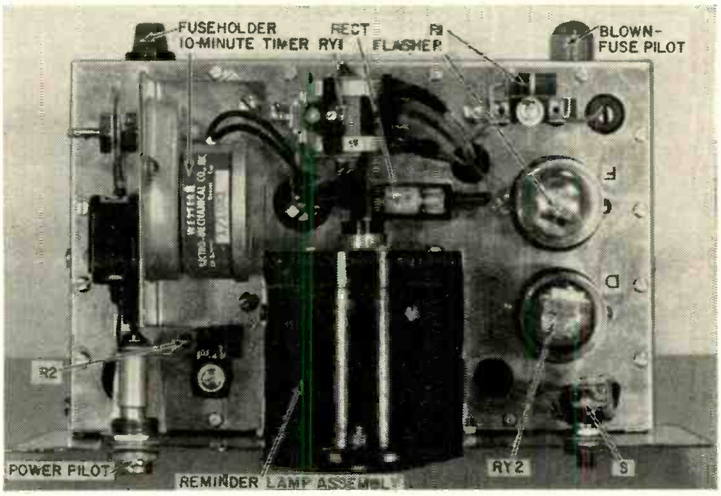
Operation is simple. Place the unit in a convenient location and turn it on. Every 10 minutes, the reminder light starts flashing. At the first transmission break after the operator observes the light, he announces the station call and time, and presses the RESET button, which extinguishes the light until the next announcement interval comes up. If the operator disregards the light, the buzzer sounds 45 seconds after the light starts flashing, and stays on until he presses the RESET button.

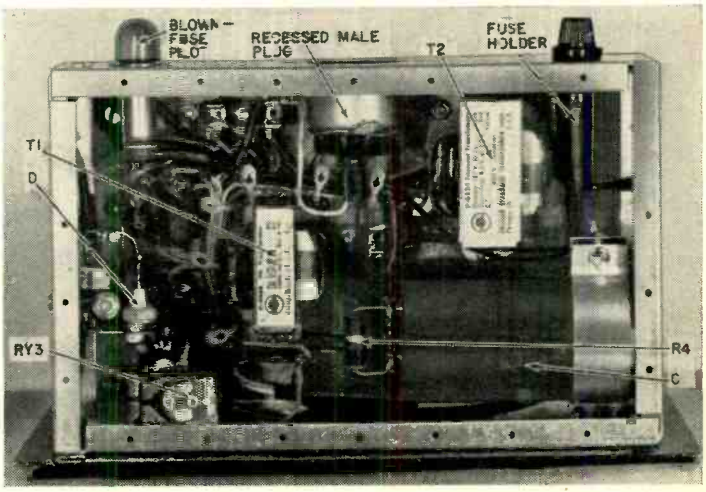
Servicing and maintenance are minimized as all components except the power pilot have a rated service life of more than 10,000 hours. Life of the power pilot is extended by using a series resistor so it has to be replaced about every 2,500 hours. Life of the reminder lamp (G-E 88) in flasher service is problematical. The only one tested lasted more than 20,000 hours, which is far in excess of the manufacturer's continuous service rating.

If you have a problem with forgetting to sign, this automatic reminder and alarm, or any one of a number of rather obvious modifications of it, should solve the problem and effectively shut off the flow of pink tickets. END

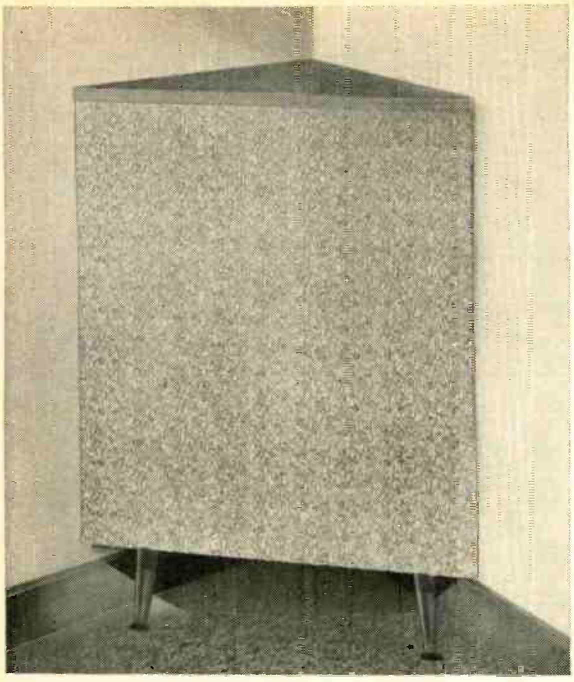
A look at the back of the case. If the fuse blows, the neon lamp lights.

Parts layout above the chassis.





Parts are placed so they are accessible for cleaning or replacement.



CORNER SPEAKER fits your home

By G. A. BRIGGS*

Britain's top authority on speakers says "corner position is best," shows how to build one that looks and sounds good

IF I WERE ASKED TO NAME THE TWO pioneers in corner-speaker development, my reply would be: the two Pauls. Paul Klipsch in the US and Paul Voigt in the UK. It is now about 30 years since I first heard the Voigt corner horn, and the famous Klipschorn was fully described in a 1946 issue of the *Journal of the Acoustical Society of America.*

My own efforts to corner the speaker market began, so to speak, in 1948, when we built our first 9-cubic-foot brick corner enclosure at a cost of 35 shillings – (say five dollars in real money). I can honestly say that the structure is as sound today as it was then.

The corner horn designs were very efficient and would give ample domestic volume level with a 5-watt amplifier. But it has been found to be much cheaper to increase amplifier output than to concentrate on speaker efficiency, although I still favor high flux density for good transient response. Then stereo records in 1958 showed that two speakers produced more bass than one of the same size, and the large corner systems suffered a decline in popularity.

But it is still true that for optimum bass the corner is the best position in the average room, and – provided room shape is oblong rather than square – two corners at a narrow end usually give the best stereo.

The fact that two small corner cabinets can look very attractive and quite unobtrusive in a nicely furnished room is illustrated by a photograph taken from my recently published book *More About Loudspeakers.*

In this case, the lady of the house *wanted* to have the speakers in the corners, but limited to a height of 30 inches because of other furniture (hence the shortened legs).

There could well be a revival of interest in corner positions and the editor of this journal has invited me to give full details of the model referred to, so here we go:

The main considerations are these:

1. The corner speaker plays into the longest air path in the room and reflections from two walls and floor help the low-frequency radiation.

2. As the enclosure shown is only 2 cubic feet in volume, the bass assistance from No. 1 is an advantage.

3. Diagonal facing is generally best for stereo in the average room, and distances of 8 to 12 feet between speakers are satisfactory with room lengths proportionately longer.

4. The cabinets can be placed a few inches out from the corner if there is too much bass resonance, or to reduce the distance between them for natural stereo.

5. The triangular shape is good acoustically because the only two reflecting parallel surfaces are the base and top,

Speaker Types

Wharfedale Model No.	Nominal size (inches)	Resonance (cycles)
Super 8/RS/DD	8	50–60
Super 10/RS/DD	10	38–43
Super 12/RS/DD	12	26–32

RS = Roll Surround; DD = Double Diaphragm

Commercial versions of the corner cabinet are shown in corners of this elegant Yorkshire room.

*Managing director, Wharfedale Wireless Works Ltd., Idle, Bradford, Yorks.

Fig. 1—Details of assembly, showing all dimensions. Use resin, casein or "white" glue and 1½-inch wood screws.

DIMENSIONS and ASSEMBLY

Material: ¾-inch plywood or chipboard (chipboard better acoustically but harder to cut). 1-inch lining of absorbent wadding (glass wool, ozite, etc.).

Volume: 2 cu. ft.

Weight: approx. 30 lb without speaker.

Front panel: 27½ x 26⅛ in., beveled 2 sides at 45°.

Backs: One 26¾ x 16⅝ in.
One 26¾ x 17⅜ in.
Both beveled on one long edge at 45°. Drill 4 holes for screwing to front panel.

Top: 18⅝ x 18⅝ x 26⅛. Front edge veneered or covered with strip of solid wood.

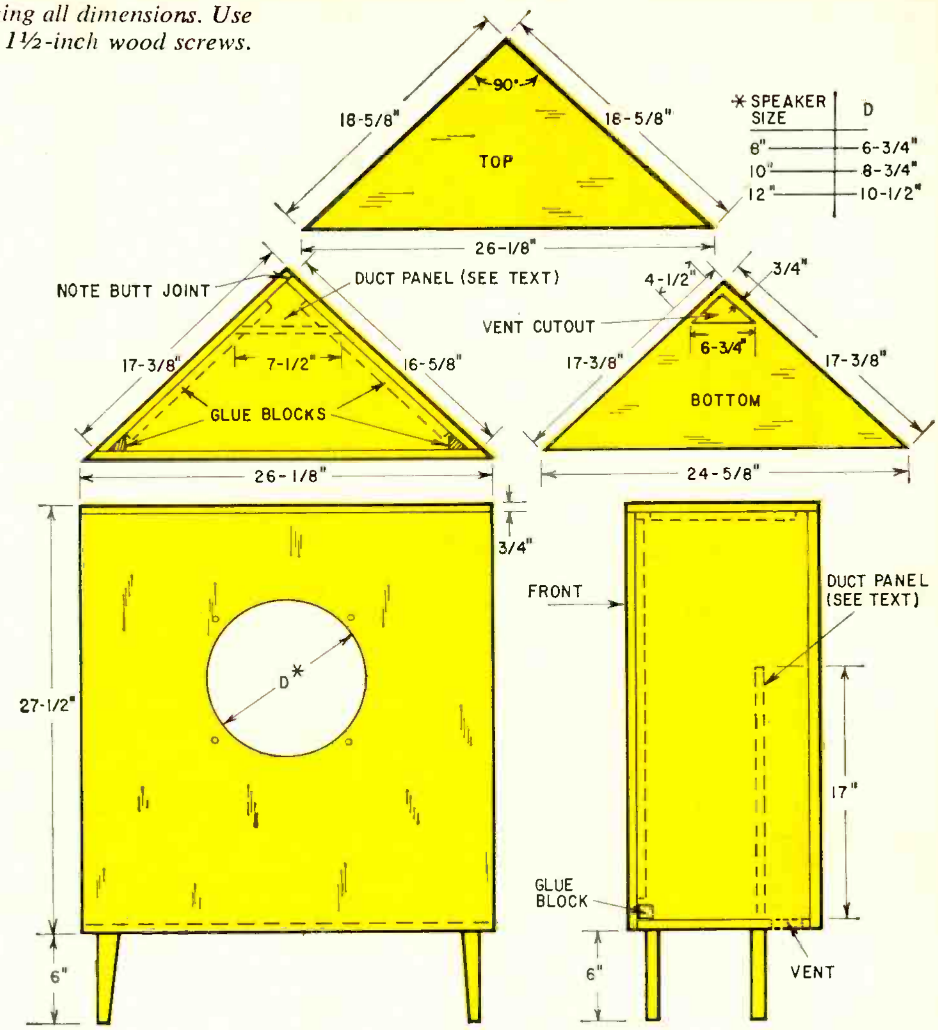
Base: 17⅜ x 17⅜ x 26⅛ in. Vent opening as in Fig. 1.

Duct: ⅜-in. plywood 17 x 7½, beveled on 2 edges 45° to fit to backs. (For 10- and 12-in. speakers only.)

Glue blocks, etc.: 2 long corner blocks for holding front panel to sides; cut diagonally from 1 piece 26¾ long x 1¼ in. sq. One rail for fixing front panel to base: 19⅝ long x ⅞ in. sq. Two rails for fixing top: 13½ long x ⅞ in. sq. White pine.

Assembly: Glue and screw backs together at right angles (butt joint—see Fig. 1). Glue and screw base in position. Glue top to fit flush with sides.

Legs: Suitable 6-inch legs can be bought and fitted without difficulty. Set rear as close to vent as possible.



which are small in area and farthest apart.

Construction details

The drawing of Fig. 1 shows the overall dimensions of the cabinet, and the photograph gives an inside view with 12-inch unit and absorbent material fixed in position.

The details in the "Dimensions and Assembly" box will help in constructing the cabinet, which must be firmly glued and screwed together to provide an air-tight enclosure, apart from the vent near the back. The last assembly job is to screw the front panel in position.

To facilitate lifting, two hand holes 3½ x 1 inch can be made, one in each back panel 4½ inches from the top and 4½ inches from the front. The openings must be covered with a piece of plywood on the inside to make them airtight.

Damping materials

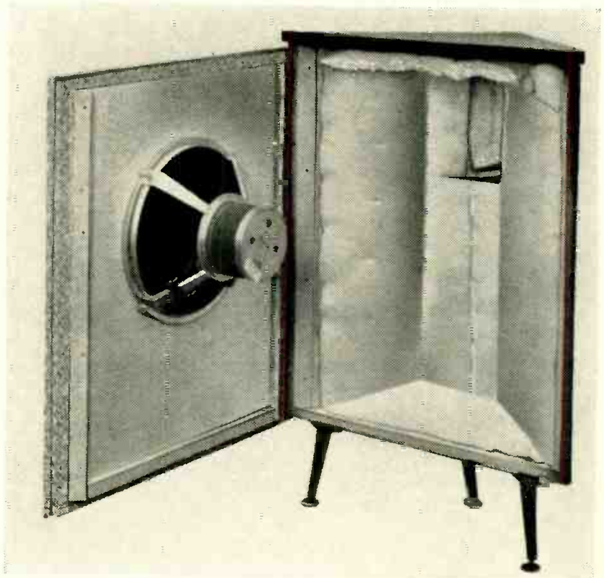
The material shown in the cabinet interior photo is bonded acetate fiber in sheet form. Other suitable absorbents are glass fiber and cotton wool. Completely filling the corner cabinet with absorbents improves the reproduction of speech but takes some of the warmth out of music.

As a rule, the amount of absorbent treatment can be reduced when smaller speakers are used, because less internal resonance is heard through the cone.

Speakers

This enclosure gives very good results with wide-range single speakers, 8, 10 or 12 inches, provided the open baffle resonance is not higher than specified with the test units. The long, ducted vent suits both the 10- and 12-inch types, but for 8-inch units the simple open vent is best.

Reasonable response down to 40 cycles is possible, but the larger units will obviously give bigger and better low-frequency output from cone and vent.



All that remains is to fasten the front panel in place. Note how padding covers all interior except back of panel. Though speaker is 12-inch model, duct is shown in this photo.

The tests of Fig. 2 indicate the performance at 40 and 50 cycles, using the Wharfedale speakers listed in the table. These are available in the USA. The oscillograms were taken with the microphone close to the cone and also close to vent opening. The input level was set as high as possible at 40 cycles without running into noticeable distortion. The power ratings are in rms watts. (The figures would be doubled for peak watts.)

Separate tests were made for vent output. As expected, there is less dis-

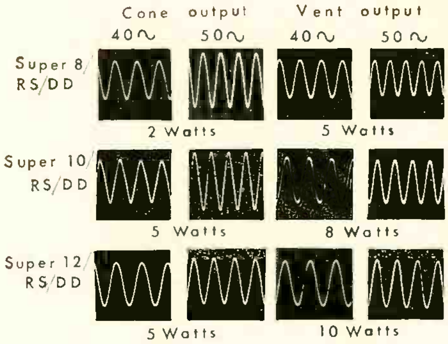


Fig. 2--Oscillograms of acoustic output with various speakers at different power levels and frequencies. No evidence of serious distortion.

tortion here as the power is increased than there is at the output direct from the cone. This is one of the benefits of reflex loading.

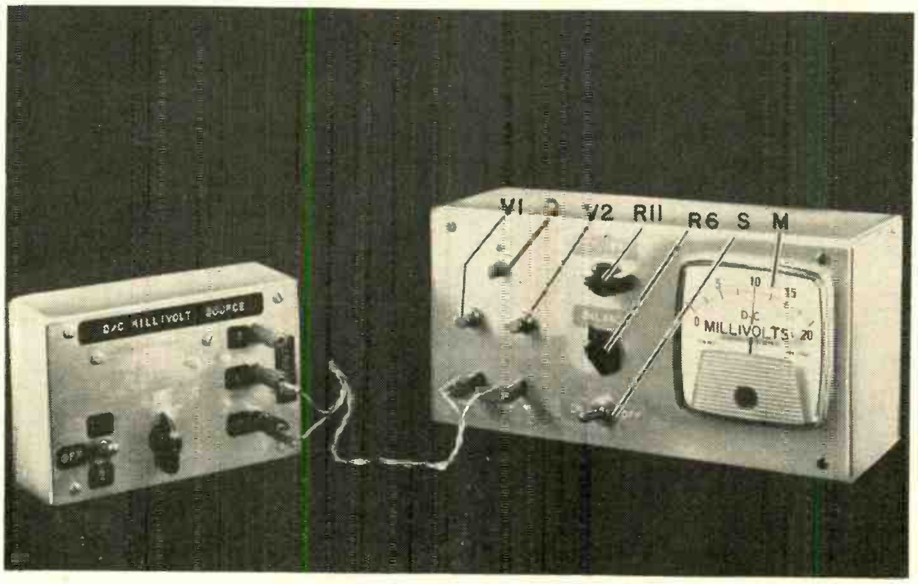
Finished appearance

We now come to that hi-fi department to which it is usually necessary to admit the ladies. If *I* take a speaker cabinet home and my wife says she does not like its appearance, I tell her to close her eyes and listen to it, but few men could get away with this sort of behavior in England (and possibly fewer in the US).

The two cabinets shown in the Ilkley photograph were fitted with a veneered plywood frame (5/16 inch thick) after the grille cloth had been fixed to the front panel, but this needs some skill to avoid the use of panel pins to hold the frame in position. We therefore tried a simpler method. The two side edges of the front panel were rounded off slightly with a plane to avoid sharp corners, and the grille cloth was taken round the edges and fixed at rear of panel with glue and staples.

Should any American readers try this design and assemble a cabinet, I hope the Mrs. American Readers will approve.

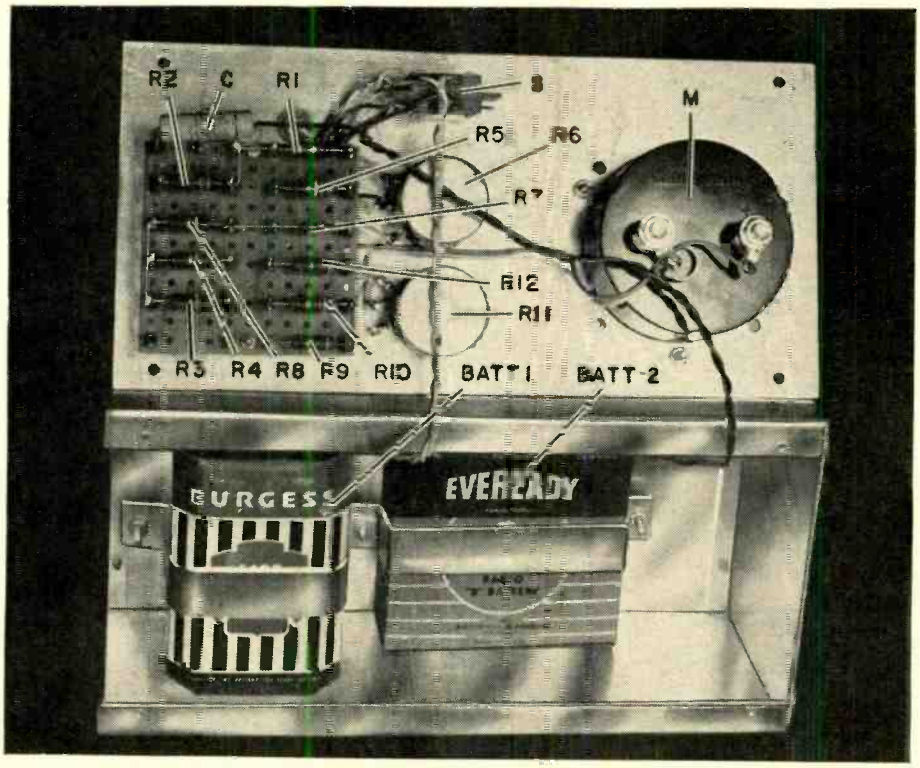
In conclusion, I should like to acknowledge the help I have had from our technical manager, Mr. K. F. Russell, A.M.I.E.E., and his assistant, Mr. W. Jamieson, who have done all the experimental work and testing involved in the production of this compact corner speaker system, well suited to the home constructor. END



The meter being calibrated from a dc millivolt source. If your vtvm or vom is accurate, rig up a 2-volt or 20-volt dc source with a 100:1 or 1,000:1 resistive divider to calibrate the millivoltmeter.

A HYBRID DC MILLIVOLTMETER

Nuvistor–transistor meter finds use in many labs. Reads 20 mv full scale **By BERT J. HILL***



Inside the millivoltmeter. Wiring and layout need not be critical. No ac for miles around!

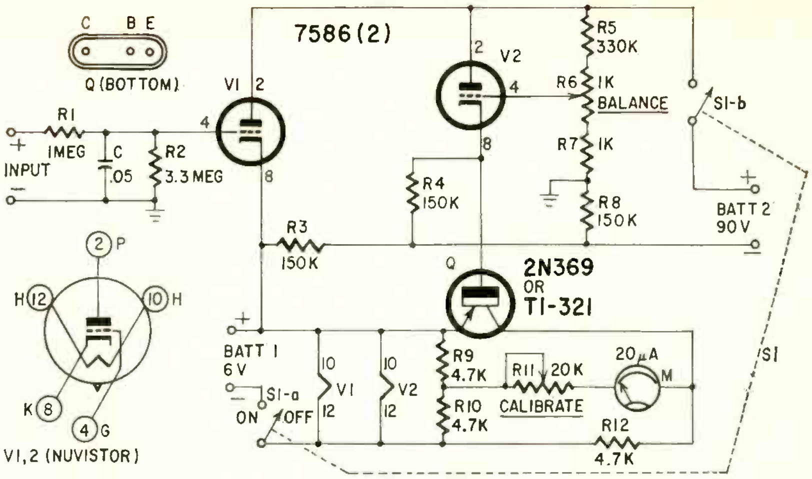
THIS INSTRUMENT CAN MEASURE A FRACtion of a millivolt dc with minimum loading of the circuit or device under test. It does not use mechanical or electrical choppers, complicated feedback or elaborate temperature compensation. Anyone interested in measuring small potentials, such as in biology, electrochemistry, geophysics or metallurgy, will find it very useful.

The instrument consists of two nuvistors in a balanced input circuit whose output feeds a single p-n-p transistor in a common emitter configuration. Self-contained batteries power the unit.

Nuvistors were chosen for their low drain, stability and low-voltage operation. The triodes tested were the 6CW4 and the industrial version, the 7586. The 7586 performed better.

The circuit is shown in the diagram. The input signal is fed to the grid of V1 which, in conjunction with V2, forms the usual balanced input stage. This circuit is often used to minimize the effects of voltage supply changes, temperature variations, etc. The 90-volt battery (BATT 2) supplies plate voltage for both nuvistors. The 1,000-ohm balance potentiometer (R6) is used to

*Research Department, Central Scientific Co.



The circuit of the millivoltmeter. Familiar dc vtvm bridge is augmented by high-gain transistor amplifier stage.

R1—1 megohm
R2—3.3 megohms
R3, R4, R8—150,000 ohms
R5—330,000 ohms
R6—Pot, 1,000 ohms, linear
R7—1,000 ohms
R9, R10, R12—4,700 ohms
R-11—Pot, 20,000 ohms, linear
All resistors ½ or 1 watt 5%
C—.05 μf, 200 v
M—0–20-μa dc meter (G-E, Weston 301, Triplett)
V1, V2—7586 nuvistor
Q—2N369 or Texas Instruments TI-321
S—dpst switch
Batt 1—4.5- or 6-volt A-battery. See text
Batt 2—90-volt B-battery
Chassis to suit
Sockets
Miscellaneous hardware

vary the bias on the grid of V2 and thus adjusts the voltage level between the cathodes. This voltage is fed to the base and emitter of transistor Q, controlling the current in the collector circuit. A balanced-bridge circuit is formed by R9, R10, R12 and the collector of Q. Thus, microammeter M can show the signal-caused current *change* rather than the total current.

After zeroing the instrument, calibrating rheostat R11 is used to adjust it to show full-scale deflection when a 20-mv dc signal is connected to the input terminals.

The 6-volt battery (BATT 1) powers the transistor stage as well as the nuvistor heaters. The unit functioned well with the 6-volt battery, but I got less drift and better stability after warmup with a 4.5-volt battery as BATT 1. In addition, the current drain decreased by about 40 ma, increasing battery life.

Linearity was excellent and there was no trouble in calibration. Drift is negligible for short-term measurements, but rezeroing is required for repeated longer-term measurements. This is no disadvantage as long as you make simple nonrecording voltage readings.

The input resistance is more than 4 megohms—practically no load to low-voltage dc sources such as thermocouples, electrodes used in pH measurements, or biological potential sources.

This instrument, while not designed to compare with expensive chopper-stabilized microvoltmeters, certainly gives us a simple unit for measuring dc millivolts effectively. It has proved its value in general laboratory work on more than one occasion. END

Couplers May Kill Color

In many cases the color set does not supersede the old black-and-white receiver, but makes the home into which it comes a two-set household. If the two sets are used with a TV coupler, it is necessary to be sure that the coupler is one that will pass color. If two black-and-white sets are already in use in the household, the color coupler may be an old type which may "suck out" the 3.58-mc frequency on which color depends.

In any case, where a coupler or dual outlet booster is used and there is trouble with color but not with black-and-white, try the color set on the antenna alone without a coupler before deciding that the trouble is somewhere inside the set or in the antenna.

By MIKE WAYNE

Peewee Attacks Radio

Can a 5-lug oscillator coil with an open winding be the trouble? Peewee thinks so

"WHAT ABOUT THIS RADIO?" I ASKED Peewee, my diminutive assistant. It was a five-tube ac–dc job that had been sitting on the bench with its innards exposed for 2 or 3 days.

"It's got a bad oscillator coil," he replied. "I've been meaning to tell you, so you could order a new one."

"We have a lot of universal oscillator coils. Why can't you use one of them?"

"Well, this one's sorta special. It has five terminals."

"Five terminals?" I questioned. "One of 'em must be a tie point."

"Nope," he declared, "I looked. There is a lead going into the coil from each terminal."

"Oh, I begin to understand. You cut your repair teeth on TV. I'd forgotten that you're not up on radio repair—it *is* a lot more complicated." Peewee must have noted the sarcasm in my voice. He asked, "Just what do you mean by that?"

"First, let *me* ask *you* a question. Just how did you come to the conclusion that the oscillator coil was defective?"

"Well," Pewee began, "I checked the radio and all I could hear was some noise. No stations. I remembered once you told me that when there is noise but no stations, it's likely that the oscillator stage isn't working."

"So?"

"So, I checked the 12BE6 oscillator–mixer and all the voltages. Then I decided to check the oscillator coil with the ohmmeter. That's when I found it."

"Found what?" I asked.

"The open winding. One of the windings wasn't connected to any other terminal on the coil."

"Did you say the voltages on the 12BE6 were OK?" I asked. "What about pin 1, the oscillator grid?"

"It was 6 or 8 volts negative, as I recall," said Peewee.

"Then it's obvious that the oscillator *was* working."

"Yeah, I thought so too, maybe, but with that winding open I figured it must be off frequency or something."

I looked at the coil connections before answering. "You know how this coil came out?"

"If you mean, can I hook it back up, the answer is yes. I made a drawing here on this scratch pad."

Hook it up again

"Well, then, get it hooked back up. I want to check this set myself. I'm tired of it cluttering up the bench."

"But . . .," he began.

"No buts," I interrupted. "Put it back!"

He did. In 15 minutes he was through. "Well, there it is," Peewee muttered unhappily.

"Fine. Turn the set on."

There appeared to be no stations but there was an unusual amount of noise, very similar to atmospheric static.

"Hand me the vtvm," I instructed. "I want to check the oscillator grid voltage on pin 1 of the 12BE6." I did. It was 7 volts negative. I touched my finger to pin 7, the signal grid, and turned the dial to our strongest local station. I could hear it faintly through the static-like noise. "Well, t'aint the oscillator stage," I concluded.

"How do you know?" Peewee asked.

"Well, that's pretty simple. Listen. Hear that station? Recognize the announcer?"

"Sure." He nodded. "That's Joe Slattery on KWTO."

"Look at the dial," I said.

"I'll be darned!" exclaimed Peewee. "Right on 560. Just where it should be."

"So?"

"So, like you say, t'aint the oscillator stage, I reckon."

"I reckon not," I gibed.

"Well, then, what *is* the trouble?" he wanted to know.

"I'm not certain," I said, "but I'll bet a milkshake that we have a bad i.f. transformer."

"How come you think so?"

"Mainly the staticlike noise. I've run into this trouble a jillion times before, and because it doesn't look like rain, I'll bet I win the milkshake."

"OK," Peewee said. "I'll go along. It'll be worth the milkshake to get you off my back. How do we tell for sure if it is an i.f.?"

(*Continued on page 68*)

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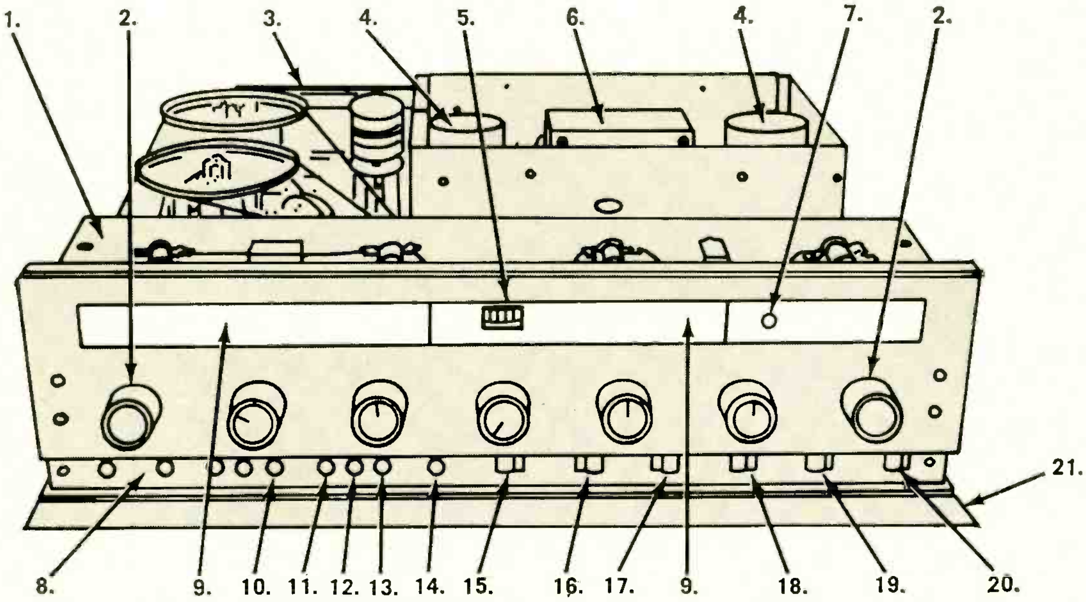

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SPECIFICATIONS—Amplifier: Power output per channel (Heath Rating): 20 watts/8 ohm load, 13.5 watts/16 ohm load, 9 watts/4 ohm load. (IHFM Music Power Output): 33 watts/8 ohm load, 18 watts/16 ohm load, 16 watts/4 ohm load @ 0.7% THD, 1 KC. **Power response:** ±1 db from 15 cps to 30 KC @ rated output; ±3 db from 10 cps to 60 KC @ rated output. **Harmonic distortion (at rated output):** Less than 1% @ 20 cps; less than 0.3% @ 1 KC; less than 1% @ 20 KC. **Intermodulation distortion (at rated output):** Less than 1%, 60 & 6,000 cps signal mixed 4:1. **Hum & noise:** Mag. phono, 50 db below rated output; Aux. inputs, 65 db below rated output. **Channel separation:** 40 db @ 20 KC, 60 db @ 1 KC, 40 db @ 20 cps. **Input sensitivity (for 20 watts output per channel, 8 ohm load):** Mag. phono, 6 MV; Aux. 1, .25 v; Aux. 2, .25 v. **Input Impedance:** Mag phono, 35 K ohm; Aux. 1, 100 K ohm; Aux. 2, 100 K ohm. **Outputs:** 4, 8, & 16 ohm and low impedance tape recorder outputs. **Controls:** 5-position Selector; 3-position Mode: Dual Tandem Volume; Bass & Treble Controls; Balance Control; Phase Switch; Input Level Controls (all inputs except Aux. 2); Push-Pull ON/OFF Switch. **FM: Tuning range:** 88 mc to 108 mc. **IF frequency:** 10.7 mc. **Antenna:** 300 ohm balanced (internal for local reception). **Quieting sensitivity:** 2½ uv for 20 db of quieting, 3½ uv for 30 db of quieting. **Bandwidth:** 250 KC @ 6 db down (full quieting). **Image rejection:** 30 db. **IF rejection:** 70 db. **AM suppression:** 33 db. **Harmonic distortion:** Less than 1%. **Multiplex: bandpass:** ±¼ db, 50 to 53,000 cps. **Channel separation:** 30 db, 50 to 2,000 cps; 25 db @ 10 KC. **19 KC suppression:** 50 db down, from output @ 1 KC. **38 KC suppression:** 45 db down, from output @ 1 KC. **SCA rejection:** 30 db. **AM: tuning range:** 535 to 1620 KC. **IF frequency:** 455 kc. **Sensitivity:** 1400 KC, 3.5 uv; 1000 KC, 5 uv; 500 KC, 10 uv—standard IRE dummy antenna. **Bandwidth:** 8 KC @ 6 db down. **Image rejection:** 30 db @ 600 KC. **IF rejection:** 45 db @ 600 KC. **Harmonic distortion:** Less than 1%. **Overall dimensions:** 17" L x 5⅜" H x 14¾" D.

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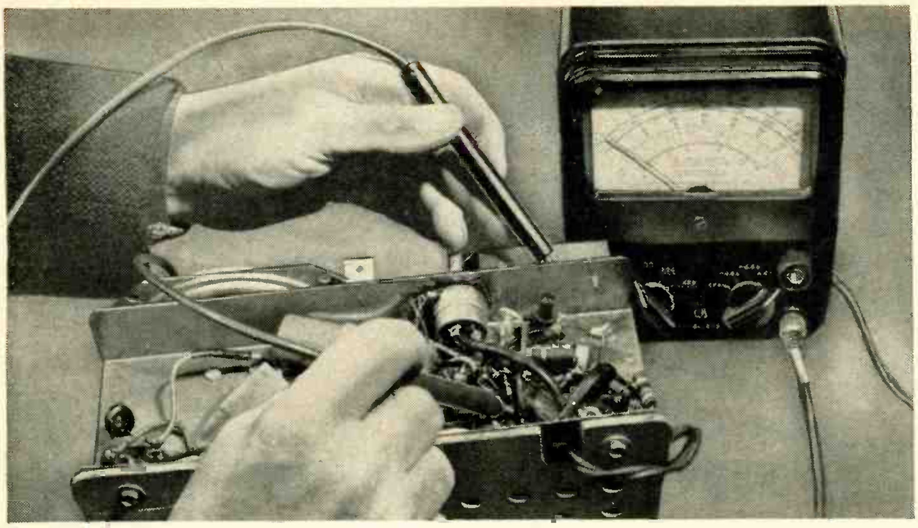

". . . One of the windings wasn't connected to any other terminal on the coil."

(*Continued from page 65*)

"First," I pointed out, "we'll localize the trouble. It could be either i.f. transformer."

"OK, so localize," he said. "How do we do that?"

"First, we pull out the 12BE6. See—we still have the noise; that just about proves that the noise is in the oscillator stage or before it."

"But this is a series-heater set. Doesn't pulling out one of the tubes keep the rest of the tubes from working?"

"It just removes the heater voltage, but the cathodes stay hot long enough to operate satisfactorily for 30 to 40 seconds. Plenty of time for us to make our tests."

"OK, just checking."

"Let's proceed then," I went on. "If we still have the noise when we pull out the 12BE6, our next step is obvious. We know our trouble follows this stage."

"So we can pull out the 12BA6 i.f. amplifier and check again," reasoned Peewee.

"Right," I said. "If the noise disappears, we'll know that the first i.f. is probably defective. If we still have the noise, then it's likely the second i.f. —or the third i.f. transformer, if this set happened to have two i.f. stages, which it doesn't. Point is, we can knock off possibilities one by one just by pulling tubes in succession like this."

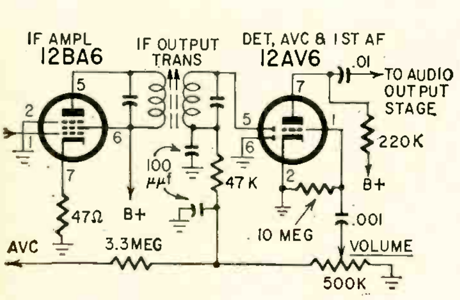

Fig. 1—Leakage between the i.f. windings caused positive voltage on the detector plate, pin 5 of the 12AV6.

And the audio stages?

"Couldn't it be further on—in the audio stages?" asked Peewee.

"Well, yes it could be," I agreed. "I'm glad you're thinking, for a change. But we can eliminate that possibility. See—when I turn the volume down, the noise is gone. The trouble has to be located before the first audio tube. Right?'

"Seems that way," he agreed.

We pulled the 12BA6 i.f. amplifier. The static noise continued.

"Now," I said, "for the final check. Lemme have the vtvm again."

"What range?" Peewee asked, with his hand on the function switch.

"Any low range. Just so it's dc and positive," I answered. "Now take the probe and touch it to the diode plate terminal of the 12AV6 socket. The one connected to the second i.f."

He did. "It's about 0.5 volt positive."

"Now watch the meter while I pull the 12AV6 detector and first audio tube out," I instructed.

"Wow!" he yelled. "The meter went off scale."

"Then I guess we trapped our culprit —the second i.f. transformer."

"What's it doing?" he asked. "Leaking between windings?"

"Well, that's about it," I agreed. "Actually, this type of small i.f. usually breaks down between the fixed capacitors that are connected across the windings. The capacitors are molded in plastic at the bottom of the i.f. The connecting lugs are extensions of the capacitor plates. Anyway, the leakage is from the primary to the secondary."

"Do the capacitors short, or what?" he asked.

"Very seldom," I replied. "The leakage is usually in the megohms. Most likely caused by moisture or dirt collections."

And the voltage?

"How come the voltage went so high when you pulled the 12AV6?"

"Well, take a look at the schematic (Fig. 1), the secondary of the i.f. is tied to the detector diode plate in the 12AV6. And when you tie a positive voltage to a diode plate—what happens?"

"It'll conduct."

"Right. And a conducting diode has very little resistance. So most of the positive voltage is shunted to ground—especially since the leakage in the transformer is a high resistance. When we pulled the tube, the shunt was removed, and the voltage rose tremendously."

"But what if it had been the first i.f. transformer?"

"Same thing holds true," I said. "The grid of the 12BA6 would act as a diode and shunt the positive voltage to ground."

"Isn't the voltage always negative at these points?"

"Right," I agreed.

"Then if there was any positive voltage at all on the 12BA6 grid or the detector diode plate—we could be pretty sure that the i.f. is bad?"

"Well, at least we would know we had trouble and just about where it is—so it wouldn't be too hard to find. The sure-fire way to find a leaky i.f. is to disconnect all wires from the secondary winding and check for any positive voltage on the secondary with a vtvm. With practice, though, simply pulling the tube and measuring the voltage is sufficient. Partially open windings can be spotted with a quick resistance check."

"Does a defective i.f. always make this noise?"

"Certainly not. Although I'd say about 50% to 60% do. But the set invariably has low sensitivity."

"I'm ready to buy the milkshake if you'll explain the oscillator coil," he said. "How come it's working with an open winding?"

"Elementary, my dear Peewee," I said condescendingly. "That's how it's made."

"You mean they make it with an open winding?"

"Yep. If you ever bothered to glance at the schematic (Fig. 2), you'd see."

He looked and it was there. A winding with an open end tied to the oscillator grid.

"It's a *gimmick*," I said. "That capacitance couples the feedback voltage to the oscillator grid. It's cheaper for the manufacturer than the separate capacitor it replaces."

Peewee was appalled. "You're dern right it's a gimmick," he said. I could see he was serious. END

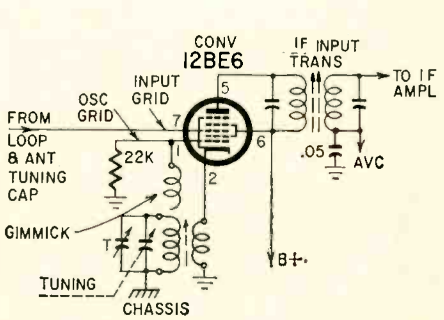

Fig. 2—The converter circuit with 5-lug oscillator coil that threw Peewee for a loss.

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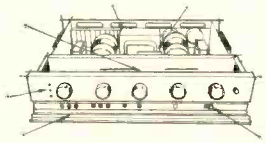

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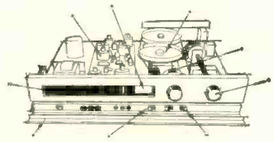

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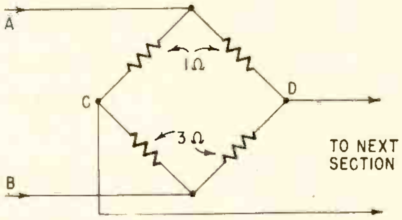
What's Your Eq?

These are the answers.
Puzzles on page 49.

What's the impedance?

Actually, a lattice section is just a fancy way of drawing a common bridge circuit. If the first lattice section is redrawn as a bridge, it is seen that since



the bridge of the first section is balanced, all subsequent sections have no effect. So the total impedance is 2 ohms.

Complex Black Box

Since the current through the 100-ohm resistor is 1 ampere, that must also be the current through the black box. Therefore, the black-box impedance is 100 ohms. The impedance of the circuit, containing both the resistor and the black box, is 150 ohms. Since the first guess is that the object in the black box is a complex impedance, an inductance or capacitance (probably the former), we can say:

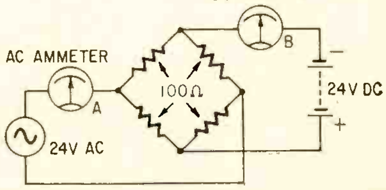
$$100 = \sqrt{R^2 + X^2} \text{ (for black box alone)}$$

$$150 = \sqrt{(R + 100)^2 + X^2} \text{ (for whole circuit)}$$

With these two simultaneous equations, we find that $R = 12.5$ ohms and $X = 99.2$ ohms. The impedance could be an inductor or capacitor, but from the ratio of resistance to reactance, it would seem reasonable that we have a coil with a reactance of 100 ohms and a resistance of 5.5 ohms. The supply voltage is, of course, sine-wave ac.

Mixed-up Currents?

The 100-ohm resistors make up a perfectly balanced bridge circuit. As a result, the resistors provide a load for the ac generator and the battery, while



simultaneously preventing the flow of current between the two sources. No dc flows through the ac ammeter, and no ac through the dc ammeter.

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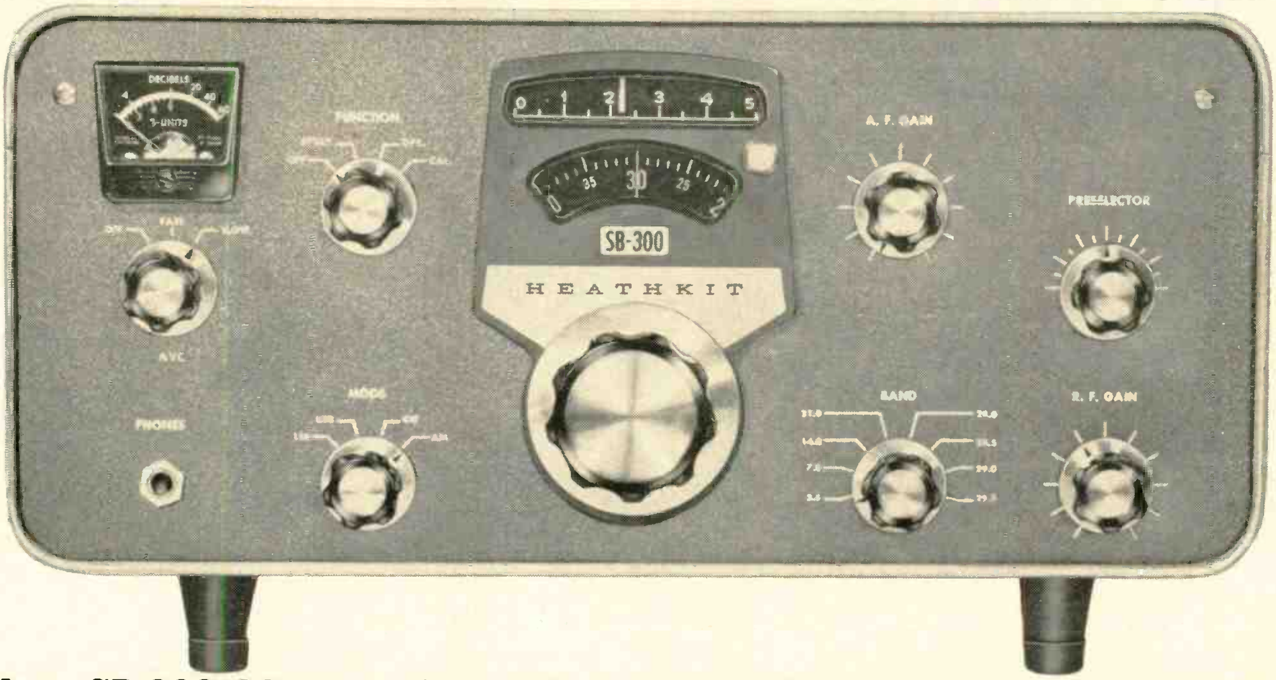

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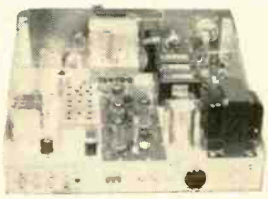

SPECIFICATIONS—Frequency range (megacycles): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megacycles. **Frequency stability:** 100 cps after warmup. **Visual dial accuracy:** Within 200 cps on all bands. **Electrical dial accuracy:** Within 400 cps on all bands. **Backlash:** No more than 50 cps. **Sensitivity:** Less than 1 microvolt for 15 db signal plus noise-to-noise ratio for SSB operation. **Modes of operation:** Switch selected: LSB, USB, CW, AM. **Selectivity: SSB:** 2.1 kc at 6 db down, 5.0 kc at 60 db down (crystal filter supplied). **AM:** 3.75 kc at 6 db down, 10 kc at 60 db down (crystal filter available as accessory). **CW:** 400 cps at 6 db down, 2.5 kc at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response: SSB:** 350 to 2450 cps nominal at 6 db. **AM:** 200 to 3500 cps nominal at 6 db. **CW:** 800 to 1200 cps nominal at 6 db. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socket. **Crystal calibrator:** 100 kc crystal. **Front panel controls:** Main tuning dial; function switch; mode switch; AGC switch; band switch; AF gain control; RF gain control; preselector; phone jack. **Rear apron connections:** Accessory power plug; HF antenna; VHF #1 antenna; VHF #2 antenna; mute; spare; anti-trip; 500 ohm; 8 ohm speaker; line cord socket; heterodyne oscillator output; LMO output; BFO output; VHF converter switch. **Tube complement:** (1) 6BZ6 RF amplifier; (1) 6AU6 Heterodyne mixer; (1) 6AB4 Heterodyne oscillator; (1) 6AU6 LM osc.; (1) 6AU6 LMO mixer; (2) 6BA6 IF amplifier; (1) 6AU6 Crystal calibrator; (1) 6HF8 1st audio, audio output; (1) 6AS11 Product detector, BFO, amplifier. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120 volts AC, 50/60 cps. 50 watts. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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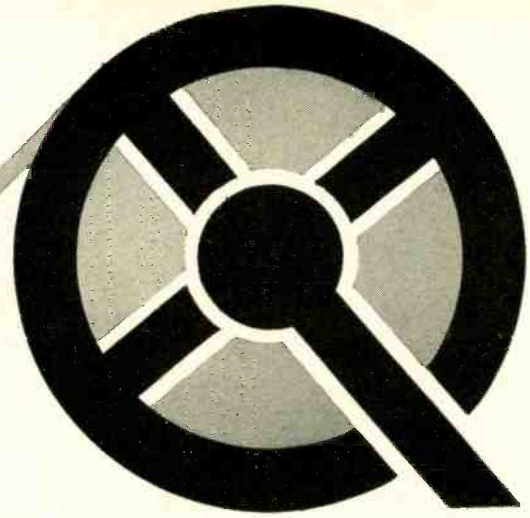


SERVICING SOUND MOVIE PROJECTORS

Part 3 / sound and lamp troubles

By JACK DARR
SERVICE EDITOR

LAST MONTH WE LEARNED A BIT ABOUT how projectors work, how to thread and run them, and how to make some adjustments. This time, we'll examine the electronics peculiar to movie projectors and talk about some of the more common electrical and mechanical troubles.

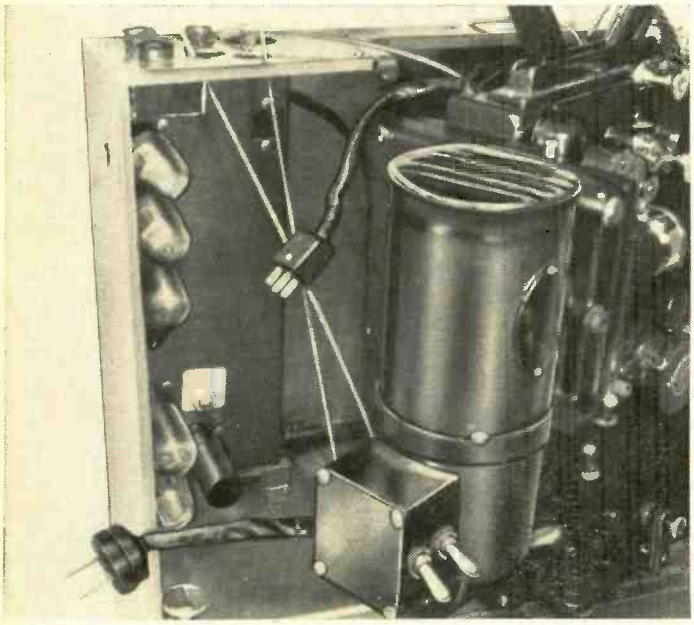


Fig. 1—Projector partly disassembled for service. Amplifier tubes are in vertical row at left.

Disassembly for servicing

Fig. 1 shows a projector partly disassembled to allow the amplifier to be removed. Here, the amplifier chassis is vertical, with bolts holding the top, while the bottom end of the chassis sits on a spring-loaded metal plate, to provide a little shock mounting. Screws through the bottom of the case hold the projector unit. The plugs connecting the exciter lamp and input power can be seen. At the right bottom side of the amplifier are the coaxial cable and Amphenol plug used to connect the phototube, which is on the projector chassis in this machine.

Fig. 2 shows the bottom of a different projector. The four outside screws are removed to let the amplifier chassis slip down and out. In this model, the entire amplifier chassis is inside the projector housing. The inner screws allow the bottom shield to be removed (Fig. 3). Fig. 4 is a top view of the amplifier. Notice the large phototube mounted on the right end of the amplifier chassis. The beam of light from the exciter lamp is reflected onto the tube by a mirror inside the sound-head drum.

Amplifier servicing

The amplifiers used in these projectors are "conventional" (much as I dislike that word) after you get past the phototube input. Power output runs 7–10 watts for the ac-powered amplifier of Fig. 4, and 3–5 watts for the ac/dc amplifier of Fig. 1. There is one other novel feature, the method of lighting the exciter lamp, which we'll get to in a minute.

Phototubes used in the older models are mostly 923's, a four-pin type, seen in Fig. 4. This has been replaced in many circuits by the newer 930. Some machines use the smaller three-pin 927.

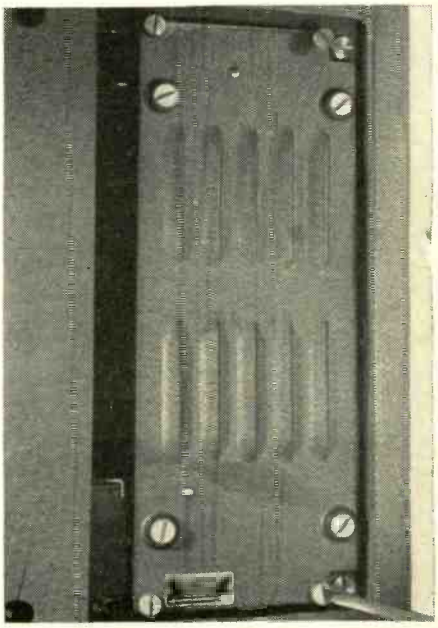


Fig. 2—Bottom of another machine. Four captive screws (screwdriver, lower left) hold amplifier in case.

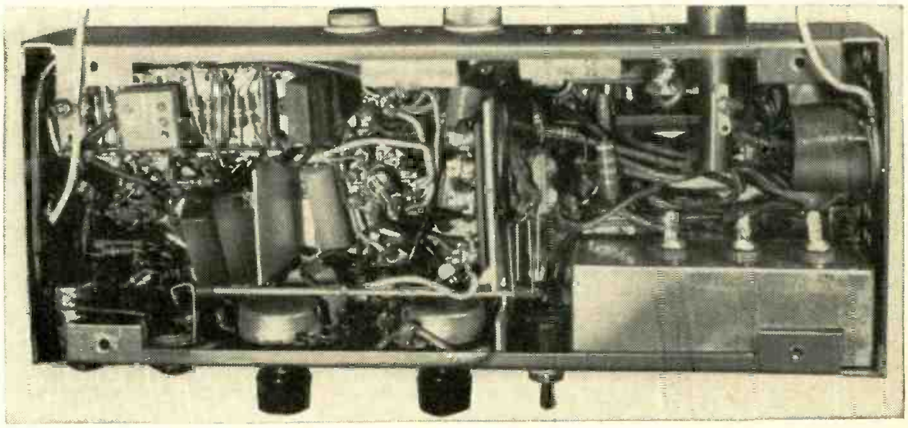
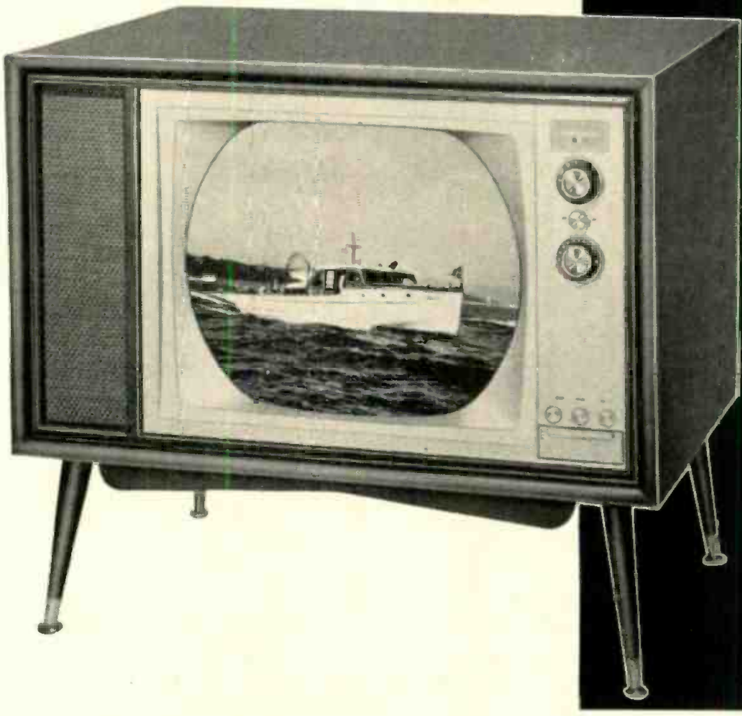


Fig. 3—Amplifier of Fig. 2, with bottom cover removed.



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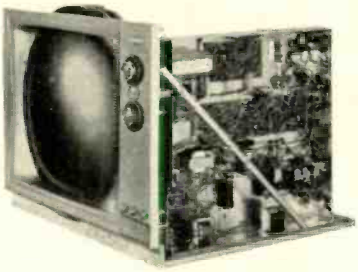

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Fig. 4—Fig. 2 amplifier again. Note photocell at right front corner.

Characteristics of all are about the same. A typical circuit appears in Fig. 5.

Checking photocell inputs

There is a good "quick-check" for sound troubles: simply turn the amplifier on and shine the beam of a penlight on the sound head, so that some of the light can get through the slot to the phototube. (No film in the sound head, of course.) If you can hear a "thump" every time the light strikes the cell, the amplifier is OK. This depends on the volume of the thump, of course. A little practice will soon tell you how loud it should be.

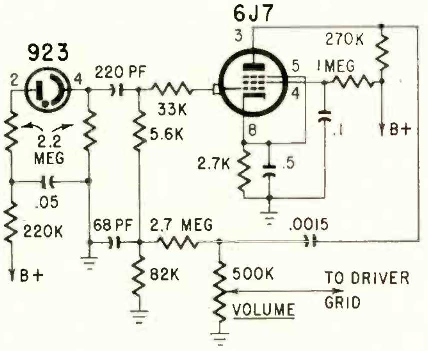


Fig. 5—Typical film-sound input circuit.

Another interesting test is shining the flashlight on the cell and tapping the case of the flash with your fingernail. This will give you a loud "bong!" Apparently this comes from the movement of the lamp filament in the flashlight. About the simplest test is to slip the shielding cover off the phototube, near the bench lights. If you hear a loud 60-cycle hum, the cell is OK.

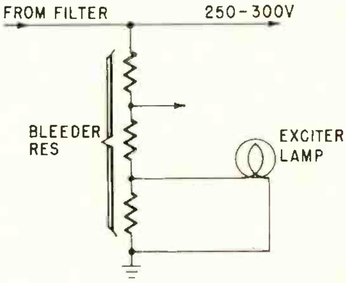


Fig. 6—One way of lighting exciter lamp humlessly—tap off a little B-plus.

Checking for weak sound

The first thing that must be checked on a complaint of weak sound is the alignment of the various parts of the sound head. Exciter lamps often have shields with holes in them. If the hole is turned so that its edge is partially blocking the light, the volume will be reduced. If the tiny slot in the sound head is full

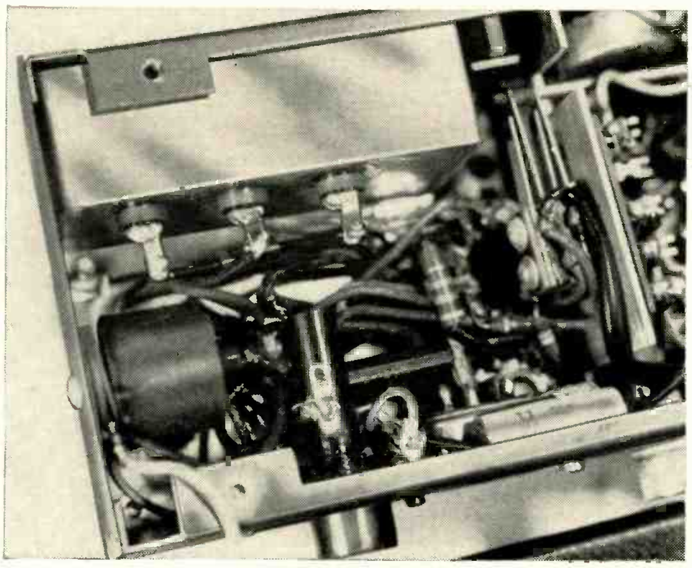
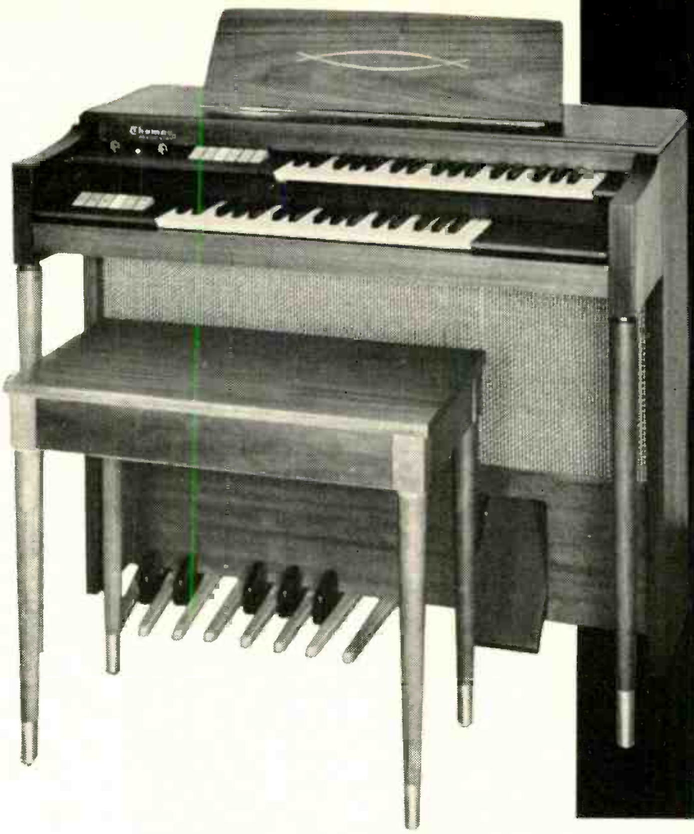


Fig. 7—Another way is to use an ultrasonic oscillator. Oscillator transformer is in lower left corner of photo, next to fuse holder.



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City ______________ Zone ______ State ______ of lint, the same thing happens. Phototubes, too, are sometimes shielded by a round metal cover, with one small hole for the light. If this has been removed and replaced improperly, the light may be partially blocked. Always check all of these things before tearing into the amplifier!

Also, most projectors have a microphone input jack. (One can be seen on the control panel in Fig. 4.) Plug a mike in and check for volume. While it seldom happens, phototubes can weaken. So if the mike input shows ample volume, but film sound is weak, try a new phototube.

Some projectors use the brilliance of the exciter lamp as a volume control. The more light, the higher the volume. With this "volume control" turned all the way down, the exciter lamp is out. This has caused the replacement of quite a few perfectly good exciter lamps!

By threading the light-colored semi-opaque "leader" of a film into the machine, you can get a good check of the focus and position of the spot of light on the film. The lens and slot should always make a clean, sharply defined bar of light on the film, not just a blur. The slot can be cleaned with an old toothbrush.

Exciter lamp and power supply

The exciter lamps used in these machines resemble automotive types, but have a longer bulb. Filament voltages between 4 and 6 are common, at fairly low direct currents (ac would cause hum).

In one circuit, the exciter lamp is simply tapped across the last few volts in the B-plus (Fig. 6).

Another circuit, used in a very popular make of projector for many years now, uses an ultrasonic oscillator for lighting the exciter lamp. This circuit uses the same type tube as those in the power output stage. Notice the three 6V6's on the amplifier in Fig. 4? One of these is the oscillator. Fig 7 shows the oscillator transformer. The circuit of

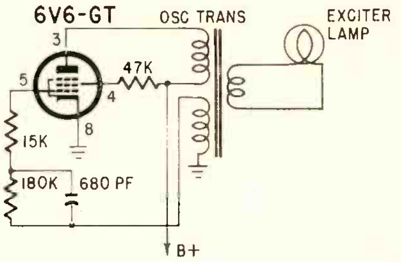

Fig. 8—Exciter lamp oscillator.

this is shown in Fig. 8. The frequency is around 20–30 kc, but isn't too important as long as it is above audibility.

Incidentally, if the exciter lamp refuses to light, and all the tubes check good, try swapping the 6V6's around! We've found a few that didn't want to oscillate, but worked perfectly in the amplifier stages. TO BE CONTINUED

Answers to the "Units" Quiz

(See questions, page 43)

If you get more than 12 right, you should be a professor of electrical engineering. Most engineers know at least 8 of these. As for me, well, I looked them up to make sure you were getting the straight dope!

1. A *volt* is the difference in potential between two points of a conductor carrying a constant current of 1 ampere when the power dissipated between the points is 1 watt. But you can call it right if you said that it is the potential required to give 1 ampere current in a resistance of 1 ohm.

2. An *ampere* is defined as that current which, if maintained through two parallel wires of infinite length 1 meter apart in a vacuum, causes a force between the wires of 2×10^{-7} newton per meter of length. A more practical definition says the ampere is the current which, from a carefully specified solution of silver nitrate, deposits .001118 gram of silver per second.

3. We can now say that an *ohm* is defined by the current from a 1-volt source, but such a definition would be circular, because of our "volt" definition above. An ohm is the resistance of a column of mercury at 0°C, 14.4521 grams in mass, of a constant cross-section and 106.300 cm long.

4. A *maxwell* is a measure of magnetic flux, and defined by the answer to No. 8, or you can say it is the magnetic flux giving a density of one line of force per unit area (cm^2).

5. A *gilbert* is a measure of magnetomotive force equal to the magnetomotive force produced by 0.7958 ampere-turn (ampere in one turn).

6. A *joule* is a unit of work or energy equal to 0.2389 gramcalorie, or the heat required to raise 0.2389 gram of water at 4°C 1°C in temperature.

7. A *myriawatt* is simply 10,000 watts or 10 kw.

8. A *weber*, as you may have guessed by now, is also a unit of magnetic flux. It is a very large unit, 10^8 maxwells (or lines), and a more practical measure to use in calculations.

9. The *dyne* is the centimeter-gram-second unit of force. It is the force that will accelerate a 1-gram mass 1 centimeter per second. An *erg* is the work done by a force of 1 dyne acting through a distance of 1 cm. An erg is also equal to 10^{-7} Joule or to 0.7376×10^{-7} foot-pounds.

10. Back to the magnetic field to find that an *oersted* is the same as a gilbert per centimeter, a measure of magnetizing force, equal to .0795 ampere turn per cm.

11. This could be tricky. A *gauss* is a unit of magnetic induction—1 *maxwell* per square centimeter. Before 1932, it was used as a unit of magnetic field intensity, a meaning now obsolete. The *oersted* is now used instead (see question 10).

12. A *baud* is a unit of signaling speed used by telegraph engineers. It represents the number of code elements transmitted per second.

13. A *sabin* is something for hi-fi fans. It is a measure of sound absorption, the absorption of 1 square foot of perfectly absorptive surface.

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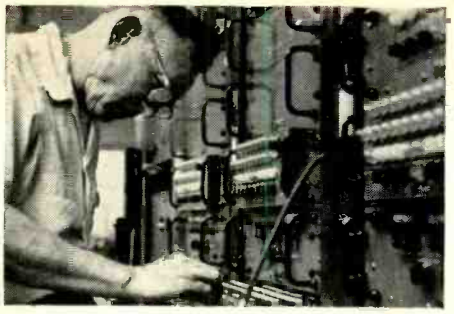

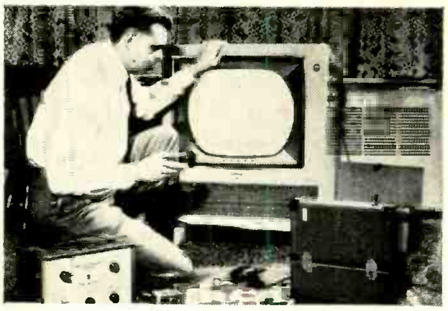

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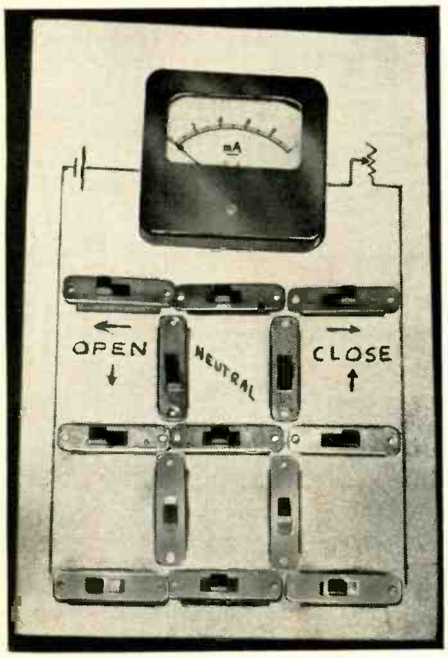
By JACK ALLISON



Schematic symbols on panel help keep grid configuration in mind.

HERE'S A GAME THAT HAS A VERY FANCY background! It's based on a game devised by Claude Shannon of Bell Labs and often played between a researcher and an electronic brain. You don't have to be an electronic brain to win at it but, as you read on, you'll see it takes a little more head-scratching than its ancestor, Tic-Tac-Toe.

Fig. 1 shows a switched grid of resistors with a meter and battery in series with them. The idea is to have one player attempt to get a direct connection through the grid while his opponent tries to open the grid and have no "juice" through the circuit. In technical language, from a neutral position, one man is going for the maximum current; the other man, the minimum.

Since each resistor is 1,500 ohms, the total resistance of the grid is still 1,500 ohms. The 2,000-ohm rheostat is set for approximately 1,500 ohms. This makes the total resistance 3,000 ohms. We are using 1.5 volts, so by Ohm's law we get a reading on the meter of 0.5 ma, or the neutral spot on the dial for the beginning of the game. As each player makes his move, the needle will swing toward 1 or 0, depending on the "slickness" of the move. The first one to reach his intended 1 or 0 is the winner!

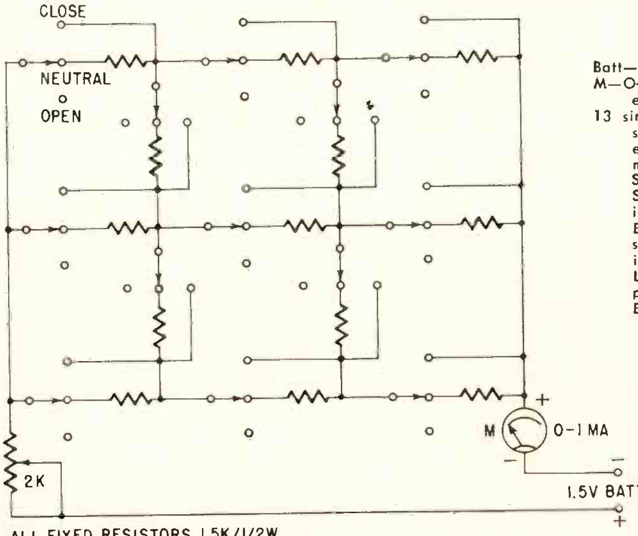
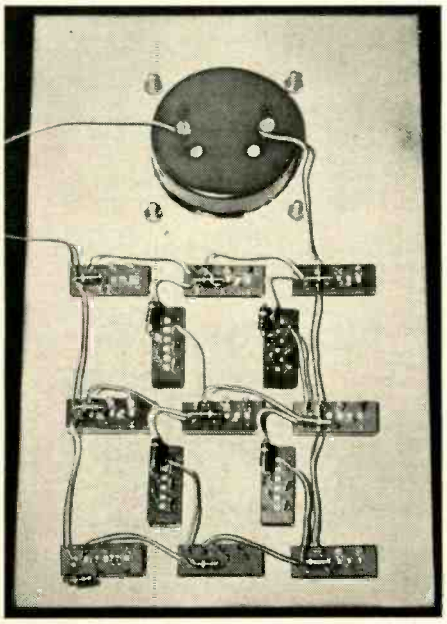


Fig. 1—Grid of resistors makes up active part of circuit. Resistors are either in, out or shorted, depending on switch position.

Batt—1.5-volt D-cell
M—O-ma dc meter (Lafayette TM-60 or equivalent)
13 single-pole (or double-pole), 3-position switches (slide type cheapest, but rotary, toggle or homemade will work as well). Try Stackpole SS-16, Continental-Wirt SW729, G-328, etc. C-W G-328 is dp3t, available from Newark Electronics Corp., 223 W. Madison, Chicago 6, Ill., for 25¢ apiece in lots of 10 to 99 (plus shipping). Lafayette SW-82 is similar, same price; order from Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, L.I., N.Y.
13 resistors, 1,500 ohms, ½ watt, 10%
Pot, 2,000 ohms, (Mallory U-6 or equivalent)
Chassis (optional) 7 x 11 x 2 inches (Premier CH-405 or equivalent)

The unit is really a number of small switch-resistor combinations made up as shown in the bottom-view photo and Fig. 2. The switch-resistor units are mounted on a 7 x 11-inch sheet of cardboard or Masonite. In the author's breadboard hookup, the potentiometer was connected in the battery lead and was hand-held. A neat job would include fastening the sheet to a wood chassis or base (or over the open top of a shallow box) mounting the pot on the base and the battery inside.

If you are willing to sacrifice the logically preferable 1,500-ohm center position, you can use dpdt center-off slide or toggle switches. (See Fig. 3 for wiring details in that case, and note that the *center* position is the *open* one.) Otherwise use one of the switches given in the parts list. The Stackpole is the "official" switch, but the others all achieve the same result by different means. The perspective drawing (Fig. 2) is good for the Stackpole switch. END



Check terminals and positions of switches you use before wiring.

Rules of the game

1. Close the switches to get a 1 reading and, using the pot, set the needle at 1 on the nose.

2. Set all switches to the middle position and you are ready to play.

3. As each game is played, each player must alternately choose to take either the "close" or "open" strategy. Players take turns on who goes first.

4. The first player throws a switch, depending on whether he is "opening" or "closing." The other player then moves a switch in *his* direction.

5. Once a switch has been opened or closed, it cannot be touched again.

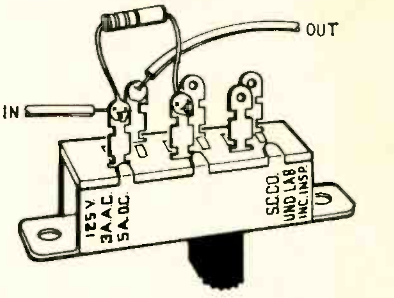


Fig. 2—This is how author wired switches he used. If you use different kind, find out which terminals are jumped to which in various positions.

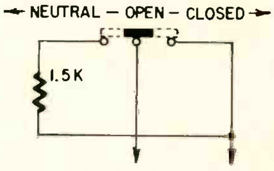


Fig. 3—If you can't find 3-position slide switches, try spdt or dpdt center-off's. Wire as here. "Neutral" (resistor in) will not be in center, however.

By FRANK G. STIVER

fuses— are they RESISTORS?

Their resistance has to be considered in low-voltage circuits

THE STUDY OF TRANSISTORS IS STILL constantly filled with comparisons and contrasts with vacuum tubes. One of the important differences between the two is that transistors are basically low-voltage, high-current devices while tubes work with low currents and high voltages. This basic difference has made it necessary for us to change some of our preconceived vacuum-tube ideas.

Recently I ran into two separate but identical situations that emphasized this basic difference. The problem in both was a transistorized regulated power supply that had poor regulation. One was designed for use in a laboratory, with several distribution points. When constructed and tested it provided over 4 amperes at 12 volts with better than 1% regulation. The other was rated at 6 volts, ½ ampere, with better than 1% regulation.

In both cases the cause of the voltage variation was not in the regulator. The poor regulation was due to a large (for transistors) voltage drop across a ½-amp fuse in the distribution line. At first when I measured a drop of over ½ volt across the ½-amp fuse, I thought there must be a bad solder joint at the holder. A measurement directly across the fuse quickly eliminated that possibility. My next thought was a bad internal connection in the fuse, but replacing the fuse resulted in an even larger voltage drop.

I finally got around to applying Ohm's law and found that ½ volt at the 400-ma test current I was using made the fuse resistance around 1.2 ohms. (After all, a fuse *is* a heat-operated device and must generate enough I^2R to activate it.)

I decided to investigate the resistance of fuses with other current ratings. Written material on the subject was very scarce; the best way of finding what I wanted to know was actually to measure the resistance of various fuses.

TABLE I—Measured resistance of medium-lag fuses.

Amp Rating	Measured Resistance (ohms)				
1/16	8.5	36.0	7.3	7.1	6.7
1/8	6.0	4.8	6.0	4.6	5.4
1/4	3.0	3.5	3.3	3.1	3.0
1/2	1.4	1.3	1.1	1.2	1.2
3/4	0.6	0.8	0.8	0.8	0.7
1	0.4	0.4	1.6	0.6	0.5
2	0.2	0.2	0.2	0.2	0.2
1/2 S-B	1.9	1.8	2.0	1.7	2.0

TABLE II—Manufacturers' resistance ratings of high-speed fuses.

Amp Rating	Resistance (ohms)	Amp Rating	Resistance (ohms)
1/100	263.4	1/2	2.7
1/32	40.0	3/4	2.0
1/16	6.9	1	0.24
1/8	6.0	1½	0.13
1/4	4.7	2	0.10
3/8	3.0	3	0.060

The results of my measurements on five fuses of each current rating are recorded in Table I. All fuses except the one ½-amp Slo-Blo group were the medium-lag type most commonly used in electronic equipment. Notice that resistance varies among fuses with the same current rating. I made no measurements on the high-speed fuses used in delicate test equipment. However, Table II lists the resistances quoted in the catalog of one of the leading fuse manufacturers.

It is interesting to note from Table I that the product of fuse resistance times rated current will give a drop centering around ½ volt across all fuses. It is also evident that, for any given current, a fuse with higher current rating will cause a smaller voltage drop.

Perhaps the easiest solution to the fuse resistance problem is to keep fuses out of low-voltage circuits where good regulation is important. Instead, whereever possible, such as in power supply circuits, let's put the fusing in the primary. If we *must* put fuses in the low-voltage circuits, let's be sure to use fuses with the largest fuse rating consistent with adequate protection, and remember that each fuse is a small resistor.

In conclusion: Low-voltage, high-current circuits, so common with transistors, force us to think of sources of resistance that can often be ignored in vacuum-tube circuits. Vacuum tubes operate at such high voltages and relatively small currents that the small voltage drop across fuses and meters can normally be ignored. In low-voltage, relatively high-current transistor circuits we must be very watchful of these small resistances. Otherwise even our good friend the fuse may become one of our problems. END

NEW IDEA

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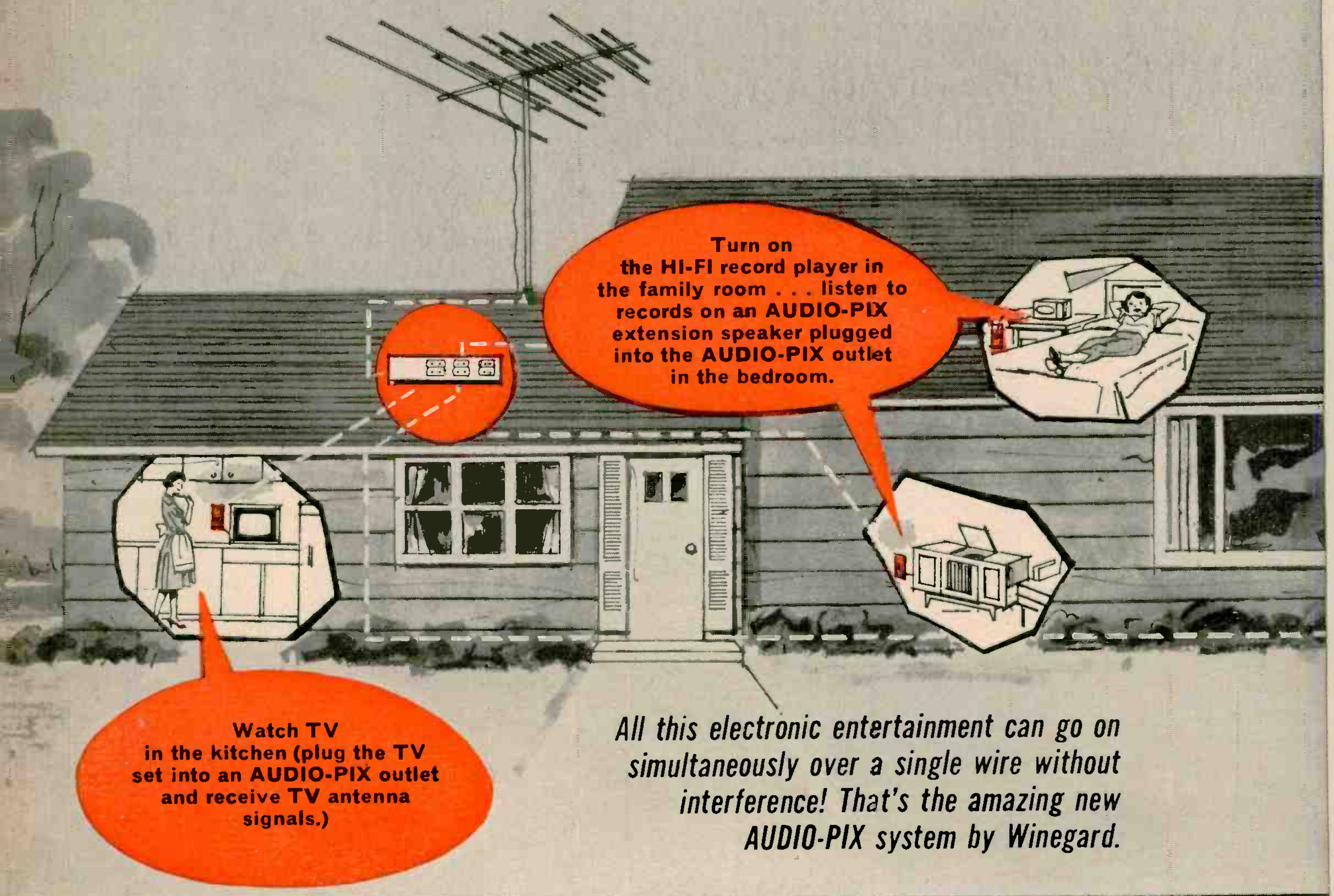
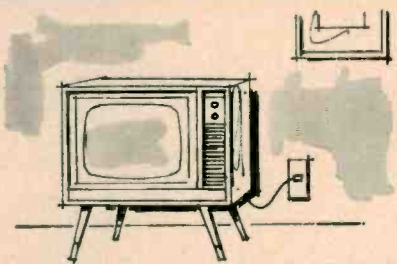
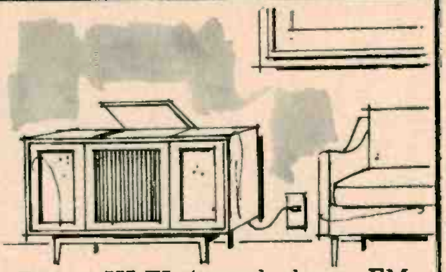
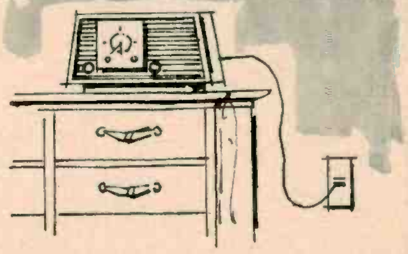




Plug TV set into any AUDIO-PIX outlet. Run one or more sets simultaneously from a single antenna.



Run a HI-FI (record player, FM or AM, or tape recorder) and feed the sound into the system to be picked up at any AUDIO-PIX outlet.)



Plug an FM receiver into the AUDIO-PIX. The AUDIO-PIX serves as an FM antenna signal source, and at the same time automatically feeds the FM sound back into the system to the extension speakers.

AUDIO-PIX is two systems wrapped into one simple, inexpensive installation. It is both a TV-FM system (distributes TV/FM antenna signals) and a HI-FI music system at a price any home owner can afford. No new home is truly modern without AUDIO-PIX.

The AUDIO-PIX is a revolutionary new electronic entertainment convenience for the home which—

(1) . . . feeds TV (Ch. 2-83) and FM antenna signals to each AUDIO-PIX outlet.

(2) . . . feeds sound from a HI-FI (record player, FM and tape recorder) to the same AUDIO-PIX outlets.

The complete Winegard AUDIO-PIX system comes in a kit which contains a special AUDIO-PIX 6-outlet coupler*, 4 AUDIO-PIX outlets and plugs (any number of additional outlets may be added if desired), special AUDIO-PIX HI-FI extension speaker, a special AUDIO-PIX attachment for FM or HI-FI system, and 100 ft. of lead-in wire. Model APK-360, list price $49.95.

Start selling AUDIO-PIX to your customers now. Write for spec sheets or ask your distributor.

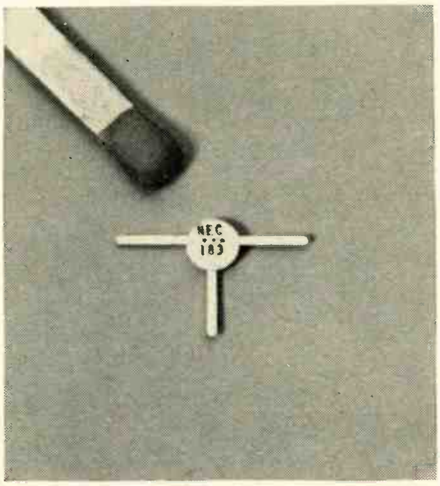
Winegard
ANTENNA SYSTEMS
3013-12 Kirkwood, Burlington, Iowa

*Pat. Pend.

New Semiconductors and Tubes

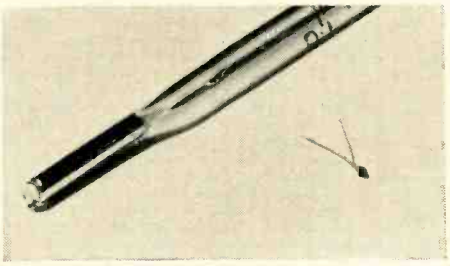
THE TWO SEMICONDUCTORS SHOWN IN these photographs are top candidates for the Littleness prize this month. If you aren't careful, they may get swept off your bench along with the solder droplets and wire cuttings.

The first is one of a series of miniature silicon planar transistors produced by Nippon Electric Co., Ltd. They are inexpensive, and intended for ordinary radio and TV applications. The one in the photo is about 1/16 inch thick, and is shown next to a perfectly ordinary



paper match. Despite the size, its collector dissipation is 150 mw and its collector–emitter breakdown voltage, 15.

The second photo shows a bead thermistor that is like a piece of dust



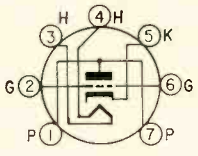
with leads. Made by G-E, it is .043 inch in diameter and has ¼-inch, .004-inch-diameter platinum leads. It is useful up to 400°C for control, measurement and time delay. That's an ordinary fever thermometer next to it.

6BK4-A

The "–A" suffix to this well known type indicates the increased plate dissipation rating of 30 watts, compared to the 25-watt rating of the 6BK4. Other ratings and all mechanical features remain the same, and the 6BK4-A is unilaterally interchangeable with the 6BK4 as a shunt high-voltage regulator in color TV sets.

6DY4

The 6DY4 and its series-string types 1-, 2- and 3DY4 are strap-frame grid triodes for uhf TV local oscillator service. They have standard 7-pin miniature bases. Transconductance is 11,000 μmhos. Sylvania cautions that the grid-to-cathode spacing is so small that it is



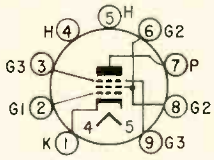
1,2,3,6DY4

risky to use more than 30 volts dc or peak ac between those elements. Watch your tube tester!

Maximum plate voltage is only 135, and the tube oscillates quite comfortably at 90 volts. At that voltage, and with a cathode resistor of 180 ohms, the tube draws 10.4 ma.

6HA6

Here is a video amplifier pentode made specially for low-B-plus black-and-white TV sets. Its high transconductance (20,000 μmhos), sharp cutoff and low plate knee characteristic make it very



6HA6

linear over a wide operating range, according to Raytheon.

The tube can also be used as a wide-band power amplifier in other applications.

Salient points:

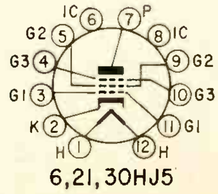
Plate volts (max)	300
Screen volts (max)	250
Plate dissipation	8 w

Plate resistance is 20,000 ohms at plate and screen voltages of 150 and 100, respectively, and with a cathode bias resistor of 33 ohms. Plate current under those conditions is 28 ma, screen current 3.5 ma.

The 6HA6 has four series-string siblings: the 8HA6, 10HA6, 15HA6 and 29HA6.

6HJ5

This husky compactron is a horizontal-deflection amplifier (horizontal output, that is) for low-B-plus TV sets



6,21,30HJ5

A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters.

Even though the Mighty Mite weighs less than 8 pounds, new circuity by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

Check these plus Sencore features: New, stick-proof D'Arsonval Meter will not burn out even with a shorted tube • Meter glows in dark for easy reading behind TV set. • New large Speedy Set-Up Tube Chart in cover, cuts set-up time • Rugged, all-steel carrying case and easy grip handle • Smallest complete tester made, less than one foot square. • The Mighty Mite will test every standard radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes (without damage) plus the new GE Compactrons, RCA Nuvistors and Novars and Sylvania 10 pin tubes.

Mighty Mite also has larger, easy-to-read type in the set-up booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9¼" x 3½". Wt. 8 lbs.

MODEL TC114 Dealer Net **$74.50**

Sencore Sam says . . .
"They all agree . . . the Mighty Mite is the real answer for the man on the go."

SENCORE ADDISON, ILLINOIS

and for color sets. It has a separate suppressor–grid connection to permit using a positive bias for "snivet squelching"—eliminating the troublesome uhf parasitics that crop up in some circuits. Dual pin connections to control and screen

30HJ5 and 6HA6

grids offer better heat dissipation.

Companion types 21HJ5 and 30HJ5 have different heaters but are otherwise identical.

Maximum ratings:

Plate volts (B-plus and boost)	770
Screen volts	220
Plate dissipation	24 w
Avg. cath. current	280 ma
Bulb temperature	240°C

Raytheon is the manufacturer. END

STATEMENT REQUIRED BY THE ACT OF OCTOBER 23, 1962, SECTION 4369, TITLE 39 UNITED STATES CODE SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO-ELECTRONICS, published monthly at 10 Ferry Street, Concord, Merrimack County, New Hampshire 03302. The General Business offices of the Publisher are located at 154 West 14 St., New York, N. Y. 10011.

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I certify that the statements made by me above are correct and complete.

(Signed) M. Harvey Gernsback
Editor

1963 SEMI-ANNUAL INDEX

RADIO-ELECTRONICS July-December, 1963 of Vol. XXXIV

KEYS TO SYMBOLS AND ABBREVIATIONS

* Construction Articles
† Section of full-length article
§ Transistorized

CI	Service Clinic
Corr	Correction
Corres	Correspondence
NB	News Briefs
NC	Noteworthy Circuits
Pat	New Patents
Tech	Technotes
TTO	Try This One
WN	What's New

Regular departments not itemized are New Books, New Literature, New Products, Technicians' News, What's Your EQ?

Continued on page 96

use it for SILVER SCREEN 85® tubes...

(10 "Universal" types meet half of all renewal needs)

SILVER SCREEN 85

The "Big 10" Tubes that fill 52% of all renewal needs:

21CBP4A	24%
21ZP4B	
21ACP4A	41%
21YP4A	
21EP4B	
21FP4C	52%
24AEP4	
21DFP4	
21AUP4A	
21DEP4A	

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

SERVICING—Continued from page 93

LEADING SOURCE
OF POWER FOR TESTING COLOR TV!

Precision's G-36 Color Bar White Dot Generator

The *easiest-operating* generator of its kind!
An essential instrument with only the essentials!
Works quickly, simply . . . gets the job done profitably!
Completely capable of testing and adjusting color phasing, matrixing, linearity and convergence circuits in all color receivers.

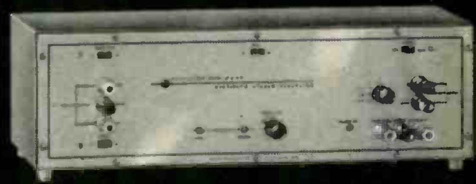
G-36K (Kit): $119.95; G-36W (Factory Wired): $179.95

LEADING SOURCE
OF MULTIPLEX SIGNALS FOR TESTING STEREO!

Precision's E-490 Multiplex Signal Generator

Specifically designed to fill the technician's need for a fast-working, high-quality multiplex signal source at a truly low price! Highly versatile, yet extremely simple to operate. Provides complete testing of multiplex circuitry in FM stereo receivers and multiplex adapters.

E-490 (Factory Wired): $249.95

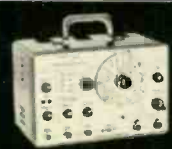


LEADING SOURCE
OF PROFIT FOR ALL TESTING NEEDS!

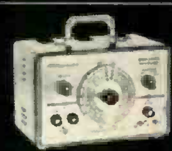
Precision's Full Line of New Test Equipment

The perfect combination of superior quality at the very lowest possible price!
A full line designed with one objective: to help you accurately handle all testing jobs faster, easier and *more profitably!* Never was there equipment designed with your real needs so much in mind!
And it's available at your local distributor *now!*

As shown:
Model G-30–Kit: $32.95; Semi-kit: $39.95; Factory Wired: $44.95
Model G-32–Kit: $85.95; Factory Wired: $159.95
Model S-55–Kit: $99.95; Factory Wired: $155.95
Model ES-550B–Factory Wired: $279.95
Model S-51–Kit: $69.95; Factory Wired: $109.95



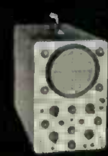
G-30 RF Signal Generator



G-32, Sweep Generator and Marker Adder

S-55 DC to 5MC Oscilloscope

ES-550B Wide Band 5MC Oscilloscope



S-51, General Purpose Oscilloscope

Write for new Catalog No. PP631 describing the *full* new Precision line containing *all* the test equipment you need!

PRECISION Apparatus, Inc.

80-00 Cooper Ave., Glendale, N.Y. 11227, 212-TW 4-4290

Export: Morhan Exporting Corp., 458 Broadway, New York, N.Y. 10013

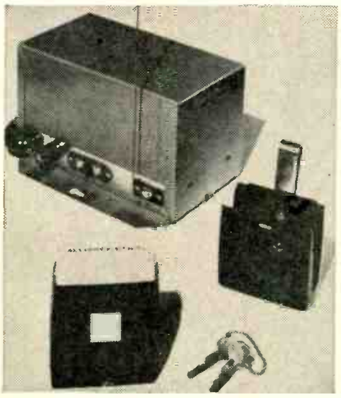
Canada: William Cohen, Ltd., 8900 Park Avenue, Montreal, Canada

new Products

CB WALKIE-TALKIE, *HA-60L.* 10-transistor, separate mike, speaker. Crystal-controlled

transistor circuit. Sensitivity better than 1 μv for 10-db signal-to-noise. No license required for use under Part 15 of FCC Rules. 8 penlight batteries. —**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y.

REMOTE CONTROL RADIO TRANSMITTER, *model AT-10.* Palm-sized, operates garage doors. 125-ft. transmission range, uses one of 21



available channels. 3¾ x 2¾ x 1¼ in. 9 oz. 22½-volt battery. Also kit with receiver and mounting hardware.—**Alliance Mfg. Co., Inc.,** Dept. MJ, Alliance, Ohio.

CB TRANSCEIVER, *TR-70C Mobile.* 12 tubes plus 4 silicon rectifiers; 7 double-tuned rf

and i.f. transformers; transistor power supply; 23-position transmit/1-crystal receive; adjustable squelch; ac on-off and volume control, 4-inch speaker. Power 6 volts, 14 amps or 12 volts, 7 amps.—**Tram Electronics Inc.,** PO Box 187, Winnisquam, N.H. 03289.

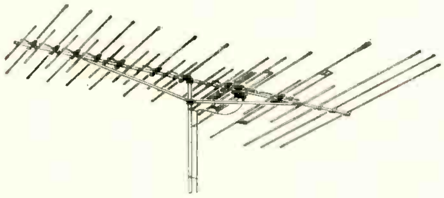
CB TRANSCEIVER, 24-channel crystal-con-

trolled transmitter, tunable receiver. Nuvistor front end, cascode rf amplifier, nuvistor 1st mixer, crystal and tunable oscillator. Tunable receiver with 6:1 vernier dial, 6-mc 1st i.f., 455-kc 2nd i.f.; separate peak, null controls. Sensitivity 0.1 μv for 6-db signal-to-noise; min. output 3.5 watts all channels. Transmit and receive neon indicator lights; silicon diode power supply; meter shows rf output, signal strength and audio level for PA.—**Polytronics Laboratories Inc.,** 88 Clinton Road, West Caldwell, N.J.

MOBILE MIRROR ANTENNA, *model 50037.* Fender-mounted rear-view mirror conceals omnidirectional vhf antenna. 150–174-mc range; swr less

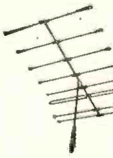
than 1.5:1 at design frequency, equals ¼-wave whip mounted in same location.—**Sinclair Radio Laboratories Inc.,** 523 Fillmore Ave., Tonawanda, N. Y.

COLOR ANTENNA, *Colortron model C-44,* for deep-fringe and fringe areas (vhf); color, black-and-white. All-channel (2–13), 30-element



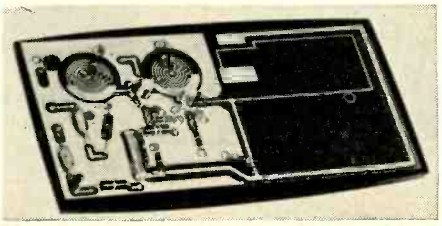
vhf Yagi; high uniform gain all channels; response: ±½ db across any 6-mc channel. 300-ohm impedance, swr 1.5:1; triple-tuned reflector for max. front-to-back ratio; no side lobes. Insulators with extra large, triple moisture barrier prevent loss of signal transfer during wet weather; double boom braces; widest element: 110-in.; boom length: 190-in.—**Winegard Antenna Systems,** 3000 Kirkwood St., Burlington, Iowa.

OUTDOOR TV AND FM ANTENNAS, combine all-channel Yagi and end-fire array. High gain, flat frequency response, high front-to-back ratio. For color and black-and-white. Electro-lens director system. 8-element FM Yagi, *RCA 500,* receives 88 to 108 mc; vswr 1.25:1; flat frequency



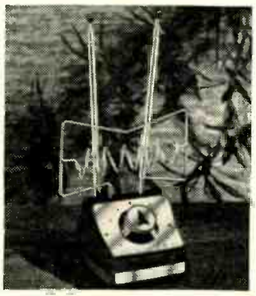
response with average 8-db gain.—Available through **RCA** parts and accessories distributors.

INDOOR ELECTRONIC FM ANTENNA, *Multitron.* Antenna system included with 2-transistor broad-band amplifier on PC board (see illus). Connects to ac outlet. Min. gain over tuned dipole,



20 db at FM broadcast frequencies. Fixed-tuned transformers. Matches 72- or 300-ohm FM tuner inputs. White or black plastic case.—**Antronics, Inc.,** 309 Queen Anne Rd., Teaneck, N. J.

INDOOR TV-FM ANTENNAS. *Model 3731* (illus), for FM mono and stereo reception; built-in single-transistor amplifier peaked to cover FM



broadcast band. Gain, 7 db; noise figure, 4 db. Usable to 60 miles from station. *Model 3718, Aurora,* for TV and FM, unamplified. Tuning knob eliminates frequent readjustment of dipole arms. *Model 3721, Apollo,* for TV only. Built-in single-transistor amplifier, switch for peaking to channel. Low-band gain, 17 db; high-band, 11 db. Noise figure 4 and 4.5 db, respectively. For suburban locations.—**Channel Master Corp.,** Ellenville, N. Y.

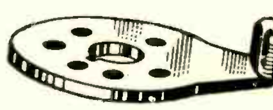
TRANSISTOR INDOOR ANTENNA, *Spico Transistar model TR-11.* Black-and-white, color TV; mono, stereo FM. Adjustable; calibrated coarse and fine tuning. Foldaway dipoles; printed

circuit; directional. Plugs into ac line. 9 x 7¾ x 2¾ in.—**Spirling Products Co., Inc.,** Hicksville, N. Y.

ROTOR SYSTEM for intermediate amateur loads, *TR-44.* Increases torque, braking, accuracy for large vhf arrays and small hf combination antennas. Rotator in all-weather bell-shaped casting;

electrical motor cutoff stops rotator 5° before mechanical stop. 100% more torque than standard TV rotators; 50 ball-bearing movement. Mounts on masts up to 2-in. diam. or flat plate.—**Cornell Dubilier Electronics Div.,** 50 Paris St., Newark 1, N.J.

SWEEP CIRCUIT BOOSTERS. Insufficient width due to component aging cured by inserting

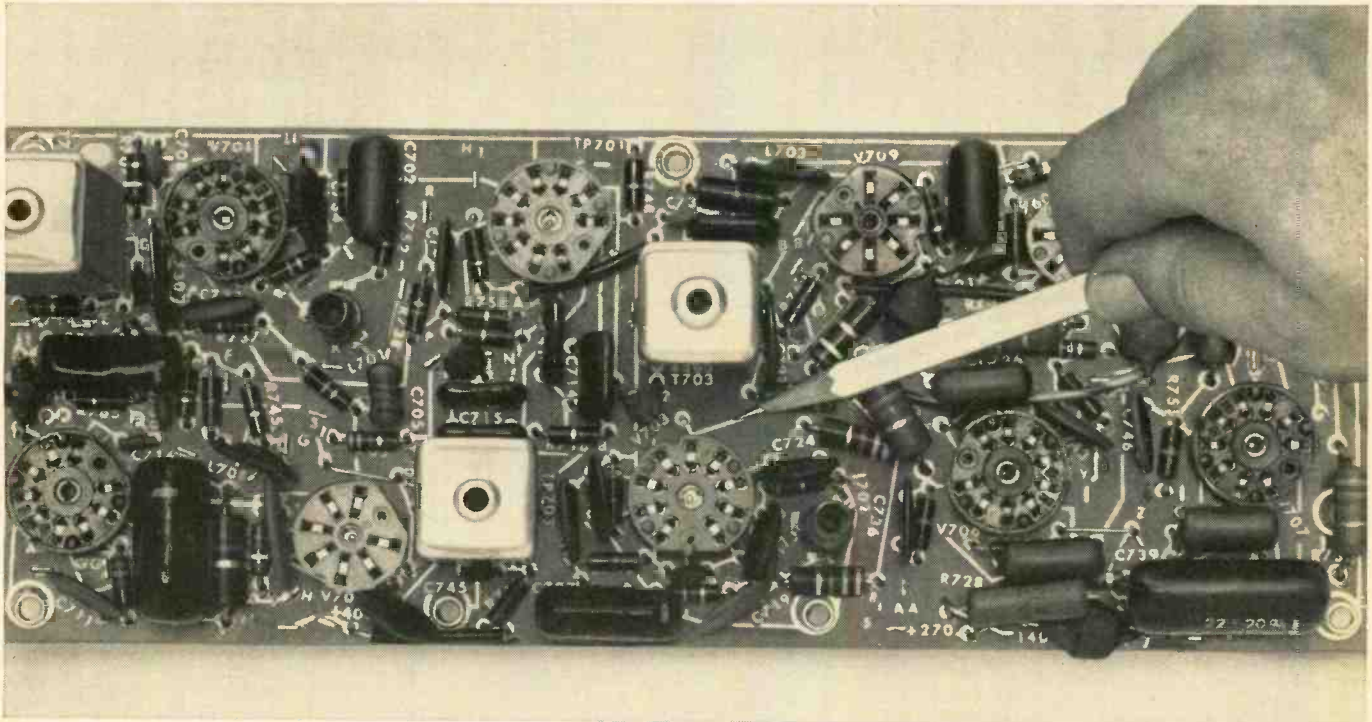


booster between damper tube and socket. Fits all octal dampers.—**Colman Electronics Products, PO** Box 2965, Amarillo, Tex.

TV PICTURE WIDENER, *No. 8760.* Capacitor lowers resonant frequency of flyback transformer secondary, thus lowering rate of change

From [illegible]A Victor–another [illegible]ig advance in

Space-Age Sealed Circuitry



RCA Victor Color TV Chroma Circuitry

You can see at a glance how new streamlined "road-mapping" makes servicing faster, easier, surer than ever before

Pictured above is the "new look" in RCA Space Age Sealed Circuitry . . . the new precision-crafted boards that you'll see in *all* 1964 New Vista Color and in most RCA Victor black-and-white television sets for 1964.

This new schematic diagram "road-mapping" consists of *straight white lines* that run *directly* from *point-to-point*. No confusion, no difficult paths. And the extra space gained has been used to make the label markings larger. You can see and trace the circuits at a glance.

Here again RCA Victor has made a vitally important contribution to easier, faster and more accurate servicing. It is part of our continuing research program to offer the utmost in reliability with Space Age Sealed Circuitry.

See Walt Disney's "Wonderful World of Color," Sundays, NBC-TV Network

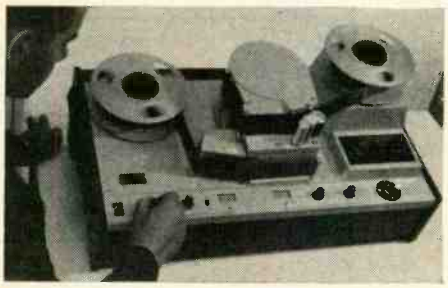
"HIS MASTER'S VOICE"

RCA The Most Trusted Name in Electronics

Tmk(s)®

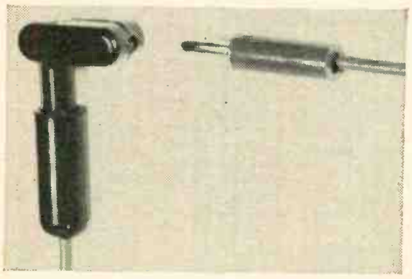
during flyback. No soldering required; slips over pins of damper tube.—**GC Electronics Co.**, Div. Textron Electronics Inc., 400 So. Wyman St., Rockford, Ill.

PORTABLE VIDEO RECORDER, *VR-660 Videotape.* Under 100 lb. Use on air with no extra equipment, meets FCC standards. 60 or 50 cycles.



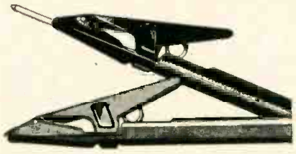
Tape speed 3.75 ips; records up to 5 hours continuous material on 12½-inch reel of standard 2-inch video tape.—**Ampex Corp.**, 401 Broadway, Redwood, City, Calif.

ELECTRONIC TEST CLAMP. Retractable spring clamp activated by light pressure on head of handle. Grips wire, retracts into insulating



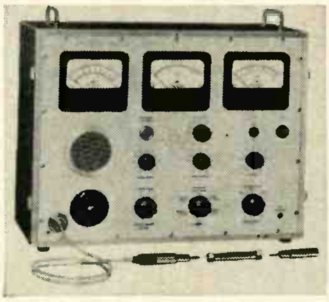
sleeve. Use in high-density circuitry wit[h] ... ing. Head has standard banana jack.—**H**... **sociates**, 321 Highland Ave., Orange, N.J...

TEST LEADS/RETRACTABLE ... *Gator Probe.* Standard test leads with ... alligator type clips with retractable probe. 52...



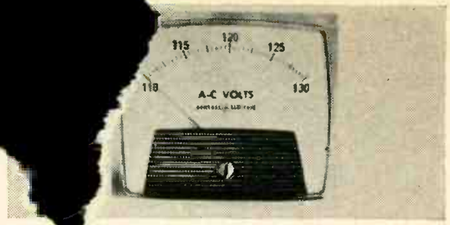
18-gage test lead wires connect to banana-tip or pin-receiving plug; swivel jaw clips clamp ¼-in. to .005 wire. Plastic parts withstand 10,000 volts dc.—**Gator Probe Corp.**, Subsidiary of Holex, Inc., Hollister, Calif.

HETERODYNE VOLTMETER, *model 2004.* Frequency 20 cycles to 30 mc; measures selective voltages at carefully controlled frequencies; built-in



speaker; input impedance 5 megohms at 100 kc, 90,000 ohms at 30 mc, paralleled by 5.5 pf. Voltage: 15, 150, 1500 μv, 15 and 150 mv. Capacitive attenuator extends voltage range to 1.5 and 15.—**B&K Instruments Inc.**, 2044 W. 106 St., Cleveland 11, Ohio.

EXPANDED-SCALE VOLTMETER, Zener-diode references, accuracy ±0.5%. 3½- or 4½-in. ac or dc. Min. span: 16% of mid-span rating (12–270 volts self-contained). Standard ratings ac: 110–130, 105–125 volts; dc: 24–30, 110–130, 220–

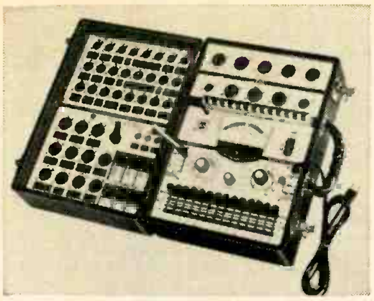


260 volts. Max. sensitivity: 100 ohms/volt; current drain: 10 ma; max. temperature influence ±0.25% of mid-span value for ±10°C variation from 25°C; at 65°C, not over 0.5% of mid-span. Max. frequency influence 0.3% of mid-span from 25–4000 cycles; 0.6% at 10,000 cycles.—**General Electric,** Schenectady 5, N.Y.

DC MILLIVOLTMETER, *model 300.* Electronic, fully transistorized, chopper-stabilized. Sensitivity .001 volt. 10 ranges: 0–.001, .003, .01, .03, 0.1, 0.3, 1, 3, 10, 30 volts. Input resistance 100,000 ohms below 0.1 volt, 1 meg per volt above that.

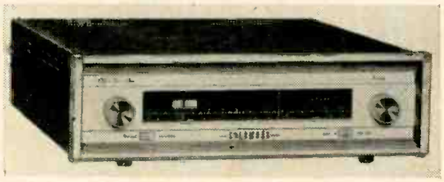
Zero-center accuracy ±2% full scale.—**IB Instruments Inc.**, 7016 Euclid Ave., Cleveland 3, Ohio.

TUBE TESTER, *model 107B.* All tube test results on meter and scale. 2 socket systems test TV, radio, industrial, foreign tubes. No setup data required; 40 prewired sockets accommodate 63 basic arrangements. Separate plug-in chassis, eight sockets connected to 14 pin selectors. Checks for leaks, shorts, grid emission, relative transconductance,



gas error.—**Seco Electronics Inc.**, Dept. 164, 1201 S. Clover Drive, Minneapolis 20, Minn.

AM, FM, FM-STEREO TUNERS, *S-2100II* FM stereo MX/AM tuner and *S-2100IV* FM/AM tuner.

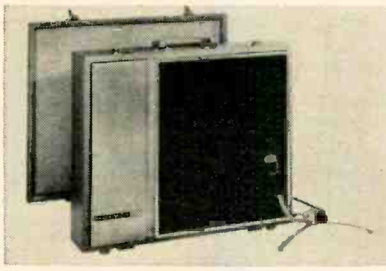


D'Arsonval tuning meter reads zero at exact center-point of frequency band-width. Sensitivity ranges 1.8 µv (IHF); 2.4-db capture ratio.—**Sherwood Electronic Laboratories Inc.**, 4300 No. California Ave., Chicago 18, Ill.

MICROVOLTER, *model 24-D.* 23 CB frequencies plus 9 optional i.f. signals; .005% accuracy. Frequencies crystal controlled. Internal and external modulation, metered outputs 0.1 to 100,000 µv full scale. 25 lbs. 10½ x 19½ x 8 in.—**Ferris Instrument Co.**, 110 Cornelia St., Boonton, N.J.

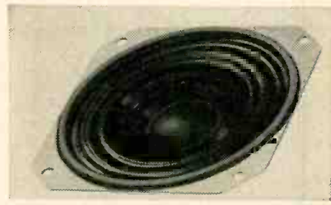
MUSIC RECEIVER/PAGING SYSTEM, *model FA-10C.* Hi-fi FM tuner, 10-watt amplifier for mike, phonograph and tape recorder. Afc, sensitivity rating 2.5 µv for 20-db quieting; response, 20–40,000 cycles ±1 db; 1% total harmonic distortion.—**Harman-Kardon Inc.**, Ames Court, Plainview, N.Y.

PERSONAL PORTABLE SOUND SYSTEM, *model 300,* self-powered, fully transistorized, self-contained PA system. On–off switch, volume control at mike that may be worn as lavalier. Powered by 2 flashlight lantern batteries. 15 lb. 4½ x 15 x 17¼ in.—**Wm. A. Holmin Corp.**, 1325 Seventh St., Rockford, Ill.



MATCHED SPEAKER AND ENCLOSURE, weather-resistant, for background music, PA, extension to hi-fi equipment. "Floating" speaker, no hardware to cause vibration or distortion. 8¾ x 8¾ x 4¼ in. Impedance 8 ohms; 3.16-oz. magnet; frequency response 70 to 13,000 cps; power handling 8 watts.—**Minneapolis Speaker Co.**, 3806 Grand Ave. So., Minneapolis 9, Minn.

SPUN ALUMINUM CONE SPEAKER, *Utah WP4A,* drive-in speaker unharmed by moisture or sunlight. 4 in. square; 1-11/16 in. deep. 0.68-oz. Alnico V magnet. 3.2-ohm voice coil handles 4 watts audio power.—**Utah Electronics Corp.**, 1124 E. Franklin St., Huntington, Ind.

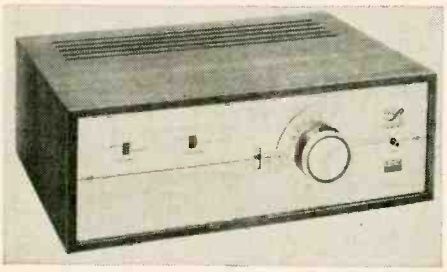


NEW STYLE STEREOPHONES, *model SEP-100,* fit atop head or under chin. Separate earphone level control; stereo–mono switch. Response: 25–18,000 cps.—**Freeman Electronics Corp.**, 729 No. Highland Ave., Los Angeles 38, Calif.

80-WATT STEREO AMPLIFIER, *model 299D*. Front-panel headphone output for private listening without speakers; center-channel output for driving independent speaker system without

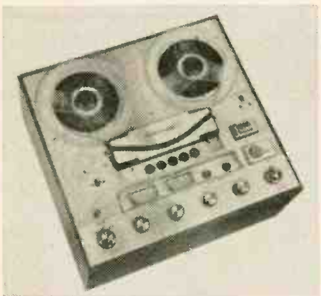
separate power amplifier. IHF power. 40 watts per channel; power band, ±1 db, 19–25,000 cycles; harmonic distortion 0.8%; hum level −80 db. Steady-state rating 32 watts per channel.—**H. H. Scott Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

FM STEREO TUNER SEMI-KIT, *model 2200*. Front-end, i.f. strip containing 4 i.f. stages and ratio detector. Rotary tuning dial, bar type



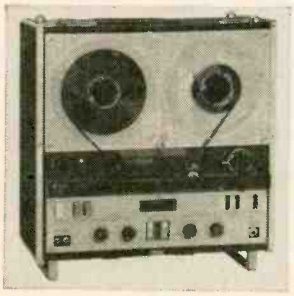
electron-ray tuning indicator, stereo defeat switch. Input: 300 ohms; sensitivity 3 μv (30-db quieting); signal-to-noise 55 db; harmonic distortion 0.6%; audio output 1 volt; ratio detector bandwidth 1 mc; output impedance 5,000 ohms.—**EICO Electronic Instrument Co. Inc.,** 33-00 Northern Blvd., Long Island City 1, N.Y.

STERECORDER, *Sony model 600,* 4-track stereo and mono recorder. Vertical or horizontal operation, mike and line mixing, source and tape monitoring. 2 VU meters, sound-with-sound, sound-



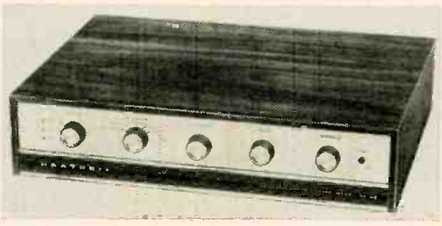
on-sound, separate monitor level controls, hysteresis-synchronous drive motor. 7½ and 3¾ ips. Frequency response 30–18,000 at 7½ ips: signal-to-noise 50 db; flutter and wow 0.17% or better at 7½ ips; bias frequency 100 kc; inputs: 2 high-level line, 2 mike or magnetic phono. Outputs: 2 600-ohm 8-db lines. 600-ohm binaural earphone monitor.—**Superscope Inc.,** Audio Electronics Div., 8150 Vineland Ave., Sun Valley, Calif.

TAPE RECORDER, *Retro-matic 220,* 2-speed quarter-track stereo recorder with 2-directional playback. Capstan between 2 playback heads so



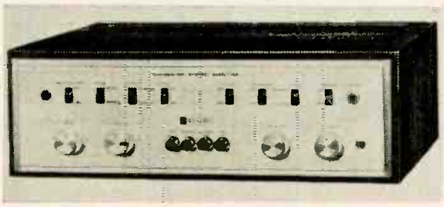
tape pulled over head in forward or reverse playback. Automatic reverse playback controlled by timed silence sensing device to detect end of program. Amplifier 6 watts per channel, 20–25,000 cycles response for record/playback at 7½ ips.—**Viking of Minneapolis Inc.,** 9600 Aldrich Ave. So., Minneapolis, Minn. 55420.

40-WATT STEREO AMPLIFIER, all transistor, *model AA-22*. 70 watts music power (IHF). Full power response at ±1 db 15–30,000 cycles. 5 stereo inputs; outputs for 4-, 8-, 16-ohm speakers, tape recorders. Output per channel: 20 watts with 8-ohm load: IM (at rated output) less than 1%; hum and noise: Mag phono. 50 db below rated output. aux inputs 65 db below rated output. 5-position selector switch; 3-position mode switch;



dual tandem volume, bass and treble controls; phase switch, input level controls; push-on, push-off switch, 20 transistors, 10 diodes.—**Heath Co.,** Benton Harbor, Mich.

100-WATT STEREO AMPLIFIER, all-transistor. 19 transistors, 8 diodes. Stereo headphone; 2-position record–monitor switch; circuit breaker. 100 watts IHF power output; response, ±½ db, 20–25,000 cps; harmonic distortion, 1.0% at full rated output; sensitivity, 0.1 volt, tuner and aux; 2.5 mv, tape; 2.0 mv, phono inputs for full rated output power. Outputs: 4, 8, 16 ohms per channel



to speakers; hi-Z center channel; hi-Z to stereo recorder; low-Z to stereo headphones.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago, Ill. 60680.

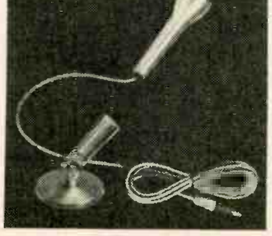
MAGNETIC RECORDING TAPE, *Scotch brand No. 175,* 15 times working life of former similar tape. Heavy-duty oxide coating. For class-

room use, high-speed computers. Resists heat and oxide ruboff.—**3M Co.,** 2501 Hudson Road, St. Paul 19, Minn.

COMPACT MIKE, *model 561*. Attached cable and standard ⅝-27 thread for mounting on flexible gooseneck or fixed pipe. Frequency response 40 to 10,000 cycles with rising characteristic to 4,500

cycles. Output level −56.0 db; impedance 50 to 250 ohms. 5 oz.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

MIKE WITH TABLE STAND, *Ceramike-Pak. Models CMC-10A, CMC-11A* for tape re-

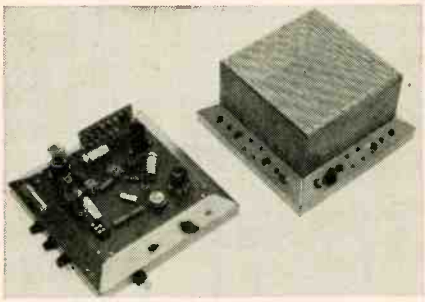


corders, home movie equipment, PA systems, conference pickups, audio-visual labs. *Model CM-11A* used when greater sensitivity desired.—**Sonotone Corp.,** Elmsford, N.Y.

PHONO CARTRIDGE, *model U-11R Soft Touch*. Lifts stylus automatically if abnormal pressure is applied to tone arm; brings soft plastic guard nib into position between cartridge and rec-

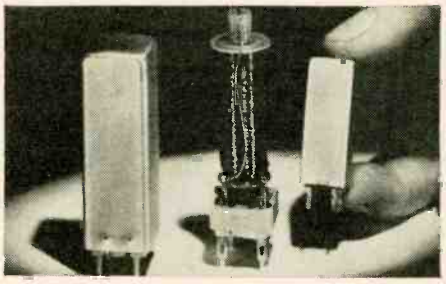
ord so stylus cannot contact record until abnormal pressure is removed. Frequency response 20–20,000 cycles. Compliance 8 × 10⁻⁶ cm/dyne. Capacitance 1,100 pf per channel. Separation 25 db at 1,000 cycles. Output 0.4 volt at 5 cm/sec. .0007 diamond stylus, .003 synthetic sapphire stylus. Photo was shown upside down in October issue.—**Euphonics Corp.,** Guaynabo, Puerto Rico, USA.

BREADBOARD KITS for experimental component assembly; conversion into operational unit.



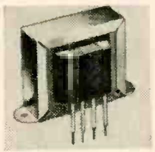
Top surface punched insulating board for mounting, placed atop metal chassis to accommodate pot, switches, monitor lights. Chassis sides at 45° angle. XXXP, epoxy paper, epoxy glass in .093- or .062-in. holes.—**Alan Kits Inc.,** Marketing Dept., PO Box Y4, Anaheim, Calif.

UPRIGHT REED RELAYS, *series 800* and *900,* multi-circuit applications; space saver on printed board or chassis. Anodized aluminum housings; magnetic shielding; varnish-impregnated coil assemblies for moisture-, shock-resistance. *Series*



900: ½ x ½ x 1¼ in. Coil voltages: 6, 12, 24 dc at 250 mw. Contact systems in gold, tungsten, mercury-wetted; ratings 15 va, 15 watts dc, 1,000 volts. *Series 800:* ¾ x ¾ x 2⅜ in. Coil voltages: 6, 12 dc at 250 mw; 48 dc at 1 watt. Contact systems gold, rhodium, silver, tungsten or mercury-wetted, 15–50 va, 15–50 watts dc, 250–1,500 volts.—**Standard Grigsby Inc.,** Reed Relays Div., Arlington Heights, Ill.

VERTICAL OUTPUT TRANSFORMERS. Exact replacement for all TV sets, including current models. *VO-120* replaces Zenith, Silvertone; *VO-122,* Silvertone; *VO-123,* Airline and Westing-



house part number; *VO-126,* 2 RCA types; *VO-127,* 4 RCA part numbers plus 2 Olympic units and Packard Bell.—**Stancor Electronics Inc.,** 3501 Addison St., Chicago 18, Ill. END

All specifications from manufacturers data.

ANOTHER GREAT ADDITION TO THE FAMOUS SERIES OF B&K ANALYSTS

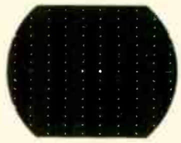
SIMPLIFIES AND SPEEDS TV SERVICING

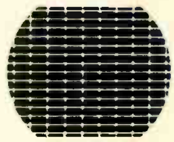
NEW!

B&K

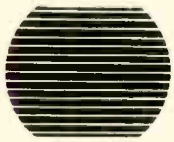
Compact Model 1074 TELEVISION ANALYST

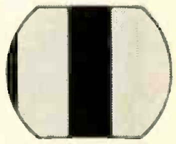
FOR BLACK & WHITE and COLOR


Dot Pattern


Crosshatch


Vertical Lines


Horizontal Lines


Color Pattern

Here is an exciting new addition to the famous B&K series of Television Analysts—*designed to give every service technician a faster, easier way to service more TV sets!*

The compact "1074" gives you a complete TV signal generating source of your own. Using the B&K *point-to-point signal injection technique*, you can isolate and pinpoint any performance problem for quick correction.

By injecting your own signals, with a visual check on the TV screen, *you can easily signal-trace and troubleshoot any stage* throughout the video, audio, r.f., i.f., sync and sweep sections of black & white and color television sets.

It becomes much easier to find and fix "tough dogs," and troublesome intermittents, as well as to solve other general TV set troubles—to the satisfaction of your customer, and to your own profit. Net, $249.95

Supplies complete r.f. and i.f. signals, with pattern video and tone audio. Video signals are switch selected for fast, visual troubleshooting. Provides FM modulated 4.5 mc sound channel, with built-in 900 cycle tone generator. Provides composite synchronizing signals. Provides separate vertical and horizontal plate and grid driving signals to check complete output circuit and interrelated components. Many other features.

Makes it Easy to Set-up and Service Color TV

Provides dot pattern, crosshatch, vertical lines, horizontal lines, burst signal and individual colors (Green, Blue, B-Y, R-Y, Red, I, and Q) one at a time on the TV set—all crystal controlled for maximum accuracy. Color phase angles are maintained in accordance with NTSC specifications. Thin lines and high stability assure fastest, easiest convergence and linearity adjustments. Color display makes demodulator alignment extremely simple.

Time-Saving, Money-Making Instruments Used and Preferred by Professional Servicemen Everywhere.


Model 375 Dynamatic Automatic VTVM


Model 360 V O Matic Automatic VOM


Model 700 Dyna-Quik Tube Tester


Model 850 Color Generator


Model 445 CRT Tester Rejuvenator

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Export: Empire Exporters, 253 Broadway, New York 7, U.S.A.

New Literature

booklets charts catalogs

SILICON DIODES AND RECTIFIERS described in 36-page General Catalog include Zener, Varicap diodes. Descriptions of manufacturer's lines of circuit modules and four pages of dimension data.—**TRW Electronics/Semiconductors Inc.,** 14520 Aviation Blvd., Lawndale, Calif.

TV PICTURE-TUBE REPLACEMENT CHART includes interchangeability guide and details of 575 tube types. Can be mounted for ready reference. Available through authorized **General Electric** tube distributors.

NEW MAGNETIC TAPE HEADS, 4-track, 4-channel, for record–reproduce on ¼-inch tape, described in data sheet *No. 7146*. Includes full specs, outline drawings.—**Nortronics Co., Inc.,** 8101 10th Ave. No., Minneapolis 27, Minn.

TV–FM AIDS FOR HOME RECEPTION described in 8-page, illustrated catalog *DC-CS-002*. Contains specs on 2-transistor, mast-mounted TV preamplifier; Powermate; vhf preamplifiers, Silver-Circuit uhf preamplifiers, amplified TV coupler and others. Prices included.—**Jerrold Electronics Corp.,** Distributor Sales Div., 15th & Lehigh Ave., Philadelphia 32, Pa.

3 NEW MERCURY-WETTED CONTACT RELAYS described in 16-page *JM* catalog, includes other previously offered relays. Table lists available range of assemblies of relays. Full specs and data. More than 300 relays categorized by resistance and wire turns.—**Potter & Brumfield,** Princeton, Ind.

PEDESTAL HEIGHT ADJUSTMENT in tape recorders described in 3-page bulletin, *Sound Talk No. 39*. Examines deficiencies and corrections.—**3M Co.,** Dept. Z3-499, 2501 Hudson Road, St. Paul 19, Minn.

COMPLETE EXPERIMENTAL LABORATORY described in 8-page catalog. Lists instruments available separately and in package, for use as lab portion of Malmstadt-Enke book-course *Electronics for Scientists* (See *New Books*, RADIO-ELECTRONICS, May 1963, p. 97). Describes idea behind book and lab, gives detailed specs on chart recorder, power supplies, vtvm, oscilloscope, sine-square generator, operational amplifier, substitution boxes, other lab equipment.—**Heath Co.,** Benton Harbor, Mich. 49023.

VHF AND UHF ANTENNAS, mobile and fixed, described in 4-page illustrated brochure. Full specs and details, radiation patterns.—**GAM Electronics Inc.,** 138 Lincoln St., Manchester, N. H.

TV ACCESSORY LINE described in 40-page brochure. Includes mast strap standoffs, U-bolts, turnbuckles, roof, wall and chimney mounts, poles, antennas.—**Parker Metal Goods Co.,** 85 Prescott St., Worcester, Mass.

RMS VOLTMETER/AMPLIFIERS detailed in 8-page illustrated spec sheet. Includes block diagram of instruments, description, related models, applications and test setups, accessories and full specs.—**B&K Instruments Inc.,** 3044 W. 106 St., Cleveland 11, Ohio.

TRANSFORMER SELECTION CHART lists and describes small high-frequency transformers. Chart is classified according to pulse or sine-wave type. Drawings and photographs cross-indexed to *Aladdin Transformer Encyclopedia* or specific bulletin.—**Aladdin Electronics,** 703 Murfreesboro Road, Nashville 10, Tenn.

ALL-PURPOSE ECONOMY RELAYS. 4-page illustrated catalog includes descriptions of many types of economy relays, including quick-disconnect, open relays, latch relays, mechanical actuators, plug-in and time-delay relays, plastic and metal housed units. Full specs.—**Artisan Electronics Corp.,** 171 Ridgedale, Morristown, N.J.

SUBMINIATURE CONNECTOR WITH INTEGRAL LOW-PASS FILTER data sheet, contains complete technical and dimensional specs.—**Sealectro Corp.,** 139 Hoyt St., Mamaroneck, N. Y.

ELECTRICAL SERVICEMAN'S INVENTORY HANDBOOK, personal guide with tube listings, columns for designating whether purchased or sold for each month. Total column indicates which moving tube stock is best to carry for your area. Includes notes, ready references.—**W. Lacy,** 4311 Baldwin Drive, Huntsville, Ala. 35805. 60¢

1/3 AND 1/1 OCTAVE-BAND FILTER SET described in 4-page brochure. Gives full specs, description, applications; also includes description of accessory, the 1/3 and 1/1 Octave-Band Extension filter set.—**B&K Instruments Inc.,** 3044 W. 106th St., Cleveland 11, Ohio.

NEW STOCK RELAY CATALOG. 6-page brochure lists 285 relays, including new time-delay, dry-reed, general-purpose, telephone type, plug-in, hermetically sealed and dust-covered relays. Full descriptions, specs and prices.—**Magnecraft Electric Co.,** 5581B No. Lynch Ave., Chicago 30, Ill.

NEON PILOT LIGHTS spec sheet, *JCA-663* details features and list prices of four differently-styled neon pilot lights. Includes data on application.—**Industrial Devices Inc.,** Edgewater, N. J.

SECTIONAL DELAY LINES. 4-page catalog details design, performance, mechanical data of separate delay line segments.—**Nytronics Inc.,** 550 Springfield Ave., Berkeley Heights, N. J.

ILLUMINATED PUSHBUTTON SWITCHES and indicator lights, detailed in 8-page catalog *No. L-169A*. Contains full specs, technical data and lamp and legend information; has illustrations, drawings, circuit diagrams and catalog number charts.—**Dialight Corp.,** 60 Stewart Ave., Brooklyn, N. Y. 11237.

INDUSTRIAL TOOLS catalog *No. 62*. 8-page brochure includes inspection tools, all-angle ball-joint mirrors, thumb-action adjustable mirrors, refill mirrors, retrieving tools, screw starters, heavy-duty compressors. Illustrations and prices.—**Ullman Devices Corp.,** Ridgefield, Conn.

"CORDLESS BATTERY POWER," reprint of published article on complete line of manufacturer's commercial, rechargeable sintered-plate, nickel-cadmium battery cells. 4-page illustrated folder details cross-section views, operational curves, packaging. Charts and tables, photos.—**Sonotone Corp.,** Battery Div., Elmsford, N. Y.

MINIATURE STRIP-CHART RECORDERS, manufacturer's full product line, accessories, leads, adapters, included in 4-page, illustrated catalog. Specs, descriptions and prices given.—**Amprobe Instrument Corp.,** Dept. AAD36, 630 Merrick Road, Lynbrook, N. Y.

53-AMP ALTERNATOR SYSTEM described in data sheet. Gives complete performance data. Diagrams show how to connect unit to positive or negative-ground automotive battery-charging systems.—**Leece-Neville Co.,** 1374 E. 51 St., Cleveland 3, Ohio.

PACKAGED ELECTRONIC CIRCUIT GUIDE *No. 7*. 8-page booklet contains complete listing of packaged electronic circuits, with replacement data, plus information on how to select, test and replace PEC's used in radio, TV and hi-fi.—**Centralab,** PO. Box 591, Milwaukee, Wis. 53201.

1964 HEATHKIT CATALOG. 100-page illustrated brochure presents wide selection of electronic kits, including complete specs and details. Product lines include: stereo/hi-fi, color and black-and-white TV, electronic organ, CB equipment, tape recorders, short-wave and amateur radio equipment.—**Heath Co.,** Benton Harbor, Mich.

SCOPE AND CAMERA CATALOG. 12-page illustrated brochure *No. 129* presents manufacturer's line of oscilloscopes, scope record cameras, pulse generators, probes and accessories. Pertinent specs on current instruments including the new transistorized high-frequency 765 series together with plug-ins.—**Du Mont Laboratories,** Scientific Instrument Dept., Clifton, N.J. END

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufactures, whose addresses are listed at the end of each item. Use your letterhead-do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears.

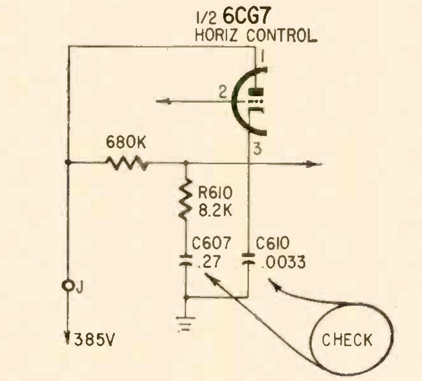
UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

TECHNOTES

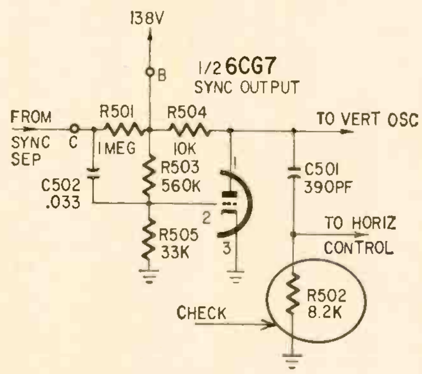
Special Color Notes

The items in this month's column were all contributed by Mr. Arthur R. Richman, and all deal with color TV troubles. Each item names the chassis, lists the complaint and points out parts to check. The partial schematics help you locate the correct portion of the circuit. Codes (such as R701, C212, etc.) are from RCA manuals.

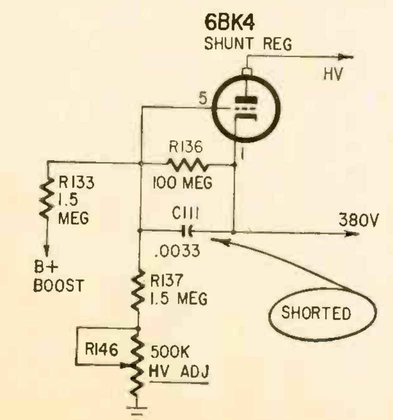
CTC9: poor horizontal range



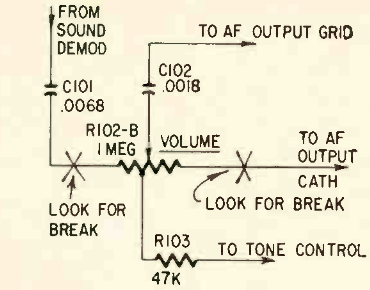
CTC9: horizontal tearing



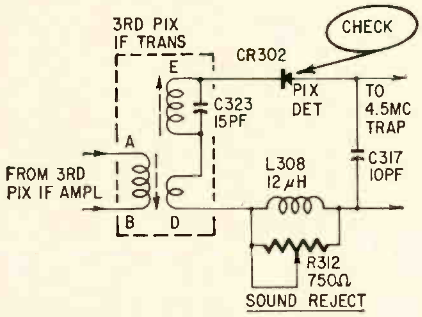
CTC9: poor width, no focus



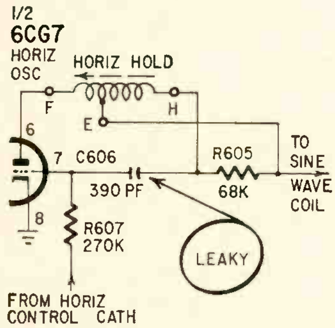
CTC9N and P (with remote control): volume will not lower



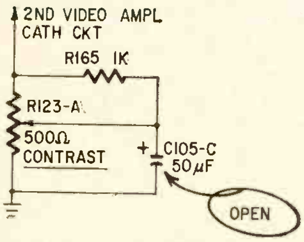
CTC9: low contrast



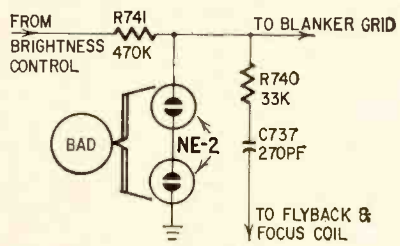
CTC9: no high voltage



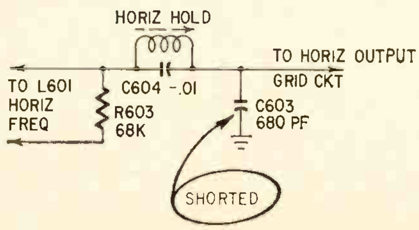
CTC9: intermittent contrast



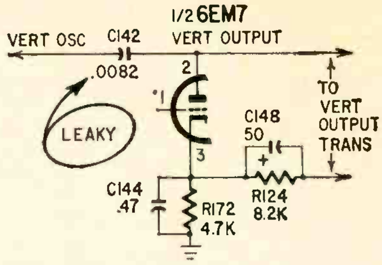
CTC10: weak or no color



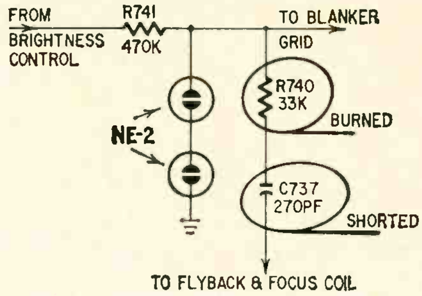
CTC10: no brilliance



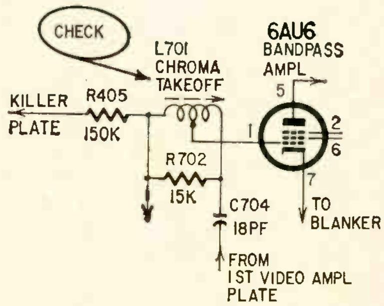
CTC10: vertical roll



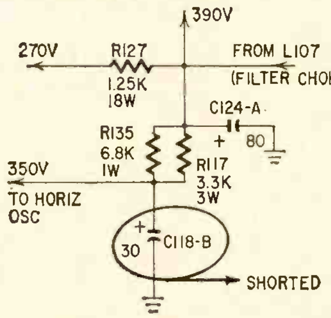
CTC10: brilliance blooms out



CTC10: no color sync

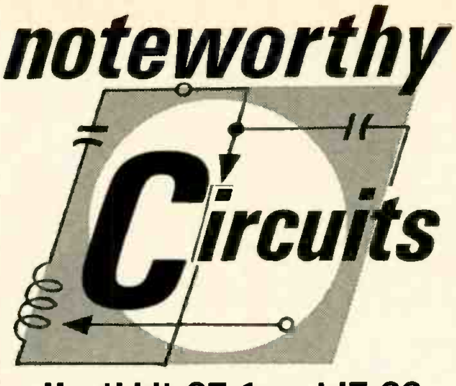


CTC12: no raster



END

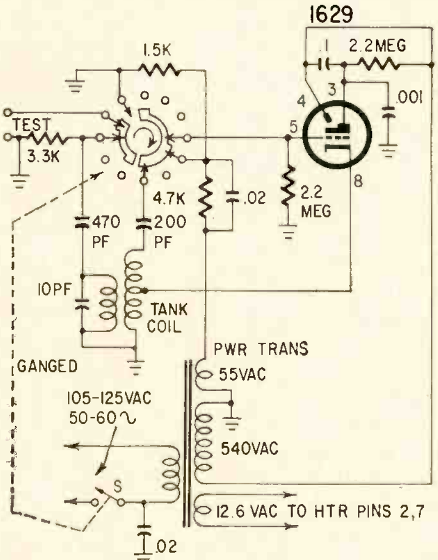
"You service hi-fi?"



Heathkit CT-1 and IT-22

Most in-circuit capacitor testers of this type have separate B-plus rectifiers, oscillator and electron-ray indicator tubes. In these two testers the 1629 indicator tube performs all three functions. (The circuit of the CT-1 is shown.) When testing a capacitor for opens, the triode section of the tube is used as a self-rectifying 19-mc oscillator. Coupling to the tank circuit is tight enough to stop oscillations.

When a good or shorted capacitor



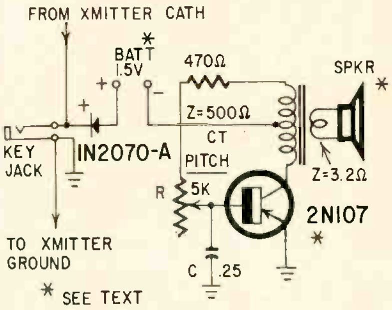
is connected to the test terminals, the circuit is detuned, developing a bias that closes the eye. For the short test, the capacitor is connected between the grid and ground. A shorted capacitor short-circuits the bias and opens the eye.—*Allan Glaser*

Code Oscillator and Monitor

This simple unit provides the amateur with an inexpensive CW monitor and the prospective ham with a code-practice oscillator. The transistor oscillator is a simplified version of the modulator in the tunnel-diode R-C transmitter in the June 1963 issue. A Bourns Trimpot salvaged from a surplus printed-circuit board is used for R, the pitch control. A fixed resistor of 1,000 to 5,000 ohms that gives the desired tone can be substituted. C also affects the frequency and may be changed to get the desired frequency range if you use a pot. The values of R and C shown on the diagram provide a frequency range of 200 to 5,000 cycles.

The diode isolates the oscillator from the transmitter when used as a CW monitor. Its piv rating must be higher than the open-circuit voltage across the transmitting key. The piv rating of the 1N2070-A is 400 and is high enough for most transmitters. If you will use the unit exclusively for code practice, replace the diode with a short.

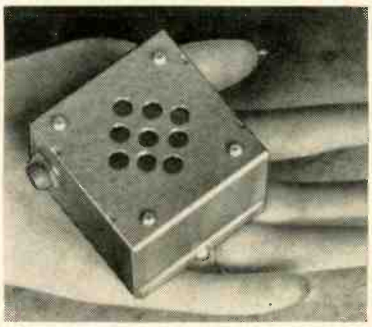
Almost any p-n-p transistor will work. I tried Poly-Paks' 15-for-$1.00



transistors and most of them worked in this circuit.

The oscillator's volume is adequate for the ham shack but falls short for group code practice. A larger speaker and 3-volt battery will solve this problem.

I constructed the unit in a small interlocking utility box. You can build

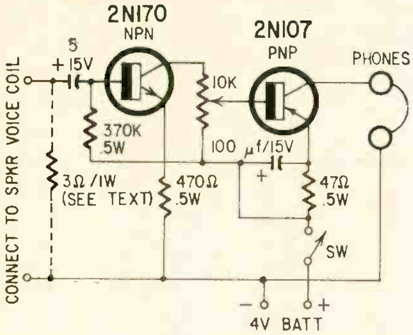


it into your transmitter. When using it as a CW monitor, be sure that the positive lead from the transmitter connects to the diode's cathode. Improper polarity will key the transmitter and burn out the transistor.—*Earl Palmer, W7POG*

Listening-Aid Amplifier

Recently a co-worker purchased a Telex model LCP90 TV Listener for his hard-of-hearing daughter. While the unit worked quite satisfactorily, there was one drawback in this particular application. The youngster's hearing is 80% restricted in one ear and 60% in the other. Consequently she required extremely high audio level to hear anything on her earphones. This proved unbearable to others watching TV on this same receiver.

One inexpensive solution was this simple two-transistor amplifier that packs a hefty signal. Without rearrangement of components already existing in the Telex TV Listener, there is ample room to build the entire amplifier and battery inside the bakelite case. The only physical change was replacing the original 100-ohm volume control with a small 10,000-ohm pot. Component values are not critical and may vary over a wide range. Transistors may be almost

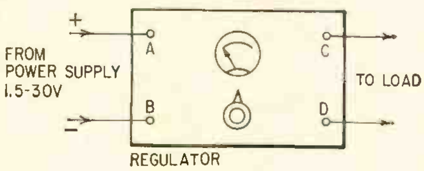


any inexpensive general audio types such as the 2N170, 2N107.

At high audio inputs, there is some tendency to overload, in which case the input can be loaded down with a 3-ohm resistor. Where less amplification is required, or desired, the input stage may be eliminated and the audio input fed to the 2N107.—*Domenic Ripani, W9JAQ*

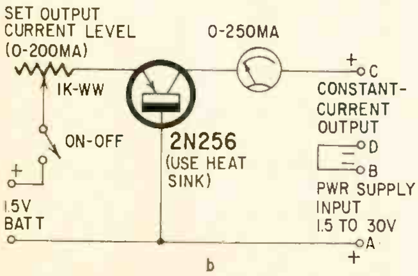
Constant-Current Regulator

Fig. 1 shows a regulator circuit that delivers a steady current at any preset level between 1 and 200 ma although the power supply output might fluctuate between 1.5 and 30 volts. The unit may be connected simply between the supply and load (see Fig. 1-a).



a

Circuit operation (Fig. 1-b) is based on the flat constant-current characteristic of a small power transistor in the common-base connection. The output current level is set by adjusting the rheo-



b

Fig. I

stat and read from the milliammeter. The 1.5-volt battery may be replaced with a midget transformer-rectifier unit, if desired.—*Rufus P. Turner* END

technicians' News

Mass. License Bill Goes Through

After several years of work, the radio–TV technicians' licensing bill sponsored by the Massachuetts Electronic Technicians Guild has passed the legislature and been signed by the governor.

The act establishes a board of radio and television technicians empowered to license applicants upon proof of competence and payment of the required fees. There will be two license grades: Master Technician License, issued to persons 21 years old and over, who have had at least one year's experience in radio–TV repair, and a Technician License, issued to persons at least 18 years old and employed by a service dealer or working under a Master Technician's supervision.

No one is permitted to do service work for pay without a license.

The licensing board created under the new law will examine applicants. In the words of the act, "the board shall require proof that the applicant has the knowledge, practical experience and skill necessary for the proper maintenance and repair of television and radio receivers and shall require a practical demonstration of the applicant's skill."

Licenses expire after a year and may be renewed without examination within 1 year from the expiration date, on payment of the renewal fee.

Initial exam fee is $15, as are the license fees for the Master grade. Subsequent examinations cost $10. The issuance fee for the Technician grade is $10, and $5 for renewal.

Penalties are stiff. For doing service work without a license there is a maximum fine of $500, or a prison term of up to three months, or both.

The new law includes a "grandfather clause." Any applicant who files before June 30, 1964, and is actively engaged in service work will be granted a license on payment of the fees, but without examination.

Chairman of the ETG Licensing Committee was Nicholas A. Averinos, who announced with justifiable pride that the total cost of getting the bill through was under $1,500—which includes legal fees, car expenses, stamps, stationery, but, he says, "No expensive lunches, dinners or any other frills."

Ohio TSA Elects

Jack Fain of Lorain, Ohio, was elected president of the Television Service Association of Ohio at the group's two-day annual convention recently. He succeeds John Graham of Columbus.

Also elected were Arthur Clough, Akron, secretary, and Arthur Spahr, Cincinnati, treasurer. Regional vice presidents are Carl Hepp, Youngstown, northern zone; Robert Hammond, Columbus, central zone, and Harry Hansen, Cincinnati, southern zone.

New Mexico TESA Told Service Vital to Color

TV service technicians have a key role in the rapidly blossoming field of color television, said Lysle O. Shanafelt, RCA's manager of distributor sales coordination, speaking to TESA–New Mexico's annual convention.

MOVING?

If you are going to move, don't forget to send us your OLD address (as it appears on your latest copy of Radio-Electronics) as well as your NEW address.

If possible, send us the actual address label which is pasted on the front cover. Be sure to include your ZIP code number with your new address.

If we receive this information before the 20th of the month, you will continue to get Radio-Electronics without interruption.

Please notify
Subscriber's Service
RADIO-ELECTRONICS
154 West 14th Street
New York, N. Y. 10011

Pointing out that color set owners and repairmen are the most important salesmen for color, he said, "Consumer demand for color television would not increase unless color receivers were being properly serviced and were delivering satisfactory performance."

He urged technicians to take advantage of the opportunities offered by the growth of color TV sales.

CSEA Sets Service Advertising Standards

The California State Electronics Association has drawn up a list of 10 principles to be followed for honest TV service advertising. Each item of the list mentions a particular type of claim that CSEA considers "misleading, untruthful" or a part of "bait" or "come-on" advertisements.

Here are the 10 points summarized:

1. Ads shall contain *all* information about the firm's legal name, address and telephone number. The phone number must be the one actually listed with "Information" under the business name of the company.

2. Words or phrases like "guaranteed" or "no fix, no pay" are permitted if the ad states clearly the nature and extent of the guarantee, and who the guarantor is—manufacturer or retailer.

3. Phrases like "24-hour service" should not be used unless such service is actually available to the public 24 hours a day.

4. Words "manufacturer" or "laboratory" should not be used unless the advertiser does actually manufacture or sell factory parts or use a laboratory. "Direct from factory to you" is taboo unless it is a statement of fact.

5. If an ad uses an expression like "repaired in your home," it should state that there is a charge if the work cannot be completed in the home to the customer's satisfaction.

6. If the price of picture tube is quoted, the ad should state whether the price is for a new or used tube, and whether it includes installation.

7. "Free" should not be used unless the article or service is actually free. This also applies to phrases like "without cost or obligation," etc.

8. Phrases like "factory-trained," "authorized," "licensed," etc., should be based on demonstrable facts.

9. Avoid "price ads." Artificially low prices quoted in ads lead to dishonest practices such as hidden charges, padded bills or hurried, sloppy work.

10. Be careful with business names that closely resemble established trade names or that use service marks much like those of other companies.

The list was apparently intended to be distributed to newspapers and periodicals. It closes by pointing out that "No honest, legitimate businessman, willing to represent his product or service fairly and openly to the public, should have the slightest fear of these standards."

New NATESA President Lists Gripes

The newly elected president of the National Alliance of Television & Electronic Service Associations, Larry Dorst of Milwaukee, has three pet peeves.

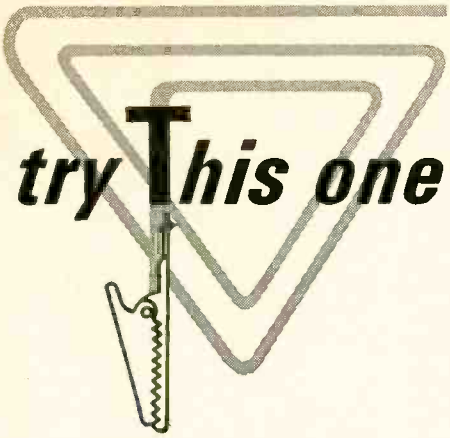
First, he says, is captive service. Running close behind are manufacturers' built-in warranties and the lack of licensing of TV service dealers.

Philco Forms Technicians' Councils

Philco Corp. will form councils of independent TV service technicians to put the company in immediate touch with any problems that develop in the field.

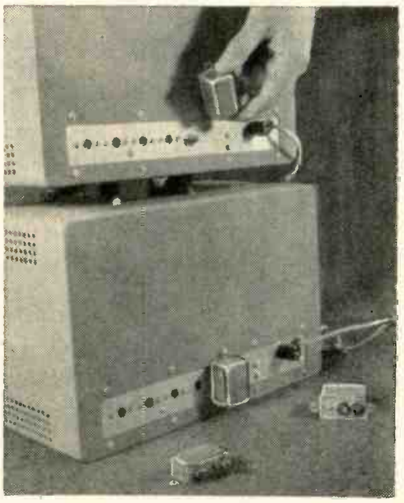
Charles Hakimian, Philco's director of distribution and customer services, announced at a meeting of the Ohio TSA that "these councils will meet with us, at our expense, to work on any and all problems that affect our relationship."

Hakimian also told the state meeting that Philco will resume introducing its new lines to service technicians at the same time the merchandise is displayed for dealers. END



Protective Covers for Shafts and Switches

To keep calibrating potentiometer adjustments from being disturbed, cover the shaft with the empty can taken from an old bathtub type capacitor. These cases are easily salvaged with a soldering iron. Lined with insulating paper they make neat covers for hot terminal screws or fuse clips. They can also keep crucial switches from being hit on or off accidentally.—*Hugh Lineback*



Clip-in Holder for Vom Battery

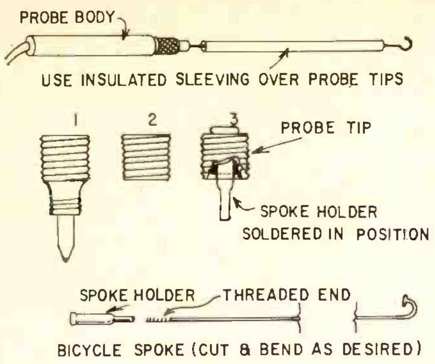
I own a vom that uses a Z-cell (penlight size) as an ohmmeter current source. Every time I wanted to replace it I had to unsolder the old cell and solder in the new one.

So I mounted a battery holder (Lafayette stock No. MS139) in the case and soldered the two battery leads to its terminals. Much better.—*Bernard J. Singer, Jr.*

Bicycle Spokes Make Test Prods

When I had trouble getting probes into tight wiring without shocking myself or shorting something, I made my own probes from an ordinary test-prod shank and some bicycle spokes.

The drawings will show you how easy it is. All you have to do is drill out



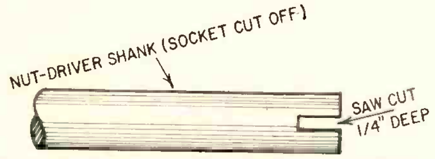
the old tip, insert and solder in a spoke holder (see your local bike shop) and screw in a bicycle spoke. The spoke can be cut, shaped and bent to meet your needs. Make several kinds, and screw in the one you need.—*M. P. Willoughby*

"Fish" Kills Superhet Oscillator For Alignment

In aligning radio i.f.'s it is often advantageous to disable the oscillator. Instead of looking around for a jumper or any old piece of metal to jam between the plates (and possibly damage them), I use a little gadget that I call "the fish." To make it, take a piece of thin aluminum such as a plate from an old tuning capacitor. Cut it to match the general outline of a "fish" about 2½-inches long. Round out the tail and pound it to a tapering thinness. Put a hole (the eye) in the other end to hang it up by. Now you have a perfectly safe shorting strip to stuff between the oscillator-section plates.—*Nicholas B. Cook*

Handy Service Tool

If you have a worn-out nutdriver lying around the shop gathering dust, try this. Cut off the socket with a hacksaw and make a ¼-inch cut at the end of the shaft. You now have a handy tool for twisting the mounting tabs on filter capacitor cans, tab-mounted controls, tab-mounted tuner shields, tab-mounted



transformers, etc. It will do a much better job than long-nose pliers, it will reach tight spots where pliers will not fit, and it will handle heavier material than long-nose pliers.—*Albert J. Krukowski.*

[The nut driver must have a solid—not a hollow—shank.—*Editor*]

Loose-leaf Binder Keeps Magazine Contents Pages

I file my issues of RADIO-ELECTRONICS in order in boxes for future reference. But first I clip out the contents pages and file them in a loose-leaf notebook. Your system of arranging articles in categories makes searching for a particular article very easy. If I want to build a preamp, I look in my notebook under "audio—high fidelity—stereo" until I find what I want. Then I look at the top of the page to see what month's issue the article is in and get the magazine from the box.—*Bernard A. Bernsen*

[As an additional aid, try clipping and filing away the annual (now semi-annual) indexes in the December and June issues, respectively.—*Editor*] END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics and the Electrical Experimenter on file for interested readers.

In December, 1913, Electrical Experimenter

Dr. de Forest on the Audion Amplifier.

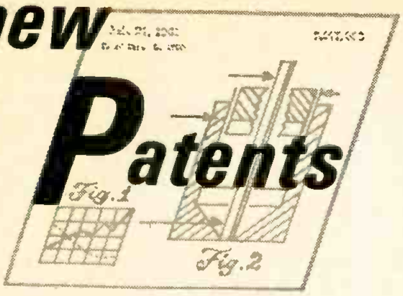
Modern Radio-Telegraphic Receiving Sets, by H. Winfield Secor.

Constructing an Oscillation Transformer, by Samuel Cohen.

How to Make a Novel Wireless Recorder, by Albert E. Shaw.

Variable Condenser Connections.

new Patents

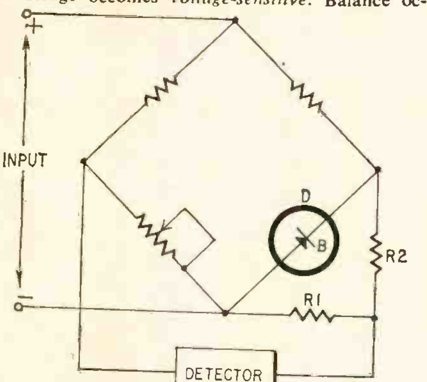


Temperature-Compensated Zener Bridge

PATENT No. 3,087,109

Melville D. Bowers, Lake Valhalla, Montville, N.J. (Assigned to McGraw-Edison Co., Milwaukee, Wis.)

By making one arm of a Wheatstone bridge a Zener diode (D) and the other arms fixed resistors, the bridge becomes *voltage-sensitive*. Balance occurs only with a definite input voltage.



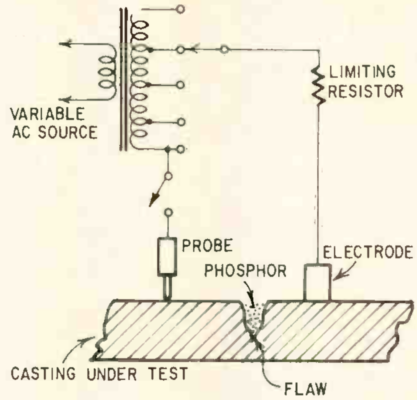
Temperature error may be eliminated by adding R1, R2, across D (see diagram). R2 has a positive temperature coefficient. To preserve balance in spite of changes in temperature, we must choose the proper temperature coefficient. The current through R1 must not change.

Flaw Detection

PATENT No. 3,097,337

Herbert S. Polin, Veyrier (Geneva) Switzerland

To check for possible cracks or flaws in a metal casting, a nonconducting phosphor powder is dusted over the metal. A fixed electrode and a movable probe are connected across high voltage ac (at least 100 volts). Where the powder has penetrated the surface, it acts as a dielectric with respect to the adjacent metal. The alternating field excites the phosphor, causing it to glow. This points out the location and size of the flaw.

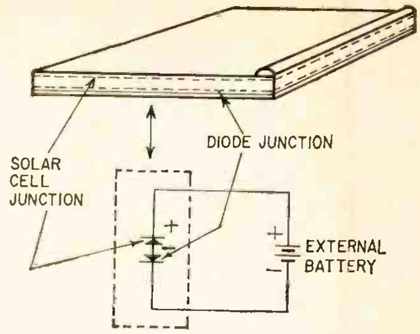


Solar-Cell Battery Charger

PATENT No. 3,089,070

Eugene L. Ralph, Skokie, Ill. (Assigned to Hoffman Electronics Corp.)

A combination of a solar cell and battery may be used to supply radios or other low-power equipment. An ordinary solar cell has low impedance in both directions, however, so the battery discharges through it when the sun is hidden.



The new device has *two* junctions. The lower one is a high-reverse-impedance rectifier. Thus the battery cannot discharge through it.

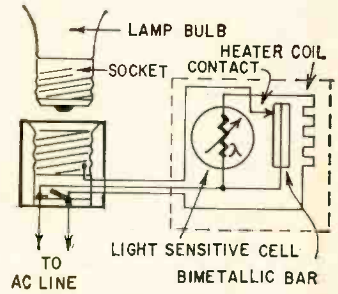
Automatic Illumination

PATENT No. 3,093,744

Michael Tabet, Norfolk, Va.

This lamp goes on automatically as darkness approaches, and off with the coming of dawn.

The drawing shows a heater in series with a photocell across the line. Daylight reduces cell resistance and permits a large current to heat the bi-metal bar. It bends away from the fixed contact to open the lamp circuit. During darkness, the bar cools, closing the contacts.



new Books

ELEMENTS OF ENGINEERING REPORTS, by Dale S. Davis. *Chemical Publishing Co., Inc., 212 5th Ave., New York 10, N. Y. 5½ x 8½ in., 200 pp. Cloth, $8.50.*

A detailed text with a number of examples of reports reproduced exactly.

TV TROUBLESHOOTER'S REFERENCE HANDBOOK, by Stuart Hoberman. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 128 pp. Paper, $2.95.*

A systematic approach for interpreting symptoms, isolating troubles, and repairing in shortest time. Color problems are included.

ELECTRONIC DEVICES AND NETWORKS, 217 pp. ELECTRONIC CIRCUIT TECHNIQUES, 212 pp. Both volumes edited by E. E. Zepler and S. W. Punnett. *D. Van Nostrand Co., Inc., Princeton, N.J., 6 x 9 in. Cloth, $6.50 each.*

These volumes cover theory, with math, of tubes, transistors, and the circuits that use them, including amplifiers, oscillators, pulse generators, etc. Written particularly for scientists and engineers who work in other fields, but must know how to use and operate electronic instruments.

CB RADIO CONSTRUCTION PROJECTS, by Len Buckwalter. *Howard W. Sams & Co., 4300 W. 62 St., Indianapolis, Ind. 5½ x 8½ in., 111 pp. Paper, $2.50.*

You can build these test equipment projects and accessories to get more out of CB radio.

ELECTRIC CIRCUITS, by E. Norman Lurch. *John Wiley & Sons, 440 Park Ave. South, New York 16, N.Y. 6 x 9 in., 565 pp. Cloth, $7.50.*

Introduction to (nonelectronic) dc and ac circuits using high school math up to trig functions and complex numbers. Many numerical problems are supplied with answers.

ABC'S OF ELECTRONIC DRAFTING, by Howard W. Sams Engineering Staff. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in. 96 pp. Paper, $1.95.*

Covers the subject extraordinarily well for its small size. The chapter on symbols is especially useful.

MATHEMATICAL ASPECTS OF PHYSICS: AN INTRODUCTION, by Francis Bitter. *Anchor Books, Doubleday & Co., Inc., Garden City, N.Y. 7¼ x 4¼ in., 188 pp. Paper, $1.25.*

MATHEMATICS AND THE PHYSICAL WORLD, by Morris Klein. *Anchor Books, Doubleday & Co., Inc., Garden City, N.Y. 7¼ x 4¼ in., 546 pp. Paper, $1.95.*

These two books tend to complement each other in their coverage. *Mathematical Aspects of Physics* is slanted toward the physical side with chapter heads and subheads such as "The Significance of Physical Measurement," "Motion of Earth Around the Sun," "Mechanical Vibrations," "The Fields of Coils," etc., while *Mathematics and the Physical World* uses such chapter

Classified Ads

Rates—55¢ per word . . . minimum 10 words. Payment must accompany all ads except those placed by accredited advertising agencies. Misleading or objectionable ads not accepted. Copy for February issue must reach us before December 14th. Figure one word: name of city (New York), name of state (New Jersey). Sets of characters as in key (741-RE), also abbreviations as 8x10 mm, A.C., D.C., C.O.D. Hyphenated words not normally considered such count as two words (Hi-Fi). ZONE NUMBER FREE. RADIO-ELECTRONICS, 154 West 14 St., New York, N. Y. 10011.

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LEARN ELECTRICITY, appliance repair in 32 compact lessons. **WORLDWIDE INSTITUTE.** Dept. 102, 2555 Shelley, Indiana, Penna.

FCC LICENSE in 6 weeks. First Class Radio Telephone. Results Guaranteed. **ELKINS RADIO SCHOOL,** 2603E Inwood, Dallas, Tex.

LEARN ELECTRONIC ORGAN SERVICING. New Home Study courses covering all makes electronic organ including transistors. Experimental kits—schematics—troubleshooting. Accredited NHSC-GI Approved. Write for free booklet. **NILES BRYANT SCHOOL,** 3631 Stockton Blvd., Dept. F. Sacramento 20, Calif.

MATHEMATICS. ELECTRONICS. Pay as you learn. Free brochure. **INDIANA HOME STUDY INSTITUTE,** P.O. Box 282, Saxonville, Mass.

LEARN WHILE ASLEEP. 92% effective. Build dynamic personality. Improve health. Motivate success. Details free. **A.S.R. FOUNDATION,** Box 70721RE, Henry Clay Sta., Lexington, Ky.

FOR SALE

ANTIQUE EDISON CYLINDER PHONOGRAPHS released from 50 years storage. All work. Complete. Concert Horn, Cylinders. Each — $70. **WHITLOCK'S STORAGE,** 114 State, Brewer, Me.

BUSINESS AIDS

1,000 Business Cards. "Raised Letters" $3.75 postpaid. Samples. **ROUTH,** RE12, 3105 Collier Drive, Greensboro, N. C. 27403.

10,000 CIRCULARS, $39.00. Information and samples free. **JASON,** 2336 Orthodox, Philadelphia, Pa., 19137.

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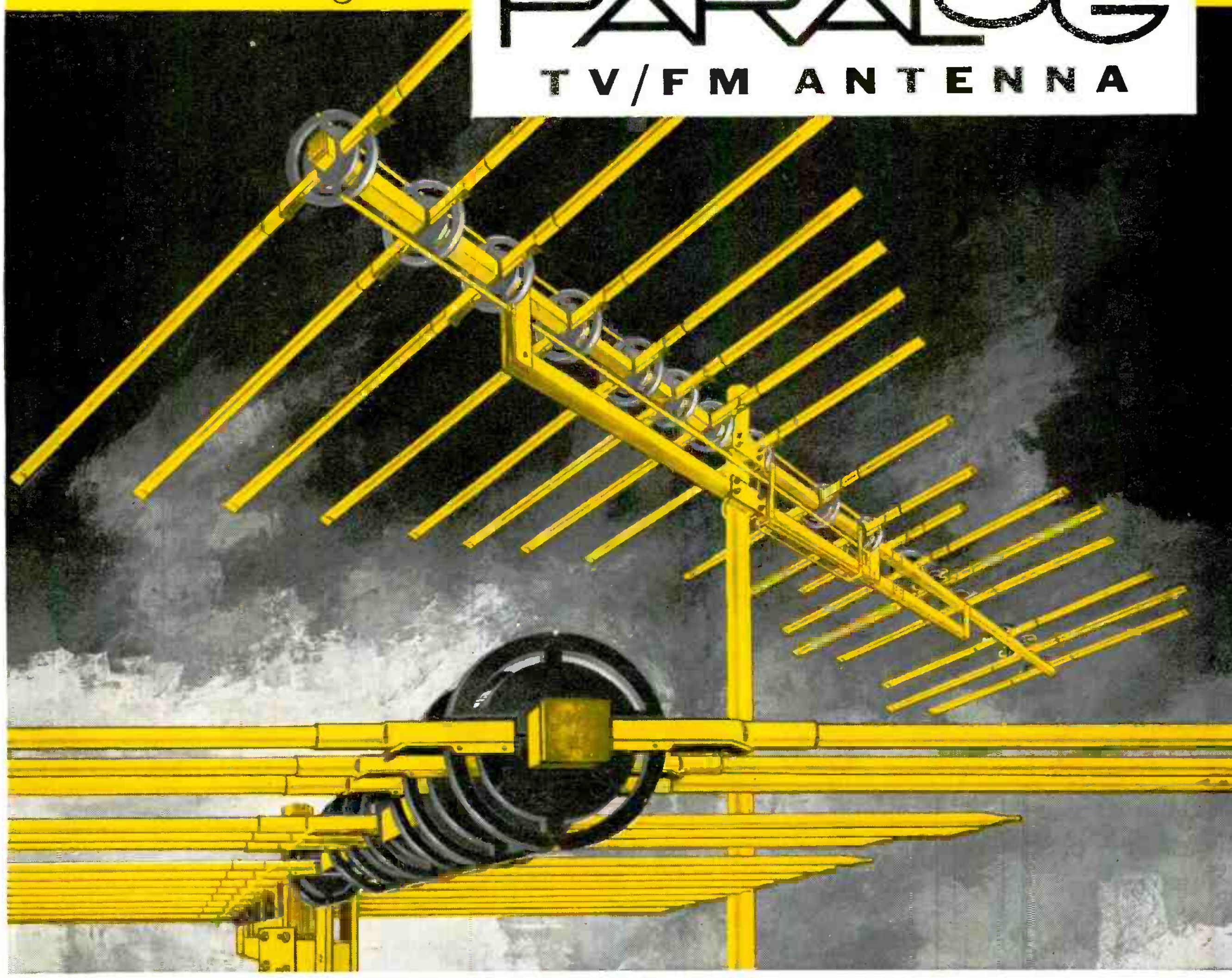

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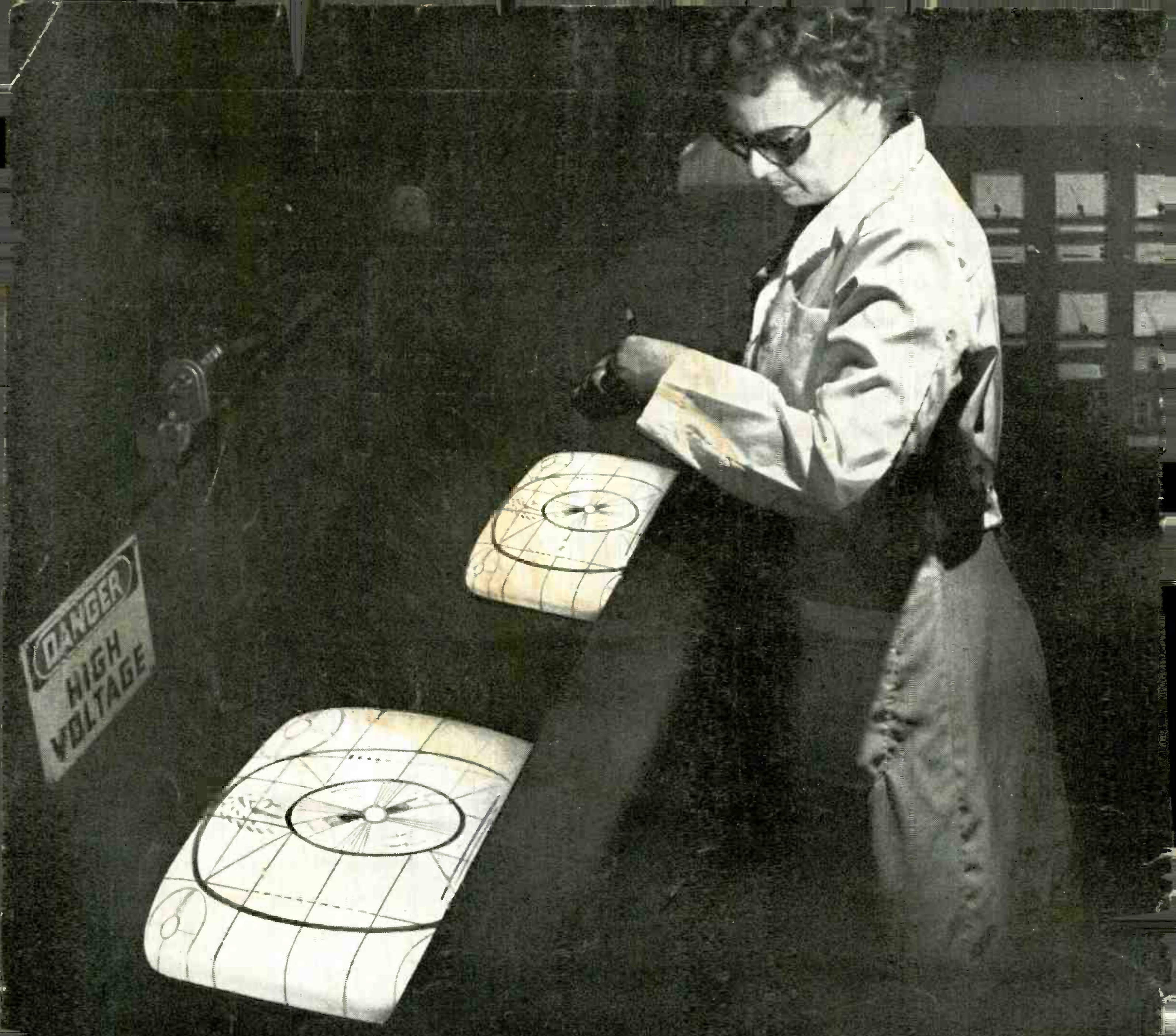

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