60c ■ JAN. 1972

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

SPECIAL ISSUE—COLOR TV 1972

Plug-In Modules Are Here

Automatic Tint Controls For Everyone

Trinitron vs Shadow Mask

Build R-E's $15 Color Convergence Generator

A GERNSBACK PUBLICATION

New Color Circuits For '72

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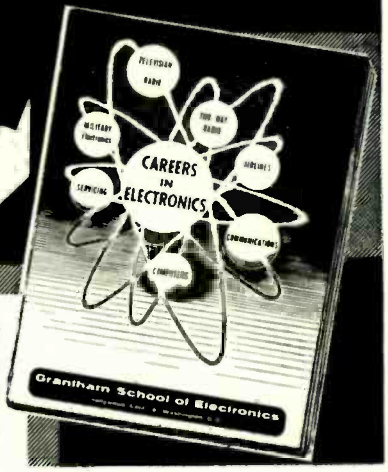

This free booklet explains what an FCC license and ASEE degree can do for your future.

In today's world of electronics employment, an FCC license is important—sometimes essential—but it's not enough! Without further education, you can't make it to the top. Get your FCC License without fail, but don't stop there. To prepare for the best jobs, continue your electronics education and get your Associate Degree in Electronics.

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If you are a beginner in electronics you will need laboratory training. Our special program for beginners includes correspondence laboratory lessons and real laboratory equipment.

Grantham School of Engineering is a college-level correspondence institution, specializing in electronics, authorized under the laws of the State of California to grant academic degrees.

The School is approved under the G.I. Bill, is accredited by the Accrediting Commission of the National Home Study Council, and is an eligible institution under the Federally Insured Student Loan Program.

Grantham offers two different programs for an associate degree in electronics—one program for beginners which includes FCC license preparation and laboratory lessons & equipment, and another program for experienced technicians which does not include FCC license preparation or laboratory lessons.

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ATTENTION, WASHINGTON D.C. AREA

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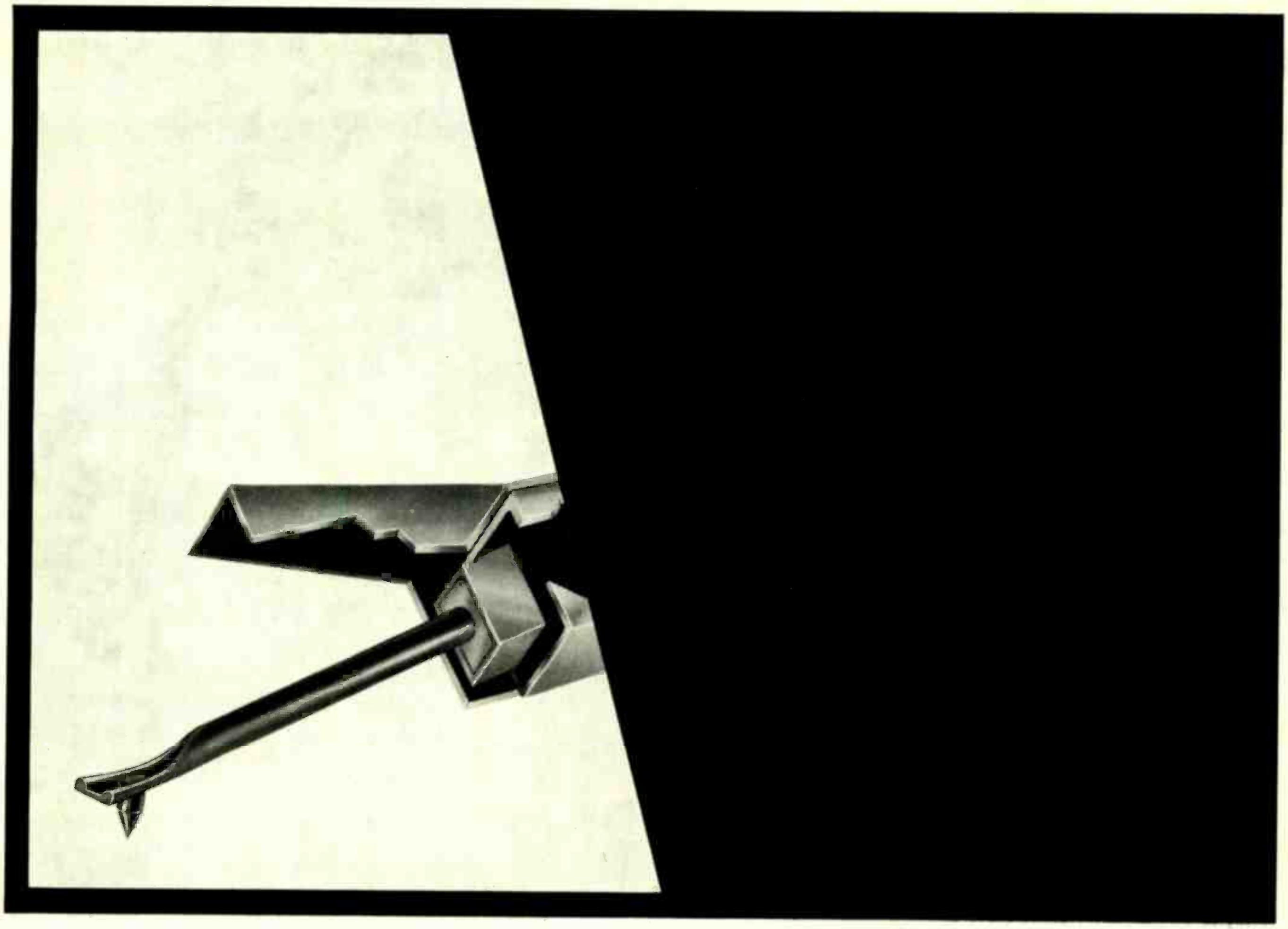
Circle 1 on reader service card



Straight talk about a stylus

Listen carefully and you can still hear some audiophiles refer to the record stylus as . . . "the needle." Although we are not about to quibble over semantics, we would like to go on record, so to speak, as observing that the stylus of today bears no more resemblance to a needle than it does to a ten-penny nail. In fact, it is probably the most skillfully assembled, critically important component in any high fidelity system. It must maintain flawless contact with the undulating walls of the record groove — at the whisper-weight tracking forces required to preserve the fidelity of your records through repeated playings. We put everything we know into our Shure Stereo Dynetic Stylus Assemblies — and we tell all about it in an informative booklet. *"Visit To The Small World Of A Stylus."* For your copy, write:

Shure Brothers Inc.
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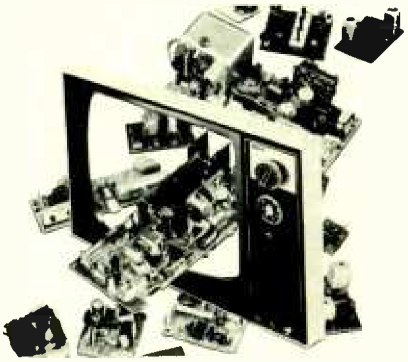
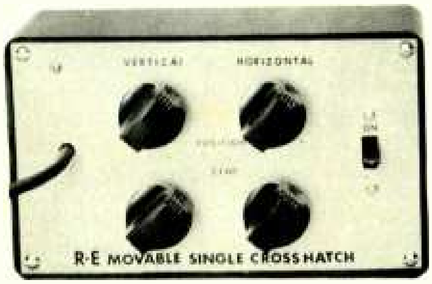
Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

January 1972



Plug-in modules are here today. For an in-depth look at the many different approaches used today. **see page 33**



Single-crosshatch generator is easy to build and costs only $15. **see page 50**

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COLOR TELEVISION

BUILD THIS

GENERAL ELECTRONICS

AUDIO

DEPARTMENTS

looking ahead

Videocassette race

Manufacturers are beginning to choose sides among the various videocassette standards, even though it may be some time before prices are low enough to bring the videoplayer within the reach of everyone's livingroom. The leading contenders so far: CBS's EVR film system has one American licensee—Motorola, already in production—four in Japan (Hitachi, Panasonic, Mitsubishi and Toshiba), plus others in Europe. Sony's "U-Matic" system, which uses three-quarter-inch video tape will be sold by 3M in U.S. (which will import Sony units for sale under the Wollensak brand) plus Panasonic, Japan Victor and Sony. Philips' system, using half-inch video tape has been standardized by most European television manufacturers, and will be sold by Norelco (North American Philips) in US. Cartridge Television Incorporated's Cartrivision system, also using half-inch tape has gained Admiral, Emerson Radio, Sears Roebuck, Montgomery Ward as adherents.

Magnavox is the latest manufacturer to announce it will have a video tape recorder in its line in 1972, but the company carefully refrained from stating which system it would use. It did say that its first units would cost more than $1,000, including a Magnavox-developed color camera. Prices for all of the first-edition videocassette machines are likely to be too high for general home use. Sony's latest announced price is $900 for playback-only unit, and $1300 for a machine which will both record and playback.

Quadraphonic FM

In addition to the stations broadcasting four-channel matrix systems, two are experimentally transmitting discrete quadraphonic signals—each using a single FM channel. The FCC has granted KIOI in San Francisco permission to experiment with the Dorren system, and General Electric has permission to experiment with its own system on its own WGFM, Schenectady, N.Y. Both systems are compatible with mono and two-channel stereo reception, and both are variations on the standard "plus-and-minus" FM-stereo system now in use. However, it is not recommended that one suspend one's respiratory activity in anticipation of the advent of discrete quadracasting. Matrixcasting, which requires no FCC approval, is likely to be all the four-channel broadcasting we'll have for some time—perhaps as long as five years. Any discrete system will require special FCC rules before regular broadcasting can begin, and past experience shows that this probably will be a long-drawn-out procedure.

4-channel compatibility

Peace may be near in the war of the quadraphonic discs. When Columbia Records' SQ system burst upon the scene last summer, Electro-Voice's Stereo-4 technique was already on the market. Both are matrix systems, but with completely different parameters—a Stereo-4 decoder wouldn't make much sense out of an SQ record, or vice versa. To complicate matters, other matrix disc systems have also been introduced—the principal one, being espoused by Japan's Sansui, is somewhat similar to, but not identical with the Stereo-4 system.

The situation was promising to become absolutely absurd—the consumer being asked to choose one type of four-channel disc and being barred from buying any others unless he bought another decoder. When you consider that radio stations already are broadcasting matrix discs, it becomes all the more ridiculous. If you did have two decoders, you'd have to switch the proper one on when you turned to a station broadcasting matrix sounds. Suppose the station played SQ and Stereo-4 discs intermixed. Would the announcer give you instructions as to which decoder to switch on for each selection?

Now Electro-Voice has announced what it believes will be the way out of this mess—a universal decoder, which will accommodate the Stereo-4, the SQ and just about any other matrix system to come, automatically, without manual switching. Electro-Voice says the decoder will be complete on an IC chip containing the equivalent of 80 transistors and 100 passive components, and will be made available to equipment manufacturers at a reasonable price, starting early in 1972. Columbia Records' reaction to this news was guardedly optimistic. If this development is as represented, it should go a long way toward bringing 4-channel discs into almost universal compatibility.

Here's how the quadraphonic matrix picture stood at presstime: About 100 different record releases were available on eight labels, using Electro-Voice's Stereo-4 technique. Some 75,000 Stereo-4 decoders were in the hands of the public, about 100,000 more being manufactured. A total of 69 FM stations were broadcasting Stereo-4 using encoders, and an unknown number were broadcasting already encoded discs (for which no encoder is required at the station). Some 20 SQ releases had been issued by Columbia Records (at a $1 premium), with 30 more expected by the end of 1971, and probably additional discs on other labels. Sony, Lafayette Radio and Columbia's Masterwork brand were offering SQ decoders. Big RCA Records was still a holdout against matrix systems, and was developing its own discrete system ("Discrete-4"). If RCA does bring out a discrete system, of course, it will raise a new spectre of incompatibility among quadraphonic records.

Another color tube

Uniray, Inc. has been formed by one-time Philco engineer David Sunstein to develop and promote a "dramatically improved color television receiving system), which is claimed to use an inherently low-cost single-gun tube with no shadow mask, capable of light output three times that of the current color tube type at lower cost and lower weight. The Uniray tube is of the "beam-indexing" type—and if that phrase rings a bell, you're enough of an old-timer to remember the "Apple" tube, developed by Philco and demonstrated in 1956, but never produced in quantity.

Sunstein claims the Uniray tube is vastly improved over the one he says he "conceived" at Philco, and that it uses a different and inherently simpler method of indexing. The basic principle of a beam-indexing tube: A single electron beam directly scans the screen, which may be composed of alternate strips of red, green and blue phosphors. Colors are determined by the intensity of the beam as it strikes any particular phosphor strip. Although the "Apple" tube produced fine color pictures, the concept was discarded because of difficulty in adapting it to mass production. Sunstein says, Uniray has overcome this problem.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

SONY® achieves true integration

In all too many transistor integrated amplifiers, the preamp stage does not quite live up to the performance of the amplifier section.

Not in Sony's new TA-1130. Thanks to an FET front end, this integrated package has a preamp stage that really does full justice to its output section.

Why FET's

For the same reason that we use them in our tuners and receivers, and in our studio professional condenser microphones; because FET's have a far wider dynamic range than ordinary transistor types.

And the preamplifier needs that range. Because it has to be sensitive enough to handle the lowest-output, moving-coil cartridges, yet still accept the highest output cartridges without overloading. (The power amp has it easier: you keep its input level fairly constant with your volume control.)

SONY® F.E.T. Amplifier

Power to Spare

But if the power amplifier doesn't need that range, it does need power. The output section of TA-1130 has it: 230 IHF watts (into 4 ohms), with continuous power rated at 65+65 watts into 8 ohms. (With all that power, we made sure that both transistor and speaker protection circuits were included.)

Nothing Stands Between You and the Sound

Both sections are powered by balanced positive *and* negative supply voltages (not just positive and ground), so there need be no coupling capacitors or interstage transformers between you and the sound.

Without them, the TA-1130 can extend its power band width down to 7 Hertz, and actually *exceed* its rated damping factor of 100 all the way down to 5 Hz.

An Abundance of Audiophile Conveniences

Of course, the TA-1130 has all the control facilities that you could ask for: low and high filters, tape monitor, a speaker selector, and even an Auxiliary input jack on the front panel. The selector switch is Sony's instant-access knob-and-lever system.

There's even provision to use the TA-1130's power amp and preamp sections separately, to add equalizers, electronic cross-overs, or 4-channel adapters to your system.

In fact, you can even get the power output section separately, as the model TA-3130 basic amp. It makes a great match for our TA-2000F preamp, too. Your Sony dealer has both models available, and at down-to-earth prices for the performance they offer. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.

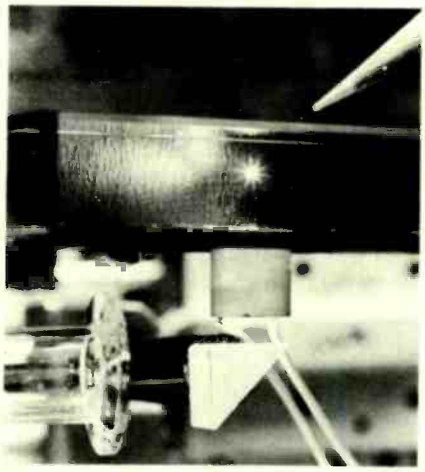
Circle 3 on reader service card

new & timely

Laser levitation

Experiments demonstrating laser levitation for the first time were conducted at Bell Labs by Arthur Ashkin and Joseph Dziedzic. The scientists use a beam of laser light to raise small transparent glass spheres off a glass surface and hold them floating in air for hours in a stable position.

The new technique is expected to provide simple, precise methods for manipulating small particles without mechanical support. It could be useful in communications research to measure scattering loss caused by particles, either in the atmosphere or in other transmission media. Such measurements may aid in developing optical communications systems for the future.



TINY STAR-LIKE PARTICLE held in the air by a light beam passed through a lens at the end of the glass tube and bent by the triangular prism to focus on the transparent glass particle from below.

In the experiment a laser beam is focused upward on a tiny glass sphere about 1/1000 of an inch in diameter. Radiation pressure from the light not only counteracts gravity and raises the particle, but also traps the sphere in the beam, preventing it from slipping out of the beam sideways.

To break the molecular attraction between the sphere and the glass plate it rests on, a ceramic cylinder attached to the plate is vibrated. When the attraction is broken, the sphere rises in the light beam and comes to rest where the upward pressure caused by the laser is balanced by the earth's gravity. As long as the light is focused on it, the sphere can be held aloft. The sphere can also be moved precisely by changing the position of the focus.

"Any laser will produce the levitation effect," Dr. Ashkin states. "However, the particle is preferably transparent. If the beam were focused on objects that absorb light, most would melt. By remaining cool, the transparent sphere allows radiation pressure to be studied without any disturbing thermal effects."

Freezing TV pictures

A laboratory concept of a future home TV information center with which viewers could freeze an individual TV picture by pushing a button was demonstrated by RCA. The experimental system would allow a housewife to select a recipe as it appears on the TV screen and freeze the picture for careful study.

The system was developed at RCA's Princeton Research Center and is housed in a home TV console equipped with two TV screens, one for the continuing TV program, the other to display the single picture. The heart of the system is a new silicon storage tube which stores an individual TV picture frame and displays it on demand.

Watch TV in safety

The U.S. Food and Drug Administration has issued a new pamphlet, What's Being Done About X-Rays From Home TV Sets, which rescinds their old recommendation that viewers sit at least six feet from an operating TV set to minimize the damage potential of possible X-ray leakages. The booklet states that there should be no significant health hazard while watching a properly serviced and operated home TV at any distance chosen by the viewer for his comfort.

Since the Federal standard limiting X-ray emissions from TV sets to prescribed levels under the most adverse operating conditions went into effect, most TV receivers have been found not to give off measurable levels of X-radiation. Any amount is unintended, not essential to the product's function, and should be controlled.

The pamphlet describes the Federal program to control TV X-rays and offers advice to consumers on buying, watching, and servicing TV sets. A copy may be purchased for 10¢ from Supt. of Documents, U.S. Gov't. Printing Office, Washington, D.C. 20402. Mention Stock #1715-0012.

Electronics and the eye

A book-sized device, *Optacon*, that enables blind persons to read conventional print, and a laser instrument, *Photocoagulator*, used to prevent possible blindness, have been developed by Stanford Research Institute. Both contributions to vision research have been cited among the 100 most significant technical products of the year in Industrial Research's annual competition in medical technology.

The idea for Optacon originated with Professor John G. Linvill of Stanford University, whose daughter is blind. Most of

(continued on page 12)


All this is yours—from Achievement Kit to the only Color TV specifically designed for training—when you enroll for NRI's TV-Radio Servicing course. Other courses are equally complete. But NRI training is more than kits and "bite-size" texts. It's also personal services which have made NRI a 50-year leader in the home-study field. Mail the postage-free card today.
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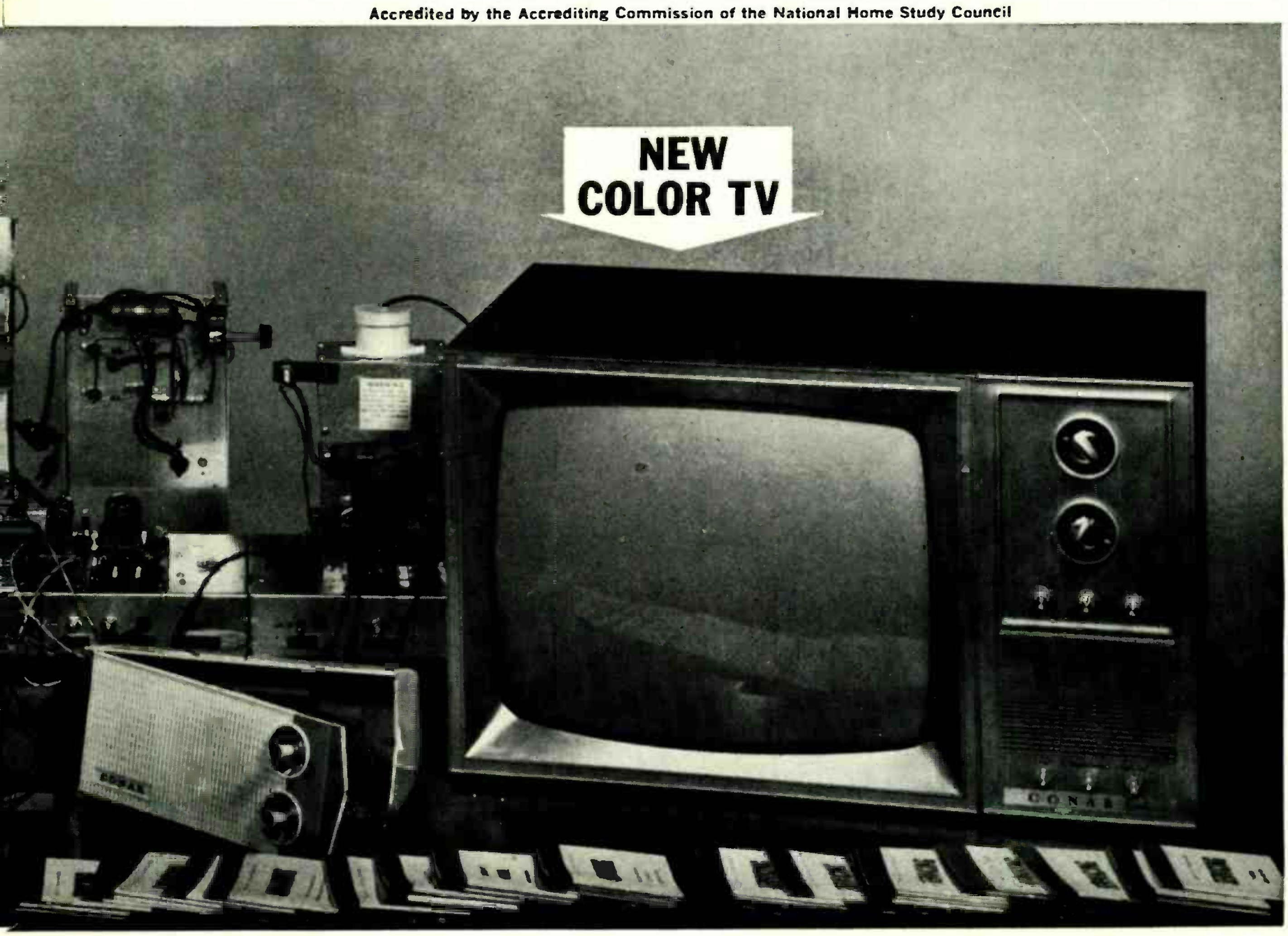

new & timely

(continued from page 6)

TREATING EYE DISEASE with the Photocoagulator.

the optical work was done at Stanford Research Institute under the direction of Dr. James C. Bliss.

The Optacon (for optical-to-tactile converter) weighs less than four pounds, is battery operated and portable. A tiny camera containing light-sensitive phototransistors scans the print, and connects to tiny metal pins set in a finger-sized depression in the unit. The reader rests his finger on the pins, which vibrate in the shape of the letter or word he is scanning with the camera in his other hand. After training, some blind persons have learned to read as many as eighty words per minute with the Optacon. While a good Braille reader can read faster, the amount of material available in Braille is limited and bulky.

Using light to clot biological material, the Photocoagulator was developed by S.R.I. in cooperation with its originator, Dr. H. Christian Zweng, an ophthalmologist. A method was discovered to project a blue-green light from an argon laser directly into the eye to repair detached retinas. With a special slit lamp the laser beam is focused on the retina and can be manipulated independently of the field of vision, changed in size and intensity, and controlled safely.

The blue-green light is easily absorbed by the red blood pigment of the eye. The absorbed light, turned into intense heat, opens the possibility that abnormally-grown blood vessels can be coagulated.

The Photocoagulator has been used to treat 11 different types of eye diseases, including diabetic retinopathy, which causes 15% of blindness in the United States. No general ill effects have been reported.

Japanese holidays

In vacations, as in other things, Japanese working people follow a different pat-

(continued on page 14)

THE OPTACON used by the blind to read conventional print.

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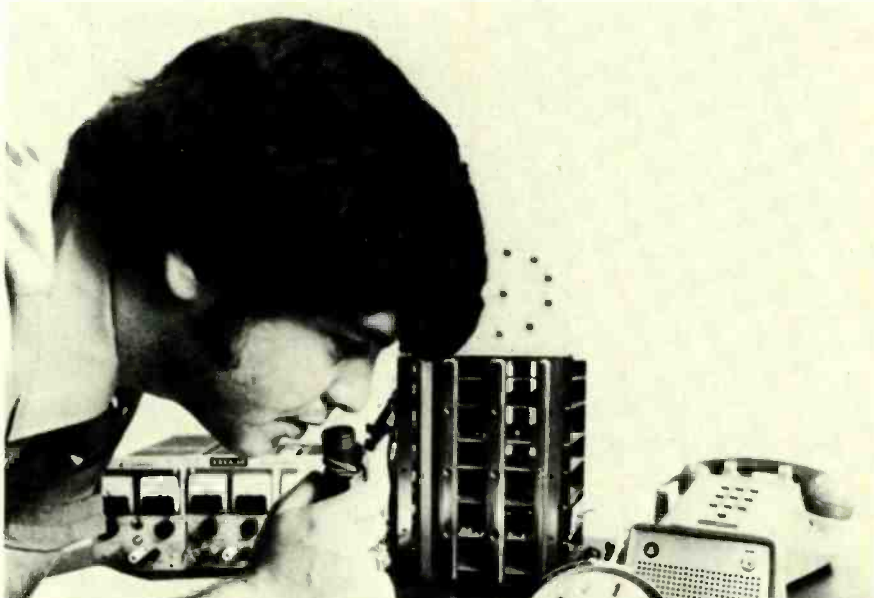
new & timely *(continued from page 12)*

tern from Westerners. They are granted up to three weeks' holiday, but rarely take the time due them, even though most corporations don't pay cash for unused vacation days. The reason offered is that Japanese workers apparently "need to be needed". If they find that their office or factory can get along without them, they feel their place in the system is diminished. As a result, some major firms such as Toyota and Sony have begun shutting down their plants for up to a week during the summer months to force their employees to take the time off.

Voice-control device

Gerald Soloway, co-developer with Meb Awipi and Cliff Hoffman of a new voice control device, "dials" a telephone number by speaking the numerals as they appear lighted in the display at center. The voice control device behind the display converts sound waves from a user's voice into electrical pulses to open and close the electromechanical switches necessary for obtaining a dial tone, executing dialing, and terminating a call. This Bell Lab experimental model may one day be the basis for "hands-free" telephone service specifically intended for motion handicapped persons.



Second annual Hugo Gernsback scholarship award

M. Harvey Gernsback, publisher of **Radio-Electronics,** has announced the Second Annual Hugo Gernsback Scholarship Award for 1972. The program consists of a $125.00 grant to a deserving student of each of eight technical home-study schools serving the electronics field.

The scholarships, sponsored by **Radio-Electronics,** were established in memory of the late Hugo Gernsback, electronics pioneer, inventor and publisher; to perpetuate Mr. Gernsback's interest in developing the technological skills of young people.

Hugo Gernsback founded **Radio-Electronics** magazine in 1929 for electronics service technicians, engineers, and advanced electronics hobbyists. 1972 scholarship award winners will be announced in the magazine during the course of the year.

The eight schools participating in the program are: Bell & Howell Schools; Career Academy; Cleveland Institute of Electronics; CREI, Home Study Division of McGraw-Hill; Grantham School of Engineering; National Radio Institute; National Technical Schools; and RCA Institutes.

ISCET reports

As the International Society of Certified Electronic Technicians (ISCET) enters its second year, Ron Crow (above), the executive director of the organization, reported to the membership. In its short history ISCET has been referred to as "the technical arm of NEA", of which it is a subsidiary. The Society also has achieved a seat on the Electronics Industry Council.

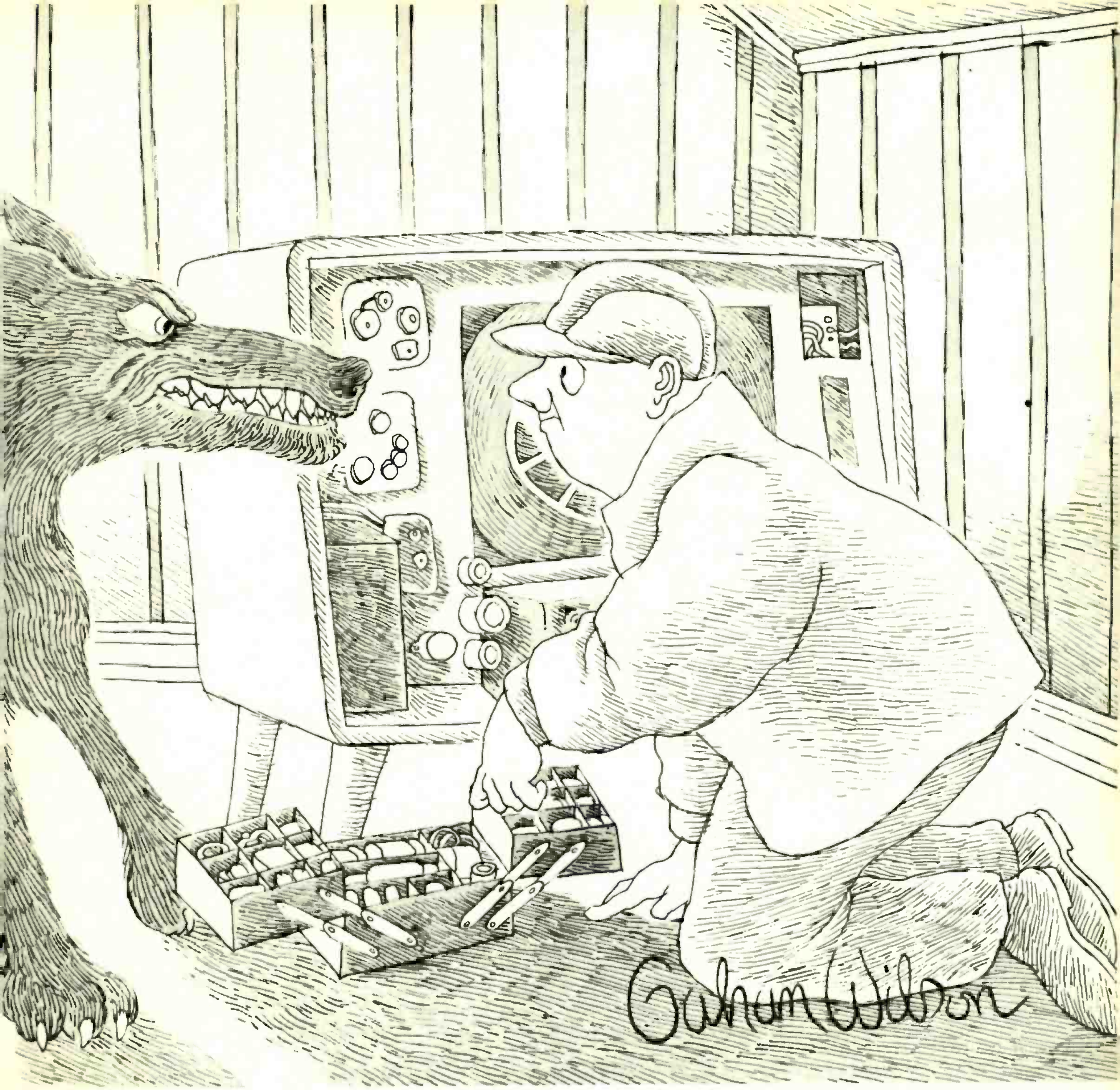
The major goal of ISCET remains "professionalism" for the electronics technician, which in turn reaps benefits on the consumer.

Radio waves "photograph" galaxy

In the Netherlands, radio astronomers have produced a "photograph" of a distant galaxy, as observed in radio waves, almost as detailed as those taken through the most powerful optical telescopes. It is believed that soon they will rival conventional photography. Since the radio emissions expose different aspects of the objects studied than the ones generating light, these pictures should expand man's knowledge of the universe.

The first picture of a distant galaxy was obtained with the Synthesis radio telescope, a mile-long row of 12 identical dish antennas, set up on an east-west line near Westerbork in northern Netherlands.

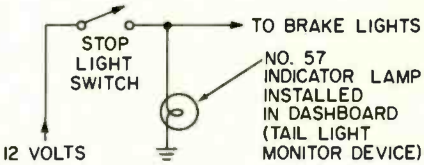
Several questions, including the chief debate in astronomy as to whether the quasars, quasi-stellar radio sources, are lighthouses marking the outermost limits of the observable universe, may possibly be resolved by radio wave "photography". **R-E**



letters

EASY TO MAKE TAIL-LIGHT MONITOR

Graf and Whalen's story in the August 1971 issue, "Tail Light Monitor For Your Car" was interesting to me as a service technician. However, I have built and installed in my own car a tail-light monitor which accomplishes the same purpose, taking advantage of the fact that most cars use the same part of the filament for brake lights and directional lights.



When I step on the brake, if the No. 57 indicator bulb lights, I know the stop-light switch is working, and when I use the directional lights I know the tail bulbs are fine, too.

When I use the directional lights and they don't blink, I know the front or rear bulbs are bad.

EDGARDO SPINELLI
Kew Gardens, N.Y.

4-CHANNEL PREAMP CONTROLS

Mr. Jack Martin of TRW Electronic Supply Co., Philadelphia, Pa. has informed us that some of the IRC Concentrikit components used to make up volume and tone controls for the 4-channel stereo preamp (October 1971) recently were discontinued and may be difficult or impossible to obtain. He adds that the listing of the control parts should be simplified to avoid confusion. The 4-section 50,000-ohm volume control is made up from one Q13-128 and three M13-128 units. Each 4-section bass and treble control is made from one Q13-123 and three M13-123 units.

If the Concentrikit components are not available, Mr. Martin recommends making the controls from components in IRC's Snaptrol line. For the volume control you need one CF63 front section, three CR62 add-on rear sections, one SS1 shaft, one BU1 bushing, one SS7A insert (use between the front and second sections) and two SS13 inserts (use between the second, third and fourth sections).

The bass and treble controls each require one CF52, three CR63's, one SS1, a BU1, a SS7A, two SS13's.

Where's the voltmeter?

New Scope Measures Peak-To-Peak Voltage with Cali-Brain®

You're looking at it in this solid state oscilloscope. The new B & K Precision 1465 is a triggered sweep oscilloscope with CALI-BRAIN – a built-in feature for measuring voltages, automatically without computation in seconds. CALI-BRAIN will measure peak-to-peak voltage on waveforms of any complexity – and at voltage levels from 10mV to 600 V. Only B & K scopes have CALI-BRAIN – a real advance in TV test equipment.

Servicing time goes down – picture quality goes up – when you use this scope. Now, in one instrument, you get triggered sweep to eliminate those waveforms that won't lock in, a vectorscope for color TV servicing, 10 MHz response for high resolution analysis. A unique sync separator generates special sweep synchronizing pulses to let you analyze any portion of the TV waveform. For economical performance, use the B & K Precision 1465.

About the Cali-Brain® System

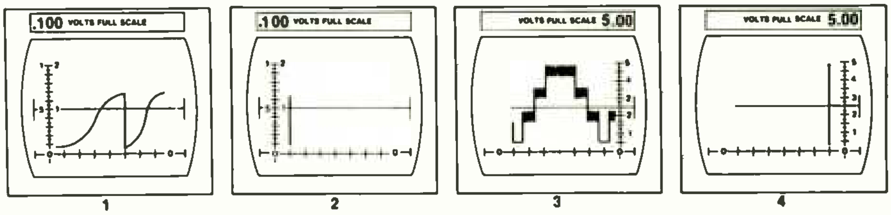
The CALI-BRAIN system increases your efficiency because it lets you measure its peak-to-peak voltage without changing your test set-up. Now you can confirm the manufacturer's service data exactly – checking out typical waveforms and peak-to-peak voltage readings at various test points.

Cali-Brain® in Action

Use CALI-BRAIN when you want to measure peak-to-peak voltage of the waveform displayed on the scope screen. Here's what happens when the CALI-BRAIN switch is activated:

A. The horizontal sweep collapses and the waveform under examination appears as a straight vertical line.
B. A numerical indicator in the CRT bezel lights up to show the full scale voltage (including decimal point) corresponding to the Vertical Attenuator setting.
C. A graduated scale on the graticule overlay is illuminated on either side of the scope screen. The scale corresponds to the full scale voltage indicator in the bezel.
D. The vertical waveform line on the CRT moves to either side of the screen, to align itself with the illuminated scale.

The entire CALI-BRAIN action is automatic – and takes less than a second. After you have read waveform voltage on the scale, you deactivate CALI-BRAIN system with a single switch, and the waveform is again displayed as before. One probe and one test instrument – lets you concentrate on trouble shooting, not the test equipment!



1 2 3 4

To read peak-to-peak voltages utilizing Cali-Brain, note the full scale voltage reading in the bezel above the screen (fig. 1–.100 volts full scale) (fig. 3–5.00 volts full scale). Pull out the Cali-Brain knob and you will notice that the 1st waveform in fig. 2. reads .067 volts P-P and the second waveform in fig. 4. reads 4.95 volts P-P.

See your local distributor or write us for more information

B&K

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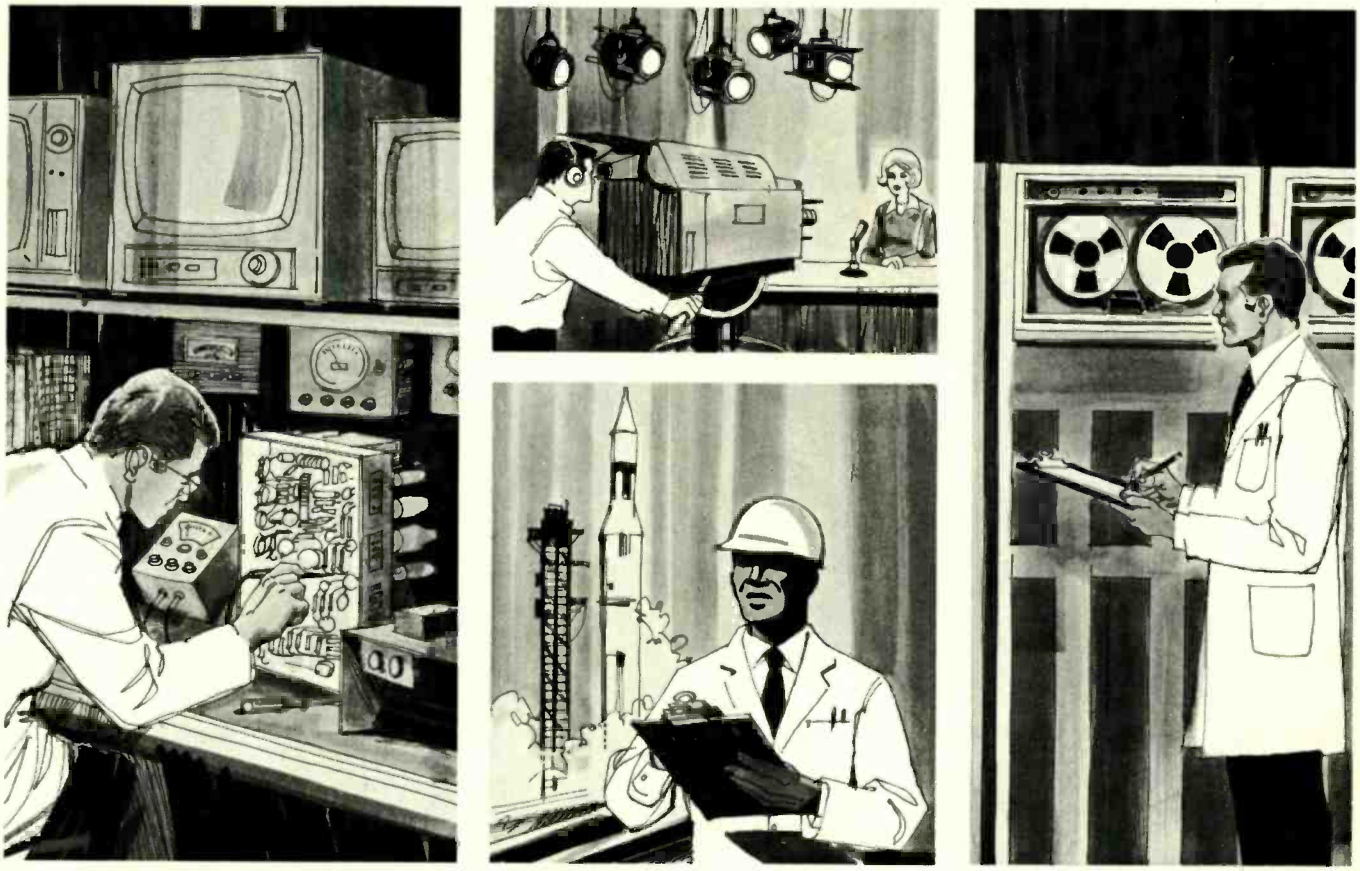
Circle 7 on reader service card

Great careers



Join the high-paid electronics technicians who got their start through NTS Home Training.

Your home can become your own private classroom-workshop. NTS sends you everything you need to learn valuable technical skills in electronics. You get easy-to-grasp lessons, comprehensive kit manuals, large fold-out charts, and more. Plus the finest professional equipment available today. It's all included in your tuition, yours to keep.

Your equipment is sent to you in kit form, matched to lesson material. With the NTS Project Method, you start with simple projects, then move from basics to more complex concepts. You discover how electronic principles work by performing practical, fascinating experiments. Learn at your own pace.

You quickly become expert in the actual equipment and methods you'll use on the job. And soon you're ready to cash in on the tremendous opportunities in the expanding, exciting world of electronics!

If your field is television, you might decide to join a first-class TV repair center. Or start a shop of your own. Or specialize in industrial applications of television. Once you master an area of electronics, the direction you take is really up to you. And you'll be able to use the test instruments you built yourself!

It all begins at home, with NTS Project Method Training. Find out how fast and easy it is to learn skills that pay off. Check card or coupon today for your *free* full-color NTS Catalog and complete details. No obligation. No salesman will call.

NTS COLOR AND B&W TV SERVICING

Build the largest, most advanced color TV made! Over-all solid-state design, 315 sq. in. ultra-rectangular screen, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state VHF tuner, and much more! Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, hi-fi, stereo, multiplex systems, radio, color and B&W TV servicing.

Solid-state B&W TV 74 sq. in. picture (cabinet included)

Learn sophisticated solid-state circuitry as you build this B&W TV receiver. Course covers the full range of home entertainment electronics.

appliance clinic

BLACK IS WHITE AND WHITE IS BLACK

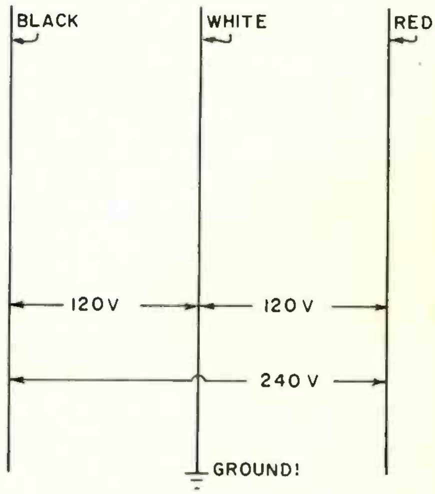
I HAD ANOTHER TITLE FOR THIS, which was even more confusing! "Black Is Hot, And White Is Not, and Vice is Often Versa!" This has nothing to do with integration or anything like that. It refers to a squabble that's been going on between electronics men and electricians for a long time. Since it is something that we both run into every day, I thought it might be a good idea to "issue a reminder" about it.

It has to do with the color-coding of wires. Electronics-trained men think of black wires as *always* being ground. White wires are always "hot," in the sense of being at a potential above ground. (Actually, the Code for a white wire means that it is the center-tap of an i.f. transformer.

Electricians use an entirely different coding, and it *is* a standard Code, by the way. If I'm not mistaken, this is from the NEC (National Electrical Code). For all 120/240-volt systems of home and industrial wiring, the black wire is always hot, and the white wire is always ground (or "neutral": same thing). So there is the possibility of confusion for both of us, if we get into the other's territory. This is most important where dangerous voltages exist.

There has been a lot of uproar lately about safety, proper grounding, and so on. So if We (electronics men) get into any household wiring problems, we must remember which wire is which! Don't ever reach into a box and grab a black wire, secure in the conviction that "Black is always ground." It isn't! (As you'll find out, as soon as you come to.)

In the three-wire 240-volt services found in many homes today, you'll find a three-wire cable. This is used for many large appliances—clothes driers, water heaters, and so on. Once again, the white wire is the ground or neutral, the black wire is one of the hot ones, and the remaining wire is probably red; also hot. (and now they're getting back to our code, where red wires are always hot!) The diagram shows the voltages and colors used.



This is a "single-phase 240-volt" system. You get the full 240 volts between the two colored conductors, and 120 volts between either of the colored conductors and the white or ground wire. Appliances using 240 volts are connected to the colored wires only, and all of the 120-volt loads are connected to one or the other colored wire and the white wire as a common. (This is exactly the same as our familiar power supply transformer with a center-tapped secondary. Of course, the transformer, out on the pole, is about 3 feet bigger!)

So when you hook up any appliance that requires a ground, check the connections to the electrical outlet, and connect the ground to the terminal with the white wire. You might run into this if the unit has a polarized plug, or one of the later plugs—the one with the two flat pins and a third, round pin, which is always ground. Incidentally, in the line cord to the appliance, this third wire is coded green.

Don't be over-confident. Just as in lots of electronics gear, you'll find cases where the maker did NOT use standard color-coding, or where some inexperienced electrician hooked up the wire-colors incorrectly! (I could show you some wiring like that in my own home; installed a long, long time ago!) So, for safety's sake test! Use a neon test-lamp, and a known ground such as a cold water pipe. This, plus an ac voltmeter, will tell you exactly what voltage you have, and where.

One good example of a use for this is the "line-connected" TV or radio chassis. These things should always be hooked up with polarized plugs, so that it cannot be plugged in with the hot side of the ac line connected to the *chassis*. If it does not have a polarized plug, and far too many of them did not, install one. Check the outlet, and if necessary

(continued on page 92)

Circle 9 on reader service card

New Heathkit AR-1500 stereo receiver

...the critics say it all:

"The AR-1500 is the most powerful and sensitive receiver we have ever measured..."
—JULIAN HIRSCH, *Stereo Review*

"...a stereo receiver easily worth twice the cost (or perhaps even more)..."
—*Audio Magazine*

"Great new solid-state stereo receiver kit matches the demands of the most golden of golden ears."
—*Radio Electronics*

Mr. Hirsch goes on to say: "The FM tuner section of the AR-1500 was outstandingly sensitive. We measured the IHF sensitivity at 1.4 microvolts, and the limiting curve was the steepest we have ever measured ...The FM frequency response was literally perfectly flat from 30 to 15,000 Hz. ...Image rejection was over 100 dB (our measurement limit)...

"The AM tuner was a pleasant surprise...It sounded very much like the FM tuner, with distinct sibilants and a quiet background, and was easily the best-sounding AM tuner we have had the pleasure of using...

"...all input levels can be matched and set for the most effective use of the loudness compensation. This valuable feature is rarely found on high fidelity receivers and amplifiers...

"The phono equalization was perfectly accurate (within our measuring tolerance)...The magnetic phono-input sensitivity was adjustable from 0.62 millivolt to about 4.5 millivolts, with a noise level of –66 dB, which is very low...When properly set up, it would be impossible to overload the phono inputs of the AR-1500 with any magnetic cartridge...

"...it significantly bettered Heath's conservative specifications. Into 8-ohm loads, with both channels driven, the continuous power at clipping level was 81.5 watts per channel. Into 4 ohms it was 133 watts per channel, and even with 16-ohm loads the receiver delivered 46.5 watts per channel. Needless to say, the AR-1500 can drive any speaker we know of and with power to spare...

"At 1,000 Hz, harmonic distortion was well under 0.05 per cent from 1 to 75 watts per channel...The IM distortion was under 0.05 per cent at a level of a couple of watts or less, and gradually increased from 0.09 per cent at 10 watts to 0.16 per cent at 75 watts...The heavy power transformer is evidence that there was no skimping in the power supply of the AR-1500, and its performance at the low-frequency extremes clearly sets it apart from most receivers...

"Virtually all the circuit boards plug into sockets, which are hinged so that boards can be swung out for testing or servicing without shutting off the receiver. An 'extender' cable permits any part of the receiver to be operated 'in the clear' — even the entire power-transistor and heat-sink assembly! The 245-page manual has extensive tests charts that show all voltage and resistance measurements in key circuits as they should appear on the receiver's built-in test meter...

"With their well-known thoroughness, Heath has left little to the builder's imagination, and has assumed no electronic training or knowledge on his part. The separate packaging of all parts for each circuit board subassembly is a major boon...

"In sound quality and ease of operation, and in overall suitability for its intended use, one could not expect more from any high-fidelity component."

From the pages of *Audio Magazine:* "...the AR-1500 outperforms the near-perfect AR-15 in almost every important specification...

"The FM front end features six tuned circuits and utilizes three FETs, while the AM RF section has two dual-gate MOSFETs (for RF and mixer stages) and an FET oscillator stage. The AM IF section features a 12-pole LC filter and a broad band detector. The FM IF section is worthy of special comment. Three IC stages are used and there are two 5-pole LC filters...

"...IHF FM sensitivity...turned out to be 1.5 uV as opposed to the 1.8 uV claimed. Furthermore, it was identical at 90 MHz and 106 MHz (the IHF spec requires a statement only for IHF sensitivity at 98 MHz but we always measure this important spec at three points on the dial). Notice that at just over 2 microvolts of input signal S/N has already reached 50 dB. Ultimate S/N measured was 66 dB and consisted of small hum components rather than any residual noise. THD in Mono measured 0.25%, exactly twice as good as claimed! Stereo THD was identical, at 0.25% which is quite a feat...

"...the separation of the multiplex section of the AR-1500 reaches about 45 dB at mid-band and is still 32 dB at 50 Hz and 25 dB at 10 kHz (Can your phono cartridge do as well?)...

"The real surprise came when we spent some time listening to AM... This new AM design is superb. We still have one classical music station that has some simultaneous broadcasting on its AM and FM outlets and that gave us a good opportunity to A-B between the AM and FM performance of the AR-1500. There was some high-frequency roll-off to be sure, but BOTH signals were virtually noise-free and we were hard pressed to detect more THD from the AM than from the FM equivalent. Given AM circuits like this (and a bit of care on the part of broadcasters), AM may not be as dead as FM advocates would have us believe!...

"As for the amplifiers and preamplifier sections, we just couldn't hear them — and that's a commendation. All we heard was program material (plus some speaker coloration, regrettably) unencumbered by audible distortion, noise, hum or any other of the multitude of afflictions which beset some high fidelity stereo installations.

"Rated distortion [0.24%] is reached at a [continuous] power output of 77.5 watts per channel with 8 ohm loads (both channels driven). At rated output (60 watts per channel) THD was a mere 0.1% and at lower power levels there was never a tendency for the THD to 'creep up' again, which indicates the virtually complete absence of any 'crossover distortion' components. No so-called 'transistor sound' from this receiver, you can be sure. We tried to measure IM distortion but kept getting readings of 0.05% no matter what we did. Since that happens to be the 'limit' of our test equipment and since the rated IM stated by Heath is 'less than 0.1% at all power levels up to rated power output' there isn't much more we can say except that, again, the unit is better than the specification — we just don't know how much better...

"As always, construction instructions are lucid enough for the inexperienced kit-builder and there is enough technical and theoretical information to satisfy even the most knowledgeable audio/RF engineer."

Kit AR-1500, less cabinet, 53 lbs. **349.95***
ARA-1500-1, walnut cabinet, 8 lbs. **24.95***

and two precedent-setting oscilloscopes

New Heathkit dual trace DC-15 MHz solid-state scope sets a low-price precedent in high performance

Heathkit 5" IO-102 brings you solid-state scope performance on a budget

The new Heathkit IO-105 brings you a high performance scope designed for a wide range of measurements in instrumentation courses, engineering, R&D and electronics...at a fraction of the cost of comparable scopes. The big 5" (8x10 cm flatface) CRT provides separate signal display in channel 1 or channel 2 modes, direct comparison display in alternate and chopped modes, x-y mode for presentation of signals as a function of each other. Has triggered time base with 18 calibrated rates, 0.2 us/cm – 100 ms/cm in 1,2,5 sequence, ±3%; x5 sweep magnification. Compare the price, compare the specs... then order your IO-105 today.

Kit IO-105, 40 lbs., mailable **399.95***

IO-105 SPECIFICATIONS — VERTICAL — Accuracy: ±3%. **Input impedance:** 1 megohm shunted by 35 pF. **Maximum input voltage:** 600 VDC. **Sensitivity:** AC or DC, 0.05 V/cm. **Frequency response:** DC to 15 MHz, 3 dB with 4 cm deflection. **Vertical windows:** 2 minimum. **Rise time:** 24 ns. **Overshoot:** Less than 10%. **Attenuator:** 9 positions in a 1,2,5 sequence. 0.05 V/cm to 20 V/cm, ±3%. Variable gain (uncalibrated) thru entire range. **Vertical display in sweep mode:** Channel 1, Channel 2, Channel 1 & 2 alternately; or Channel 1 & Channel 2 chopped (50 kHz). **HORIZONTAL — Time base:** Triggered with 18 calibrated rates, 0.2 us/cm to 100 ms/cm in a 1, 2, 5 sequence, ±3%. Continuously variable (uncalibrated) within the same range. **Sweep magnifier:** x5 (time base accuracy is ±5% when the magnifier is being used). **External horizontal input:** 750 millivolts/cm (uncalibrated & not adjustable). 100 K ohm minimum input impedance, DC to 100 kHz. **X-Y MODE — Sensitivity:** 0.05 V/cm to 20 V/cm, ±3%. **Frequency response:** −3 dB @ 100 kHz (Channel 2). **Phase shift between channels:** ±5° or less from DC to 50 kHz within graticule limits. **TRIGGERING — Delay:** Approx. 600 ns. **Auto:** Zero crossing ±½ cm of zero crossing. **Norm:** Within viewing area. **Source:** Channel 1, Channel 2, or Channels 1 & 2. **Polarity:** + or − slope. **Coupling:** AC or DC. **Sensitivity:** Internal, ½ cm; external, 100 mV minimum, 7 V max. **GENERAL — Blanking in:** TTL compatible (Logic 0-blank). **Gate out:** 3.5 volts minimum. **Input connections:** Vertical, coaxial & BNC; horizontal, binding post; external trigger, binding post on ¾" center with ground. **CRT accelerating potential:** 2200 VDC regulated. **CRT type:** 8x10 cm, rectangular, flat-face, D14-107GA. **Retrace suppression:** DC coupled unblanking of the CRT. **Graticule:** 8 cm x 10 cm grid, edge lighted. **Power requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 60 watts. **Warm-up time:** CRT heating time, approx. 30 seconds; for full calibration, approx. 15 minutes. **Overall dimensions:** 12⅜" H x 10⅝" W x 15" D. **Note:** Specifications measured at 25° C with 120 VAC line voltage.

The Heathkit IO-102 general purpose scope combines the virtues of top performance, maximum convenience and low cost. All solid-state design is your assurance of long-term reliability under sometimes rough shop conditions. Wide 5 MHz bandwidth, 30 mV/cm sensitivity and 80 nanosecond rise time add up to truly unusual value at this low price. Switch-selected AC or DC coupling adds extra convenience and versatility. Frequency-compensated 3-position attenuator accommodates varying input levels. A separate switch position grounds the input to provide a zero reference line. One megohm FET input minimizes circuit loading. The recurrent, automatic sync type sweep generator provides continuous sweep from 10 Hz to 500 kHz. Front panel external horizontal and sync inputs. One volt P-P output included. The 5" flat-face 5DEP1 CRT gives a brilliant, highly visible trace, even in high light levels. 6x10 cm ruled graticule makes amplitude easy to determine. All supplies are zener-regulated to give the IO-102 excellent display stability. 120/240 VAC wiring options. Put this top value scope to work for you now.

Kit IO-102, 31 lbs. **119.95***

Assembled IOW-102, 29 lbs. **179.95***

IO-102 SPECIFICATIONS — VERTICAL CHANNEL — Sensitivity: 30 mV/cm, uncalibrated. **Frequency Response:** DC to 5 MHz, ±3 dB. **Rise Time:** 80 nanoseconds. **Input Impedance:** 1 megohm shunted by 35 pF. **Attenuator:** 3-position, frequency compensated; x1, x10, x100. **HORIZONTAL CHANNEL — Sensitivity:** 0.1 V/cm. **Frequency Response:** 1 MHz ±3 dB. **Input Impedance:** 1 megohm shunted by 50 pF. **Sweep Generator-Type:** Recurrent, automatic sync. **Range:** 10 Hz to 500 kHz in five switch-selected steps, continuously variable between steps. **GENERAL — Cathode Ray Tube:** Type, 5DEP1, green medium persistance phosphor. **Viewing area**, 6x10 cm. **Power Supplies:** All solid-state rectifiers. All amplifier supplies regulated. **Power Requirements:** 120/240 VAC, 50-60 Hz, 35 watts. **Overall Dimensions:** 12¾" H x 9¼" W x 16¼" L, including knobs, handle, feet, etc.

See these kits at your local Heathkit Electronic Center... or fill out the coupon at right.

ARIZ.: Phoenix, 2727 W. Indian School Rd.; **CALIF.: Anaheim**, 330 E. Ball Rd.; **El Cerrito**, 6000 Potrero Ave.; **Los Angeles**, 2309 S. Flower St.; **Redwood City**, 2001 Middlefield Rd.; **San Diego (La Mesa)**, 8363 Center Dr.; **Woodland Hills**, 22504 Ventura Blvd.; **COLO.: Denver**, 5940 W. 38th Ave.; **FLA.: Miami (Hialeah)**, 4705 W. 16th Ave.; **GA.: Atlanta**, 5285 Roswell Rd.; **ILL.: Chicago**, 3462-66 W. Devon Ave.; **Downers Grove**, 224 Ogden Ave.; **KANSAS: Kansas City (Mission)**, 5960 Lamar Ave.; **MD.: Rockville**, 5542 Nicholson Lane; **MASS.: Boston (Wellesley)**, 165 Worcester St.; **MICH.: Detroit**, 18645 W. Eight Mile Rd. & 18149 E. Eight Mile Rd.; **MINN.: Minneapolis (Hopkins)**, 101 Shady Oak Rd.; **MO.: St. Louis**, 9296 Gravois Ave.; **N.J.: Fair Lawn**, 35-07 Broadway (Rte. 4); **N.Y.: Buffalo (Amherst)**, 3476 Sheridan Dr.; **New York**, 35 W. 45th St.; **Jericho, L.I.**, 15 Jericho Turnpike; **Rochester**, Long Ridge Plaza; **OHIO: Cincinnati (Woodlawn)**, 10133 Springfield Pike; **Cleveland**, 5444 Pearl Rd.; **PA.: Philadelphia**, 6318 Roosevelt Blvd.; **Pittsburgh**, 3482 Wm. Penn Hwy.; **TEXAS: Dallas**, 2715 Ross Ave.; **Houston**, 3705 Westheimer; **WASH.: Seattle**, 2221 Third Ave.; **WIS.: Milwaukee**, 5215 Fond du Lac.

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20-1

Circle 100 on reader service card

equipment report

B & K 747 Dyna-Jet Tube Tester

Circle 26 on reader service card

EVERY SO OFTEN SOME CLOD TELLS ME. "But you don't need a tube-tester any more!" This is very peculiar, and shows an almost total unfamiliarity with the facts of life. There are millions of TV sets in this country with tubes; not to mention radios, amplifiers, etc.

So there will always be a need for a test instrument like the new B & K 747 Dyna-Jet Tube Tester. (Oddly enough, they call it a "Solid-State Dynamic Mutual Conductance" tube tester. It uses an FET in the short and grid-emission tests!)

The basic idea behind the design of this instrument is fast operation. Pull 'em out, plug 'em in, push the button and away you go. There are 21 sockets on the special Jet-Check board. Each of these fits one of the most commonly encountered tube-types used in radio-TV sets. In fact, each of these sockets will test as many as five different tubes. All you have to do is set the HEATER VOLTAGE and SENSITIVITY controls, plug the tube in and bang. Push the button and there it is. For more convenience, the TUBE TYPE and SENSITIVITY control setting is printed right on the board alongside each socket. You get the heater voltage from the type number; 6JE6 is 6 volts, and so on. Everything else is preset. So, this allows you to quick-check practically all of the tubes most likely to be causing trouble, without even having to look them up in the chart.

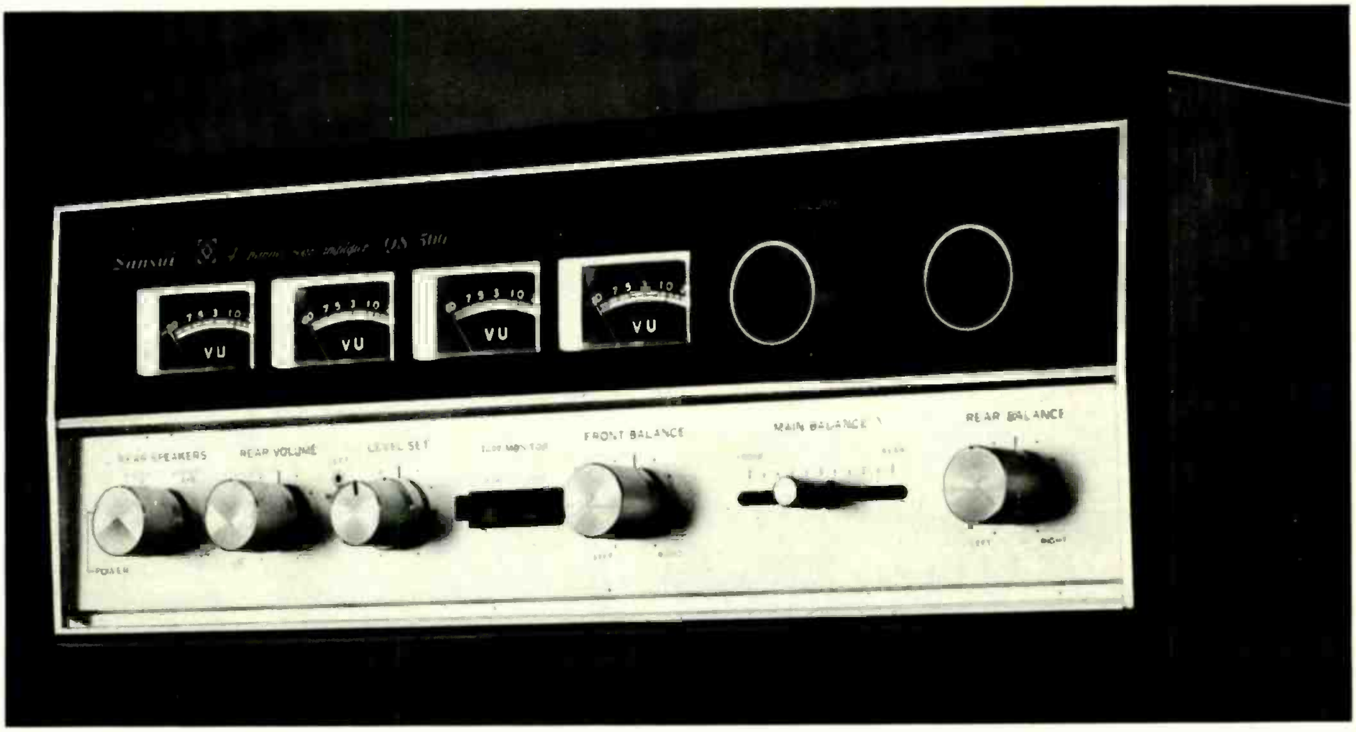
For the rest of the tubes, an array of switches is set up in a PROGRAMMED-TEST bank, just below the Jet-Check section. Another row of sockets is used with these, one for each present base (including those weird little 10-pin mini's). By setting these switches, you can connect any element of any tube to any pin of the socket. The switches are designed so that any pin of the tube can be left open. This is a surprisingly handy thing. So many tubes now have internal jumpers and connections that chart makeup can be a disaster area! All of these can be disabled by simply leaving them open. (Look at the base connections of a 1X2B as an example.)

All standard tests are provided; gas, grid emission, shorts and mutual conductance. The mutual-conductance test is made by hooking the tube up as an amplifier, applying a dc bias to the grid, and a rectified dc voltage to the plate. It is a part of a bridge circuit; the meter then reads the output signal, giving a reading of the true mutual conductance of the tube.

The short check uses a neon lamp as the indicator. Dc bias is applied to the grid, and dc voltage between plate and cathode. The screen is grounded; any shorts to plate or cathode fires the neon lamp. A short to the grid, which is connected to the gate of a FET, will make the meter read into the GRID EMISSION REJECT part of the scale.

The grid emission test is becoming very popular, especially in color TV. Believe me when I say that grid emission can cause some of the most weird and wonderful color troubles imaginable. All tubes in the color circuits should be tested for this. Once again, the FET is used as a meter-driver; the tube under test is biased well below cutoff, although all normal voltages are applied. If there is any grid emission, current flows to the FET gate, and the meter reads. This test will detect as little as 0.5 μA grid-current. (100 megohms of leakage resistance.) For another example, a color set gradually drew more and more 6JE6 cathode current until it tripped the breaker. Finally turned out to be grid-emission in the 6JE6! **R-E**

if you go for four channel...



you don't have to go for broke

Buy yourself a miracle for as little as $209.95. That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

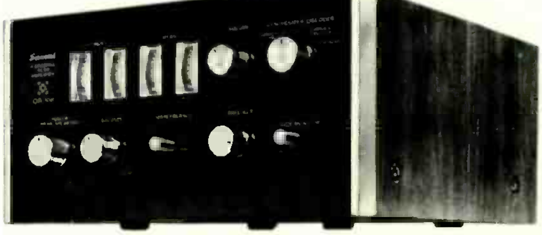
The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $279.95.

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $209.95.



Sansui®

SANSUI ELECTRONICS CORP.

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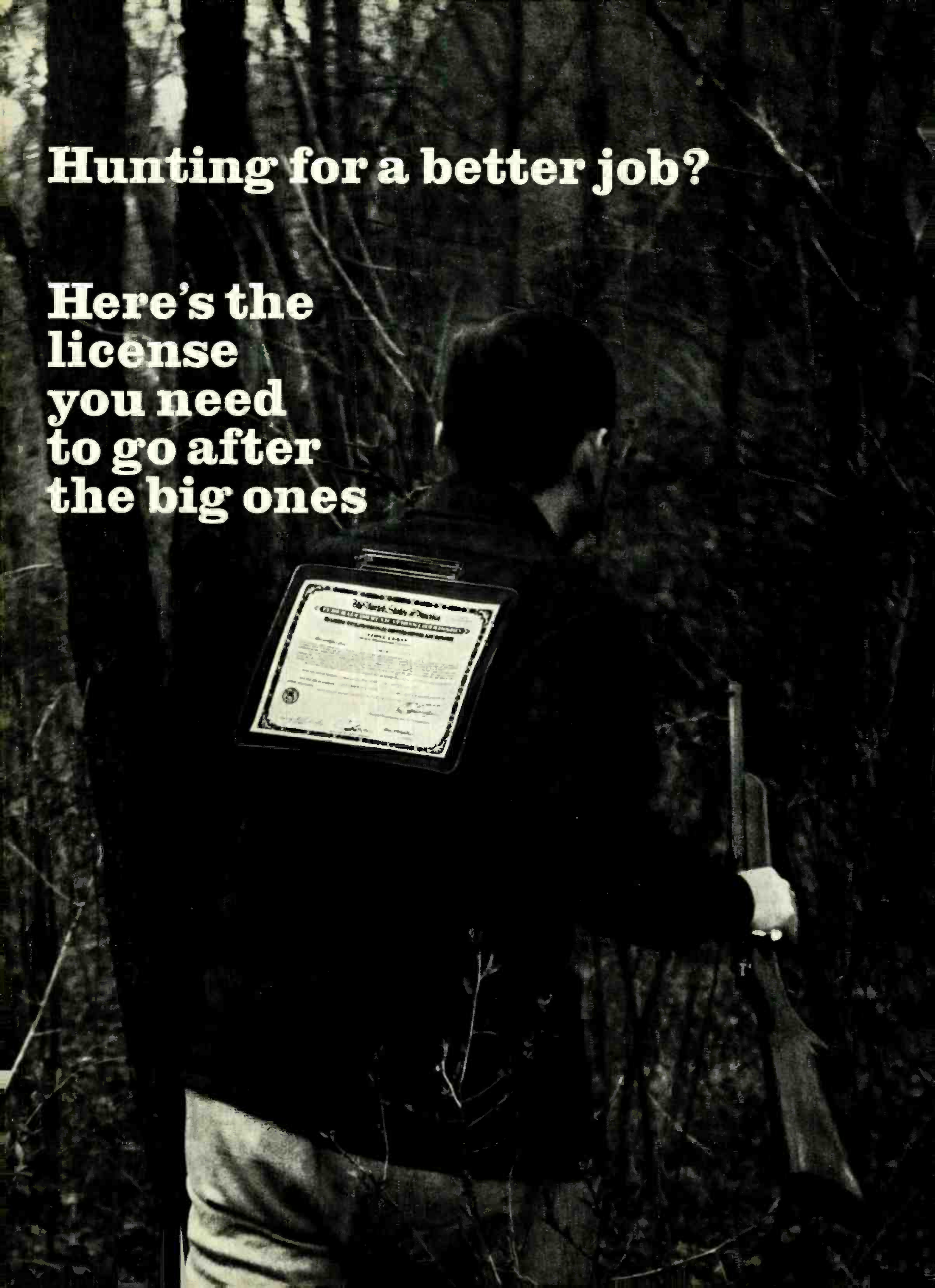
Circle 11 on reader service card


Hunting for a better job?
Here's the license you need to go after the big ones

A Government FCC License can help you bring home up to $10,000, $12,000, and more a year. Read how you can prepare for the license exam at home in your spare time—with a passing grade assured or your money back.

IF YOU'RE OUT TO BAG A BETTER JOB in Electronics, you'd better have a Government FCC License. For you'll need it to track down the choicest, best-paying jobs that this booming field has to offer.

Right now there are 80,000 new openings every year for electronics specialists—jobs paying up to $5, $6, even $7 an hour...$200, $225, $250, a week... $10,000. $12,000, and up a year! You don't need a college education to make this kind of money in Electronics, or even a high school diploma.

But you *do* need knowledge, knowledge of electronics fundamentals. And there is only one nationally accepted method of measuring this knowledge...the licensing program of the FCC (Federal Communications Commission).

Why a license is important

An FCC License is a legal requirement if you want to become a Broadcast Engineer, or get into servicing any other kind of transmitting equipment—two-way mobile radios, microwave relay links, radar, etc. And even when it's not legally required, a license proves to the world that you understand the principles involved in *any* electronic device. Thus, an FCC "ticket" can open the doors to thousands of exciting, high-paying jobs in communications, radio and broadcasting, the aerospace program, industrial automation, and many other areas.

So why doesn't everyone who wants a good job in Electronics get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of 10 CIE graduates who take the exam pass it. That's why we can back our courses with this iron-clad Warranty: Upon completing one of our FCC courses, you must be able to pass the FCC exam and get your license—or you'll get your money back!

They got their licenses and went on to better jobs

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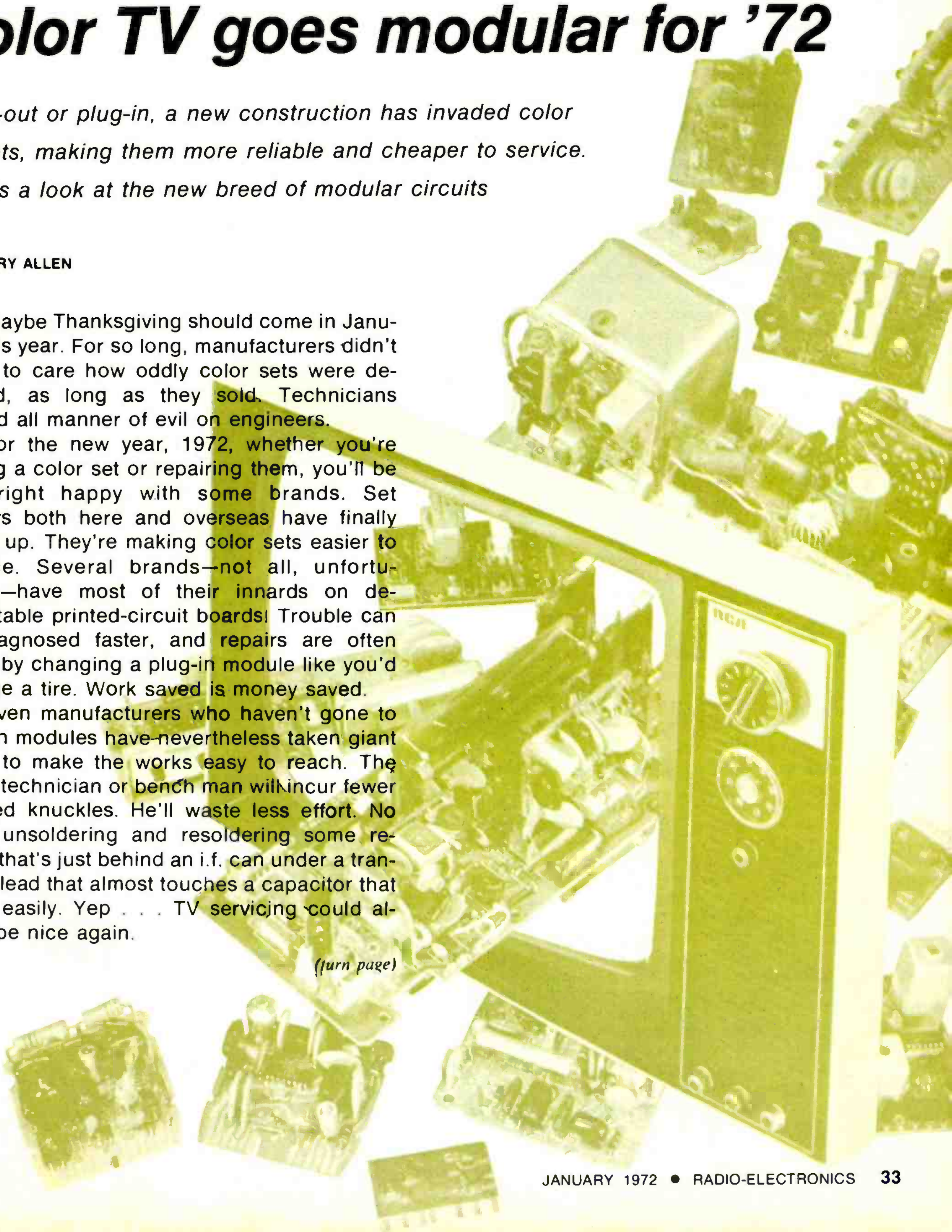
Circle 12 on reader service card

color TV goes modular for '72

Snap-out or plug-in, a new construction has invaded color TV sets, making them more reliable and cheaper to service. Here's a look at the new breed of modular circuits

by LARRY ALLEN



Maybe Thanksgiving should come in January this year. For so long, manufacturers didn't seem to care how oddly color sets were designed, as long as they sold. Technicians wished all manner of evil on engineers.

For the new year, 1972, whether you're buying a color set or repairing them, you'll be downright happy with some brands. Set makers both here and overseas have finally wised up. They're making color sets easier to service. Several brands—not all, unfortunately—have most of their innards on demountable printed-circuit boards! Trouble can be diagnosed faster, and repairs are often made by changing a plug-in module like you'd change a tire. Work saved is money saved.

Even manufacturers who haven't gone to plug-in modules have nevertheless taken giant steps to make the works easy to reach. The home technician or bench man will incur fewer skinned knuckles. He'll waste less effort. No more unsoldering and resoldering some resistor that's just behind an i.f. can under a transistor lead that almost touches a capacitor that melts easily. Yep . . . TV servicing could almost be nice again.

(turn page)

Module pioneering

Motorola started plug-in modularization. Other manufacturers bad-mouthed that first Quasar. "Not practical." "Cost too much to build." "Wait till those connector pins get loose." The 1967–68 season was proving time.

And it wasn't all roses. There were bugs. Motorola oversold the idea that Quasar could be repaired at home. Technicians caught flak when a defect was on the main chassis, in a tuner, or (heaven forbid) in a connector.

But the all-transistor Quasar did work. It made color-TV history. Sales moved so well that the price came down, the plug-in technology spruced up, and solid-state modular color became accepted. Quasar II follows the pattern, but with a few tubes for economy. The main Quasar this year incorporates marked improvements.

Lets look at the Motorola modules. "Works in a drawer" accessibility, as Fig. 1 depicts, is still a major Quasar selling point. One panel drops down so a technician can get at two of the boards.

Fig. 2 pinpoints the screw and strip that hold video-i.f./sound and aft modules in the chassis. And Fig. 3 shows the two modules after they're unplugged. I'm pointing to the flat-pack audio IC in that section of the i.f. module.

Fig. 4 gives you some idea of the mechanics of Motorola's newest plug-ins. Long pins protrude upward (beneath the board being lifted). Others plug into the other end, and sometimes along the sides. Teflon fasteners (Fig. 5) hold some boards in place.

The board sockets are shown close-up in Figs. 6 and 7. Leaf-type spring contactors in the receptacles make surface

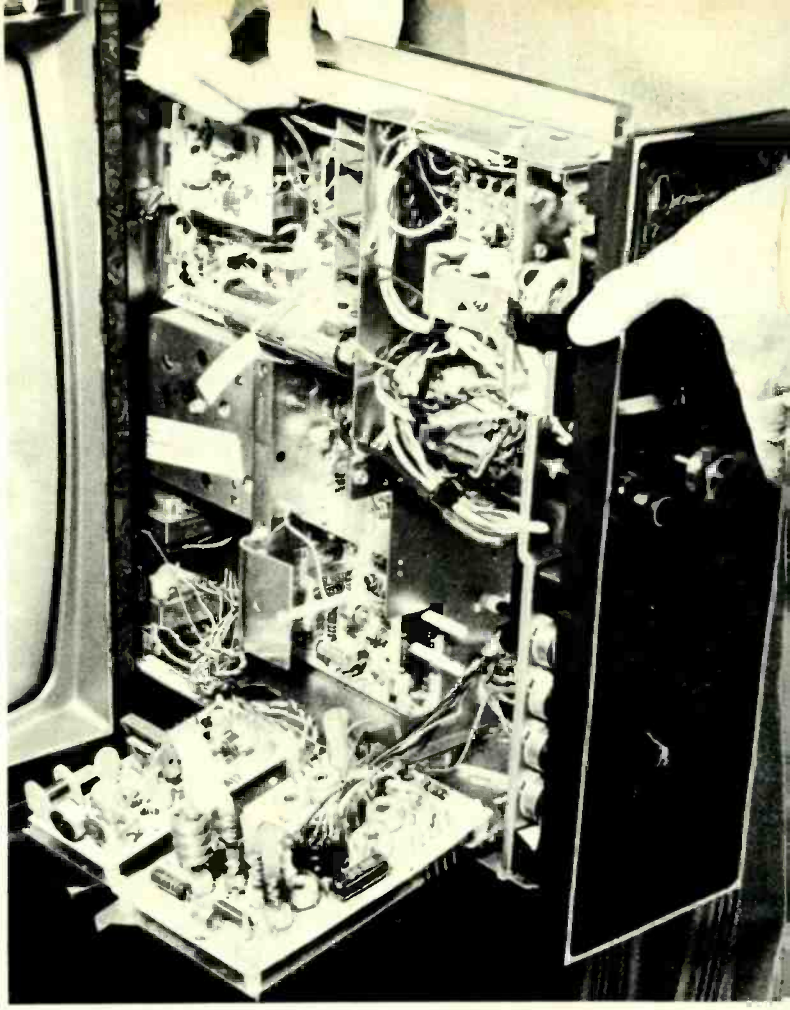


FIG. 1—QUASAR WORKS in a drawer (above) is key to Motorola's approach.

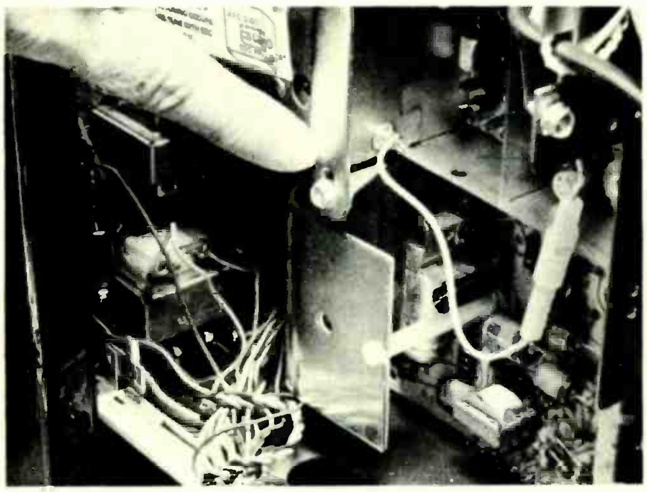


FIG. 2—SCREW AND STRIP (left) hold video-i.f./sound and aft modules to Quasar.

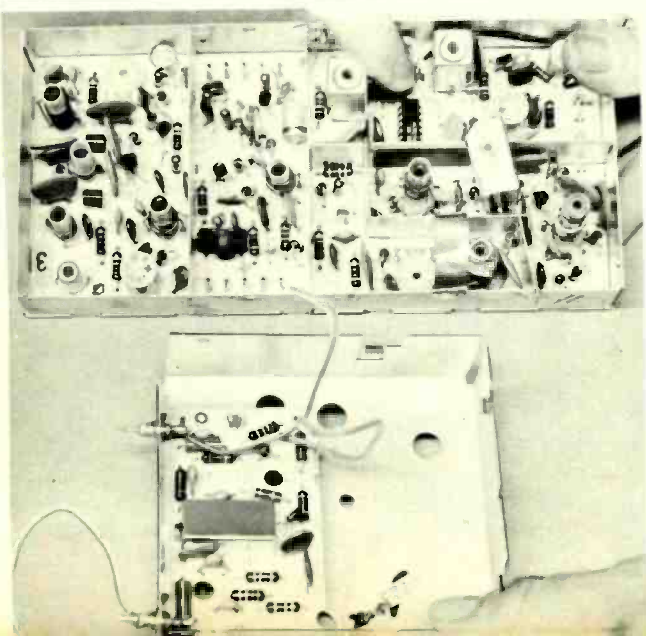


FIG. 3—UNPLUGGED modules (left). Note DIP IC. It's the audio section.

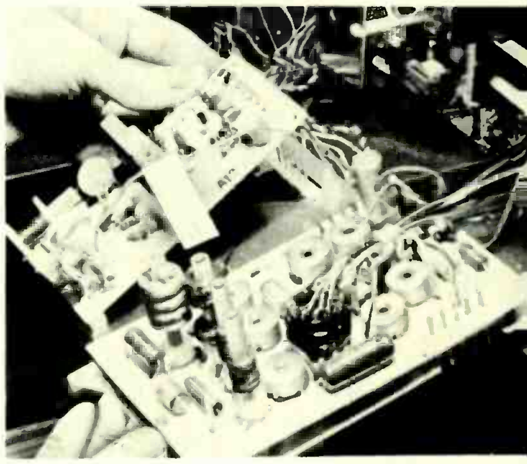


FIG. 4—LONG PINS (right) on both ends of the plug-in board act as connectors.

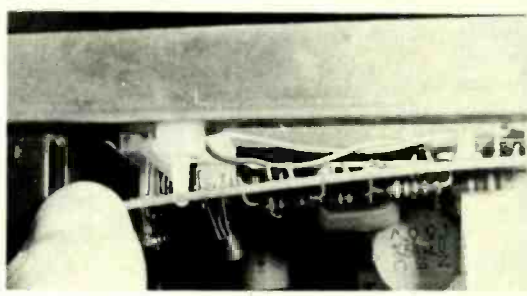


FIG. 5—TEFLON FASTENERS (right) hold some Quasar boards. These are press-latch types.

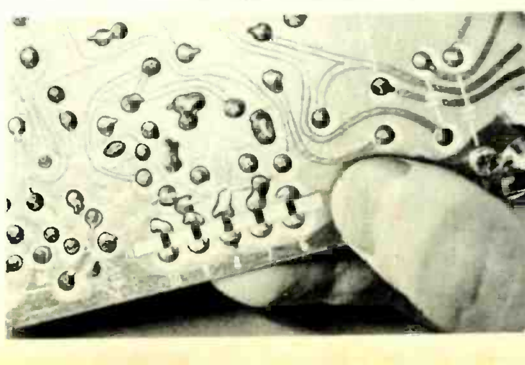
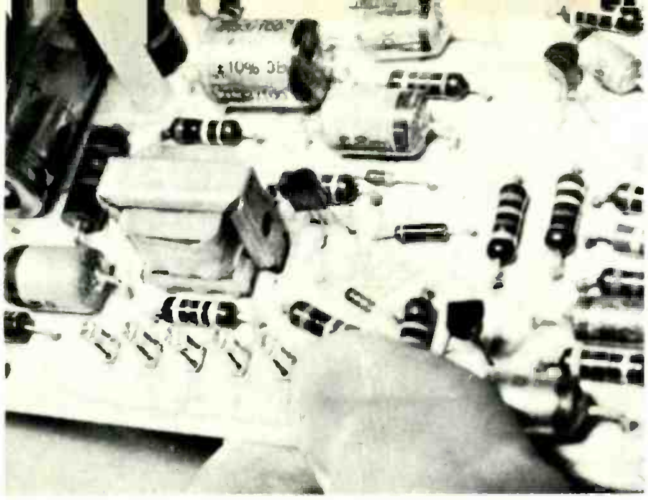


FIG. 6—LEAF-TYPE spring contactors (right) make surface rather than point contact.



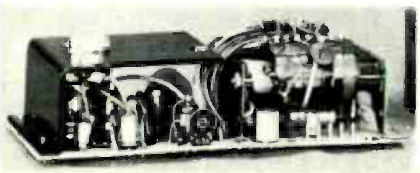


FIG. 7—QUASAR BOARD closeup (above) shows connectors on circuit board.

FIG. 8—NEW MODULAR power supply (left) operates at horizontal-oscillator frequency. Does away with large power transformer.

FIG. 9—ZENITH DURA-MODULES have rows of holes giving the circuit board a perf-board appearance.

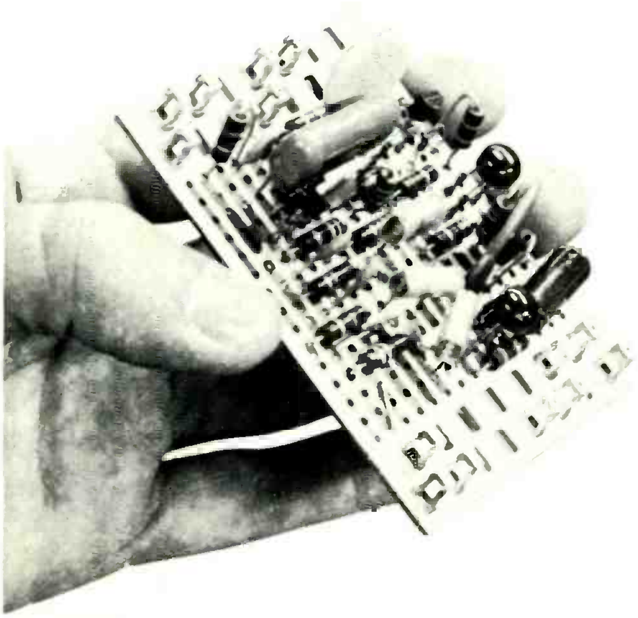
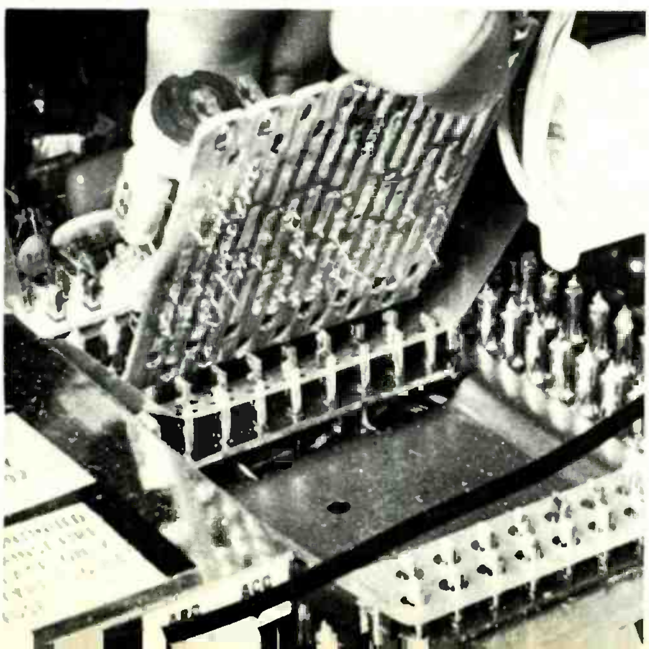


FIG. 10—DURA-MODULE PLUGS into set (bottom left) as shown. Plastic strips over pins to ease unplugging.



instead of point contact. The bottom view shows where the pins enter.

The early modular concept left power-supply components on the main chassis. Trouble there meant a chassis had to go to the shop for repairs. Fig. 8 shows Motorola's new smaller modular power supply. Besides small size and weight, the solid-state supply features automatic-reset overload protection. After an overload, the viewer resets merely by turning the set off and back on. Best of all, the thing plugs in. Now the power supply can be replaced just as quickly and easily as the rest.

Computer-designed modules

Chronologically, Zenith Dura-Modules appeared next. Fig. 9 reveals appearance and size.

Dura-Module is a board perforated in rows. Underneath, the rows of holes are connected by printed foil and a solder coating. The connection side is exposed in Fig. 10. (Plastic strips fit over the pins beneath the board to make unplugging a Dura-Module easy: just grasp the tabs and pull upward.)

There's a closer view of Dura-Module contacts in Fig. 11. A wiper leaf inside each receptacle assures good electrical contact. If a row needn't make contact to the chassis, no contactor is inserted in the board.

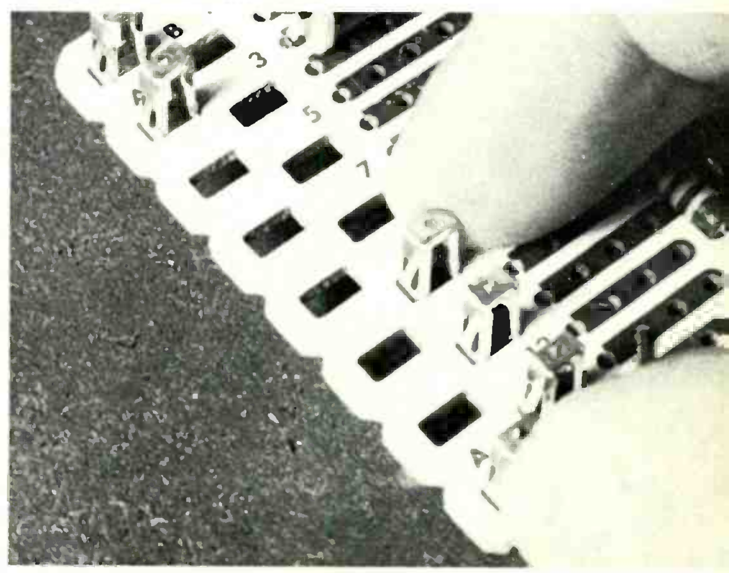
An interesting benefit from Dura-Module structure is the concept of coordinate layout. Notice in Fig. 11 the rows are numbered across the end. Along the side, letters represent coordinates for each hole in each row. Given interconnections and physical dimensions of components, a computer can devise optimum layouts, show where to break the foil along each row, and decide which rows get contacts for external connection.

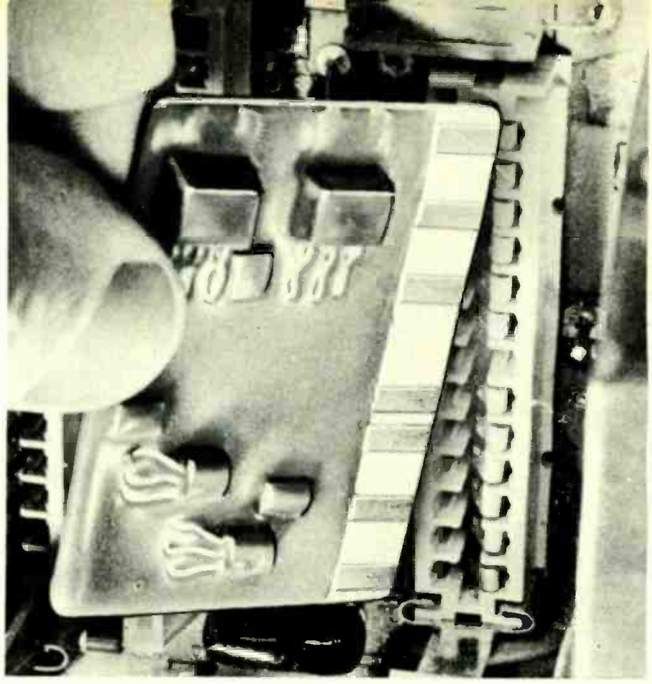
The newest Zenith chassis, the all-transistor 25CC55, uses five Dura-Modules. Among them they contain nearly three-fourths of the circuitry.

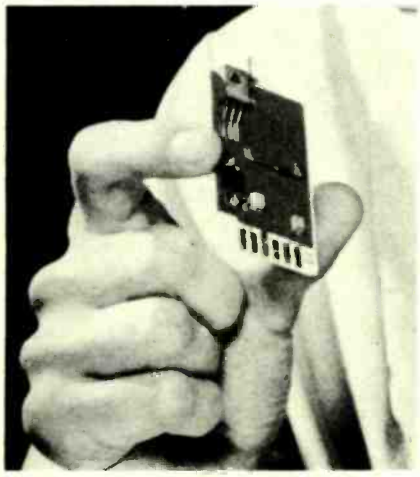
The horizontal-driver module in future versions of the 25CC55 chassis will have an integrated circuit of a variety new to television. It will be thick-film (hybrid, they're sometimes called to distinguish them from monolithic IC's). The encapsulated IC, about half the size of the module board, will take in most of the components and circuitry now on the module board.

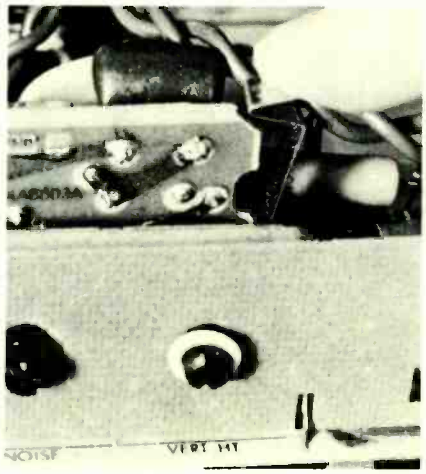
The Zenith i.f. is easy to take out, though not in the Dura-Module manner. With the tuner cable unplugged on top, three screws and a few slip-off connections below-chassis release the i.f. section for repair or replacement.

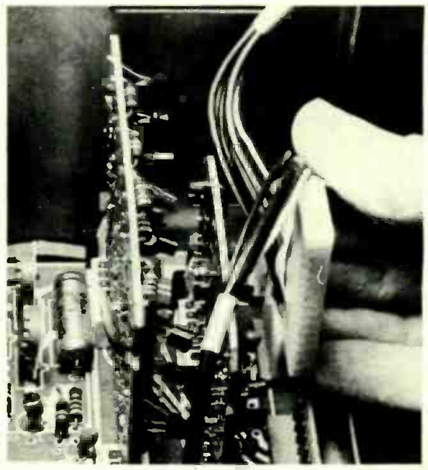
FIG. 11—CLOSE-UP OF DURA-MODULE contact (below). Notice that rows are numbered across the end.











Ceramic-encapsulated modules

The modules RCA uses in its new CTC 46 and CTC 54 color chassis are unique. They're made like computer circuit cards. The contacts, instead of being pins and connectors, are part of the printed board foil. Fig. 12 and Fig. 13 show them.

The module in 12 is the video amplifier and sync section. You can see the delay line across the top.

Each set uses three modules like Fig. 13. It's a color-video output amplifier. Opposite the plug-in edge, which goes into the computer-card socket, is an output tip. A wire from the color picture tube socket clips on there. The whole board is encapsulated in ceramic. Several components inside are deposited by thick-film technology. The whole module is more compact than an earlier one with many separate components.

Fig. 14 shows a ceramic power supply module and its socket. The module contains rectifier diodes and regulator parts, and some of the degaussing circuit. Some modules are held by clips, some by spring-leaf retainer (Fig. 15).

Sockets for some modules are on large printed boards, which carry foil interconnections. In some, like the i.f. module in Fig. 16, cables with plugs carry wiring from one large board to another.

Doubts of how popular modular plug-ins might become were dispelled when Heathkit announced its build-it-yourself transistor color chassis with plug-in boards.

The chassis (Fig. 17) holds nine of them. The power supply and several power transistors are on the main chassis. Connectors are different from those in Motorola or Zenith, but are part of the printed-board modules.

Old timers may remember a multiple chassis by Setchell Carlson, a company no longer in consumer TV. A similar sys-

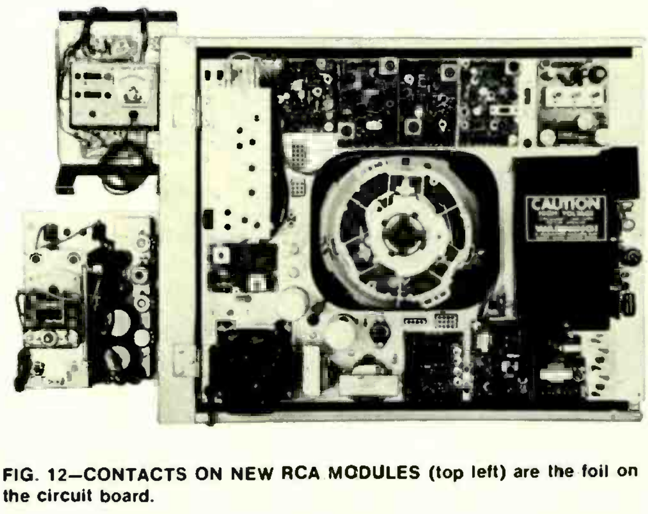


FIG. 12—CONTACTS ON NEW RCA MODULES (top left) are the foil on the circuit board.

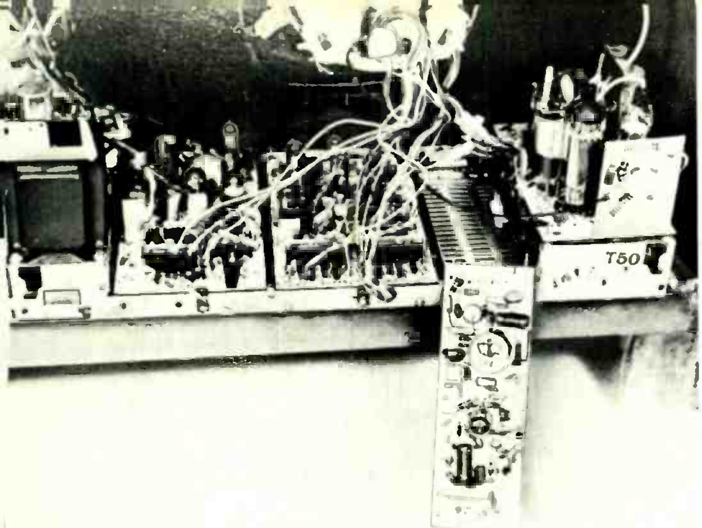
FIG. 13—CERAMIC THICK-FILM MODULES (above left) are also used in some new RCA chassis. This one is a color-video output.

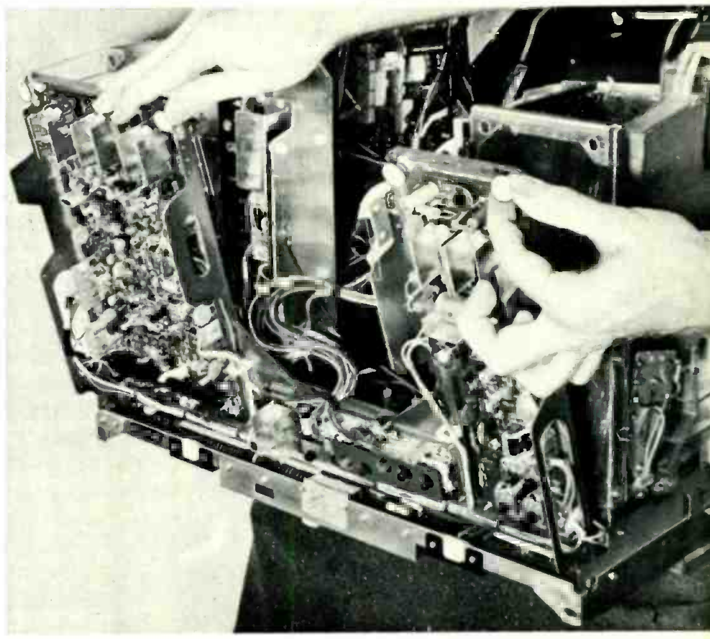
FIG. 14—CERAMIC POWER-SUPPLY MODULES and socket (top right). The module contains rectifier diodes and regulator parts.

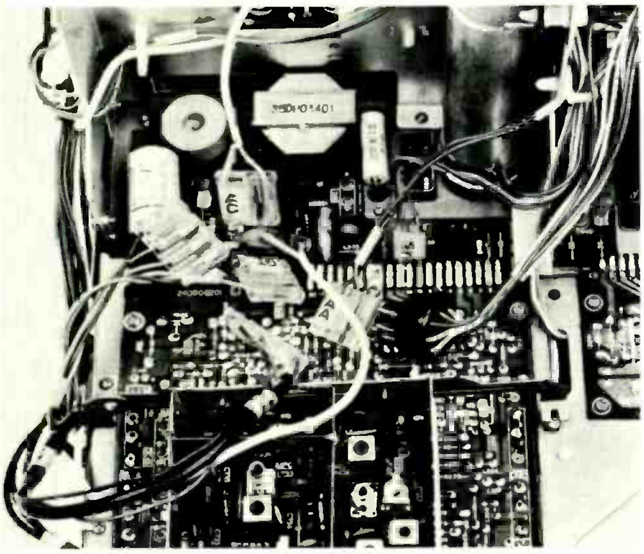
FIG. 15—SPRING-LEAF RETAINER (above middle) holds this RCA module firmly in its socket, yet board is easy to remove.

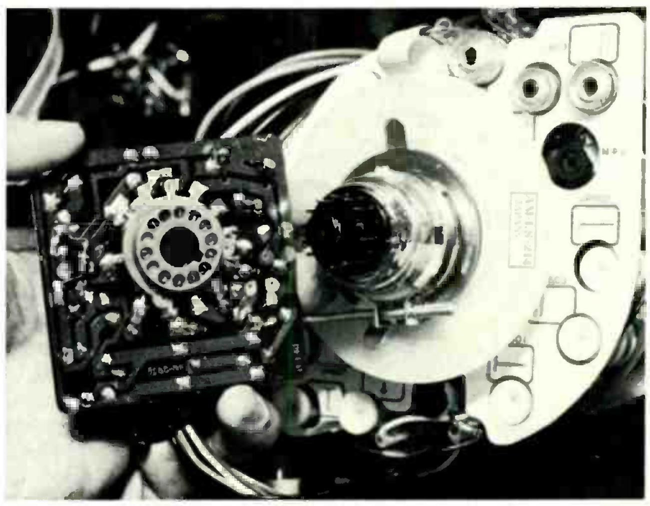
FIG. 16—CABLES WITH PLUGS (right center) connect this i.f. module to other sections of the set.

FIG. 17—NINE PLUG-IN BOARDS (above) are used in solid-state Heathkit color sets.









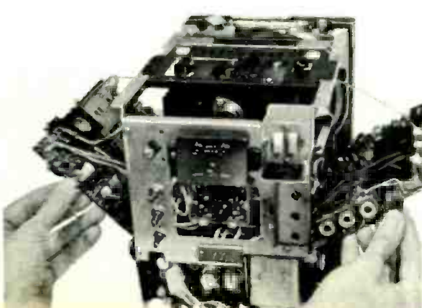


FIG. 18—MULTIPLE-CHASSIS approach (top left) is used in Channel-Master 25-inch color set.

FIG. 19—TIP-OUT BOARDS (top right) are used in MGA sets to provide access to both sides of boards.

FIG. 20—PLUG-IN CABLES (above) ease removal of circuit boards in MGA receiver.

FIG. 21—HINGE CONSTRUCTION (left) is used by Sony and Hitachi to aid servicing. Photo shows two Hitachi boards folded out.

FIG. 22—SONY TRINITRON chassis (left) has side panels that drop down for repairs.

FIG. 23—CROWN COLOR chassis (above right) has pix-tube socket mounted on circuit board.

tem showed up this year in several brands. The first one I saw was in a Channel Master 25-inch (Fig. 18).

The works are divided into five sections. Circuitry for each section is on a printed board—or on a metal subpanel.

You should see the all-transistor 19-inch color chassis MGA (a Japanese company) just began to sell. It's a slide-out, snap-out, fold-out design. You take the back off with three screws. Remove a Phillips screw and two 5/16 nuts and slide the chassis backward. Then unsnap four plastic fasteners and you can tip the main boards down as I'm doing in Fig. 19. This gives access to both sides.

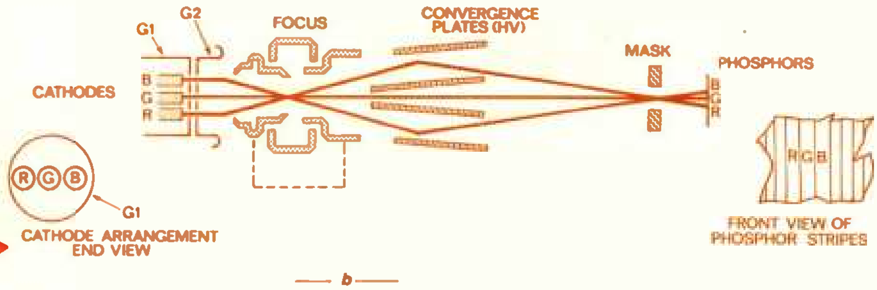
You can run the set with the boards open; just connect a cheater cord. The i.f. section, with sound and video circuitry, is in a completely shielded box. But the top and bottom come off and you can hinge the whole assembly up for access to both sides. Other circuit boards come out easily because interconnecting cables have plugs (Fig. 20).

JVC, another Japanese manufacturer, uses cable plugs to connect circuit boards to one another and to the main chassis.

Hitachi and Sony both use hinge construction to aid ser-

(continued on page 94)

TRINITRON versus SHADOWMASK



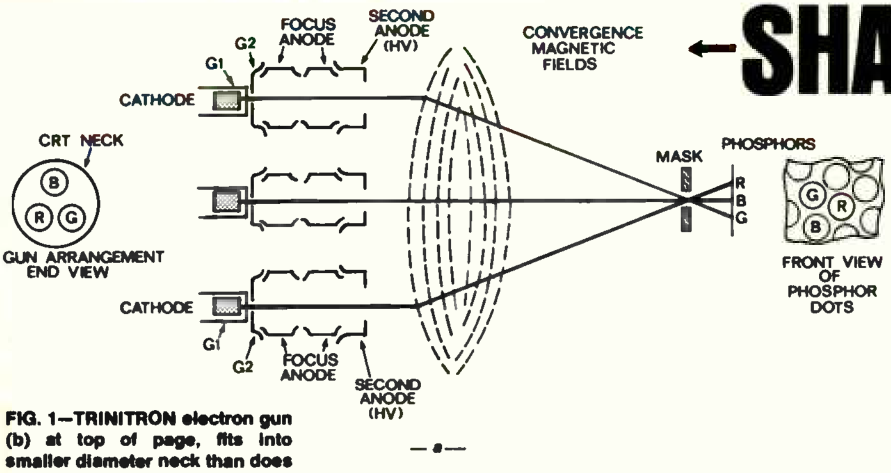


FIG. 1—TRINITRON electron gun (b) at top of page, fits into smaller diameter neck than does the shadow-mask 3-gun structure (a) shown directly above.

Both are tricolor picture tubes, but that's where the similarity between them ends

by FOREST H. BELT

THE TRINITRON PICTURE TUBE FOR color isn't new. Sony demonstrated a 7-inch version back in 1968. But that was merely a prototype. Sets with a 12-inch Trinitron began entering the US for sale in late 1969. By the 1971 selling season, there was also a 9-inch. This spring, a 17-inch goes on sale.

But new or not, the Trinitron picture tube still raises questions. Only Sony has Trinitron, but curiosity runs high. The most prevalent query is: "How does a Trinitron work?" One way to explain it is by comparison with a shadow-mask color picture tube. About everyone is familiar with that.

Hardly anything in the one resembles its counterpart in the other. The electron guns are built differently. Because of that, the Trinitron neck is smaller. Screens of both use red, green, and blue phosphors, but the chemicals are not deposited the same way, nor are the phosphors the same. Anode structures are dissimilar. The conventional picture tube has a shadow mask back of the screen, the Trinitron an aperture grill. Convergence components and procedures differ completely. Video drive circuits are not the same, because tube operating requirements don't match.

One gun vs three

Any tricolor picture tube needs three beams. In the shadow-mask type, three individual electron guns supply three streams of electrons to light three sets of phosphor dots. Each gun has its own cathode. control grid (G1), and screen or accelerator anode (G2). Focus anodes are part of each gun, although all three connect to the same base pin. Fig. 1-a illustrates functionally the gun structures in a typical shadow-mask picture tube. (Some special G-E picture tubes have in-line guns.)

The Trinitron has only one gun. However, the single gun emits three streams of electrons. The makeup of a Trinitron electron gun is shown in Fig. 1-b. Each beam comes from its own individual cathode. The three cathodes sit in a row inside the grid-1 cylinder. The first, or control. grid serves all three cathodes. So does G2, and of course the focus anode. This greatly simplifies picture-tube circuitry, as you'll see later.

The Trinitron structure has something more: a set of convergence plates. They affect all three beams more or less simultaneously. Figs. 1-a and 1-b suggest basically how convergence differs between the two kinds of color picture tubes.

Beams in a conventional picture tube pass through magnetic fields that bend them together. They cross at a common hole or perforation in the shadow mask. Then each strikes its designated color of phosphor dot. The magnetic fields are a mixture of fixed and varying fluxes.

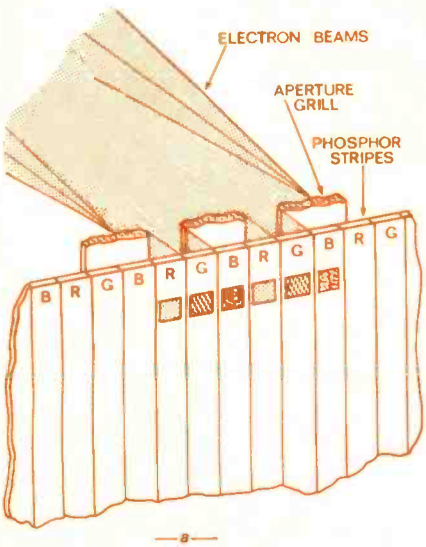
The Trinitron beams cross first in the focus-anode assembly. The primary purpose is to focus each electron stream into a fine beam, but the crossover is inherent. Electrostatic fields in the convergence-plate structure bend the three beams back toward each other. They meet again and cross at a common slot in the aperture grill. From there, each beam goes on to illuminate its respective phosphor stripe.

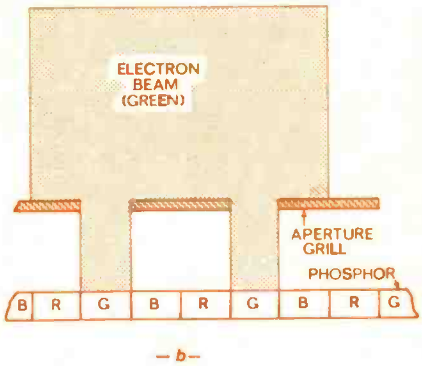
Phosphor illumination control

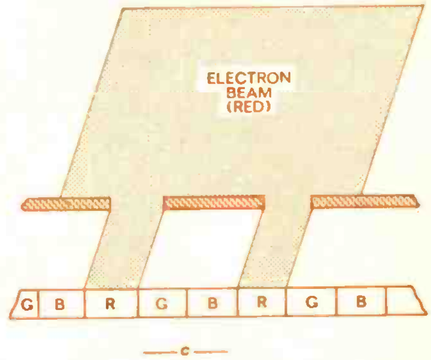
If the blue beam hits red phosphor, or green hits blue, etc., the screen can't faithfully recapture the colors a TV station sends out. Further, if any beam is larger than one phosphor dot—or, in the Trinitron, larger than one phosphor line—it may illuminate those adjacent.

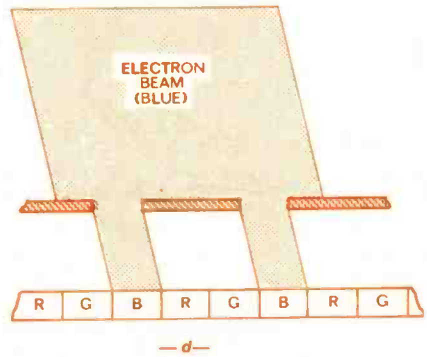
But limiting beam size precisely is difficult. A mask just behind the screen blocks out beam "edges." The portion of beam that goes through and strikes phosphor is crisp, and overlaps only minutely.

Circular holes cover the shadow mask of a typical color tube, one hole for each triad of phosphor dots. The Trinitron mask is a grill of vertical slots, one slot for each three phosphor stripes. Sony calls the Trinitron mask an *aperture grill.* (Years ago, the hole-filled shadow mask was sometimes called "aperture mask.")









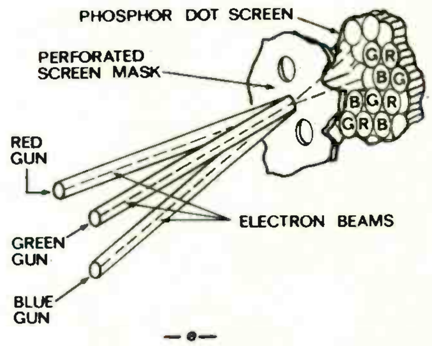


FIG. 2—TRINITRON SCREEN has phosphor stripes and slotted grill. Electron beam (a) covers two slots in aperture grill. Arrival from three angles (b, c and d) guides beam to proper phosphor stripes. In a shadow-mask tube, three electron beams pass through single hole to correct color dots (e).

Figure 2 shows the relationships between aperture grill, beams, and phosphor stripes. The electron beams in a Trinitron are much wider than any one stripe. In fact, as you can see from Fig. 2-a, one beam left to itself would spread over seven or eight stripes. But the apertures or slots prevent that.

Take a look at Fig. 2-b. The green beam, coming to the screen straight, strikes grill and phosphor exactly perpendicular. The grill masks the beam, allowing only two narrow streams of electrons through. The positions of the slots in relation to the phosphor directs those two beams only to green stripes.

Next see Fig. 2-c. The red beam comes in from an angle. It goes through the same slots, but the angle directs it only to red stripes. Figure 2-d shows how the blue beam approaches the grill from the opposite angle. It, of course, is directed to blue stripes.

Figure 2-e illustrates a similar relationship in a regular picture tube. The angles of the three beams at their crossover point, exactly at the shadow mask, direct them through to the correct dots. You can see how important it is that (a) the beams cross properly, (b) the mask be positioned correctly, and (c) the mask be the right distance from the screen. These rules apply also to the Trinitron aperture grill.

Operating a picture tube

One undeniable benefit of the Trinitron is simpler drive circuitry (Fig. 3). With G1 and G2 part of a single gun, the complex networks used with other color picture tubes are unnecessary.

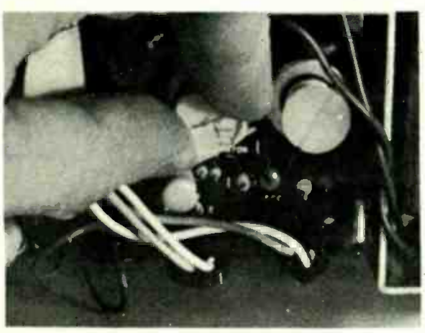
Sony design (Fig. 3-a) puts Y signal back into the color-difference signals at the color demodulators (not shown). Therefore the cathodes of the Trinitron get color-video signals.

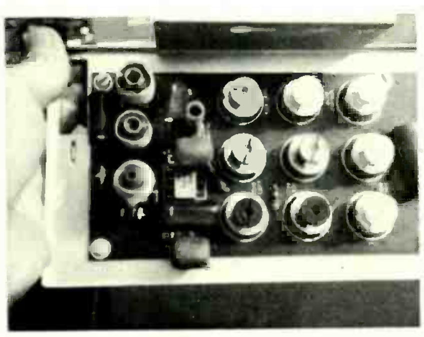
Conventional color picture tubes (Fig. 3-b) matrix Y and color themselves. Color-difference amplifiers drive the control grids of the color guns, while Y signal goes to the cathodes. For balance, drive controls determine the amplitude of video (Y) signal for each cathode in relation to the other two. These controls determine the bright-screen gray scale (color temperature).

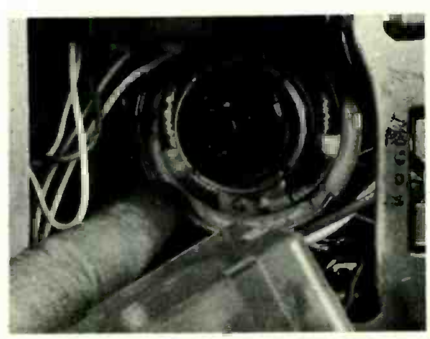
The no-video gray-scale tracking is determined by settings of three screen (G2) controls. It's common to work back and forth several times between screen and drive controls before you get tracking adjusted right.

In the Trinitron, one control takes care of the single screen grid (G2), setting acceleration of all three beams. Trinitron beams make a white raster when dc voltages on the three cathodes are balanced. The controls, called BACKGROUND but not included in Fig. 3-a, also affect Sony color-video output stages, and therefore take care of gray-scale tracking automatically. The control grid (G1) in a Trinitron stays at zero dc, but does accept horizontal and vertical blanking.

Sony lost a little ground with the 17-inch Trinitron, at least for simplicity. Fig. 3-c diagrams the larger tube and its circuitry. The major change lies in gun structure. Each cathode has a separate







CONVERGENCE CONTROLS. The 2-knob convergence panel of a Trinitron 9-incher is a far cry from the 9-knob, 4-slug panel on a conventional color set. There is no comparison between the size of the tiny convergence yoke and one for a shadow-mask tube.

grid. (Beams couldn't be controlled as simply as in smaller-screen Trinitrons.) Background controls are relegated to the grid circuits. These pots set bias between each grid and its respective cathode. They make the raster white when no video is present.

Dc levels on the three cathodes stay about equal in the 17-incher. But all three voltages vary together when the brightness control. several stages back and not shown. is turned.

Drive controls in the emitter circuits of the output amplifiers set the comparative amount of color video sent to each cathode. They balance cathode drives so the raster stays white with video (contrast) turned up. Setting up gray-scale in the larger-screen Trinitron chassis offers no less aggravation than ordinary color sets do.

Focus-control circuitry for Trinitron tubes differs mainly in the dc voltage level. Focus-electrode voltage for a conventional color picture tube usually ranges somewhere between 4 and 5 kV. The Trinitron needs less than 400 volts. putting it in the class of ordinary monochrome picture tubes.

High-voltage requirements don't differ much. A 12-inch Trinitron takes 19 kv, about the same as for a three-gun picture tube of that viewing size. The new 17-inch square-corner Trinitron needs slightly higher voltage. as do larger regular picture tubes.

Convergence simplicity

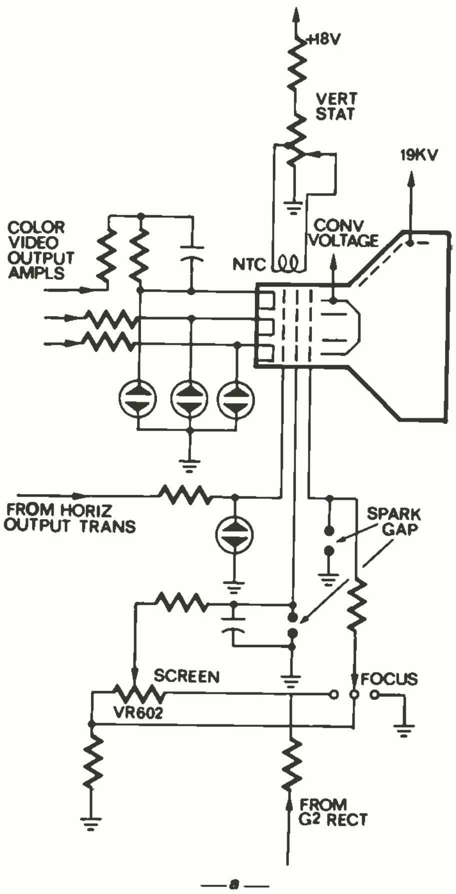
Boasts about the ease of adjusting Trinitron convergence and pincushion are not exaggerated. The task is quick and painless. Look at the two convergence-panel photos. Two controls in one photo and the usual baker's dozen in the other. Thirteen to two makes a steep ratio when you're counting adjustments to make. Notice, too. how small and uncomplicated the convergence neck assembly is for Trinitrons.

The partial schematic (Fig. 4-a) suggests how comparatively simple the electronics of converging a small Trinitron can be. There is more circuitry in just the control *panel* of conventional convergence stages. as Fig. 4-b proves.

Some of the Trinitron secret lies in the vertical phosphor structure. It can tolerate slight up-or-down inaccuracy of beam landing. Vertical convergence correction is designed into the sweep section and needs no special adjustment. But if the beam hits to the right or left of where it should, it hits a phosphor of the wrong color. So horizontal convergence sometimes needs correction.

Look back at Fig. 1-b. The convergence plates exert the principal influence for correcting Trinitron dynamic convergence—making the beams hit the correct phosphors all the way out to the edges of the screen. The plates carry

FIG. 3—SIMPLE CIRCUITS AROUND PICTURE TUBE (a) characterize the small-screen Trinitron chassis. Compare this with circuitry around the conventional shadow-mask picture tube. (b). The larger Trinitron (c) has three control grids and three background controls but its circuit is still much simpler than that required for a shadow-mask picture tube.



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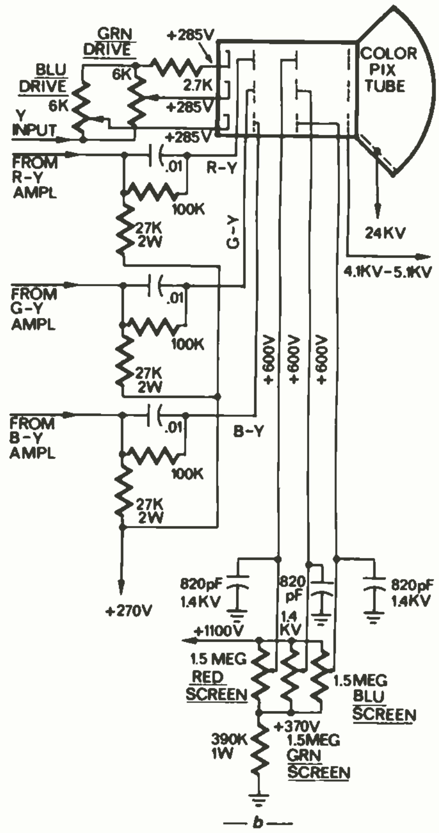

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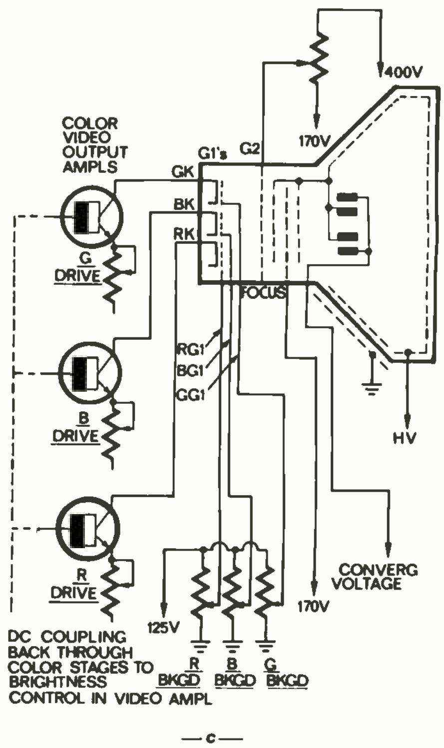


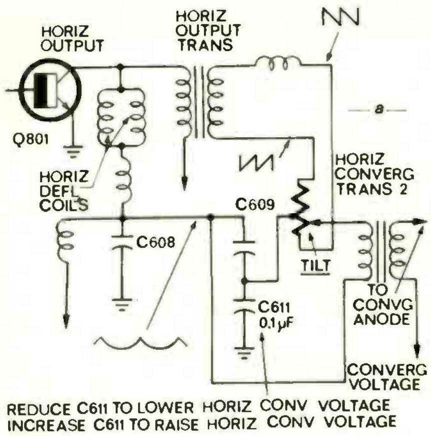
—c—

the full dc high voltage. 19 kV. but with a paraboloid voltage superimposed. The circuit in Fig. 4-a forms and applies that convergence waveform.

Capacitor C608 is ground return for the horizontal deflection coils. The parabolic waveform develops across it. Divider C609-C611 determines how much parabolic signal goes to the TILT potentiometer. A sawtooth mixes with the paraboloid at the TILT control. The slider sets phase and amplitude. The now-shaped convergence waveform goes to the secondary of the horizontal convergence transformer. through which also passes the 19-kV convergence-anode dc voltage. The corrective waveform on the convergence plates keeps the beams aimed properly as they sweep back and forth across the screen.

A beam-alignment coil assembly on the Trinitron neck corrects any twist tendency of the three beams. Faint misalignment during tube manufacture might allow the effect shown in the inset of Fig. 5. The beam alignment coils. a small part of the diagram in Fig. 5. take care of that electromagnetically. The beam-twist circuit has two coils and two capacitors.

Mainly. however. Fig. 5 shows convergence circuitry for the newer 17-inch Trinitron. Essentially. the convergence waveforms are still developed across the ground return for horizontal deflection coils. The 0.1-μF capacitor. 270-ohm resistor. convergence tilt coil. and 5-watt 220-ohm resistor form the deflection return path. The convergence yoke bridges the tilt coil and 5-watt resistor.



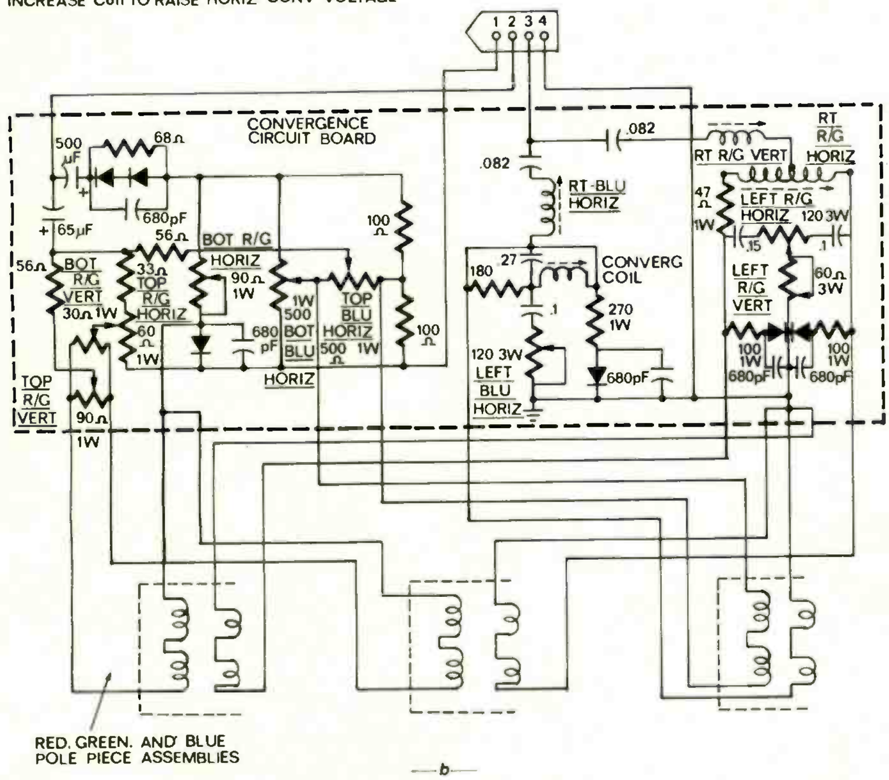


FIG. 4—TILT CONTROL IS MAIN DYNAMIC CONVERGENCE ADJUSTMENT in a Trinitron circuit (a). Range of control can be varied by changing the value of one capacitor. Compare this with the thirteen controls (b) on the usual convergence board.

The sawtooth portion of the convergence signal comes from a winding on the horizontal output transformer; taps permit adjustment of sawtooth amplitude. The core of the convergence tilt inductance moves back and forth from one half of the winding to the other. The inductance change varies the phase of the sawtooth applied across the convergence yoke coils (grounded at terminal 6 by the 470-μF capacitor).

The 17-inch Trinitron takes a dc voltage on its convergence plates, but minus the sawtooth/paraboloid. This dc voltage mainly affects horizontal static convergence. A potentiometer adjustment is part of the high-voltage system (not shown).

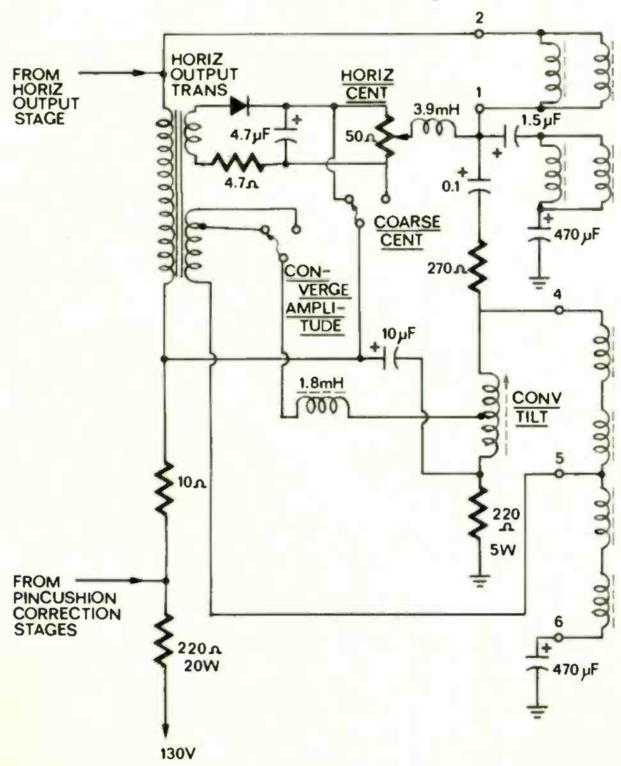
Pincushion correction for the newer Trinitron works about the same as in a conventional color chassis. It's simpler than a few: one control. Labeled PINCUSHION ADJUST, a potentiometer controls the amplitude of the vertical signal fed into the horizontal system to correct pincushioning at top and bottom. (Fig. 5 shows where the pincushion correction waveform joins horizontal sweep.) The nature of the convergence circuitry in Fig. 5 takes care of any tilt to pincushion correction. A second control in the pincushion section is labeled HORIZONTAL SIZE, but it also takes care of side pincushioning.

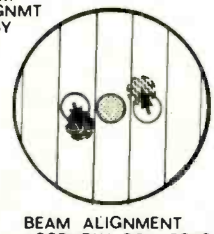
Which is better?

That's another common question. Naturally, Sony ads claim the Trinitron is best, and American (and other Japanese) set-makers say otherwise.

The fact is, both kinds of picture tube do their jobs well. Claims of brighter pictures from either one seem pointless, since high-output phosphors, not gun structure, make colors bright or not. The Trinitron might have had a slight edge before black-surround phosphors in shadow-mask tubes. Because of the way its beams strike the phosphors, the Trinitron got slightly better efficiency. But that's past.

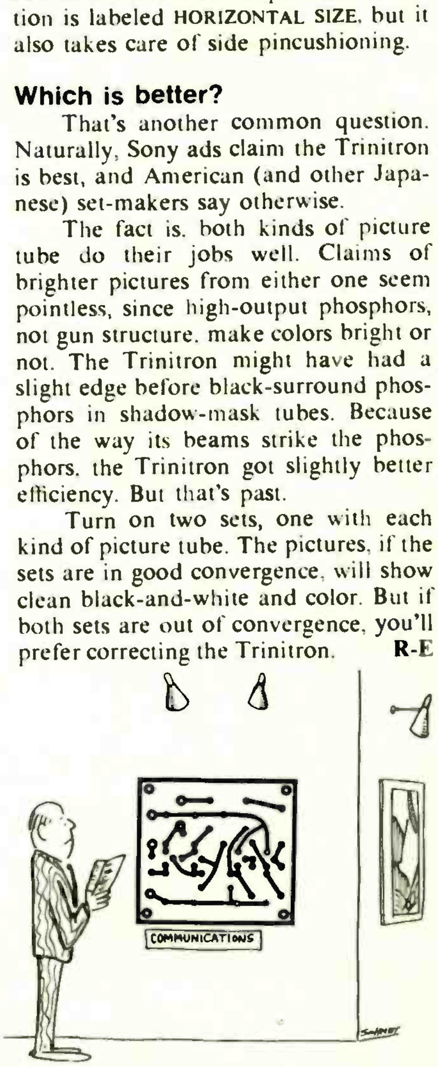
Turn on two sets, one with each kind of picture tube. The pictures, if the sets are in good convergence, will show clean black-and-white and color. But if both sets are out of convergence, you'll prefer correcting the Trinitron. **R-E**





BEAM ALIGNMENT ASSEMBLY CORRECTS THIS

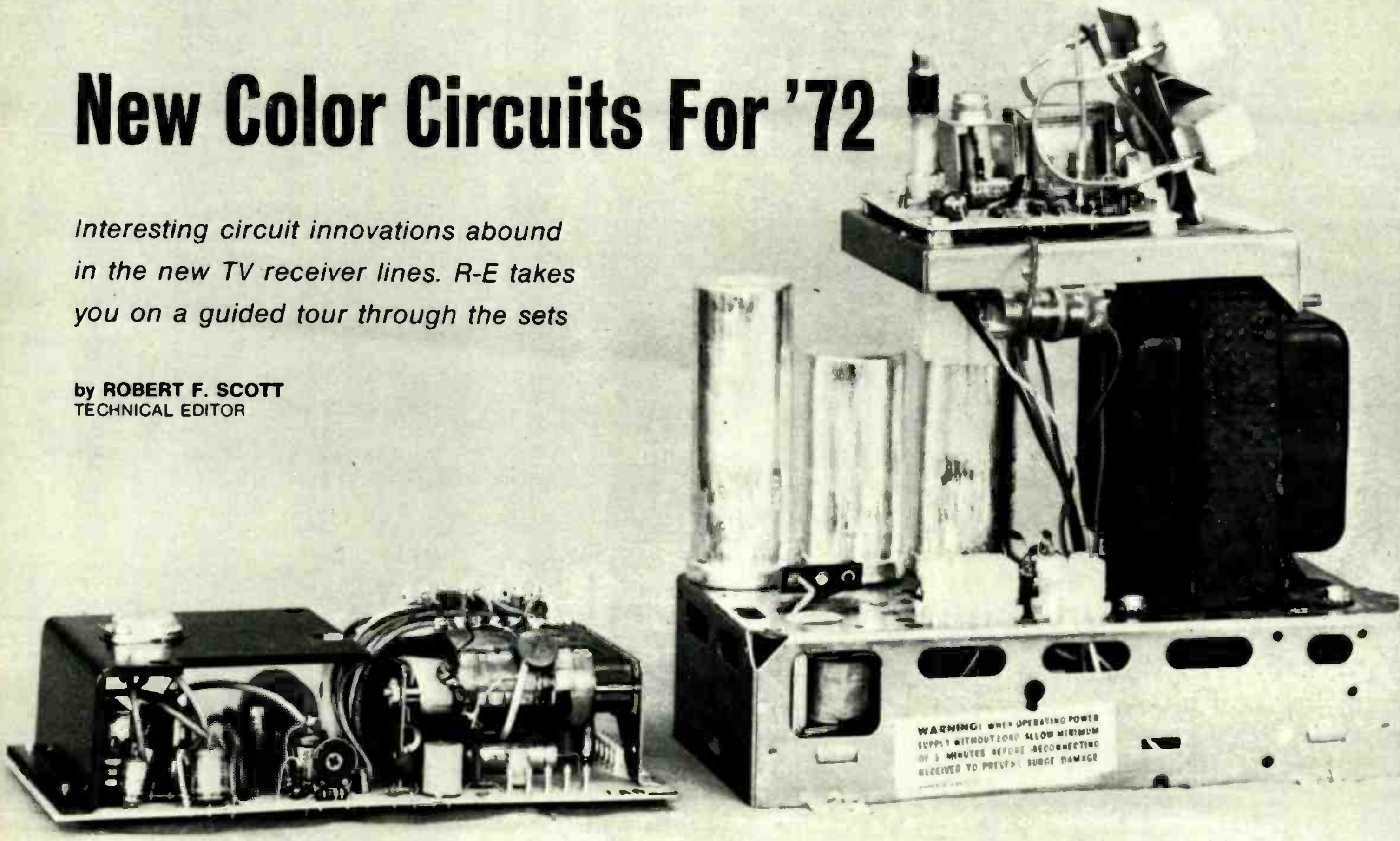
FIG. 5—CONVERGING the 17-inch Trinitron is only a little more complicated than for the smaller screens. The tap for altering convergence voltage amplitude is handier than soldering in a capacitor as in smaller receivers with Trinitron picture tubes.



New Color Circuits For '72

Interesting circuit innovations abound in the new TV receiver lines. R-E takes you on a guided tour through the sets

by ROBERT F. SCOTT
TECHNICAL EDITOR



Most of the 1972 color and b/w TV receivers have new and interesting circuit innovations for greater reliability, better performance or ease of servicing. We have selected a few of the most interesting for discussion in this article.

Electronic low-voltage power supply

The all solid-state Motorola Quasar color TV receivers for 1972 use an electronic B+ power supply for improved regulation, reduced weight and smaller size (see photo). Servicing is simplified because most of its components are on a plug-in panel. This unique power supply (Fig. 1) is the source of five regulated B+ voltages, 6 volts dc for the picture-tube heater, 6 volts ac for the pilot lamps and -6 volts dc for the brightness-control network. The supply gets its operating voltages (+280, 50 and 33 volts) from a voltage doubler (not shown) across the ac power line.

In operation, the power supply is similar to vibrator-type supplies used, up until a few years ago, in auto radios and dc-to-ac converters. A switching transistor (Q5) takes the place of the vibrator, opening and closing the primary circuit of the power transformer 15,750 times each second so pulsating dc (at 280 volts) flows through the primary to ground. The pulsating dc develops stepped-up ac voltages in the transformer's secondary windings. These voltages are rectified and filtered and then fed to the various receiver circuits.

Transistor Q1 is a 15,750-kHz blocking oscillator synchronized at the horizontal scanning frequency by pulses from the horizontal sweep circuit. The oscillator voltage—tapped off the collector—is converted to a *variable-width* square wave by shaper Q3. Driver Q4 amplifies the square waves to the level needed to turn on the switching transformer so current pulses flow in the transformer primary.

The width of the pulses used to control the switching transistor is controlled by regulator Q3. The "on" pulse is broadened or reduced in width to hold the supply's output voltages constant under varying loads and changing ac line voltages.

The current demands on the secondary windings vary with picture brightness—the brighter the picture, the greater the current drain. Secondary voltage tends to drop as current drain increases. Thus, to keep secondary voltage constant under load, there must be a corresponding increase in primary current. This is done by lengthening the switching pulse. The switching transistor is on for a longer period; allowing the primary current to rise to a higher level and thus satisfy the secondary demands.

The width of the switching pulse is determined by regulator Q2's base bias. A constant bias voltage from the +33-volt line is fed through D1 to voltage divider R1-R2-R3. This divider is also fed a positive voltage developed by rectifying the ac voltage in a separate secondary winding on the power transformer. As the load current increases and secondary volt-

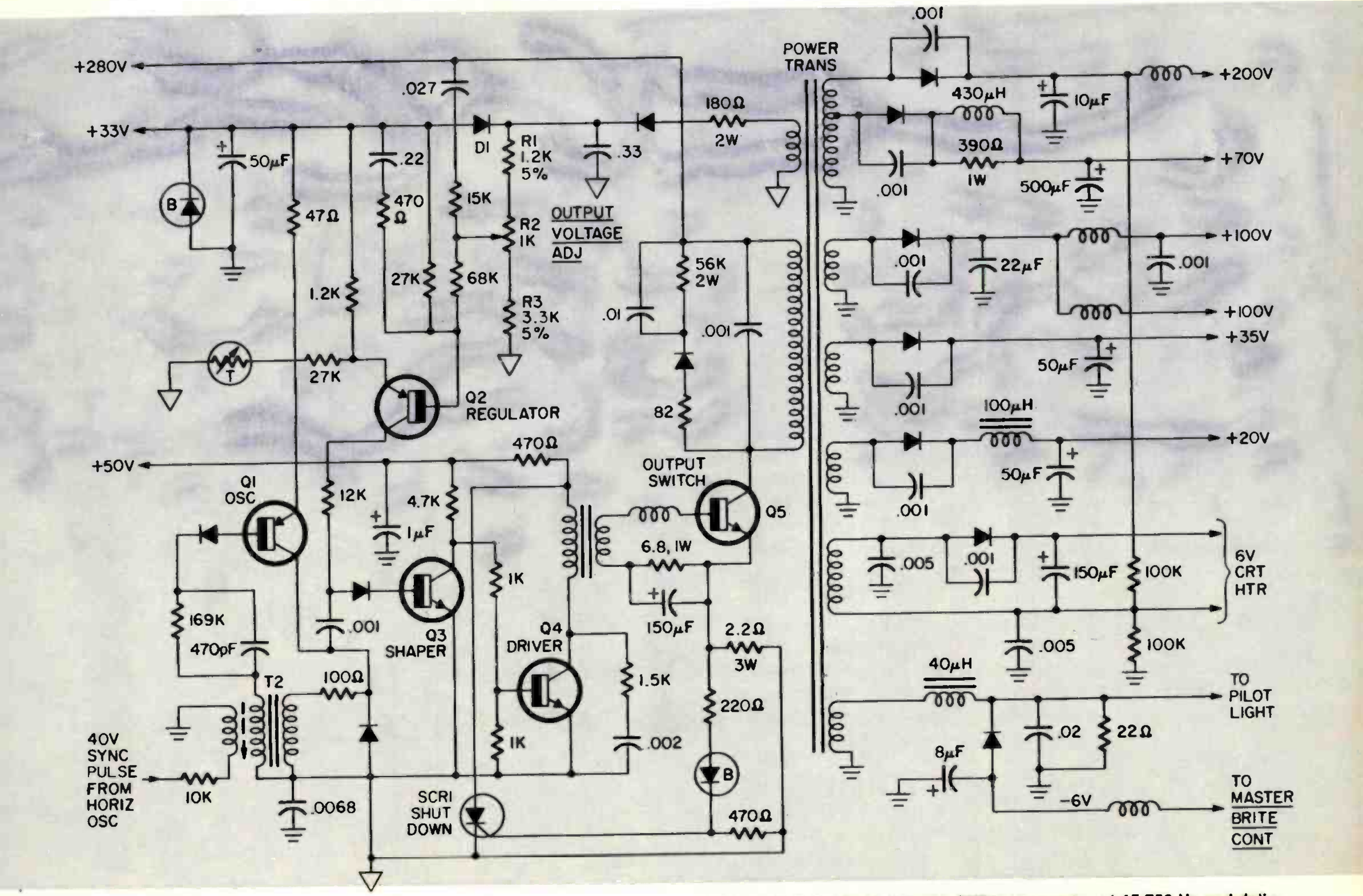


FIG. 1—ELECTRONIC POWER SUPPLY operates at 15,750 Hz and delivers five regulated B+ voltages.

ages drop, the regulator base voltage changes so as to widen the switching pulse—increasing primary current and restoring secondary voltages to their original preset values.

Conversely, when secondary current load decreases the secondary voltages tend to rise. The regulator now narrows the width of the switching pulses and reduces the primary current. Similarly, a rise or fall in ac line voltage causes corresponding changes in transformer secondary voltages. These changes are sensed by the regulator, which changes the switching-pulse width to hold the secondary voltages constant.

A silicon controlled rectifier (SCR1) protects the electronic power supply against possible damage from overloads. Its gate monitors the voltage across the 2.2-ohm emitter resistor for switching transistor Q5. The circuit is set up so the SCR fires when Q5's emitter current rises above a preset level. This shorts out the driver's collector supply voltage and disables the switching transistor to protect the supply from damage. The SCR latches and remains on until all power is removed by opening the on-off switch.

G-E's gray-scale clamp

In most color TV sets, picture-tube control grids are direct coupled to the plates of the color-difference (R - Y, B - Y and G - Y) amplifiers to maintain the dc component of the chroma signal. With this arrangement, gray-scale—also called black and white tracking, white balance and color temperature—remains constant only as long as the color-difference amplifier plate voltages are constant. Any change in plate voltages due to parts aging or circuit malfunctions upsets the screen background color.

The G-E 1972 version of the KE-II chassis now uses ac coupling between the color-difference amplifier plates and the picture-tube grids. A new clamp circuit (Fig. 2) maintains the picture-tube control grids at a constant voltage, regardless of any changes that may occur in the color amplifier plate circuits.

The clamp circuit is a form of sync-derived dc restoration that provides a stable gray scale—with or without an incoming TV signal. The clamp circuit is connected to each picture-tube control grid through a network consisting of a 2.2-megohm resistor, a diode and a 3300-ohm resistor (R771, diode CR754 and R764 in the red-grid circuit). The base of clamp transistor Q1 is capacitance coupled to the plate of the sync separator.

In the absence of an incoming signal, Q1 saturates. Q2, diode CR754 and the corresponding diodes in the blue- and green-grid circuits are biased to cutoff. Collector voltage for Q2 is supplied through R756, R757, R768 and R760. Current flow through this network provides 325 Vdc on Q2's collector (point 3) and the cathodes of the network diodes.

Voltage divider R765-R766-R767 supplies +167 volts at point 1—Q2's emitter and C753—and +200 volts on the anodes of the diodes and the grid sides of the coupling capacitors (point 4). The other sides of the coupling capacitors are connected to the color-amplifier plates. Thus, the net charge across the coupling capacitors is zero and each picture-tube grid is biased at 200 volts from point 2 through the 2.2-megohm and 3300-ohm resistors. Q2 and the network diodes are biased off and do not contribute to circuit operation under no-signal conditions.

When a TV station is tuned in, negative-going sync pulses from the sync-separator plate (occurring during the retrace interval) are shaped by the 20-pF coupling capacitor to develop 3.5-μsec negative pulses at Q1's base. The diode between the base and ground limits the pulse to 0.8 volts p-p. Q1 is driven to cutoff and its collector voltage rises sharply, developing a pulse that drives Q2 to saturation. Q2 now presents a very low resistance and the voltage at point 3 drops from +325 to around +190 volts. The network diodes are now forward biased so they conduct.

At this instant, a relatively high current flows from ground to +400 volts through C753, Q2, the 3300-ohm resistors and diodes in the clamping networks, the coupling capacitors and the 47,000-ohm plate load resistors for the color-difference amplifiers. This current pulse causes the voltage at point 4 to be about .07 volt more negative with respect to point 5 than it was before Q2 was keyed on by the sync pulse.

While Q2 and the network diodes are conducting, the voltages at points 1, 2 and 4 rise about 3 volts due to the additional current flow through R756 and Q2. Simultaneously, the voltage on the plates of the color-difference amplifiers drops about 10 volts but rises again when Q2 cuts off at the end of the sync pulse.

The voltage at point 3 again rises to 325, cutting off the network diodes. During the 60-μsec trace interval. The +228 volts at point 2 is greater than the 199.93 volts at point 4 and the picture-tube grids (remember point 4 dropped .07 volt while Q2 was conducting). This voltage difference charges the coupling capacitors; but only by .07 volt to 200 before the next sync pulse arrives. This small voltage change is due to the 22,000-μsec time constant formed by the .01-μF coupling capacitors and the 2.2-megohm network resistors. The arrival of the next sync pulse triggers a repetition of the clamping action, thus keeping the picture-tube control grids at a constant level.

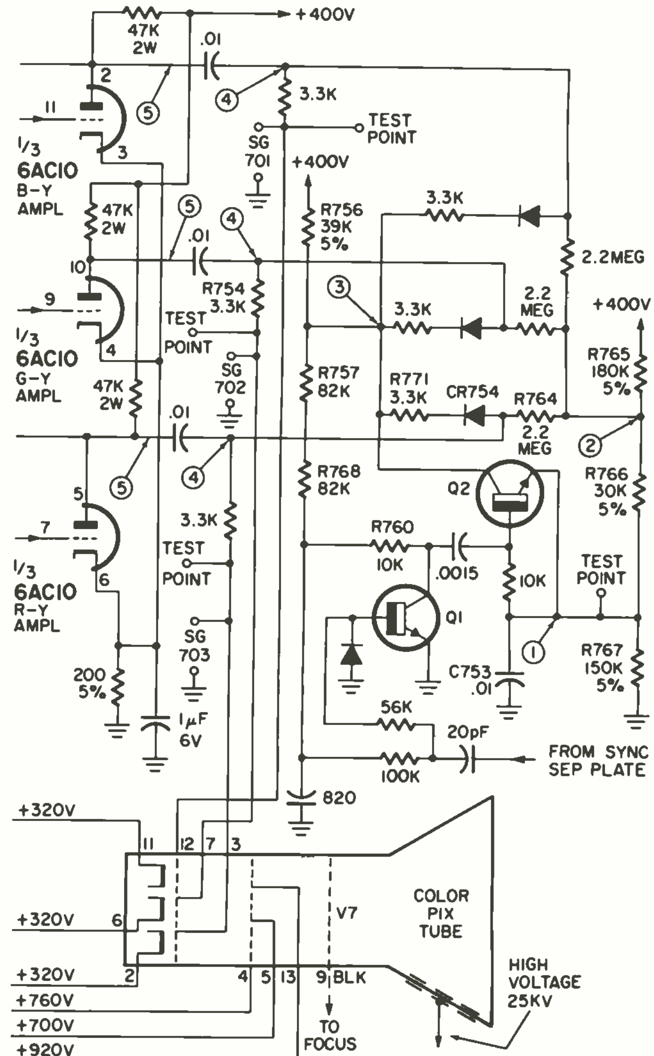


Fig. 2

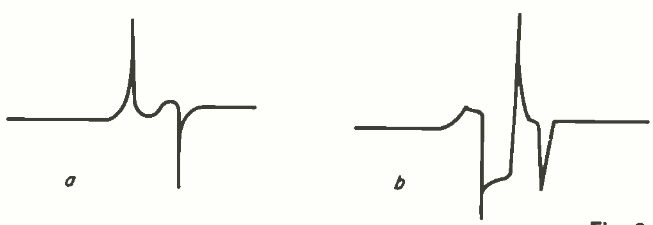


Fig. 3

Troubleshooting the clamp circuit

Fig. 3-a shows the blanking pulse at the plate of a color-difference amplifier in a KE-II chassis without the clamp circuit and Fig. 3-b is the clamping pulse that occurs at the same point in chassis that use the gray-scale clamping circuit. A clamping pulse like that in Fig. 3-b with an amplitude of about 10 volts p-p on the plate of *any* color-difference amplifier shows that the clamp circuit is working. A pulse at all three plates indicates that the network clamping diodes are working. **DO NOT** use a scope on the anodes of the clamp diodes or the control grids of the picture tube. The 10-megohm probe input impedance will disable the clamp circuit. When measuring voltages on the picture-tube control grids, always use a vtvm with an input impedance of at least 100 megohms.

If a diode shorts, the voltage across it rises to about 275 and the voltage on the others rises to about 250 volts. The picture blooms in the color of the defective diode. A reddish screen shows that the clamp diode for the red grid is shorted.

If a clamp diode opens, its anode rises about 15 volts with no change on the other diodes and only a slight change in screen color.

A loss of sync pulses on Q1's base causes only a slight

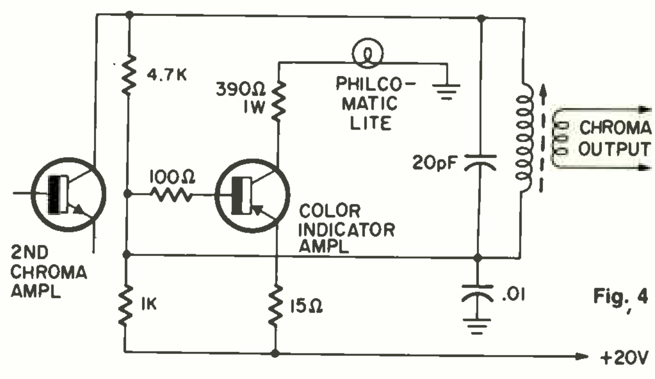


Fig. 4

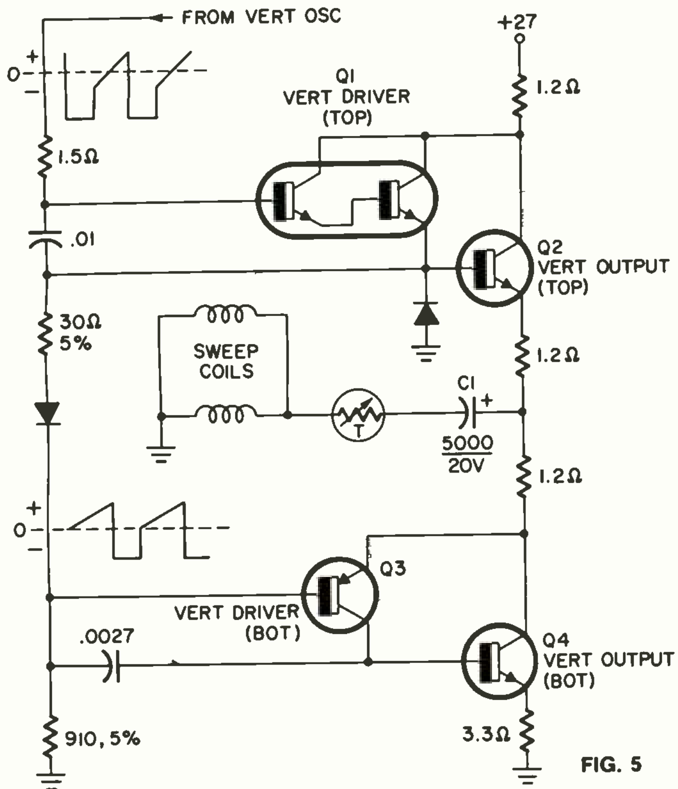


FIG. 5

FIG. 2—NEW CLAMP CIRCUIT keeps picture tube grids at a constant voltage, regardless of changes at the color amplifier plates. This keeps gray scale (black and white tracking) constant.

FIG. 3-a—BLANKING PULSE at plate of color difference amplifier. b—clamping pulse that appears at same point in set with clamp circuit.

FIG. 4—COLOR-LITE INDICATOR tells user when a color telecast is being received. Circuit is used by Philco.

FIG. 5—FREE-RUNNING MULTIVIBRATOR and push-pull output transformerless vertical amplifier is used in some Sylvania sets.

FIG. 6—CLOSE-COUPLED CRT grids provide additional dc coupling to the control grids in the picture tube. Circuit changes include addition of R252, R253, D209 and C240.

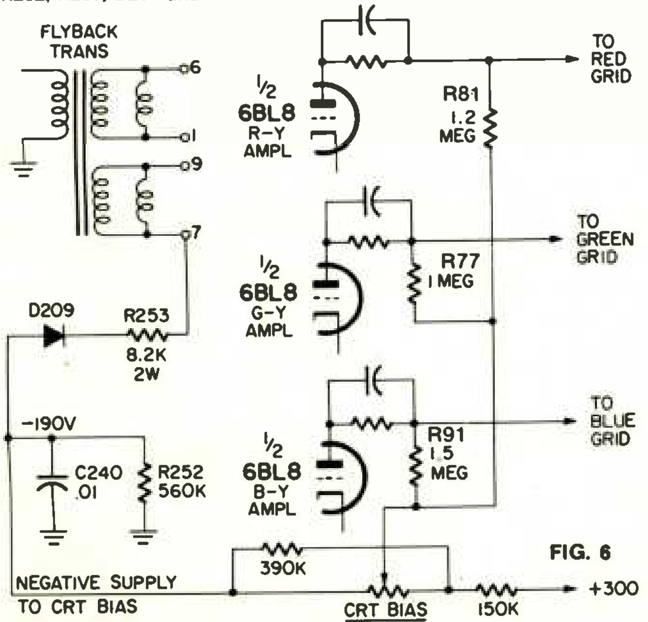


FIG. 6

change in brightness and color amplitude—the customer won't notice it. The same thing occurs when Q1 is open or shorted or if Q2 is open. When Q2 shorts, the picture blooms and the color (for that diode's circuit) weakens somewhat as its corresponding grid rises to about 280 volts. The 2.2-megohm resistor limits grid current and protects the picture tube.

Color indicator light

Philcomatic is the name Philco sales personnel give their "Color Lite" indicator that glows when a color telecast is being received. The circuit used in the 22LT45 chassis is shown in Fig. 4. When chroma-sideband information is present, the second chroma amplifier draws enough current to drop the voltage at the junction of the 4700- and 1000-ohm resistors in its collector circuit. The color indicator amplifier is biased to saturation, turning on the indicator lamp. The lamp remains on throughout the color telecast.

The Color Lite—a customer tuning aid—can be used as a servicing aid to isolate chroma troubles ahead of or behind the IC incorporating the 3.58-MHz color oscillator, control reactance and color demodulators.

Push-pull OTL vertical output

Sylvania D17/D19 chassis use a free-running multivibrator and push-pull OTL (output transformerless) vertical amplifier (Fig. 5) for improved sweep linearity. The output circuit consists of a Darlington-pair composite transistor (Q1) driving output transistor Q2, driver Q3 and Q4, the other half of the push-pull deflection amplifier. The drive voltage from the sweep oscillator is fed to Q1. The Darlington pair provides a high input impedance to minimize loading on the sweep oscillator and wave-shaping network.

The emitter voltage of Q1 supplies base drive for Q2, Q3 and Q4. When Q2 is driven on, it conducts for a little more than half the sweep cycle, charging C1 to B+ through the vertical deflection coils and the thermistor. The charge on C1 provides collector voltage for Q4 and emitter bias for Q3.

When the negative-going half of the drive signal voltage turns on Q3 it, in turn, turns on Q4. Capacitor C1 now discharges through the deflection coils, completing the remainder of the sweep-current waveform. C1 also blocks dc, preventing it from flowing through the deflection coils and causing possible decentering.

Close-coupled CRT grids

Philco's 22ST80 chassis is similar to the earlier 21ST90 but uses a new circuit (Fig. 6) for additional dc coupling to the control grids in the picture tube. The circuit changes include the addition of R252, R253, D209 and C240. This network of components rectifies pulses from the flyback transformer to supply approximately -190 volts to the bottom end of the CRT BIAS control—this point is grounded in earlier chassis. This added voltage makes it possible to increase the coupling to the control grids in proper proportion. Resistors R81, R77 and R91 are now approximately three times the values used in the 21ST90 series chassis.

These changes in the dc coupling remove unwanted complementary colors that tend to contaminate the true colors. For example, if a bunch of yellow flowers are shown against a green background, the leaves would appear bluish-green since blue is the complementary color of yellow. The closer dc coupling between the color-difference amplifiers and the picture-tube control grids reduces color contamination that can be caused by complements of predominant colors in the televised scene. **R-E**

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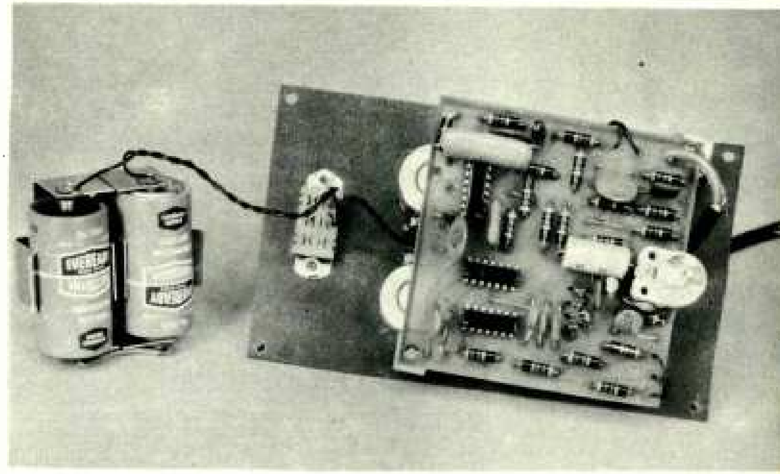
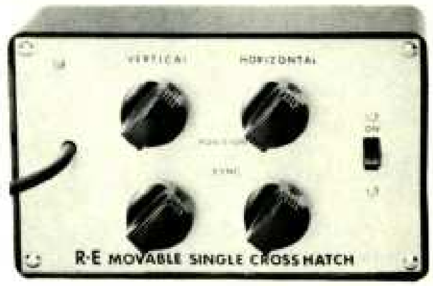


Build R-E's $15 Color Convergence Generator

The single move-anywhere-cross is the big feature of this instrument. Others are its portability and low cost

B. R. ROGEN



Of all the functions of a color-bar generator, that of the crosshatch is the most useful, as it is this one that enables you to make a quick check of the pix tube convergence. Any displacement of either the red, green, or blue electron beams stands out like a sore thumb. Although some service technicians like to use the dot pattern, if you stop to consider it, the crosshatch gives more information about convergence.

There is one small problem with most crosshatch generators—they put too many lines on the screen. Because there is no industry standard, the number of white lines can go from 3 vertical and horizontal, to as many as 23 in both directions. Unfortunately, this is not a case of the more the merrier, as you often lose track of which line you were using after you take your eyes off the screen to locate the correct convergence adjustment control. Some manufacturers have seen the light and are using as little as 3 to 5 lines in both directions, while one manufacturer actually uses a single, variable-position crosshatch.

The generator described here was born of necessity after a few years experience with commercial color-bar generators. Only one vertical and one horizontal line are generated, however, each can be positioned at will anywhere on the screen where the convergence must be touched up. Because it is battery powered, and feeds the color set via the antenna terminals, it makes an excellent convergence checker that easily fits a tube caddy.

Besides making a useful convergence checker, the circuit is also useful to those readers that are studying digital logic, as the complete generator, except for the modulator and rf stage are built up of digital-logic gates.

How it works

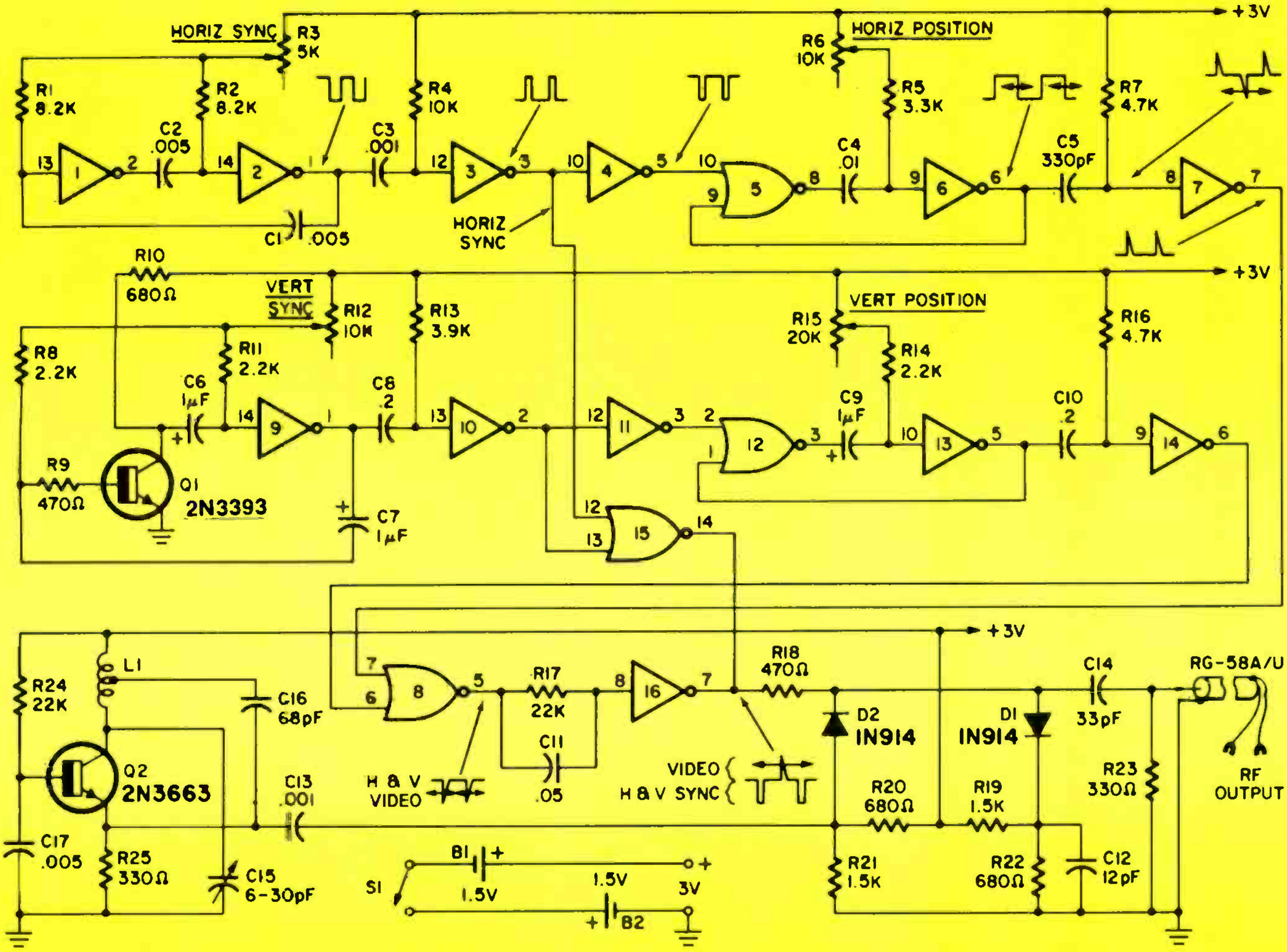
Essentially, the circuit shown in Fig. 1 is a complete TV transmitter that generates both horizontal and vertical sync pulses, along with a unique video modulation that generates the single variable crosshatch. Because both the horizontal and vertical sections are similar, except for the timing differences between the 15,750 Hz of the horizontal and the 60 Hz of the vertical, only one section will be described in detail. This is how the horizontal portion operates.

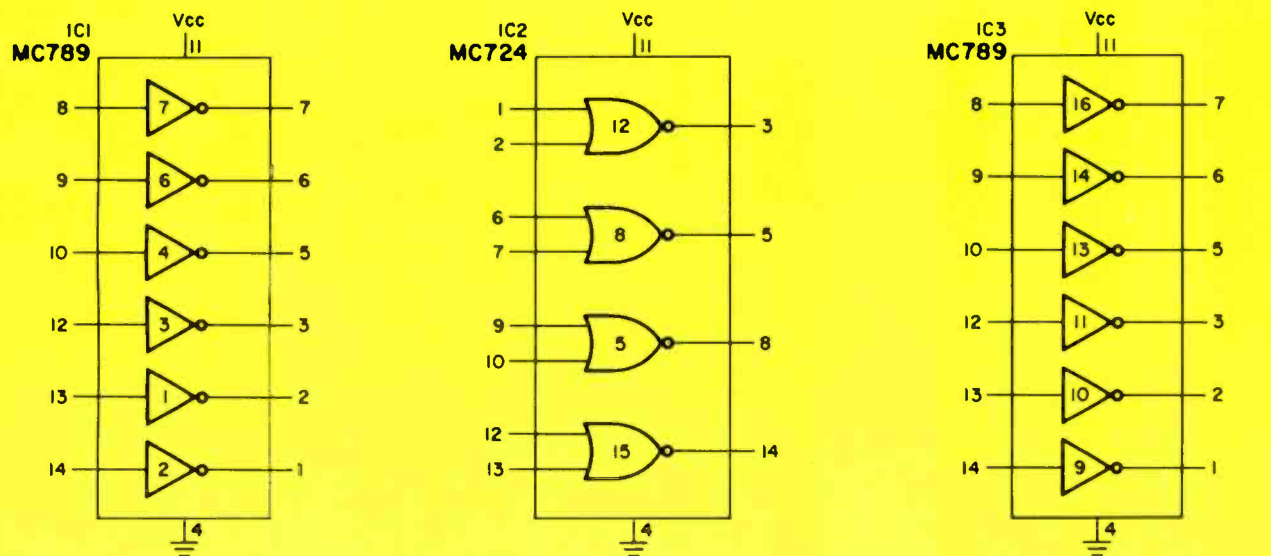
Inverters 1 and 2 are capacitor cross-coupled creating an astable multivibrator. Each inverter is simply a transistor having a base and collector resistor diffused on the same chip. Although we are using an MC724P IC, a µL914 may be used. Now assume that the input to inverter 2 is grounded. The output of this inverter will swing positive (the transistor will be cut off) charging capacitor C1. Inverter 1 is on as it receives base current through R1. Now remove the short. Capacitor C2 charges through R2 until the right side of C2 reaches about .6-volt, the point at which inverter 2 will turn on, causing its output to drop to ground. Because a charged capacitor cannot discharge instantaneously, the left side of C1 swings negative, turning inverter 1 off. The circuit has now changed state. However, the left end of C1 starts to charge via R1. Meanwhile C2 is also starting to charge. When the input of inverter reaches .6-volt, it turns on, its output drops to ground, and the circuit has changed state again.

The time (period) taken between the change of states is a function of the value of the capacitors and their associated resistors. This can be calculated from T = 1.4RC, where T is the period in milliseconds, R is in kilohms, and C is in microfarads. This equation holds true as long as C1 and C2, and R1 and R2 are similar in value. In order to cause this astable to oscillate at the desired horizontal line frequency, the resistor value must be adjustable since an exact R-C combination may be hard to arrive at. This adjustment is made via R3, the horizontal sync control.

Because the output signal from inverter 2 is essentially a reoccuring (15750 Hz) squarish wave, it must be width limited to act as an almost real horizontal sync pulse of about 5-6 microseconds width. This is accomplished by the half monostable represented by inverter 3, capacitor C3, and resistor R4. The half monostable relies on the fact that the charge on a capacitor cannot change instantaneously. In a half monostable, the input must be positive before triggering. This is done via R4. During this time, C3 charges up. When the input voltage, via C3 is brought to ground, the charge on C3 input to inverter 3 must swing negative by the same amount. This causes inverter 3 to turn off allowing its output to swing

FIG. 1—SINGLE CROSS is generated by this circuit using three popular IC's. The IC functional and base pin diagrams are below the schematic. Numbers within the IC elements correspond to those in the schematic. This shows how the elements are used.

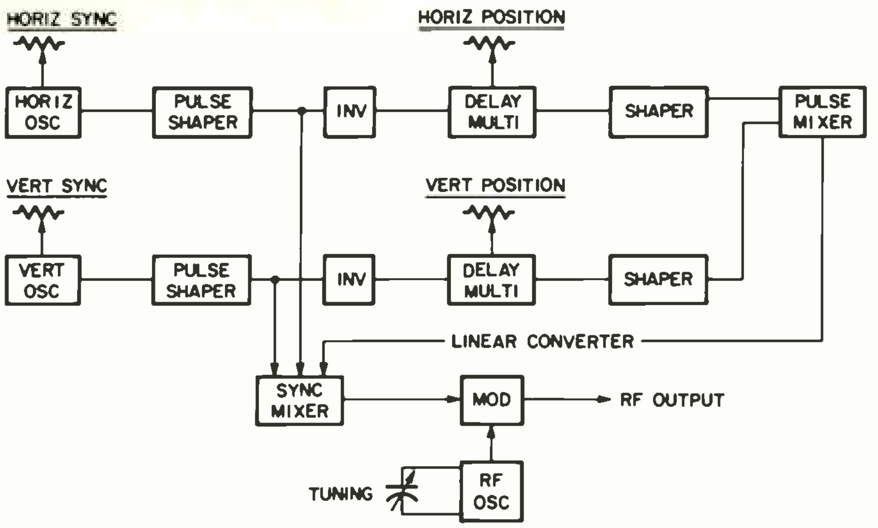




PARTS LIST

All resistors ½ watt 10%
R1, R2—8200 ohms
R3—5000 ohms, potentiometer
R4—10,000 ohms
R5—3300 ohms
R6, R12—10,000 ohms, potentiometer
R7, R16—4700 ohms
R8, R11, R14—2200 ohms
R9, R18—470 ohms
R10, R20, R22—680 ohms
R13—3900 ohms
R15—20,000 ohms, potentiometer
R17, R24—22,000 ohms
R19, R21—1500 ohms
R23, R25—330 ohms
C1, C2, C17—.005μF disc ceramic
C3, C13—.001μF disc ceramic
C4—.01μF disc ceramic
C5—330pF disc ceramic
C6, C7, C9—1μF electrolytic
C8, C10—.2 μF
C11—.05 μF
C12—12 pF disc ceramic
C14—33 pF disc ceramic
C15—6-30 pF trimmer
C16—68 pF disc ceramic
D1, D2—IN914 or similar
Q1—2N3393, MPS3393
Q2—2N3663, HEP56
BATT 1, BATT 2—1.5-volt "C" cell
IC1—724 quad dual-input gate
IC2, IC3—789 hex inverter
L1—4½ turns, No. 20, ¼" dia., ⅜" long; tap 1 turn from positive end
S1—spst (on-off)
MISC.—Case, dual "C" cell holder, coaxial cable with pair of clips, knobs (4), etc.

A complete kit of parts including case, screened panel, etched and drilled board, and IC sockets is available from Photolume Corp., 118 E. 28th St., New York, N.Y. 10016; kit #RE172, price $16.00. Board & semiconductors only $10.00. New York residents add sales tax.



BLOCK DIAGRAM OF THE GENERATOR. Timed multivibrators and wave shapers generate the vertical and horizontal sync pulses. The delay multivibrators, keyed by sync pulses, develop vertical and horizontal lines that can be moved anywhere on the TV screen.

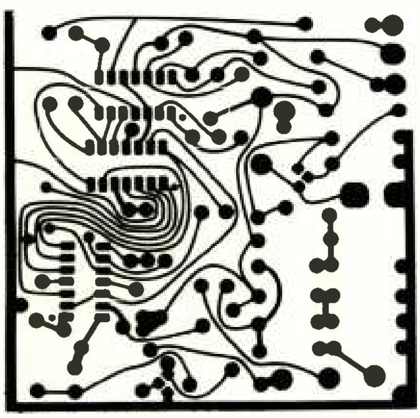


FIG. 2—FOIL PATTERN for the PC board is smaller than full size. Use photograph or other means to enlarge to 3⅜ inches wide.

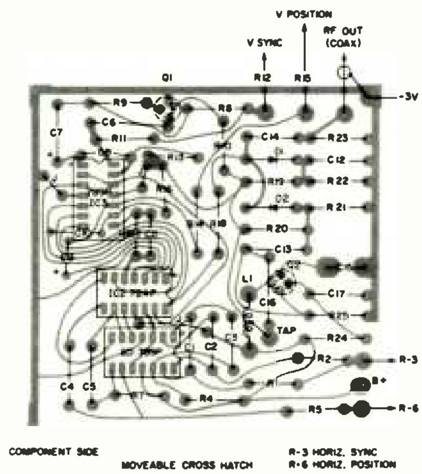


FIG. 3—COMPONENT-SIDE of the PC board. Call-outs show where parts are located.

positive. This positive ouput remains for the length of time it takes R4 to recharge C3. The result, if C3 and R4 are correctly chosen, is a very sharp positive spike, occurring each time the astable output swings negative (in this case, at 15,750 Hz). This "on" time is determined from T=.8RC, where T is in milliseconds, R is in kilohms, and C is in microfarads.

The horizontal sync pulses are then passed to mixer gate 15, where it will be mixed with the vertical sync pulses (generated in the same fashion by Q1, inverter 9, and inverter 10), and the delayed spike video.

After passing through inverter 4 to obtain the correct polarity, the sync pulse then triggers a monostable multivibrator consisting of inverters 5 and 6. At any instant, this monostable can be in either of two states, but eventually, it must arrive at the state where inverter 6 is turned on, due to base current being supplied via R5 and R6. This is where the monostable will remain until it is triggered.

When the positive edge of the sync pulse appears at the input to inverter 5, the monostable will flip to its unstable state, and remain there until C4 charges. The output waveform is then a square wave, whose positive leading edge is fixed, but whose trailing (negative-going) edge is variable with the value of R6. After differentiation through C5-R7, and passing through inverter 7, we now have a sharp, less than one-microsecond wide spike, whose distance from the original triggering horizontal pulse can be varied with potentiometer R6. This spike, along with its vertical sync pulse referenced companion, is passed to video mixer gate 8. The common output of this gate is negative-going very sharp spikes.

In a commercial TV signal, the sync is usually "on the bottom" with the video extending above it. Because the positive-going sync pulses are fed directly into gate 15, their outputs are negative going. However, to cause the "video" to extend above the sync, the gate being supplied with the video must be operated in a linear fashion. This can be accomplished by correctly biasing the input to the gate. Of the two methods available, a series resistor (R16) method was used. C11 serves to bypass the ac video signal. The output of gate 15 then looks like a conventional TV signal, in that the sync pulses are arranged across the "bottom" with the video extending up. The video is then fed to a conventional diode modulator (D1,D2), which is supplied rf power from rf oscillator Q2. The rf output is taken across approximately 300 ohms (resistor R23). The rf oscillator frequency is tuned to any unused channel on the TV low band.

Construction

Although any method of construction may be used, you will find it much easier to use a printed-circuit board, using the foil pattern shown in Fig. 2. Point-to-point wiring can be difficult what with all the IC connections to be correctly made. Once the board is completed, the components are installed in accordance with Fig. 3. Observe the polarity of all IC's, the transistors, electrolytic capacitors, and diodes. Make sure that a low-wattage soldering iron and fine solder is used, as excessive heat can damage the IC's, and make sure that no solder bridges exists between the closely spaced foil leads.

The generator is battery powered—two "C" cells as all it takes is 50 mA from a 3-volt supply. Any type of chassis may be used, but for portable operation, a 6 × 3½ × 2-inch plastic box is large enough.

Using your generator

Remove the antenna from the set under test, and replace the connections with the clips at the end of the generator output coaxial cable. Turn the TV set to an unused low-band channel, turn on the power to the generator and adjust variable capacitor C15 until a series of black marks are seen on the screen. Adjust both R3 (horizontal zync) and R12 (vertical sync) until the raster locks in. It may be necessary to readjust C15. Place the receiver contrast at maximum, and the brightness at some low level. A single white crosshatch should be seen on the screen. Operation of potentiometer R6 will cause the vertical line to move about, while operation of potentiometer R15 causes the horizontal line to move about. The variable crosshatch should encompass at least two-thirds of the screen, and if not, this is most likely due to the tolerance of the timing components in either the gate 5-6 or gate 12-13 circuits.

Now, you can position either the vertical or horizontal crosshatch at any point on the screen, check the convergence, and be sure that you won't loose your place if you take your eyes off the screen. Using the single crosshatch also removes the distraction of other, unused lines that only tend to confuse. **R-E**

AUTOMATIC TINT CONTROLS FOR EVERYONE

Automatic tint control for correct flesh-tone rendition—barely two years old—is full-grown now and takes many forms. Here is a look at several.

by HENRY O. MAXWELL

WHEN MAGNAVOX INTRODUCED atc—automatic tint control—in its 1970 color TV receivers, we felt that this was a much-needed development and that other manufacturers would be sure to develop their own versions. A few manufacturers had atc in their 1971 models. Some were electronic while others were simply preset controls that could be switched in-circuit when the front-panel controls were misadjusted—as is often the case when the set is operated by young children.

The purpose of atc is to keep fleshtones relatively constant and to eliminate the need to adjust the tint and hue controls after camera or program changes or when switching channels.

Every color produced on the TV screen is the result of a definite phase relationship between the 3.58-MHz burst and the 3.58-MHz sinewave chroma signal. By now, you are probably familiar with the color wheel showing the colors that are produced by the phase difference between the chroma signal and the color burst. For example, yellow, orange, red, magenta, blue, cyan and green *lag* the burst by 13, 57, 76, 119, 193, 258 and 299 degrees, respectively. The R - Y signal is at 90° and the B - Y is at 180°. The most natural fleshtones occupy a narrow sector a few degrees above and below 57°.

Phase errors resulting from camera changes or other variations in the transmission setup cause un-natural fleshtones. A transmission error causing the 57° (+I) vector to shift toward the burst causes greenish faces. A phase error toward 90° gives faces an excessively red tint.

Skin colors resulting from phase errors can be made less objectionable by widening the demodulation angle. The more uniform skin tones resulting from widening the demodulation angle causes errors in all other colors but these are easily overlooked when faces look natural to the viewer.

There are two common approaches to atc circuit design. One is to widen the modulation angle by shifting the phase of the 3.58-MHz CW signal fed to one or both color demodulators. The other is by shifting the phase of the chroma signal fed to the demodulators.

Another Magnavox approach

The original Magnavox atc circuit—discussed in the November 1969 and January 1970 issues—was introduced in the T940 chassis and is used in the later T952 chassis. A new and relatively simple atc circuit (Fig. 1) is used in the T958. Fleshtones are made less dependent on relative phase angles and tint control settings by increasing the phase angle between the two 3.58-MHz signals fed to the demodulator grids.

The 3.58-MHz signal from the oscillator is fed directly to one of the grids (pin 6) of the color demodulator. Normally, the signal on the other grid (pin 9) is delayed 90 by a network consisting of L716, C760 and R772. When the atc is off, the cathode of diode D73 is ungrounded. D73, D74 and C73 operate as a voltage doubler, charging the .01-µF capacitor at D73's cathode to about twice the peak output of the 3.58

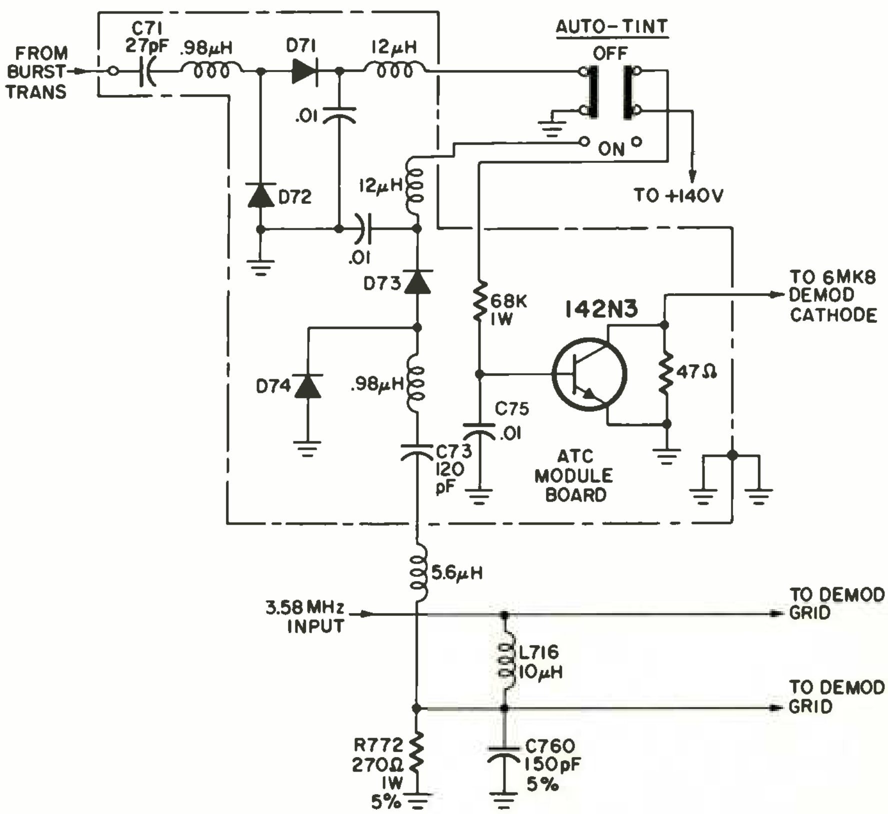


FIG. 1—MAGNAVOX SECOND-GENERATION ATC circuit is simpler than the original Auto-Tint.

oscillator. This capacitor does not have a discharge path so D73 becomes reverse-biased and is effectively removed from the circuit. Now, almost instantly C73 charges through D74 to the peak value of the oscillator signal. C73 is now without a discharge path so it appears as an open circuit which does not affect circuit operation.

When the atc is activated, D73's cathode is grounded, providing a discharge path for C73. D73 and D74 now conduct on alternate half-cycles of the oscillator signal, effectively placing C73 in parallel with C760. This added capacitance delays the phase of the B - Y signal an additional 30° so there is a 130° phase difference between the R - Y and B - Y axes.

This 30° phase shift must be divided equally between the R - Y and B - Y signals, rather than affecting only the B - Y signal. This is done by advancing the phase of the burst signal in the secondary of the burst transformer when the atc switch is in the ON position.

When the atc is off and the phase difference between B - Y and R - Y is 90°, D71 and D72 conduct on alternate half-cycles of the burst, effectively placing C71 across half the secondary of the burst transformer (not shown).

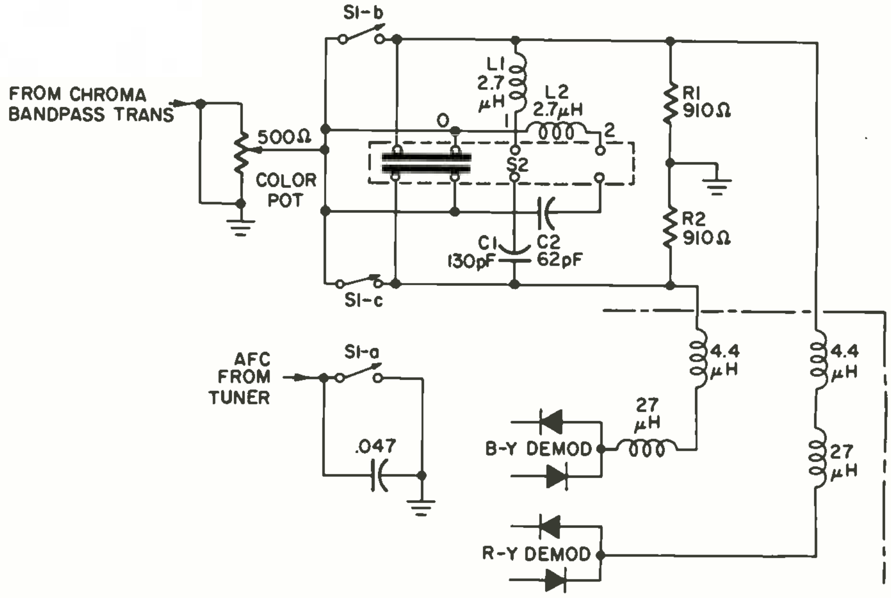
When the atc is turned on, C71 is held charged to the peak of the burst signal and is effectively removed from the circuit by action similar to the operation of C75 when the switch is in the OFF position and C73 appears as an open circuit. With C71 effectively out of the circuit, the burst transformer is detuned, resulting in a 15° advance in the phase of the burst signal. This advances both the R - Y and B - Y 15° and the total 30° increase in phase between the teo signals is divided equally between them.

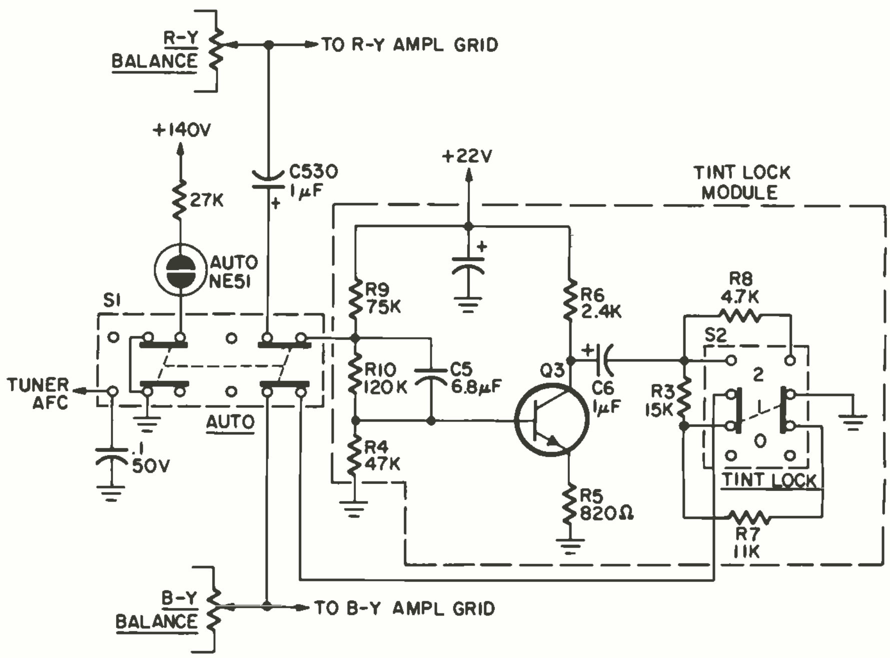
The 30° delay in the B - Y axes (caused by switching C73 into the circuit) and the 15° advance in both the R - Y and B - Y signals (by switching C71 out of the circuit) results in the R - Y axes shifting to 75° and the B - Y shifting to 195°. These new phase angles cause an increase in the amplitudes of the demodulated signals in the skintone and blue regions.

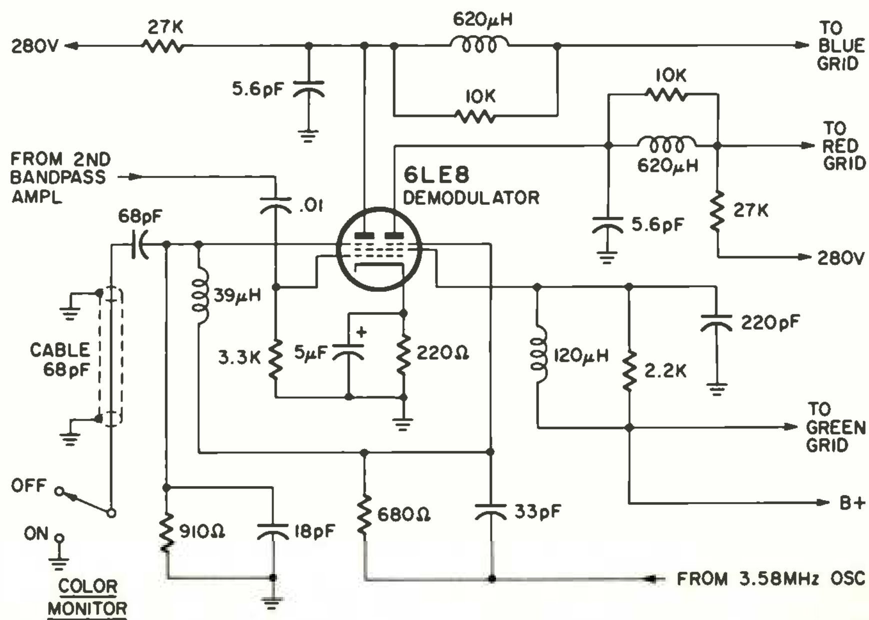
The transistor holds color saturation constant as atc is turned on and off. It is connected across the 47-ohm cathode resistor for the 6MK8 color demodulator. When the atc circuit is off, a positive base bias drives the transistor to saturation, effectively shorting out the resistor and removing the small amount of degeneration it develops.

Tint Lock

G-E uses three different types of atc—they call it Tint Lock—in the KE-II, N2 and C2/L2 chassis. In the deluxe 23-inch KE-II chassis, the demodulation







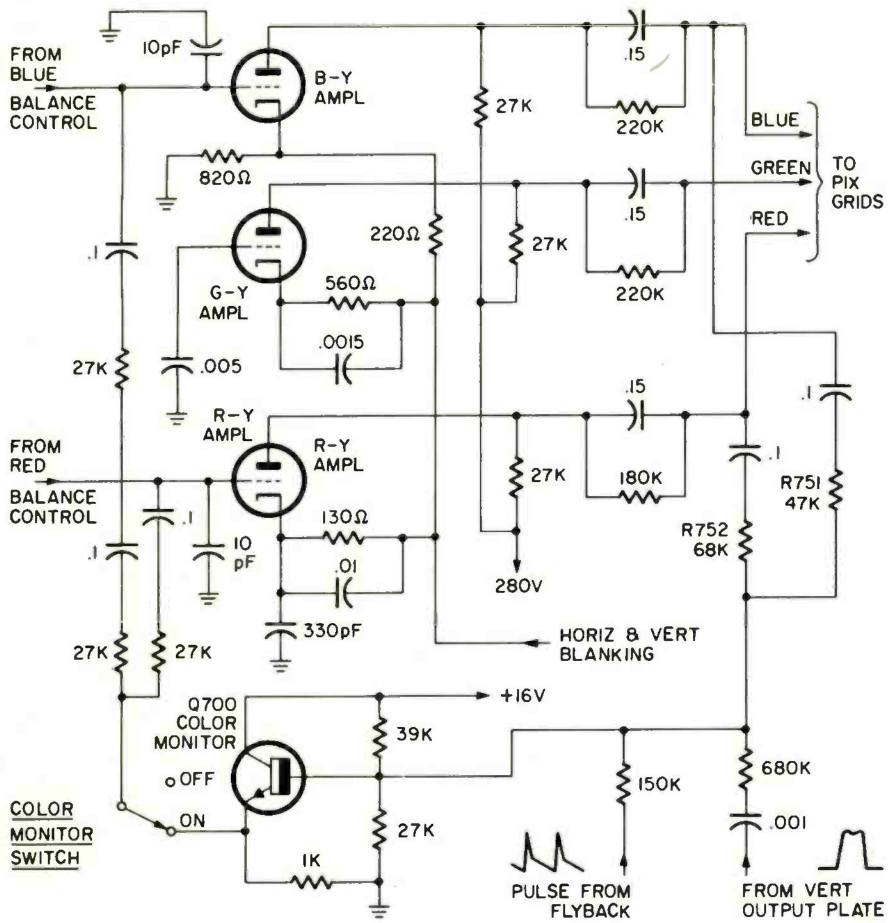


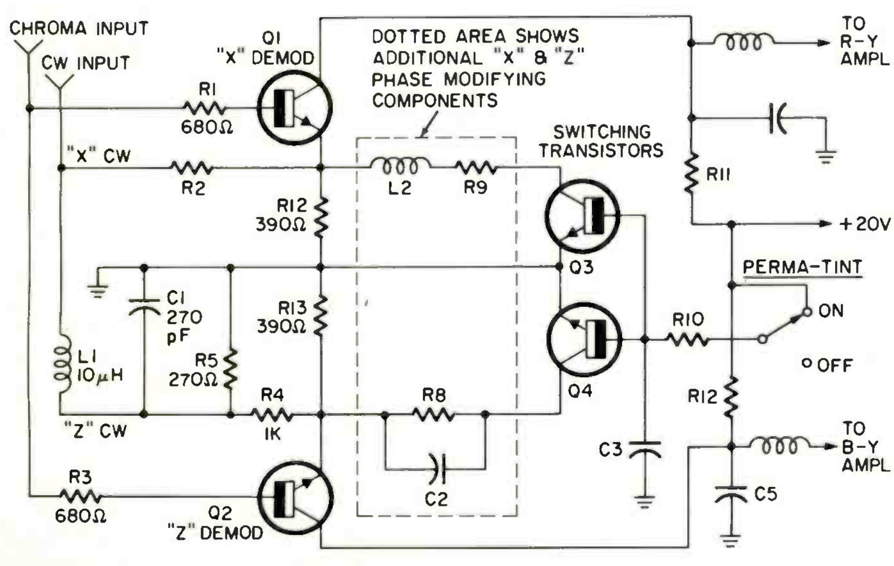
FIG. 2—PASSIVE CIRCUITRY (top left) is used in this General Electric Tint Lock.

FIG. 3—ACTIVE TINT LOCK (left) in G-E's N-2 chassis applies phase corrections to signals after they leave the color demodulators.

FIG. 4—COLOR MONITOR (bottom left) in Admiral 15K16 chassis—one of two types for 1972.

FIG. 5—MATRIX COLOR MONITOR (above) in Admiral's K18 sets uses feedback-type atc.

FIG. 6—PERMATINT (below) is Sylvania's atc. This version is used in EO-10 color chassis.



angle is set at 110 degrees and the Tint Lock circuit can be switched in to widen the demodulation angle to 130 and 150 degrees.

The Tint Lock circuit in the KE-II chassis (Fig. 2) works through S1, the MANUAL/AUTOMATIC switch consisting of two interlocked pushbuttons. One is up when the other is down. When the MANUAL button S1-a is depressed (closed) it grounds the afc line to the tuner. The AUTOMATIC button moves up, closing S1-b and S1-c, bypassing the TINT LOCK switch (S2) and its associated circuitry. The chroma signal from the COLORcontrol is fed in the same phase to the B – Y and R – Y demodulators for a demodulation angle of 110°—as in sets without atc.

Pressing the AUTOMATIC button opens the three sections of S1, turning on the afc and connecting S2 and its associated components into the circuit. When S2 is in the normal (0) position, the chroma information is fed to both demodulators in the same phase and amplitude as when the MANUAL button was pressed.

When S2 is in position 1, the chroma signal to the B – Y demodulator passes through a differentiator consisting of the 130-pF capacitor and 910-ohm resistor to ground. This advances the phase of the chroma signal to the B – Y demodulator, rotating the B – Y chroma information counterclockwise—equivalent to rotating the B – Y subcarrier clockwise.

The chroma information to the R – Y demodulator goes through an integrator (a 2.7-μH choke and 910-ohm resistor to ground) producing a lag that rotates the R – Y chroma information clockwise—the same as rotating the R – Y subcarrier counterclockwise. The 5° R – Y shift and 15° B – Y shift add to widen the demodulation angle to 130 degrees.

Moving the TINT LOCK switch to position 2 decreases the capacitance in the differentiator by switching C2 in series with C1; producing an equivalent clockwise shift of 30° in the B – Y subcarrier phase angle. In the integrator, L2 is switched in series with L1, doubling the inductance and developing a 10° shift in the R – Y subcarrier. The demodulation angle is thus shifted 40° from the original adjustment to 150 degrees.

The atc circuit in G-E's N-2 chassis operates on the color-difference signals *after* they leave the color demodulators (see Fig. 3). A portion of the –(R – Y) signal is inverted by the transistor and fed into the B – Y amplifier. The AUTO switch controls the afc and atc circuits and the Tint Lock indicator lamp. The TINT LOCK switch is connected as a three-step attenuator controlling the amount of +(R – Y) signal mixed with the –(B – Y) signal and fed to the grid

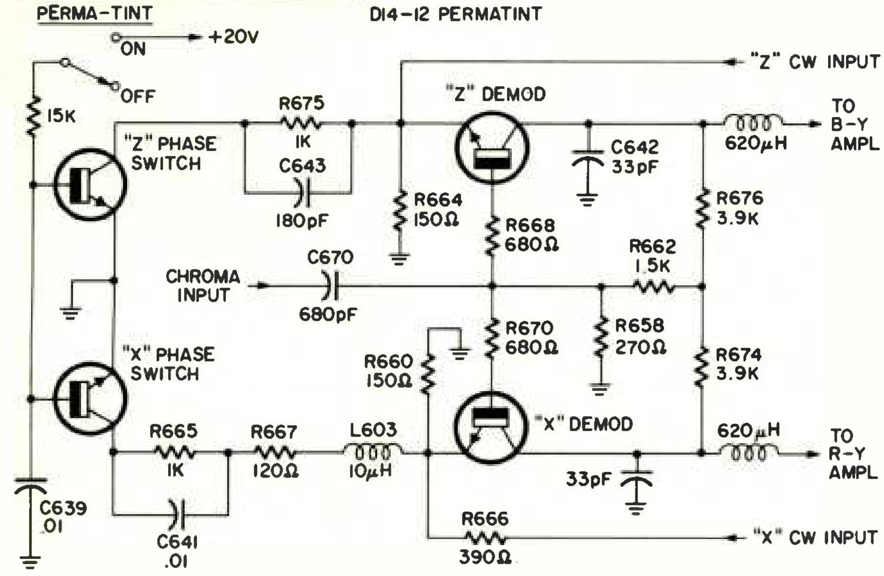


FIG. 7—PHASE CORRECTION circuits in Sylvania's D14-12 sets are similar to Fig. 6.

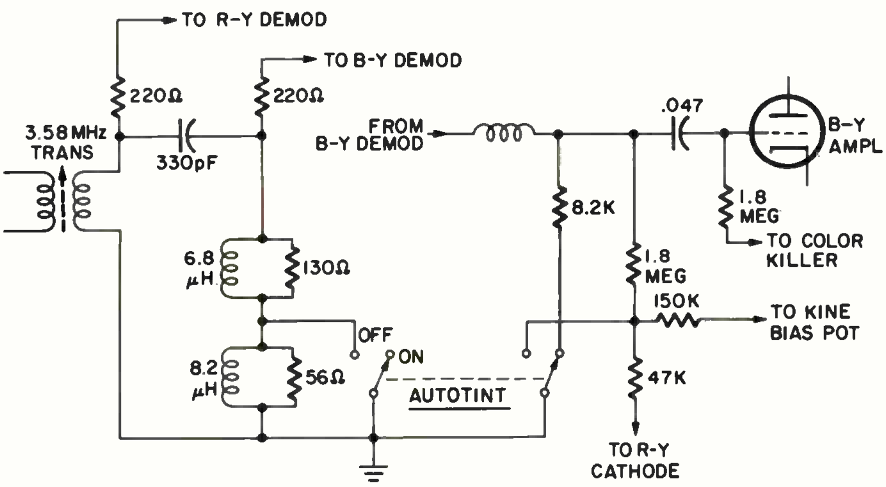


FIG. 8—ACCUTINT is RCA'S basic circuit for automatic tint control.

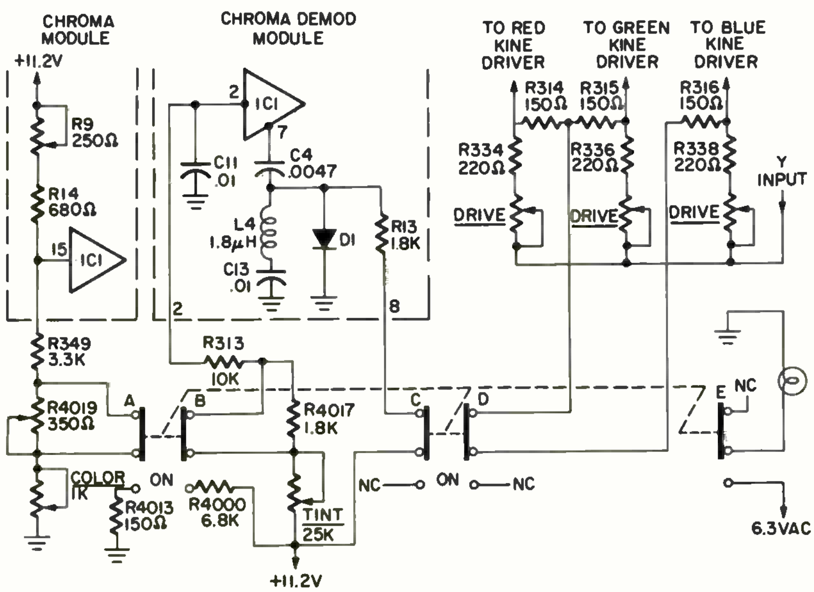


FIG. 9—RCA'S ACCUMATIC is AccuTint with refined tint and color control ranges.

of the B – Y amplifier.

The -(G – Y) input to the G – Y amplifier is the result of matrixing the -(R – Y) and -(B – Y) signals across the common cathode resistor. When the atc circuit is operating, a portion of +(R – Y) is fed to the G – Y amplifier, resulting in a desaturated green signal being fed to the picture tube from the G-Y amplifier.

A vectorscope at the output of the color-difference amplifiers shows that when the TINT LOCK switch is in position 1, the petals along the B – Y axis are slightly shortened. In position 2, the B – Y axis is compressed even more and there is a pronounced counterclockwise rotation of the vector pattern that you can see on the scope.

The atc circuit in the C2 and L2 chassis (not shown) is similar to that in the N-2 chassis but does not use a separate -(R – Y) inverter. Instead, the atc circuit takes the inverted signal from the plate of the R – Y amplifier and feeds it through the attenuator—selected by the TINT LOCK switch—to the grid of the B – Y amplifier.

Color Monitor

There are two new versions of the Color Monitor. In the Admiral 15K16 chassis (Fig. 4) the demodulation angle is determined by a network consisting of the 39-µH coil, 910-ohm resistor and capacitance to ground (52 pF) consisting of the 18-pF and 68-pF capacitors in series with the 68-pF capacitance of the coax cable to the COLOR MONITOR switch. This develops a demodulation angle of 90 degrees—producing acceptable fleshtones over a range of about 20 degrees.

When the Color Monitor circuit is switched on, the capacitance to ground is increased to 86 pF (68 and 18 pF in parallel) to add about 15 degrees to each side of the demodulation angle; widening the fleshtone range to about 70 degrees.

A matrix-type Color Monitor (Fig. 5) is used in the K18 chassis. When the COLOR MONITOR switch is in the ON position, the output of the R – Y and B – Y amplifiers is combined across R751 and R752 to develop an error voltage along the Q (147° magenta—327° blue-green) axis. This error voltage, positive or negative when fleshtones are incorrect and zero when fleshtones are correct, is fed through the emitter follower to the grids of the R – Y and B – Y amplifiers. When the error voltage is other than zero, a corrective phase shift develops to restore fleshtones to their color.

Horizontal and vertical pulses are fed to the transistor. Their polarity opposes the blanking pulses in the chroma signal so blanking does not reach the difference-amplifier grids.

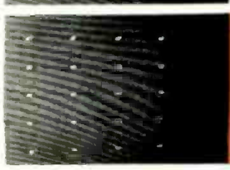
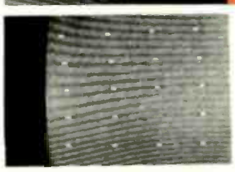
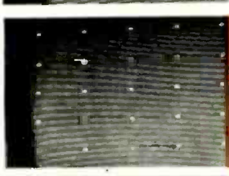
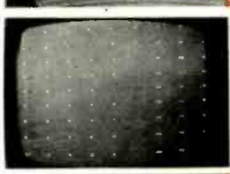
(continued on page 70)

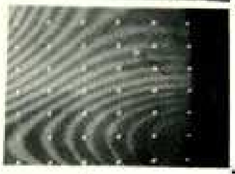
Horizontal Dynamic Convergence

Kwik-Fix™ picture and waveform charts

© Forest H. Belt & Associates*

SCREEN SYMPTOMS AS GUIDES / WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Normal Right-side Mid area			
	Normal Left-side Mid area			
 	Left and right both out of convergence; R/G controls no effect			C1, L1
	Red dots on right side, too far to left			L1
	Red dots on right side, too far to right and above			R1, L2, L5
	R/G dots on left side can't be converged; L1 & L2 no effect			L2, C2, R2, C3, D1
	Dots on left side far apart; R2, R3 no effect			R2, R3
	Can't get ends converged at same time center is			R5, D2
	Can't converge R/G anywhere			L5, L6

	Blue dots too high in center, too low on ends; blue controls no effect			C4, C6, L4, L7
	Blue dots too low in center or on one side; blue controls may not work			D3, R7

NOTES:

Use this Guide to help you find which key voltage or waveform to check first, or to guide you to the causes of symptoms that don't have voltage or waveform clues.

Study the screen with a dot pattern fed into the set. Try each horizontal dynamic convergence control.

You'll find the most helpful trouble clues at the key test point indicated opposite whatever symptom you observe.

Make voltage or waveform checks whenever indicated for specific screen symptoms.

Use the Voltage Guide or Waveform Guide to analyze the results of your tests.

For a quick check, test or substitute the parts listed as the most likely causes of the symptoms you observe.

DC VOLTAGES AS GUIDES

Voltage change	to zero	very low	low	slightly low	slightly high	high
Test point A Normal –0.1 V	C1 open L1 open L2 top open R1 open R4 open D1 open, shorted			C2 shorted		L5 open
Test point B Normal –2.0 V	R4 open D1 open, shorted	C1 open L1 open L2 top open R1 open	C2 shorted			L5 open
Test point C Normal –0.2 V	C1 open L1 open R5 open D2 open, shorted	L2 bot open	C3 shorted			R1 open L2 top open
Test point D Normal –1.3 V	R5 open D2 open, shorted	C1 open L1 open	L2 bot open L6 open C3 shorted			R1 open L2 top open
Test point E Normal –0.2 V	C4 open L3 open D3 open, shorted R6 open					L7 open
Test point F Normal –3.5 V	C4 open L3 open D3 open, shorted R6 open			C4 shorted		L7 open

NOTES:

Use this guide to help you pinpoint the faulty part.

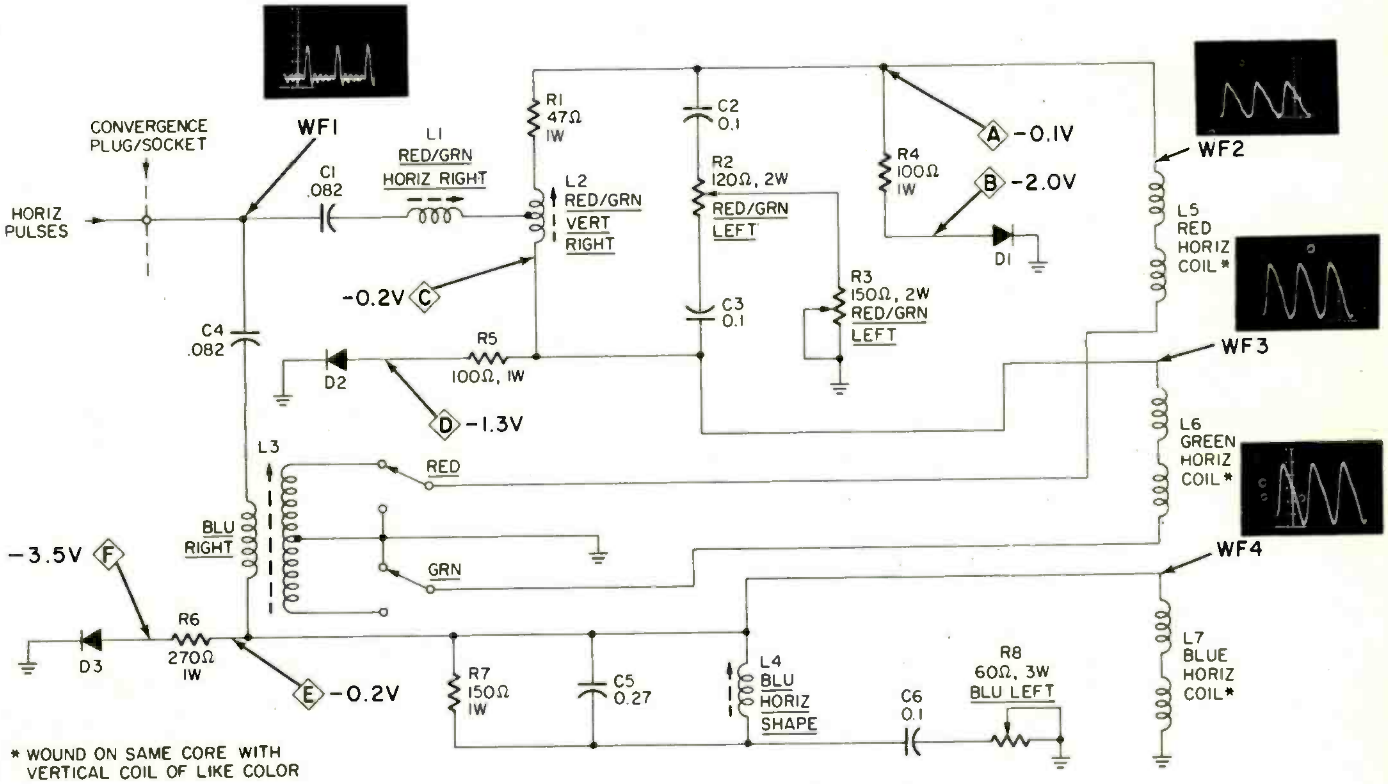
Measure each key voltage with a vtvm or fetvom.

For each, move across to the column that best describes the change you find.

Notice which part is listed as possibly causing that change.

Finally, notice which parts are repeated opposite other voltage changes you find.

For more help to further narrow down the faulty part, see the Waveforms Guide.



The Stages

This particular set of circuits that develop waveshapes for dynamic horizontal convergence is typical of both American-made and imported color receivers. (The major exception is the Trinitron chassis made by Sony.) The goal is to shape and time the horizontal pulses applied to three horizontal convergence coils.

The three coils are part of a convergence yoke assembly on the neck of the color picture tube. Each coil sits above its respective picture-tube beam—red coil over red gun, blue coil over blue, etc. The magnetic field set up by the coil, carefully shaped by the current waveform, "warps" the beam just enough to correct any misconvergence as the beam sweeps back and forth across the picture tube.

There are two major sections or "stages." One supplies a shaped signal to the blue horizontal convergence coil. The other stage feeds the red and green. The design leaves some interaction between red, green, and blue, largely because L3 is common to both branches. Interaction is less when the red and green coils go to ground instead of to the coil winding. Some receivers don't have the transformer connection movable. Circuitwise, the difference is slight. In adjustment procedure, nothing changes except that the taps can be reversed or grounded for best convergence.

Another factor to remember as you analyze horizontal dynamic convergence stages: Each convergence coil is shown here as if it were by itself. In actuality, each one is wound on the same core with its counterpart in the vertical convergence section.

Design variations usually consist of rearranging the components. For example, the BLUE LEFT potentiometer control might precede the BLUE RIGHT and BLUE HORIZONTAL SHAPE coils in that part of the blue stage. Or, RED-GREEN HORIZONTAL inductance might be made common to the "bottom" end of the red and green horizontal convergence coils. If you encounter what looks like a complicated variation, simply sit down with a piece of paper and sketch out the circuits. Try to arrange them somewhat in the order of this schematic. You'll likely find a strong resemblance, enough that you can easily figure out operation from this typical version.

Signal Behavior

Input for the horizontal convergence section comes from a winding on the horizontal output or flyback transformer. Usually, it is the same winding that supplies pulses for agc, horizontal afc, etc.

Capacitor C1 couples the pulse waveform to the red-green stage of the section. Coil L1 imparts some inductive rounding to the waveshape, and couples it on to L2. Center-tapped inductance L2 splits the signal and sends a portion of it in each direction toward the red and green convergence coils.

Potentiometer R2 balances the division of signal. Capacitors C2 and C3 couple the two signals to each end of the balancing pot. This control sets the ratio between the magnetic field affecting red beam and that affecting green beam. Potentiometer R3 determines to some extent how much balancing effect R2 has on the two signals.

Each convergence coil has a shaping-diode network. It operates somewhat as a clamp. Diode D1 and resistor R4 shape the waveform for the red horizontal coil. D2 and R5 do the same for the green coil.

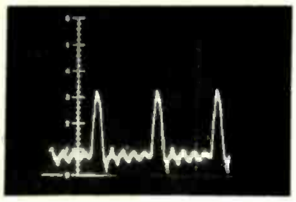
BLUE RIGHT inductance L3 has small effect on the magnetic field within L5 and L6, the red and green horizontal convergence coils, despite the ground return through the L3 secondary winding (in many models). The effect on the scope waveform is hardly visible. You can see some small effect on red-green horizontal lines, but L3 mostly affects blue dots.

Where various tap combinations can be used on L3, the choice depends on whether the set converges easily or not. One convergence coil can be grounded and the other returned through L3, or vice versa, or both can be grounded, or both can be returned through L3. The effect of tap changes is mostly on red and green.

Capacitor C4 couples the horizontal pulse signal to the branch for blue horizontal convergence. L3 rounds the waveshape slightly. Diode D3 and resistor R6 form one shaping network in this branch. Further shaping is accomplished by a resonant circuit consisting of C5, L4, and damping resistor R7. Capacitor C6 and potentiometer R8 control how much shaping the resonant circuit accomplishes. The blue horizon-

WAVEFORMS AS GUIDES

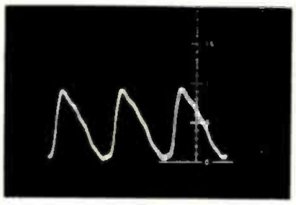
V p-p low	V p-p high	V p-p zero	Changed Shapes



WF1 Normal 320 V p-p

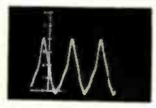
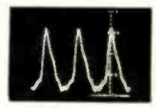
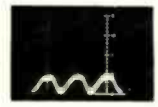
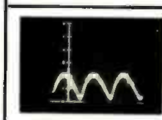
Taken at input to horizontal convergence section, conveniently at the convergence plug/socket terminal, this waveform is the same horizontal pulse that keys agc or feeds horizontal afc. Shown here mainly for reference, although certain component failures can drag amplitude down through loading. Trouble may show first in one of the other sections receiving these pulses.

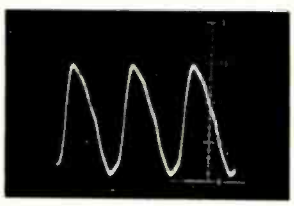
V p-p low	V p-p high	V p-p zero	Changed Shapes
C1 shorted C4 shorted L1 shorted			



WF2 Normal 15 V p-p

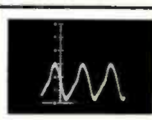
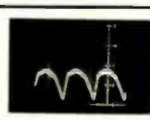
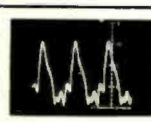
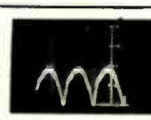
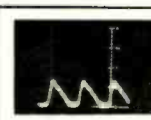
Taken at top (high side) of red horizontal convergence coil, this waveform is shaped by C1-L1, by L2-C2-R2-R3, and by R4-D1. Amplitude is given for normal convergence settings, although gun tolerance in some color picture tubes may require higher or lower value of this waveform. Resetting L2, R2, or R3 may change the "normal" peak-to-peak voltage. Normal shape may be slightly different, too, for same reasons.

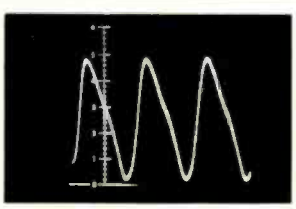
V p-p low	V p-p high	V p-p zero	Changed Shapes				
D1 shorted L5 open	R4 open D1 open C4 open		 4V p-p C1 open L1 open	 35V p-p C2 open R2 open R3 open	 40V p-p L1 core out	 12V p-p C2 shorted	 5V p-p R1 open L2 top open
			 20V p-p L3 pri open				



WF3 Normal 15 V p-p

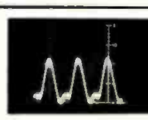
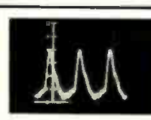
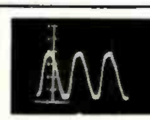
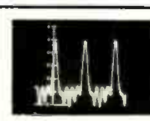
Taken at top (high side) of green horizontal convergence coil, this waveform is shaped by C1-L1, by L2-C3-R2-R3, and by R5-D2. Amplitude given is for normal convergence, although gun tolerance in some color picture tubes may dictate different value of waveform. Resetting L2, R2, or R3 may change the "normal" peak-to-peak voltage. Normal shape may be slightly different, too, for same reasons.

V p-p low	V p-p high	V p-p zero	Changed Shapes				
L2 bot open D2 shorted	R1 open R5 open D2 open L2 top open		 3V p-p C1 open L1 open	 8V p-p L6 open	 25V p-p C3 open R2 open R3 open	 10V p-p L3 pri open	 6V p-p C3 shorted



WF4 Normal 45 V p-p

Taken at top (high side) of blue horizontal convergence coil, this waveform is shaped by L3, by R7-C5-L4, by C6-R8, and by R6-D3. Amplitude is for normal convergence, although gun tolerance in some color picture tubes may dictate different value. Resetting L3, L4, or R8 may change the "normal" peak-to-peak voltage. Normal shape may be slightly different, too, for same reasons.

V p-p low	V p-p high	V p-p zero	Changed Shapes				
D3 shorted	R6 open D3 open L7 open		 1V p-p C4 open L3 pri open	 40V p-p L4 open	 45V p-p C5 open	 60V p-p C6 open R8 open	

NOTES:

Use this Guide and the Voltage Guide to help you pin down fault possibilities.
Set controls for best convergence possible, even if it's not correct convergence over the whole TV screen. Use dot pattern.
Use direct probe of the scope. Set scope sweep to about 5 kHz, to display three cycles.

Check the four waveforms at the four key test points. Note amplitude. If it's low or high, check the parts listed under those columns.
Note waveshape. If there's a change that matches one shown, check the parts indicated.

tal convergence coil is returned to ground in most sets.

DC Distribution

The only dc in these stages develops in the resistor-and-diode clamp circuits. C1 and C4 block any dc that might enter from outside. C2 and C3 keep the settings of R2 or R3 from lowering dc clamping levels. C6 does the same for R8. Dc finds a path to ground through L5, L6, and L7: that explains why voltages at points A, C, and E are lower than voltages at B, D, and F. Control settings vary dc voltages in the horizontal convergence section only if waveshape is altered drastically.

Station and Control Effects

Changes in signals from stations have no discernible effect on the convergence section. But waveforms definitely are altered by the three potentiometers and four variable inductances. You can see results of control or inductance manipulation best with a convergence-dot pattern on the face of the picture tube. Examples: Coil L1, the RED-GREEN HORIZONTAL inductance, affects red and green (but not blue) dots halfway up the right edge of the picture tube: L1 moves them sideways till they superimpose each other (forming yellow if blue has been killed). Coil L2 moves the same dots up and down: that is, red and green dots move vertically with respect to each other as you turn L2.

Potentiometers R2 and R3 have a like effect on red and green dots midway up the left side of the picture tube screen. R2 moves them up and down with respect to each other while R3 moves them side to side. As with L1 and L2, a certain amount of interaction between R2 and R3 forces you to alternate adjusting them till you get a yellow dot with no red or green fringing.

Inductance L3 works primarily on blue dots, since it is in the signal path to the blue horizontal convergence coil. L3 moves blue dots up or down near the midpoint right side of the CRT screen. Potentiometer R8 does the same thing for dots over at the midpoint left side. L3 and R8 interact to some extent, and may have to be juggled for correct convergence.

Coil L4, the blue horizontal shape adjustment, affects the bowing of the line of blue dots across the center of the picture tube. You adjust L4 so the line of dots is as straight across the tube as possible. Then if the yellow dots don't coincide, you can move the whole line of blue dots up or down at the center with the static convergence or magnet.

Quick Troubleshooting

Perhaps the quickest clue to a faulty part is the inability to make one adjustment or another work. If turning L1 has no effect, either the coil is bad or you have the slug too far in or out of the core. By the same token, if a potentiometer doesn't move the dots in its assigned screen area, you can assume trouble with the control or in some associated part.

Related adjustments may be a further clue. For example, if the primary of L3 were to open, neither L4 nor R8 could have any effect on blue dots. Similarly, if the slider of R2 lost contact, neither R2 nor R3 could move the red and green dots.

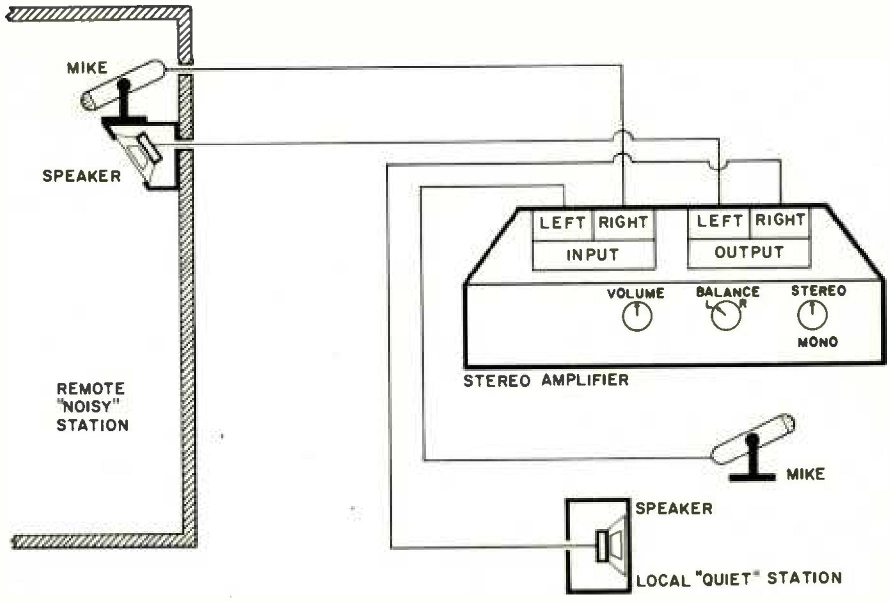
If a convergence coil opens, you can tell easily. Dots of that particular color will not move when you turn any related control. As an example, if L5 were open, moving L1, L2, R2, or R3 would not shift any red dots: however, green dots would react to any or all of the controls. Likewise, an open blue coil eliminates whatever effect L3, L4, and R8 should have.

Another little hint: D1, D2, and D3 are often in a multiple-diode package. If one of them goes bad, you'll have to replace all.

Instant Paging-Intercom System

by HERMAN LEVIN

It's easy to turn a stereo amplifier into a paging-intercom



The need for two-way communication between stations with vastly different noise levels can be handled readily by using an inexpensive stereo amplifier. Since reproduction quality is not vital in this kind of application, an amplifier with relatively high distortion and limited frequency response works well.

The amplifier should be connected to microphones and speakers as shown in the illustration. Each channel's individual volume and tone controls can be set to provide the desired level at each station.

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(Continued on page 70)

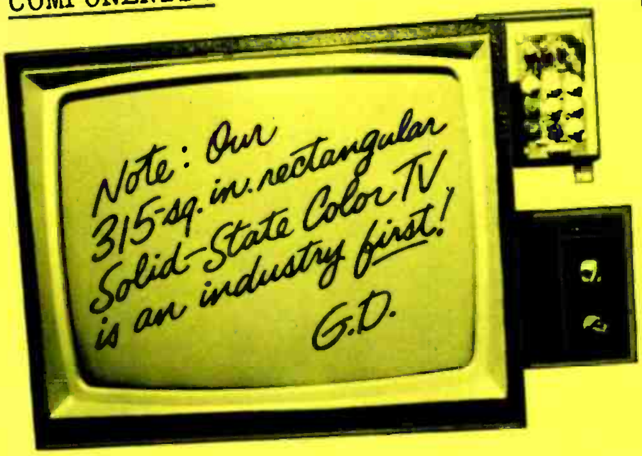
BELL & HOWELL TECHNICAL REPORT

Subject: New Home Entertainment Electronics Systems Program

Competitive Advantages:

- Features first Solid-State Color TV (315-square inch, rectangular screen) Kit for at-home training to build, keep.
- Helps prepare recipient for Color TV Service Business of his own. Covers solid-state circuitry in depth--also other Home Entertainment equipment. Fully updated.
- Provides three additional professional quality kits to assemble, keep, use.

COMPONENTS:



Specifications:

New 25" diagonal, ultra rectangular screen. 315-sq. inch viewing area. 25,000 volt, solid-state design, w/ 45 transistors, 55 diodes, 2 silicon rectifiers. 4 advanced IC's w/46 transistors, 21 diodes. 2 tubes: picture and high voltage rectifier. Solid-State VHF and UHF tuners. 3-stage solid-state IF. AFT standard. VHF power tuning. Also: "Instant On" circuit, automatic color control, noise limiter.

Descriptive analysis:

Modular plug-in circuit board design provides for more than 100 advanced solid-state devices. Insures premium color, sound control, exceptional reliability, easy access. Includes Hi-Fi amplifier for sound output, built-in dot generator, tilt-out convergence panel. Handy Volt-Ohm meter permits initial set-up and adjustment plus detailed trouble-shooting. 315-sq. inch picture tube face transmits entire image. Push button channel advance. AFT module brings in perfect picture, sound automatically. Easier to service than older, non solid-state sets. Quality components throughout.

Electro-Lab-at-Home: Components included:

The Electro-Lab® consists of three units, arriving in 16 shipments which recipient assembles, keeps. All components are professional quality. The circuit DESIGN CONSOLE contains built-in power supply, test light, speaker. Patented Modular Connectors permit plug-in to console to rapidly "breadboard" many different circuits. No soldering or messy un-soldering necessary.

The portable 5-inch, wide-band OSCILLOSCOPE is calibrated for peak-to-peak voltage and time measurements... offers 3-way jacks to handle test leads, wires, plugs. Images on screen are bright, sharp.

The lightweight TRANSISTORIZED METER combines most desired features of a vacuum-tube voltmeter and a high-quality multimeter. Features a highly sensitive, 4-inch, jewel-bearing d'Arsonval meter movement. Registers slightest power surge or lag on large, easily read dial. CONSENSUS: first class gear.

Program is designed to give:

- Understanding of electronic circuits in most home entertainment electronic systems
- Ability to analyze and troubleshoot a wide variety of advanced solid-state and other TV circuits
- Capability to understand and use test equipment and procedures with special emphasis on TV testing
- Ability to assemble, test and adjust the solid-state TV kit included with the program

Color TV is going Solid-State—here's how to help yourself get ready for it:

There's nothing else like this exciting new program that offers the *first* 315-sq. inch Solid-State Color TV available for at-home training.

As you follow the simple, step-by-step assembly and testing procedures, you will soon become thoroughly familiar with the most advanced solid-state TV circuitry. And you'll help prepare yourself for a profitable Color TV service business of your own—either full or part time.

Why Color TV pays better.

Today, Color TV is the big seller. And tomorrow, when it goes all solid-state, the man who has mastered this circuitry, will be in demand. This, of course, is where the money is going to be made.

But, this new Bell & Howell Schools program will also give you the in-depth knowledge of the basics as well as TV circuit analysis. You'll get the theory and practical experience you need to handle radios, Hi-Fi's, stereos, tape recorders, B & W television as well as most other home entertainment electronic devices.

Build, keep your own 25″ diagonal Solid-State Color TV Set

Whether you are a beginner, an experienced hobbyist, or a pro working in the field, you are going to be delighted with the performance you get from this new solid-state kit. So proud, you'll want to show it off to your relatives and friends.

The "specs" at left give a few of the facts. But there are many, many features besides these which you will not find in any set on the market today. Send for all the facts and this is the one you'll want.

You're ready for many kinds of Home Entertainment Equipment

This is a thorough-going program, put together by professionals, with completely up-dated components and materials. When you have completed it, you'll have a new kind of confidence in your ability to tackle almost anything related to electronics in the home. And I can assure that these devices are definitely on the increase!

In addition, you'll have the kind of sound technical background you need for either a career as a technician in the Electronics industry or a business of your own—either full or part time.

Note: TV picture is simulated.

CONSIDER THESE ADVANTAGES:

Bell & Howell Schools' Electro-Lab-at-Home Plan gives you the most thorough background possible in solid-state Color TV. Everything comes to you by mail. No traveling. You go at your own speed and never miss a paycheck!

When you've completed your program, our **Lifetime National Employment Service** will help you locate in an area that interests you. This service is available at any time—now or in the future.

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Our programs are approved for Veterans' Benefits. If you're a Vet, check the space in the card for full details.

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Special Help Sessions.

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Bell & Howell Schools offer you even more. Once you have finished your program at home, you may decide you want more advanced preparation. In this case, you can earn **transfer credits** to any one of our seven schools which are located all across the country.

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322

IC Potpourri

7 ways to use IC transistor arrays

Circuits shown this month include five current-source circuits and two rf-i.f. amplifiers

by WALTER JUNG

OUR LAST INSTALLMENT OF THIS SERIES focused on the basic elements of monolithic IC's, the transistors themselves. We examined the representative characteristics of popular monolithic arrays and explored a single biasing hookup with a couple of circuits. Now let's go a few steps further.

It turns out the deceivingly simple matched-transistor biasing technique (repeated in Fig. 1-a) with its variations is one of the most widely used circuits in our popular IC's. Take a close look at a 709, 723 or almost any monolithic IC schematic and you'll see it. It's a powerful tool, and to illustrate this statement, let's look further at some circuits which demonstrate its usefulness.

In this matched transistor combination Q2 is commonly known as a constant-current source or more simply, current source. It is termed a current-source transistor because it's collector current is constant and relatively independent of what its collector voltage is doing. This is because the determining factor for Q2's collector current is the low impedance base voltage impressed upon it from Q1. Therefore a stage biased in this manner will hold the collector current of Q2 constant.

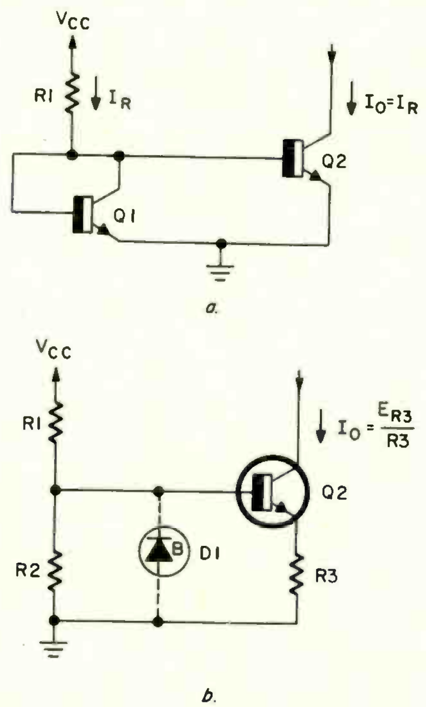


FIG. 1—CURRENT SOURCE using monolithic transistors. Q1 (a) is diode-connected and is shown as a diode on some IC schematics. In the equivalent circuit (b) using discrete components resistor R2 may be replaced by a Zener diode as shown.

Compare the efficiency of this current source with the more conventially biased discrete-component circuit in Fig. 1-b. Here Q2 is biased at a constant collector current by voltage divider R1–R2 (or R1–D1 using Zener-diode bias). In either case a constant voltage is applied between base and ground, and a fixed emitter resistor stabilizes the current I_o in Q2 at a steady level.

But look at the efficiency of this circuit. With a fixed bias of 3–6 V (typical Zener voltages) applied to Q2, this V is the lower limit of Q2's collector dynamic range. The 3–6 volts which the regulator uses for bias can be a large percentage of the dc supply. Thus, this circuit (Fig. 1-b) definitely limits dynamic range and efficiency.

If we go back and look at Fig. 1-a we note that Q2's collector voltage can swing very close to ground potential. Or, for a safe minimum limit, to 1 V_{be} above ground, the voltage at which V_{cb} = 0. A couple of examples of this exact biasing scheme are the Fairchild 703 and Teledyne 911 (National LM371) IC's intended for communications rf and i.f. service. The amplifiers, entirely biased by diode strings, are shown in Fig. 2. Look at the simplicity of biasing—a single resistor to V_{cc} is all that is required to bias the amplifier stage.

Variations on the basic current source are many. One rather obvious one shown by Fig. 3-a is to parallel more transistors on diode-connected Q1 to generate 1, 2, 3 or more current sources—as many as are necessary, each equal (within the limitations of the circuit) to the reference current I_R. In a similar manner current sources can be scaled by a factor of 2, 3 or more by merely jumpering the collector outputs as in Fig. 3-b. For the examples shown I_{ot} = $2I_R$, but other multiples are also feasible, as well as combinations of multiple and single sources. This configuration is a good one to conserve power by minimizing the power consumed by the reference current I_R. For instance, the reference current I_R can be set at a small fraction of the desired output current by selecting the appropriate number of multiplier current sources to scale the reference current by the proper ratio. An example of such an approach is National's LM703L which is a low power 703 rf/i.f. amplifier (Fig. 2-a) with a bias chain (R1-R2-Q1-Q2) operating at 1/5 the current of the current-source output transistor! This reduces the otherwise wasteful bleed current of the bias string and optimizes circuit efficiency with no sacrifice in performance.

A decided improvement over these basic circuits is gained by adding emitter resistances in each leg which not only improves the current-source regulation but allows easy adjustment of current ratio by altering the ratio of the two resistances. Referring to Fig. 4-a, in the case where $R_{E1} = R_{E2}$, $I_R = I_o$ because of the monolithic match. But this is more than a simple change over Fig. 1-a. The emitter resistances improve the current-source regulation by raising the output impedance of Q2 and reducing its sensitivity to collector-voltage variations. This higher output impedance makes the device a much more useful circuit tool as we will see when we begin to apply stages such as this in circuit configurations.

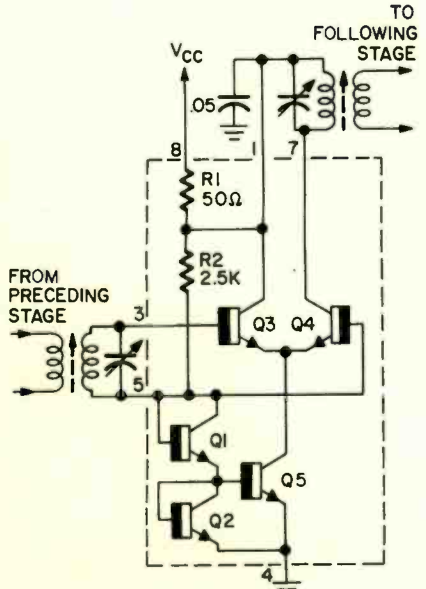
These resistors will be no larger than 1000 ohms for effective operation, and thus they do not substantially increase the voltage drop across the transistors if the currents are kept below 1 mA. By using emitter resistances and scaling their ratios, small adjustments (3/1 or less) may be made between I_R and I_o.

One of the neatest tricks used to scale currents is the logarithmic current source of Fig. 4-b. Here Q1 is diode-connected as before, but Q2 is operated at a lower current by the addition of an emitter resistor R_E. Operation of this stage is based upon the very exact relationship between collector current and V_{be} in matched transistors.

If Q1 and Q2 of Fig. 4-b are operating at two different currents, they will exhibit a base-emitter voltage difference, or ΔV_{be}. Therefore R_E must drop this ΔV_{be} while passing the emitter current of Q2, which we will approximate here by calling it I_o.

Mathematically this difference in base-emitter voltage is expressed as $\Delta V_{be} = \frac{KT}{q} \ln\left(\frac{I_R}{I_o}\right)$ In this expression K, t and q are physical parameters of
K = Boltzman's constant
t = Temperature in degrees Kelvin
q = Charge on an electron
which, at room temperature reduces to the familiar 26 mV found so often in transistor related expressions. This 26 mV times the natural log (ln) of the current ratio $\frac{I_R}{I_o}$ will give you the V_{be} differential you will have to work with. Let's take an example to clarify it. To simplify, choose $\frac{I_R}{I_o} = 10$. Then since $\ln X = \frac{\log 10}{.43429}$ and $\log 10 = 1$, $\ln X = \frac{\log 10}{.43429} =$ 2.3. Taking 2.3 times 26 mV yields 60 mV as the ΔV_{be} for two matched transistors operating at a current ratio of 10/1. This is a good number to remember—the ΔV_{be} for a matched pair is *60 mV per decade of difference in collector currents.* In Fig. 4-b, if I_R was 1 mA and I_o 100 μA, $R_E = \frac{.06V}{100\mu A} = \frac{6 \times 10^{-2}}{1 \times 10^{-4}} = 600$ ohms.

By using a common diode connected Q1 for a master reference any number of additional logarithmic current sources may be added by calculating their individual current ratios and solving for R_E in each case. R-E



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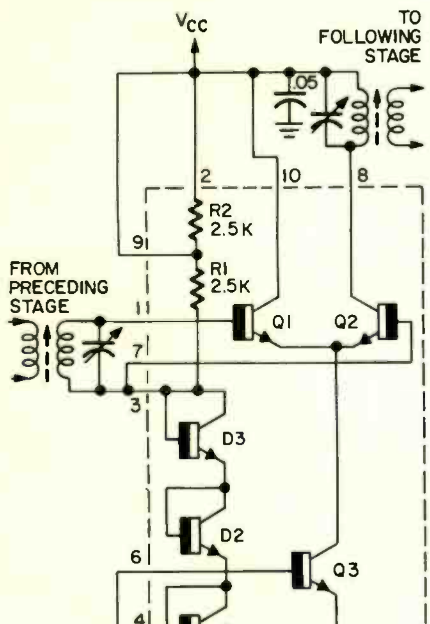
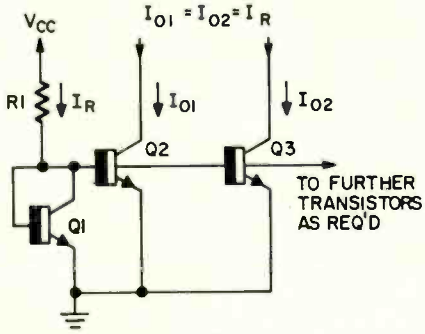


b

FIG. 2—IC RF-I.F. AMPLIFIERS as used in a typical application. The type 703 IC is at (a). Compare this with (b) designed around a 911 or LM731 IC.



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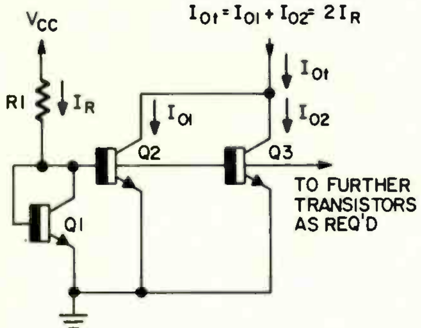
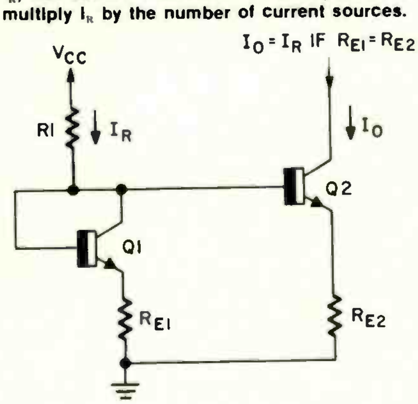


b

FIG. 3—BASIC CURRENT SOURCE with multiple outputs (a), each having current equal to I_R. When current source must supply more than I_R, the source collectors are strapped (b) to multiply I_R by the number of current sources.



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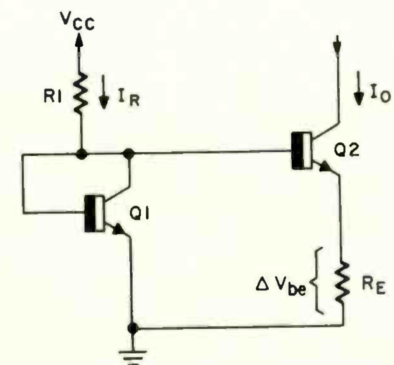


b

FIG. 4—IMPROVED CIRCUITS have emitter resistors (a) for better regulation. When load current I_o is small, the logarithmic current source (b) is used and is adjusted precisely by value of R_E.

Eliminating Hum Bars

A "hum bar" of the type usually associated with interference from silicon power-supply rectifiers may appear in the picture in weak-signal areas. In some cases this interference occurs when the neon channel-indicator lamps are operated on ac tapped off terminal 2 (the cold side) of on-off switch S4101. Later production models have the lamps operated off dc as in the partial schematic in Fig. 1. The two 22,000-

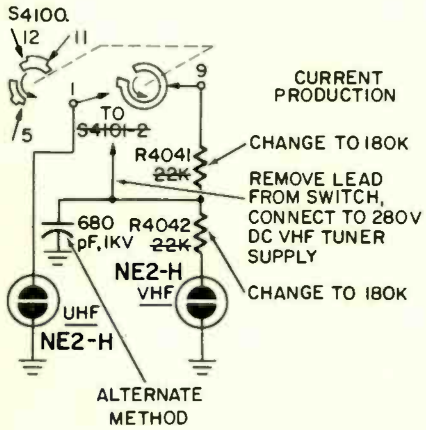
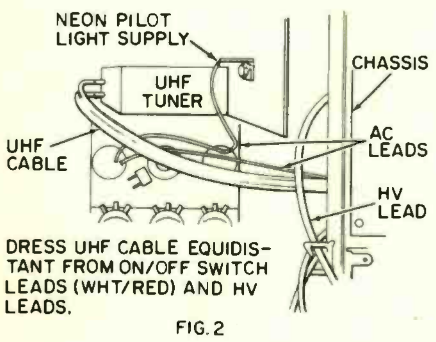


FIG 1

ohm limiting resistors have been changed to 180,000 ohms and the supply line to the lamps is removed from the switch and connected to the 280-volt dc line to the vhf tuner.

An alternate method, which may eliminate the interference on one channel and not on another is to add a 680-pF, 1-kV capacitor as shown.

In early-production model EQ-447 sets using the CTC 55 chassis, the bar interference may develop when the set is tuned to low uhf channels. This may result from improper uhf antenna cable



DRESS UHF CABLE EQUIDISTANT FROM ON/OFF SWITCH LEADS (WHT/RED) AND HV LEADS.

FIG. 2

lead dress. As shown in Fig. 2, it should be positioned equidistant between the on-off switch leads and the high-voltage leads. In later production, a bead link wire tire secures the cable in this position.—*RCA TV Service Data* **R-E**

AUTOMATIC COLOR CIRCUITS
(continued from page 56)

Perma-Tint

Perma-Tint (Sylvania appears to spell it with and without the hyphen) atc circuits correct phase errors in Sylvania receivers. Normally, the demodulation angle is 100°—the Z axis at 170 and the X axis at 70 degrees. The atc circuit widens the demodulation angle to 130° by inserting additional phase-shift components into the demodulator circuits. The Z axis is shifted to 200° while the X axis is held at 70°. Figure 6 is the basic circuit used in the EO-10 chassis.

Closing the PERMA-TINT switch applies forward bias to the switching transistors; driving them to saturation to connect phase-shift networks L2-R9 and C2-R8 into the circuit and widen the demodulation angle. This changes the amplitudes of the drive signals to the R – Y and B – Y from their normal levels. Now, a phase error tending to make purple faces produces less X-drive to the R – Y amplifier and little or no Z-drive to the B – Y amplifier. This causes flesh tones to shift into the orange region where they are more acceptable.

Phase error tending toward greenish yellow faces when the demodulation angle is 100° will, with atc, reduce the X-drive to the R – Y amplifier a little while the Z-drive to the B– Y amplifier is greatly increased. This shifts the fleshtones into the orange range.

Fig. 7 shows the Perma-Tint circuit in the D14-12 chassis. Activating the atc circuit drives the X and Z phase switching to saturation, thus inserting the phase-shift networks across the emitters of the X and Z demodulators.

Like the other circuits discussed here, the RCA AccuTint atc circuit alters the R – Y and B – Y demodulation axes and, in addition, reduces the amplitude of the R – Y signal for better fleshtone rendition. The basic AccuTint circuit is in Fig. 8.

When the ACCUTINT switch is placed in the ON position, an additional phase-shift network (8.2 μH shunted by 56 ohms) is switched into the circuit to shift the phase of the 3.58-MHz CW signal fed to the B – Y demodulator. The shift in the R – Y signal results from detuning of the 3.58-MHz transformer as the added network is connected across its secondary. The change in the B – Y axes is slight but is away from the Q axis so as to prevent the Q signal from contaminating the fleshtones.

The 8200-ohm resistor switched across the B – Y demodulator output causes the output of the B – Y amplifier to fall to approximately 80% of the R – Y signal level. The B – Y output is 120% of R – Y when atc is turned off.

The AccuMatic circuit's operation is similar to AccuTint while optimizing the COLOR and TINT controls by sharply restricting their operating ranges. Figure 9 is the basic AccuMatic circuit. The switch is shown in the OFF position. Section C applies –11.2 volts to the anode of D1, driving it to saturation and grounding the junction of C4 and L4. Section D of the switch ties together the kine-driver emitters through 150-ohm resistors.

When the atc is turned on, the bias is removed from D1, cutting it off to switch L4 and C4 into the circuit. This changes the phase and amplitude of the 3.58-MHz signal to the B – Y demodulator. Section D modifies the gain of the blue kine-driver by disconnecting it from the others.

Sections A and B of the atc switch set the range of the COLOR and TINT controls. When turned off, both controls have a very wide range. When atc is on the range of the controls is severely limited—allowing only minor deviations from the optimum setting.

For example, with atc turned off, the TINT control's range is from deep green through deep purple as the resistance from pin 2 of the demodulator module to ground is varied from 35,000 to 10,000 ohms. When the atc is on, the resistance in the tint control circuit has a maximum of around 27,000 ohms and a minimum of 22,000 ohms, thus limiting tint adjustments to the range of normal fleshtones. **R/E**

ANNUAL INDEX
(continued from page 63)

*Construction articles: † part of larger article, ER (equipment report), NC noteworthy circuits, Corr (correction), CI (service clinic); P (programmed)

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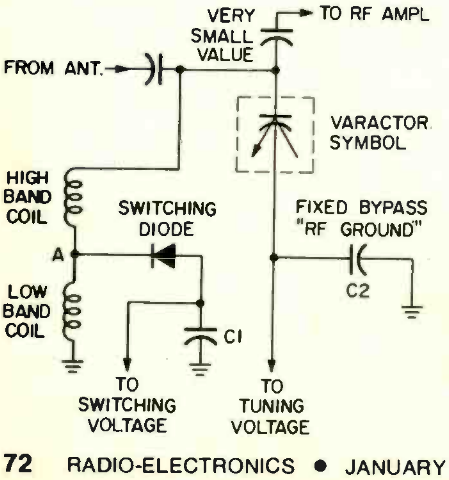
Switching diodes for TV front ends

Solid-state diodes can replace the mechanical switches in TV tuners

JACK DARR
SERVICE EDITOR



LAST MONTH, WE TALKED ABOUT VARACTOR diodes for tuning TV sets without any mechanical switch contacts (except for a couple of very simple ones.). We mentioned another one: the "Switching Diode". Now let's see how *this* little monster works. It's really pretty simple, if you remember how all diodes work!

Once again, we're using the principle of controlling ac (tuned) circuits with dc voltages. Properly designed, they will not have any effect on each other. Let's go back to the basic characteristics of all diodes. "All", though these will probably be germaniums, since these do have a lower forward voltage drop than silicons.

If we apply a forward bias to a diode, which makes it conduct current, (– to cathode, + to anode) the thing becomes a "closed circuit". So, we could say that it was a closed *switch*. If we apply reverse bias to the diode, (– to anode, + to cathode) it stops conducting and becomes an open circuit. (In practical circuits, of course, there will be a very small capacitance, and perhaps a very high resistance—the "back-resistance" of the diode—but this can be taken care of in the design of the circuit, by "allowing for it".)

We can use this device as a "No-moving-parts" switch, by simply applying either forward or reverse bias to it! The diagram shows a simplified, basic circuit of one stage of a TV tuner using this type of switching between high and low vhf channels. (This happens to be the rf input, but all of the rest will look the same.) Remember, in this we will run into the combination of "ac and dc effects", but don't let 'em confuse you. They actually have no effect on each other.

The coil is the same as that used in those all-too-familiar "switch-tuners" (incremental-inductance type). For tuning Channel 2, the lowest low-channel, the whole coil is in-circuit. Here, this would be both "low" and "high" coils. To get to a higher-frequency channel, we simply short out parts of the coil with a selector switch. On Channel 13, all we have left is one miserable little half-turn of wire.

In this one, we have a single varactor diode, which tunes all of the high channels or low channels, with a single coil for each. It does this by varying the "turning voltage" on the varactor. The high-band coil is the top one in the diagram. The "low band coil" is both of them. We will call the lower part the "low-band coil".

Now, note the diode connected to the middle of the coils. This is it: the thing that switches the tuner from low to high bands on vhf. Let's see how. For low-band operation we want both coils in the circuit. So, we feed a high reverse-bias voltage (The "switching voltage") to the diode. This makes it a completely open circuit. And, C1 is not in the circuit at all. (Remember C1. This is the key part!)

To cover the low channels, 2 to 6, we vary the varactor dc voltage. This causes it to change capacitance, and away we go. To change to the high channels we have to get that high-inductance (comparatively speaking!) low-band coil out of there. As you all know, the high vhf channels work at such high frequencies that the "inductors" wind up (that wasn't intended as a joke, and it wasn't) as only a half-turn of wire apiece. We can't have those great big 4-turn low-band coils cluttering up the place.

We get rid of them, just as in the older tuners, by shorting them out. Only now, we short them all at once. How? By connecting a good big *bypass capacitor* from the junction of the two coils to ground! That's why I told you not to forget C1! It is actually a feed-through capacitor, but it is a 0.001-μF unit that is a very dead short to vhf. So if we "close a switch" at point A, we have made this point a very good rf ground, and now we have nothing but the high-band coils left in the circuit. The varactor can tune these coils (sic) to any desired high-channel, by varying the dc tuning voltage.

How can we "close the switch"? By applying a high forward bias to the *switching diode*. When we do this, it conducts heavily, and becomes a nice fat short-circuit, switching the capaci-

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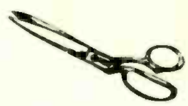

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tance of C1 from the center of the two coils to ground, and there we are.

If anyone's interested, we can use the same varactor for tuning both high and low bands. We simply feed it more or less bias voltage. Remember, last month we said that a typical varactor could be changed from about 2.5 pF to 12 pF simply by changing the dc tuning voltage from 0.5 volt to +28 volts. With properly designed coils, this much change in capacitance is plenty.

There you have it. Simple, huh? If we remember the basic principle of operation we can get along very nicely with the latest model tuners. In fact, they ought to be a lot *easier* to work with than the older models! For instance: a tuner works fine on the low band, but not at all on the high band. The switching-diode is open, or the switching-voltage is not there. The whole coil is in-circuit at all times. If it was just the reverse; high band fine, low band nothing, the switching-diode is probably shorted.

In other words, it'll be just as it is now—if we know how the thing works, we'll have a lot less trouble finding out why it doesn't work!

Reader Questions

TRIPLE TROUBLE

Since this happened to me, no initials! This CTC-24 chassis came in from another shop, after having a flyback replaced. Made a picture, but had a very distinct "drive-line" looking thing right in the middle of the raster.

After some checking, I found the lead to terminal 1 of the flyback hanging open! Ah ha! Hook this up, and what happens? No raster. Cathode current of the 6JE6 jumps to 400 mA (it was slightly low before) and the high voltage goes down. Eventually, I found that the (original) focus transformer was shorted. Replace this, and things looked much better.

Second problem: After this, the cathode current of the 6JE6 was OK, but the horizontal efficiency coil refused to dip, and the coil ran very hot. Replacing this helped. Now it would dip, and ran much cooler. Evidently, it too had a small (but sufficient!) short. Now things were better except for a tendency of the picture to jitter and flicker. Looked like an intermittent arcing somewhere in the high voltage circuit.

The high-voltage rectifier socket and leads were checked. All OK of course. So I checked the focus rectifier by replacement. No help. Scope waveforms around the hv circuit, boost, etc. showed a pronounced jitter. Finally, we got to the boost-boost. This was very low, and very unstable. In fact, it read only about 900 volts instead of the normal 1100 volts, although the boost voltage was up to normal.

Taking the boost-boost rectifier out, I found that I could get a reading on an ohmmeter! Forward resistance was only about 2–3 megohms! A new one read a very high resistance in the same direction, and the back resistance was absolutely infinite even on the 0–1000-megohm scale. This cured the problem. Evidently, this rectifier was arcing internally, and had partially shorted.

VERTICAL LINEARITY PROBLEM

I've two or three problems in this Zenith 24NC31Z! It has a very odd vertical linearity problem, and those resistors across the degaussing coil are burning up! There seems to be a short somewhere, but I can't find it.—O.M., Brooklyn, N.Y.

Step 1: replace those "resistors" across the degaussing coil. These are not standard resistors, but a VDR (*V*oltage *D*ependent *R*esistor) and a thermistor.

There is a good chance that this set has been visited by lightning not too long ago! If so, these parts seem to be the ones most frequently damaged.

If these are bad, you can get some weird effects in your power supply, because of the distortion of the ripple waveform. I have seen this happen. Replace the VDR/thermistor combination, and see if your other trouble doesn't clear up.

FOCUS RECTIFIER BURNOUT

I've put three focus rectifiers into a Philco-Ford 18MT70 inside of the last three weeks! I'm using good parts and I can't find a sign of a leakage or short anywhere in the focus circuit. Something is blowing these out.—J.H., Grand Forks, N.D.

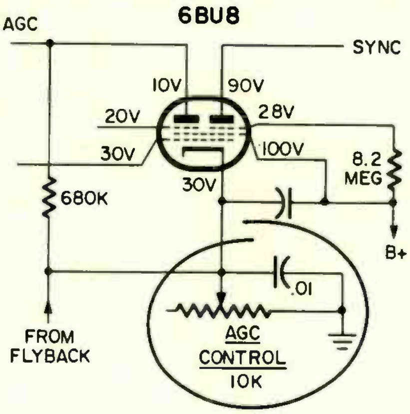
Most likely suspect, an intermittent arc from the focus circuit to ground. Check the terminal strip where the focus rectifier is mounted. We have found troubles here in the past. If you have had an arc at this point, the terminal strip will char and make a carbon path from the terminal lug which is much "closer to ground". If the humidity goes up, etc . . . you can get another arc-over that will destroy the new rectifier.

Replace the terminal strip. Alternate; tack a small one to the original lug, to get the focus rectifier farther away from the ground. Paint it with corona dope, for luck.

NO HORIZ SYNC?

I've an old Zenith, a 16D21Q, with no horizontal sync. The video waveform on the output looks funny, and the dc voltages around the 6BU8 tube are all away too high. Tried new 6BU8, no help.—P.Q.R., Pine Bluff, Ark.

Check continuity on the agc control! If all of the voltages on this tube are high, something is wrong in the bias, and the only thing in the cathode circuit



is that control! The diagram shows it. If this is open, so that your cathode voltage is too high, this will not only upset sync, but agc. This could account for your "funny-looking" video waveform; probably clipping sync in the i.f. besides the other troubles.

ARE THEY THE SAME?

I've got a Philips stereo, model 22GF446/072, and the output stage transistors have blown. I got a schematic from the factory, and they seem to show the output pair as being the same. These are type AD-161 and AD-162. Parts list says "AD161/162, Part No. 4822-130-40349". However, the schematic shows them as a pnp and npn!

Help, help. Do you know of a substitute for these?—E.S., Philadelphia, Pa.

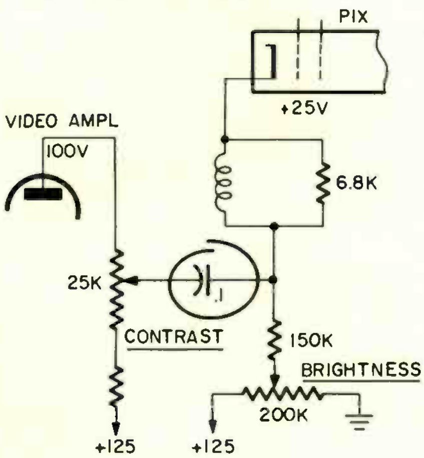
From the schematic you sent, and the voltages given, this is a complementary-symmetry output pair and not a "totem-pole" or "stacked" circuit. The last does use identical transistors. These are germanium, apparently. I did find one listing of the AD-161, which is an npn germanium. So the AD-162 would have to be a pnp germanium type.

The only thing I can find is a Sylvania ECG-131 for the pnp, and an ECG-155 for the npn. The only difference I see is a slightly higher wattage for the 155.

PICTURE BLOOMS

When I turn the contrast control up on this GE S-2 chassis, the picture *blooms. It gets much brighter, then expands, then suddenly shrinks and dims! I've seen blooming before, but this doesn't look like it. The high voltage seems to be OK.—A.G., New York City.*

Read the cathode voltage on the picture tube with the contrast control turned down. Turn the brightness control up and down; it should vary this voltage, and kill the raster at about a +50 volts. A normal-brightness picture should read +25 volts.



Now turn the contrast control. The cathode voltage should not change. If it goes up and down as this control is turned, you have probably got a shorted video coupling capacitor. This is the 0.1-μF between the contrast control slider and the pix tube cathode. This will allow the higher dc voltage from the video amplifier plate to leak over to the cathode of the pix tube.

NO BOOST-BOOST VOLTAGE

I got this RCA CTC-24 in with a bad picture; weak, low brightness, etc. Finally found that the boost-boost voltage, instead of 1100 volts, was only about 850, which is the same as the boost that feeds it.

I replaced the boost-boost rectifier, with a new RCA part. Now, instead of having 850 volts on the boost-boost, I get only 300 volts! I can't find a short anywhere in the screen controls, which is about the only load on the thing.—H.L., Tucson, Ariz.

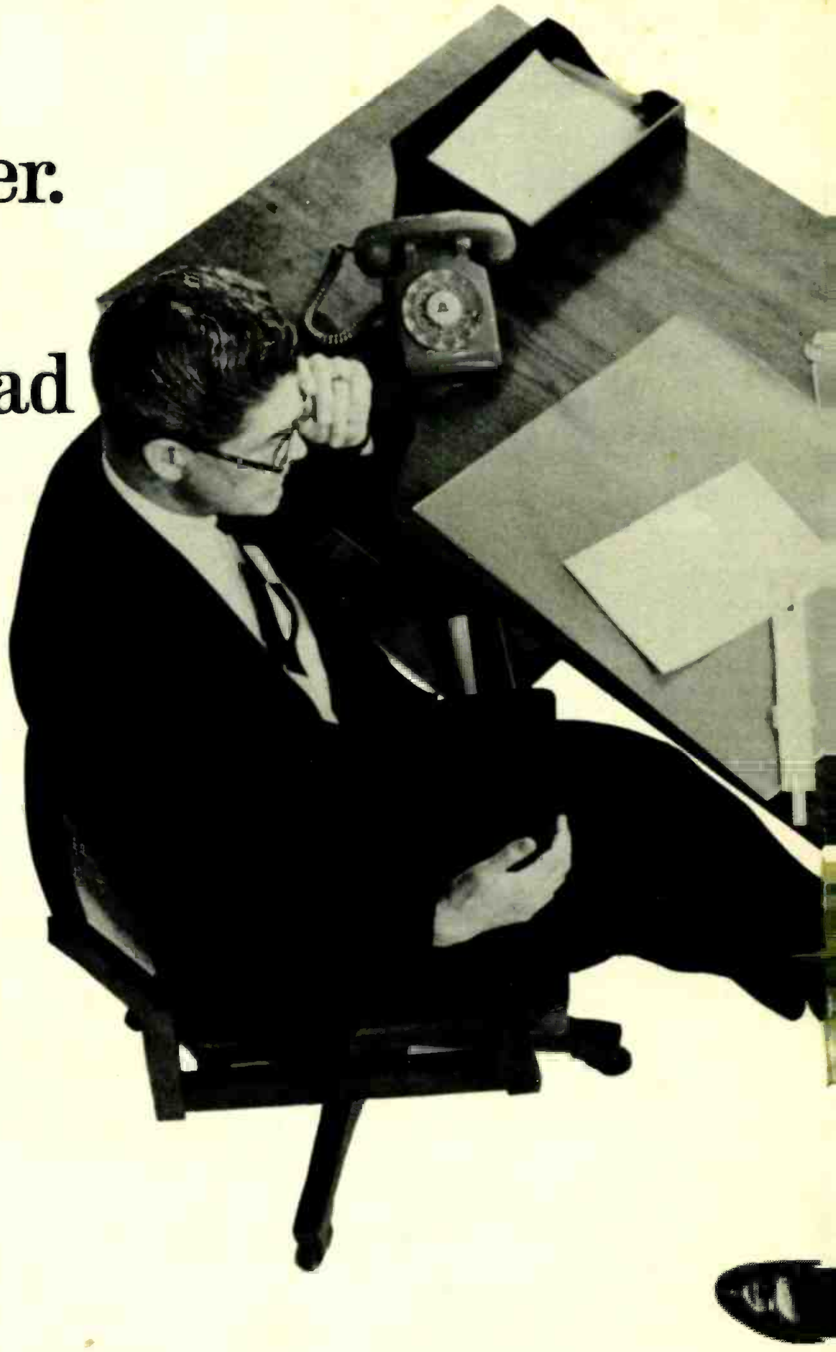
Grasp your long-nose pliers firmly in one hand and soldering iron in the other. Now take the new rectifier out, reverse it, and put it back. I think your boost-boost will come back! The newer RCA rectifiers used for this are not marked with polarity. However, the silver end of the thing is the cathode! (I will never tell anyone where I got this little gem of information, but believe me it's based on actual experience!

HELPFUL HINT, ADMIRAL COLOR

Some time ago you replied to a reader about an intermittent short in

(continued on page 99)

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

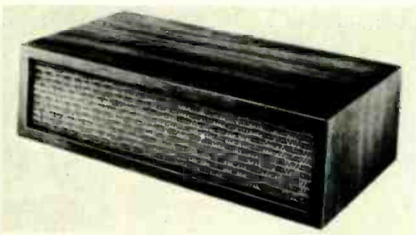
Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule. You study with the assurance that what you learn can be applied to the job immediately.

CREI Programs cover all important areas of electronics including communications, radar and sonar, even cable TV engineering. You're sure to find a program that fits your career objectives.

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 101 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

SECURITY SYSTEM, *the Protector,* incorporates features of a commercial ultrasonic electronic security system while being small and designed with wood grain cabinet and fabric front for home or office use. The unit emits ultrasonic waves which blanket about 300 square feet. Once an intruder enters the protected area he breaks the wave pattern and triggers the alarm. Any type of alarm, sirens, lights, bells, can be attached to the *Protector.* Special accessory alarm circuit permits the installation of smoke, fire and gas detectors or peripheral alarm systems.—**Radatron Corp.,** 2424 Niagara Falls Blvd., North Tonawanda, N.Y. 14120.

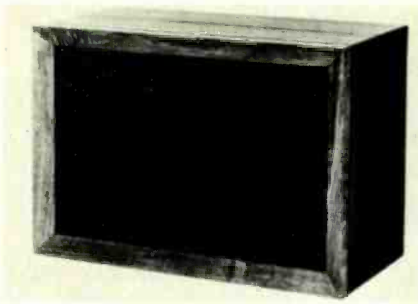


Circle 31 on reader service card

4-CHANNEL CONVERTER *Iras Multisonic System* converts standard 2-channel recorded material into 4-channel surround sound. Converter connects between amplifier outputs and speaker systems. Can be used with Dynaco and E-V encoded materials. Unit samples the two-channel material and directs these signals according to their phase, frequency and amplitude to your speakers. $59.95.—**Iras Multisonic,** 774 Woodruff Pl. West Drive, Indianapolis, Ind. 46201

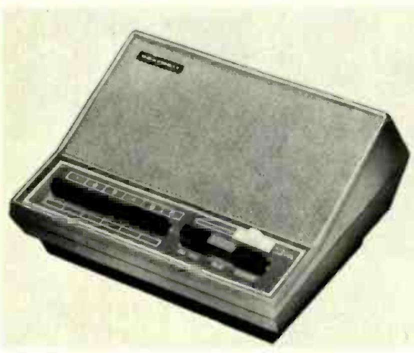
Circle 32 on reader service card

INTRUSION ALARM, *model RA-3.* This coincident intrusion alarm system virtually eliminates false alarms because both ultrasonic and ultra-high frequency sensors must be triggered to initiate the alarm. Unit has individual sensitivity controls for each mode, optional remote area ultrasonic sensor, provision for connection to a closed loop perimeter system. Operates on 24 volts ac from transformer. Comes with self-contained, rechargeable standby power pack. Maximum range for ultrasonic is six to 40 feet, depending upon room acoustics and humidity; for microwave the same, depending on area furnishings and construction.—**Bourns Security Systems, Inc.,** 681 Old Willets Path, Smithtown, N.Y. 11787.



Circle 33 on reader service card

HOME INTERCOM SYSTEM, *GD-110 series.* Room-to-room communication, monitoring, and front-door security combined in the kit which is based on the six-channel master unit, *GD-110* (shown), to which can be added other masters, the Indoor remote unit, *GD-120,* and the outdoor remote, *GD-130.* The master plugs into a standard 120 or 240 Vac home outlet. The master station provides push-buttons to talk to all stations at once, to provide 2-way communication with any pre-selected remote, and to hold open the listen and talk mode for extended conversation. Master intercom *GD-110* is $39.95 in kit form; indoor remote *GD-120* is $12.95; outdoor remote *GD-130* is $9.95.—**Heath Co.,** Benton Harbor, Mich. 49022.



Circle 100 on reader service card

WIRELESS HEADPHONE, *Freedom Fone, model FF-1.* This headset has built in induction receiver to give the listener freedom of movement anywhere within the range of the transmission induction loop. The *FF-1* is a complete transmission and receiving system, consisting of two sections, the solid-state receiver, built inside the headphone's ear cup, and the transmission system. Full instructions for an easily constructed Induction loop included. Frequency response of 70-12,000 Hz. Output level 30 mV. $29.95.—**Superex Electronics Corp.,** 151 Ludlow St., Yonkers, N.Y. 10705.

Circle 34 on reader service card

TELEPHONE PICKUPS, *models 30-6000 and 30-6002.* Both are low-impedance magnetic pickups designed to be used with most transistor tape recorders and amplification devices. The *30-6000* is a conventional suction-cup type unit and may be attached wherever a reasonably strong magnetic field is present in the telephone—at top of handset or adjacent to coil block on side of the phone base. The *30-6002* slips over earpiece of phone handset. Because the unit is molded to fit glove-tight, there is no "wrong" position for it, and it minimizes extraneous noise

pickup. Both units terminate in a miniature phone plug. *Model 30-6000* is $2.45 and *30-6002* is $2.90.—**GC Electronics,** 400 South Wyman St., Rockford, Ill. 61101.

Circle 35 on reader service card

TOOL KIT, *model K-77.* 72-piece tool kit stores screwdrivers, pliers, wrenches, voltage tester, soldering aid, inspection mirror and other tools which are included in kit. Designed for repairmen, service

technicians, field engineers. The kit, complete with attache case, is $139.50. Attache case alone is $39.50.—**Telvac Instrument Co.,** 14614 Raymer St., Van Nuys, Calif. 91405.

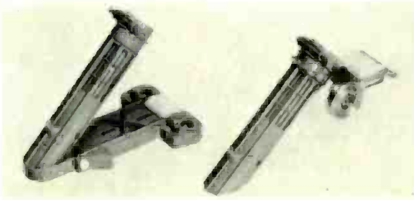
Circle 36 on reader service card

DIGITAL PANEL METER, *model 1291.* 3-½ digit economy DPM features full scale readout of 1000, 100% over-range (1999), an accuracy of 0.1% full scale ±1 digit with a minimum full-scale range of 100 mV or 10μA, dual-slope integration, high input impedance (50 megohms on 100 millivolt range). Repairable circuit boards (not potted), complete chassis removal from front of

panel. Takes only 7 sq in. of panel space (4 x 1.75 in.) with a depth behind the panel of less than 1.5 in. $99.75.—**Weston Instruments,** Inc., 614 Frelinghuysen Ave., Newark, N.J. 071 i 4.

Circle 37 on reader service card

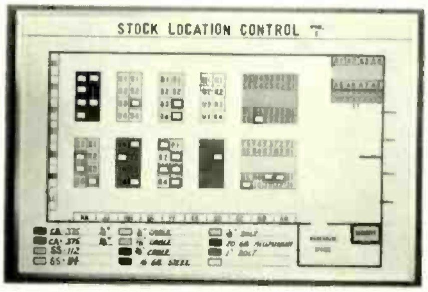
SOLDERING IRON HOLDER, *Idle-Rest,* accommodates the *Loner* soldering tool. Designed to conserve heat energy in the internal controlled environment. When in-



serted into the *Idle-Rest*, the *Loner* is safe to transport or store immediately after use. Available in base-mounted version for traveling technician and bench mounted type for permanent installations. Tip and element life increased due to inner ceramic thermal blanket. Durable polycarbonate exterior remains cool. $12.50.—**Edsyn Inc.**, 15954 Arminta St., Van Nuys, Calif. 91406.

Circle 38 on reader service card

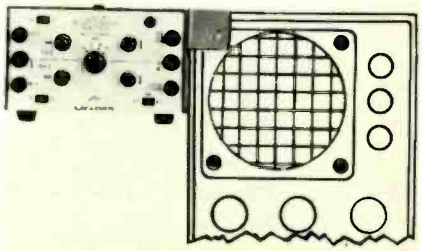
WRITE-ON BOARD, *Magnetec*. Magnetic board of 9-ply white laminated board with satin non-glare finish is an addition to the visual communications line. Write on it in color, eliminate chalk. Use magnetic accessories, project slides, films and trans-



parencies on white glare-free screen. Combine handwriting, magnets and slides. Colorful markers available in water color and semi-permanent fluid. Combine two types for graphs, maps, charts and diagrams. Available sizes 2 ft. x 3 ft. for $48.00; 3 ft. x 4 ft. for $89.50; 4 ft. x 6 ft. for $159.50. Special size boards (up to 4 ft. x 8 ft.) available at $9.00 per sq. ft.—**Methods Research Corp.**, 105 Willow Ave., Staten Island, N.Y. 10305.

Circle 39 on reader service card

ELECTRONIC SWITCH, *model LS-5*.Solid-state 4-frequency converts a single-trace oscilloscope into dual trace. Switching frequencies of 1.5, 5, 30 and 50



kHz. Features an "instant-on" capability and a triggered output to facilitate fast and stable synchronization of observed patterns. Mounting bracket for direct placing of unit on any scope. Frequency response is dc to 300 kHz and 2 Hz to 300 kHz on ac. Two channel inputs, ac or dc switchable for each channel. Vertical sensitivity is 0.05 V/cm and input impedance is 1 megohm at 40 pF. 115 V/50-60 Hz power supply. $69.95.—**Leader Instruments Corp.**, 37-27 27th St., Long Island City, N.Y. 11101. **R-E**

Circle 40 on reader service card

new literature

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service card on page 101 and circle the numbers of the items you want. Then mail the postage-paid card.

TEST EQUIPMENT CATALOG, *BK-2,* for electronic servicing, school, lab and industrial applications. Presents 21 instruments including a mutual conductance tube tester, dc—10-MHz triggered-sweep scope, solid-state digital multimeter, and a semiconductor curve tracer. Probes and adapters are also featured. Full specifications and application information, charts and patterns.—**Dynascan Corp.,** 1801 W. Belle Plaine Ave., Chicago, Ill. 60613.

Circle 41 on reader service card

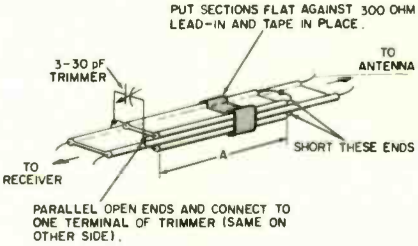
INDUSTRIAL CATALOG, *1972, No. 720.* This 616-page catalog of electronic parts and components provides tab margin index for locating items, and a manufacturer's index with details on the various suppliers by name and by items. Specifications, descriptions and illustrations cover IC's, tubes, timers, resistors, capacitors, sockets, plugs, fuses, wire and cable, and other items. A major section includes test instruments, audio and public address equipment, industrial chemicals, tools and solder equipment, technical books, etc. $2.00; free with order; free to request on company letterhead.—**Allied Electronics,** 2400 W. Washington Blvd., Chicago, Ill. 60612. R-E

Circle 42 on reader service card

technotes

HAM AND FM STATION TVI

A tuned interference trap like that shown in the diagram is very effective in minimizing picture interference caused by a strong amateur radio or FM station located close to the TV receiver. It consists of two one-quarter wavelength shorted stubs with the open ends paralleled and tuned by a small trimmer capacitor. The lead-in is sandwiched between the stubs as shown.

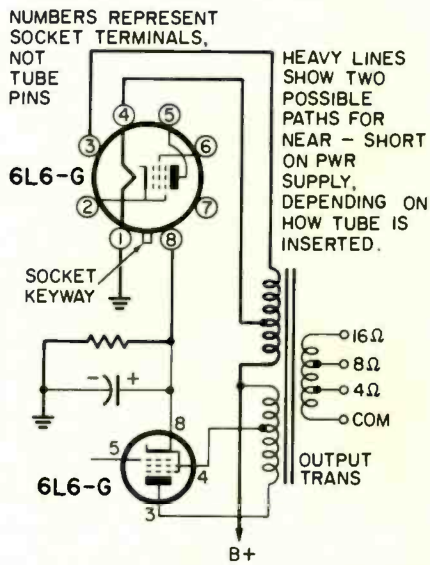


The actual physical length of the stubs (A) required is somewhat shorter than determined by the formula $A = (2952 \times V)/f$ where A is length in inches, V (velocity factor) is 0.82 for 300-ohm twin lead and f is frequency in MHz.

Adjust the capacitor for minimum interference, slide the trap along the lead-in until most effective position is found and tape in place.—*Emerson Field Service Bulletin*

ULTRA-LINEAR AMPLIFIER

Recently I had to repair a Sargent-Rayment hi-fi amplifier dating from the mid-1950's. It had a push-pull ultra-linear 6L6 output stage. The trouble: a few seconds after the amplifier was turned on, a loud hum would issue from the speaker, and then the fuse would blow. My first thought was that the first or second electrolytic filter capacitor was shorted. So I



disconnected all the wires from the plus terminals and checked with an ohmmeter. No trouble. Rectifier internally shorted? No. I put the ohmmeter leads from the output transformer primary B-plus leads to ground. Almost zero ohms! Shorted output transformer?

I was already looking around the shop for a possible emergency replacement when something made me pick up the ohmmeter probe again. I touched it to one of the 6L6 plate terminals and pulled the tube out of its socket. The pointer swung up toward infinity. I looked at the tube. The center post on the base had broken off, making it possible to insert the tube in any of eight different ways! The tube had been plugged in so that the heater, normally between pins 2 and 7, was actually bridging either 3 and 8 or 4 and 1, either of which put a near short-circuit across the B-plus line. I reinserted the tube carefully, making sure it went in as it was intended to go, then resoldered the connections I'd disrupted and tried the amplifier. No hum, the fuse held, and the amplifier delivered 15 watts at clipping with 1 volt input. Problem solved. A new 6L6 was installed so the trouble would not recur the next time the owner decided to test his tubes.—*Peter Sutheim*

REPLACING 15MP22

Early production runs of the G-E model M235GWD-1 (G-1 chassis) portable color receivers used a 15MP22 picture tube that requires 640 volts on the red, blue and green screen grids. Later, a 15MP22 with a modified gun was introduced. This tube, a current replacement type, requires only 450 volts on the screen grids.

Both tube types are designated 15MP22. To identify early and late types, look at the neck of the tube near the base. Early 15MP22's have *blue* glass rods supporting the electron guns inside the tube. Later versions of this tube have *green* support rods.

OBJECTIONABLE SOUND IN HORIZONTAL OUTPUT

Monochrome and color television receivers generate sound at the fundamental and subharmonic of the horizontal sweep frequencies. When this sound level becomes objectionably loud, the following steps should reduce the sound.

1. Substitute several tubes for the horizontal output, damper, regulator (if used) and high-voltage rectifier, one at a time, to see if the sound level is reduced. An alternate method is to hold an insulated rod against the glass envelope of each tube to see if it will dampen the sound. Replace tube(s) which produce(s) objectionable sound.
2. If receiver has a pincushion-correction circuit, slightly reduce pincushion amplitude control and note if objectionable sound is reduced. If it is, tighten mounting nuts or place toothpicks between coils and core.
3. With an insulated rod, exert pressure on all mounting screws, rivets, brackets and hinge pins on the high-voltage cage and door. Any part causing sound can be corrected by applying a dab of Silastic RTV silicon rubber, Admiral part 17199-3, or by adding a tab of adhesive tape.
4. To eliminate sound caused by the horizontal output transformer, carefully move transformer away from its mounting just far enough to insert a rubber spacer and grommets over the transformer mounting screws. Carefully reinsert transformer mounting screws into side of cage. Mounting nuts should be tightened sufficiently to insure secure fit, using care not to over-tighten.
5. To insure good operation and customer safety, it is recommended that high-voltage adjustment and safety checks be made as instructed in the service manual.—*Admiral Service*

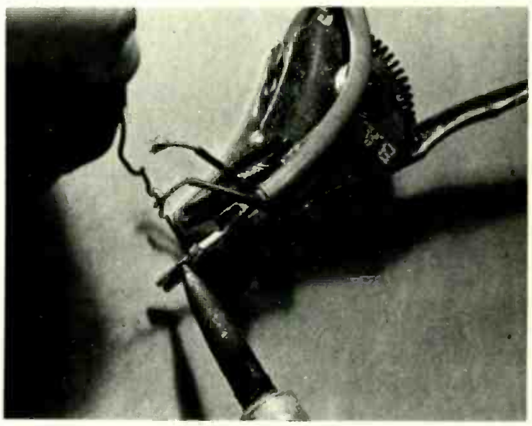
try this one

Scope Probe Holder

Many oscilloscopes have bezel mounting studs with holes through their centers. The holes are just the right size to accept a standard banana plug. If you are tired of loose prods when you are not using the scope, try this one: Attach a banana plug to a spring clip (capacitor mounting clip, a pegboard tool-holding clip, plastic cable assembly clips, etc.) Then just plug the clip into any one of the four bezel studs and hang your leads on it.—*Basilio Alferow*

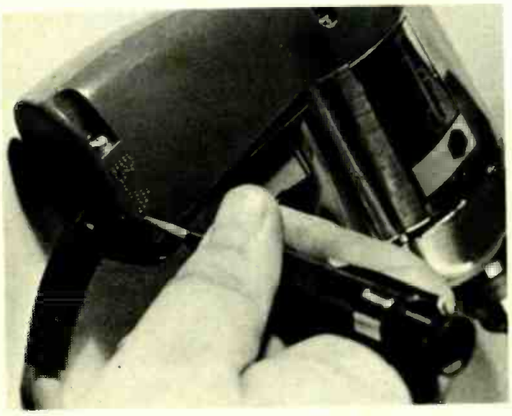
Wire Stripper—A Third Hand

A pair of automatic wire strippers makes a useful spring-loaded clamp to hold small parts while they are being soldered or assembled. The spring pressure is high and the stripper heavy enough to hold securely such parts as alligator clips, banana plugs, phono plugs, small circuit boards, etc.—*Basilio Alferow*



Improvised Engraving Tool

An electric engraving tool may be too specialized an item to purchase when there aren't many items to be marked. However, most well-equipped shops have an automatic center punch on the bench. Using the standard 5 by 7 dot matrix and the punch, it is simple and easy to mark tools and other items. Just set the punch to give a good impression on the sur-



face being used and in almost no time you'll have indelible markings.—*Basilio Alferow* **R-E**

50% OF US HAS COLOR TV SETS

According to an NBC estimate, 50.1% of all US TV households have color TV receivers—that's a total of 31 million color-equipped homes. And that means a lot of color-TV repair work for **Radio-Electronics** readers. The estimate comes from Allen R. Cooper, Vice President, Planning for NBC.

new books

INFORMATION TECHNOLOGY IN A DEMOCRACY, edited by Alan F. Westin. Harvard University Press, Cambridge, Mass. 6 5/16 x 9½ in., 499 pp. Hardcover, $12.50.

As part of a sociological study this book collects readings from various sources designed to show how computers and telecommunication systems are used to correlate data from large and complex organizations, and the benefits and dangers to the nation and the private person of expanded information technology, as it is used in governmental decision-making.—*MCL*

MONOCHROME ZENITH TV SERVICE MANUAL, by Harvey L. Swearer, 160 pp; ADMIRAL COLOR TV SERVICE MANUAL, by Homer L. Davidson, 160 pp; and RCA MONOCHROME TV SERVICE MANUAL, by Carl H. Babcoke, 176 pp. Tab Books, Blue Ridge Summit, Pa. 17214. All are 8½ x 11 in. Vinyl cover, $7.95, softcover, $4.95.

Three more manuals from Tab for brand name color and black-and-white TV set servicing. These contain complete service data and schematics on a multitude of Zenith, Admiral and RCA sets, giving the information necessary for adjustments.

RCA HIGH-SPEED, HIGH-VOLTAGE, HIGH-CURRENT POWER TRANSISTORS—FOR AMPLIFICATION, SWITCHING AND CONTROL (Technical Series PM-81). RCA Solid State Div., Somerville, N. J. 08876. 5¼ x 8 in., 96 pages. $2.00.

This manual provides a basic understanding of the theory and application of high-speed, high-voltage and high-current power transistors. It covers physical theory, structures, geometries, packaging, SOAR (safe-operating area) considerations, thermal fatigue and the operation and requirements of power transistors in typical amplifier, switching and control applications. Charts are included to enable the user to select the optimum transistor for a variety of commercial, military and industrial applications.—*RFS*

FUNDAMENTALS OF ELECTRONICS, by E. Norman Lurch. John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. 6¾ x 9¼ in., 829 pp. Hardcover, $12.95.

Solid-state and electron-tube devices, silicon controlled rectifiers and triacs, decibels, auxiliary components, a/c circuits, transistor-bias circuits, and R-C coupled amplifiers are included in this basic text for the technician who plans to work in electronics.—*MCL*

MONOCHROME TELEVISION SERVICING COURSE, prepared by M. N. Beitman. Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 160 pp. 8½ x 11 in. $3.00.

A knowledge of the fundamentals of electronics and some radio service experience is necessary. The text concentrates on faults observed on the picture tube, for practice in evaluation and servicing. Covers tube and transistor sets. Vol. I of a two volume set. Vol. 2 covers color servicing.—JW

TV TROUBLE DIAGNOSIS MADE EASY, by Art Margolis. Tab Books, Blue Ridge Summit, Pa. 17214. 5½ x 8½ in. 256 pp. Hardcover, $7.95, softcover, $4.95.

New TV servicing guide for solving troubles encountered in either color or black-and-white receivers. Arranged so technicians can compare the symptoms of a defective set with those pictured or described to pinpoint the trouble to a specific circuit or component quickly. Over 200 illustrations. **R-E**

APPLIANCE CLINIC

(continued from page 22)

replace it with one of the new 3-pin type. The circuit can be checked on the schematic, and the new line cord connected so that the chassis side always goes to the ground side of the line. (In all properly-hooked up ac power lines, one side is *always* ground and the other hot—in 120-volt services.)

There are several types of polarized plug/socket combinations for 120-volt service. However, the new 3-pin types are much better, for there is no way that you can use them without getting it hooked up properly. Although there are "adapters" which will let these be used in the older receptacles, don't use them except in emergencies.

The 3-wire line cords can be added to any appliance which didn't have it originally. When you do this, be sure to check it out with the color coding. Black and white wires go to the motor, heating element, or anything connected to the ac line. The third wire, the green one, goes to the round pin of the plug ("Round For Ground") and must always be connected tightly to the case of the appliance!

JACK DARR
SERVICE EDITOR

next month

FEBRUARY 1972

- **Replacing Electrolytic Capacitors**
  This component is probably the most troublesome part in any electronic circuit. Locating the bad one and finding a proper replacement is easy—when you know how. R-E's expert—Service Editor Jack Darr—presents the complete solution.

- **Troubleshoot Faulty Transistors Fast**
  Simple techniques to find, identify and replace troublesome transistors with a minimum of effort.

- **Build A Dual Clock Generator**
  New Don Lancaster project provides a dual-signal source for audio testing, digital logic and electronic music synthesis.

- **Scope Analysis of Audio Distortion**
  Another way to use your scope to solve those tricky complaints of "distortion" in an audio amplifier.

- **IC Binary Counter**
  Digital demonstrator shows how the computer counts. An easy way to gain an insight into binary counting and logic.

PLUS:
Jack Darr's Service Clinic
IC Poupourri
Appliance Clinic
Equipment Reports

MODULAR TV
(continued on page 37)

vicing. Fig. 21 shows two Hitachi boards folded out. Teflon fasteners hold them in place until you exert pressure. Fig. 22 is a 9-inch Trinitron chassis of Sony's, showing how side panels drop down for repairs.

Figure 23 shows minor modularizing in a Crown color chassis. The board the picture-tube socket is mounted on contains (on the other side) components for the final picture-tube drive.

Perhaps the ultimate step in modular color is the all-integrated-circuit receiver. Closest to that I've seen is a prototype Sanyo hopes to market soon. Sixteen IC's plug into five printed boards, which fit into a box like circuit cards in a computer. The only transistors go in the tuners, the first video i.f., the last three video amplifiers, horizontal and vertical outputs and vertical driver, and a voltage regulator. The idea is fascinating.

So . . . as you can see, TV makers on both sides of the ocean trend to modules. Hardly anyone has more than one or two chassis in modules yet, but wait till next year. **R-E**

market center

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TELEVISION Broadcasting Employment Information; "How to Break In," $2.00 **I.Q. ENGINEERING,** Box 374, Canoga Park, Ca. 91305

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ADVERTISING INDEX

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Diodes Isolate Two Power Supply Outputs

Simple techniques let you use a few ordinary silicon diodes to isolate two outputs of a single power supply

You often need two independent dc supplies when only one ac winding or source is available. You *can* have two by using the redundant diodes (D2 and D3) which are used for isolation (see Fig. 1-a). (Fig. 1-b shows the circuit redrawn as it would appear in an equipment diagram.)

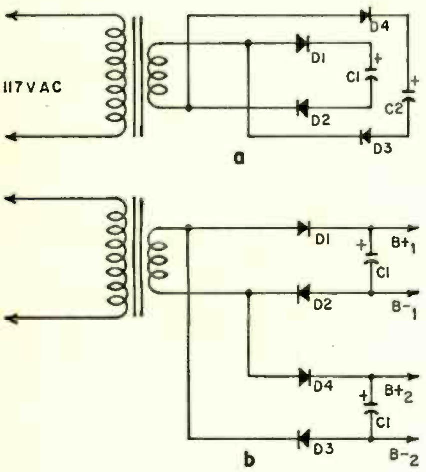

Fig. 1

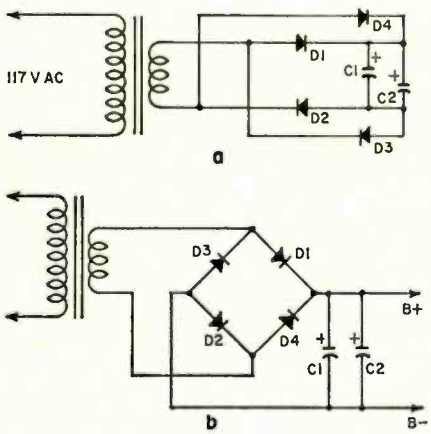

Fig. 2

A diode is in each lead of the filter capacitor even though only one is needed for rectification. The two supplies work on opposite halves of the ac cycle. While diodes D1 and D2 are forward-biased and rectifying, D3 and D4 are back-biased and isolating C2 from the ac winding and from C1.

The two supplies are independent and can be connected in series, parallel (Fig. 2-a) or used in separate parts of the same circuitry. If they are paralleled the circuit is the familiar full-wave bridge rectifier (Fig. 2-b) with the two capacitors in parallel.

When the supplies are in series as in Fig. 3-a, the negative of C1 is connected to the positive of C2 (or vice versa). They now form a full-wave voltage doubler (Fig. 3-b). Diodes D2 and D4 are now redundant. They are paralleled back to back and serve no useful

(continued on page 100)

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Circle 86 on reader service card

READER QUESTION

(continued from page 77)

Admiral color chassis such as the G13, H10 or H12. Here's another good possibility!

In the Non-instant-play versions they use a thermal switch, Part 77C160-3, for the degausser timing. Some of the turns of the heater-winding will short, causing the bimetal blade to overheat and warp. When the set cools, the contacts will open normally, but the warped strip keeps on its merry way and *grounds* to the case!

So when you turn it on again, the dc power supply is shorted to ground while the strip is heating! After a few seconds have passed, the strip heats, the short clears, and everything is fine. It will operate normally once the circuit breaker is reset.

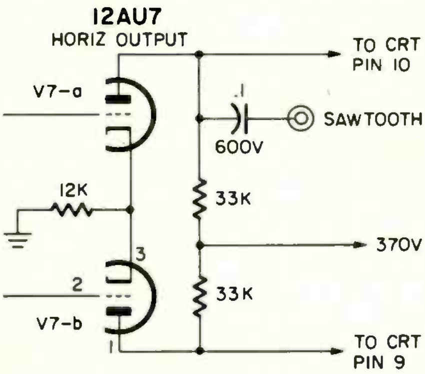
The cure is to replace the thermal switch. Use the later version, 77C160-4. Follow the instructions with it and tape up the heater lead.—Charles E. Koontz, Burlington, Iowa.

HEATH 10-12 SCOPE

I need a source of sawtooth voltage for testing flybacks, etc. I have a Heath IO-12 scope, and I think I can get it from that; seems as if I read an article somewhere about it.

If so, where would I get it, and how? J.L., Newark, New Jersey

You may have an early-run IO-12 Heath scope. The schematic I have on this instrument *shows* a jack for a hori-



zontal-sweep frequency sawtooth takeoff on the panel already (see diagram;. It is just a 0.1 μF capacitor, connected from the plate of V7-a, pin 6, which goes to a jack on the panel. Strangely enough, I can't find any reference to it in the assembly instructions, nor does it show on the completed panel. It could be a modification.

There should be room for this jack on the front panel, say just above the HORIZONTAL INPUT, or between the EXT SYNC and 1-V p-p CALIBRATING jacks at the bottom. This should give you all the sawtooth voltage you need. Be sure to use at least a 600-volt capacitor. R-E

DIODES ISOLATE POWER SUPPLY

(continued from page 97)

function.

The supplies can be used independently with loading of one causing no

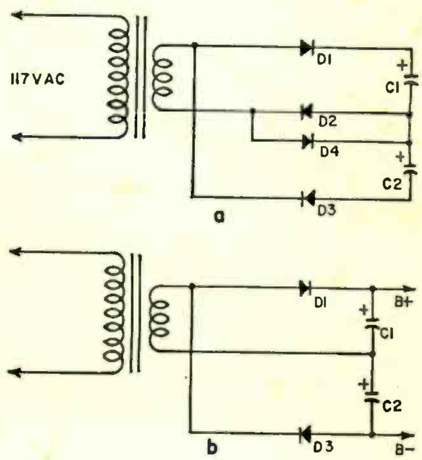
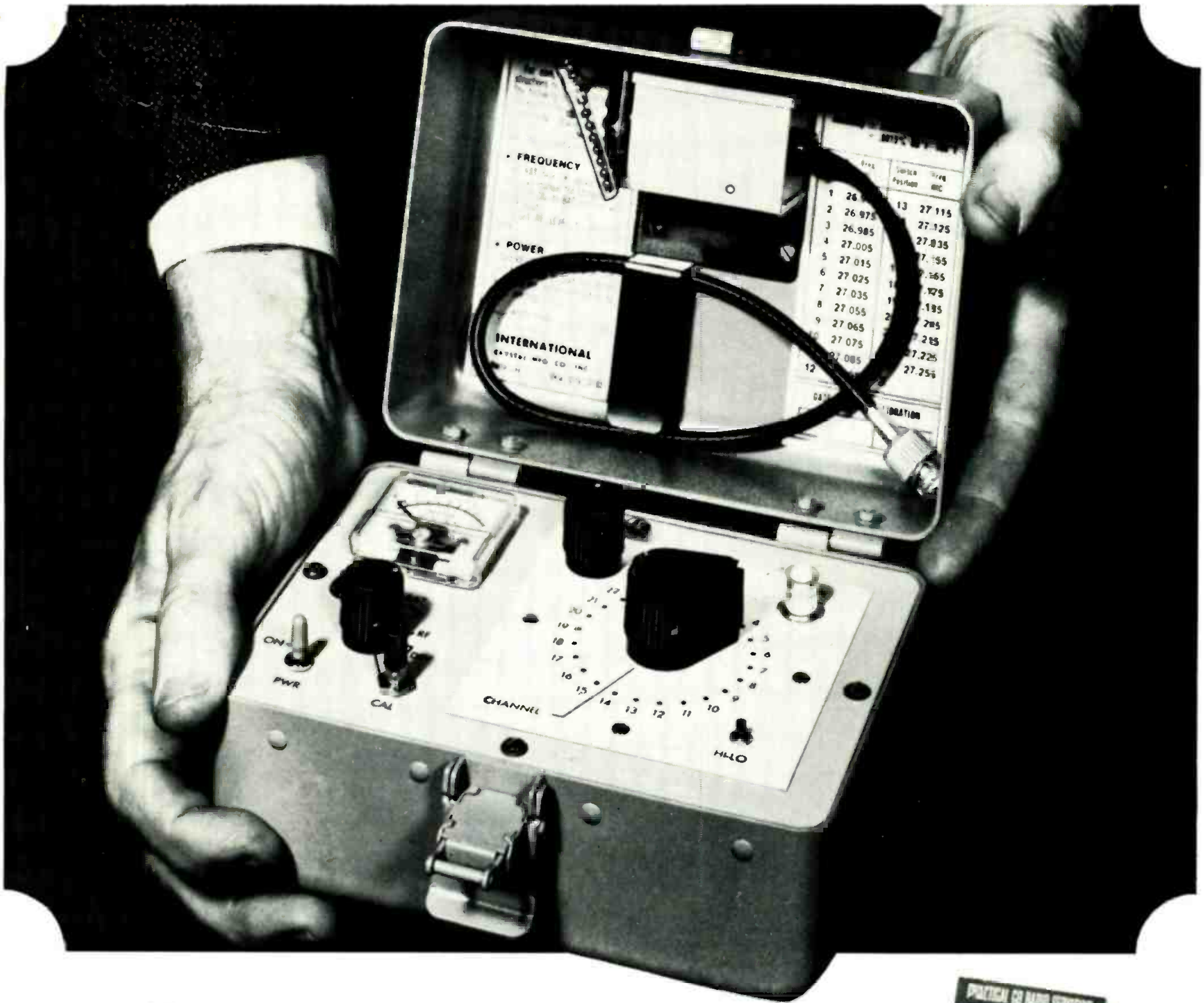


Fig. 3

disturbance on the regulation of the other since the transformer is used alternately by them. The degree of isolation depends on diode back resistance.

The supplies must be fed from an isolated source. The ac line cannot be used because one side is grounded.—*William R. Laitinen* **R-E**



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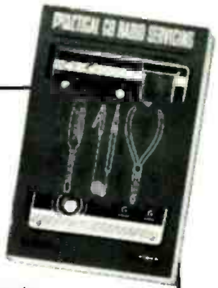

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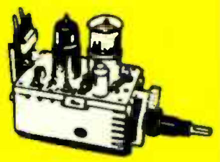
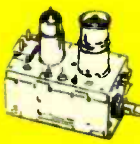
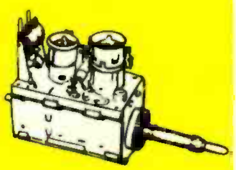
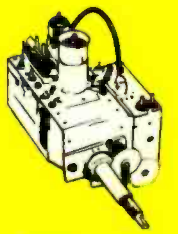
CR6XL	Parallel 6.3v	2½"	12"	41.25	45.75	10.45
CR7XL	Series 600mA	2½"	12"	41.25	45.75	11.00
CR9XL	Series 450mA	2½"	12"	41.25	45.75	11.00









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